

DRAFT STATE REVOLVING FUND
SRF PROJECT PLAN SUMMARY
MARCH 2024

Oakwood and Leib CSO Facility Improvements Project – SRF Project Plan



Prepared for:

Michigan Department of Environment, Great Lakes, and Energy





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Appendix A: Study and Conceptual Design Report

Appendix B: NPDES Permit

Appendix C: Environmental Assessment

Appendix D: Notice of Project Planning Public Meeting

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Appendix F: Geotechnical Report



Acronyms and Abbreviations

%	percent
A	amperes
AHU	air handling unit
ANSI	American National Standards Institute
ATS	automatic transfer switch
BEP	best efficiency point
CBOD ₅	5-day carbonaceous biochemical oxygen demand
CCTV	closed-circuit television
CFM	cubic feet per minute
cfs	cubic feet per second
CIP	Capital Improvement Plan
CSO	combined sewer overflow
CWSRF	Clean Water State Revolving Fund
DCS	distributed control system
DRI	Detroit River Interceptor
EGLE	Michigan Department of Environment, Great Lakes and Energy
EL	elevation
FEMA	Federal Emergency Management Agency
FRP	fiber-reinforced plastic
ft	foot/feet
ft ²	square feet
gal	gallon(s)
GIS	geographic information system
GLWA	Great Lakes Water Authority
gpm	gallon(s) per minute
GPS	Global Positioning System
HI	Hydraulic Institute
HIM	human interface module

hp	horsepower
HVAC	heating, ventilation, and air conditioning
I&C	instrumentation and control
in	inch(es)
JOC	job order contract
kV	kilovolts(s)
kVA	kilovolt-ampere(s)
kW	kilowatt(s)
LEIB	Leib
mA	milliampere(s)
MAU	make-up air unit
MBH	1000 British thermal unit(s) per hour
MCC	motor control center
MDNR	Michigan Department of Natural Resources
MDOT	Michigan Department of Transportation
MG	million gallon(s)
mg/L	milligram(s) per liter
MGD	million gallons per day
mL	milliliter(s)
mm	millimeter(s)
MVA	megavolt-ampere(s)
N/A	not applicable
NaOCl	sodium hypochlorite
NH ₃ -N	ammonia nitrogen
NPDES	National Pollution Discharge Elimination System
NPSH	net positive suction head
NPW	non-potable water
NWI	Northwest Interceptor
O&M	operation and maintenance
OIT	Operator Interface Terminal

OKW	Oakwood
PLC	programmable logic controller
POR	preferred operating range
pph	pound(s) per hour
ppmv	part(s) per million volume
PS	pumping station
RTB	retention treatment basin
SCADA	supervisory control and data acquisition
SCC	system control center
SDF	Screening and Disinfection Facility
SEMCOG	Southeast Michigan Council of Governments
SHPO	State Historic Preservation Office
SOP	standard operating procedures
SRP	Scheduled Replacement Plan
TP	total phosphorus
TRC	total residual chlorine
TSS	total suspended solids
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VFD	variable frequency drive
WRD	Water Resources Division
WRRF	Water Resource Recovery Facility
WSE	water surface elevation
WWMP	Wastewater Master Plan



Executive Summary

The Great Lakes Water Authority (GLWA) hired CDM Smith, the design and consulting engineer, to develop a Project Plan to apply for a Clean Water State Revolving Fund (CWSRF) loan through the Michigan Department of Environment, Great Lakes and Energy (EGLE). This Project Plan was prepared for in accordance with the CWSRF Project Planning Document Preparation Guidance (January 2023).

The Intent of the CWSRF project is to Implement a series of improvements at the Oakwood Combined Sewer Overflow (CSO) Retention Treatment Basin (RTB) and storm/sanitary pumping station, and the Leib CSO Screening and Disinfection Facility (SDF). The goal of the CWSRF project is to implement improvements that will significantly upgrade the process mechanical and instrumentation and control (I&C) systems and site improvements at both facilities, as well as heating, ventilation, and air conditioning (HVAC), architectural, structural, electrical, and site civil improvements. Based on the analysis summarized in this project plan, the selected improvements include:

- 1) Comprehensive upgrades to the Oakwood and Leib disinfection systems, including replacement of chemical storage and feed systems and sampling systems intended to improve process control and reliability, reduce operations and maintenance costs, standardize with other CSO facility improvements, and accommodate future flows and disinfection requirements.

- 2) New and improved sewage sampling and monitoring throughout each facility to continuously monitor total residual chlorine demand and decay and optimize the chemical usage.

Modification of the existing Oakwood CSO RTB storm pumps, and modifications to pump controls for the storm and sanitary pumping systems, to maximize service life and reliability of equipment while reducing operating cost and seal water usage.

- 3) Replacement of the existing COPA screens at Leib with Romag screens so that operations and maintenance are standardized around identical equipment instead of multiple technologies.

Modifications to the flushing and drainage systems throughout each facility to facilitate future automated cleaning and reduce frequency and difficulty of manual cleaning between CSO events.

- 4) General civil work, intended to facilitate site access for staff and waste disposal and chemical shipment vehicles, enhance site security, repair damaged pavement, and improve site drainage.

- 5) Architectural improvements, intended to facilitate separation of unclassified and hazardous classified areas (Leib), repair and recoat modified facilities, and accommodate improvements to HVAC equipment access.

- 6) Major modifications to the Leib CSO SDF screen channels to accommodate new and rehabilitated screens including improved maintenance access.

1.0 Background

The Great Lakes Water Authority (GLWA) operates and maintains nine combined sewer overflow (CSO) facilities. The primary function of the CSO facilities is to screen, settle, skim, and disinfect combined sewer/storm water during rain events before discharge to the receiving water body or return captured water to the Wastewater Resource Recovery Facility (WRRF) for further treatment. These CSO facilities play a vital role in keeping combined sewer water out of residents of the City of Detroit's basements and protecting public health and the environment. All facilities must meet discharge requirements contained in GLWA's National Pollutant Discharge Elimination System (NPDES) permit (see **Appendix B**). Detailed facility descriptions are provided in the following sections.

There are two types of CSO facilities: Retention Treatment Basins (RTBs) and Screening and Disinfection Facilities (SDFs). Both facilities provide screening and disinfection. The RTB provides dedicated settling within a retention basin. The SDFs provide contact time for disinfection within effluent conduits prior to discharge to the river. The effluent conduits are up to 1 mile long.

Table 1.1 presents key existing design criteria and general information for the Oakwood and Leib CSO SDF.

Table 1.1 – Oakwood and Leib Existing Facility Overview

	Leib	Oakwood
Facility Abbreviation	LEIB	OKW
Facility Type	SDF	RTB
Year of Startup	2002	2012
Hydraulic Capacity (cfs)	2,000	1,660
River Level Basis for Hydraulic Capacity (Detroit Datum)	Not influenced by river elevation	N/A
Treatment Capacity ^a (cfs)	1,550	1,660
Storage Volume (MG)	N/A	9
Screen Type (size of slot or opening)	Racked Vertical and Horizontal Bar Screens (4-mm)	Perforated Plate (6-mm)
Disinfectant Type	Liquid Sodium Hypochlorite (NaOCl)	
Receiving Water Body	Detroit River	Rouge River

^a Treatment capacity refers to the design capacity of the screening and disinfection systems.

Notes:

cfs = cubic feet per second

MG = million gallon(s)

mm = millimeter(s)

N/A = not applicable

NaOCl = sodium hypochlorite

In 2021, GLWA along with Jacobs Engineering, performed an assessment (CS-299 CSO Facilities Assessment, Volume 2 – Multi-Disciplinary Facilities Assessment, April 9, 2021) of various CSO facilities. This assessment identified needs for projects to address issues identified at Oakwood and Leib pertaining to equipment reliability, process optimization, and accommodating new flows from the Northwest Interceptor (NWI) and Meldrum interceptors which are being routed to Oakwood and Leib

respectively in response to recommendations from the wastewater master plan (WWMP) (Great Lakes Water Authority Wastewater Master Plan, 2020).

1.1 Study and Service Areas

The Oakwood CSO RTB and Leib CSO SDF study areas are in the City of Detroit, located in Wayne County, servicing approximately 2.9 million residents 1.16 million households. The service areas are shown in **Figure 1.1**. The Oakwood CSO RTB is located 12220 Pleasant Street, Detroit, MI 48217 on the lower portion of the Rouge River immediately south of I-75. The Leib CSO SDF is located at 2198 Mt Elliot Street, Detroit, MI 48217.

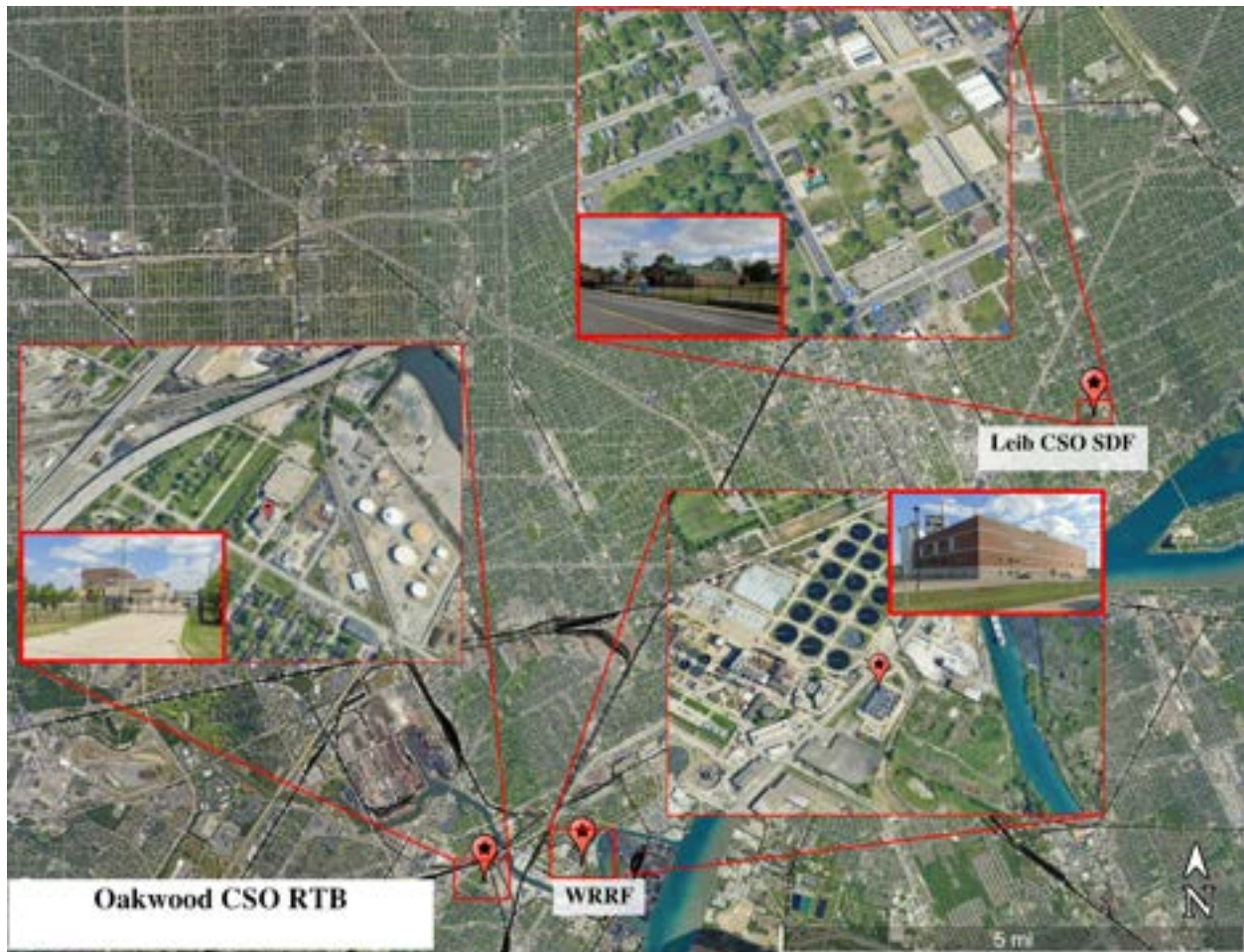


Figure 1.1 – Oakwood CSO RTB and Leib CSO SDF locations



Figure Error! No text of specified style in document.2 - Oakwood CSO RTB Aerial Map (1220 Pleasant Street)



Figure 1.3 – Leib CSO SDF Aerial Map (2198 Mt Elliot Street)

1.2 Population

Population projections were made for the 2020 wastewater master plan (*Great Lakes Water Authority Wastewater Master Plan, 2020*). Population projections were based on the Southeast Michigan Council of Governments (SEMCOG) forecast for 2045 supplemented by GLWA Member surveys and extrapolation to the year 2060.

SEMCOG prepares annual analyses of population and households by local unit of government within its 7-county planning region. The 2045 forecast was completed in June 2018. Population forecasting, and the associated economic and demographic projections that drive population growth, is an essential component of master planning. Population change directly impacts sanitary wastewater flows (including domestic, commercial, industrial, and institutional flows) and the increase in the size of the service area (infiltration/inflow).

Based on the Member survey and SEMCOG projections from the wastewater master plan, the GLWA regional service area population is forecast to grow up to 9 percent by the year 2060:

- 2.75 million residents in 2018
- 2.77 million residents in 2025
- 2.90 million residents in 2045
- 3.06 million residents in 2060

1.3 Existing Environmental Evaluation

1.3.1 Cultural and Historic Resources

The Oakwood and Leib CSO facilities are adjacent to the Rouge River and the Detroit River, respectively.

A search of the Michigan Historic Site Online did not identify any state registered historical sites near the proposed project sites.

State agencies including the State Historic Preservation Center (SHPO), EGLE Water Resources Division (WRD), Michigan Department of Natural Resources (MDNR) offices of endangered species and wildlife and fish will be contacted for review.

The proposed project has the possibility to have impacts on tribally important cultural or religious sites of the following American Indian tribes in Wayne County: Bay Mills, Grand Traverse Band of Ottawa and Chippewa Indians, Gun Lake Tribe, Hannahville, Keweenaw Bay Indian Community, Lac Vieux Desert Band of Lake Superior Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Bands of Odawa Indians, Nottawaseppi Huron Band of the Potawatomi, Pokagon Band of the Potawatomi Indians, Saginaw Chippewa Indian Tribe of Michigan, and Sault Tribe of Chippewa Indians. These tribes will be contacted to review the proposed sites.

1.3.2 Air Quality

The most recent EGLE Air Quality Report (2022) is reviewed to assess the air quality in the study area. Since EGLE began monitoring in the early 1970s, criteria pollutant levels have decreased, indicating that the air is much cleaner today than when the federal Clean Air Act began. The entire state of Michigan is in attainment for carbon monoxide, lead, nitrogen dioxide, and particulate matter. Portions of the state are in nonattainment, for sulfur dioxide and ozone, but the levels of these pollutants are continuing to decrease.

1.3.3 Wetlands

Wetland maps for the Oakwood and Leib CSO facilities were generated at the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory website. The maps are included in **Appendix C**.

River Rouge is directly adjacent to the Oakwood CSO facility. The Detroit River is also adjacent to the Leib CSO SDF. These riverine systems are not anticipated to be impacted by this project.

1.3.4 Great Lakes, Shorelands, Coastal Zones, and Coastal Management Areas

The proposed project is not expected to impact the Great Lakes, Shorelands, Coastal Zones, or Coastal Management Areas.

1.3.5 Natural or Wild and Scenic Rivers

Natural or Wild and Scenic Rivers, particularly Rogue River and Detroit River, are not expected to be impacted upon the construction of the proposed project.

1.3.6 Major Surface Waters

The main surface water body within the project areas are the Rogue River and the Detroit River. These rivers are intensively developed, with extensive urban, commercial, and industrial complexes. They are not expected to be negatively impacted upon construction of the proposed project. Improvements at the Oakwood CSO RTB and Leib CSO SDF will improve the quality of the water being discharged into both of the rivers.

1.3.7 Topography

Appendix C includes the existing topography from the USGS quadrangle maps. The city of Detroit is relatively flat. The study area is part of the vast central lowlands of North America, consisting of plains and low hills.

1.3.8 Floodplains

The project work area lies outside of the 100-Year Floodplain. FEMA issued Flood Plain Maps are shown in **Appendix C**. There are no special flood hazards near the Oakwood and Leib CSO facilities. Consequently, the proposed project is not expected to impact floodplains.

1.3.9 Geology

There are no geological structures or formations in the vicinity of the proposed project study areas.

1.3.10 Soil Types

At the Oakwood CSO facility, the soils consist of clayey topsoil, fill soils (mixture of crush aggregate and silty sand), silty sand and clayey sand fill soils, and native brown and gray lean clay or sandy lean clay soils.

At the Leib CSO SDF, the soils consist of clayey topsoil, granular fill soils consisting of sand with silt, and native sandy lean clay.

1.3.11 Agricultural Resources

There is no agricultural land within the Oakwood CSO RTB or Leib CSO SDF service areas. Consequently, the proposed project is not expected to impact agricultural resources.

1.3.12 Fauna and Flora

A USFWS Section 7 review will be completed for this project. According to the USFWS website, there are 3 federally listed endangered species including the Indiana Bat (*Myotis sodalis*), the Northern Riffleshell (*Epioblasma torulosa rangiana*), and White Catpaw (*Epioblasma obliquata perobliqua*).

Because the proposed work is limited to the existing facilities, it was determined that no impacts to federally listed endangered or threatened species are anticipated.

1.4 Existing System

1.4.1 Leib CSO SDF Existing System

The Leib CSO Facility is an SDF with a treatment capacity of 1,550 cfs. It was constructed in 2002. The facility has a nearly 1-mile-long effluent conduit used for disinfection contact time before discharge into the Detroit River. The facility consists of a Headworks area in the basement, chemical room, utility support (electrical, emergency generator and mechanical rooms), control room, sample room, supply fan room and other miscellaneous rooms. The facility also includes an underground outfall vault near the river.

1.4.1.1 Disinfection

The sodium hypochlorite disinfection system consists of two fiber-reinforced plastic (FRP) tanks, six low-rate diaphragm pumps, two high-rate centrifugal pumps, four disinfectant rapid mix zones, and 18 induction mixers. There are two channels with four ROMAG screens and two channels with Copa screens discharging into screened effluent channels. From there screened effluent flows to four disinfectant rapid mix zones. There are four induction mixers per disinfectant rapid mix zone consisting of one pair of mixers upstream and one pair of mixers downstream of a concrete baffle wall that directs all flow down and past the mixers. There are also two induction mixers in the influent channel upstream of screening referred to as prechlorination mixers. Four of the low-rate sodium hypochlorite pumps are each paired to a disinfectant rapid mix zone. Flow is metered from each pump and then flow is split in a manifold to the four induction mixers in each disinfectant rapid mix zone. The manifold includes a solenoid valve, manual valve, and a sight flow indicator to each induction mixer. Flow splitting between induction mixers is primarily dependent on equal back pressure valve settings to the induction mixers. The other two low-rate sodium hypochlorite pumps are each paired to one of the influent channel mixers. The two

high-rate pumps discharge to a four-way manifold with flow metering on each branch. These tie into the discharge from the four low-rate pumps upstream of the manifold to each disinfectant rapid mix zone. There are also valved connections allowing the high-rate pumps to be used for the influent channel induction mixers.

The design which was intended to provide redundancy and flexibility is atypically complex and results in the manifolds including valves and sight flow indicators to be inaccessible due to their height on the wall.

Table 1.2 provides an overview of the existing disinfection system at Leib CSO SDF.

Table 1.2 – Leib Disinfection Details

Parameter	Value
Treatment Capacity (cfs)	1,550
Design Feed Strength (% hypochlorite)	5.0
Max. Dosage at Design Flow (mg/L Cl ₂)	38
Disinfection Contact Time (min)	10
Storage Tanks	
Number	2
Volume of Each Tank (gal)	10,450
Material	FRP
Pumps	
Number	8 Total; 6 low-rate, 2 high-rate
Capacity (gpm)	Low-rate: 7.6, High-rate: 112
Type	Low-rate: Diaphragm, High-rate: Centrifugal
Mixers	
Number / Type	18 / Chemical induction mixers
Model Number/ hp / Manufacturer	SWC15FX / 15 / Water Champ

1.4.1.2 Screening

The Leib CSO SDF has two types of screens: 1) raked horizontal bar screen (manufactured by COPA) and 2) raked vertical bar screens (manufactured by Romag). Constructed in 2002, the facility was intended to be a full-scale pilot facility for this type of fine screen. There are four screening channels in the facility, with a total of eight COPA screens and a total of four Romag screens.

During dry weather, raw sewage is routed through the facility and to the Toward Treatment Sewer. During wet weather events, the flow increases, and the flow enters the screening channels as the wet weather flow exceeds the capacity of the Toward Treatment Sewer.

Screenings are conveyed to the Toward Treatment Sewer and then the Detroit River Interceptor (DRI) for eventual removal at the WRRF by the portion of influent conveyed to screenings collection channel. The COPA screens recently received a complete overhaul in 2019. The existing Romag screens were also rebuilt in 2019; however, the control panels and power packs were not upgraded.

Table 1.3 provides an overview of the existing screening system at Leib CSO SDF.

Table 1.3 – Leib Screening Details

Parameter	Value	
Treatment Capacity (cfs)	1,550	
No. of Screens	4 (2 in each of 2 channels)	8 (4 in each of 2 channels)
Manufacturer	Romag	COPA
Screen Type	Raked Vertical Bar Screen	Raked Horizontal Bar Screen
Opening Size	4-mm spacing	4-mm spacing
Depth or Length	29 ft 6 in	17 ft 0 in
Width	4 ft 0 in	4 ft 0 in
Screen Cleaning	Mechanical Comb	Mechanical Comb
Screening Removal	Conveyed to Toward Treatment Sewer and then to WRRF	

1.4.1.3 Flushing and Dewatering

The Leib CSO SDF does not have a dedicated dewatering or flushing system for the screening and disinfection area. The facility drains by gravity and, due to the limited use, solids accumulation has not been a major issue at this facility, except for the screening channels. However, in the future with connection of Meldrum sewer, the number of events will increase.

The outfall conduit has dewatering pumps to dewater the lower portion of the effluent conduit. These pumps are located near the Outfall Sample Building. The dewatered flow is pumped to the DRI.

Table 1.4 provides an overview of the existing flushing and dewatering system at Leib CSO SDF.

Table 1.4 – Leib Flushing and Dewatering Details

Parameter	Value
Headworks Dewatering and Flushing System	Headworks (basin) area is dewatered by gravity to the Toward Treatment sewer or disinfection (effluent) conduit. Manual flushing of screens and channels after each wet weather event.
Effluent Conduit Dimensions	16-ft-dia. effluent sewer to Junction Chamber, two 11-ft-dia. pipes to dewatering gate, two 10 ft × 10.5 ft box conduits to Detroit River
Effluent Conduit Dewatering and Flushing System	Two 1,500 gpm dewatering pumps located near Effluent Sample Building are used to dewater lower end of effluent conduit. Flow is pumped to the DRI. There is no flushing system in the effluent conduit.

1.4.1.4 Odor Control

There is no odor control system at the Leib facility. Building space for a carbon adsorber system, space in the electrical room for the fan motor, and a duct penetration to the screening facility below grade were provided, if odor control is needed in the future. However, odor complaints have not been received for this facility since it has been in operation. Therefore, an odor control system is not needed.

There is a need to isolate the hazardous classified screen area from the unclassified main building to eliminate the existing path for hazardous gases to migrate to the unclassified area. The duct will be sealed at each end and filled with sand to provide this required isolation between these spaces.

1.4.1.5 HVAC

The Leib CSO SDF consists of a Headworks area in the basement, chemical room, utility support (electrical, emergency generator and mechanical rooms), control room, sample room, supply fan room and other miscellaneous rooms. The facility also includes an underground influent channel. **Table 1.5** provides summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, and emergency eyewash shower. Emergency shower/eye washes are addressed, if safety issues were discovered, in **Section 1.4.1.10**.

Table 1.5 – Leib HVAC Equipment Details

Location	Unit No.	Description	Capacity (Per Unit)
Headworks (Screening Chamber)	SF-1	Supply Fan	59,000 CFM
Chemical Room	HV-2	Air Handling Unit	2,700 CFM 300 MBH
	EG-2	Exhaust Fan	3,010 CFM
Electrical Room	HV-1	Air Handling Unit	2,700 CFM 300 MBH
	EF-3	Exhaust Fan	4,650 CFM

1.4.1.6 Electrical

The Leib facility's electrical system consists of one DTE Energy utility feed from a 480 V, 3-phase outdoor transformer (secondary metering) and one diesel generator feed from a 350 kW, 480 V, 3-phase stationary generator. The utility feed is connected to a 600 A motor control center (MCC-B) with a 600 A sub-feed connection to a 600 A automatic transfer switch (ATS). The ATS then feeds a distribution panel with two 600 A breakers, which feeds two MCCs (MCC-A and MCC-C). The MCCs feed the various pumps, valves, motors, transformers, panels, etc. at the facility. **Table 1.6** provides a summary of the major electrical equipment for this facility.

Table 1.6 – Leib Electrical Details

Location	Major Electrical Equipment	Description
Generator Room	Generator (Diesel)	350 kw, 480/277 V, 3-Phase
Electrical Room	MCC-A	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-B	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-C	600 A, 480/277 V, 3-Phase

1.4.1.7 Instrumentation and Controls

Control System: The original control system was installed in 2002 under PC-732. In 2004 the system was upgraded and interfaced into GLWA's overall supervisory control and data acquisition (SCADA) Ovation control system. This upgrade provided the ability to remotely monitor the operations of the facility and the local collection system at the system control center (SCC).

The existing control system contains an Allen Bradley-based programmable logic controller (PLC) system consisting of an Allen-Bradley redundant PLC-5 with local I/O controls that are installed in the facility's local control system panel. The operator workstation software has a Rockwell RSView operating platform and is located in the control room. The existing hardwired local back-up control panel and other miscellaneous subsystems that are incorporated into the overall control system are outdated and need replacement. The control system network and switches are obsolete and do not meet GLWA SCADA Governance standards on redundant networks and switches, and that all CSO facilities use Ovation workstations with new high-performance graphics. The current system is equipped with a back-up radio system to communicate critical monitoring points back to GLWA System Control on wide area network failure. Improvements to the control system are currently on-going as part of another project focused on upgrade to GLWA standard system controls for the existing process and instrumentation equipment.

Flow and Level Sensors: **Table 1.7** summarizes the level sensors and flow meters at the Leib CSO SDF for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 1.7 – Leib Flow and Level Sensors Details

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent Sewer (Larger Sewer)	1	Transit-Time (AccuSonic)
Influent Sewer (Smaller Sewer)	1	Transit-Time (AccuSonic)
Towards Treatment Sewer	1	Transit-Time (AccuSonic)
Outfall	1	Transit-Time (AccuSonic)

Area	Quantity	Instrument Type
CSO Facility Level Sensors		
Influent (Sewer and channel)	2	Ultrasonic
Mixing Chamber	1	Ultrasonic
Effluent (Outfall, Towards Treatment Sewer)	2	Ultrasonic
DRI Discharge Regulator Chamber	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed Pumps	8	Magnetic

1.4.1.8 Site Civil

The Leib CSO facility was built in 2002. The site includes a 6-ft high security fence along the perimeter of the site. A sliding cantilever entrance gate is provided at the Mt. Elliott entrance. The parking lot consists of 8-in thick reinforced pavement with 8-in. crushed limestone base. There is a 5-ft wide, 4-in. thick sidewalk along the building entrances and 10-in. aggregate site pavement along the perimeter of the facility. Site utilities include potable water, natural gas, electrical, telephone services, stormwater, and sanitary sewer connections.

1.4.1.9 Architectural

The Leib CSO SDF consists of chemical room, utility support (electrical, emergency generator and mechanical), control room, odor control room, screen room, sampler room and other miscellaneous rooms. The facility also includes an underground influent channel, screen area, mixing chamber and effluent channel.

1.4.1.10 Safety

Safety related items include fall protection, exit signage, hatch access, handrails, and other miscellaneous safety-related features.

1.4.2 Oakwood CSO RTB Existing System

The Oakwood CSO Facility is an RTB with 9 million gallons (MG) of storage and a treatment capacity of 1,660 cfs. It was constructed in 2012. There are three buildings. The main building contains the Storm Pump Station (PS), Sanitary Pump Station, chemical room, control room, utility support (electrical and mechanical rooms), odor control room, sample room, shipping and receiving and miscellaneous other rooms. The Headworks Building contains the headworks, headworks control room, make-up air unit (MAU) room and hydraulic room. The basin odor control room contains the odor control systems for the East and West Basins.

1.4.2.1 Disinfection

The sodium hypochlorite disinfection system consists of two FRP tanks, 10 gear pumps, and multiport injection on the discharge of the eight-stormwater vertical mixed flow pumps. The storm pump pumps stormwater into the screen facility. Three of the sodium hypochlorite pumps are low-rate and seven are high-rate. Sodium Hypochlorite Pumps 1 through 8 inject on the discharge pipe of Storm Pumps 1 through 8, respectively. Sodium Hypochlorite Pump 9 is a high-rate pump serving as the backup to high-rate pumps 3 through 8. Sodium Hypochlorite Pump 10 is a low-rate pump serving as the backup to low-

rate pumps 1 and 2. Each pump has a variable frequency drive (VFD) to adjust chemical feed flow based on storm pumping rate. Flow is metered from each pump. The disinfection system is summarized in **Table 1.8**.

Table 1.8 – Oakwood Disinfection Details

Parameter	Value
Treatment Capacity (cfs)	1,660
Design Feed Strength (% hypochlorite)	7.5
Max. Dosage at Design Flow (mg/L Cl ₂)	12
Disinfection Contact Time (min)	6 min w/ 1 CSO basin, 12 min w/ 2 CSO basins in service
Storage Tanks	
Number	2
Volume of Each Tank (gal)	11,500
Type	FRP
Pumps	
Number	10 Total; 3 low-rate, 7 high-rate
Capacity (gpm)	Low-rate: 0-26, High-rate: 151
Type	Gear
Mixers	
Number / Type	Hypo added to pump discharge pipe.
Model Number/ hp / Manufacturer	Not Applicable (Hypo added to pump discharge pipe where mixed as conveyed to Screen Facility)

1.4.2.2 Screening

The Oakwood CSO Facility has six perforated plate screens that were placed into service in 2012 (see **Table 1.8**). Raw wastewater is pumped to the screens from the Oakwood Storm Pump Station. Screened flow enters either one or both of the CSO basins via the Screen Outlet Chamber.

Screened material is removed from the screens using a rotating brush and high-pressure spray and discharged into a screw conveyor. The conveyor transports the screenings to a dumpster for eventual disposal in a landfill. A washer/compactor/grinder is installed at the end of the conveyor, prior to discharge to the dumpster.

1.4.2.3 Storm Pump Station

The storm water pump station consists of eight vertical mixed flow pumps. Design criteria is presented in **Table 1.9**. The pump station is divided into two equal sized wet wells. Each wet well contains one smaller pump and three larger pumps. The storm pumps are equipped with an external flushing water system for bearing cooling and lubrication. The seal water system consists of secondary water piping with a dedicated seal water booster pump for each storm pump. As the wet wells fill, the storm pumps start based on the wet well levels and control system logic. The station was designed for operation using a constant-level control strategy. Features of this control strategy include narrow wet well operating range, pump speed ramping up and down, and pumps turning on/off to match a set level. This requires pumps with VFDs and a high degree of turn-down capability for the pumps. The station is typically manually controlled as that control strategy has not been well aligned with the influent flow characteristics during wet weather events.

Table 1.9 – Oakwood Storm Pump Station Details

Storm Pump No.	Design Capacity, MGD	Total Head, ft	Drive Type
1 and 2	97	48	VFD
3, 4, 7, and 8	178	48	Constant Speed
5 and 6	178	48	VFD

1.4.2.4 Sanitary Pump Station

The Sanitary Pump Station of the Oakwood CSO Facility consists of two separate wet wells (east and west) and an enclosed sanitary pump station room located at ground level. Each wet well includes two submersible sanitary sewage pumps for a total of four pumps. Even numbered pumps (SN2 and SN4) are located in the east wet well, while odd numbered pumps (SN1 and SN3) are located in the west wet well.

1.4.2.5 Odor Control

There are three odor control systems at the Oakwood facility. One system, located in the Odor Control Building next to the sanitary pump station, treats air from the east and west storm wet wells, the sanitary wet wells, and the sanitary pump station room. The second and third systems, both located in the Basin Odor Control Building, treat air from the East and West Retention Basins. Each of the retention basin odor control systems also serves the headworks, as it is connected to both CSO basins.

The system serving the pump stations consists of a grease filter/mist eliminator, an odor control fan, and a single bed vertical activated carbon vessel. The system also includes a bypass ventilation fan, which allows foul air to be removed from the pump stations and bypass the carbon column. Carbon is replaced through the top access hatch on each vessel.

The systems serving the retention basins operate in parallel. Each system consists of an odor control fan and an activated carbon vessel (there are no grease filter/mist eliminators). Each system also has a bypass ventilation fan.

These odor control systems operate under air permit requirements (Permit to Install No. 91-06). The emission limit for the Pump Station system is 0.0043 pounds per hour (pph) of hydrogen sulfide. At a design air flow of 30,000 cfm, this equates to approximately 0.028 parts per million volume (ppmv) concentration of hydrogen sulfide. The emission limit for the CSO basin systems is 0.0031 pph. At a design air flow rate of 22,000 cubic feet per minute (each), this equates to approximately 0.028 ppmv concentration of hydrogen sulfide. The carbon is tested for remaining bed life on a quarterly basis as required by the permit. Carbon was replaced in all three carbon vessels in Spring 2018, which was the first time it was replaced since it was put into service in 2012.

In 2021, GLWA reported no odor complaints have been received for at least the past three years.

1.4.2.6 Flushing and Dewatering

Dewatering System: The Oakwood screening facility and CSO basins (East and West) are largely dewatered by gravity through drain lines that discharge to the NWI. The CSO drain system has sufficient capacity to allow both CSO basin drain valves to be opened simultaneously; however, there is a flow control valve and magnetic flow meter provided on the drain line to the NWI to control the flow to the

NWI to prevent overflows in the collection system between the CSO Basin and the WRRF. Also, there is a Surge Chamber on the gravity drain lines that will direct flow back to the head of the plant if the basin dewatering flow rate exceeds the available capacity in the line to the NWI. Refer to **Table 1.10** for overview of the dewatering system.

Due to system hydraulics, the water in the lowest levels of the basins that cannot be discharged to the NWI by gravity is instead routed back to the Oakwood Pump Station, where flow is pumped by the sanitary pumps to the NWI.

Flushing System: A flushing gate system (see **Table 1.10**) is used for cleaning solids from the floor of the basin following dewatering. There are 20 total flushing gates—eight in each of the two CSO basins, and two in each of the two basin influent channels. The flushing gates in each basin are arranged in two groups of four. The flushing gates operate in a latch-unlatch manner and are controlled by a common hydraulic power pack. The flushing reservoirs are filled as the basins fill during a wet weather event. When the basin and screening facilities dewater, flushing water remains behind the flushing gates. Flushing is initiated by sequentially unlatching two basin flushing gates (one in each basin) at a time until all are open. Then, if the last of the four reservoirs was full prior to its gate opening, the second set of flushing gates will sequentially open. Once basin flushing is completed, one gate is opened in each influent channel. The flushing sequence only allows one gate in each channel to be open at a time.

Table 1.10 – Oakwood Flushing and Dewatering Details

Parameter	Value
Total Basin Volume (MG)	9
Headworks and Basin Dewatering and Flushing System	▪ Basins are dewatered by gravity by opening the Drain Valve to the NWI ▪ There are 20 flushing gates: 8 in each basin and 2 in each basin distribution channel ▪ Flushed solids are routed to the Oakwood Pump Station for pumping to the NWI

1.4.2.7 HVAC and Plumbing

The Oakwood CSO facility consists of three buildings. The main building contains the Storm Pump Station, Sanitary Pump Station, chemical room, control room, utility support (electrical and mechanical rooms), odor control room, sample room, shipping and receiving and miscellaneous other rooms. The Headworks Building contains the headworks, headworks control room, MAU room and hydraulic room. The Basin Odor Control Room contains the odor control systems for the East and West Basins.

Table 1.11 provides a summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, gas-fired water heater, emergency shower/eye wash, emergency eye wash, sump pumps, pressure booster pumping system, and compressed air system.

Table 1.11 – Oakwood HVAC Details

Location	Unit No.	Description	Capacity (Per Unit)
Main Pump Station	SF-1 to 2	Supply Fan	5,000 CFM
Headworks (Screen Facility)	MAU-3	MAU	35,800 CFM 3,000 MBH
CSO Basin	EF-20 to 22	3 × Exhaust Fan (East Basin)	52,800 CFM
	EF-23 to 26	3 × Exhaust Fan (West Basin)	52,800 CFM
	SF-5 to 7, SF-10	4 x Supply Fan (East Basin)	52,800 CFM
	SF-5, SF-8 to 10	4 x Supply Fan (West Basin)	52,800 CFM
Chemical Room	AC-2	Air Conditioning Unit	315 CFM 1.25 ton
	MAU-4	MAU	5,000 CFM 400 MBH
	EF-18	Exhaust Fan	2,500 CFM
Electrical Room	AHU-1	AHU	25,000 CFM, Cooling Capacity (125 tons), Heating Capacity (353 MBH)
	EF-35	Exhaust Fan	13,880 CFM
	EUH-8	Electric Unit Heater	1,700 CFM 15 KW
Mechanical Room	AHU-1A	AHU	2,700 CFM
Make-up Air Room	MAU-3	MAU	35,800 CFM
Odor Control Room	EF-28, EF-29	Exhaust Fan	3,000 CFM
	EF-33, EF-34	Exhaust Fan	22,000 CFM
	EUH-6 to 7	Electric Unit Heater	1,700 CFM 15 KW

1.4.2.8 Electrical

The Oakwood facility's electrical system consists of double ended 4.8 kV, 3,000 A switchgear with dual (redundant) utility feeds, metering of the 4.8 kV feeds and an adjacent DTE substation with two 15 MVA outdoor transformers. The switchgear has a tiebreaker and automatic source transfer controls. Circuit breakers in the switchgear then feed eight storm pumps and two 2,500 kVA outdoor pad mount transformers. The 2,500 kVA transformers then feed a double ended 480 V, 3,200 A switchboard with a key interlocked tie-breaker. Circuit breakers in the switchboard then feed four MCCs and four 125 hp sanitary pumps. The MCCs then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. **Table 1.12** provides a summary of the major electrical equipment for this facility.

Table 1.12 – Oakwood Electrical Details

Location	Major Electrical Equipment	Description
Electrical Room	Double ended 4.8 kV switchgear with automatic source transfer	3,000 A, 4.8 kV, 3-Phase
Electrical Room	VFD (Storm Pumps)	(4) 4.8 kV, 3-Phase
Storm Pump Motor Room	Vertical mixed flow pumps	(2) 1,500 hp, (6) 2000 hp, 4.8 kV, 3-Phase
Outdoors	Pad Mount Transformers	(2) 2,500 kVA, 4.8 kV-480 V, 3-Phase
Electrical Room	Double ended switchboard w/ tie-breaker	3,200 A, 480 V, 3-Phase
Electrical Room	VFD (Sanitary Pumps)	(4) 480 V, 3-Phase
Sanitary Pump Room	Sanitary Pumps	(4) 125 hp, 480 V, 3-Phase
Electrical Room	MCC-1	1,200 A, 480/277 V, 3-Phase
Electrical Room	MCC-2	1,200 A, 480/277 V, 3-Phase
Screening Facility Control Room	MCC-3	1,200 A, 480/277 V, 3-Phase
Screening Facility Control Room	MCC-4	1,200 A, 480/277 V, 3-Phase

1.4.2.9 Instrumentation and Controls

Control System: The original Ovation control system was installed in 2012 under PC-755. In 2015 under PC -773D, the Ovation control system controllers and software were upgraded to version O.V.3.5.0.

The existing Ovation system includes remote I/O cabinets located in the Headworks/CSO Basins that are networked to the Ovation controller/I/O cabinets and data concentrator cabinet located in the Communication Room. The system currently has one dual screen operator workstation, plus a database server with wall mounted displays and printers in the Control Room. The Ovation redundant pair of controllers provides the facility with a redundant network, controls and I/O capabilities. A 10 kVA Liebert uninterruptible power supply is used to provide constant power to the Ovation system and network. The Ovation network is equipped with primary and backup network switches. The switches are connected to the GLWA AT&T wide area network via the facility's router. The network connections inside the station are via copper Ethernet cables. All workstations and controller connections have redundant networks. The controller connections are dual-homed to provide system redundancy. Should one network fail, the backup, redundant network is available to provide station monitoring and control. The Ovation system is equipped with a backup radio system to communicate critical monitoring points back to the SCC on wide area network failure.

Flow and Level Sensors: Table 1.13 summarizes the level sensors and flow meters at the Oakwood CSO Facility and Pump Station for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 1.13 – Oakwood Flow and Level Sensors Details

Area	Quantity	Instrument Type
CSO Flow Meters		
Storm Pump Flow Meters	8	Area Velocity
Drain to NWI Meter Vault	1	Magnetic
CSO Facility Level Sensors		
Screening Area	1	Ultrasonic
	1	Radar
Basin Influent (East and West)	2	Ultrasonic
	2	Radar
Basins (East and West)	2	Ultrasonic
	2	Radar
Basins Flush Gates (Gates 7, 8, 10, and 11)	4	Ultrasonic
NWI	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed	10	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Ultrasonic
Sanitary Pump Station Flow Meters		
Pump Meter Vault (East and West)	2	Magnetic
Pump Station Level Sensors		
Wet Wells (East and West, Upstream and Downstream)	4	Ultrasonic
Sanitary Surge Relief Chamber	1	Ultrasonic

1.4.2.10 Site Civil

Access to the site is off Pleasant Street through a 26-ft wide sliding vehicular gate. The parking lot consists of 8-in. thick reinforced concrete pavement. Roads onsite consist of 26 ft wide, 9 in. thick reinforced concrete pavement with 8-in. aggregate base designed to support HS-20 loading. There is also a gravel road around the CSO basin building consisting of 8 in. of aggregate. Concrete sidewalks are 4 to 5 ft wide and 4 in. thick with a 2-in. sand base. Site security is provided by a perimeter fence comprised of an 8-ft ornamental iron fence and an 8-ft chain-link fence. Stormwater runoff from the site is collected and conveyed to the storm junction chamber upstream of the pump station.

1.4.2.11 Architectural

Three buildings make up the Oakwood CSO RTB: The Storm Pump Station, screening building, and retention basins. These buildings include a chemical room, utility support, control room, odor control room, screen room, sampler room, storm pump room, sanitary pump room, hydraulic room, MUA room, shipping and receiving rooms, and other miscellaneous rooms.

1.4.2.12 Safety

Safety-related items include fall protection, exit signage, hatch access, handrails, and other miscellaneous items included throughout the facility.

1.5 Need for Project

The drivers for this project are focused on improving facility treatment reliability, flexibility, operation, maintenance, and safety features. These improvements will support planned increases in utilization/peak flow for both the Oakwood CSO RTB and Leib CSO SDF upon implementation of the selected alternatives identified by the study report (provided in Appendix A). Future projects planned by GLWA will impact the peak flow at these facilities. The Northwest Interceptor (NWI) connection will divert additional flow to the Oakwood RTB and to the Meldrum sewer connection will divert additional flow to the Leib CSO SDF. As a result of this additional flow improvements will be needed to avoid potential water quality compliance issues. Improvements to the disinfection systems will be needed at both facilities to provide adequate disinfection to the new CSO. Screening improvements at the Leib facility is needed to prevent CSO sanitary debris from discharging into the receiving water body. Below is a list of the detailed needs by facility and discipline.

1.5.1 Leib CSO SDF Needs

The needs and issues were identified from meetings with operation and maintenance (O&M) staff and site visit and investigations. The following issues were identified related to each of the components making up the Leib CSO SDF.

1.5.1.1 Disinfection Needs

Chemical storage system. The WWMP recommended a diversion to the Leib SDF which will increase utilization at the facility. To prepare for larger flows, the chemical storage system needs to be improved.

The existing disinfection system has two sodium hypochlorite storage tanks of 10,450 gallons, which will not accommodate increased flows. To address this, the storage tanks will need to be replaced with larger tanks (two, 12,600 gallon tanks) to meet future collection system peak design storm demands. The original design had a peak storm volume of 225 MG and the future collection system is 367 MG. A new system must be right-sized to meet these anticipated future demands.

Chemical feed system. In addition to the desire to standardize on one type of chemical feed pumps between facilities and the desire to simplify chemical feed system where possible, the Leib chemical feed system has the following issues:

- Lack of flow-paced and total residual chlorine (TRC)-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding the appropriate dosage of sodium hypochlorite solution. To stay compliant with the NPDES permit, overfeeding hypochlorite is common.
- The chemical feed pumps are expensive to maintain and replace. The pumps and motors are difficult to remove from the containment area.

- There are 18 chemical induction mixers to distribute the hypochlorite into the flow that requires relatively frequent and costly maintenance. Their infrequent usage causes the seals to dry out between CSO events.
- The chemical feed piping is highly complex, with a high number of components, as depicted in **Figure 1.4**.
- Components of the chemical feed piping (e.g., valves) are inaccessible due to height on wall, as depicted in **Figure 1.4**.
- The VFDs and electrical equipment are located in the corrosive environment of the chemical room, accelerating equipment wear and tear.
- Currently, a hose must be moved and connected to each pump suction pipe to flush the hypochlorite solution from the feed system with non-potable water (NPW), as shown in Figure 1.2. A hard-piped flushing water connection is desired so that flushing could be accomplished by opening a valve to each pump.
- The chemical room floor has been damaged due to a chemical leak from one of the storage tanks.



Figure 1.4 – Leib CSO SDF Chemical Feed Pumps and Piping Manifold

1.5.1.2 Screening Needs

The technology for COPA screens has not changed in the last few decades and no improvement options exist except for the replacement of screens. These screens are difficult to maintain, frequently become blinded, and cleaning after storm events is labor intensive. There are no US representatives for spare parts, repair, or technical support, nor are there any other known successful installations in the US. No updates or improvements to the screen controls or operation have been made since the installation.

Due to these issues with the COPA screen, Romag is the preferred screening technology currently used at Leib and standardizing operations, maintenance, and replacement parts around Romag screens is preferred.

1.5.1.3 Instrumentation and Control Needs

As described under the Disinfection Needs section, there is currently no ability to monitor TRC or dosage requirements at Leib, which means that sodium hypochlorite solution is often overdosed to ensure adequate disinfection. As such, more robust and reliable TRC-based and flow-paced controls are desired to optimize sodium hypochlorite usage and prevent over- or under-dosing of disinfectant.

1.5.1.4 Flushing and Dewatering Needs

Manual flushing the screening channels after every storm event is difficult and time-consuming. Both the screenings channel and the screen influent channels accumulate significant volumes of screenings that must be manually cleaned between storm events but are difficult to access.

1.5.1.5 HVAC Needs

Access to supply fan SF-1 for maintenance and repair is difficult; there is very little clearance to service belts and bearings in the supply fan room. Additionally, in discussions with operations staff, a replacement of thermostat was identified as a need to provide an indication of the temperature in the office.

1.5.1.6 Electrical Needs

Operators need to call an electrician to reset the mixer units, which includes inherent delay for staff to travel to site to perform this activity.

1.5.1.7 Site Civil Needs

A new access roadway from Meldrum Street is needed due to safety concerns associated with the current entrance gate on Mt. Elliot Street, which is heavily trafficked with narrow shoulders. Vehicles must stop in the road or pull over to the narrow shoulder to allow time for the gate to open before entering.

1.5.1.8 Architectural Needs

The architectural needs include the following:

- Removal and reinstallation of chemical facility wall to accommodate sodium hypochlorite storage tank replacement.
- Wall modification, door removal, and new double door for SF-1 access.

- East and West vestibule modifications for NFPA 820 area isolation: provide required separation between hazardous classified spaces and unclassified spaces.
- Potential modifications to the chemical storage/feed room.

1.5.1.9 Safety Needs

The Leib CSO SDF lacks fall protection to allow safe access to appurtenances and valves above the sodium hypochlorite tanks. Fall protection is desired for safety.

Table 1.14 – Leib Safety Needs

Location	Description
Garage	No exit sign
Chemical Room	No guardrails on tanks
Chemical Storage Tanks	Fall Protection

1.5.2 Oakwood CSO RTB Needs

1.5.2.1 Disinfection Needs

The chemical storage system at Oakwood CSO RTB needs to be resized to meet increased peak demands. The currently storage tanks will need to be replaced with larger FRP tanks (15,000 gallons). The original design storage had a peak storm volume of 98 MG but will increase to 368 MG for the future collection system configuration to better reflect true disinfection needs established during the study phase of the design. The chemical feed system is at the end of its useful life and has several maintenance issues. In addition to the desire to standardize on one type of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Oakwood chemical feed system has the following issues:

- The gear pumps are expensive to replace and repair.
- The gear pumps vibrate despite efforts to eliminate vibration.
- The chemical feed pumps are on skids. The skid frames reduce access to the pumps and components and do not aid in the removal of the pumps.
- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common.
- Corrosion concerns at chemical injection points on pump discharge.
- Desire for side access manway on hypochlorite tanks for improved ease of inspection and future relining.

1.5.2.2 Screening Needs

Water carry-over into screenings dumpster and onto floor near dumpster: Screenings and spray water from the screens are conveyed by the screw conveyor directly into the dumpster at ground floor. There is a significant amount of water that can completely fill the dumpster during an event if grinder is off-line and spills onto the floor around the dumpster. This phenomenon is depicted in **Figure 1.5**. A wheel mounted screenings washer/compactor/grinder (i.e., compactor) was provided in the original system

and can be moved into place to wash and compact the screenings. The compactor has a drain that can divert the excess water to a drain line. The compactor, however, was problematic because screenings fill the compactor chute, dry in place, and are unable to be pushed out of the chute during the subsequent storm. However, GLWA modifications to the compactor have resulted in its reliable operation. The excess water conveyed to the compactor remains a challenge if it is off-line, and thus reduction of the water conveyed by the conveyor is desired.



Figure 1.5 – Oakwood CSO RTB Screenings Dumpster Overflowing During Storm Event

1.5.2.3 Storm Pump Station Needs

The following needs were identified for the storm water pump station:

- A significant volume of drinking water is currently used for seal water. Reduction or elimination of drinking water used for pump seals is desired.
- Debris buildup results in plugging on lubrication grooves in bearings, which under a worst case scenario can cause seizing of pumps.
- Multiple pump components require replacement, including shaft sleeves, line shaft bearings, bowl bearings, rolling element bearings, discharge pressure gauges, and lip seals.
- A motor thrust bearing cooling water system is desired.
- Possibility for improvements to pump controls to improve efficiency and reduce maintenance. These are described under **Section 1.5.2.5**.

1.5.2.4 Sanitary Pump Station Needs

Similar to the Storm Pump Station, there is room for improvement of the pump controls to improve efficiency and reduce maintenance. These are described under **Section 1.5.2.5**.

1.5.2.5 Instrumentation and Controls Needs

The following instrumentation and controls needs were identified:

- There is room for improvement of the storm and sanitary pump controls and operating strategy. With the current controls, the starting storm pump cannot be manually selected by operators, and the wear and tear on each pump is thus not consistent. Manual selection will ensure that the operation of the pumps is more evenly distributed between the pumps. Additionally, monitoring the wet well level and incorporation into the pump controls will allow pumps to operate closer to their preferred operating range (POR), maximizing efficiency and reliability.
- Storm pump flow meters are beyond their service life and no longer provide reliable flow information.
- A backup flow measurement method is desired for each storm pump if the flow meter is not working properly.
- Vibration monitoring on the storm pumps is currently configured to trip alarms when vibration exceeds a peak of 0.85 in/sec, irrespective of the sensor location. This alarm is frequently tripped.
- Operators have indicated the human interface modules (HIMs) for the Chemical Feed Pump VFDs are difficult to operate locally.

1.5.2.6 Flushing and Dewatering Needs

The storm wet well flushing system requires modifications to facilitate improved flushing of settled debris from the sanitary trench and storm wet well after each wet weather event.

CSO Basin Flushing valves are hard to reach during maintenance activities and scaffolding needs to be setup to reach the valves, which is difficult due to steep slope on the floor.

Significant grit accumulation at the flushing sumps in the CSO basins leads to plugging of the 12-in. drainage pipeline at the effluent end of the basin.

1.5.2.7 Electrical Needs

The needs of electrical work at the Oakwood CSO RTB as part of this project are limited to supporting process, I&C, and plumbing improvements.

1.5.2.8 Site Civil Needs

Site civil needs at the Oakwood CSO RTB are as follows:

- The current road around the basin is gravel and susceptible to potholing.
- There are areas around the basin with poor drainage, including electrical and instrumentation vaults.
- There are several locations around the perimeter of the Control Building where the concrete access sidewalk has settled, leaving uneven cracked flags of sidewalk. Several of these areas corrected as part of an earlier project, but not all.

The following needs are generally preventative maintenance items intended to ensure that the site features or utilities are serviceable throughout their expected service lives:

- Clear vegetation overgrowth from Surge Relief Basin.
- Seal joints in concrete pavement drive to ensure serviceability.

1.6 Project Future Needs

This project will provide the necessary capacity for treatment and hydraulic passage of CSO events over the entire project life cycle in anticipation of the future connection of the Meldrum Sewer and Northwest Interceptor to the Leib and Oakwood CSO facilities, respectively. These treatment and flow requirements for each facility were established during the study phase of this project and are summarized in **Appendix A**.

Hydrographs through the Oakwood and Leib facilities were generated using the Regional Wastewater Collection System (RWCS) SWMM model. The RWCS model was developed under the Wastewater Master Plan (WWMP) Project for planning and decision-making purposes. The RWCS model provides a detailed representation of the wastewater collection system as it is today. The RWCS model was used for this project to provide design flow rates at the CSO facilities. The design events selected for this analysis were the 6-month, 24-hour and 10-year, 24-hour storm events.

The RWCS model was run for the design storm events for current and future conditions. Model predicted influent peak flow rates to each facility are summarized below in **Table 1.15** for current and future conditions at the Leib and Oakwood facilities based on present planning. Current conditions represents the wastewater collection system as it is today. Future conditions assumes the Meldrum connection to the Leib CSO SDF and the Oakwood District Intercommunity Relief Sewer (ODIRS)

connection to the Oakwood CSO RTB and Pump Station have been constructed and are in-service. The original facility design flow rates are also included in **Table 1.15** for comparison purposes.

The predicted peak flow rates presented in **Table 1.15** are based on 5-minute model output. The reporting time step of 5-minutes was selected under the Wastewater Master Plan Project to match meter time stamp data. The modeling effort for this project retained these parameters.

Table 3.1 – Flow Rate Comparison

Facility	Facility Original Design Flow Rate (cfs)	Collection System Conditions (Current or Future)	Predicted 5-minute Peak Flow Rate (cfs)	
			6-month, 24-hour Design Event	10-year, 24-hour Design Event
Leib CSO SDF	1,550 (Peak Design Flow)	Current	118	520
	2,000 (Hydraulic Capacity)	Future	380	950
Oakwood CSO RTB and PS	1,660 (Firm Capacity)	Current	135	765
		Future	531	1,231



2.0 Analysis of Alternatives

Much of the alternatives analysis that informed the design of this project were recommended as part of CS-299, which is included in **Appendix E**. For instances where the conceptual study identified additional alternatives based on revised project criteria and scope items, these alternatives are identified and discussed in detail in the technical memoranda included in the Study and Conceptual Design Report in **Appendix A**.

2.1 No Action

The No Action alternative involves maintaining current system operations. Since this project is intended to accommodate additional flows from the Meldrum diversion sewer and the NWI diversion sewer, the Oakwood and Leib CSO's risk exceeding their current design treatment and/or hydraulic capacities. Additionally, aging equipment will eventually fail and leave the facilities at risk of achieving inadequate treatment, causing sewer backups, operation, and maintenance issues, NPDES permit non-compliance, degraded water quality in receiving water bodies (the Rouge and Detroit Rivers) and additional problems. The objectives of the project are not met under the No Action alternative and are not in accordance with the recommendations of CS-299 or the conceptual design study performed by CDM Smith.

2.2 Optimum Performance of Existing System

Optimization of existing systems involves operational changes and equipment or personnel changes to achieve the goals of the project beyond construction or replacement alternatives. In general, this overall alternative approach is appropriate for specific systems in the CSO facilities but is not appropriate where equipment age and reliability is the primary concern. Major examples of optimization improvements are:

- Comprehensive monitoring, feedback, and control of total residual chlorine (TRC), tank/wet well level, facility flow rates, and pumped flow rates to better inform the optimal sodium hypochlorite dosage at each facility. Optimization of chemical usage will result in overall lower chemical usage and superior effluent quality.
- Modifications to the operating controls of the pumped systems at Oakwood CSO RTB to reduce energy, drinking water usage, and O&M costs.
- Replacement of chlorination mixers downstream of the screen effluent channels at the Leib CSO SDF with chemical feed drop pipes to distribute disinfectant significantly reduces energy and O&M costs associated with operating the mixers.

2.3 Regionalization

The improvements included in this project were identified based on the need to divert additional flows from nearby sewers to these CSO facilities to more fully utilize their capacity and optimize collection system operations in such a way that protects water quality and prevents sewer backups. While the

diversions themselves are not in the scope of this project, the facility improvements will be designed to accommodate these diverted flows and improve water quality treated effluent to CSOs.

The nature of the combined sewage network served by the Oakwood and Leib CSO facilities is that they are used to alleviate both hydraulic issues associated with local sewer subcatchments and mitigate water quality issues associated with existing combined sewer overflow events. Decommissioning these CSO facilities without significant investments to redirect flows exceeding the hydraulic capacity of the combined sewer or increasing the capacity of the combined sewer downstream of each facility would result in uncontrolled and untreated CSO events. Thus, decommissioning these facilities is not an option considered as part of this project.

2.4 Monetary Evaluation

A monetary evaluation of alternatives for this project was performed as part of CS-299 and was used as the basis for selecting the recommended alternatives provided in that document, which were in turn incorporated into this project. Other alternatives were evaluated during the study phase of this project, in which a monetary evaluation was also performed and are provided in the Study and Conceptual Design Report.

2.4.1 Sunk Costs

Sunk costs are the investments or financial commitments made before or during project planning. These costs are not included in the cost-effectiveness analysis since they have already been committed regardless of the alternative selected. Sunk costs typically include the cost of existing facilities and land, outstanding bond indebtedness, and the cost of preparing the project planning document.

As described in **Section 2.3**, these CSO facilities cannot be relocated or decommissioned, and is thus not considered in this analysis.

2.4.2 Present Worth

The present worth of the construction of this project is calculated as follows:

$$PW = F * \frac{1}{(1 + i)^n}$$

Where:

F = Future Value = Estimated construction cost = \$44,000,000

PW = Present worth of one – time expenditures

i = Discount rate = 2.2%

n = Number of years = 3.8 years to construction mid – point.

The real discount rate was determined from the Federal Office of Management and Budget (OMB) from Appendix C of OMB Circular A-94 for a 3-5 year analysis. The number of years is calculated based on the time from present day (April 2024) to the anticipated mid-point of construction, estimated as 1/27/2028, which is 3.8 years. This results in an estimated present worth of \$41,000,000.

O&M costs associated with these improvements are expected to decrease significantly from their present values and are generally consistent between alternatives, thus not considered as part of alternatives analysis.

2.4.3 Salvage Value

The only work which may produce any meaningful substantial salvage value includes the removal of the COPA screens at Leib, which are made of stainless steel, and the removal of the existing chemical feed pumps at Oakwood, which contain Hastelloy heads/gears. Due to the highly specific sizing and applications of this equipment, it is assumed that they cannot be resold and only have value as scrap metal. Relative to the overall construction costs, these salvage values are insignificant and are thus not included in the monetary evaluation of alternatives.

2.4.4 Escalation

Escalation in the monetary evaluation for SRF loan approval is limited to energy costs and land value. As described in **Section 2.3**, these facilities cannot be relocated and the value of the land is not considered as it cannot be sold. In general, the energy savings associated with the project improvements are far outweighed by savings from reduced maintenance, reduced water usage, optimized chemical usage, and improved equipment reliability as a result of the infrequent operation of the facilities. Additionally, energy usage is considered to be similar between the evaluated alternatives.

2.4.5 Interest During Construction

Interest during construction was assumed in the most recent Opinion of Probably Construction Cost (OPCC) as 5 percent per year and is included in the overall project cost calculation. It was assumed for the purposes of alternatives analysis that all evaluated alternatives will result in similar construction schedules and thus similar interest rates.

2.4.6 User Costs

The cost to users is determined based on the duration of the SRF loan and overall project cost, as described in **Section 3.8**. Refer to that section for details on the end costs to users.

2.4.7 Project Delivery Method

The project delivery method for this project is traditional design-bid-build.

2.5 Environmental Evaluation

All improvements proposed within this project plan will be made to existing wastewater infrastructure at existing treatment facilities. Additionally, the construction methods are expected to have minimal environmental impact. Soil erosion and sediment control measures are included in the capital cost of the project and enforced during construction. Efforts will be made to mitigate and minimize construction noise and interruptions to traffic.



3.0 Selected Alternative

3.1 Summary

The work associated with the improvements at the GLWA Oakwood RTB and Leib SDF are required to address the disinfection, flushing, electrical, and instrumentation and control systems, and site improvements at both facilities, as well as HVAC and structural/architectural improvements needed to support the process modifications. This section contains a high-level summary of the work to be performed at each facility.

3.1.1 Leib CSO SDF

- Flow-paced and TRC-paced chemical feed control system.
- New chemical feed pumping and piping.
- New sodium hypochlorite storage tanks.
- Model disinfection performance and replace/remove chlorination mixers as feasible.
- Screening chamber flushing system improvements.
- HVAC and Architectural Improvements needed to comply with code requirements.
- Replacement of COPA screens with new Romag screens and rehabilitation of existing Romag screens.
- Site Improvements including alternate drive/gate access.
- Addition of process cameras.
- I&C and electrical improvements need to support process improvements.

3.1.2 Oakwood CSO RTB

- Flow-paced and TRC-paced chemical feed control system.
- New chemical feed pumping and piping.
- New sodium hypochlorite storage tanks.
- Modification of storm pumps to improve reliability.
- Storm pumps and sanitary pumps operational strategy improvements.
- Improved measurement of basin influent flow with Doppler flow meters.
- Screw conveyor drainage improvements.
- Improvements to the flushing valves and addition of basin drain sump flushing systems.
- Site improvements including improved drainage, onsite access roads and sidewalk repair.
- Elimination of cast-in-place steps in sanitary wet well influent channels.
- I&C and electrical improvements need to support process improvements.

3.2 Design Parameters

3.2.1 Design Criteria

Design criteria for the Oakwood and Leib CSO Control Facility Improvements are provided in **Table 3.1**. The anticipated flows for both facilities were developed based on storm hydrographs associated with each influent sewer and developed with the future Meldrum Sewer and NWI diversions to Leib and Oakwood CSO facilities, respectively, in service.

Table 3.1 – Design Criteria for Oakwood and Leib CSO Facility Improvements

Design Criterion	Leib CSO SDF	Oakwood CSO RTB
Treatment Capacity	950 cfs	1,231 cfs
Hydraulic Capacity	2,000 cfs	1,660 cfs
Design Storm Event 1	6-month 24-hour storm	6-month 24-hour storm
Design Flow Rate	380 cfs	531 cfs
Design Storm Volume	54 million gallons	92 million gallons
Design Storm Event 2	10-year 24-hour storm	10-year 24-hour storm
Design Flow Rate	950 cfs	1,231 cfs
Design Storm Volume	367 million gallons	368 million gallons
Screening		
# of Screens	8 (4 existing to be rehabilitated, 4 new)	6 (existing)
Screen Manufacturer / Type	Romag (deflection bar screen)	Andritz (perforated panel)
Screen Opening Size	4 mm	6 mm
Screen Capacity	158 cfs (each)	277 cfs (each)
Sampling and Monitoring		
# of Sampling Pumps	2 (new)	7 (new)
Pump Type	Submersible	Submersible
Disinfection		
Disinfection Contact Volume	6.5 million gallons	9 million gallons (total)
Design NaOCl Solution Strength	10.0 mg/L to 15.0 mg/L	5.0 mg/L to 15.0 mg/L
# of NaOCl Solution Storage Tanks	2 (new)	2 (new)
NaOCl Solution Storage Volume	15,000 gallons (each)	12,600 gallons (each)
Design NaOCl Dose	6.3 to 11.1 mg/L	7.4 to 14.0 mg/L
# of Recirc and Chemical Feed Pumps	3 (new)	4 (new)
Pump Type	Centrifugal, sealless mag-drive	Centrifugal, sealless mag-drive
# of Chemical Mixers	2 (existing)	N/A
Flow Retention		
# of Retention / Contact Basins	N/A	2
Retention Basin Volume	N/A	4.5 million gallons (each)
Storm Pumps		
# of Storm Pumps	N/A	8 (existing to be modified)
# of thrust bearing cooling water booster pumps	N/A	8 (existing)
# of grease lubrication central stations	N/A	8 (new)

Design Criterion	Leib CSO SDF	Oakwood CSO RTB
CSO Basin Solids Suspension Pumps	N/A	2 (new)

3.2.2 Flow Schematics

Existing schematic flow diagrams of the treatment processes at each facility are presented in **Figure 3.1**, **Figure 3.2**, and **Figure 3.3**. In general, the improvements associated with this project will not change the flow path through the facilities, with the following exceptions:

- New locations for TRC monitoring and sampling pumps.
- Slightly modified flow path for the new Leib screens – flow through the existing COPA screens moves vertically upward through the screen before flowing over the screen effluent weirs, while flow through the horizontal Romag screens moves horizontally through the screens and over the screen effluent weirs. Per the proposed improvements, all screening will be through the horizontal Romag screens.
- New chemical storage and feed systems, for which proposed new flow schematics are provided in **Figure 3.4** and **Figure 3.5**.

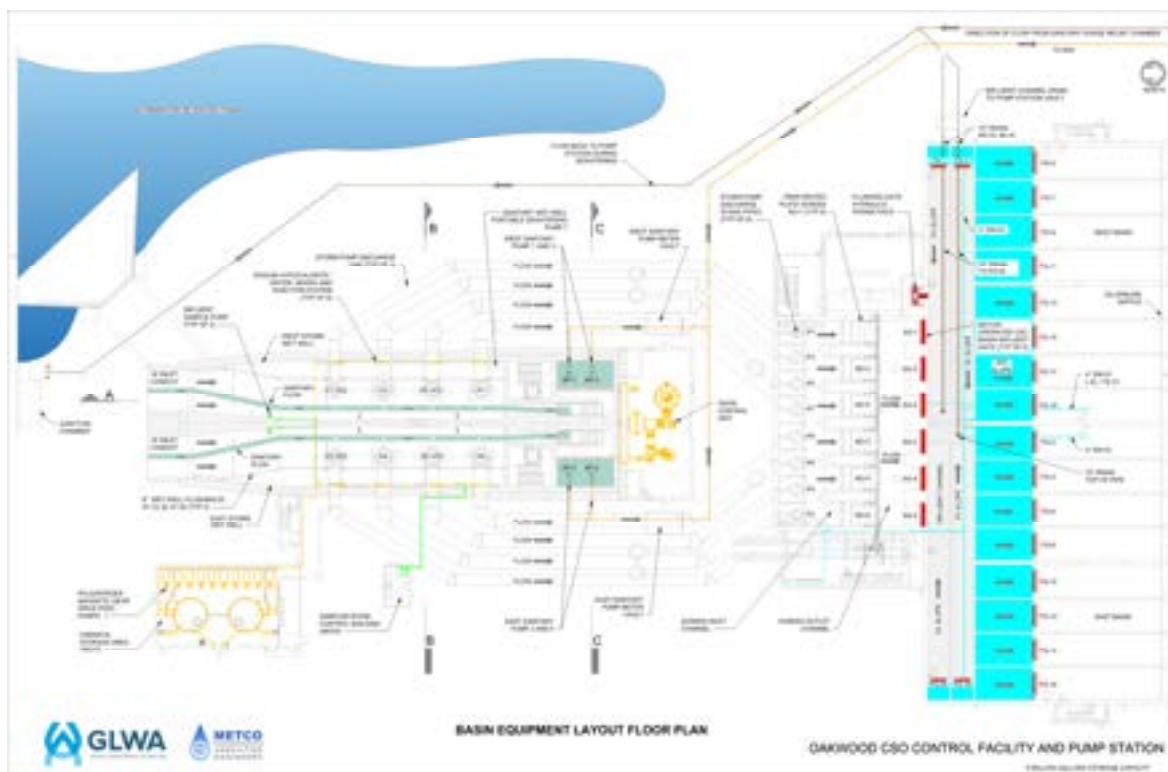


Figure 3.1 – Existing Oakwood CSO RTB Flow Schematic – Upstream End

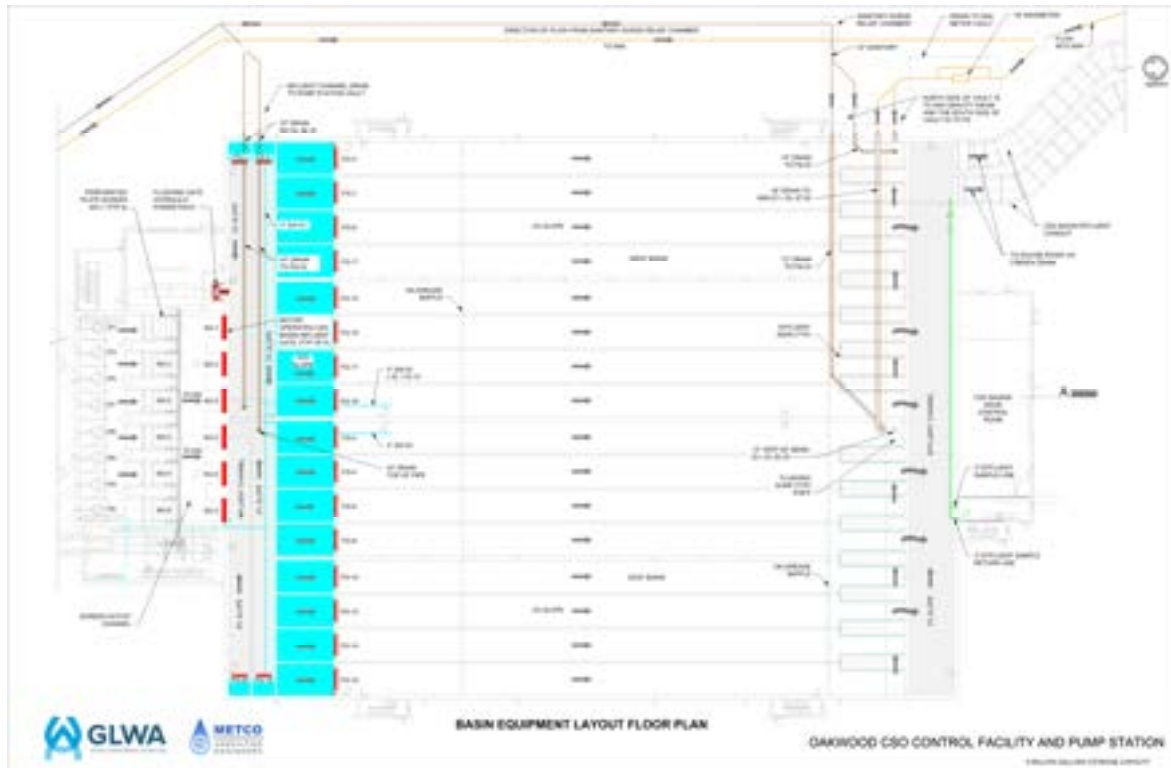


Figure 3.2 – Existing Oakwood CSO RTB Flow Schematic – Downstream End

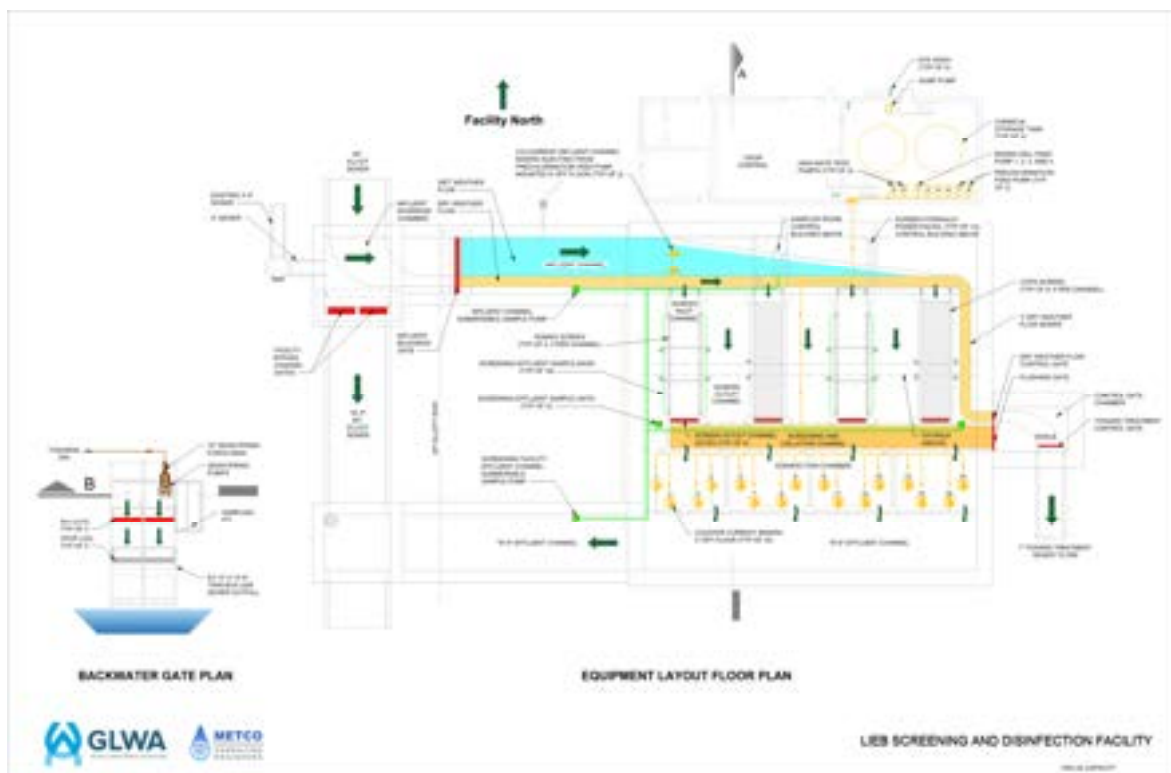


Figure 3.3 – Existing Leib CSO SDF Flow Schematic

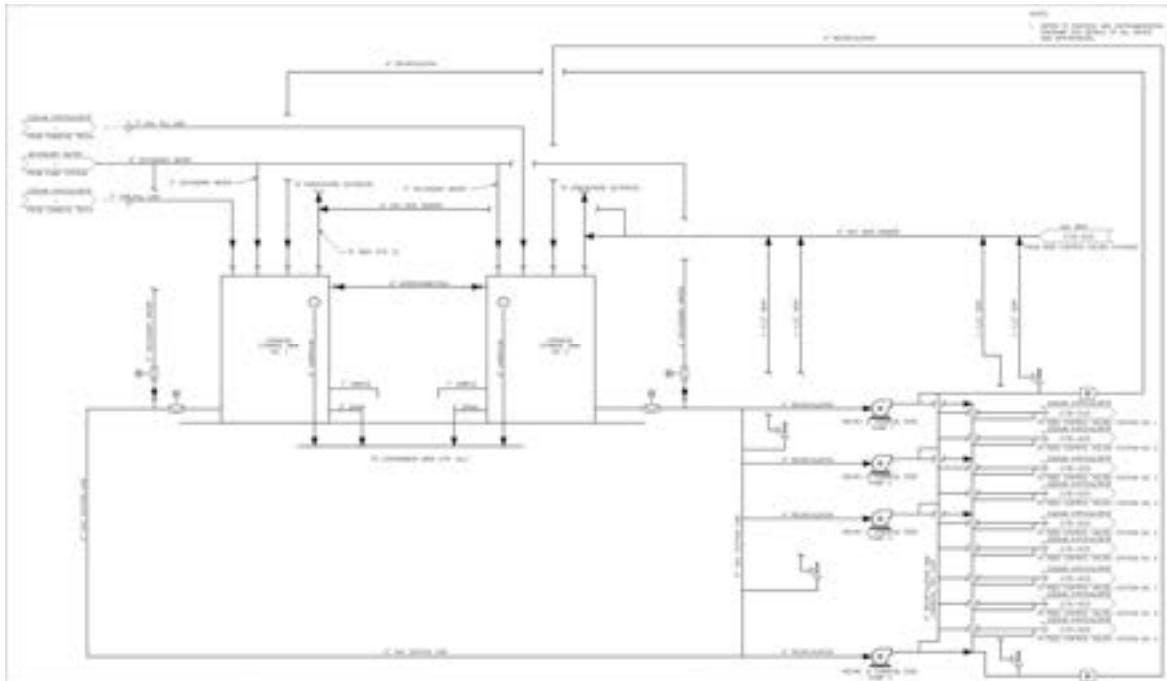


Figure 3.4 – Proposed New Oakwood CSO RTB Chemical System Flow Schematic

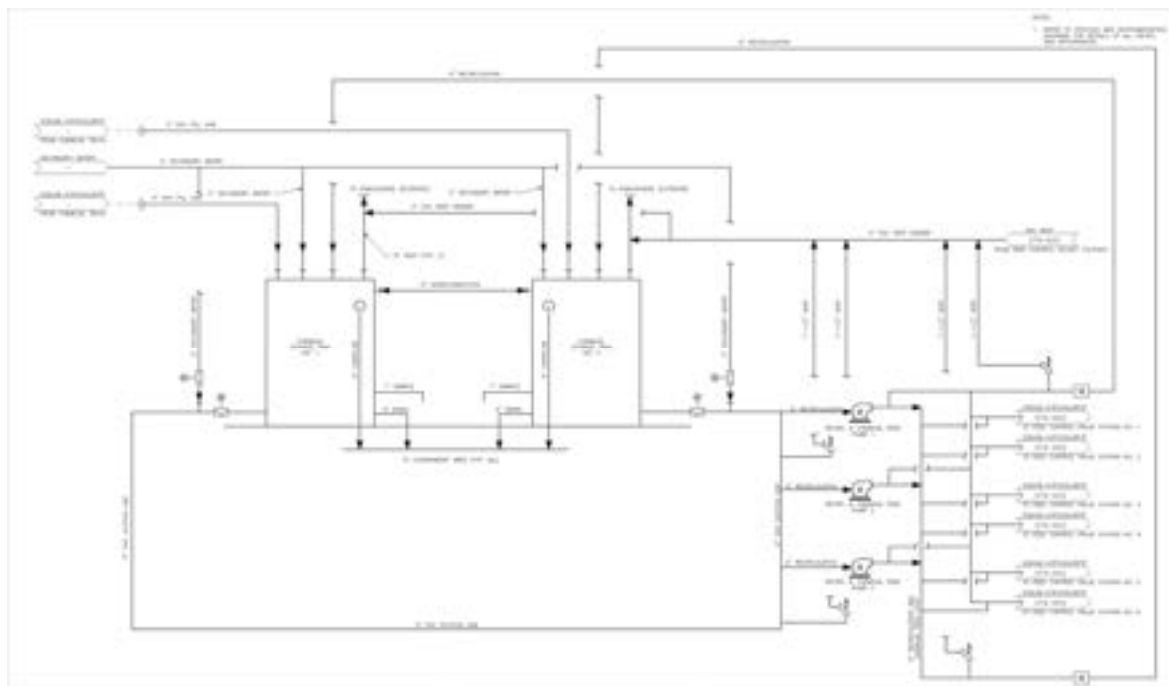


Figure 3.5 – Proposed New Leib CSO RTB Chemical System Flow Schematic

3.2.3 Soil and Erosion Control

Site and erosion plans for each facility are provided in **Figures 3.6** and **3.7**.

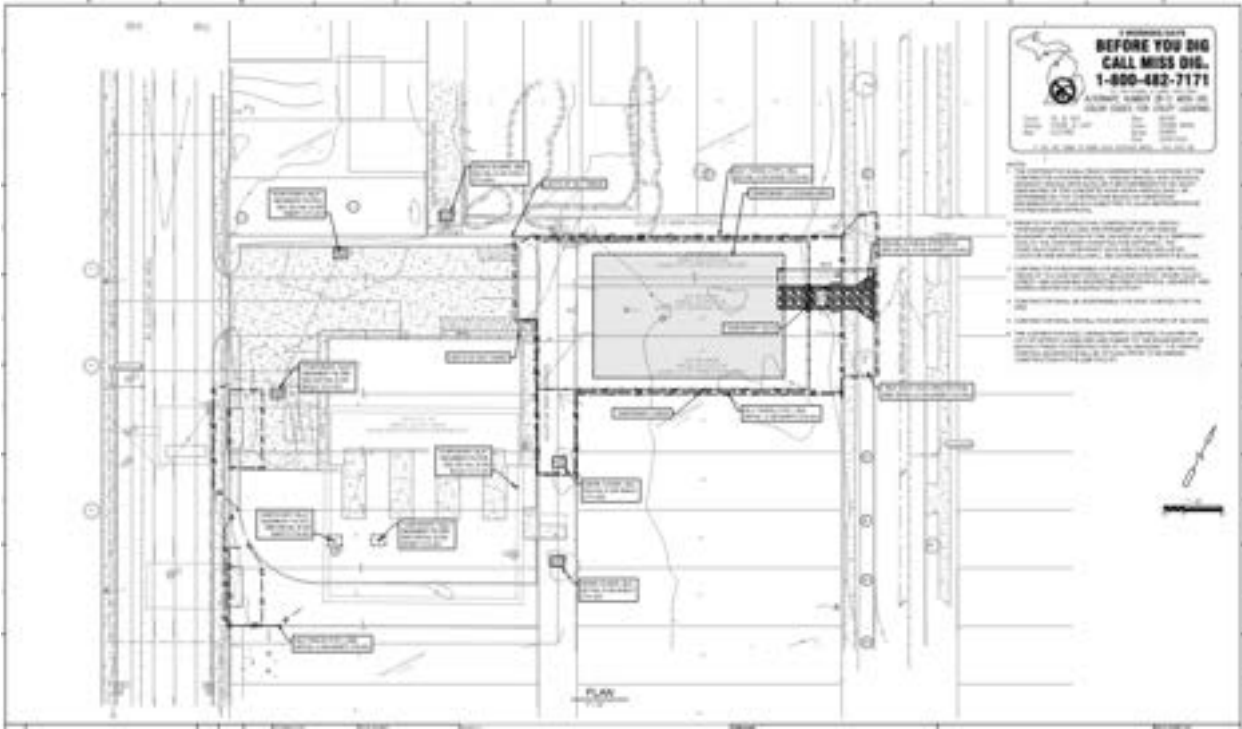


Figure 3.6 – Leib Site and Erosion Plan

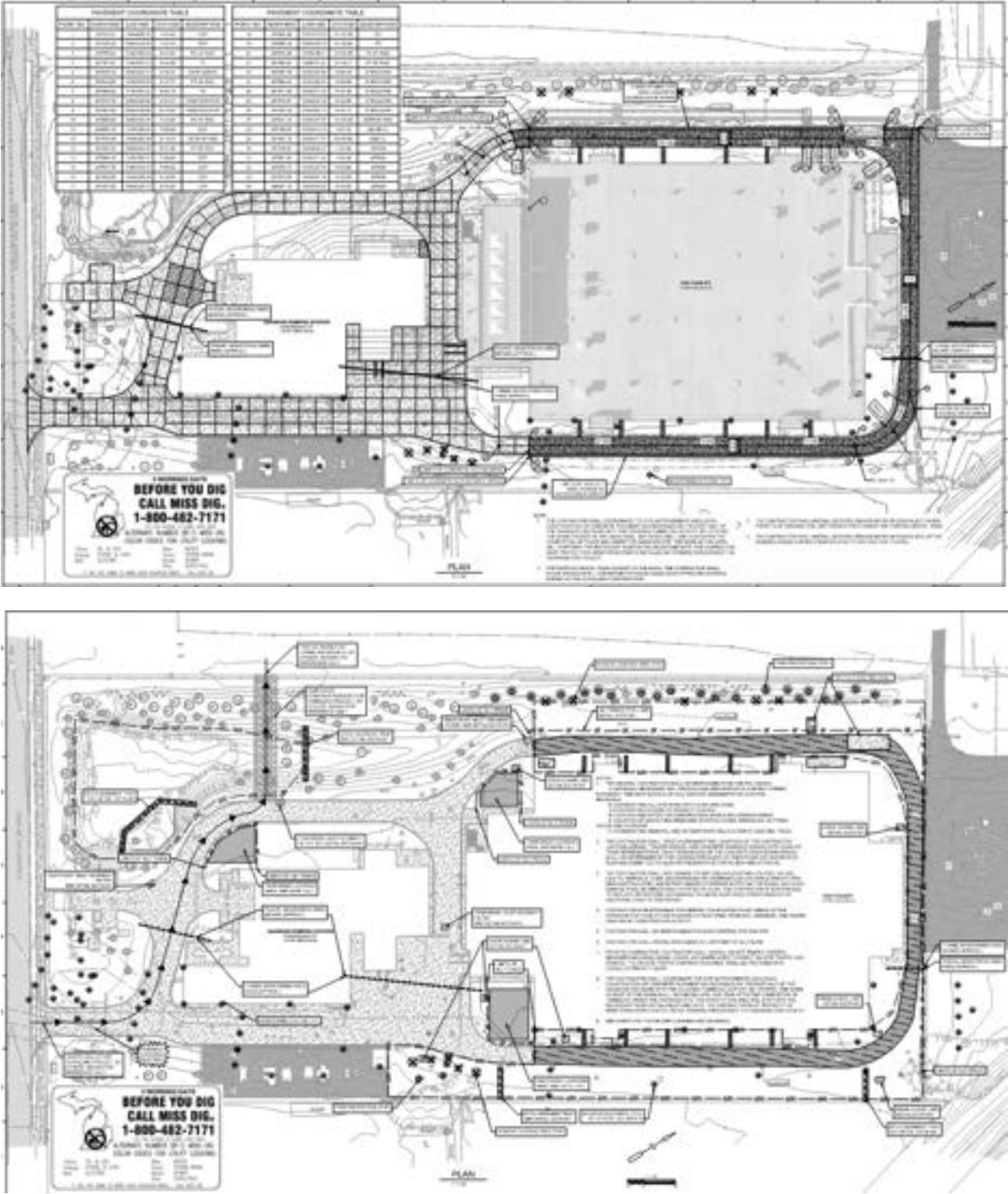


Figure 3.7 – Oakwood Site & Erosion Plans

3.2.4 NPDES Permit Requirements

The current NPDES Permit No. MI0022802, provided in **Appendix B**, authorizes combined sewer overflow discharge from the Oakwood CSO RTB and the Leib CSO SDF, requiring the daily monitoring and reporting of effluent flow, as well as reporting effluent carbonaceous biochemical oxygen demand (CBOD₅), total suspended solids (TSS), ammonia nitrogen (NH₃-N), and total phosphorus (TP), fecal coliform bacteria, pH, and dissolved oxygen. Both facilities must meet a fecal coliform limit of less than or equal to 400 counts per 100 mL from May 1 to October 31, and less than or equal to 1,000 counts per 100 mL from November 1 to April 30. The Oakwood CSO RTB is also required to report oil and grease concentrations during each storm event as well as daily influent flow to the RTB.

The permit also includes a TRC minimization program which provides operational goals for the CSO facilities of 1.5 mg/L TRC as an event average value and 2.0 mg/L (November through April) or 3.0 mg/L (May through October) TRC as an event instantaneous maximum value at each facility. The improvements to chemical feed, monitoring, and controls proposed as part of this project are designed to meet or exceed these operational goals.

3.2.5 Existing Sewer and Future Connections

The Leib CSO SDF intercepts combined sewage from the Mt. Elliot Sewer, a 16-ft 3-in diameter sewer tunnel running below Mt. Elliot Avenue in Detroit. Treated effluent from this facility re-enters the Mt. Elliot Sewer, which provides disinfection contact time prior to discharge at the CSO outfall in the Detroit River. The improvements to the Leib CSO SDF proposed in this project are in response to the planned installation of a new 5-ft diameter sewer, the “Meldrum Diversion Sewer”, below Waterloo Avenue, which will divert flow to the Leib CSO SDF from the 9’ diameter Meldrum Sewer below Meldrum Avenue.

The Oakwood CSO RTB intercepts flow from several sewers near the Oakwood Pumping Station located approximately one and a half miles from the WRRF. Excess flow Northwest Interceptor (NWI) will be diverted to the Oakwood CSO RTB as part of the recommendations from Wastewater Master Plan Update, which has available treatment capacity under the design 10-year 24-hour storm flow event. The improvements to the Oakwood CSO RTB proposed in this project will enhance reliability and provide upgrades to facilitate conveyance and treatment of this additional flow to the facility.

3.3 Proposed Improvements

3.3.1 Common or Similar Improvements at Oakwood and Leib CSO Facilities

3.3.1.1 Disinfection Improvements

Proposed improvements include replacement and reconfiguration of the sodium hypochlorite storage and feed systems at each CSO control facility. The existing chemical feed systems are at the end of their useful life and the new systems will be designed in response to usage requirements determined through influent sampling and disinfectant dose response curves at each facility developed in the study phase of the project.

The new chemical storage and feed systems will include new centrifugal chemical feed pumps, feed control valves, the addition of a recirculation manifold to the chemical feed control valves, new piping,

equipment support pads, and new storage tanks. These new systems will be right-sized for the chemical doses determined in the study phase of this project, and will improve to equipment and process piping to facilitate O&M.

3.3.1.2 Instrumentation and Control Improvements

Each facility will be outfitted with new sampling systems to enable real-time monitoring of TRC during storm events, and new control systems to optimize the chemical feed rate in response to this monitoring. The improvements will include a flow-paced control system that matches the chemical feed rate to the combined sewage flow to each facility, as well as establishing feedback-based dosage requirements based on effluent TRC. This new monitoring instrumentation, process equipment, and controls will be integrated with the existing Emerson Ovation DCS platform used at GLWA facilities.

3.3.2 Leib CSO SDF Improvements

3.3.2.1 Screening Improvements

At the Leib CSO SDF, the existing COPA screens will be replaced with new Romag screens. This will require structural modifications to the screen channels. The channel wall openings will be lowered to accommodate the new screen design thru-bar velocity requirement provided by Romag as we coordinated the design improvements. Additionally, Concrete stairs located in the screen inlet channel bottom slabs will be removed and replaced with stairs with much longer treads, strategically placed sidewall and riser fillets to balance the maintenance access needs of the screens with the reduction of effort for post-event flushing.

3.3.2.2 Chemical Distribution Improvements

CFD modeling of chemical mixing through the Leib CSO SDF indicated that adequate distribution of disinfectant in the combined sewage could be maintained by replacing the sixteen sodium hypochlorite mixers downstream of screening with single-point chemical addition drop pipes located immediately downstream of the Romag screens in the screen outlet channels. This will reduce energy costs associated with operation of the mixers, as well as significantly reduce mixer maintenance costs. The existing mixers can be salvaged or kept for replacement of the remaining pre-chlorination mixers.

3.3.2.3 Flushing and Cleaning Improvements

At the Leib CSO SDF, a new flushing system will be provided at the downstream end of each screen inlet channel and at upstream end of the screenings collection channel to minimize cleaning requirements after wet weather events. These screenings are flushed into the Toward Treatment Sewer, which continues to the WRRF.

The existing concrete steps in the screen influent channels accumulate significant amounts of screenings after a storm event, requiring difficult and time-consuming cleaning. The accumulated screenings also present a safety hazard if the stairs are climbed. Thus, these steps will be replaced with a smooth concrete slope such that uncaptured screenings are conveyed to the Toward Treatment Sewer when the storm flows subside.

3.3.2.4 Ancillary Improvements

Ancillary improvements at Leib are as follows:

- A new access road will be constructed, providing vehicular access from Meldrum Street east of the facility. This new access drive will include fencing and security, and displaced parking will be relocated.
- Bioswales will be added or expanded to improve drainage around the facility and accommodate the increased runoff from the impervious paving added to the site.
- New soft starters will replace the existing soft starters to allow for manual and virtual resetting when a starter is tripped for the two remaining mixers at Leib, simplifying and streamlining operations.
- To provide improved maintenance access to the supply fan, the Supply Fan Room will be enlarged by creating an opening in the east wall of the room, adding a room extension with a ceiling, and adding a set of double exterior doors to allow for future replacement. Per operator recommendations, the wall-mounted thermostat on the ground floor will be replaced to provide a visual indication of the temperature.
- Process cameras will be installed to enhance site security and process monitoring.

3.3.3 Oakwood CSO RTB Improvements

3.3.3.1 Pumping Improvements

The storm pumps at the Oakwood CSO RTB will be modified to extend their service life, optimize energy efficiency, and reduce maintenance requirements. These modifications will include the replacement of shaft sleeves, line shaft bearings, and bowl bearings. Additionally, individual grease lubrication pump central stations will be provided for each storm pump, eliminating the use of seal water and providing substantial savings in the cost of drinking water used at the facility. Cooling water will be supplied for the thrust bearings to extend equipment life and improve reliability.

3.3.3.2 Instrumentation and Control Improvements

For both the storm pumps and the sanitary pumps, the pump control system will be modified to optimize energy usage and maximize equipment service life.

The existing Oakwood CSO RTB storm pump discharge (basin influent) flow meters are past their useful design life and no longer produce usable flow data and thus will be replaced. Each of the eight existing meters will be replaced with advanced Doppler insertion meters in each of the storm pump discharge pipes. As a backup to this system, influent flow rate can be estimated by Ovation algorithm based on storm wet well level, pump run status, and pump speed (for VFD speed controlled pumps) from Ovation, using the storm pump performance curves. This secondary flow measurement method can be used to check the insertion flow meter output and can serve as a method of estimating flow if the insertion meters are out of service during a wet weather event. These flow measurements will be critical to the flow-paced sodium hypochlorite disinfection controls.

Redundant non-contact level sensors will be added to the wet wells to provide more reliable level measurements that provide valuable real-time operation and control data.

3.3.3.3 Flushing, Cleaning, and Dewatering Improvements

Improvements to the flushing systems at the Oakwood CSO RTB include the addition of pumps in the retention basin to provide recirculation and minimize the accumulation of sediment in the sump after a wet weather event.

Issues with the high volume of water conveyed to the screenings grinder/washer/compactor and screenings dumpster will be addressed by providing three drain sections and drain boxes in the screenings conveyor to minimize the volume of water included in the material conveyed to the grinder.

3.3.3.4 Ancillary Improvements

Ancillary improvements at the Oakwood CSO RTB are as follows:

- Under certain basin level and flow conditions, existing stairs in the sanitary pump station wet well influent channel create a cascade that entrains air into the sewage and releases foul odors and corrosive sewer gases into the air. To mitigate this phenomenon, the stairs will be replaced with a smooth concrete slab that permits the smooth surface for flow to be conveyed down into the sanitary wet well influent channel.
- The perimeter road around the CSO Retention Basins will be repaved according to MDOT standards for HS-20 loading per the recommendations from the geotechnical report (**Appendix F**). The repaved road will be provided with a shoulder on the outer edge of the road, as well as improved signage, bollards, and wider turning radii to facilitate large vehicular traffic around the site and improve safety.
- The storm and sanitary pump wells and influent tunnels will be cleaned as part of this project construction to facilitate access for construction.
- Bioswales will be added or expanded to improve drainage around the facility and accommodate the increased runoff from the impervious paving added to the site.

3.4 Useful Life

The design life of project is determined using a weighted average, calculated as the sum of each asset's dollar value times its estimated useful life, divided by the total estimated dollars spent on assets. The design life of the project is expected to exceed 20 years, but not 30 years. Thus, a 30-year SRF loan is requested.

3.5 Project Maps

Graphics showing the locations of the Leib CSO SDF, the Oakwood CSO RTB, and the WRRF are shown in **Figures 1.1, Figure 1.2, and Figure 1.3**. All work associated with this project will occur at the Leib CSO SDF and the Oakwood CSO RTB sites.

3.6 Water and Energy Efficiency

Specific components of this project are explicitly intended to improve energy and water usage efficiency and provide associated cost savings. In particular, the changes in pump operation at the Oakwood CSO RTB and the replacement of the chlorination mixers at the Leib CSO SDF are intended to provide energy savings. Improvements to the flushing systems at Oakwood will likely reduce the water use required to clean and flush the retention basins between wet weather events. Additionally, replacing the existing seal water systems for the Oakwood CSO RTB with grease lubrication systems will significantly reduce use of water. Changes at both Oakwood and Leib CSO facilities regarding total residual chlorine monitoring and sodium hypochlorite dosing are intended to improve the efficiency of chemical use.

3.7 Schedule for Design and Construction

A preliminary schedule for design and construction of the selected alternatives is presented in **Table 3.2**:

Table 3.2 – Proposed Project Schedule

Project Milestone Description	Actual/Projected
Design Contract Start	9/16/2022
Construction Document Ready for Bid	12/13/24
Construction Notice to Proceed	10/27/25
Construction Substantial Completion	2/11/2030
Construction Final Completion	4/29/2030

3.8 Cost Summary

Construction cost for the rehabilitation of the Oakwood and Leib CSO facilities by the recommended rehabilitation method is estimated to be \$44,000,000, which is a Class 2 estimate for budgetary purposes as defined by the American Association of Cost Engineering International. The cost carries an expected accuracy range of (-) 10% to (+) 15 percent.

In addition to the construction cost, the total project cost also includes:

- Design: \$8,600,000
- Construction Administration: \$1,700,000

The total project cost is \$55,000,000, rounded to the nearest \$1 million.

The CWSRF loan is anticipated to be financed for a 30-year term at 2.75 percent interest. The equivalent annual cost for this project is determined using the following equation:

$$A = PW * \left[\frac{i * (1 + i)^n}{(1 + i)^n - 1} \right]$$

Where:

A = Equivalent Annual Cost

PW = Present Worth = Total Project Cost = \$55,000,000

i = SRF Interest Rate = 2.75%

n = Term of SRF Loan = 30 years

Therefore, the equivalent annual cost is \$2,700,000.

The number of persons per household in Michigan was estimated by the United States Census Bureau as 2.47 in 2019. The estimated number of households that will be impacted by this project is estimated to be 1.16 million. The per household unit cost is thus \$2.34 per year.

3.9 Implementability

The Oakwood and Leib CSO control facilities are owned and operated by GLWA. GLWA is a regional utility with broad statutory authority. GLWA has entered contracts with its suburban customers, which establish the terms and conditions for receiving and treating wastewater and overseeing the operation and maintenance of the system. GLWA has substantial experience in the financing of capital improvements under a variety of programs. It has a proven track record for using system revenues to retire its debt on new facilities and projects. GLWA is responsible for the legal, financial, and managerial aspects of the Oakwood and Leib CSO control facilities and will be the loan applicant for the proposed project.



4.0 Environmental and Public Health Impacts

Formal contact with SHPO, THPO, USFWS, MNFI, and EGLE Water Resources Division will be made to review potential beneficial and adverse effects of the project to the environmental and/or public health.

4.1 Direct Impacts

Direct impacts are environmental impacts directly attributed to the construction and operation of the project. The effects of the proposed project on environmental factors have been analyzed.

The CSO facilities project will not have many direct impacts to the environment and public. In general, the project is creating improvements to the existing site and impacts to the environmental and public will be minimal and confined.

For both project sites, disturbance of traffic patterns, including detours, may be experienced. Additionally, the estimated cost per household annual user cost is \$2.43 per year.

4.1.1 Leib Direct Impacts

A new site access from Meldrum Street is proposed for the Leib CSO SDF. The construction of a new access road will include a 24-ft wide access drive and will be 175-ft off Meldrum Street. This will also include paving of Mt. Elliot in front of the Leib facility. The construction of a new access road may lead to soil disruption and drainage issues during excavation. Increased traffic could also contribute to localized air pollution, impacting air quality and respiratory health. Additionally, temporary traffic control near Meldrum Street could raise safety concerns for pedestrians and drivers. Mitigation measures are crucial to address these direct impacts and will be reviewed in **Section 5**.

4.1.2 Oakwood Direct Impacts

Improvements at the Oakwood CSO facility include adding paved roads around the basin, addressing drainage around the CSO Basin with green stormwater infrastructure featuring bioswale, addressing drainage in the electrical and instrumentation vaults, and replacing the settled concrete sidewalk. These improvements will have direct impacts on both the environment and construction site. Excavation for the paved roads and drainage may disturb soil and alter natural drainage patterns, necessitating erosion control measures to prevent sediment runoff. In addition, traffic on the project site may be impacted. The replacement of the settle concrete sidewalks will involve demolition and reconstruction activities, potentially generating noise and dust. Mitigation measures are crucial to address these direct impacts and will be reviewed in Section 5.

4.2 Indirect Impacts

Indirect impacts resulting from the proposed project include temporary impacts to air and noise pollution. The most significant air quality impacts are associate with construction debris and dust. Additionally, heavy equipment and construction noise may pollute surrounding areas outside the sites. Temporary changes to the natural environment and aesthetics of the area during construction will be restored upon completion. Because the proposed project is confined to previously constructed sites, there are no anticipated impacts to the following:

- Changes in the rate, density, or type of development (residential/commercial/ industrial).
- Changes in land use (i.e., open space, floodplains, prime agricultural land, shorelands, forested areas, or other natural habitats).
- Changes in water quality due to facilitated development.
- Impacts on cultural, human, social, and economic resources.
- Resource consumption over the useful life of the project.

4.3 Cumulative Impacts

Cumulative impacts are those impacts to the environment which increase in magnitude over time, or those which result from individually minor but collectively significant actions taking place over time. There are no anticipated cumulative impacts that would increase over time.



5.0 Mitigation

Where impacts cannot be avoided, mitigation measures will be taken. These are described in the following sections.

5.1 Mitigation of Short-Term Impacts

The most significant short-term impacts will be on the surface and subsurface where excavation will take place for the installation of the new sidewalks and access roads. Many mitigation techniques can be used to minimize construction impacts, including traffic and safety hazard control, dust control, noise control, and soil erosion and sedimentation control. Each of these will be included within the construction contract. Restoration and/or replacement of roads, vegetation, and utilities will also be handled within the construction contract.

5.2 Mitigation of Long-Term Impacts

It is not anticipated that there will be any long-term impacts at either of the construction sites.

5.2.1 General Construction

Mitigation measures would be developed to ensure that sensitive environments will not suffer permanent damage. In locations proposed for construction, permits will be obtained, and complete mitigation measures outlined within the permit will be adhered to.

5.2.2 Siting Decisions

Aside from the proposed new access road to Meldrum Street at the Leib CSO SDF, all improvements will be made at the existing CSO control facilities within the footprint of the existing sites.

5.2.3 Operational Impacts

No new operational impacts are expected aside from improvements to discharge effluent quality and operator safety. Operation of the upgraded facilities are expected to improve effluent discharge quality. Odors, aerosols, and noise were not identified as major issues with these facilities and the upgrades included in this project will not affect these. Several upgrades will be made to facility safety. Potential releases of hazardous chemicals (i.e., sodium hypochlorite solution) are already addressed in the facilities operation plan for the current chemical feed system and will not need to be modified.

5.3 Mitigation of Indirect Impacts

The proposed projects do not involve expansion of the facilities or implementation of a new treatment facility. The proposed work will not influence the rate of development, population density, zoning, or land use. Therefore, no direct impacts are foreseen as a part of this project.



6.0 Public Participation

6.1 Public Meeting

A Public Hearing for the Oakwood/Leib Project Plan was held on April 10, 2024, at the GLWA Water Board Building, online via Zoom Video conferencing, and through telephonic hearing. The intent of the Public Hearing meeting is to discuss the need for the project, principal alternatives, environmental impacts, description of the recommended alternative, and associated cost estimates and user charges, and scheduling of the proposed project.

A copy of the public hearing transcript is included in **Appendix D**.

6.2 Public Meeting Advertisement

The Public Hearing was advertised (online, paper, etc.) on month, day, 2024, XX days before the hearing date in accordance with SRF guidelines. Copies of the draft project plan detailing the proposed project were available for the inspection on March 27, 2024. The Public Hearing Notice is included in **Appendix D**.

6.3 Public Meeting Summary

The following topics were discussed at the public hearing:

- Project background.
- A description of the existing facilities.
- A description of the principal project alternatives that were considered.
- A breakdown of capital costs and O&M costs for each alternative.
- Proposed method of financing.
- Comparison of environmental impacts for the principal alternatives.
- The recommended alternative.
- Proposed monthly user costs for the implementation of the recommended alternative for the average residential customer.



7.0 Technical Considerations

As the scope of this project work is limited to the CSO facilities and does not contain any elements relating to infiltration and inflow removal, sewer system evaluation, structural integrity of sewer lines, a fiscal sustainability plan, or special assessment district properties.

Appendix A: Study and Conceptual Design Report

STUDY AND
CONCEPTUAL
DESIGN REPORT

**CSO Facilities Improvements-
Oakwood Retention Basin and Pump Station,
and Leib Screening and Disinfection Facility**
Contract No. 2101475

Great Lakes Water Authority

July 21, 2023



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Appendix E- CS-299 Report

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Appendix G - Comment Resolution Log

Executive Summary

The selected alternatives or major decision made during the Conceptual and Study Phase as documented in this report are summarized in **Table ES-1**. The decisions are organized by technical memoranda number.

Table ES-1: Major Decisions from the Conceptual and Study Phase

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
Recommended design storms and design flow rates as defined in TM-1 appendix	Facility Hydraulic Models	1		X		X		Review comments on Design Storm Event and Facility Flow Rate Summary memo (TM-1 Appendix A)
One construction contract for storm pump work + remaining work of this project.	Storm Pump Rehab & Wet Well Cleaning	2		X		X		GLWA agreement during 4/19 Workshop
Recommended two storm pumps be rehabilitated at a time based on the historical records showing no more than five pumps in operation for large wet weather events, See TM-15 Section 3.	Storm & Sanitary Pump Op. Strategies Imp. Eval.	15		X				Based on Key Decision Table GLWA comment, added recommendation for number of storm pumps to be rehabilitated at one time in TM-15, where backup/basis located.
Feasible to flush storm wet well after each event	Storm Pump Rehab & Wet Well Cleaning	2		X		X		GLWA agreement during 4/19 Workshop
Sanitary pumps will not be used during wet well cleaning process by outside contractor	Storm Pump Rehab & Wet Well Cleaning	2		X		X		GLWA agreement during 4/19 Workshop

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
Storm pump rehab/modification: CDM Smith proposed pump mfrs for rehab acceptable; one grease lube system per storm pump; grease lube system to be located on motor room level; connect the one existing grease lube bearing to new grease lube system.	Storm Pump Rehab & Wet Well Cleaning	2		X		X		GLWA agreement during 4/19 and 5/3 Workshops, final location of grease lube system on motor level to be vetted during BOD phase
Cooling water disposal alternative B acceptable but will require sump pump backup with a second pump (backup pump above the sump)	Storm Pump Rehab & Wet Well Cleaning	2		X		X		GLWA agreement during 4/19 and 5/3 Workshops
Remove cooling water booster pump (storm pump motor thrust bearing cooling)	Storm Pump Rehab & Wet Well Cleaning	2		X		X		5/24 meeting, Agree if path forward demonstrates sufficient pressure with not even one excursion. CDM Smith Recommends removal if water pressure monitoring demonstrates consistent adequate water pressure
Storm pump rehab (grease lube system considered modification) to include replacement of line shaft bearings, bowl bearings and likely the shaft sleeves	Storm Pump Rehab & Wet Well Cleaning	2		X		X		GLWA agreement during 4/19 Workshop

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
Cleaning methods and constraints identified in the specification for cleaning as part of this project to be patterned after the recent Pullman led cleaning work. Access to the wet well would not be modified as part of this project.	Storm Pump Rehab & Wet Well Cleaning	2		X	Recommend following similar procedures with exception of no sanitary pump use.	X		GLWA agreement during 4/19 Workshop
ST-5 be removed for rehab and grease lube modifications for work to be performed at pump manufacturer's facility.	Storm Pump Rehab & Wet Well Cleaning	2		X		X		GLWA agreement during 4/19 Workshop
Grease lube system modification to each storm pump to be performed as part of this project.	Storm Pump Rehab & Wet Well Cleaning	2		X		X		GLWA agreement during 4/19 Workshop
Only one stair, which aerates wastewater under certain operating conditions, requires modification, the other two stairs do not require modification.	Sanitary PS Concrete Stair Mod. Evaluation	3		X		X		GLWA agreement during 4/5 Workshop
Stair C (in sanitary influent channel upstream of screen) modifications to include stair removal and replacement with sloped concrete ramp.	Sanitary PS Concrete Stair Mod. Evaluation	3	X		Concluded this is the stair observed aerating flow, requires removal	X		GLWA input received during 4/19 workshop

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
OKW SCR-2 Addition of drain boxes to the conveyor trough to move forward into next design phase	Oakwood Screw Conveyor & Grinder System Modifications	4	X			X		GLWA agreement during 4/19 and 5/3 Workshops
OKW SCR-2 GLWA will continue to use the existing grinder	Oakwood Screw Conveyor & Grinder System Modifications	4	X			X		GLWA agreement during 4/19 and 5/3 Workshops
No change to screen cleaning washwater pressure	Oakwood Screw Conveyor & Grinder System Modifications	4		X		X		GLWA agreement during 4/19 and 5/3 Workshops
There are no further modifications to the vertical screenings chute needed	Oakwood Screw Conveyor & Grinder System Modifications	4		X		X		GLWA agreement during 4/19 and 5/3 Workshops
All-Romag screen alternative selection assuming operating in accordance with screen manufacturer recommendations	Leib Screening Evaluation	5	X		Determine to be technically feasible (hydraulics evaluated in detail)			HOLD: mfr coordination on recently indicates thru-screen velocity ongoing
All-Romag screen alternative to be provided in one phase or two phases (replace Copa screens in one or both channels as part of this project)	Leib Screening Evaluation	5		X				
OKW wet well level sensors will not be contact type.	I&C Improvements	7		X		X		GLWA agreement during 4/5 workshop and discussions with staff

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
OKW upstream and downstream wet well channels will each have redundant level sensors	I&C Improvements	7		X		X		GLWA agreement during 4/5 workshop
Leib DRI Level sensor (LIT3) is being replaced by GLWA project 2004538	I&C Improvements	7		X		X		Confirmation by GLWA on 4/12
OKW I/O expansion will be based on the Ovation platform	I&C Improvements	7		X		X		GLWA agreement during 4/5 workshop
Leib - SF-1 Maintenance Access - GLWA requested that a set of double doors be added to the exterior wall of the Supply Fan Room to allow for the removal of SF-1 in the future, as discussed in the TM Workshop.	Leib HVAC Improvements	8		X		X		GLWA agreement during 4/5 Workshop
Leib - SF-1 Maintenance Access - Alternate 2 - Enlarge Room by Creating an Opening in the East Wall of Supply Fan Room, and Adding Room Extension with Ceiling was selected during the TM Workshop as the best alternate. This alternate has been revised to include the double doors requested during the Workshop.	Leib HVAC Improvements	8	X			X		GLWA agreement during 4/5 Workshop

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
Leib - SF-1 Maintenance Access - The existing floor drain in the Garage located in the footprint of the Supply Fan Room extension shall be relocated and not abandoned per direction from GLWA provided in the review of the Draft TM-08.	Leib HVAC Improvements	8		X		X		GLWA comment during TM-8 Review
Leib - Office Temperature Controls - Alternate 2 - Replace Wall Mounted Thermostat was selected during the TM Workshop as the best alternate.	Leib HVAC Improvements	8	X			X		GLWA agreement during 4/5 Workshop
Leib - East and West Vestibule Connectivity Issue - Per the discussions that took place at the TM Workshop and with the CSO Manager, Alternative 2 was selected as the best solution, that provides adequate security and the desired weather protection.	Leib NFPA 820 Analysis	9	X			X		GLWA agreement during 4/5 Workshop and D. McCord 4/18 Meeting
Leib - East and West Vestibule Connectivity Issue - A bird screen is acceptable for the desired protection. A bug screen is not needed per discussions with the CSO Manager.	Leib NFPA 820 Analysis	9		X		X		GLWA decision during D. McCord 4/18 Meeting

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
Leib - Odor Control Duct for Future Use Connectivity Issue - Per the discussions that took place at the TM and Preliminary Review Workshops, the Odor Control Duct shall be abandoned as noted above in this Technical Memorandum.	Leib NFPA 820 Analysis	9	X			X		GLWA agreement during 2/10 Conceptual Design Overview 4/5 Workshop
OKW-use of geogrid material under the pavement to bridge over the organic pockets	Survey and Site Constraints	11		X	Geotechnical report has been revised to include this as an alternative and confirmed technically feasible.	X		Requested consider this alternative at 4/5 workshop
Speed range changes for storm and sanitary pumps as presented in TM-15	Storm & Sanitary Pump Op. Strategies Imp. Eval.	15		X		X		GLWA agreement during 5/12 Workshop
Changes to minimum wet well level (lead pump shutoff) for Storm pumps as summarized in TM-15	Storm & Sanitary Pump Op. Strategies Imp. Eval.	15		X		X		GLWA agreement during 5/12 Workshop
Changes to overall control based on rising level setpoint for Storm pumps	Storm & Sanitary Pump Op. Strategies Imp. Eval.	15		X		X		GLWA agreement during 5/12 Workshop
SN – Operation with one pump serving dry weather flow wet well level range in lieu of three	Storm & Sanitary Pump Op. Strategies Imp. Eval.	15		X		X		GLWA agreement during 5/12 Workshop

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
SN- speed constraints to maintain operation within AOR	Storm & Sanitary Pump Op. Strategies Imp. Eval.	15		X		X		GLWA agreement during 5/12 Workshop
Changes to number of operating sanitary pumps as a function of wet well level.	Storm & Sanitary Pump Op. Strategies Imp. Eval.	15		X		X		GLWA agreement during 5/12 Workshop
Partitioning the chlorine demand/usage between first flush conditions and the balance of the storm event.	Chlorine Dose Response Results and ICT Model/Chlorine System Alternatives	18 / 20	X			X		GLWA agreement during 5/12 Workshop
Oakwood ICT values	Chlorine Dose Response Results and ICT Model/Chlorine System Alternatives	18 / 20	X			X		GLWA agreement during 5/12 Workshop
Leib ICT Values	Chlorine Dose Response Results and ICT Model/Chlorine System Alternatives	18 / 20	X			X		GLWA agreement during 5/12 Workshop
Base minimum SHC flow rate on minimum ICT value from the chlorine dose response testing performed to date and the minimum flow rate for each facility.	Chlorine Dose Response Results and ICT Model/Chlorine System Alternatives	18 / 20	X			X		GLWA agreement during 5/12 Workshop
Use colorimetric TRC analyzers and Swan as the manufacturer	Chlorine System Automation Evaluation	19	X			X		GLWA agreement during 5/12 Workshop

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
Agreement with means of controlling and optimizing the chlorine disinfection process: Manual Control, Flow Paced, ICT Dose Paced with TRC Analyzers, and Machine Learning (ML) Dosing model	Chlorine System Automation Evaluation	19	X			X		GLWA agreement during 5/12 Workshop
Chlorine Demand and Chlorine Decay sampling locations at Oakwood.	Chlorine System Automation Evaluation	19	X			X		GLWA agreement during 5/12 Workshop
TRC analyzer locations for Chlorine Demand and Chlorine Decay at Oakwood at Screen Facility (either roof of Screen Inlet Chamber or Mechanical Room of Screen Facility) will be evaluated during Basis of Design.	Chlorine System Automation Evaluation	19		X	Evaluate location of TRC Analyzer at either roof of Screen Inlet Chamber or Mechanical Room of Screen Facility) during Basis of Design	X		From 5/24 meeting, Agree if recommendation made in BOD phase, since will not finalized in study phase
Chlorine Demand sampling location at Leib agreed.	Chlorine System Automation Evaluation	19		X	General location for Chlorine Demand sample was agreed upon (in effluent channel) but exact location will be determined based upon CFD modeling results.	X		Recommendation will be based on CFD Model results.

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
TRC analyzer location to be in the existing sampling room.	Chlorine System Automation Evaluation	19	X			X		GLWA agreement during 5/12 Workshop. Typical for all location determinations - to be verified during design [BOD phase] as size requirements are finalized and appropriate virtual modeling is conducted
Redundant TRC analyzers will be provided	Chlorine System Automation Evaluation	19	X			X		GLWA agreement during 5/12 Workshop
Redundant TRC sample pumps	Chlorine System Automation Evaluation	19		X	Do not include redundant sample pumps for TRC analyzers, nor a shelf spare. Instead, utilize a lookup table with historic chlorine demand and decay data to select values to be utilized in the ICT algorithm if a sample pump is out.	X		From 5/24 meeting, would rather have on the shelf spare
Redundant influent sample pumps	Chlorine System Automation Evaluation	19		X		X		From 5/24 meeting, would rather have on the shelf spare

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
SHC (Hypo) proposed storage concentration (10.5% at Oakwood and 10% at Leib) as the basis of design.	Chlorine System Alternatives	20	X			X		GLWA agreement during 5/12 Workshop
Oakwood - Do not install baffles in the RTB	Chlorine System Alternatives	20	X			X		GLWA agreement during 5/12 Workshop
Oakwood - Replace existing SHC storage tanks with two new FRP tanks with a working storage volume of 15,000 gallons	Chlorine System Alternatives	20	X			X		GLWA agreement during 5/12 Workshop
Oakwood - Replace existing feed system with recirculation loop w/ centrifugal pumps and flow control valves	Chlorine System Alternatives	20	X			X		GLWA agreement during 5/12 Workshop
Leib - Replace existing SHC storage tanks with two new FRP tanks. Working storage volume to be 12,600 gallons	Chlorine System Alternatives	20	X			X		GLWA agreement during 5/12 Workshop
Leib - Replace existing feed system with recirculation loop w/ centrifugal pumps and flow control valves	Chlorine System Alternatives	20	X			X		GLWA agreement during 5/12 Workshop

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
Continue additional undisinfected, wet weather water quality sampling and analysis moving forward. Focus on undisinfected bacteria, along with TSS, turbidity, UVT, TOC and the other water quality parameters tested during CDM Smith sampling. Also perform blends of NWI/Oakwood to understand possible impacts to ICT value. Chlorine dose response testing should be performed periodically.	Chlorine System Alternatives	20	X			X		GLWA agreement during 5/12 Workshop. GLWA review comment GLWA Key Decisions Table review comment: CDM to recommend sampling program for GLWA. What is the timeline for this and when would it take place? [Response, sampling plan under development, intend begin shortly and be one year in duration.]
GLWA agreed with the recommendation to meter Oakwood basin influent flow using insertion type advanced Doppler flow meters on the storm pump discharge pipes, if can demonstrate that reliable for the proposed meter type in wet/dry application.	Basin Influent Flow Metering	21		X	Evaluate reliability with trial meter provided by ADS (Nivus meter)	X		5/24 meeting: Agreement subject to confirmation of reliability
GLWA agreed with the recommendation for backup flow estimate to be calculated within Ovation	Basin Influent Flow Metering	21		X		X		GLWA agreement during 4/19 Workshop

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
Storm wet well flushing: do not add header on "back side" of splitters; lower storm wet well flushing water header; remove sanitary flow trench covers; automate flushing sequence; flushing water quantity could increase as evaluated by Design Team.	Flushing Systems	22		X		X		GLWA agreement during 4/19 Workshop
Leib FD-1 - GLWA to confirm the inclusion of the screening inlet channels and the screening collection channel for the flushing system	Flushing Systems	22		X		X		GLWA agreement during 4/19 Workshop
OKW FD-2 - GLWA to confirm relocation of flushing valves. Also to confirm extension of flushing water header to the RTB sumps.	Flushing Systems	22		X		X		GLWA agreement during 4/19 Workshop
OKW FD-2 - GLWA to confirm the implementation of the sump conditioning pump and flushing water manifold in the RTB sumps.	Flushing Systems	22		X		X		GLWA agreement during 4/19 Workshop pending follow-up on action items

Description of Decision	Technical Memo		CDM Smith Team			GLWA		
	Title	T M	¹ Selected Alternative	² Key Decision	³ Recommended Path Forward	Agree	Disagree	Comments
OKW- GLWA prefers shoulder along the outer perimeter of the proposed road instead of curb and curb opening alternative, runoff to flow over the road and shoulder and drain into the bioswale	Site Civil Design	24		X	GLWA prefers this option to avoid plow damage to curb, deemed technically feasible	X		Discussed at 5/24 meeting
Leib - GLWA prefers that the Design Team utilizes drainage swales and the existing drainage system for the recommended alternative.	Site Civil Design	24		X	Determined to be technically feasible	X		GLWA preferred surface drainage and bioswale as expressed at 4/5 workshop
Leib - combining 3 parcels to avoid 2 separate drops	Site Civil Design	24		X	Additional meetings between GLWA, DTE and CDM Smith ongoing			Ongoing
Leib - the Alternative 2 with Fencing in the Vacated Alley	Site Civil Design	24	X			X		GLWA agreement during 4/5 Workshop

Notes:¹ Alternative selected by GLWA² If no alternative was selected by GLWA and Key Decisions were made this was used by the Engineer to make a recommendation³ Engineers Recommended Path Forward based on Key Decisions. Refer to GLWA Agree/Disagree column for confirmation of recommendation acceptance

Section 1

Introduction

1.1 Report Purpose

This Study and Conceptual Design Report documents the efforts the CDM Smith design team has undertaken during Task B of the Study Phase to define the improvements that will be further designed/developed during the Basis of Design Phase – Task C.

Major decisions that were made as a part of Task B are included in the final technical memorandums (TM's) in Section 2 of this report. This report is intentionally concise; the on-site investigation, project coordination, final conclusions and design criteria for progression undertaken as a part of this task are memorialized as within the TM's with the major decisions summarized within the executive summary.

1.2 Project Description

Professional services from the CDM Smith design team for Contract No. 2101475 CSO Facilities Improvements, has been focused on improving facility reliability, flexibility, operation, maintenance and safety to support planned increases in utilization/peak flow for the Oakwood and Leib CSO facilities upon completion of other projects that are being planned to divert flow from the Northwest Interceptor (NWI) to the Oakwood CSO Facility and to divert flow from the Meldrum sewer for treatment in the Leib SDF. In addition, engineering services included preparation and development of computational fluid dynamics (CFD) modeling for the Baby Creek SDF and the Connor Creek RTB CSO facilities.

1.3 Project Scope

Task B – Conceptual and Study Phase scope of work is summarized in Table 1-1, which lists the major tasks and the technical memoranda that discusses the investigation, results and recommendations of each task.

Table 1-1: Project Scope Major Tasks

Improvement No.	Description	Technical Memo No.
OKW-DIS-1	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	17, 18, 19, 20
OKW-DIS-2	Install Flow-paced and TRC-paced Chemical Feed Control System	17, 18, 19, 20
OKW-DIS-3	Repair Hypochlorite Storage Tanks and Provide Side Access Manways	20
OKW-FD-2	Reservoir Flushing Valves Relocation and Sump Flushing	22
OKW-SITE-1	Site Improvements	11, 24
OKW-PUMP- 1A	Storm Pumps and Sanitary Pumps Operational Strategy	15
OKW-PUMP-1B	Rehabilitate Storm Pumps and Clean Wet Wells	2
OKW-PUMP-2	Eliminate Cast-in-Place Steps in Sanitary Wet Wells	3
OKW-I&C-1A	Improved Measurement of Basin Influent Flow	7, 21
OKW-I&C-1B	Process Cameras	7
OKW-SCR-2	Oakwood Screw Conveyor & Grinder System	4
LEIB-DIS-1	Chemical Feed utilizing Manifold Pump Distribution and Centrifugal Pumps	17, 18, 19, 20
LEIB-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	17, 18, 19, 20
LEIB-DIS-3	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	17, 18, 19, 20
LEIB-FD-1	Screening Chamber Flushing System	22
LEIB-HVAC-1	HVAC Improvements	8, 9
LEIB-SCR-1	Screening Improvements and Pilot Screen	5
LEIB-SITE-1	Site Improvements and Alternate Access	11, 24
LEIB-ELEC-1	Electrical Improvements	6
LEIB-I&C-1A	I&C Improvements	7
LEIB-I&C-1B	Process Cameras	7
BC-DIS-3	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	13
CON-DIS-3	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	14

Section 2

Final Technical Memoranda

2.1 Site Civil, TM-11 & TM-24

Oakwood CSO Retention Treatment Basin (RTB) and Pump Station

- Replace gravel road around CSO basins with concrete pavement
- Improve poor surface drainage around CSO basins
- Expand swales around CSO basins
- Replace damaged concrete pavement and sidewalks
- Remove vegetation from surge basin area

Leib CSO Screening and Disinfection Facility (SDF)

- Provide new access roadway off Meldrum St.
- Add fencing for second access road to site
- Drainage modifications to accommodate access roadway
- Add bollards for protection as needed along access roadway
- Provide motorized access rolling gate



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Mark Schobert, CDM Smith
Atul Kajale, CDM Smith
Spalding DeDecker (Sub-Consultant)
SOMAT (Sub-Consultant)*

Date: June 1, 2023

*Subject: TM-11 Survey and Site Constraints
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

The purpose of this technical memo (TM) is to characterize above ground and below ground existing conditions to support the design of the site improvements described as OKW-SITE-1, and LEIB-SITE-1.

Topographic surveys and geotechnical investigations of the Oakwood (OKW) and Leib sites were performed in the fall of 2022. The Design Team conducted the Topographic Surveys and Geotechnical Field Investigations, and prepared the Draft Geotechnical Investigation Reports.

The existing conditions base mapping, and geotechnical reports and findings for both sites are included as appendix items to this TM. Also included in the appendix are relevant as-built drawings and the MISS DIG utility files which were supplied to the surveyor by third-party utilities near the subject project sites.

The information in this technical memorandum is utilized for concept design in TM – 24 – Site/Civil Design

1.0 Introduction and Purpose

The purpose of this TM is to support the design of the site improvements described as OKW-SITE-1, and LEIB-SITE-1 in the Engineering Services Agreement for the Combined Sewer Overflow (CSO) Facilities Improvements Project. These improvements are also referenced in the CS-299 CSO Facility Needs Assessment Report dated April 9, 2021 (CS-299 Report). The improvements are intended to improve facility reliability, flexibility, operation, maintenance, and safety to support planned increases in utilization for the Oakwood and Leib CSO facilities upon completion of other projects that are being planned for implementation. The Oakwood Facility is located at 12220

Pleasant Street, Detroit, MI 48217. The Leib Facility is located at 2198 Mt Elliot Street Detroit Michigan.

OKW-SITE-1 consists of paving an existing gravel drive that goes around the CSO basin, fixing drainage issues and damaged concrete around the CSO basin area, sealing the existing concrete driveway areas, and removing the overgrowth of vegetation in the surge basin area.

LEIB-SITE-1 consists of confirming the size, configuration, and geometry of a new access drive from Meldrum St. and associated changes to the Leib parking lot, parking lot striping, protection of the transformer with bollards, fencing, motorized vehicle gate, security badge access, and necessary electrical needed to facilitate the improvements. Three parcels in which the driveway is intended to cross are owned by Detroit Water and Sewerage Department (DWSD). The alley in between the existing Leib Facility parcel and these three parcels has been vacated. Electrical and telecommunications providers have utilities in the influence of the proposed driveway.

Topographic surveys of the Oakwood and Leib sites, as well as adjoining right-of-ways and parcels were performed in fall of 2022 utilizing aerial imagery and conventional ground surveying methods. Digital terrain models were computed, and contours developed at 1-foot intervals. Facility records and third-party utility information obtained from MISS DIG requests were obtained and checked against the survey field information to develop site base maps of existing conditions to be used for conceptual design. Underground utilities are shown based upon a combination of record information along with actual field measurements for above-ground manifestations of underground utilities. Mapping in both pdf and CAD formats is provided and a set of base map drawings have been produced for each site using Civil 3D.

Two Draft Geotechnical Reports have been prepared, one for each site. The geotechnical reports are attached in Appendix B of this report. At the Oakwood Site, the field exploration program consisted of six hand-auger probes which were extended to depths approximately 4 to 6 feet below existing grades to support the design of new pavement and a potential bioswale feature. The proposed pavement section is 9-inch-thick reinforced concrete over a minimum 8-inch-thick aggregate MDOT 21AA base with HS-20 loading. Geotechnical recommendations for the proposed pavement section and proposed bio-swale are provided in the geotechnical report. At the Leib Site, the field exploration program consisted of two soil borings which extended to 10 feet below existing grades to support the design of new 9-inch-thick reinforced concrete over a minimum 8-inch-thick aggregate MDOT 21AA base with HS-20 loading. Geotechnical recommendations for the proposed pavement section are provided in the geotechnical report.

2.0 Existing Systems Description and Conditions

Figures 2-1 and **2-2** show aerial photographs of the Oakwood and Leib Sites respectively taken in fall of 2022. Mt Elliot Street in front of the Leib Facility has been recently paved and striped.



Figure 2-1
Fall 2022 Aerial Image of Oakwood Site, 12220 Pleasant Street, Detroit



Figure 2-2
Fall 2022 Aerial Image of Leib Site, 2198 Mt Elliot Street, Detroit

2.1 Oakwood Site – Existing Conditions

A site visit was conducted November 22, 2022 at the Oakwood Site. Pictures were taken of existing conditions around the CSO Basin. **Figures 2-3, 2-4, and 2-5** show photos taken along the existing gravel roadway on the west, north, and east side of the Oakwood CSO Basin. The gravel roadway is uneven, has many areas of standing water and is poorly drained.



Figure 2-3
Site Photos – West Side of Oakwood CSO Basin



Figure 2-4
Site Photos – North Side of Oakwood CSO Basin



Figure 2-5
Site Photos – East Side of Oakwood CSO Basin

Two storm manholes are presumed to be buried beneath the gravel roadway and could not be located with a metal detector. Several large concrete vaults lie within or adjacent to the gravel roadway on the west side of the CSO Basin and will need to be integrated into the paving plan. These chambers are the Sanitary Surge Relief Chamber, the Drain to Northwest Interceptor (NWI) Meter Vault and the Drain to NWI Valve Vault. **Figure 2-6** shows the location of these features. **Figure 2-7** shows the electrical and instrumentation conduits which are below the gravel roadway on the western side of the Oakwood CSO Basin. **Figure 2-8** shows pictures during construction of the existing underground duct bank which was constructed as part of the facility in 2012.

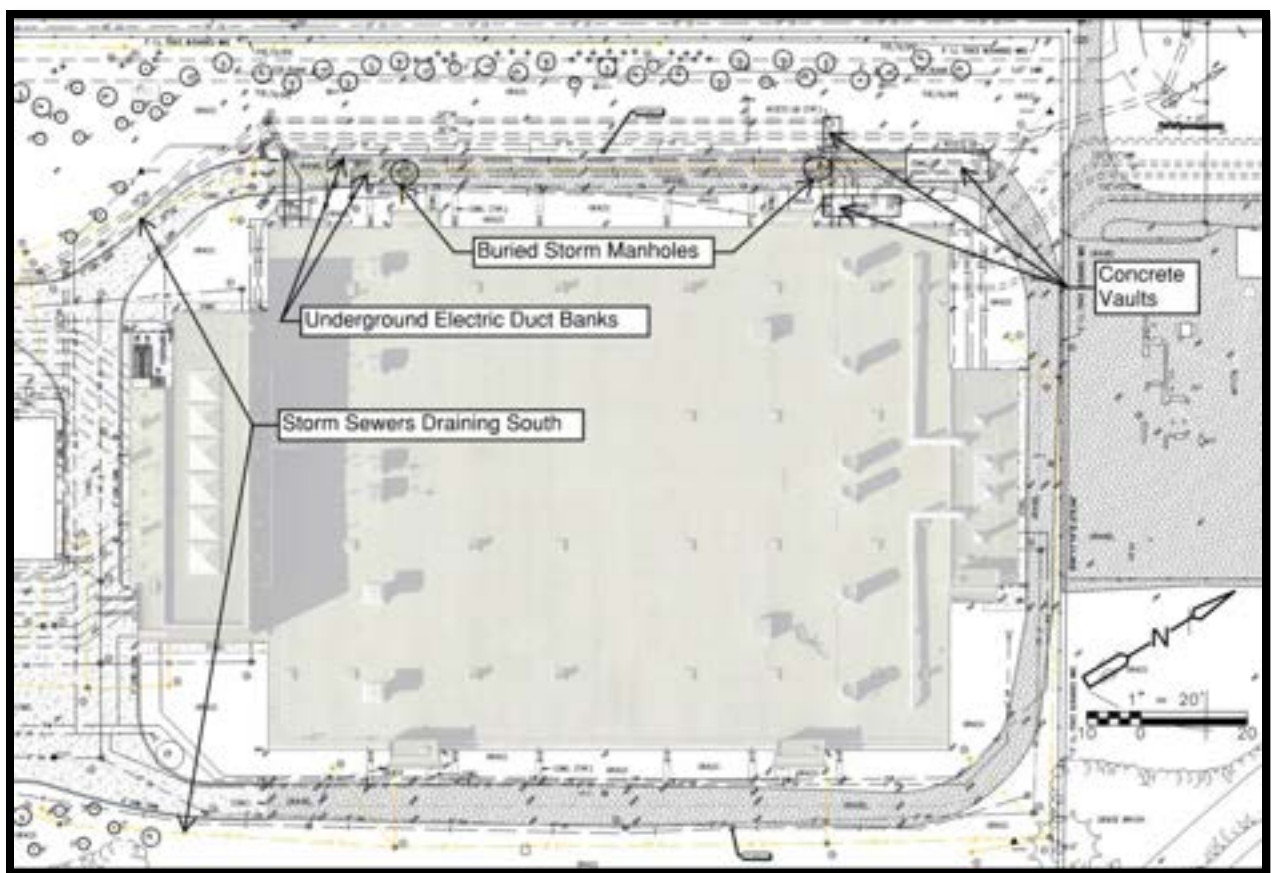


Figure 2-6
Existing Site Conditions Around Oakwood CSO Basin

Page 8



The Oakwood CSO Facility Drain Valve Improvements Project (CON-254) Existing Electrical As-Built drawings dated 10/15/19, indicate a new duct bank was installed over an existing duct bank which runs beneath the existing gravel roadway. (**Figure 2-9**) The new duct bank is approximately 30-inches below grade and runs from existing I&C manholes 201 and 202 to the existing Drain Valve Vault located at the northwest corner of the facility. The existing duct bank will need to be considered as drainage options are evaluated in TM-24 Civil/Site Design.

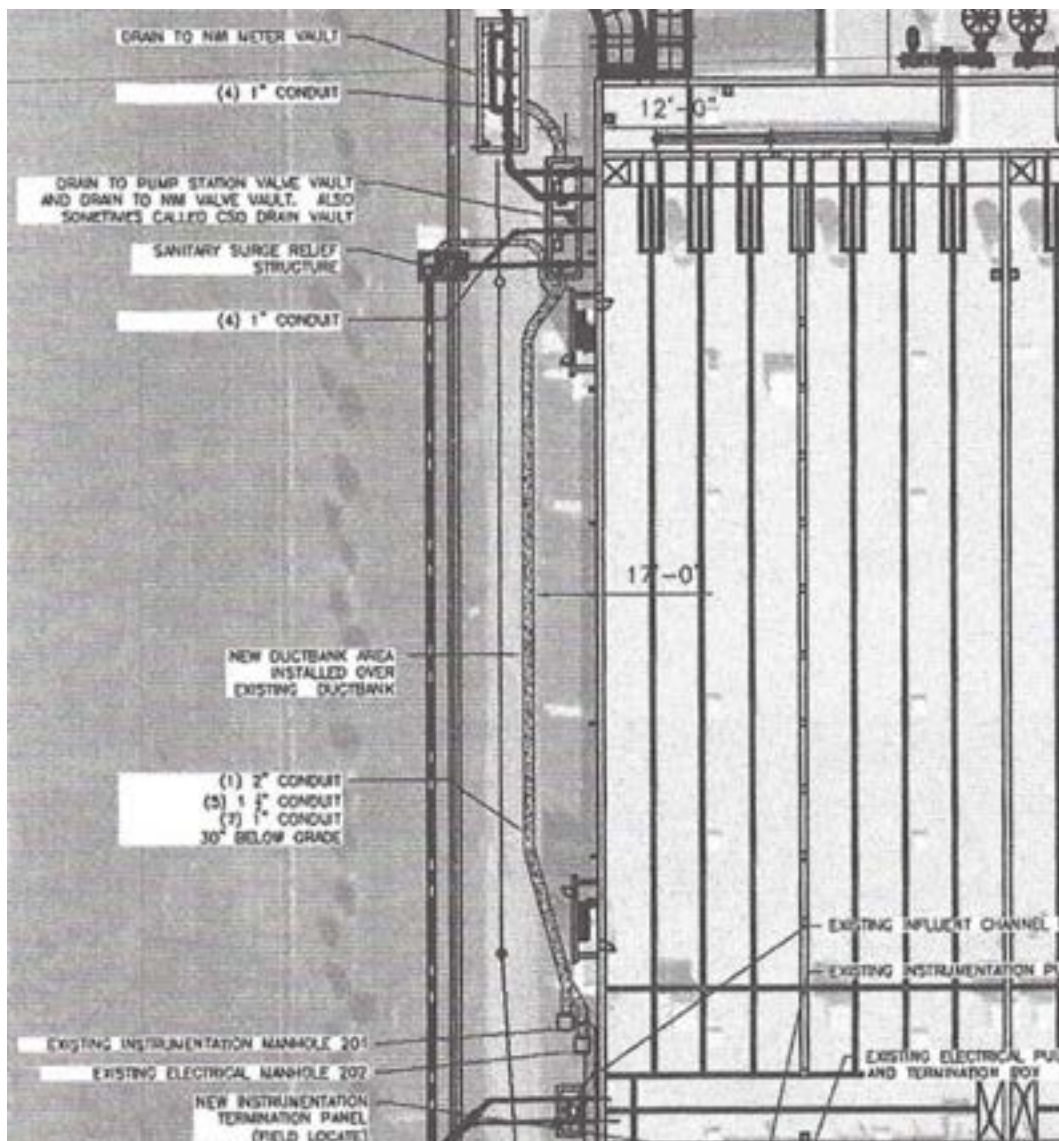


Figure 2-9
CON254 –New Duct bank 30 inches Below Grade Installed Over Existing Duct Bank

Table 2-1 shows third-party utility information obtained from MISS DIG requests for the Oakwood site.

Table 2-1 Oakwood Existing Site Utilities

Utility Provider	Contact Number	MISS DIG RESULTS	Date
AT&T TELEPHONE	(231) 409-7939	RECEIVED	10/26/2022
BUCKEYE PARTNER LP PIPELINE	(800) 331-4115	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (WATER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (SEWER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT PUBLIC LIGHTING ELECTRIC	(313) 267-5130	NOT RECEIVED	
DTE ENERGY (ELECTRIC) ELECTRIC	(313) 407-5364	RECEIVED	11/8/2022
DTE ENERGY (GAS) GAS	(248) 318-7839	RECEIVED	10/26/2022
GREAT LAKES WATER AUTHORITY (SEWER)	(313) 799-0289	RECEIVED	11/8/2022
INTERNATIONAL TRANSMISSION CO. (FIBER OPTICS)	(888) 269-8740	RECEIVED	11/4/2022
KINDER MORGAN COCHIN, LLC PIPELINE	(713) 369-9795	RECEIVED	10/26/2022
LINDE, INC. GAS	(313) 849-4326	RECEIVED	10/26/2022
MARATHON PIPELINE, LLC PIPELINE	(800) 537-6644	RECEIVED	10/27/2022

Note: See Appendix for Responses from Utility, MISS DIG TICKET # 2022102503611

2.2 Leib Site – Existing Conditions

A site visit was conducted November 22, 2022 at the Leib Site. Pictures were taken of existing conditions around the CSO Basin. **Figure 2-10** shows notable existing features of the site. These features include:

- 1) An existing DTE Transformer and underground service from existing DTE Pole. The existing DTE Transformer is located in the parking lot. A buried electrical service lead runs from the transformer to a nearby DTE Pole. The underground DTE service lead crosses a vacated alley which will be paved over to provide a new service entrance driveway to the Leib CSO facility. The existing DTE Electric Pole carries the existing AT&T wire which will need to be raised to provide clearance for service trucks using the new service drive to the facility.
- 2) Existing AT&T pole. The existing AT&T pole is located in the vacated alley.
- 3) Existing rolling gate and actuator at the entrance to the CSO Facility off of Mt Elliot.



Figure 2-10
Existing Site Conditions Photos at the Leib Site

Table 2-2 shows third-party utility information obtained from MISS DIG requests for the Leib site.

Table 2-2 Leib Existing Site Utilities

Utility Provider	Contact Number	MISS DIG RESULTS	Date
AT&T TELEPHONE	(231) 409-7939	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (WATER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (SEWER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT PUBLIC LIGHTING ELECTRIC	(313) 267-5130	NOT RECEIVED	
DTE ENERGY (ELECTRIC) ELECTRIC	(313) 407-5364	RECEIVED	11/8/2022
DTE ENERGY (GAS) GAS	(248) 318-7839	RECEIVED	10/26/2022
GREAT LAKES WATER AUTHORITY (WATER)	(313) 799-0289	RECEIVED	11/8/2022
GREAT LAKES WATER AUTHORITY (SEWER)	(313) 799-0289	RECEIVED	11/8/2022
INTERNATIONAL TRANSMISSION CO. (FIBER OPTICS)	(888) 269-8740	RECEIVED	11/4/2022
MCI/VERIZON BUSINESS FIBER OPTICS	(800) 624-9675	NOT RECEIVED	
NEXTEL COMMUNICATIONS FIBER OPTIC	(816) 309-4004	NOT RECEIVED	

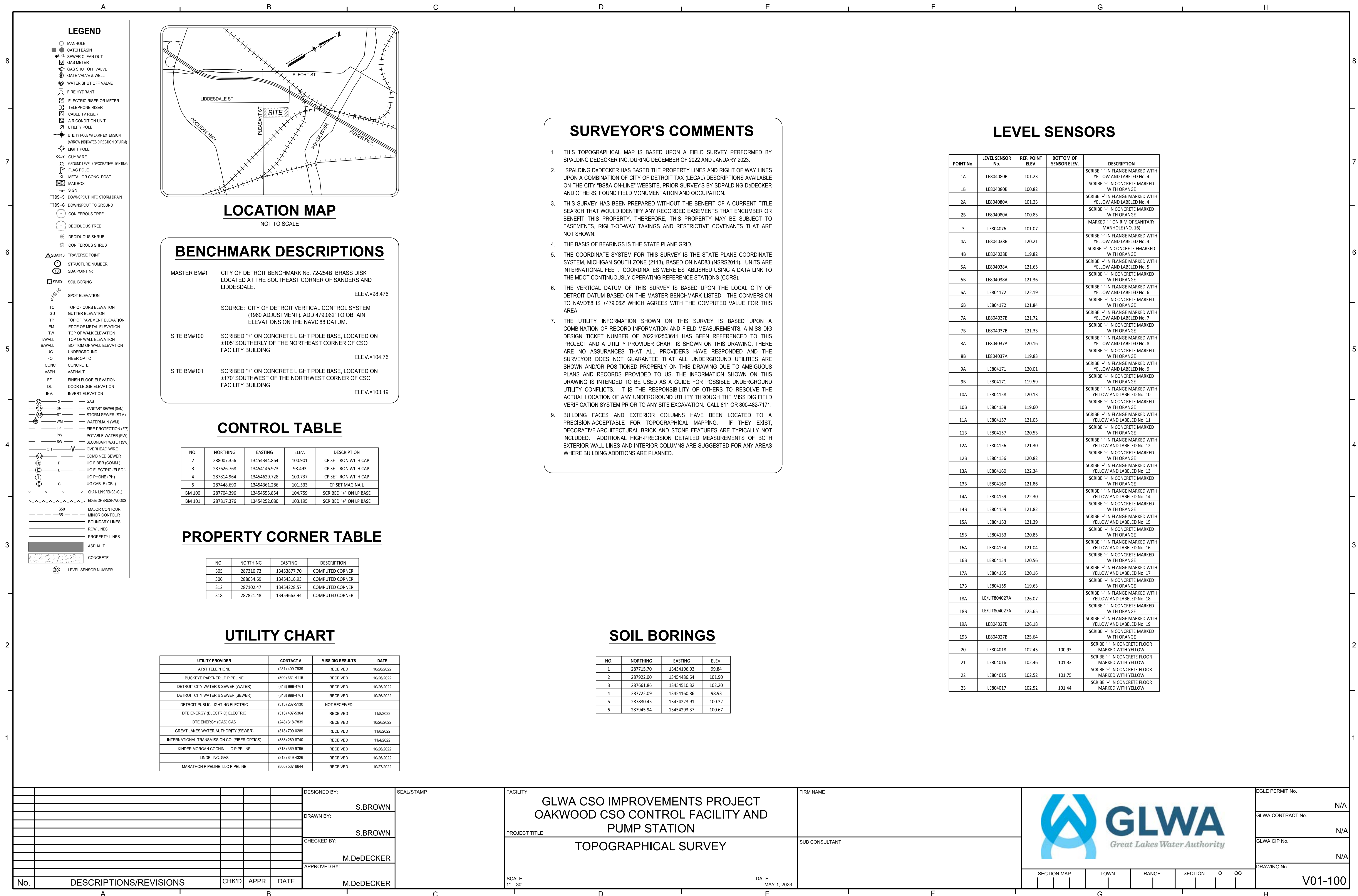
Note: See Appendix for Responses from Utility, MISS DIG TICKET # 2022102503675

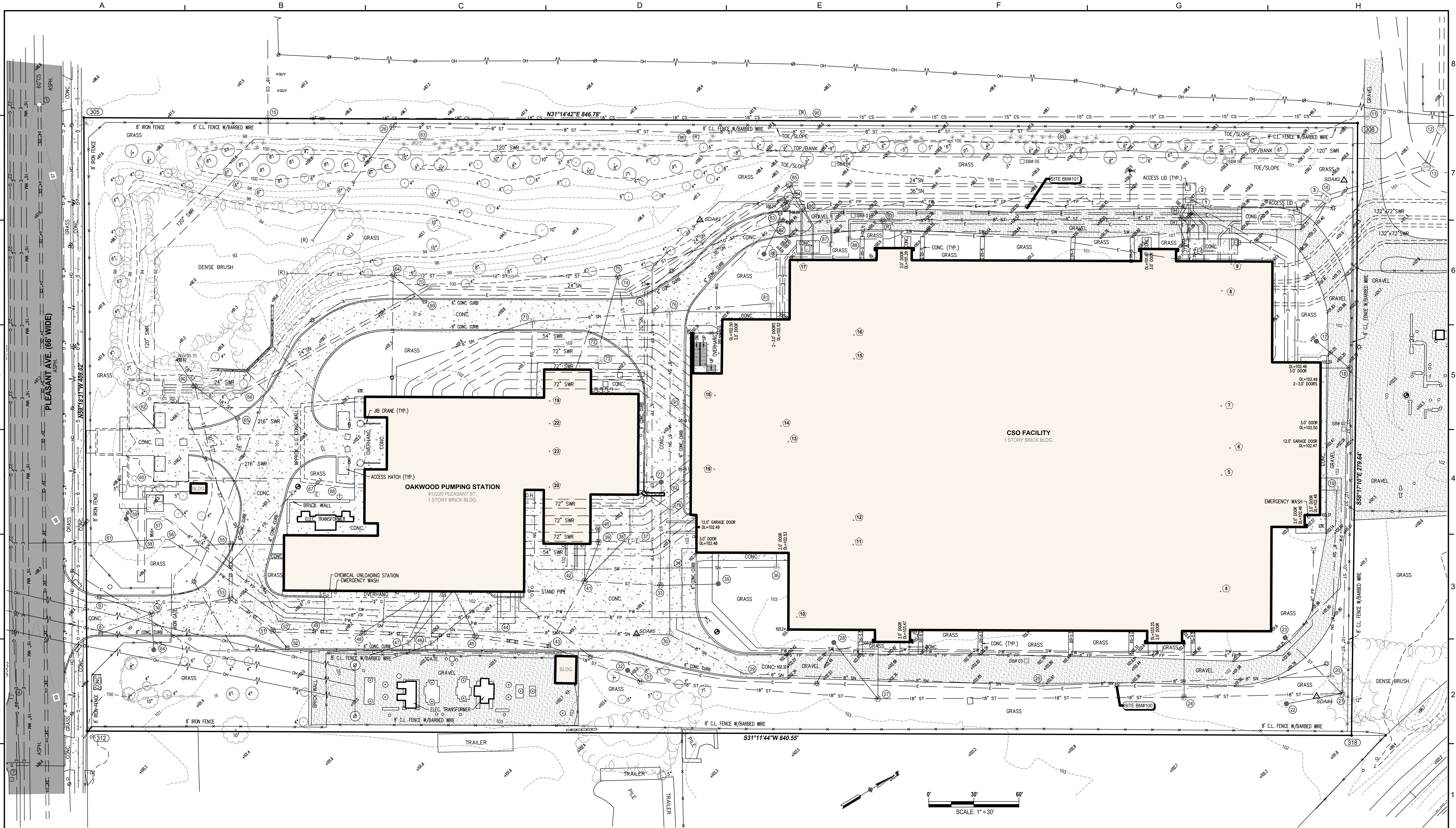
Appendices

Appendix A	Oakwood Site - Existing Conditions Base Survey
Appendix B	Oakwood Site - Geotechnical Report
Appendix C	Oakwood Record Drawings from Recent Projects
Appendix D	Oakwood Utility Files
Appendix E	Leib Site - Existing Conditions Base Survey
Appendix F	Leib Site - Geotechnical Report
Appendix G	Leib Record Drawings from Recent Projects
Appendix H	Leib Utility Files
Appendix I	Kercheval Alley Vacation Resolution

Appendix A

Oakwood Site - Existing Conditions Base Survey





No.	DESCRIPTIONS/REVISIONS	CHK'D	APPR	DATE

DESIGNED BY:	S.BROWN
DRAWN BY:	S.BROWN
CHECKED BY:	M.DeDECKER
APPROVED BY:	M.DeDECKER

SEAL/STAMP

FACILITY	GLWA CSO IMPROVEMENTS PROJECT
PROJECT TITLE	OAKWOOD CSO CONTROL FACILITY AND PUMP STATION
	TOPOGRAPHICAL SURVEY
SCALE: 1" = 30'	DATE: MAY 1, 2023

FIRM NAME	
SUB CONSULTANT	



GLWA
Great Lakes Water Authority

SECTION MAP	TOWN	RANGE	SECTION	Q	QQ

EGLE PERMIT No.	N/A
GLWA CONTRACT No.	N/A
GLWA CIP No.	N/A
DRAWING No.	V01-101

STRUCTURE TABLE

#	TYPE	RIM	SIZE	MTRL	INVERT	DIRECTION	CONNECT
1	SANITARY MANHOLE	98.84	60"	24"	N/A	NW (REC) SE (REC)	
2	ELECTRIC MANHOLE	98.56					
3	ELECTRIC MANHOLE	99.41					
4	SQUARE CATCH BASIN	98.81					
5	SQUARE CATCH BASIN	99.10					
6	SANITARY MANHOLE	99.73					
7	SQUARE CATCH BASIN	99.10					
8	SQUARE CATCH BASIN	98.60	10"		N/A	NORTH	10 (REC)
9	SQUARE CATCH BASIN	98.59	10"		N/A	NNE	10 (REC)
10	SANITARY MANHOLE	99.23	10"		N/A	SOUTH	8 (REC)
			10"		N/A	SSW	9 (REC)
			10"		N/A	SE	54 (REC)
			12"		N/A	NNE	53 (REC)
11	SANITARY MANHOLE	100.22	15"		N/A	SW	96 (REC)
12	SANITARY MANHOLE	100.77	36"	RCP	90.77	NW	
			36"		90.77	NORTH	
			36"		N/A	ESE	13 (REC)
	BOTTOM	90.77					
13	SANITARY MANHOLE	100.66	36"	RCP	92.21	NNW	12
			36"	RCP	92.31	SOUTH	16
			120"		N/A		14 (REC)
			120"		N/A	EAST (REC)	
	BOTTOM	92.26					
14	SANITARY MANHOLE	100.19	120"		N/A	WNW (REC)	
			120"		N/A	ESE	13 (REC)
15	SANITARY MANHOLE	96.68	12"	CMP	86.38	SE	
			18"	RCP	85.18	NW	
			18"		N/A	NE	95 (REC)
	TOP / DEBRIS	86.18					
16	SANITARY MANHOLE	101.07	36"	RCP	92.42	SW	84
			36"	RCP	92.32	NNE	13
	BOTTOM	92.37					
	FLOW DIRECTION:	NNE					
17	ROUND CATCH BASIN	101.29	10"	PVC	96.39	EAST	18
	BOTTOM	96.39					
18	STORM MANHOLE	102.28	12"	PVC	95.93	SE	21
			12"	PVC	96.03	WEST	17
			6"		N/A	SW (REC)	
19	SANITARY MANHOLE	102.22	10"	PVC	96.72	SW	BLDG
			10"	PVC	96.72	SE	20
	BOTTOM	96.72					
20	SANITARY MANHOLE	100.62	10"	PVC	97.12	NW	19
			10"	PVC	97.07	SSW	25
21	STORM MANHOLE	100.96	12"	PVC	95.50	NW	18
			12"	PVC	95.46	WEST	23
			18"	RCP	95.26	SW	24
			12"	PVC	96.56	SW	22
	BOTTOM	95.46					
22	BEEHIVE BASIN	100.44	12"	PVC	97.44	NNE	21
	BOTTOM	97.39					
23	ROUND CATCH BASIN	100.60	12"	PVC	97.10	NE	21
	BOTTOM	97.10					
24	STORM MANHOLE	101.61	18"	RCP	95.01	NE	21
			18"	RCP	94.91	SW	27
			6"	PVC	94.96	NW	BLDG
25	SANITARY MANHOLE	102.30	10"	PVC	95.80	NE	20
			10"	PVC	95.75	SW	29
26	STORM MANHOLE	96.19	10"	PVC	91.59	SSE	ES
	NO LID		10"	PVC	91.59	NE	96
	TOP / WATER	91.79					
	BOTTOM	90.89					
27	STORM MANHOLE	102.48	18"	RCP	94.48	NE	24
			18"	CMP	94.38	SW	31
			12"	PVC	96.88	WEST	28
			6"	PVC	96.88	WNW	BLDG
	BOTTOM	94.38					
28	ROUND CATCH BASIN	102.36	10"	PVC	96.65	EAST	27
	BOTTOM	96.66					
29	SANITARY MANHOLE	102.16	10"	PVC	94.68	NE	25
			10"	PVC	94.63	WSW	30
	BOTTOM	94.68					
30	SANITARY MANHOLE	101.87	10"		N/A	ENE	29
			8"		N/A	SW	44
			8"		N/A	NW	34
31	STORM MANHOLE	101.46	18"	RCP	94.16	NNE	27
			18"	RCP	94.01	WSW	43
			10"	PVC	97.21	SW	32
	BOTTOM	93.96					
32	ROUND CATCH BASIN	100.84	10"	PVC	97.34	NE	31
	BOTTOM	97.34					

#	TYPE	RIM	SIZE	MTRL	INVERT	DIRECTION	CONNECT
33	STORM MANHOLE	101.62	8"		N/A	NE	35
			8"		N/A	SW	41
			6"		N/A	NW	77
34	SANITARY MANHOLE	101.77	8"		N/A	NW	78
			8"		N/A	SE	30
			6"		N/A	NE	36
			6"		N/A	SW	42
35	ROUND CATCH BASIN	102.10	6"		N/A	NW	
			8"		N/A	SW	33
36	SANITARY MANHOLE	102.29	6"		N/A	NW	
			6"		N/A	SW	34
37	ELECTRIC MANHOLE	101.97					
38	ELECTRIC MANHOLE	101.98					
39	SANITARY MANHOLE	102.46	3"		N/A	ESE	41
			3"		N/A	NW	40
40	SANITARY MANHOLE	102.37	3"		N/A	SE	39
41	STORM MANHOLE	101.98	6"		N/A	NW	BLDG
			3"		N/A	ENE	39
			6"		N/A	NORTH	
			8"		N/A	NE	33
			10"		N/A	ESE	43
42	SANITARY MANHOLE	102.22	6"		N/A	NE	34
			6"		N/A	NW	BLDG
			6"		N/A	SW	
43	SQUARE CATCH BASIN	101.30	24"	RCP	94.30	SW	45
			12"	RCP	94.50	NNW	41
			12"	PVC	95.10	ENE	31
	BOTTOM	94.30					
44	SANITARY MANHOLE	101.45	8"		N/A	NE	30
			8"		N/A	SW	49
			6"		N/A	NW	BLDG
45	STORM MANHOLE	101.48	24"	RCP	93.78	NE	43
			24"	RCP	93.58	SW	48
			6"	PVC	95.48	WSW	BLDG
	BOTTOM	93.58					
46	ELECTRIC MANHOLE	101.55					
	TOP / WIRE	96.05				NNW / SSW	
	BOTTOM	91.95					
	FLOW DIRECTION:	EAST					
47	ELECTRIC MANHOLE	101.63					
	TOP / WIRE	96.13				NNW / SSW	
	BOTTOM	91.83					
48	STORM MANHOLE	101.61	24"	RCP	93.61	NE	45
			24"	RCP	93.51	SW	51
			6"	PVC	96.51	NORTH	BLDG
	BOTTOM	93.61					
49	SANITARY MANHOLE	101.53	8"		N/A	NE	44
			6"		N/A	SW	52
			6"		N/A	NW	BLDG
50	SQUARE CATCH BASIN	100.85	12"	PVC	96.85	WEST	51
	BOTTOM	96.85					
51	STORM MANHOLE	101.08	24"	RCP	93.68	NE	48
			24"	RCP	93.38	WEST	53
			12"	PVC	96.68	EAST	50
	BOTTOM	93.38					
	FLOW DIRECTION:	WEST					
52	SANITARY MANHOLE	101.24	8"		N/A	NE	49
			8"		N/A	WEST (REC)	
53	STORM MANHOLE	100.53	24"	RCP	93.53	ENE	51
			24"	RCP	93.23	WNW	55
			12"		N/A	SSW	10
	BOTTOM	93.23					
	FLOW DIRECTION:	WNW					
54	ROUND CATCH BASIN	98.33	10"		N/A	NW	10
55	STORM MANHOLE	101.03	8"		N/A	NE	BLDG
			24"		N/A	SE	53
			8"		N/A	SW	58
			10"		N/A	WNW	90
56	WATER MANHOLE	98.74					
57	WATER MANHOLE	98.88					
58	STORM MANHOLE	98.76	8"		N/A	NE	55
			10"		N/A	WEST	59
59	ROUND CATCH BASIN	97.67	10"		N/A	EAST	58
60	SANITARY MANHOLE	98.88					
61	WATER MANHOLE	98.97					
62	SANITARY MANHOLE	98.62	10"		N/A	EAST	
63	STORM MANHOLE	98.39	120"		N/A	NE	
	TOO DEEP TO MEASURE		120"		N/A	SW	

#	TYPE	RIM	SIZE	MTRL	INVERT	DIRECTION	CONNECT
64	STORM MANHOLE	99.30	12"	RCP	91.00	NE	75
			12"	RCP	91.10	SW	ES
			10"	PVC	92.90	EAST	69
			6"	PVC	94.10	ESE	
	BOTTOM	91.00					
65	SQUARE CATCH BASIN	99.82	18"	RCP	91.62	SE	
			18"	RCP	90.32	WSW	90
	BOTTOM	90.32					
66	SANITARY MANHOLE	99.62	24"	RCP	74.91	SSW	
			24"	RCP	75.12	NORTH	70
	BOTTOM	75.02					
67	ELECTRIC MANHOLE	102.24					
68	PHONE MANHOLE	102.26					
69	SQUARE CATCH BASIN	100.09	10"	PVC	95.58	WSW	64
	BOTTOM	95.59					
70	SANITARY MANHOLE	100.27	24"	RCP	76.87	NE	74
			24"	RCP	76.57	SSE	66
	TOP / DEBRIS	76.67					
71	SANITARY MANHOLE	100.85	6"	PVC	95.35	NE	76
			6"	PVC	96.65	ENE	BLDG
			6"		95.65	SSE	
	BOTTOM	95.35					
	FLOW DIRECTION:	NE					
72	SANITARY MANHOLE	102.21					
	TOP / WIRE	94.51					
	BOTTOM	92.71					
73	SANITARY MANHOLE	102.28					
	TOP / WIRE	94.88					
	BOTTOM	93.28					
74	SANITARY MANHOLE	101.54	24"	RCP	78.23	NORTH	85
			24"	RCP	78.04	SW	70
	BOTTOM	78.04					
75	STORM MANHOLE	100.76	12"	RCP	91.15	SW	64
			10"	PVC	91.46	NNE	83
			3"		N/A	SSE	
			4"		N/A	ESE	
	BOTTOM	91.16					
76	SANITARY MANHOLE	101.50	6"	PVC	94.85	SW	71
			6"	PVC	96.70	NE	81
			6"	PVC	94.80	SE	78
	BOTTOM	94.85					
77	ROUND CATCH BASIN	101.87	6"		N/A	SW	
			6"		N/A	SE	33
78	SANITARY MANHOLE	101.98	8"		N/A	NW	76
			8"		N/A	SE	34
			8"		N/A	WEST	BLDG
79	SANITARY MANHOLE	101.86	36"	RCP	96.86	NORTH	84
	VERY STRONG FLOW		36"	RCP	96.86	SE	
	FLOW DIRECTION:	NORTH					
80	ROUND CATCH BASIN	99.49	12"	PVC	95.59	NNW	82
	BOTTOM	95.59					
81	SANITARY MANHOLE	101.89	6"	PVC	97.29	SE	BLDG
			6"	PVC	97.09	SW	76
	BOTTOM	97.19					
82	STORM MANHOLE	99.74	12"	PVC	94.94	SE	80
			10"	PVC	95.19	WNW	83
			10"	PVC	93.70	NE	93
			10"	PVC	91.74	SSW	75
	BOTTOM	91.74					
83	SQUARE CATCH BASIN	99.61	10"	PVC	95.71	SE	82
	BOTTOM	95.71					
84	SANITARY MANHOLE	100.24	36"	RCP	94.64	SOUTH	79
	HEAVY FLOW		36"	RCP	94.64	NE	16
	BOTTOM	93.14					
	FLOW DIRECTION:	NORTH					
85	SANITARY MANHOLE	99.77	36"	RCP	86.36	NE	
			24"	RCP	78.67	SSE	74
			24"	RCP	78.67	EAST	86
	BOTTOM	78.27					
86	SANITARY MANHOLE	99.99	12"	CLAY	86.69	SE	
			12"	CLAY	86.69	EAST	
			24"	RCP	86.79	WEST	85
			6"	PVC	87.49	NE	
	BOTTOM	86.49					
	FLOW DIRECTION:	WEST					
87	ELECTRIC MANHOLE	100.65					
88	ELECTRIC MANHOLE	100.50					
89	ROUND CATCH BASIN	97.53	8"		N/A	SW	96 (REC)
	NO PIPES VISIBLE						
	TOP / WATER	96.53					
	TOP / DEBRIS	93.53					
90	SANITARY MANHOLE	98.12	24"	RCP	74.02	SW	
			12"	RCP	74.02	NE	
			24"	RCP	88.62	ENE	85
			10"	PVC	88.82	EAST	55
			18"	RCP	90.12	WSW	ES
	BOTTOM	74.02					

Appendix B

Oakwood Site - Geotechnical Report



REPORT ON GEOTECHNICAL INVESTIGATION

GREAT LAKES WATER AUTHORITY (GLWA)
DESIGN SERVICES FOR COMBINED SEWER OUTFALL
IMPROVEMNETS PROJECTS– CONTRACT NO. 2101475
GLWA OAKWOOD CSO FACILITY
DETROIT, MICHIGAN

Owner:
Great Lakes Water Authority (GLWA)
Detroit, Michigan

Prepared for:
CDM Smith
535 Griswold Street, Suite 930
Detroit, Michigan 48226

May 01, 2023
2022136A



May 01, 2023
2022136A

Mr. Ali Khraizat, P.E.
CDM Smith
535 Griswold St., Suite 930
Detroit, Michigan 48226

RE: Report on Geotechnical Investigation
Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO) Improvements Project
GLWA Oakwood CSO Facility - Contract Number 2101475
Detroit, Michigan

Dear Mr. Khraizat:

We have completed the Report on Geotechnical Investigation for the GLWA Oakwood CSO Facility Project in the City of Detroit, Michigan. This report presents the results of our observations and results of the geotechnical.

The soil samples collected during our field investigation will be retained in our laboratory for 90 days from the date of the final report, at which time these samples will be discarded unless otherwise directed by you.

It was a pleasure working with you on this project. If you have any questions regarding this report, please do not hesitate to contact us 313-963-2721.

Sincerely,
Somat Engineering, Inc.

A handwritten signature in black ink, appearing to read 'Sean Panetta'.

Sean Panetta
Staff Geologist

A handwritten signature in blue ink, appearing to read 'Jane Abadir'.

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**REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA OAKWOOD CSO FACILITY
DETROIT, MICHIGAN**

REPORT SUMMARY

A general summary of the report conclusions is provided below:

1. The field exploration program consisted of performing a total of 6 hand auger probes for the GLWA Oakwood CSO Facility Project in Detroit, Michigan. The auger probes extended to depths ranging between 5 and 6 feet below existing grades.
2. Generalized soil profile: fill soils were encountered in 4 of the 6 auger probes and extended to depths ranging between 2 and 5.5 feet below existing grades. The fill soils generally consisted of roadway gravel and granular soils. Native soils consisting of lean clay or sandy lean clay were encountered below the fill or below the topsoil and extended to the exploration depths of the probes. The consistency of the native clays was stiff to very stiff and the moisture content ranged between 15 and 45%.
3. Groundwater was not encountered during or upon completion of augering in any of the probes. Based on the change from brown to gray in the cohesive soils of SB-04 and 06, the long-term groundwater table is estimated to be situated at about 3.3 to 4 feet (EL. 95 to 99 feet±) below existing grades. Perched groundwater trapped in the granular fill soils within close proximity of any excavations should also be expected.
4. The gravel service road is planned to be replaced with new reinforced concrete pavement that will extend around the perimeter of the basin connecting with the existing concrete service road on either side of the basin. The current pavement design calls for a total length of about 1,000 lineal feet and a width of 16 feet in addition to 2-foot-wide shoulder on the outer side. The shoulder will be gravel and will not be paved. The pavement will be widened at the turns to facilitate the turning of WB-50 trucks. The proposed pavement section will be Portland cement concrete (PCC) designed to support HS-20 loading.
5. Based on our probe investigation, the existing gravel road consisted of 10 to 18 inches of crushed aggregates mixed with silty sand over granular fill soils. The fines content of the existing gravel road material ranged between 11 and 25% which is higher than the allowable limit of fines content of MDOT 21AA aggregate. The excessive fines in this material would reduce its permeability and increase its susceptibility to detrimental frost action. Therefore, it is NOT suitable for re-use as base course below the new pavement. As such, we recommend removal of a portion of the existing gravel and replacing with new, clean, and compacted aggregate base material similar in gradation to MDOT 21AA. The remaining existing crushed aggregate (if any) may be left below the new base course.



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6. Based on our analysis, the following proposed pavement section design should be adequate to support the required traffic loading for the access drive. This pavement section should be uniform across the mainline and the widened turns.
- 9 inches of Portland cement concrete, over
 - 8 inches of new aggregate base course similar in gradation to MDOT 21AA, over
 - (only where required) Triaxial geogrid such as Tensar NX750 or another engineer approved geogrid equivalent, over
 - The compacted existing subgrade soils consisting of the remaining road gravel and granular fill soils.

The geogrid should be placed at the widened paved turns since the bearing soils at these areas have not been pre-consolidated in the past. To avoid differential settlement and pavement cracking at these widened turns, we recommend the geogrid to be placed immediately below the new 21AA base material and should span laterally from edge of pavement to edge of pavement with a minimum two feet extension beyond the outer (widened) edge. Longitudinally along the road, the geogrid should extend a minimum of 3 feet on either end of the widened section.

The geogrid installed as described above may also be used to bridge over the organic pocket encountered in Boring SB-03 at a depth of 3 feet below grade. This is an alternative to undercutting these organics to their full vertical extent and replacing with engineered fill.

Compact the existing subgrade with a vibratory roller or plate compactor until subsequent passes result in no significant downward displacement. The subgrade and the new base material should be compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D1557 (Modified Proctor).

7. A total of 3 auger probes were performed within the existing bioswale located on the west side of the basin. The general soil profile consisted of topsoil over granular fill soils over native clays. The layer of the granular fill soils consisted of clayey sand and ranged in thickness between 4 and 18 inches. These fill soils had 43% of fines (silt and clay) which is considered elevated and will not promote positive drainage. Based on the in-situ falling head permeability tests performed at a depth of 4 to 6 feet below existing grades, the mean hydraulic conductivity of the existing native clay soils ranged between 0.007 and 0.025 inch/hour which is considered almost impermeable.

For the proposed bioswale, we recommend undercutting the existing fill and some of the native clay soils and replacing with drainable engineered fill with gradation in accordance with the GSI design specifications. The width, length, and depth of the proposed bioswale will be designed by others to accommodate the anticipated volume surface water surface runoff during the wet seasons, and taking into consideration the anticipated long-term groundwater table at the site.



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GREAT LAKES WATER AUTHORITY (GLWA)
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The summary presented above is general in nature and should not be considered apart from the entire text of the report with all the qualifications and considerations mentioned therein. Details of our findings and recommendations are discussed in the following sections and in the appendices of this report.

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**REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA OAKWOOD CSO FACILITY
DETROIT, MICHIGAN**

1.0 INTRODUCTION

1.1 GENERAL

Upon authorization from CDM Smith, Somat Engineering, Inc. (Somat) has completed the geotechnical investigation for the development of the Great Lakes Water Authority (GLWA) Design Services for Combined Sewer Outfall (CSO) Improvements Project at the Oakwood CSO Facility in the City of Detroit, Wayne County, Michigan.

Somat was retained by CDM Smith to perform a pre-design geotechnical investigation for the referenced project within the project limits. The geotechnical investigation was performed in general accordance with Somat Proposal No. P210314B dated January 12, 2022. The results of the investigation will be used to support the design of the project and development of construction specifications.

1.2 PROJECT INFORMATION

The overall project includes design services required to implement a series of improvements at the Oakwood CSO Retention Treatment Basin (RTB) and storm/sanitary pumping station located at 12220 Pleasant Street, Detroit, Michigan. The site improvements include constructing a new access service drive that will extend around the perimeter of the basin connecting with the existing concrete service road on either side of the basin and expanding the existing bioswale on the west side of the basin to improve drainage conditions.

The following sections of this report provide a description of our field investigation, the results of the field and laboratory tests, the logs of auger probes, our interpretation of subsoil and groundwater conditions, recommendations related to the proposed construction.



2.0 SUBSURFACE INVESTIGATION

2.1 FIELD EXPLORATION

The field exploration program consisted of performing a total of six (6) hand auger probes, designated SB-01 through SB-06. Borings SB-01, 02, and 03 were performed along the existing gravel access road and extended to a depth ranging between 5 and 5.5 feet below existing grades. In-situ Dynamic Cone Penetrometer (DCP) tests were performed at each of these probes to assess the strength of the subgrade soils and support the pavement section design of the access road.

Hand auger probes SB-04, 05, and 06 were performed along the existing bioswale that is located on the west side of the basin. These probes extended to depths ranging between 4 and 6 feet below existing grades. In-situ infiltration tests were performed near each of these probes at depths ranging between 4 and 6 feet below existing grades.

Soil boring coordinates and the ground surface elevations (included in the soil boring logs) were provided by the Project Surveyor using City of Detroit Datum. A schematic of the approximate soil boring locations and the corresponding infiltration test locations can be found in Appendix A. The Logs of Test Borings are included in Appendix B.

2.1.1 Drilling Operations

The drilling operations were performed on December 1 and December 2, 2022. The hand auger probes were performed using a 3-inch hand auger bucket. Upon completion, all boreholes were backfilled with soil cuttings and the site was restored to the best of our ability.

2.1.2 Geotechnical Sampling

Bulk soil samples were collected from each hand auger probe at every apparent stratum change. The samples were sealed in plastic zip lock bags in the field to protect the soil and maintain the soil's natural moisture content. All samples were identified with unique information on hand auger number, sample number, and sample depth. The samples were transported to Somat's laboratory in Romulus, Michigan.



All soil samples for the geotechnical investigation were transported to Somat's laboratory for further analysis and testing and will be retained in our laboratory for a period of 90 days after the date of the final report, after which they will be discarded unless we are notified otherwise.

2.1.3 In-Situ Dynamic Cone Penetrometer (DCP) Tests

A dual-mass Dynamic Cone Penetrometer (DCP) test was performed in general accordance with ASTM D6951 at probes SB-01, 02, and 03. The test was performed starting at the surface material, and extended to depths of about 4 feet below existing grade, approximately. The DCP test is utilized to estimate the California Bearing Ratio (CBR) values from 0.1 to 100. A CBR value is an index commonly used in pavement design, indicative of base and subgrade support characteristics for granular soils. The test procedure involves dropping a 17.6-pound hammer from a distance of 22.6 inches onto an anvil/coupler assembly that drives the graduated drive rod with a disposable cone or tip. The cone has a 60° angle with a maximum diameter of 0.79 inches. The rate of cone penetration per blow is measured at selected penetration or hammer drop intervals. The analysis was performed based on relationships developed by USACE to estimate the California Bearing Ratio (CBR) value from the results of the DCP test. The correlated CBR values ranged between 10 and 100 (an outlier CBR of 4.8 was eliminated). The DCP test results and correlated CBR values are presented in Appendix C.

2.1.4 Groundwater Level Observation Procedures

Whenever possible, groundwater level observations were made during the augering operations and are shown on the individual Logs of Auger Probes. During augering, the depth at which free water was observed, where soil cuttings became saturated or where saturated samples were collected, was indicated as the groundwater level during drilling. In granular, pervious soils, the indicated water levels are considered relatively reliable when hand auger probes are used. However, in cohesive soils, groundwater observations are not necessarily indicative of the static water table due to the low permeability rates of the soils, and due to the sealing off of natural paths of groundwater flow during augering operations.



It should be noted that seasonal variations and recent precipitation may influence the level of the groundwater table significantly. Groundwater observation wells are generally used if precise groundwater table information is needed, however, the installation of groundwater monitoring wells was not included in the scope of the investigation. Therefore, the discussion and recommendations provided within the report are based on our knowledge of the soil and groundwater conditions in this area, which should provide for a reasonable approximation of the groundwater level.

2.1.5 In-Situ Falling Head Permeability Test

The falling head in-situ permeability testing was performed in accordance to the Stormwater Management Design Manual of the City of Detroit Water and Sewerage Department (2018 which is adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015). The permeability tests consisted of the following steps:

1. Advance a borehole to the required depth of the proposed infiltration interface depth of 4 to 6 feet using a 6-inch hand auger bucket. The augured hole diameter is at least two inches larger than the outer diameter of the inner casing. The inner casing will consist of a PVC pipe with minimum inner diameter of four inches.
2. Push the inner casing within the augured hole to the infiltration interface and firmly set into the bottom of the borehole. Measure the depth from the top of casing to the bottom of the hole to the nearest 0.1 feet.
3. Place two inches of fine gravel or coarse sand in the bottom of the borehole to prevent scour during filling of the casing. Place gravel or sand uniformly to obtain an even depth within the hole. Re-measure the depth from the top of casing to the gravel or sand surface to the nearest 0.1 feet.
4. Presoak test holes immediately prior to testing to simulate saturated conditions. Fill casing with water at a very low rate so as not to disturb the bottom sediments. Place water to a depth of at least six inches above the bottom and readjust every 30 minutes for one hour. The drop in the water level during the last 30 minutes of the presoaking period to be applied to the following standard to determine the time interval between readings:
 - a. If water level drop is two inches or more, use ten-minute measurement intervals.
 - b. If water level drop is less than two inches, use 30-minute measurement intervals.
5. After the presoaking, the water level is measured using an approved method per the ASTM standard, where the water level remains at least 12 inches above the bottom of the bottom of the hole. All water added was recorded as a volume along with the time of addition.



6. Measurements of water level were made from the top of casing and continued at the interval determined until a minimum of eight readings are completed or until a stabilized rate of drop was obtained, whichever occurred first. A stabilized rate of drop means a difference of about 0.25 inch or less of a drop between the highest and lowest readings for four consecutive readings.
7. Calculate the infiltration rate as described in ASTM D6391.

The results of the permeability tests and the graphic presentation of the calculated mean hydraulic conductivity, K_1 , versus the elapsed time at each test location are discussed in Section 3.3 and presented in Appendix D.

2.2 GEOTECHNICAL LABORATORY TESTING

All soil samples were classified in accordance with the Unified Soil Classification System (USCS). Cohesive soil samples were subjected to laboratory tests consisting of moisture content determinations, hand penetrometer tests, grain size analysis, and Atterberg Limits tests. Loss-on-ignition (LOI) tests were performed on any samples that appear to contain significant organic content.

The results of the soil classifications and the laboratory tests are included on the respective Logs of Auger Probes in Appendix B and/or tabulated or presented graphically in Appendix E. All laboratory tests were performed in accordance with their applicable ASTM procedures. A general description of each test method is presented in Appendix E, immediately following the result sheets.

2.3 LIMITATIONS

The scope of our services was strictly geotechnical and did not include environmental investigation. Our scope of services did not include investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on, below or around this site.

Somat has made no observations or recommendations with regard to the presence or absence of mold or other biological contaminants (such as spores, fungi, bacteria, viruses, and the byproducts



of such organisms), now or in the future, on this site or within or on any structures to be constructed on this site. Any consideration with regard to the presence of mold, or the possibility of mold growth in or on the structure to be constructed on this site are not within our scope of services on this project.

Some soils have been identified on the Logs of Test Borings as “fill” or “possible fill” if a soil deposit is suspected to have been placed by human activity, versus having been deposited by natural means. These designations were based on our professional engineering judgment considering factors such as our visual classification, the presence of foreign materials (i.e., bricks, concrete, plastic, etc.), and/or site topography, among many other possibilities. As such, the “fill” or “possible fill” descriptions should be considered as secondary information to the standardized soil classification. Due to the large variation of types of fill, methods of fill placement, potential changes of historical use of the site, and soil sample size, it is difficult to discern whether the subject soil sample is native to this site, or fill material based on visual classification alone. As such, the designation of “fill” may not be reliable and hence should be considered as informational only. Conversely, where a soil is not designated as “fill” on the boring logs, it does not necessarily mean it is not a fill soil, only that there were no apparent observations indicating a fill material. Therefore, we cannot guarantee that our description of “fill” soils is accurate, or that we have identified all types of fill material encountered with our sampling on the site.

3.0 SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

Soil conditions encountered at the boring locations have been evaluated and presented in the form of logs of auger probes. The logs of auger probes include approximate soil stratification with detailed soil descriptions and selected physical properties for each stratum encountered in the auger probes. In addition to the observed subsoil stratigraphy, the auger logs present information relating to sample data, groundwater level conditions observed in the probing, personnel involved, and other pertinent data. For information, and to aid in understanding the data as presented on the auger



logs, General Notes defining nomenclature used in soil descriptions are presented immediately following the Logs of Test Borings. It should be noted that the Logs of Test Borings included with this report have been prepared on the basis of laboratory classifications and testing as well as field logs of the soils encountered.

A generalized description of the soils and pavement encountered in the six (6) auger probes beginning at the existing ground surface and proceeding downward, is provided below:

Stratum 1: Surface Material:

- **Topsoil:** Clayey topsoil was encountered at the surface of SB-04, SB-05, and SB-06 and had a thickness of 6 inches.
- **Roadway Materials:** Fill soils consisting of a mixture of crushed aggregate and silty sand were encountered at the surface of SB-01, SB-02, and SB-03. These fill soils extended to depths ranging between 0.8 and 1.5 feet below existing grades and had fines content ranging between 11 and 25% (silt and clay).

Stratum 2: Fill Soils:

- **Granular Fill:** Silty sand and clayey sand fill soils with varying amounts of silt and gravel were encountered below the topsoil in SB-04 and 05, and below the roadway gravel in SB-01, 02, 03. The fill soils extended to depths ranging between 2 and 5.5 feet below existing grades. The granular fill extended to the termination depths of auger probes SB-01 and SB-03. The fines content ranged between 11 and 43%. Organic pocket was encountered in the granular fill soils in SB-03 at a depth of about 3 feet below existing grades. Based on the Loss-On-Ignition (LOI) test the organic content was 7.2%.

Stratum 3: Native Cohesive Soils

- Native brown and gray lean clay or sandy lean clay soils were encountered generally below the fill soils in SB-02 and SB-05, and below the topsoil in SB-06 and extended to the explored depths of the auger probes at 4 to 6 feet below existing grades. The consistency of the clay was stiff to very stiff. The moisture content of the native clays ranged between 15 and 45%. Based on the Atterberg limits test result on the clay sample obtained from a depth of 5 feet at probe SB-01 the liquid limit was 38% and the plasticity Index (PI) was 18%. Graphical presentation of the Atterberg Limits results plotted on the Casagrande chart shows that the clay is classified as lean clay (CL). The chart is presented in Appendix E.



The Logs of Auger Probes are presented in Appendix B and the Hand Auger Probe Location Diagram is presented in Appendix A. It is emphasized that the stratification lines shown on the Logs of Test Borings are approximate indications of change from one soil type to another at the locations of the boreholes. The actual transition from one stratum to the next may be gradual and may vary within the area represented by the test boring.

3.2 GROUNDWATER LEVEL OBSERVATIONS

Groundwater was not encountered during drilling or upon completion of any of the hand auger probes. A lack of groundwater in some of the auger holes, does not necessarily mean there is no groundwater in this area, due to the sealing off of natural flow paths during the drilling process. Oftentimes, a change in color from brown to gray in cohesive soils is a good indication of the long-term groundwater level (indicating oxidation). Based on the change from brown to gray in the cohesive soils of SB-04 and SB-06, the long-term groundwater table is estimated to be situated at about 3.3 to 4 feet below existing grades (EL. 95 to 99 feet±).

Perched groundwater within the granular and fill soils above the less permeable clay layers should be expected and the Contractor should be prepared to handle. Water trapped in existing utility trenches in the area, which are often sand backfill within the native clay soils, should be expected.

It should be noted that the elevation of the long-term groundwater table is likely to vary throughout the year depending on the amount of precipitation, runoff, evaporation, and percolation in the area, as well as on the water level in any surface water bodies in the vicinity affecting the groundwater flow pattern.

3.3 IN-SITU FALLING HEAD PERMEABILITY TEST RESULTS

The in-situ falling head permeability testing was performed in accordance to the Stormwater Management Design Manual of the City of Detroit Water and Sewerage Department (2018 which is adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015)).



Per the request of CDM Smith, the infiltration tests were performed at about 4 to 6 feet below existing grades in the native soils. The mean hydraulic conductivity, K_1 , is defined as the average rate of water movement through a saturated soil mass, as tested for the in-situ permeability testing using the falling water level method. The mean hydraulic conductivity was calculated based on the equation adopted from ASTM D6391-11.

The equation is as follows:

$$K_1 = R_T G_1 \frac{\ln\left(\frac{Z_1}{Z_2}\right)}{(t_2 - t_1)}$$

Where:

K_1 is the mean hydraulic conductivity in inch/hour and in cm/sec

G_1 is the test setup parameter

R_T is the temperature coefficient

t_1 and t_2 are the time interval in seconds

Z_1 and Z_2 are the head measurements in cm, measured from the bottom of the borehole to the water level.

The results of the hydraulic conductivity, in equivalent inches per hour, at each testing location were then compared to soil textures of the U.S. Department of Agriculture (USDA) textural triangle presented in Table 3.3-1 to identify the general soil texture and the corresponding hydrologic soil grouping. The following table is an excerpt of the USDA Classification Table:



Table 3.3-1 - Summary Table of Hydraulic Soil properties Classified by Soil Texture

Texture class	Minimum Infiltration Rate (Hydraulic Conductivity) (Inch/hour)	Hydrologic Soil Grouping
Sand	8.27	A
Loamy Sand	2.41	A
Sandy Loam	1.02	A
Loam	0.52	B
Silt Loam	0.27	B
Sandy Clay Loam	0.17	C
Clay Loam	0.09	D
Silty Clay Loam	0.06	D
Sandy Clay	0.05	D
Silty Clay	0.04	D
Clay	0.02	D

The following Table 3.3-2 summarizes the mean hydraulic conductivity measured at each borehole and interpretation for the corresponding soil texture and hydrologic group based on the referenced USDA soil group. The results of the in-situ falling head tests and the graphic presentation of the mean hydraulic conductivity (in cm/sec) versus the elapsed time (in seconds) at each test location are presented in Appendix D.

Table 3.3-2 Summary Table of the In-Situ Falling Head Permeability Tests Results

Hand Auger Probe ID	Mean Hydraulic Conductivity, K_1 (cm/sec)	Mean Hydraulic Conductivity, K_1 (inch/hour)	General Soil Texture and the Corresponding Hydrologic Soil Grouping*	
			Texture Class	Hydrologic Soil Grouping
SB-04	7.062E-06	0.01	Clay	D
SB-05	1.736E-05	0.025	Clay	D
SB-06	5.181E-06	0.007	Clay	D

*Based on soil textures of the U.S. Department of Agriculture (USDA) Textural Triangle

Based on the in-situ falling head permeability tests performed at a depth of 4 to 6 feet below existing grades, the mean hydraulic conductivity of these soils ranged between 0.007 and 0.025 inch/hour (1.7E-05 – 5.2E-06 cm/sec).



4.0 GEOTECHNICAL RECOMMENDATIONS

4.1 PROPOSED ACCESS SERVICE DRIVE

The project includes the construction of a new paved access service drive around the perimeter of the basin connecting with the existing concrete service road on either side of the basin. The current design calls for a total length of about 1,000 lineal feet and a width of 16 feet. There will be a gravel shoulder on the outside edge of this access drive. We understand that the shoulder will be gravel and will not be paved. The proposed pavement section will be Portland cement concrete over aggregate base course that is in conformance to MDOT 21AA gradation. The pavement will be designed to support HS-20 loading. Some added width of the pavement is anticipated at the curvatures to increase the radius and facilitate the turning of large vehicles such as WB-50 trucks.

4.1.1 Existing Subgrade Conditions

Based on the hand auger probes, the existing access road consists of 10 to 18 inches of a mixture of gravel and silty sand (road gravel) over granular fill soils. Based on the laboratory grain size analysis performed on the surface gravel layer, the fines content ranged between 11 and 25% which is considered excessive. Also, the gradation does not conform with the gradation of MDOT 21AA because the percent finer by weight was exceeded for the ½ inch, #8, and #200 sieves. As such, we do NOT recommend re-using the existing road gravel material as a base course below the new pavement because the excessive fines may reduce the ability of the material to effectively allow drainage below the pavement and may pose a risk of detrimental frost action.

The existing granular fill soils below the gravel layer consisted of poorly graded sand with silt and silty sand which extended to a depth of 4.5 to 5.5 feet below existing grades. Native stiff clay was encountered at a depth of 4.5 feet in boring SB-02 and extended to the explored depth of 5 feet.

A pocket of organics was encountered in the granular fill soils at a depth of about 3 feet at the location of probe SB-03. Loss-On-Ignition (LOI) test performed on that soil sample showed an organic content of 7.2% which is considered excessive. In general, we would recommend undercutting this localized area to remove the organics to its full depth and replacing with clean



granular engineered fill. There should be no concerns of creating a bathtub due to the undercut and backfill because the procedure is performed within the existing granular fill soils and not in the native cohesive soils.

Alternatively, using the geogrid as recommended in Section 4.1.4.2 should help bridge over such similar organic pockets and minimize the settlement potential under the new pavement due to the decomposition of the organic material.

4.1.2 Subgrade Preparation and Groundwater Control Recommendations

Once a rough subgrade has been achieved, the exposed pavement subgrade along the entire section of access service drive to be constructed should be visually checked for the presence of debris, organic matter, and other unsuitable material.

If unsuitable or highly organic subgrade soils (organic contents greater than 4%) are encountered during construction, the material should be assessed by the on-site geotechnical engineer to determine the depth and extent of the material and whether it should be fully undercut.

All of the pavement subgrade areas should be thoroughly proof rolled before placement of the new base course and pavement. The purpose of the proof rolling is to locate overly loose or soft areas as well as to uniformly compact the subgrade surface. In granular soils, proof rolling should be performed with a heavy (minimum 30 ton) self-propelled vibratory roller. Loose or soft areas revealed during compaction or during the proof rolling should either be suitably compacted and aerated if necessary. Any areas that exhibit excessive pumping or yielding should be stabilized, scarified, and re-compacted, if weather conditions permit, or by the removal of the yielding soils and their replacement with engineered fill.

The subgrade and base material will need to be compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D1557 (Modified Proctor). It may



be necessary in some areas to undercut unsuitable soils and replace them with a stabilization layer of engineered fill.

Based on the change from brown to gray in the cohesive soils encountered at SB-04 and SB-06, the long-term groundwater table is estimated to be situated at a depth of about 3.3 to 4 feet below existing grades (EL. 95 to 99 feet±). Perched groundwater within the granular and fill soils above the less permeable clay layers should be expected and the Contractor should be prepared to handle. Water trapped in existing utility trenches in the area, which are often sand backfill within the native clay soils, should be expected. We do not expect the excavations required to construct the access service drive would extend below the estimated long-term groundwater. As such, we believe the groundwater should be adequately controlled using standard sump pits and pumping methods.

4.1.3 Drainage Considerations

The effects of frost heave are anticipated to be more significant in areas where water is not allowed to drain freely either due to subsoil conditions, site grades, or other factors. We recommend including a new drainage system within the new base course to drain water away from the pavement. The pavement and subgrade will need to be positively graded towards these drainage features or away from the center of the roadway to allow for gravity flow of groundwater. As we understand, the storm runoff from the site will be collected and conveyed to the storm junction chamber upstream of the Oakwood CSO.

For all new pavements, final pavement elevations should be designed to provide positive surface drainage. The minimum surface slope of 2 percent is recommended. The pavement surface should be smooth, free of roller marks or depressions, and should not contain any irregularities which would pond or impede water flow



4.1.4 Pavement Design Recommendations

4.1.4.1 Subgrade Design Values

We anticipate the subgrade soils for the proposed pavement construction will consist of existing fill soils. The recommended subgrade resilient modulus (M_R) and vertical subgrade reaction (K_v) provided below assumes the soil conditions encountered in the auger probes are representative of the soil conditions within the proposed pavement construction areas. This also assumes the recommended earthwork operations will have been incorporated into the project specifications and that the subgrade soils will have been compacted. If during construction, the subgrade is found to vary from the expected soil conditions, we should be contacted so we may re-evaluate our soil design parameters.

For Portland cement concrete pavement design, based on our experience with similar soil conditions and the results of the in-situ DCP tests, we recommend the following coefficients of subgrade reaction (K_v), subgrade resilient moduli (M_R), and CBR's be used as representation for the conditions of the soils at the new base course and subgrade levels compacted to project specifications.

Table 4.1.4.1 Recommended Pavement Subgrade Design Parameters

Soil Type	Coefficient of Vertical Subgrade Reaction, (K_v)	Subgrade Resilient Moduli (M_R)	CBR
Existing Granular Fill subgrade compacted in place	175 pci	15,000 psi	10 (lowest CBR value shown in the in-situ DCP tests)
Existing Native Clay Soils	85 pci	6,000 psi	4
New Engineered Sand Fill (MDOT Class II)	235 pci	22,500 psi	15
New Engineered Aggregate Base (MDOT 21AA)	340 pci	37,500 psi	25

Other factors should also be considered in the final pavement design, in addition to the subgrade modulus values. These factors may include, but are not limited to, adequate subgrade preparation, adequate placement of engineered fill and pavement layers, and surface and subsurface drainage.



4.1.4.2 Pavement Section Design Recommendations

The pavement will be designed to support HS-20 loading. We performed pavement analysis utilizing the AASHTO 1993 Guide for Design of Pavement Structures and the associated design charts and nomographs. The following list summarizes our input parameters and assumptions based on AASHTO guidelines and our observations:

Pavement Design Life	20 years (7 days per week)
Loading	HS-20 (8,000 lb/ front axle and two 32,000 lb/ rear axles (Given)
Load Equivalent Factor (LEF)	2.985 (calculated based on HS-20 loading using AASHTO LEF tables for terminal serviceability of 2.5)
Maximum Average Daily Traffic (ADT)	200 vehicles per day with HS-20 loading criteria (Back calculated)
Maximum Design ESAL's:	4,200,000 ESAL (Back calculated)
Percent Trucks:	100 %
Reliability:	90 % (Arterial road)
Standard Deviation:	0.35 (Rigid pavement)
Drainage Coefficient:	1.0
Initial Serviceability:	4.5 (Rigid pavement)
Terminal Serviceability:	2.5 (Major collectors)
Growth Rate	3%
Load Transfer Coefficient	2.7 (Dowel and mesh)
Concrete Elastic Modulus	6,000,000 psi (Assumed)
Effective Modulus of Subgrade Reaction of new base course (MDOT 21AA)	340 pci (CBR =25)
Mean Concrete Modulus of Rapture	650 psi

Based on our analysis, the following proposed pavement section design should be adequate to support the proposed traffic loading for the access service drive. This pavement section should be uniform across the mainline and the widened turns.

- 9 inches of Portland cement concrete, over
- 8 inches of new aggregate base course similar in gradation to MDOT 21AA, over
- (only placed where required) Triaxial geogrid such as Tensar NX750 or another engineer approved geogrid equivalent, over
- The compacted existing subgrade soils. Compact the existing subgrade with a vibratory roller or plate compactor until subsequent passes result in no significant downward displacement.



The subgrade and base material should be compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D-1557 (Modified Proctor).

Through the interlock restraint mechanism, this recommended system of base material reinforced with one layer of geogrid will provide the following benefits:

- The geogrid will help to tie together the widened paved turns with the pavement of the mainline access drive in order to avoid differential settlement since these areas have not been pre-consolidated by traffic load as the mainline road has experienced in the past.
- The geogrid system will help minimize the undercutting at localized areas of the existing fill soils (such as the organic pocket noted at 3 feet depth at the location of boring SB-03) and hence will reduce the additional earthwork costs. We still however recommend the normal practice that once rough subgrade has been exposed that any visible organic pockets be removed to the full vertical extent prior to placing the geogrid and the new base material course. A geotechnical engineer or qualified technician should confirm the suitability of the subgrade soils in the field at the time of construction.

To avoid differential settlement and pavement cracking at these widened turns, we recommend the geogrid to be placed immediately below the new 21AA base material and should span laterally from edge of pavement to edge of pavement with a minimum two feet extension beyond the outer (widened) edge. Longitudinally along the road, the geogrid should extend a minimum of 3 feet on either end of the widened section.

If needed, we recommend a 2-foot minimum overlap of the geogrid in conformance with manufacturer's recommendations to promote continuity of its load distribution performance.

The nominal size of the Tensar triaxial NX750 geogrid roll consists of 197 feet long and 12.5 feet wide geogrid strip that is generally commonly available and in stock. The standard specification of Tensar NX750 is attached in Appendix F for reference. An equivalent alternative to the Tensar



NX750 may be used as approved by the engineer provided it is co-extruded and has similar aperture size and shape.

4.2 PROPOSED BIOSWALE

As we understand, there are areas around the CSO basin that are poorly drained. On the basin's west side, there is an existing shallow drainage swale with dimensions of approximately 360 feet by 30 feet. The current plan calls for expanding and improving this swale to increase its volume to accept the flow that is discharged from the west side of the basin roof during wet weather.

A total of three (3) hand auger probes were performed along the existing bioswale. These probes were SB-04, 05, and 06 and each extended to a depth of 6 feet, 4 feet, and 5 feet, respectively.

Based on the findings of the hand auger probes, the soils consisted of 6 inches of topsoil over a granular fill layer over the native clay. The granular fill layer encountered in probes SB-04 and SB-05 consisted of silty sand and clayey sand soils, and had a thickness of 4 and 18 inches, respectively. Laboratory grain size analysis performed in accordance with ASTM D6913 indicated that the fines content of this granular layer was 43%, which is considered excessive.

In-situ falling head permeability tests were performed in the native clay soils at the termination depths near the probes. The infiltration tests were performed in offset boreholes within 2 feet from the locations of the sampling probes per the guidelines of the City of Detroit stormwater manual. Based on the in-situ infiltration tests the mean hydraulic conductivity (K1) of the native clay ranged between 0.007 and 0.025 inch per hour, which is considered almost impermeable.

Based on the findings of the infiltration tests, we recommend undercutting the existing granular fill soils and some of the native clays and replacing with drainable engineered fill in conformance to the Green Infrastructure Solution (GIS) design. The geometry of the new expanded swale (length, width, depth, and thickness of the granular soils) shall be designed by the GIS Engineer based on the maximum anticipated surface water runoff at the site.



The GIS design engineer should also consider the level of the anticipated long-term groundwater at the site during the design of the bioswale and the associated drainage systems. Based on the findings at the time of the geotechnical investigation (December 2022), the long-term groundwater table is estimated to be situated at a depth of about 3.3 to 4 feet below existing grades ((EL. 95 to 99 feet $\pm$)).

5.0 GENERAL QUALIFICATIONS

All construction activities should be monitored under the direction of a qualified Geotechnical Engineer to verify conditions as interpreted in this report. This report and the attached Logs of Auger Probes are instruments of service, which have been prepared in accordance with generally accepted soil and foundation engineering practices. We make no other warranties either expressed or implied as to the professional advice included in this report.

The contents of this report have been selected in order to aid in the evaluation of expected subsoil properties to assist the Engineer in the design of this project. In the event that any changes are made in the geotechnical aspects of this project, however slight, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and the conclusions of this report are modified in writing by our office.

Since the information obtained from auger probes is specific to the exact test locations, soil and water information could be different from those occurring at other locations of the site. This report does not reflect variations which may occur between the test holes. The nature and extent of these variations may not become evident until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate the recommendations provided in this report.

This report and the associated soil logs should be made available to bidders prior to submitting their proposals and to the successful Contractor and subcontractors for their information only, and to supply them with facts relative to the subsurface investigation, laboratory tests, etc.



The discussions and recommendations submitted in this report are based on the soil information contained in the Logs of Auger Probes and test results appended to this report. We expect that the logs of auger probes, test results, and the soil profiles included in this report along with our discussions and conclusions will assist you in designing the proposed pavement. Please refer to Appendix F for important information about this geotechnical investigation report. If you have any questions regarding this report, please contact us.



APPENDIX A

SOIL BORING LOCATION DIAGRAM



Adapted from Google Earth satellite imagery

Drawing Scale as noted

Project Site – Vicinity Map
Great Lakes Water Authority (GLWA)
GLWA Oakwood CSO Facility
Detroit, Michigan



APPENDIX B

LOGS OF TEST BORINGS AND GENERAL NOTES

PROJECT NO. 2022136A

DATE STARTED: 12/1/2022

DATE COMPLETED: 12/1/2022

LOG OF TEST BORING
SB-01 (Oakwood)

LOG OF SOIL PROFILE			FIELD DATA			LABORATORY DATA							▼ SPT N VALUE ▼						
ELEVATION ft			DEPTH (ft)	SAMPLE NO.	SAMPLE RECOVERY (in)	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	10	20	30	40	
															● MOISTURE CONTENT (%) ●				
															10	20	30	40	
															■ UCC STRENGTH (psf) ■				
															2000	4000	6000	8000	
		Ground Surface Elevation 99.84 ft	0																
98.34	+	FILL - Mixture of crushed aggregate and sand with silt, gray-brown, (Roadway gravel)	1.5	HA1				0.5											
				HA2				1.5						13					
94.84	+	FILL - Poorly graded fine to coarse sand, trace silt, trace gravel, gray-brown, moist (SP)	5.0																
				HA3				2.7						11					
		End of Boring at 5 feet	5																

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Northing: 287715.7
Easting: 13454196.9Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company:

Drill Rig:
Logged By: A. Patil
Drilling Method: Hand Auger
Method Notes: ---
Hammer Type:
Backfilled With: Cuttings
Checked By: ALOG
QA/QC By: JA
Remarks:

Somat Engineering Inc.

Great Lakes Water Authority (GLWA)
Combined Sewer Outfall (CSO) Improvements
Project
Oakwood CSO Facility
Detroit, Michigan

PROJECT NO. 2022136A

DATE STARTED: 12/1/2022

DATE COMPLETED: 12/1/2022

LOG OF TEST BORING
SB-02 (Oakwood)

LOG OF SOIL PROFILE			FIELD DATA								LABORATORY DATA								▼ SPT N VALUE ▼			
ELEVATION ft			DEPTH (ft)	SAMPLE NO.	SAMPLE RECOVERY (in)	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	● MOISTURE CONTENT (%) ●							
															■ UCC STRENGTH (psf) ■							
															2000	4000	6000	8000				
		Ground Surface Elevation 101.90 ft	0																			
	+	FILL - Mixture of crushed aggregate and sand with silt, gray-brown, (Roadway gravel)		HA1				0.5						11								
100.40																						
	+	FILL - Poorly graded fine to coarse sand with silt, with gravel, trace roots, dark brown, moist (SP-SM)		HA2				1.5														
	+																					
97.40	+			HA3				3.5														
	+																					
96.90	+	Stiff LEAN CLAY, few sand, trace gravel, brown (CL)		HA4				5.0	3000*	25.1		38	18									
		End of Boring at 5 feet	5																			

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Northing: 287922.0
Easting: 13454486.6Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company:

Drill Rig:

Logged By: A. Patil

Drilling Method: Hand Auger

Method Notes: ---

Hammer Type:

Backfilled With: Cuttings

Checked By: ALOG

QA/QC By: JA

Remarks:



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Detroit, Michigan

LOG OF TEST BORING GLWA OAKWOOD AND LEIB CSO FACILITIES (2).GPJ SOMAT.GDT 4/28/23

4/28/23

PROJECT NO. 2022136A

DATE STARTED: 12/1/2022

DATE COMPLETED: 12/1/2022

LOG OF TEST BORING
SB-04 (Oakwood)

LOG OF SOIL PROFILE			FIELD DATA										LABORATORY DATA										▼ SPT N VALUE ▼			
ELEVATION ft			DEPTH (ft)	SAMPLE NO.	SAMPLE RECOVERY (in)	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200		10	20	30	40							
		Ground Surface Elevation 98.93 ft	0																							
98.43		Field-reported as 6 inches of TOPSOIL	0.5																							
		LEAN CLAY with sand, trace topsoil, trace roots, trace gravel, dark brown (CL)		HA1				1.0	< >	19.0																
95.60			3.3																							
		Stiff LEAN CLAY, few sand, trace gravel, brown (CL)		HA2				4.0	3000*	22.3				84												
92.93			6.0																							
		End of Boring at 6 feet In-Situ falling head permeability test performed at a depth of 6 ft. had mean hydraulic conductivity of 0.01 inch/hour																								
			10																							

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Northing: 287722.1
Easting: 13454160.9Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company:

Drill Rig:

Logged By: A. Patil

Drilling Method: Hand Auger

Method Notes: ---

Hammer Type:

Backfilled With: Cuttings

Checked By: ALOG

QA/QC By: JA

Remarks:



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Detroit, Michigan

PROJECT NO. 2022136A

DATE STARTED: 12/2/2022

DATE COMPLETED: 12/2/2022

LOG OF TEST BORING
SB-05 (Oakwood)

LOG OF SOIL PROFILE			FIELD DATA			LABORATORY DATA							▼ SPT N VALUE ▼					
ELEVATION ft			DEPTH (ft)	SAMPLE NO.	SAMPLE RECOVERY (in)	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	10	20	30	40
		Ground Surface Elevation 100.32 ft	0															
99.82		Field-reported as 6 inches of TOPSOIL	0.5															
98.32		FILL - Poorly graded fine to coarse sand, with silt, with clay, few gravel, brown, moist (SP-SM)	2.0	HA1				1.5						43				
96.32		SANDY LEAN CLAY, few gravel, trace roots, dark brown (CL) (Possible fill)	4.0	HA2				2.7	3000*	14.8								
		End of Boring at 4 feet In-Situ falling head permeability test performed at a depth of 4 ft. had mean hydraulic conductivity of 0.025 inch/hour	5															
			10															

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Northing: 287830.5
Easting: 13454223.9Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company:

Drill Rig:

Logged By: A. Patil

Drilling Method: Hand Auger

Method Notes: ---

Hammer Type:

Backfilled With: Cuttings

Checked By: ALOG

QA/QC By: JA

Remarks:



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Oakwood CSO Facility
Detroit, Michigan

PROJECT NO. 2022136A

DATE STARTED: 12/2/2022

DATE COMPLETED: 12/2/2022

LOG OF TEST BORING
SB-06 (Oakwood)

LOG OF SOIL PROFILE			FIELD DATA			LABORATORY DATA								▼ SPT N VALUE ▼				
ELEVATION ft			DEPTH (ft)	SAMPLE NO.	SAMPLE RECOVERY (in)	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	10	20	30	40
		Ground Surface Elevation 100.67 ft	0															
100.17		Field-reported as 6 inches of TOPSOIL	0.5															
		Stiff SANDY LEAN CLAY, trace roots, trace gravel, brown (CL)		HA1				1.5	4000*	18.1								
96.67																		
		Stiff SANDY LEAN CLAY, trace roots, trace gravel, gray (CL)		HA2				4.5	5000*	18.0								
95.67			5.0															
		End of Boring at 5 feet In-Situ falling head permeability test performed at a depth of 5 ft. had mean hydraulic conductivity of 0.007 inch/hour																
			10															

																</		

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Northing: 287945.9
Easting: 13454293.4Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company:

Drill Rig:

Logged By: A. Patil

Drilling Method: Hand Auger

Method Notes: ---

Hammer Type:

Backfilled With: Cuttings

Checked By: ALOG

QA/QC By: JA

Remarks:



Somat Engineering Inc.

Great Lakes Water Authority (GLWA)
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Project
Oakwood CSO Facility
Detroit, Michigan



GENERAL NOTES

Unified Soil Classification System (USCS) ASTM D2488 (Modified)

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon – 1 3/8" I.D., 2" O.D. (standard)	BS:	Bulk Sample	RC:	Rock Core with diamond bit, NX size, (unless otherwise noted)
S:	Split Spoon – non-standard size, as noted	HSA:	Hollow Stem Auger		
ST:	Thin-Walled Tube – 3" O.D., (unless otherwise noted)	DP:	Direct Push	RB:	Rock Bit/Roller Bit
LS:	Liner Sample	PS:	Piston Sample	WR:	Wash Rotary
PA:	Power Auger	PT:	Pitcher Sample	NR:	No Recovery
HA:	Hand Auger	WS:	Wash Sample	VS:	Vane Shear Test
AU:	Auger Sample			ER:	Hammer Energy Ratio

Standard Penetration Test Resistance, N-Value: Sum of 2nd and 3rd 6-inch increments, in blows per foot of a 140-pound hammer falling 30 inches and driving an 18-inch to 30-inch long, 2-inch OD split spoon.

WATER LEVEL MEASUREMENT:

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. In pervious soils, the indicated levels may reflect the location of a groundwater table. In low permeability soils (clays and silts), the accurate determination of groundwater levels may not be possible with only short-term observations. Groundwater levels at times and locations other than when and where individual borings were performed could vary.

DESCRIPTIVE SOIL CLASSIFICATION:

Soil classification is based on the Unified Soil Classification (USC) System and ASTM Standards D-2487 and D-2488. Coarse-grained soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are generally described as: clays, if they are plastic, and silts, if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their apparent in-place density and fine-grained soils on the basis of their apparent in-place density (silty soils) or consistency (clayey soils).

CONSISTENCIES OF COHESIVE SOILS:

The pocket penetrometer, pocket torvane, and in-situ vane shear tests are converted into an estimated unconfined compressive strength, in pounds per square feet (psf), for presentation on the logs. The unconfined compressive strength is estimated to be about two time the shear strength.

DESCRIPTORS OF MINOR CONSTITUENTS

Primary Constituent	Fine-Grained (Silt & Clay)	Coarse-Grained (Sand & Gravel)	
Descriptor of Other Constituents	Relative Portion of Coarse Grained Soils as a % of Dry Weight	Relative Portion of Fine Grained Soils as a % of Dry Weight	Relative Portion of Coarse Grained Soils as a % of Dry Weight
Trace	<5%	<5%	<5%
Few	≥5% - <15%	N/A	≥5% - <15%
With	≥15% - <30%	≥5% - 12%	≥15%
Modifier	≥30%	>12%	N/A

FINE-GRAINED SOILS

Unconfined Compressive Strength Q_u , psf	Consistency	N-Value	Apparent Density
< 500	Very Soft	0 – 4	Very Loose
500 - <1,000	Soft	5 – 9	Loose
1,000 - <2,000	Medium	10 – 29	Medium Dense
2,000 - <4,000	Stiff	30 – 49	Dense
4,000 - <8,000	Very Stiff	50 – 80	Very Dense
≥ 8,000	Hard	>80	Extremely Dense

COARSE-GRAINED SOILS

DEFINITIONS OF PAVEMENT CONDITION

Condition	Description
Good	ACC Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks and transverse cracks (open ¼ inch). No patching or very few patches in excellent condition.
	PCC Moderate scaling in several locations. A few isolated surface spalls. Shallow reinforcement causing cracks. Several corner cracks, tight or well sealed. Open (¼ inch wide) longitudinal or transverse joints.
Fair	ACC Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (½ inch deep or less).
	PCC Severe polishing, scaling, map cracking, or spalling over 50% of the area. Joints and cracks show moderate to severe spalling. Pumping and faulting of joints (½ inch with fair ride). Several slabs have multiple transverse or meander cracks with moderate spalling.
Poor	ACC Alligator cracking (over 25% of surface). Severe distortions (over 2 inches deep) Extensive patching in poor condition. Potholes.
	PCC Extensive slab cracking, severely spalled and patched. Joints failed. Patching in very poor condition. Severe and extensive settlement or frost heaves.

DEFINITIONS OF STRUCTURAL AND DEPOSITIONAL FEATURES

Term	Definition
Parting	≤ 1/16 inch (1.6 mm) thick
Seam	> 1/16 inch (1.6 mm) → ½ inch (12.7 mm) thick
Layer	> ½ inch (12.7 mm) to ≤ 12 inches (305 mm) thick
Pocket	Small, erratic deposits of limited lateral extent
Lens	Lenticular deposit
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Varved	Alternating partings or seams (1 mm – 12 mm) of silt and/or clay and sometimes fine sand
Stratified	Alternating layers of varying material or color with layers ≥ 6 mm thick
Laminated	Alternating layers of varying material or color with layers < 6 mm thick
Fissured	Contains shears or separations along planes of weakness
Slickensided	Shear planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Homogeneous	Same color and appearance throughout
Occasional	One or less per foot (305 mm) of thickness
Frequent	More than one per foot (305 mm) of thickness
Interbedded	Applied to strata of soil lying between or alternating with other strata of a different nature

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Size Range
Boulders	≥ 12" (300 mm)
Cobbles	< 12" - 3" (300 mm – 75 mm)
Gravel - Coarse	< 3" - ¾" (75 mm – 19 mm)
Gravel - Fine	< ¾" - #4 (19 mm – 4.75 mm)
Sand - Coarse	< #4 - #10 (4.75 mm – 2 mm)
Sand - Medium	< #10 - #40 (2 mm - 0.425 mm)
Sand - Fine	< #40 - #200 (0.425 mm - 0.074 mm)
Silt	< 0.074 mm - 0.005 mm
Clay	< 0.005 mm



GENERAL NOTES

Unified Soil Classification System (USCS) ASTM D2487

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	Group Name <i>B</i>
COARSE-GRAINED More than 50 % retained on No. 200 sieve	Gravels (More than 50 % of coarse fraction retained on No. 4 sieve)	Clean Gravels	$Cu \geq 4$ and $1 \leq Cc \leq 3^D$	GW	Well-graded gravel ^E
		(Less than 5% fines ^C)	$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3]^D$	GP	Poorly graded gravel ^E
		Gravels with Fines	Fines classify as ML or MH	GM	Silty gravel ^{E,F,G}
		(More than 12 % fines ^C)	Fines classify as CL or CH	GC	Clayey gravel ^{E,F,G}
	Sands (50 % or more of coarse fraction passes No. 4 sieve)	Clean Sands	$Cu \geq 6$ and $1 \leq Cc \leq 3^D$	SW	Well-graded sand ^F
		(Less than 5 % fines ^H)	$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3]^D$	SP	Poorly graded sand ^F
		Sands with Fines	Fines classify as ML or MH	SM	Silty sand ^{F,G,I}
		(More than 12 % fines ^H)	Fines classify as CL or CH	SC	Clayey sand ^{F,G,I}
FINE-GRAINED SOILS 50 % or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	$PI > 7$ and plots on or above "A" line ^J	CL	Lean clay ^{K,L,M}
			$PI < 4$ or plots below "A" line ^J	ML	Silt ^{K,L,M}
		organic	(Liquid Limit - oven dried) / (Liquid Limit - not dried) < 0.75	OL	Organic clay ^{K,L,M,N} Organic silt ^{K,L,M,O}
	Silts and Clays Liquid limit more than 50	inorganic	PI plots on or above "A" line	CH	Fat clay ^{K,L,M}
			PI plots below "A" line	MH	Elastic silt ^{K,L,M}
		organic	(Liquid Limit - oven dried) / (Liquid Limit - not dried) < 0.75	OH	Organic clay ^{K,L,M,P} Organic silt ^{K,L,M,Q}
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			Pt	Peat
^A Based on the material passing the 3-in. (75-mm) sieve. ^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name. ^C Gravels with 5 to 12 % fines require dual symbols: GW-GM well-graded gravel with silt GW-GC well-graded gravel with clay GP-GM poorly graded gravel with silt GP-GC poorly graded gravel with clay ^D $Cu = D_{60} / D_{10}$ $Cc = (D_{30})^2 / (D_{10} \times D_{60})$ ^E If soil contains ≥ 15 % sand, add "with sand" to group name. ^F If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM. ^G If fines are organic, add "with organic fines" to group name.				^H Sands with 5 to 12 % fines require dual symbols: SW-SM well-graded sand with silt SW-SC well-graded sand with clay SP-SM poorly graded sand with silt SP-SC poorly graded sand with clay ^I If soil contains ≥ 15 % gravel, add "with gravel" to group name. ^J If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay. ^K If soil contains 15 to < 30 % plus No. 200, add "with sand" or "with gravel," whichever is predominant. ^L If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name. ^M If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name. ^N $PI \geq 4$ and plots on or above "A" line. ^O $PI < 4$ or plots below "A" line. ^P PI plots on or above "A" line. ^Q PI plots below "A" line.	

^A Based on the material passing the 3-in. (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12 % fines require dual symbols:

GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

^D $Cu = D_{60}/D_{10}$ $Cc = (D_{30})^2 / (D_{10} \times D_{60})$

^E If soil contains ≥ 15 % sand, add "with sand" to group name.

^F If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^G If fines are organic, add "with organic fines" to group name.

^H Sands with 5 to 12 % fines require dual symbols:

SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

^I If soil contains ≥ 15 % gravel, add "with gravel" to group name.

^J If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

^K If soil contains 15 to < 30 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name.

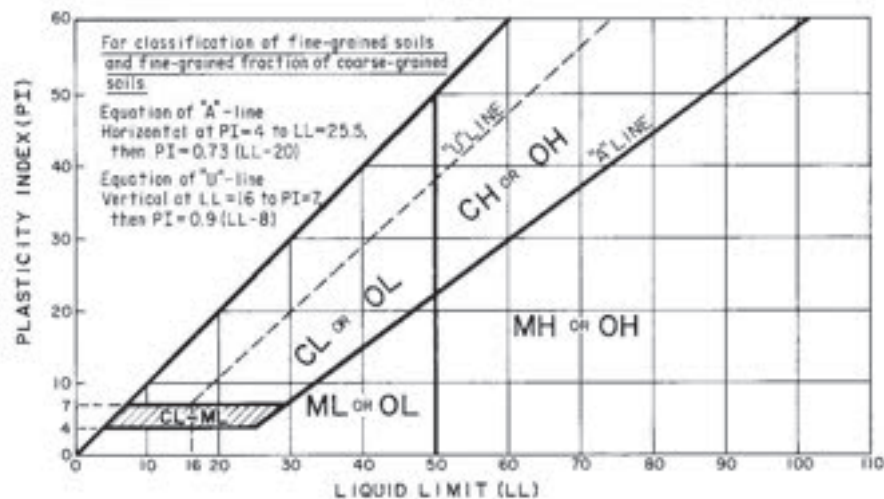
^M If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



Order of Classification: 1) Consistency or Apparent Density, 2) Type of Soil, 3) Minor Soil Type(s), 4) Inclusions, 5) Layered Soils, 6) Color, 7) Water Content, 8) USCS Symbol, 9) Geological Name

APPENDIX C

DYNAMIC CONE PENETROMETER (DCP) TEST RESULTS



SOMAT ENGINEERING, INC.
GEOTECHNICAL - GEORENVIROMENTAL - MATERIALS TESTING

RESULTS OF DCP TESTING

SB-01

Page 1 of 1

Project: Great Lakes Water Authority (GLWA)
GLWA Oakwood CSO Facility

Hand Aguer SB-01
Probe ID:

Location: Roadway Gravel

Project No.: Detroit, Michigan
2022136A

Date: 12/1/2022
Personnel: A. Patil

Weather: 34°
GS Elevation: #REF!

Start Depth: 6.0 in.
Water Depth: none ft.

Latitude:
Longitude:

Type of Material	Classification	# of Blows per Set (1)	Cumulative Penetration (in) (2)	Cumulative Penetration (mm) (3)	Incremental Penetration per Blow Set (mm) (4)	Cumulative Blows (5)	Penetration per Blow for Set (mm/blow) (6)	Hammer (7)	DCP Index (mm/blow) (8)	Estimated CBR (%) (9)
FILL-Mixture of crushed aggregate and sand		5	6.0	153	0	0				
FILL-Mixture of crushed aggregate and sand		5	6.6	168	15	5	3.0	1	3	85
FILL-Mixture of crushed aggregate and sand		5	6.9	174	6	10	1.2	1	1	100
FILL-Mixture of crushed aggregate and sand		5	7.2	183	9	15	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	7.6	194	11	20	2.2	1	2	100
FILL-Mixture of crushed aggregate and sand		5	8.1	205	11	25	2.2	1	2	100
FILL-Mixture of crushed aggregate and sand		5	8.5	215	10	30	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	8.8	224	9	35	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	9.2	233	9	40	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	9.5	242	9	45	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	10.2	258	16	50	3.2	1	3	79
FILL-Mixture of crushed aggregate and sand		5	10.7	273	15	55	3.0	1	3	85
FILL-Mixture of crushed aggregate and sand		5	11.2	285	12	60	2.4	1	2	100
FILL-Mixture of crushed aggregate and sand		5	11.8	299	14	65	2.8	1	3	92
FILL-Mixture of crushed aggregate and sand		5	12.3	312	13	70	2.6	1	3	100
FILL-Mixture of crushed aggregate and sand		5	12.7	323	11	75	2.2	1	2	100
FILL-Mixture of crushed aggregate and sand		5	13.2	335	12	80	2.4	1	2	100
FILL-Mixture of crushed aggregate and sand		5	13.7	348	13	85	2.6	1	3	100
FILL-Mixture of crushed aggregate and sand		5	14.1	357	9	90	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	14.4	365	8	95	1.6	1	2	100
FILL-Mixture of crushed aggregate and sand		5	14.9	378	13	100	2.6	1	3	100
FILL-Mixture of crushed aggregate and sand		5	15.3	388	10	105	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	15.7	398	10	110	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	16.0	407	9	115	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	16.7	425	18	120	3.6	1	4	70
FILL-Mixture of crushed aggregate and sand		5	17.0	433	8	125	1.6	1	2	100
FILL-Mixture of crushed aggregate and sand		5	17.4	443	10	130	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	18.0	458	15	135	3.0	1	3	85
FILL-Mixture of crushed aggregate and sand		5	18.6	473	15	140	3.0	1	3	85
FILL-Mixture of crushed aggregate and sand		5	19.1	485	12	145	2.4	1	2	100
FILL-Mixture of crushed aggregate and sand		5	19.5	495	10	150	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	19.9	505	10	155	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	20.3	516	11	160	2.2	1	2	100
FILL-Mixture of crushed aggregate and sand		5	20.3	516	0	165	0.0	1	0	
FILL-Mixture of crushed aggregate and sand		5	20.6	523	7	170	1.4	1	1	100
FILL-Mixture of crushed aggregate and sand		5	21.0	533	10	175	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	21.4	543	10	180	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	21.6	549	6	185	1.2	1	1	100
FILL-Mixture of crushed aggregate and sand		5	22.0	559	10	190	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	22.4	569	10	195	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	22.8	578	9	200	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	23.0	585	7	205	1.4	1	1	100
FILL-Mixture of crushed aggregate and sand		5	23.4	595	10	210	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	23.8	605	10	215	2.0	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	24.2	615	10	220	2.0	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	24.7	627	12	225	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	25.2	639	12	230	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	25.7	653	14	235	2.8	1	3	92
FILL - Sand, trace silt, trace gravel	SP	5	26.2	665	12	240	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	26.7	677	12	245	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	27.1	689	12	250	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	27.8	705	16	255	3.2	1	3	79
FILL - Sand, trace silt, trace gravel	SP	5	28.1	715	10	260	2.0	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	28.5	723	8	265	1.6	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	29.1	740	17	270	3.4	1	3	74

(1) Number of hammer blows between test readings

(2) Cumulative cone penetration after each set of hammer blows.

(3) Incremental penetration between blow sets

(4) Cumulative total of blows

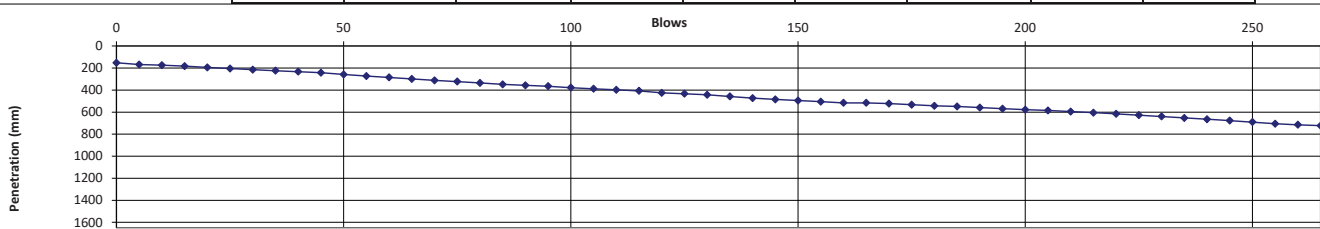
(5) (3) divided by (1)

(6) Enter 1 for 17.6 lb. hammer, 2 for 10.1 lb. hammer.

(7) (5) x (6)

(8) From CBR versus DCP Correlation.

X (# of Blows)		Y (Penetration)		Blow Count	Total Penetration (mm)	Hammer Factor	Log Report	
Begin	End	Begin (mm)	End (mm)				(mm/Blow)	depth (ft)
0	50	153	258	50	105	1	2.1	0.5
50	100	258	378	50	120	1	2.4	0.8
100	150	378	495	50	117	1	2.3	1.2
150	200	495	578	50	83	1	1.7	1.6
200	270	578	740	70	162	1	2.3	1.9



Infrastructure Engineering Solutions



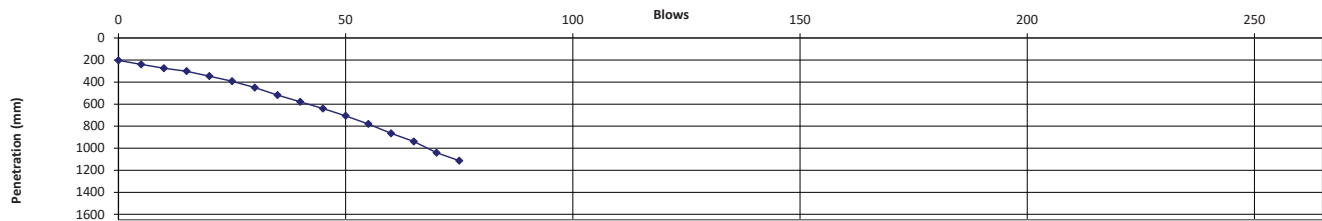
SB-02

Project:	Great Lakes Water Authority (GLWA) GLWA Oakwood CSO Facility	Hand Aguer Probe ID:	SB-02	Location:	Roadway Gravel
Project No.:	Detroit, Michigan 2022136A	Date: Personnel:	12/1/2022 A. Patil	Weather: GS Elevation:	36"
		Start Depth: Water Depth:	8.0 none	in. ft.	Latitude: Longitude:

[illegible]

(8) From CBR versus DCP Correlation.

X (# of Blows)		Y (Penetration)		Blow Count	Total Penetration (mm)	Hammer Factor	Log Report	
Begin	End	Begin (mm)	End (mm)				(mm/Blow)	depth (ft)
0	20	204	346	20	142	1	7.1	0.7
20	30	346	450	10	104	1	10.4	1.1
30	60	450	865	30	415	1	13.8	1.5
60	70	865	1041	10	176	1	17.6	2.8
70	75	1041	1114	5	73	1	14.6	3.4



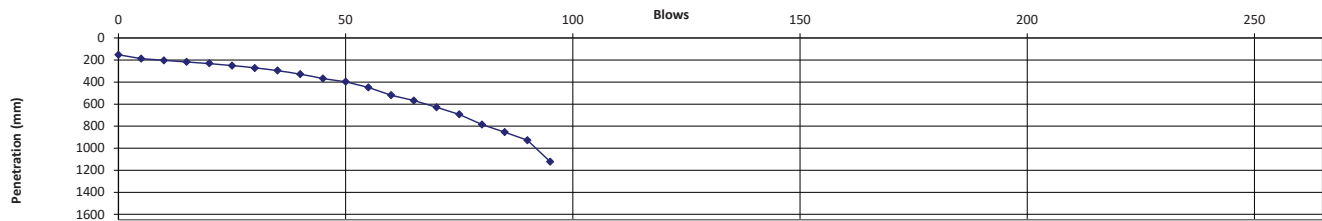


SB-03

Page 1 of 1

(1) Number of hammer blows between test readings	(5) (3) divided by (1)
(2) Cumulative cone penetration after each set of hammer blows.	(6) Enter 1 for 17.6 lb. hammer, 2 for 10.1 lb. hammer.
(3) Incremental penetration between blow sets	(7) (5) x (6)
(4) Cumulative total of blows	(8) From CBR versus DCP Correlation.

X (# of Blows)		Y (Penetration)		Blow Count	Total Penetration (mm)	Hammer Factor	Log Report	
Begin	End	Begin (mm)	End (mm)				(mm/blow)	depth (ft)
0	20	153	230	20	77	1	3.9	0.5
20	30	230	273	10	43	1	4.3	0.8
30	60	273	519	30	246	1	8.2	0.9
60	80	519	785	20	266	1	13.3	1.7
80	95	785	1123	15	338	1	22.5	2.6



APPENDIX D

IN-SITU FALLING HEAD PERMEABILITY TEST RESULTS



Somat Engineering,
INCORPORATED

IN-SITU FALLING HEAD PERMEABILITY TEST REPORT

SB-04

Page 1 of 1

PROJECT: Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO)
Improvements Projects GWLA Oakwood CSO Facility
Detroit, Michigan
PROJECT NO: 2022136A

PRESOAK START DATE/TIME/DURATION: 12/1/2022 11:33
TEST START DATE/TIME: 12/1/2022 12:03
TEST END DATE/TIME: 12/1/2022 13:02
FIELD ENGINEER/ANALYST: A. Pail
BOREHOLE DRILL DATE: 12/1/2022
BOREHOLE LOCATION: Grass
TOP OF BOREHOLE/GROUND ELEV.: 98.93 Feet
NORTHING: 287722.09 Feet
EASTING: 13454160.86 Feet
COORDINATES/ELEVATION NOTES: Project Surveyor

In-situ falling head permeability test and calculations performed per guidelines adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015) and ASTM D-6391 Method A

EQUIPMENT	
PRESSURE TRANSDUCER	In-Situ Level TROLL 700
DATA LOGGER SOFTWARE	Win-Situ 5

DATA INPUT	
CASING DIAMETER, D1	6.0 in.
CASING DIAMETER (inside casing), d	6.0 in.
DISTANCE BOTTOM OF CASING TO BOTTOM OF STATUM, b1	10.0 ft.
TEST DEPTH (below existing grade)	6.0 ft.
APPROX. TEST ELEVATION	-6.0 ft.

EQUATIONS	
-----------	--

Mean hydraulic conductivity (K1):
(Equations obtained from D6391-11)
$$K1 = Rt \cdot G1 \cdot \ln(H1/H2) / (t_2 - t_1) \quad \text{eq. 1}$$
$$G1 = (\pi d^2 / 16 D_1) [1 + a(D_1 / 4b_1)] \quad \text{eq. 2}$$

Rt = temperature coefficient (varies)
a = material at the test depth = 1
G1 = test setup parameter 4.407 (calculated based on data input)

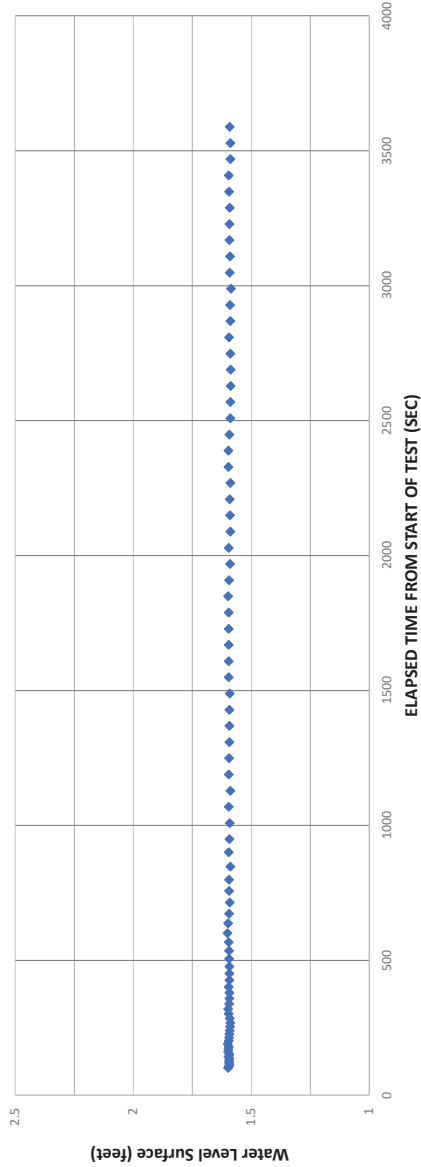
- 1.) Use inner diameter of casing for "D₁" and "d" because no standpipe was used
- 2.) Rt calculated as 2.2902(0.9842)^{1/T-17.0} and T is temperature in °C
- 3.) "a" in eq. 2 is "-1" for permeable base; or "1" for impermeable base below test stratum
- 4.) b₁ is distance from bottom of casing to bottom of stratum
- 5.) H₁ and H₂ are the level surface elevations at times t₁ and t₂

MEAN HYDRAULIC CONDUCTIVITY (K1)	
K ₁	7.062E-06 cm/sec (0.010 inch/hour)

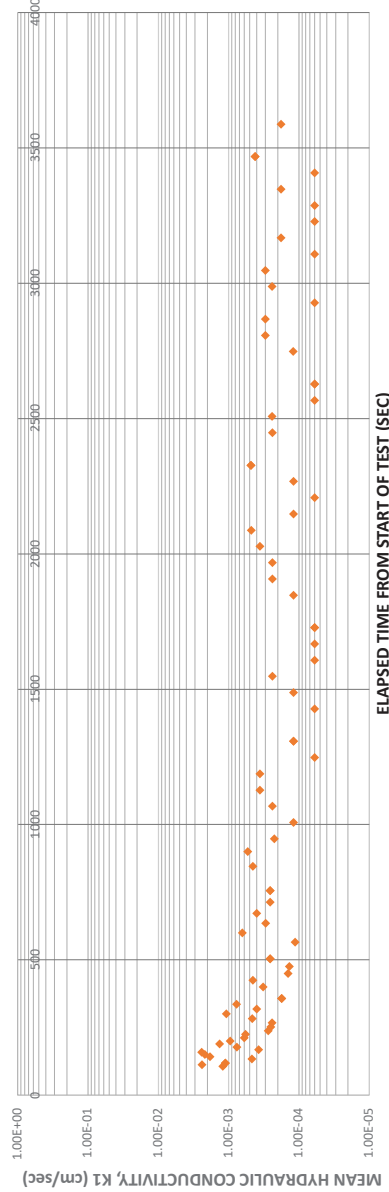
SOIL TYPE AT TEST DEPTH	
DESCRIPTION	DEPTH (ft.)
LEAN CLAY, few sand, trace gravel	6.0

NOTES: Groundwater encountered during drilling: none
Groundwater reported upon completion of drilling: none

WATER LEVEL SURFACE vs. TIME ELAPSED



MEAN HYDRAULIC CONDUCTIVITY vs. TIME ELAPSED





Somat Engineering,
INCORPORATED

IN-SITU FALLING HEAD PERMEABILITY TEST REPORT

SB-05

Page 1 of 1

PROJECT: Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO)
Improvements Projects GWLA Oakwood CSO Facility
Detroit, Michigan
PROJECT NO: 2022136A

PRESOAK START DATE/TIME/DURATION: 12/2/2022 13:31
TEST START DATE/TIME: 12/2/2022 14:01
TEST END DATE/TIME: 12/2/2022 15:02
FIELD ENGINEER/ANALYST: A. Pail
BOREHOLE DRILL DATE: 12/2/2022

BOREHOLE LOCATION: Grass
TOP OF BOREHOLE/GROUND ELEV.: 100.32 Feet
NORTHING: 287830.45 Feet
EASTING: 1345423.91 Feet

COORDINATES/ELEVATION NOTES: Project Surveyor

In-situ falling head permeability test and calculations performed per guidelines adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015) and ASTM D-6391 Method A

EQUIPMENT	
PRESSURE TRANSDUCER	In-Situ Level TROLL 700
DATA LOGGER SOFTWARE	Win-Situ 5

DATA INPUT	
CASING DIAMETER, D1	6.0 in.
CASING DIAMETER (inside casing), d	6.0 in.
DISTANCE BOTTOM OF CASING TO BOTTOM OF STATUM, b1	10.0 ft.
TEST DEPTH (below existing grade)	4.0 ft.
APPROX. TEST ELEVATION	-4.0 ft.

EQUATIONS

Mean hydraulic conductivity (K1):
(Equations obtained from D6391-11)
$$K1 = \frac{Rt \cdot G1 \cdot \ln(H1/H2)}{(t_2 - t_1)} \quad \text{cm/sec} \quad \text{eq. 1}$$
$$G1 = \frac{(\pi d^2 / 4) (H1 + H2)}{4L} \quad \text{cm} \quad \text{eq. 2}$$

Rt = temperature coefficient
a = material at the test depth = 1
G1 = test setup parameter = 4.407 (calculated based on data input)

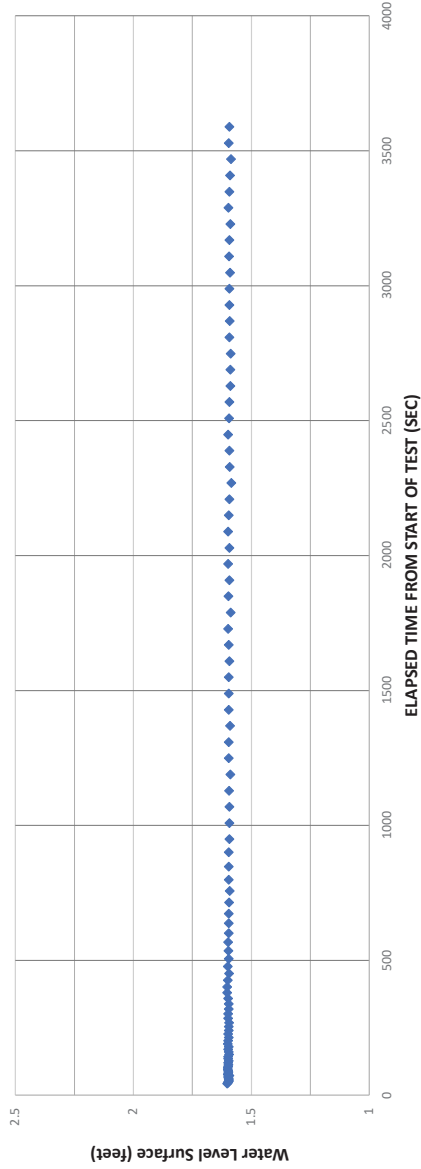
- 1.) Use inner diameter of casing for "D," and "d" because no standpipe was used
- 2.) Rt calculated as 2.2902(0.9842)^{1/T-17.0} and T is temperature in °C
- 3.) "a" in eq. 2 is "-1" for permeable base; or "1" for impermeable base below test stratum
- 4.) b1 is distance from bottom of casing to bottom of stratum
- 5.) H1 and H2 are the level surface elevations at times t1 and t2

MEAN HYDRAULIC CONDUCTIVITY (K1)	
K1	1.736E-05 cm/sec (0.025 inch/hour)

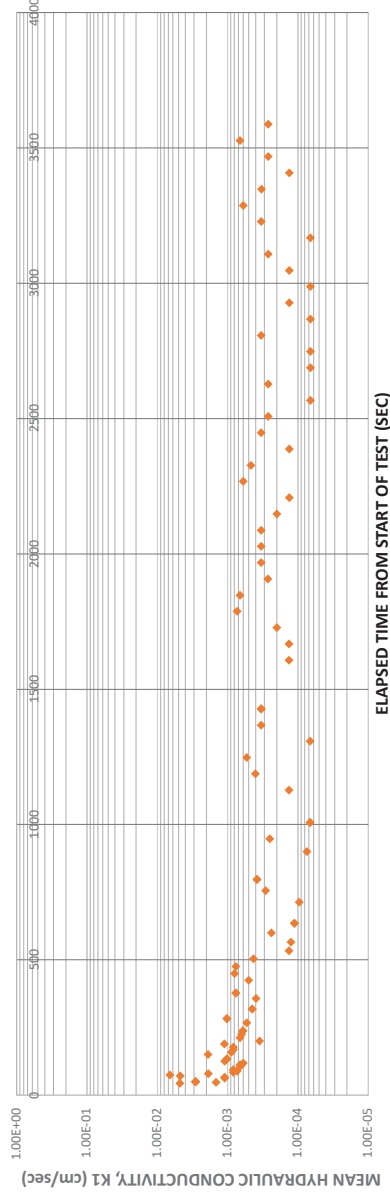
SOIL TYPE AT TEST DEPTH	
DESCRIPTION	DEPTH (ft.)
SANDY LEAN CLAY, few gravel, trace roots	4.0

NOTES: Groundwater encountered during drilling: none
Groundwater reported upon completion of drilling: none

WATER LEVEL SURFACE vs. TIME ELAPSED



MEAN HYDRAULIC CONDUCTIVITY vs. TIME ELAPSED





Somat Engineering,
INCORPORATED

IN-SITU FALLING HEAD PERMEABILITY TEST REPORT

SB-06

Page 1 of 1

PROJECT: Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO)
Improvements Projects GWLA Oakwood CSO Facility
Detroit, Michigan
PROJECT NO: 2022136A

PRESOAK START DATE/TIME/DURATION: 12/2/2022 10:29
TEST START DATE/TIME: 12/2/2022 10:59
TEST END DATE/TIME: 12/2/2022 12:00
FIELD ENGINEER/ANALYST: A. Pail
BOREHOLE DRILL DATE: 12/1/2022
BOREHOLE LOCATION: Grass
TOP OF BOREHOLE/GROUND ELEV.: 100.67 Feet
NORTHING: 287945.94 Feet
EASTING: 13454293.37 Feet
COORDINATES/ELEVATION NOTES: Project Surveyor

In-situ falling head permeability test and calculations performed per guidelines adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015) and ASTM D-6391 Method A

EQUIPMENT	
PRESSURE TRANSDUCER	In-Situ Level TROLL 700
DATA LOGGER SOFTWARE	Win-Situ 5

DATA INPUT	
CASING DIAMETER, D1	6.0 in.
CASING DIAMETER (inside casing), d	6.0 in.
DISTANCE BOTTOM OF CASING TO BOTTOM OF STATUM, b1	10.0 ft.
TEST DEPTH (below existing grade)	5.0 ft.
APPROX. TEST ELEVATION	-5.0 ft.

EQUATIONS

Mean hydraulic conductivity (K1):
(Equations obtained from D6391-11)

$$K1 = \frac{Rt \cdot G1 \cdot \ln(H1/H2)}{(t2 - t1)} \quad \text{eq. 1}$$
$$G1 = \frac{(\pi d^2 / 4) [1 + a(D1/4b1)]}{4.407} \quad \text{eq. 2}$$

Rt = temperature coefficient
a = material at the test depth = $\frac{1}{4.407}$ (calculated based on data input)
G1 = test setup parameter

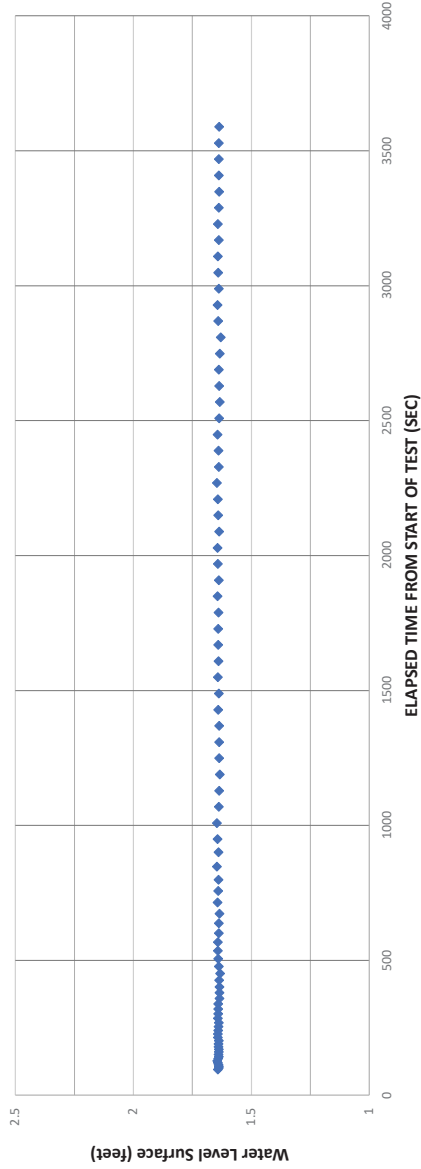
- 1.) Use inner diameter of casing for "D1" and "d" because no standpipe was used
- 2.) Rt calculated as $2.2902(0.9842)^{T/T_{ref}}$ and T is temperature in °C
- 3.) "a" in eq. 2 is "-1" for permeable base; or "1" for impermeable base below test stratum
- 4.) b1 is distance from bottom of casing to bottom of stratum
- 5.) H1 and H2 are the level surface elevations at times t1 and t2

MEAN HYDRAULIC CONDUCTIVITY (K1)	
K1	5.181E-06 cm/sec (0.007 inch/hour)

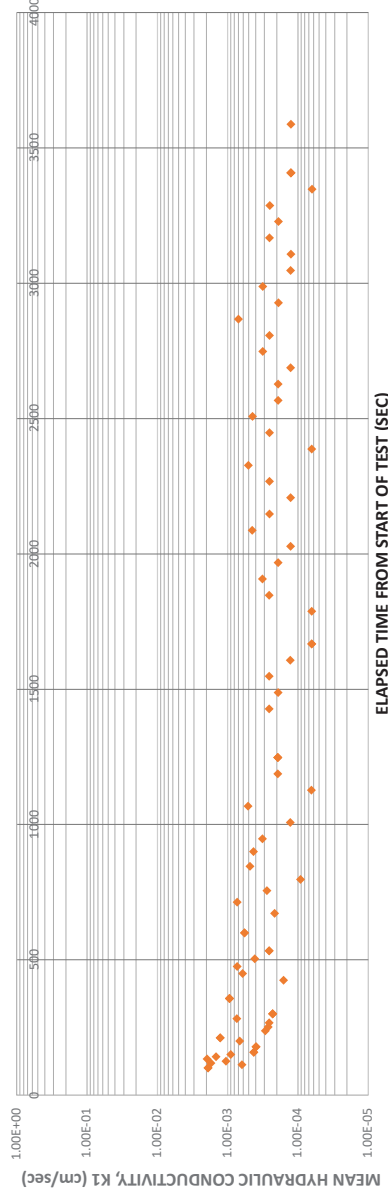
SOIL TYPE AT TEST DEPTH	
DESCRIPTION	DEPTH (ft.)
SANDY LEAN CLAY, trace roots, trace gravel	5.0

NOTES: Groundwater encountered during drilling: none
Groundwater reported upon completion of drilling: none

WATER LEVEL SURFACE vs. TIME ELAPSED



MEAN HYDRAULIC CONDUCTIVITY vs. TIME ELAPSED



APPENDIX E

LABORATORY TEST RESULTS & LABORATORY TEST DESCRIPTIONS

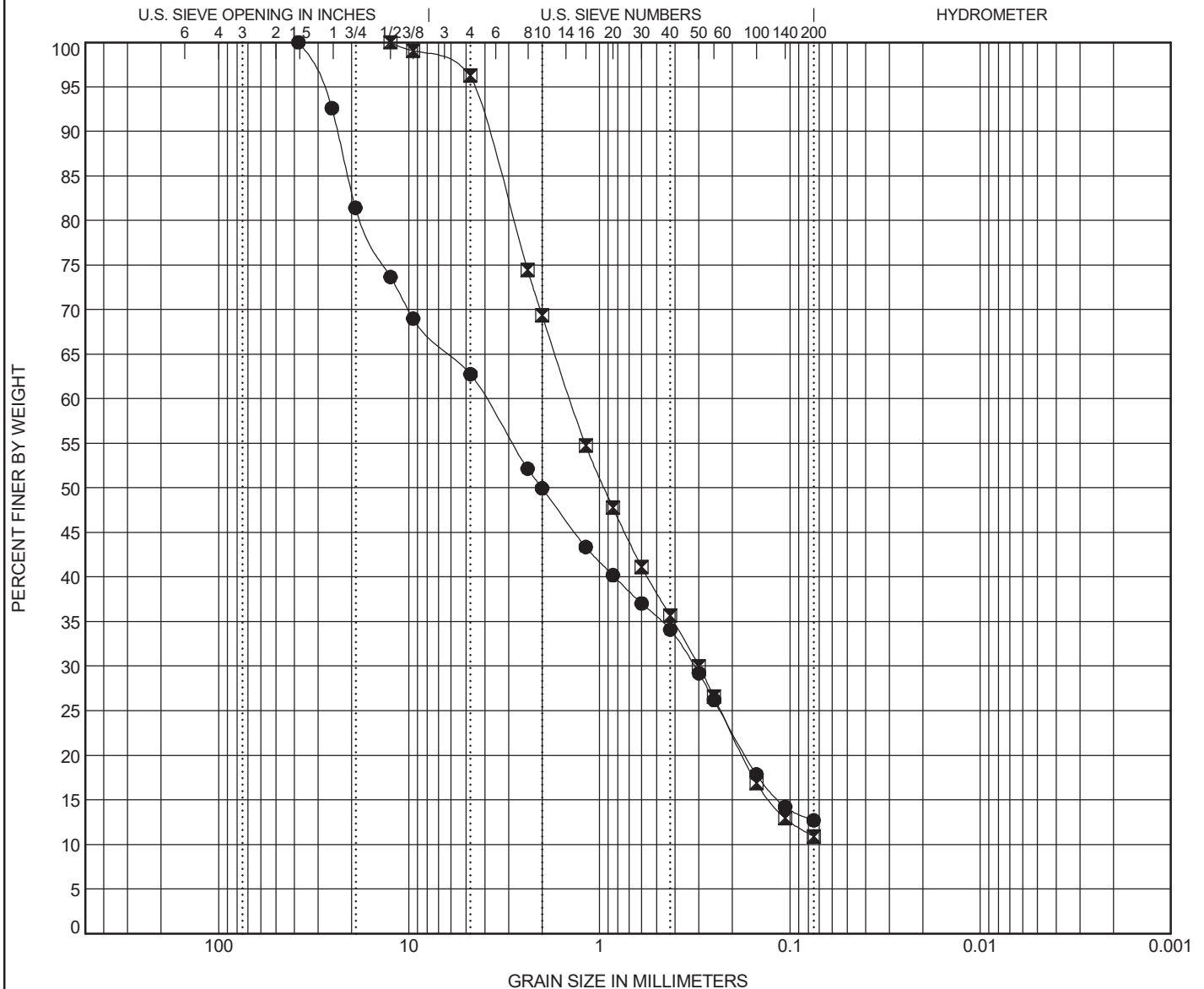


Somat

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Depth ft.	Remarks					LL	PL	PI	Cc	Cu
●	SB-01	1.0	1-inch sieve retained one stone									
☒	SB-01	2.2									0.98	22.17
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
●	SB-01	1.0	38.1	3.97	0.318		37.2	50.1	12.7			
☒	SB-01	2.2	12.5	1.425	0.3		3.7	85.3	10.9			

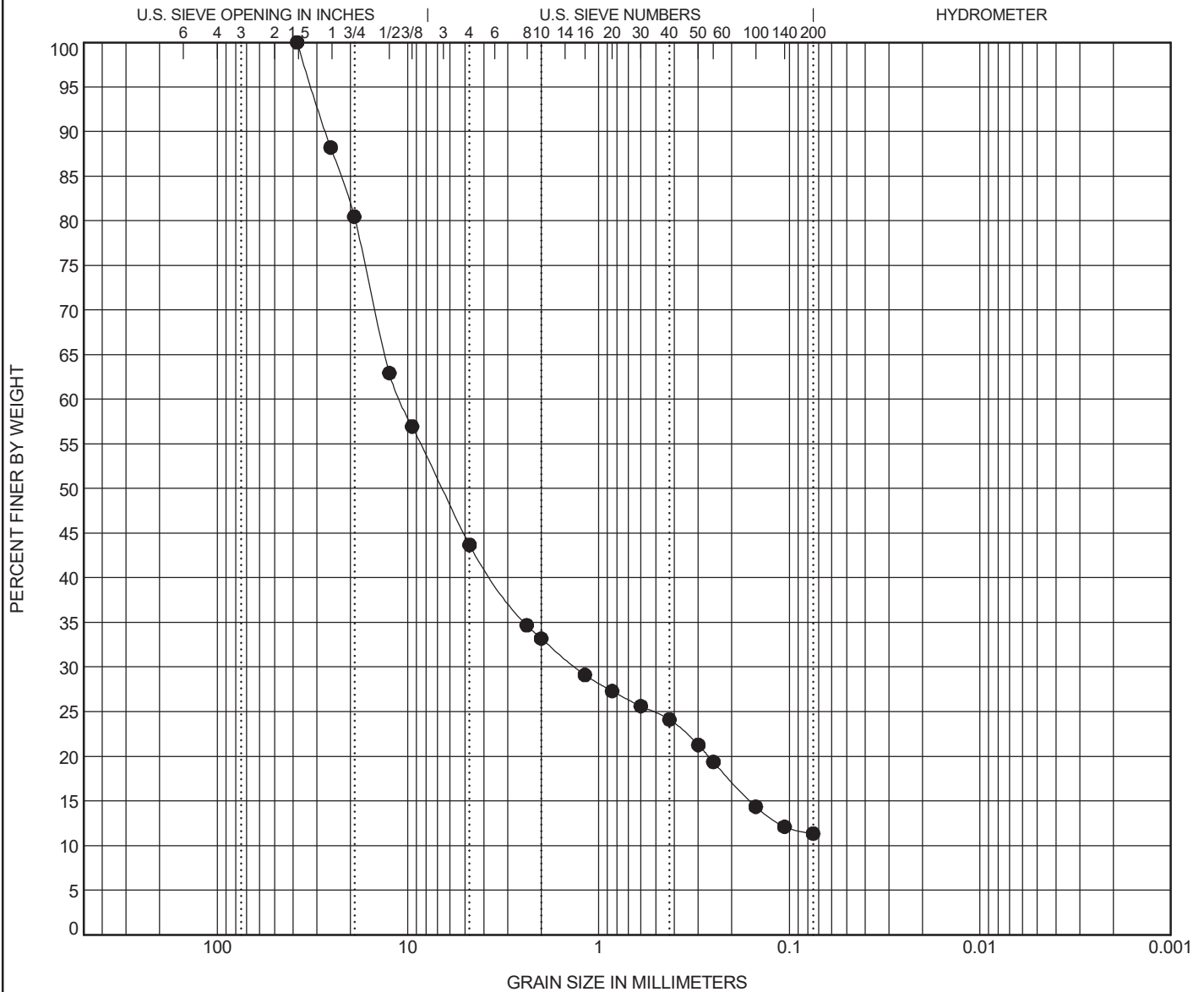


Somat

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Depth ft.	Remarks					LL	PL	PI	Cc	Cu
● SB-02	0.0									3.91	265.65
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● SB-02	0.0	38.1	10.925	1.325		56.3	32.4	11.3			

GRAIN SIZE GLWA OAKWOOD AND LEIB CSO FACILITIES.GPJ SOMAT.GDT 12/18/22

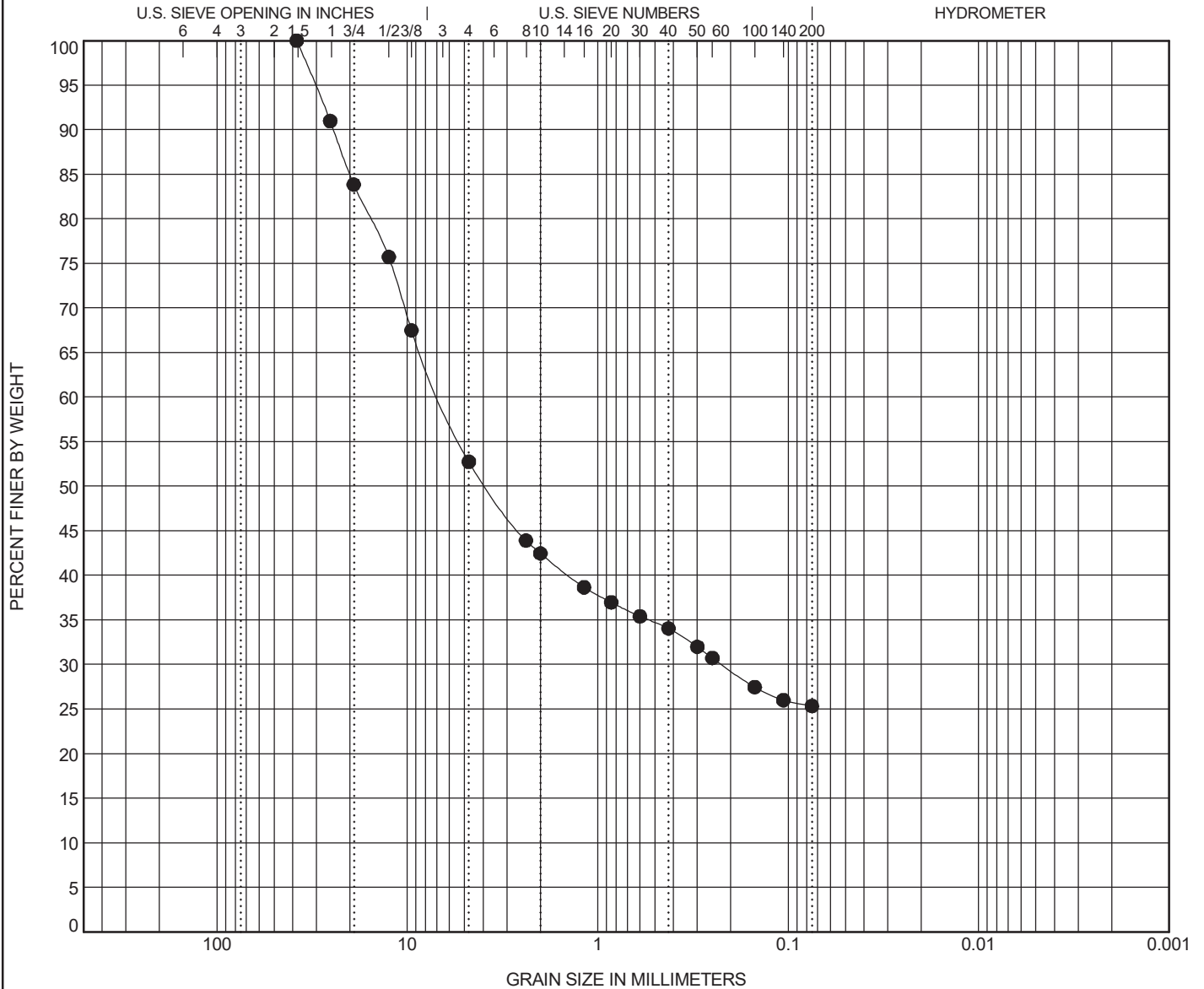


Somat

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Depth ft.	Remarks					LL	PL	PI	Cc	Cu
● SB-03	0.0										
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● SB-03	0.0	38.1	6.682	0.223		47.3	27.4	25.3			

GRAIN SIZE GLWA OAKWOOD AND LEIB CSO FACILITIES.GPJ SOMAT.GDT 12/18/22



Somat

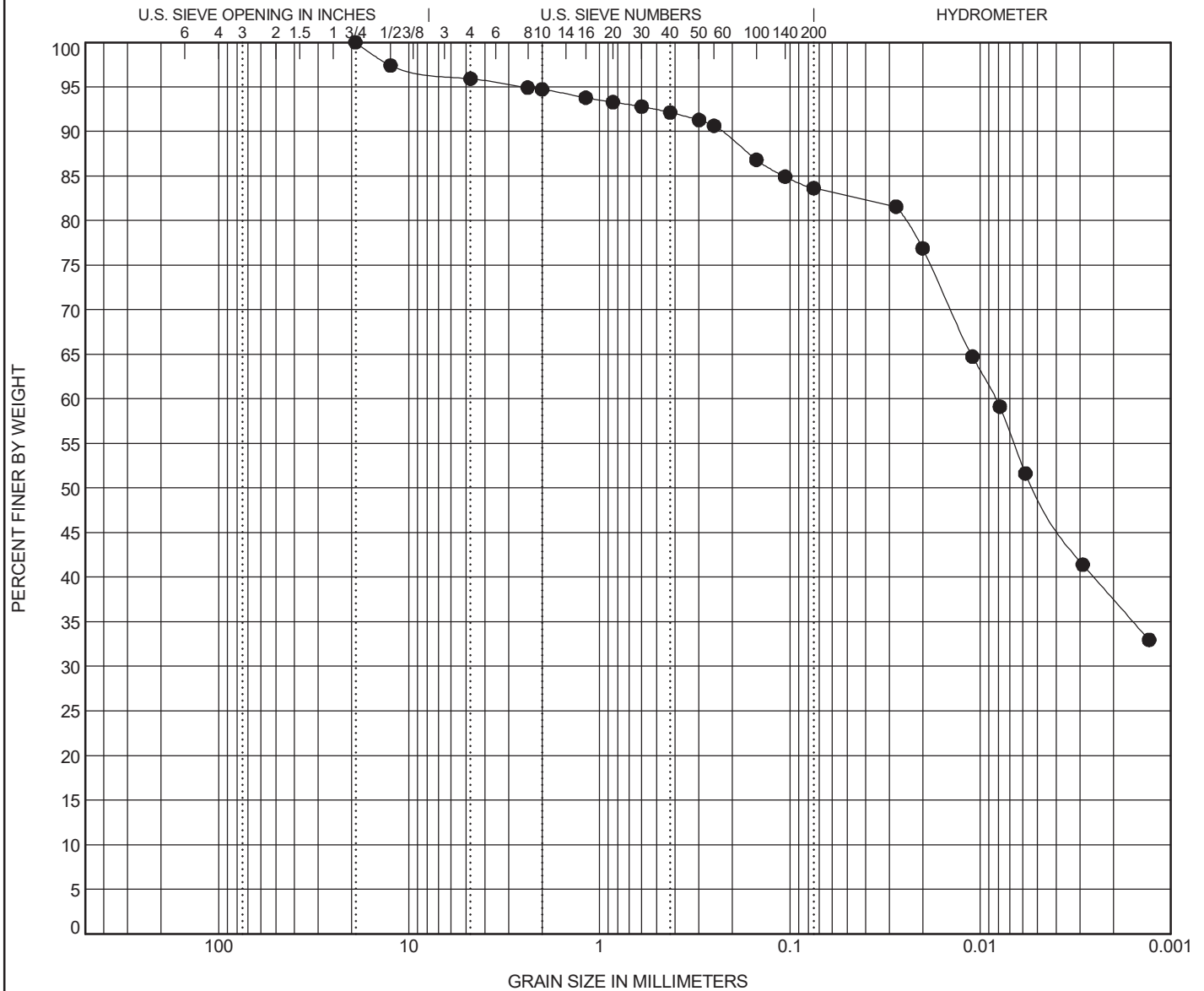
Great Lakes Water Authority (GLWA) Contract #2101475

Combined Sewer Outfall (CSO) Improvements Project

Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A



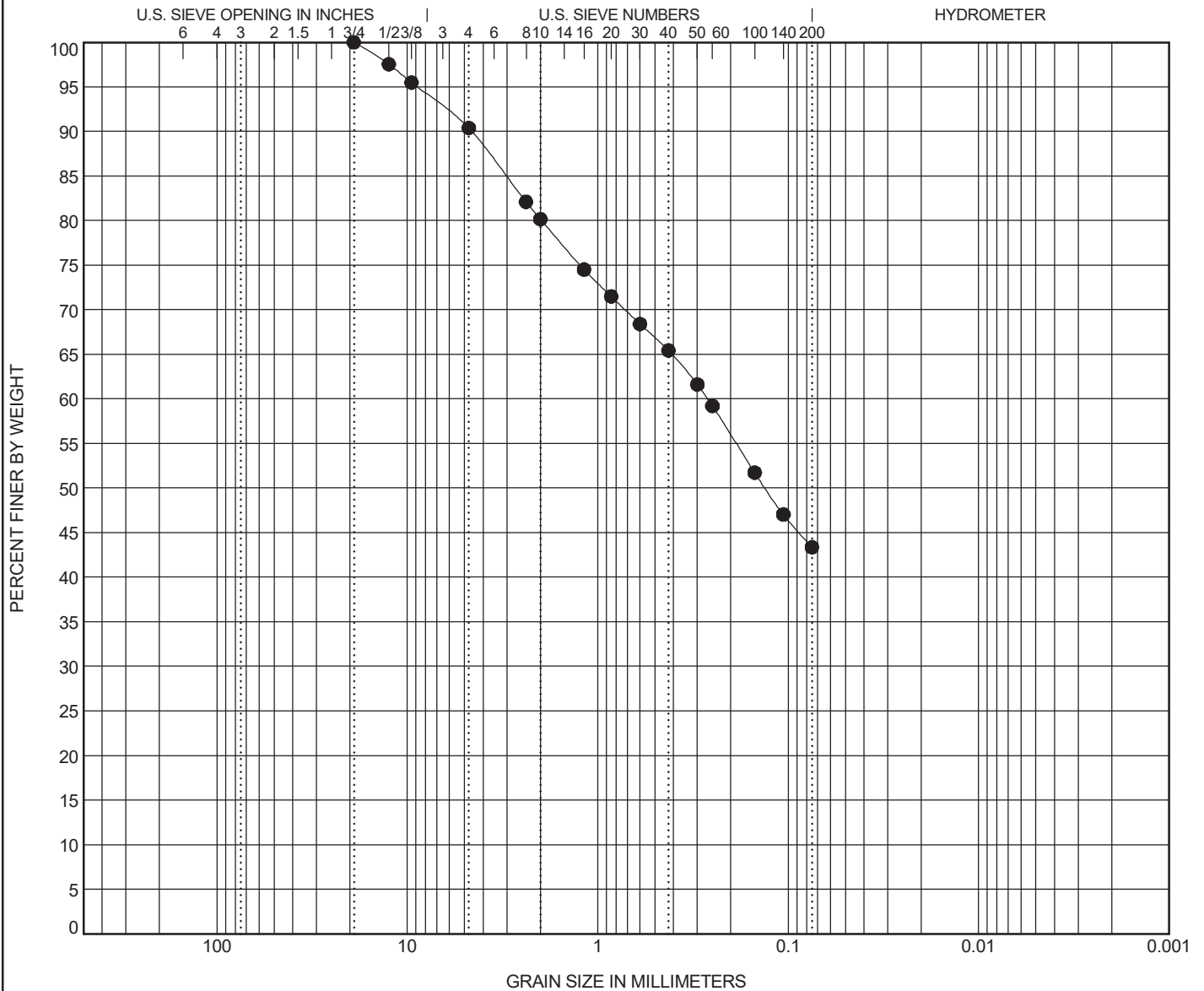


Somat

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A

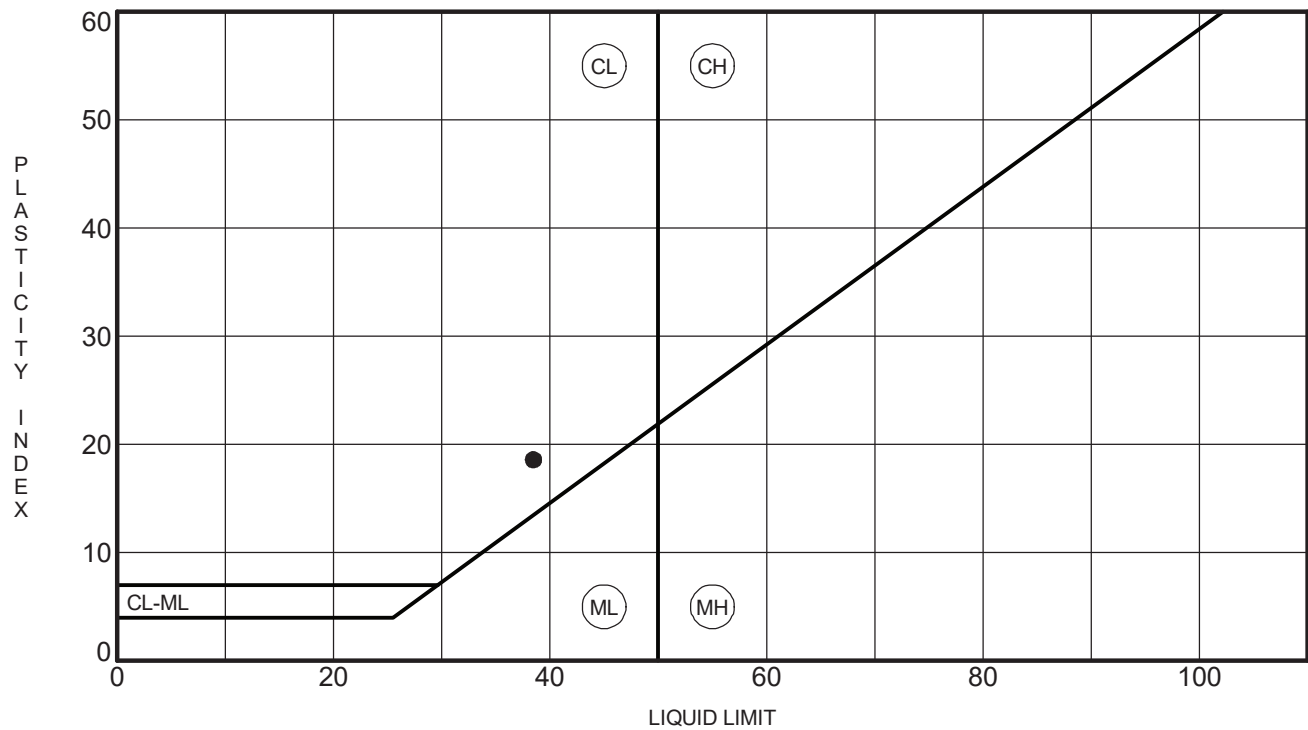


Somat

**Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility**

ATTERBERG LIMITS RESULTS

PROJECT NO. 2022136A

[illegible]

Description of Frequently Used Laboratory Testing Procedures

Visual Engineering Classification

Visual classification was performed on all samples (though other means of refining the classification may also be used). The General Notes provided immediately following the Logs of Test Borings include a brief discussion of the general method used to visually classify the soil, which is based on the visual-manual procedure (ASTM D2488). The visual classification is used to assign an appropriate Unified Soil Classification System (USCS) group symbol. The USCS symbol is shown in parentheses following the textural description of the various strata on the boring logs.

Where more laboratory testing is performed (requiring both grain size and Atterberg limit tests), the classification may also be refined further based on USCS ASTM D2487.

Moisture Content (ASTM D2216)

Moisture content determination tests were performed in accordance with ASTM D2216. Samples were sealed in the field to retain the natural moisture content of the soil specimen. Samples were then dried at a constant temperature (approximately 110° C) overnight in an oven. After drying, the samples were weighed to determine the dry weight of the sample (and the loss in weight representing the water contained in the original sample). The moisture content of the specimen is expressed as a percent and is the weight of the water compared to the dry weight of the specimen.

Hand Penetrometer

A hand/pocket penetrometer was used to estimate the unconfined compressive strength of cohesive (clay) samples. In the hand penetrometer test, the shear strength of a cohesive soil sample is estimated by measuring the resistance of the sample to the penetration of a small, calibrated spring-loaded cylinder. The maximum capacity of the penetrometer is 4.5 tons per square foot. The shear strength is doubled and reported on the soil boring logs as an estimate of the unconfined compressive strength.

Grain Size Analyses (ASTM D6913, D7928, and/or D422-2017)

Grain size analyses were performed in accordance with ASTM D6913, D7928, and/or D422-2017 on selected soil samples to evaluate the gradation of the soil represented by the sample. The distribution of particle sizes larger than 75 micrometers (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 micrometers is determined by a sedimentation process using a hydrometer.

Atterberg Limits Tests (ASTM D4318)

Determination of the Liquid Limit, Plastic Limit, and Plasticity Index of cohesive soils (known as Atterberg Limits) were performed in accordance with ASTM D4318. Fine-grained soils are tested to determine the Liquid Limit (LL) and Plastic Limits (PL), which are moisture contents that define boundaries between material consistency states. The LL and PL values define the transitional boundaries between non-plastic, plastic, and viscous fluid states. The plasticity index (PI) defines the complete range in water content for the plastic state.

Description of Frequently Used Laboratory Testing Procedures (continued)

Organic Content (Loss-On-Ignition) Tests (ASTM D7348)

The organic content of a soil is determined through a Loss-On-Ignition test performed in accordance with ASTM D2974 on soil samples suspected to contain significant organics. After the sample has been oven-dried, the soil sample is super-heated in a 440°C muffle furnace as a means to burn off all present organic matter. The weight of the remaining ash is used to calculate the percentage of organic matter as compared to the dry weight of the sample.



APPENDIX F

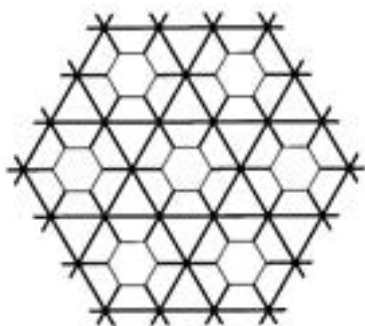
STANDARD SPECIFICATIONS FOR TRIAXIAL GEOGRID BY TENSAR NX750

Product Data Sheet InterAx™ NX750™ Geogrid

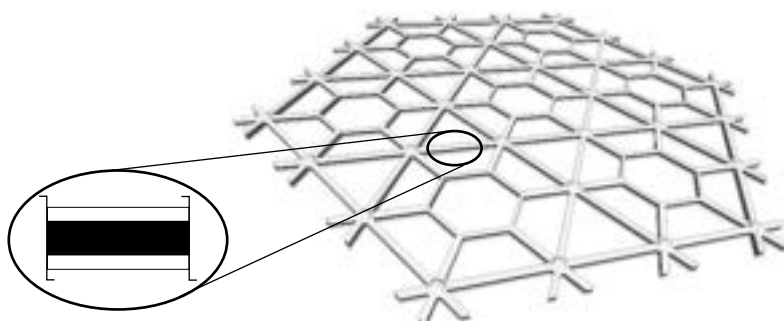
Tensar International Corporation reserves the right to change its product specifications at any time. It is the responsibility of the person specifying the use of this product and of the purchaser to ensure that product specifications relied upon for design or procurement purposes are current and that the product is suitable for its intended use in each instance.

General

- The geogrid is manufactured from a coextruded, composite polymer sheet, which is then punched and oriented. The resulting structure consists of continuous and non-continuous ribs forming three aperture geometries (hexagon, trapezoid, and triangle) and an unimpeded suspended hexagon.



Tensar NX750 Geogrid
Plan View



Tensar NX750 Geogrid
Perspective View

- The following properties are intended for product identification:

Identification Properties ¹	General
- Aperture shapes - Structure - Rib shape - Continuous parallel rib pitch⁽²⁾, mm (in) - Rib aspect ratio⁽³⁾ - Node thickness⁽²⁾, mm (in) - Color identification	Hexagonal, Trapezoidal, & Triangular Coextruded & Integrally Formed Rectangular 80 (3.2) > 1.0 3.5 (0.14) White / Black / White

Dimensions and Delivery

The geogrid shall be delivered to the jobsite in roll form with each roll individually identified as NX750 (aka, XPG5560 or NextGen-A). Rolls are shipped with nominal measurements: Equal to 3.8 meters (12.5 feet) in width by 60 meters (197 feet) in length.

Notes

- Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D4759-02
- Nominal dimensions
- Ratio of the mid-rib depth to the mid-rib width

Tensar International Corporation
2500 Northwinds Pkwy., Ste. 500
Atlanta, Georgia 30009
Phone: 800-TENSAR-1
www.tensarcorp.com

This specification supersedes any and all prior specifications for the product designated above and is not applicable to any product shipped prior to March 1, 2021. Tensar and InterAx are trademarks of Tensar International Corporation or its affiliates in the US and many other countries. U.S. and foreign patents pending on this product and its method of manufacture and use. Final determination of the suitability of the above-mentioned information or product for the use contemplated, and its manner of use are the sole responsibility of the user. Tensar International Corporation disclaims any and all express, implied or statutory warranties, including but not limited to, any warranty of merchantability or fitness for a particular purpose regarding this product or the Company's other products, technologies or services. The information contained herein does not constitute engineering advice. (04.21)

APPENDIX G

GEO-PROFESSIONAL BUSINESS ASSOCIATION (GBA) MESSAGE

Important Information about This Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual site-wide subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists.*



**GEOPROFESSIONAL
BUSINESS
ASSOCIATION**

Telephone: 301/565-2733

e-mail: info@geoprofessional.org www.geoprofessional.org

Appendix C

Oakwood Record Drawings from Recent Projects

Appendix C-1

Oakwood Drain Valve Improvements CON-254 - Record Plans by Weiss

**WEISS CONSTRUCTION CO., LLC**

400 Renaissance Center, Suite 2170

Detroit, Michigan 48243

TEL # (313) 567-4500 FAX # (313) 567-7635

LETTER OF TRANSMITTAL

October 15, 2019

TO: Great Lakes Water Authority
9300 West Jefferson
Detroit, MI 48209

RE: GLWA CON-254
Oakwood CSO Control Facility Drain
Valve Improvements
WCC Job No. 2018-04

Attn: Mr. Partho Gosh

- | | |
|---|--|
| ☒ ATTACHED FOR YOUR USE | ☐ FOR YOUR ACTION |
| ☐ UNDER SEPARATE COVER | ☐ PER YOUR REQUEST |
| ☐ AMEND AND RESUBMIT | ☐ MAKE CORRECTIONS AS NOTED |

DATE	QTY	DESCRIPTION
10/15/2019	1	As-Built Drawings
		Resubmittal for information
		#046A Z-CON-254-0-S200-01720-(all)-001

Please review submittal for the above referenced project.

PLEASE CONTACT THE SENDER IF YOU HAVE ANY QUESTIONS REGARDING THE TRANSMITTAL.

Receipt Signatures:GLWA

_____ Emailed

Date: 10/15/2019

WEISS CONSTRUCTION CO., LLC

*Jake Weiss*_____
Jake Weiss, Project Engineer



Weiss Construction Co. L.L.C.

**Oakwood CSO Facility
Drain Valve Improvements**

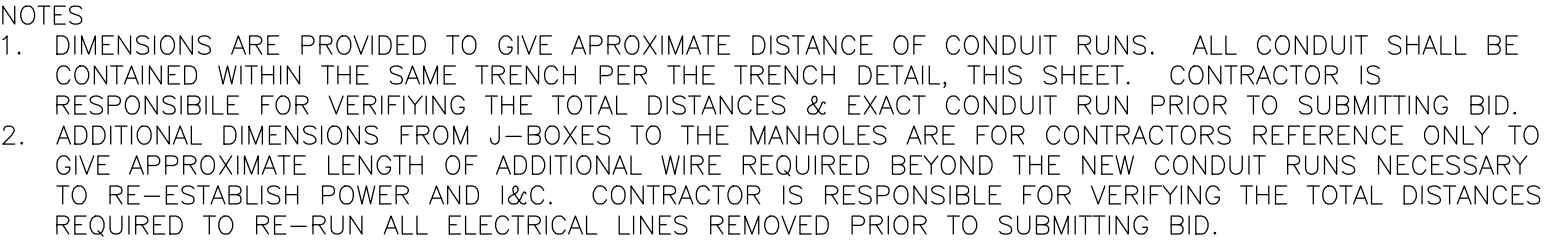
**Z-CON-254-0-S200-01720-(all)-001
Submittal #046A
As-built Drawings**

Electrical Contractor

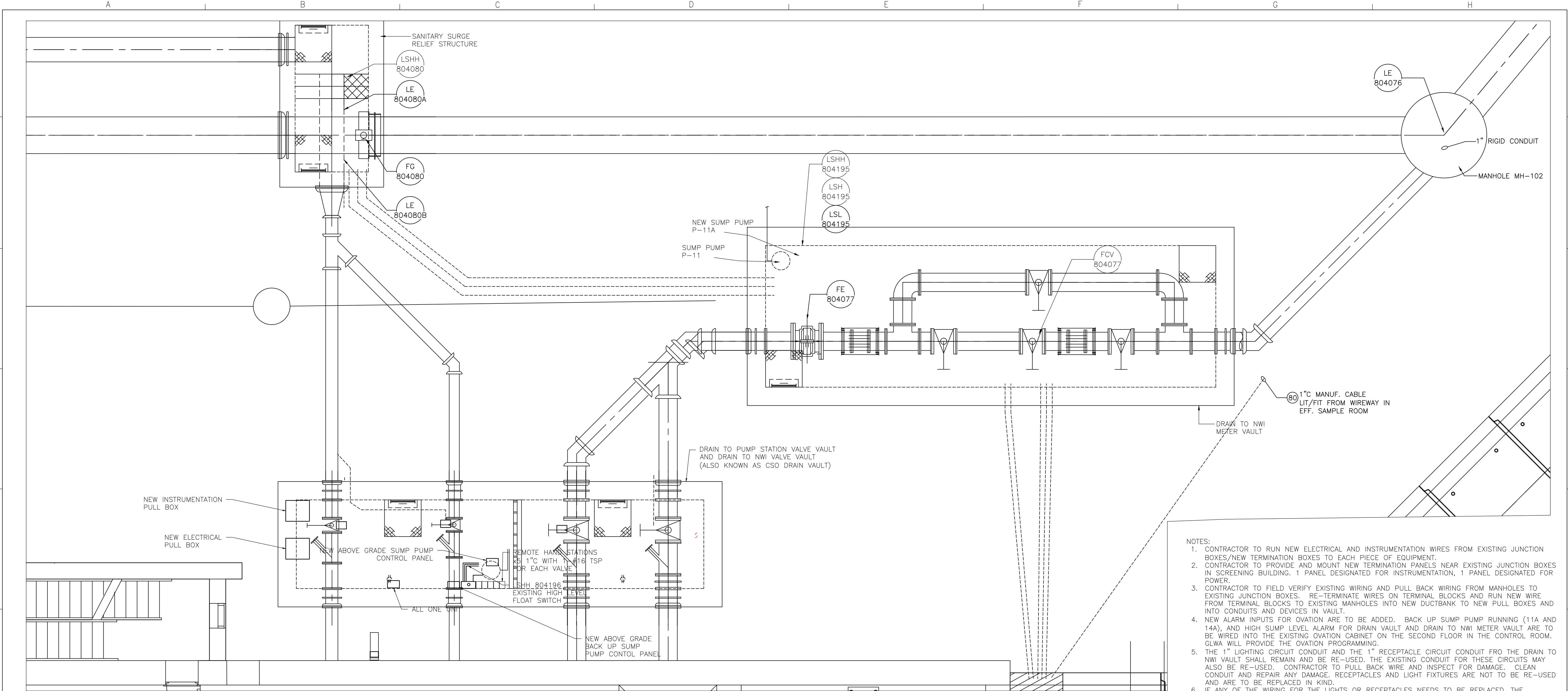
**Rotor Electric Co.
9522 Grinnell Avenue
Detroit, MI 48213
(313) 891-0331**

Engineer

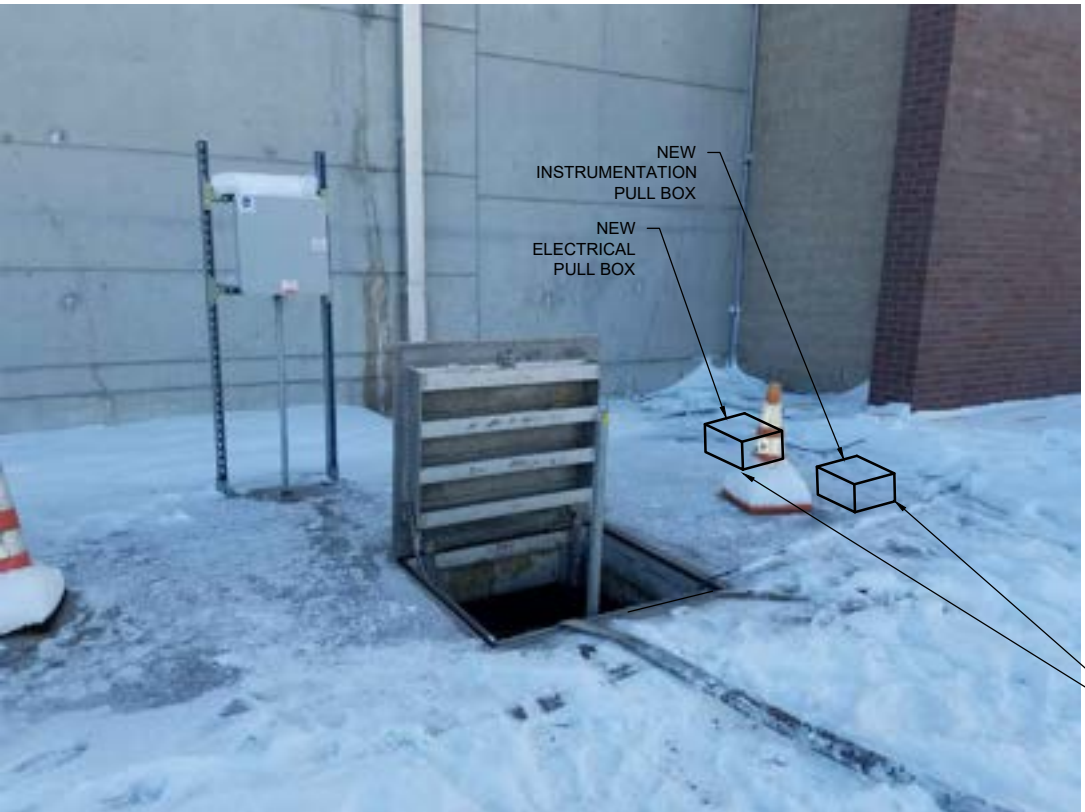
**Wade Trim
500 Griswold St. Suite 2500
Detroit, MI 48226
(313) 961-3650**



F					DESIGNED BY: K. THOMAS	SEAL / STAMP	FACILITY OAKWOOD CSO CONTROL FACILITY AND PUMP STATION 12082 PLEASANT DETROIT, MICHIGAN 48217	PROJECT TITLE CSO DRAIN VALVE ELECTRICAL IMPROVEMENTS PROPOSED DUCTBANK	AS-BUILT	 GLWA Great Lakes Water Authority	MDEQ PERMIT No. NOT APPLICABLE						
E					DRAWN BY: M. FLANAGAN						GLWA CONTRACT No. CON-254						
D					CHECKED BY: J. REYNHOUT						GLWA CIP No. NOT APPLICABLE						
C					APPROVED BY: J. REYNHOUT						DRAWING No. E-3						
B																	
A	ISSUED FOR BID	JWR	SM	01/31													
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE													
A		I		B		C		D		E		F		G		H	

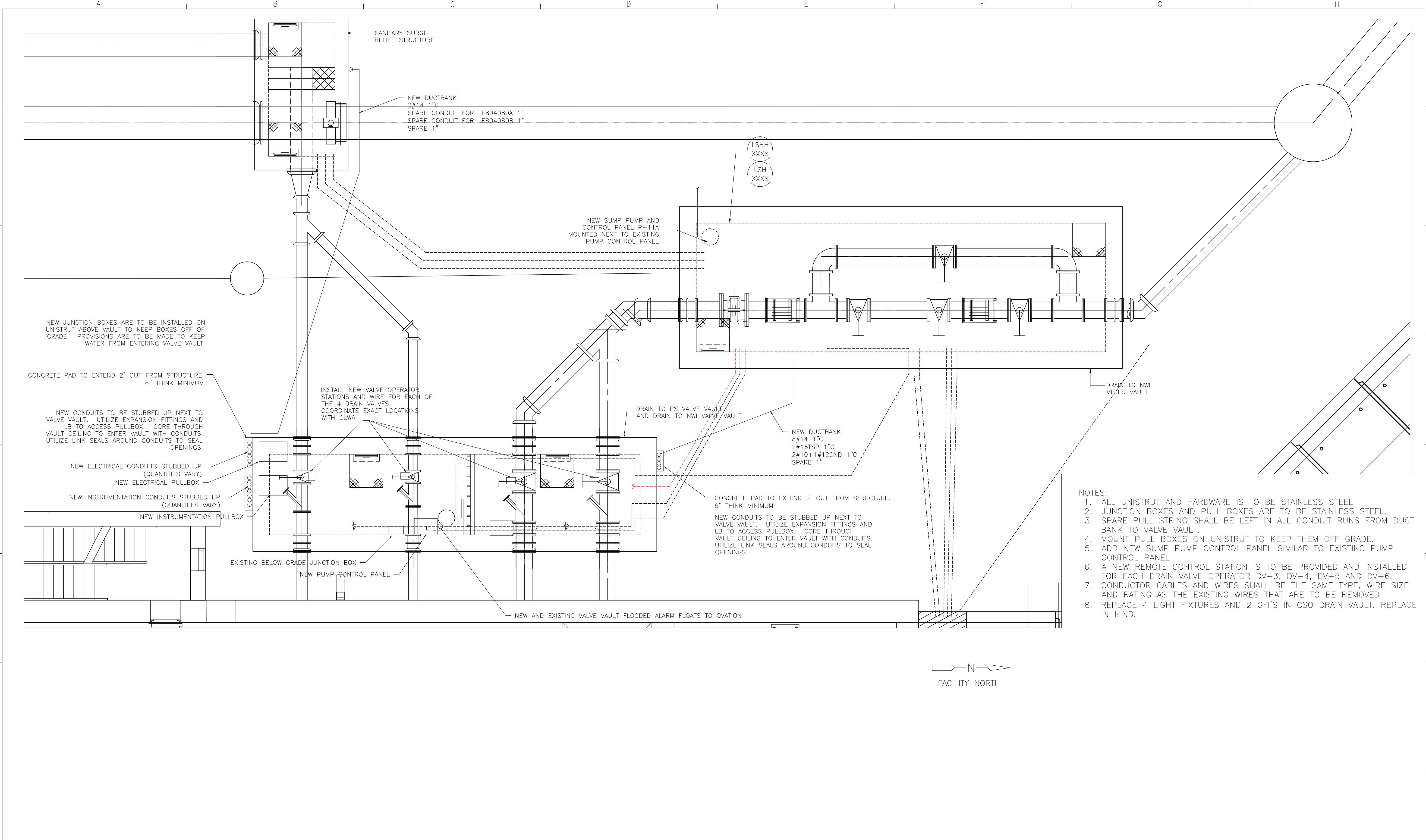


- NOTES:
1. CONTRACTOR TO RUN NEW ELECTRICAL AND INSTRUMENTATION WIRES FROM EXISTING JUNCTION BOXES/NEW TERMINATION BOXES TO EACH PIECE OF EQUIPMENT.
 2. CONTRACTOR TO PROVIDE AND MOUNT NEW TERMINATION PANELS NEAR EXISTING JUNCTION BOXES IN SCREENING BUILDING. 1 PANEL DESIGNATED FOR INSTRUMENTATION, 1 PANEL DESIGNATED FOR POWER.
 3. CONTRACTOR TO FIELD VERIFY EXISTING WIRING AND PULL BACK WIRING FROM MANHOLES TO EXISTING JUNCTION BOXES. RE-TERMINATE WIRES ON TERMINAL BLOCKS AND RUN NEW WIRE FROM TERMINAL BLOCKS TO EXISTING MANHOLES INTO NEW DUCTBANK TO NEW PULL BOXES AND INTO CONDUITS AND DEVICES IN VAULT.
 4. NEW ALARM INPUTS FOR OVATION ARE TO BE ADDED. BACK UP SUMP PUMP RUNNING (11A AND 14A), AND HIGH SUMP LEVEL ALARM FOR DRAIN VAULT AND DRAIN TO NWI METER VAULT ARE TO BE WIRED INTO THE EXISTING OVATION CABINET ON THE SECOND FLOOR IN THE CONTROL ROOM. GLWA WILL PROVIDE THE OVATION PROGRAMMING.
 5. THE 1" LIGHTING CIRCUIT CONDUIT AND THE 1" RECEPTACLE CIRCUIT CONDUIT FRO THE DRAIN TO NWI VAULT SHALL REMAIN AND BE RE-USED. THE EXISTING CONDUIT FOR THESE CIRCUITS MAY ALSO BE RE-USED. CONTRACTOR TO PULL BACK WIRE AND INSPECT FOR DAMAGE. CLEAN CONDUIT AND REPAIR ANY DAMAGE. RECEPTACLES AND LIGHT FIXTURES ARE NOT TO BE RE-USED AND ARE TO BE REPLACED IN KIND.
 6. IF ANY OF THE WIRING FOR THE LIGHTS OR RECEPTACLES NEEDS TO BE REPLACED, THE CONTRACTOR SHALL DO SO.
 7. REMOVE EXISTING JUNCTION BOX ON EAST WALL OF DRAIN VAULT BELOW GRADE.
 8. ADD NEW SUMP PUMP CONTROL PANEL ABOVE GRADE NEXT TO EXISTING SUMP PUMP CONTROL PANEL.
 9. ROUTE NEW CIRCUITS FROM LP-3 IN CONTROL ROOM TO NEW POWER DISTRIBUTION EQUIPMENT AND NEW SUMP PUMP CONTROL PANELS.
 10. INSTALL NEW VALVE OPERATOR STATIONS AND WIRING ABOVE GRADE ON TOP OF DRAIN VAULT.
 11. NEW DISCONNECT SWITCH TO BE NEMA 3R STAINLESS STEEL.
 12. NEW 5KVA TRANSFORMER AND POWER DISTRIBUTION CENTER TO BE RATED NEMA 3R MINIMUM.



PULL BOXES TO BE SECURELY INSTALLED ON S.S. UNISTRUT TO KEEP OFF OF CONCRETE. PICTURE MAY NOT ACCURATELY PORTRAY SIZE OF THESE BOXES

F					DESIGNED BY: K. THOMAS	SEAL / STAMP	FACILITY OAKWOOD CSO CONTROL FACILITY AND PUMP STATION 12082 PLEASANT DETROIT, MICHIGAN 48217	PROJECT TITLE CSO DRAIN VALVE ELECTRICAL IMPROVEMENTS PROPOSED ELECTRICAL EQUIPMENT LOCATIONS 1	AS-BUILT		MDEQ PERMIT No. NOT APPLICABLE
E					DRAWN BY: M. FLANAGAN						GLWA CONTRACT No. CON-254
D					CHECKED BY: J. REYNHOUT						GLWA CIP No. NOT APPLICABLE
C					APPROVED BY: J. REYNHOUT						DRAWING No.
B											E-4
A	ISSUED FOR BID	JWR	SM	01/31							
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE							



- NOTES:
1. ALL UNISTRUT AND HARDWARE IS TO BE STAINLESS STEEL
 2. JUNCTION BOXES AND PULL BOXES ARE TO BE STAINLESS STEEL.
 3. SPARE PULL STRING SHALL BE LEFT IN ALL CONDUIT RUNS FROM DUCT BANK TO VALVE VAULT.
 4. MOUNT PULL BOXES ON UNISTRUT TO KEEP THEM OFF GRADE.
 5. ADD NEW SUMP PUMP CONTROL PANEL SIMILAR TO EXISTING PUMP CONTROL PANEL
 6. A NEW REMOTE CONTROL STATION IS TO BE PROVIDED AND INSTALLED FOR EACH DRAIN VALVE OPERATOR DV-3, DV-4, DV-5 AND DV-6.
 7. CONDUCTOR CABLES AND WIRES SHALL BE THE SAME TYPE, WIRE SIZE AND RATING AS THE EXISTING WIRES THAT ARE TO BE REMOVED.
 8. REPLACE 4 LIGHT FIXTURES AND 2 GFI'S IN CSO DRAIN VAULT. REPLACE IN KIND.

F					DESIGNED BY: K. THOMAS	SEAL / STAMP	FACILITY OAKWOOD CSO CONTROL FACILITY AND PUMP STATION 12082 PLEASANT DETROIT, MICHIGAN 48217	PROJECT TITLE CSO DRAIN VALVE ELECTRICAL IMPROVEMENTS PROPOSED ELECTRICAL EQUIPMENT LOCATIONS 2	AS-BUILT		MDEQ PERMIT No. NOT APPLICABLE
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D					CHECKED BY: J. REYNHOUT						GLWA CIP No. NOT APPLICABLE
C					APPROVED BY: J. REYNHOUT						DRAWING No. E-5
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A	ISSUED FOR BID	JWR	SM	01/31							
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE							

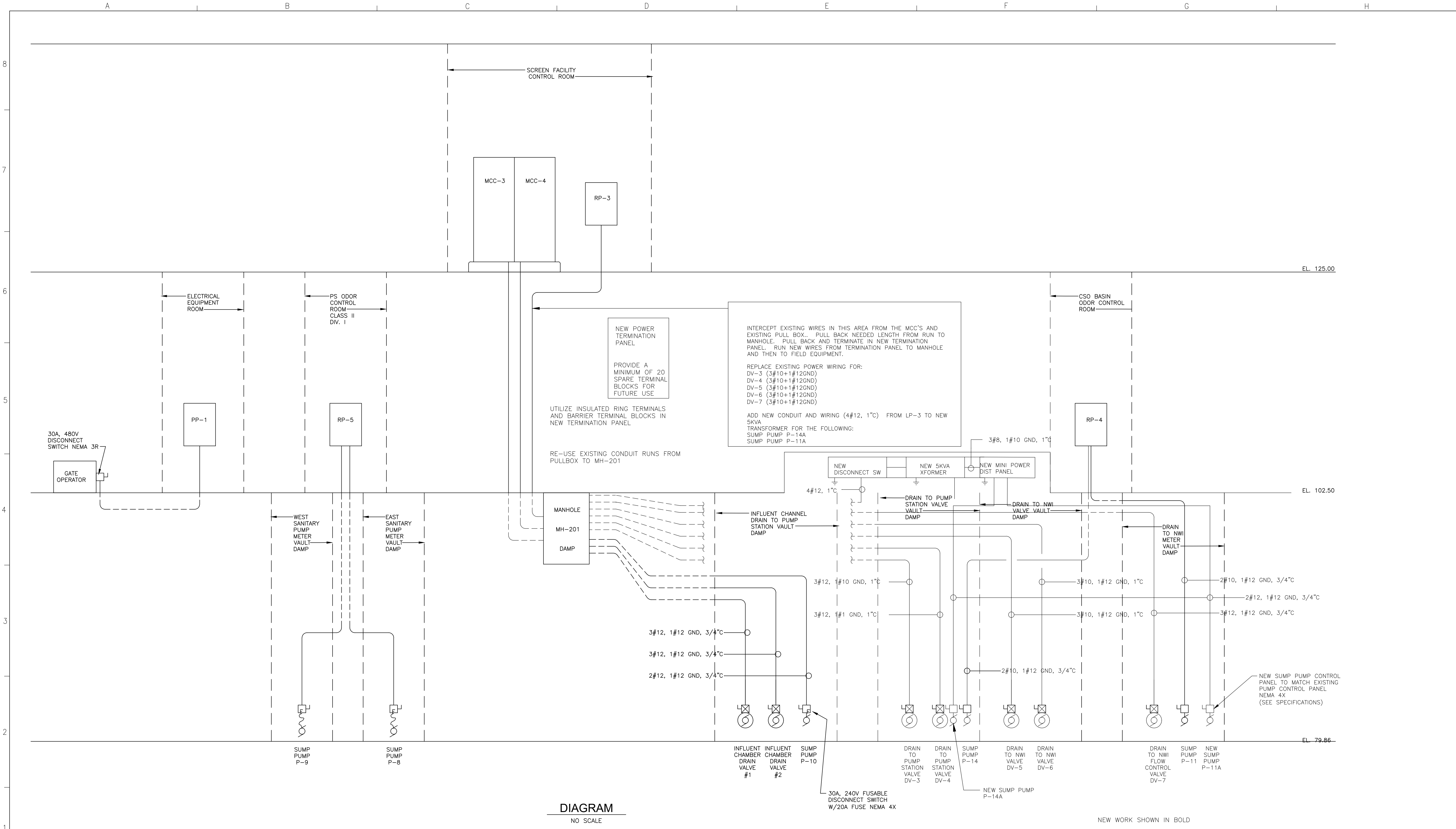
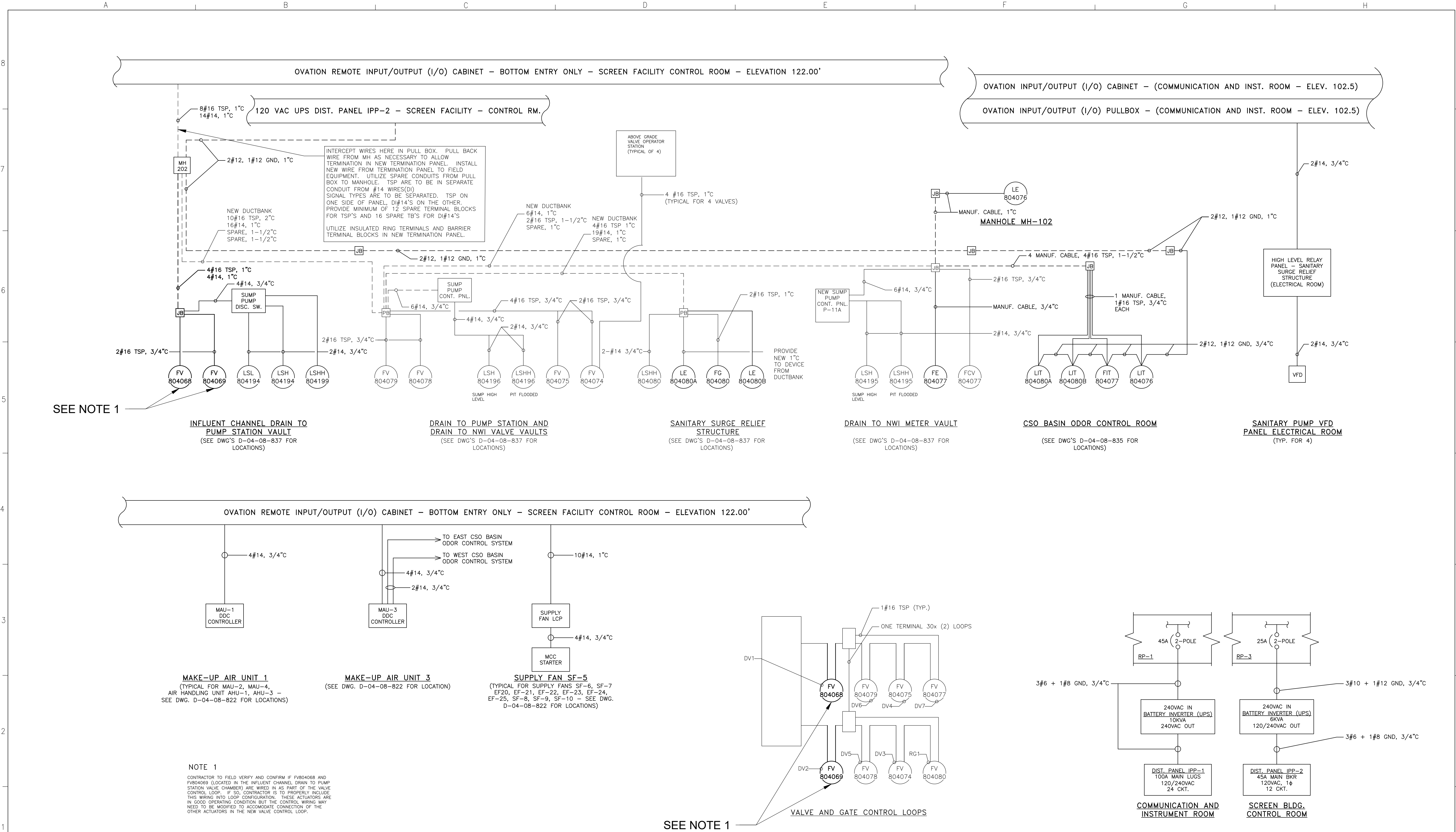
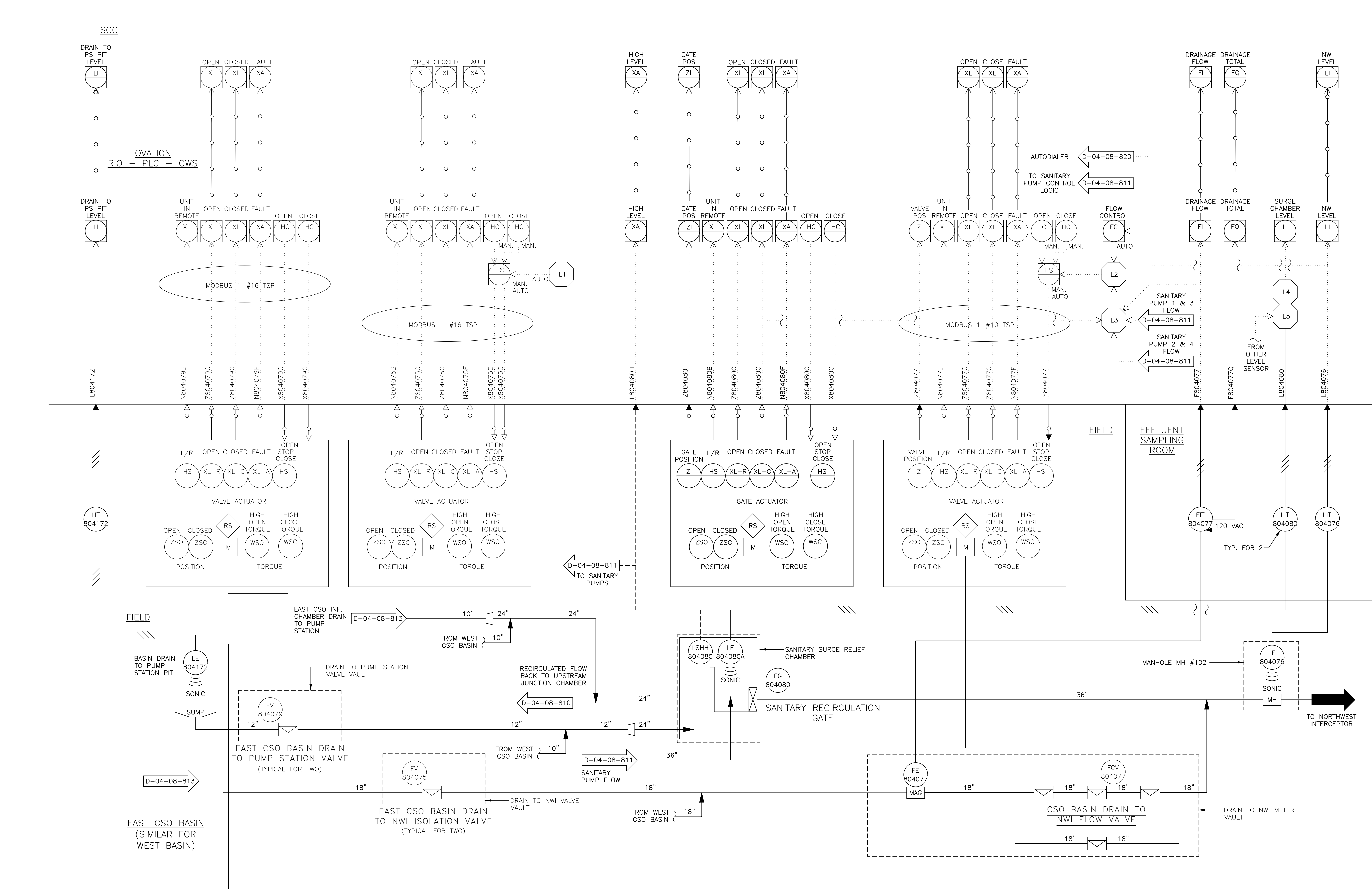


DIAGRAM
NO SCALE

F					DESIGNED BY: K. THOMAS	SEAL / STAMP	FACILITY OAKWOOD CSO CONTROL FACILITY AND PUMP STATION 12082 PLEASANT DETROIT, MICHIGAN 48217	PROJECT TITLE CSO DRAIN VALVE ELECTRICAL IMPROVEMENTS ELECTRICAL CONDUIT RISER	AS-BUILT		MDEQ PERMIT No. NOT APPLICABLE
E					DRAWN BY: M. FLANAGAN						GLWA CONTRACT No. CON-254
D					CHECKED BY: J. REYNHOUT						GLWA CIP No. NOT APPLICABLE
C					APPROVED BY: J. REYNHOUT						DRAWING No. E-6
B											
A	ISSUED FOR BID	JWR	SM	01/31							
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE							



F					DESIGNED BY: K. THOMAS	SEAL / STAMP	FACILITY OAKWOOD CSO CONTROL FACILITY AND PUMP STATION 12082 PLEASANT DETROIT, MICHIGAN 48217	PROJECT TITLE CSO DRAIN VALVE ELECTRICAL IMPROVEMENTS INSTRUMENTATION CONDUIT RISER	AS-BUILT	 Great Lakes Water Authority	MDEQ PERMIT No. NOT APPLICABLE
E					DRAWN BY: M. FLANAGAN						GLWA CONTRACT No. CON-254
D					CHECKED BY: J. REYNHOUT						GLWA CIP No. NOT APPLICABLE
C					APPROVED BY: J. REYNHOUT						DRAWING No. E-7
B											
A	ISSUED FOR BID	JWR	SM	01/31							
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE							



L1

OPEN VALVE DURING CSO EVENT AND WHEN ASSOCIATED NW INTERCEPTOR FLOW IS LESS THAN 23.2 CFS. CLOSE VALVE WHEN CSO DRAINING IS COMPLETE.

L2

REGULATE FLOW BASED ON NW INTERCEPTOR LEVEL. FLOW IS NOT TO EXCEED 23.2 CFS.

L3

TOTAL FLOW TO NW INTERCEPTOR FROM SANITARY PUMPS AND CSO DRAINAGE. SET SANITARY PUMP FLOW TO ZERO IF SANITARY RECIRCULATION GATE IS CLOSED.

L4

COMPARE LEVELS AND OUTPUT HIGHER LEVEL.

L5

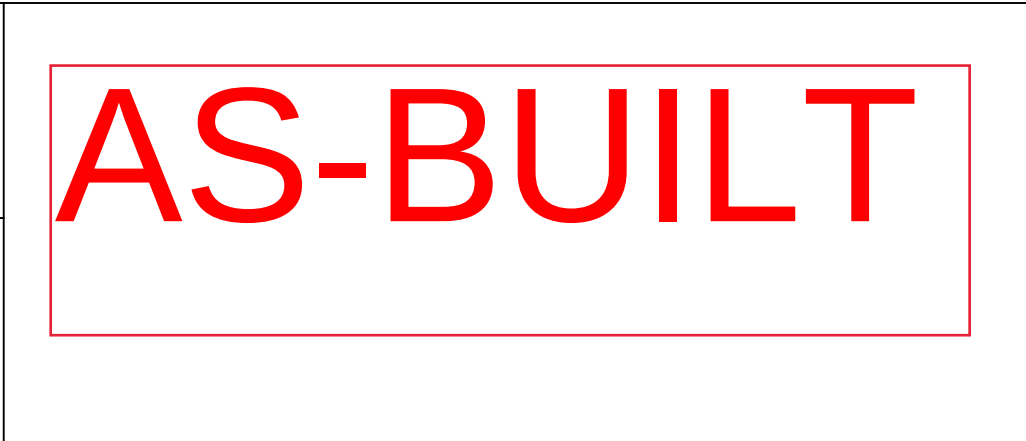
ALARM WHEN THE DIFFERENCE BETWEEN THE COMPARED LEVELS EXCEEDS 3% AFTER A 10 SECOND TIME DELAY.

GLWA TO PROVIDE OVATION PROGRAMMING

F				DESIGNED BY:	
E				K. THOMAS	
D				DRAWN BY:	
C				M. FLANAGAN	
B				CHECKED BY:	
A	ISSUED FOR BID	JWR	SM	01/31	
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE	
				APPROVED BY:	
				J. REYNHOUT	

SEAL / STAMP

FACILITY	OAKWOOD CSO CONTROL FACILITY AND PUMP STATION
	12082 PLEASANT
	DETROIT, MICHIGAN 48217
PROJECT TITLE	CSO DRAIN VALVE ELECTRICAL IMPROVEMENTS
	P & ID



MDEQ PERMIT No.	NOT APPLICABLE
GLWA CONTRACT No.	CON-254
GLWA CIP No.	NOT APPLICABLE
DRAWING No.	E-8

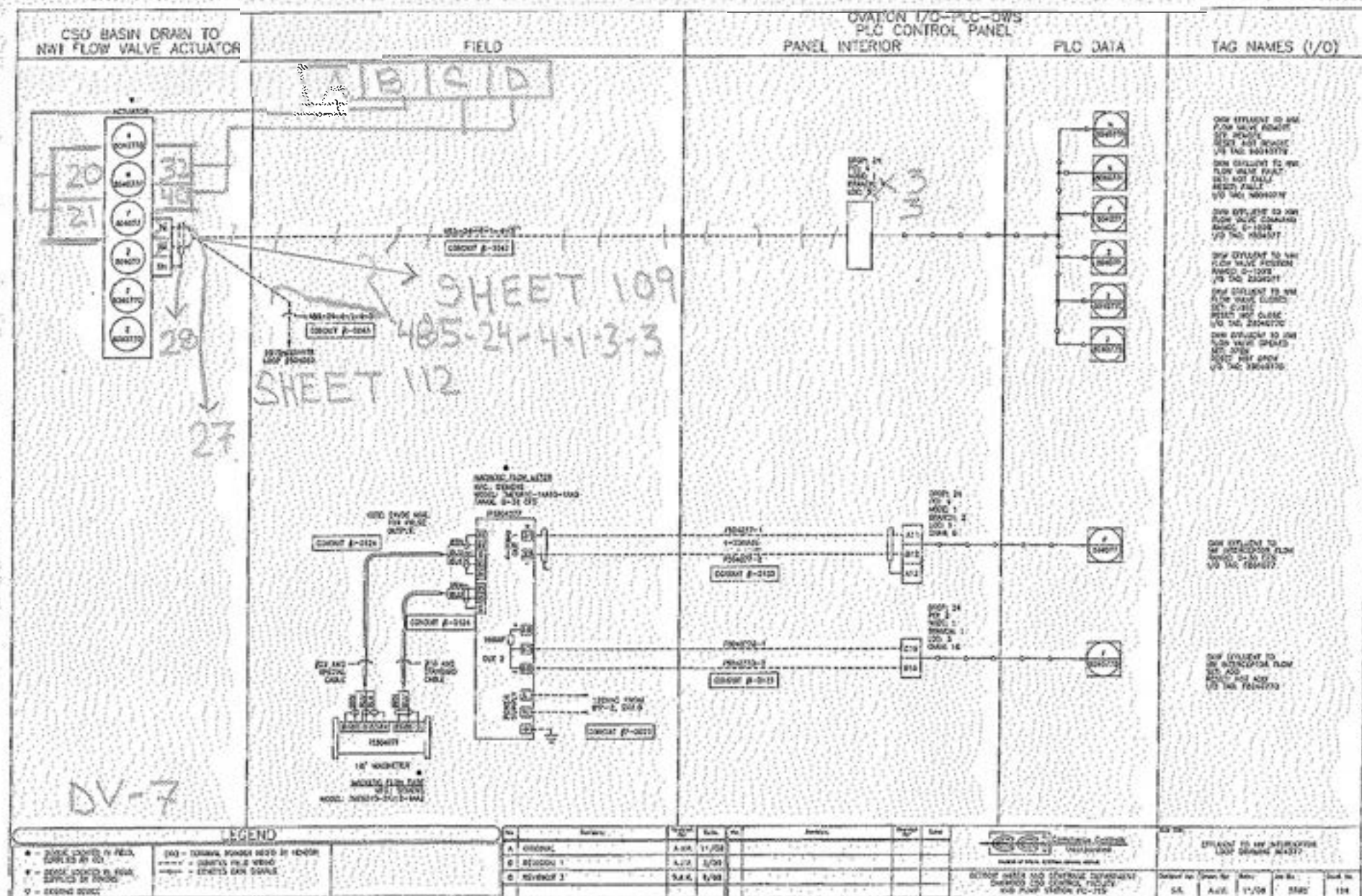




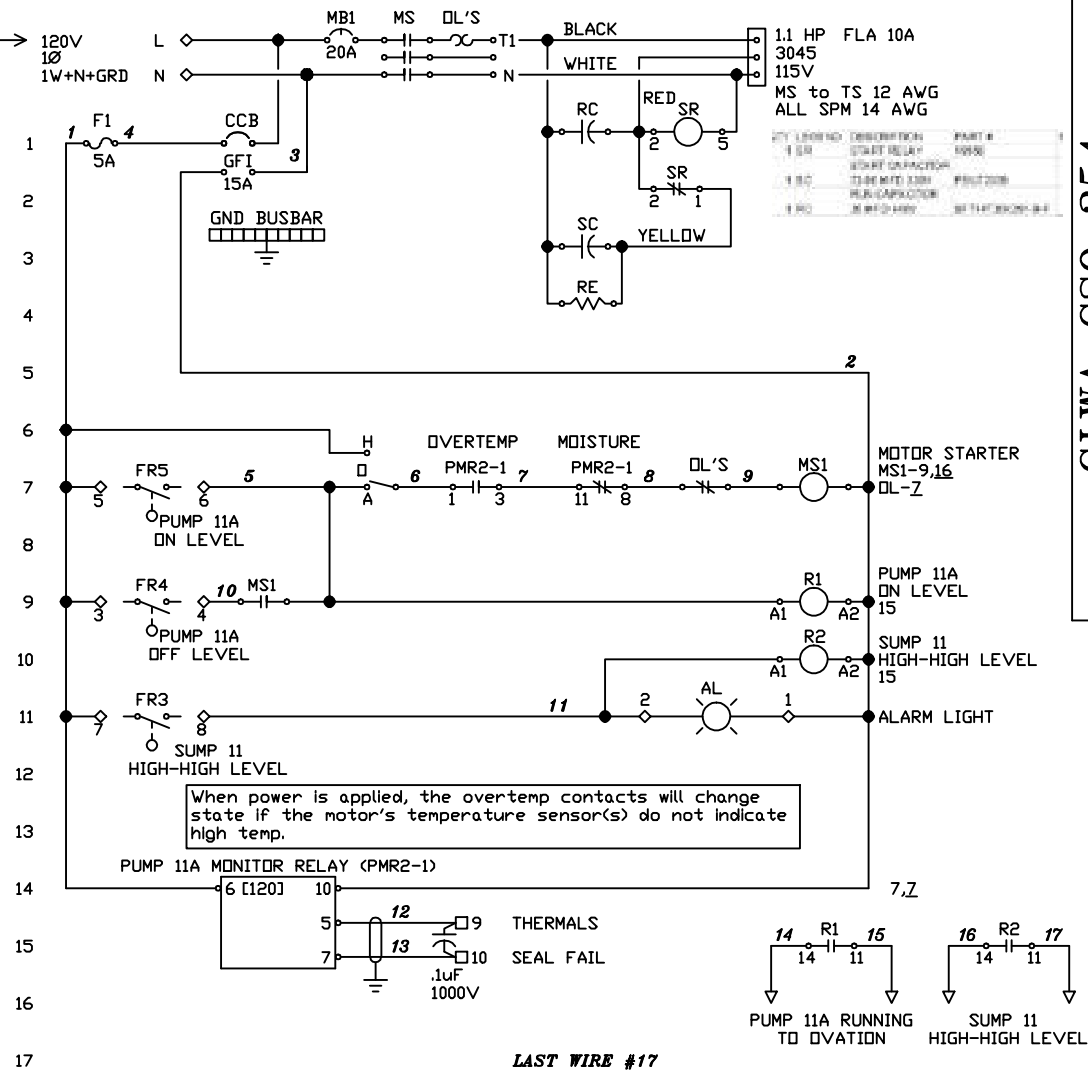






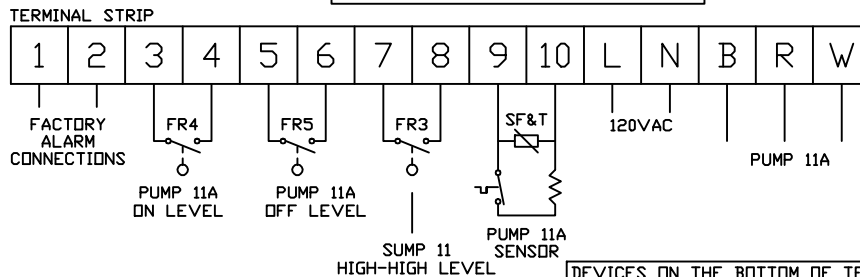


CUSTOMER MUST PROVIDE AND INSTALL BRANCH CIRCUIT OVER CURRENT PROTECTION & DISCONNECT IN ACCORDANCE WITH CURRENT NEC. TYPE: CIRCUIT BREAKER MINIMUM RATING 120 VAC - 30 AMPS



LAST WIRE #17

Nonintrinsically safe wiring terminals



DEVICES ON THE BOTTOM OF TERMINAL STRIP ARE REMOTE ENTERING CONTROL PANEL. DEVICES ON THE TOP OF TERMINAL STRIP ARE CONTACTS LEAVING THE CONTROL PANEL.

FUSE REPLACEMENT CHART	
FUSE	REPLACEMENT
F1	KTK-R-5/600V

CUSTOMER	KENNEDY IND.			
JOB NAME	GLWA CSO 254			
ENCLOSURE	UL TYPE RATING:	UL TYPE 4X		
VOLTAGE	120V	PHASE 1		HZ 60
H.P.	#1 1.1	#2 X	#3 X	#4 X
F.L.A.	10A	X	X	X
TOTAL F.L.A.	15A			
SERIAL #	CP-638	DATE: 11/15/2018		
SCCR:	10 KA SYMMETRICAL	RMS, 120 V. MAX.		
MANUFACTURED BY:				
STA CON INC 2525 S. DBT APOPKA FL 32703				

SQD Terminal Block GK6 + GR6 + GC6	
Wire Range AWG CU	Torque lb-in.
(Type GK6) 22-10	11-12
(Type GR6) 22-8	18-20
(Type GC6) 18-4	32-35

SQD Ground Busbar PK7GTA, PK12GTA, PK15GTA	
Wire Range AWG CU-AL	Torque lb-in.
14-10 CU, 12-10 AL	20
8	25
6-4	35
Two 14 or 12 CU, Two 12 or 10 AL	25

T&B BLACKBURN LUG TORQUE TIGHTENING	
Wire Range/Screw Type & Wrench Size AWG CU	Torque lb-in.
(SLOTTED) 10-14	20
(SLOTTED) 8	15
(SLOTTED) 4-6	35
(SLOTTED) 2-2/0	50
(3/16 HEX) 2/0	100
(5/16 HEX) 3/0L2501-350	275
(3/8 HEX) 500-600	450*
(3/8 HEX) 750-1000	550
*UNLESS OTHERWISE NOTED ON CONNECTOR	

GLWA CSO 254

QUOTE NO. DATE DRAWN BY REVISION
48467AB10/02/2019 DJL/JDJ MOD1

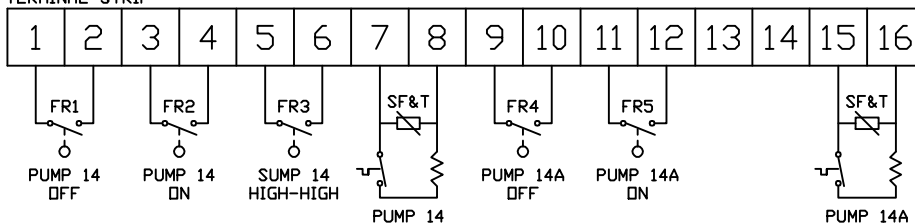
2525 SOUTH DBT
APOPKA, FLORIDA
32703



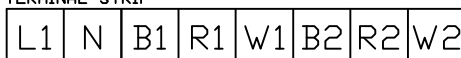
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Nonintrinsically safe wiring terminals

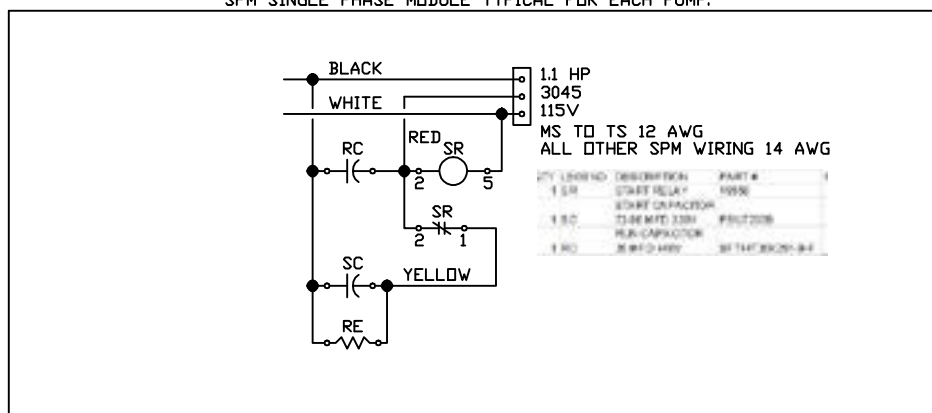
TERMINAL STRIP



TERMINAL STRIP



SPM SINGLE PHASE MODULE TYPICAL FOR EACH PUMP.



DEVICES ON THE BOTTOM OF TERMINAL STRIP ARE REMOTE ENTERING CONTROL PANEL.
DEVICES ON THE TOP OF TERMINAL STRIP ARE CONTACTS LEAVING THE CONTROL PANEL.

FUSE REPLACEMENT CHART	
FUSE	REPLACEMENT
F1	10A KTK-R-5/600V

CUSTOMER	KENNEDY IND.		
JOB NAME	GLWA CSO 254		
ENCLOSURE UL TYPE RATING	UL TYPE 4X		
VOLTAGE	120V	PHASE 1	HZ 60
H.P.	#1 1.1	#2 1.1	#3 X #4 X
F.L.A.	10A	10A	X X
TOTAL F.L.A.	25A		
SERIAL #	CP-639	DATE:	11/13/2018
SCCR:	10 KA SYMMETRICAL RMS, 120 V. MAX.		
MANUFACTURED BY:	STA CON INC 2525 S. DBT APOPKA FL 32703		

SQR Terminal Block GK6 + GR6 + GC6	
Wire Range	Torque
AWG CU	lb-in.
<Type GK6> 22-10	11-12
<Type GR6> 22-8	18-20
<Type GC6> 18-4	32-35

SQR Ground Busbar PK7GTA, PK12GTA, PK15GTA	
Wire Range	Torque
AWG CU-AL	lb-in.
14-10 CU, 12-10 AL	20
8	25
6-4	35
Two 14 or 12 CU, Two 12 or 10 AL	25

T&B BLACKBURN LUG TORQUE TIGHTENING	
Wire Range/Screw Type & Wrench Size	Torque
AWG CU	lb-in.
<SLOTTED> 10-14	20
<SLOTTED> 8	25
<SLOTTED> 4-6	35
<SLOTTED> 2-2/0	50
(3/16 HEX) 2/0	100
(5/16 HEX) 3/0[250]-350	275
(3/8 HEX) 500-600	450*
(3/8 HEX) 750-1000	550
*=UNLESS OTHERWISE NOTED ON CONNECTOR	

GLWA CSO 254

2 SIMPLEX

QUOTE NO. DATE DRAWN BY REVISION
48467BB 10/02/2019 DJL/JDJ MOD 1

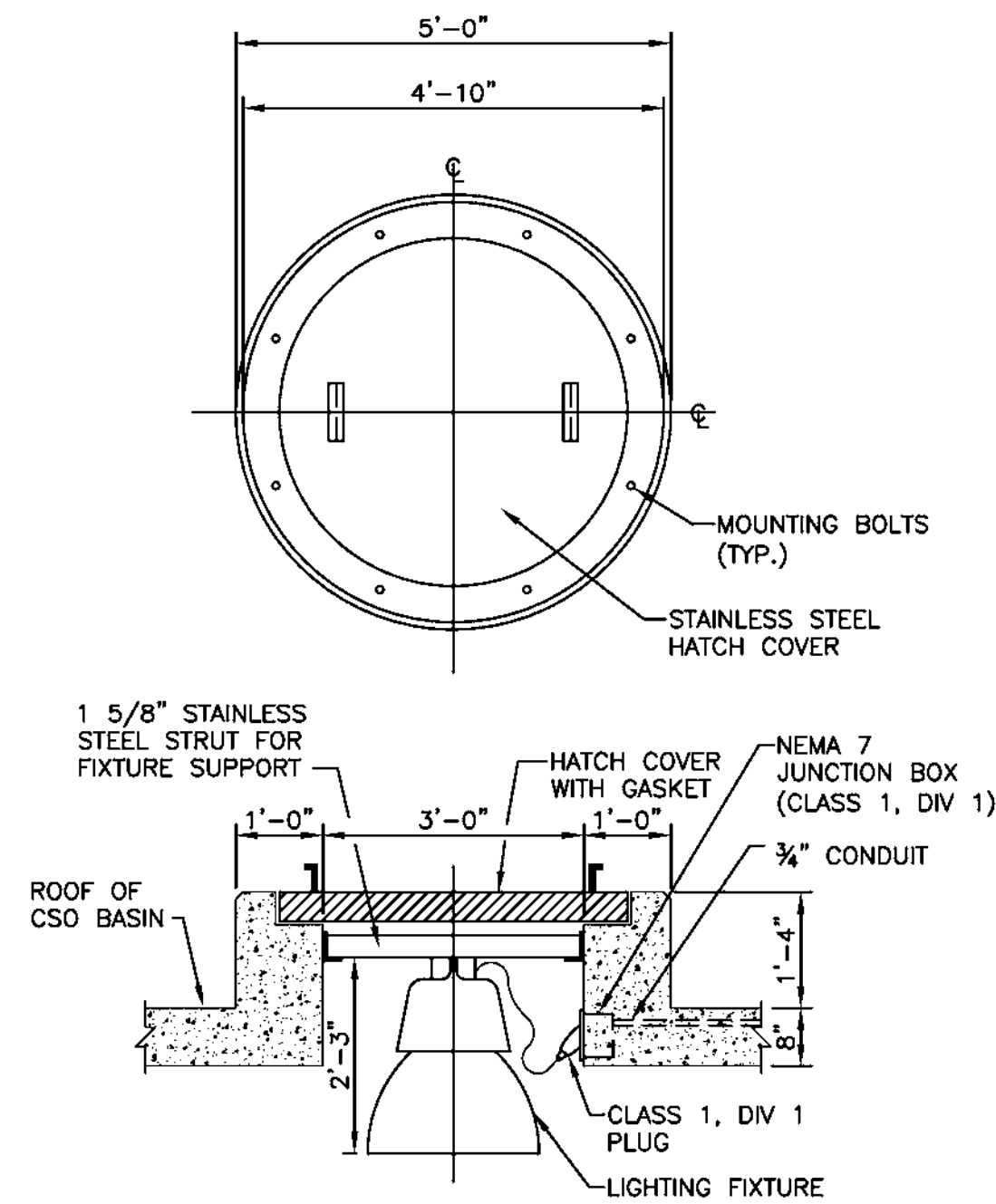
2525 SOUTH DBT
APOPKA, FLORIDA
32703



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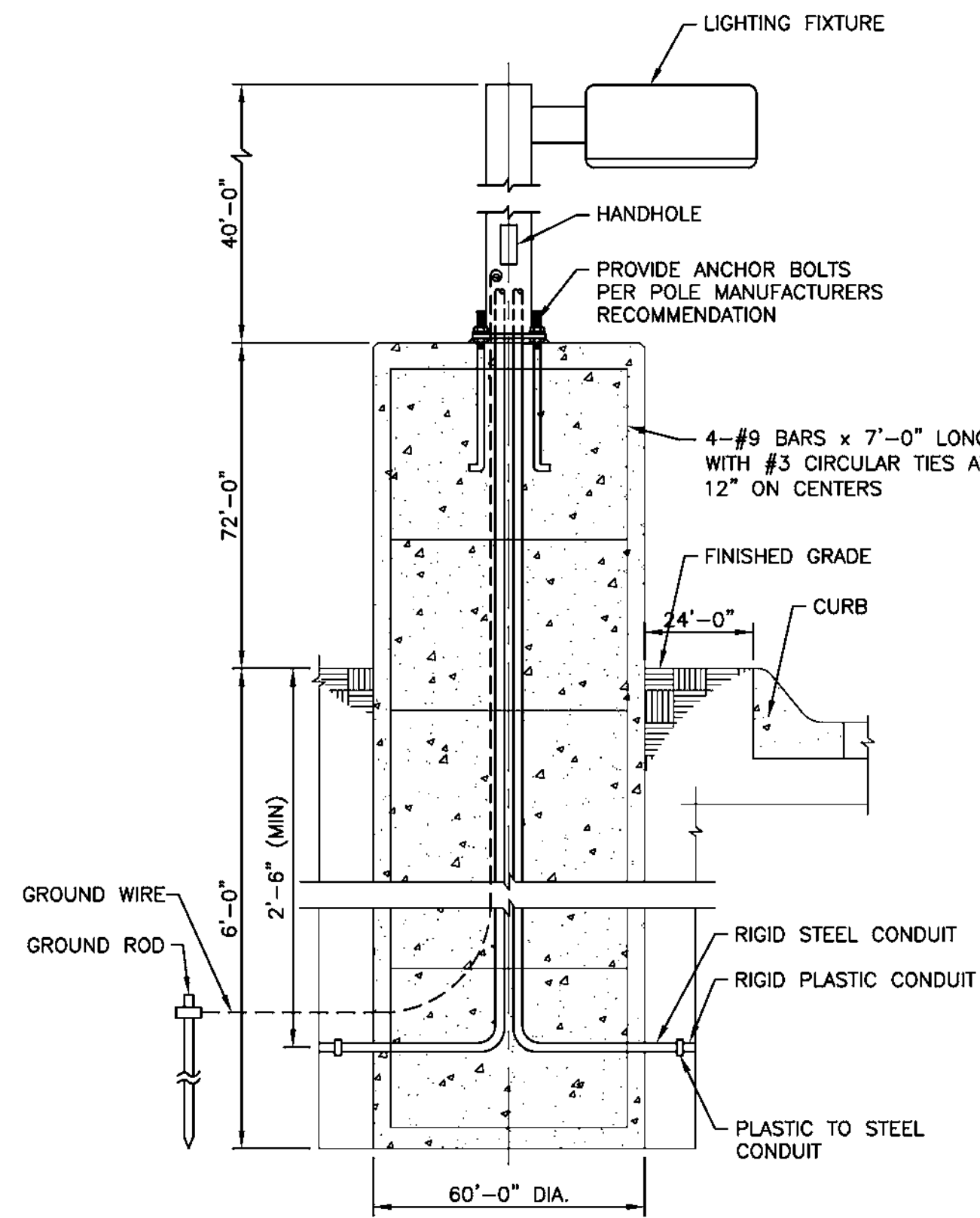
Appendix C-2

PC-755 OKW Electrical As-Built Selected Sheets



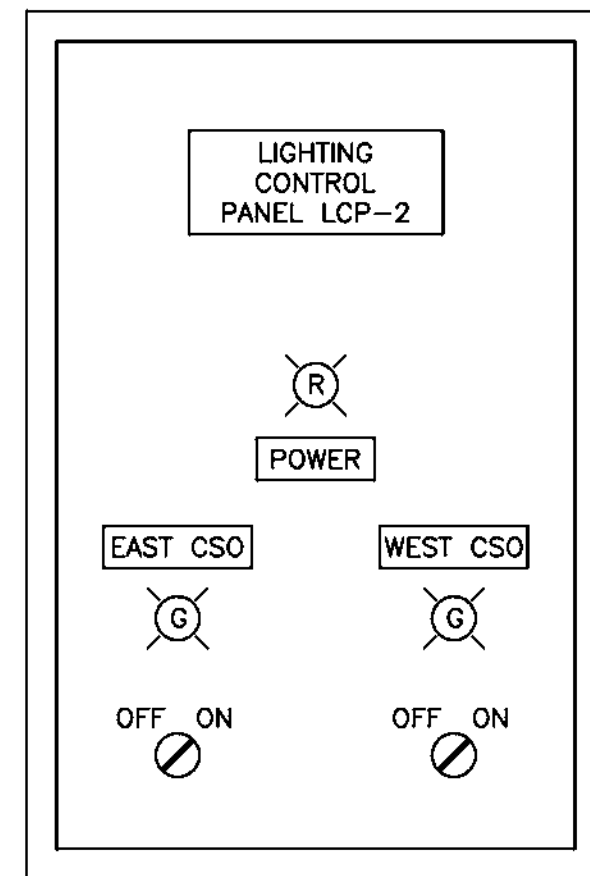
CSO BASINS LIGHTING MOUNTING DETAIL

DETAIL A
1/2" = 1'-0" 751 791

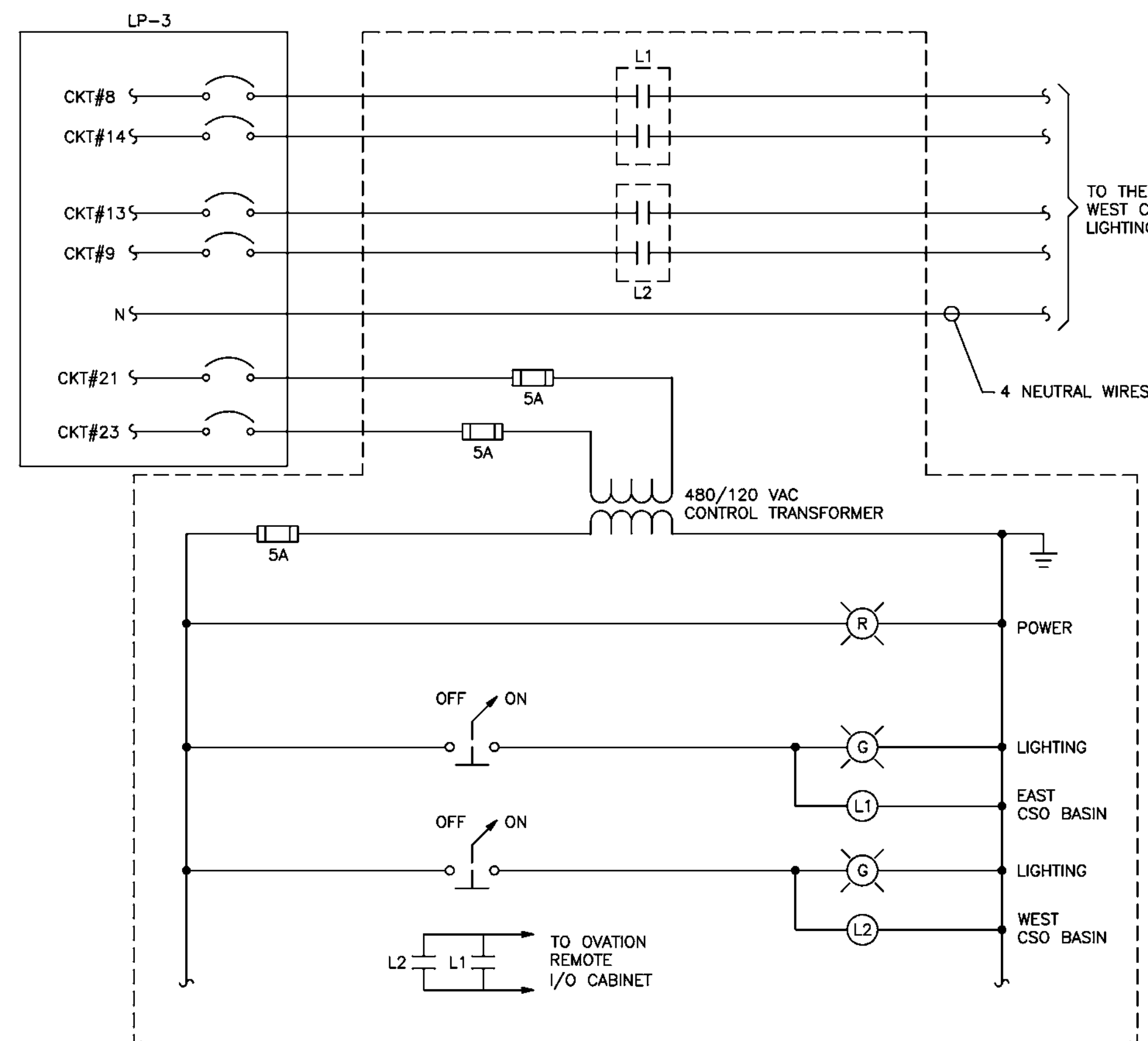


POLE MOUNTED LIGHTING

DETAIL F
NOT TO SCALE 770 791



CSO BASINS
LIGHTING CONTROL PANEL SCHEDULE
NO SCALE

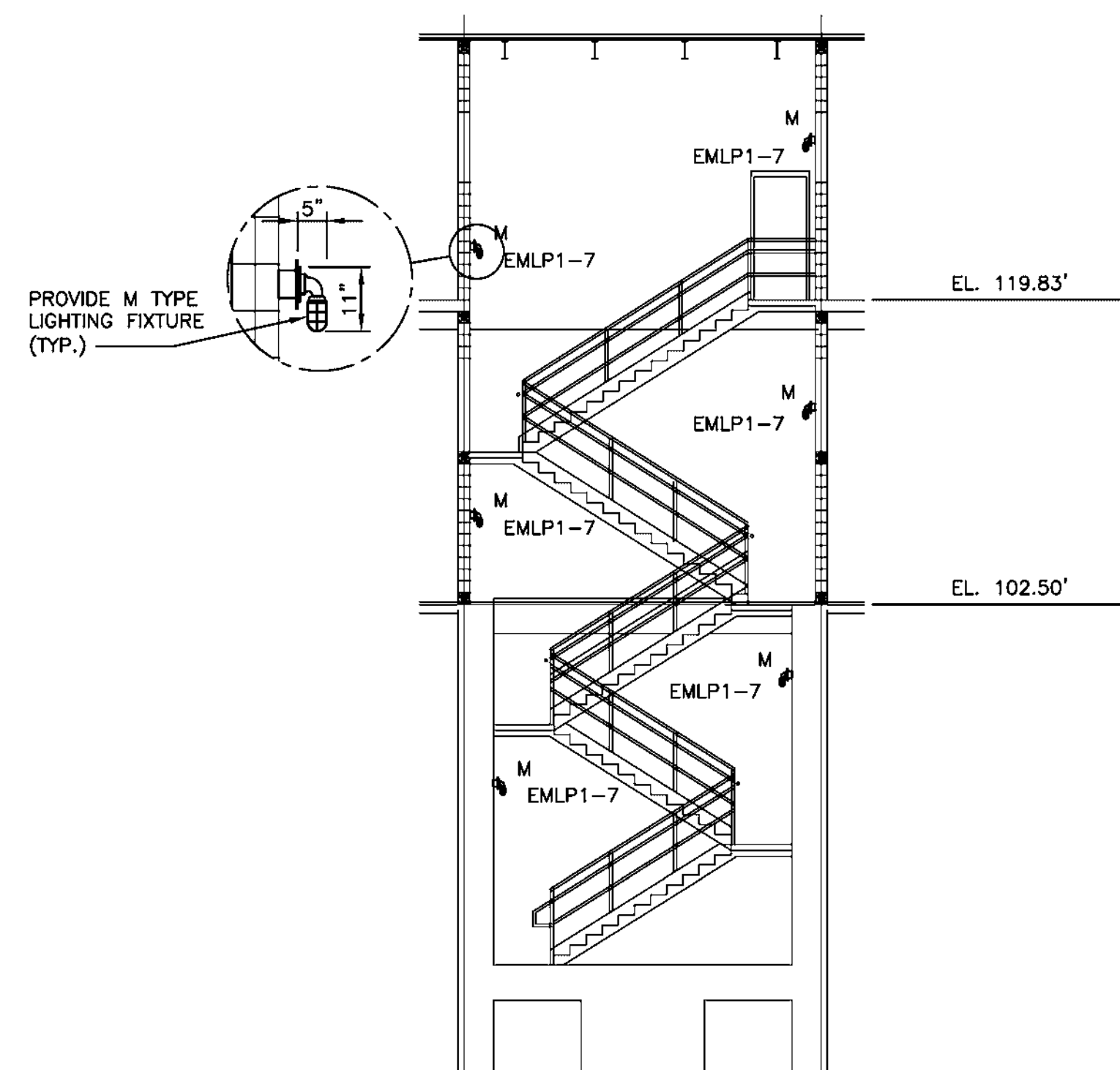


CSO BASINS
LIGHTING CONTROL PANEL SCHEMATIC DIAGRAM
NO SCALE

STANDARD MOUNTING HEIGHTS

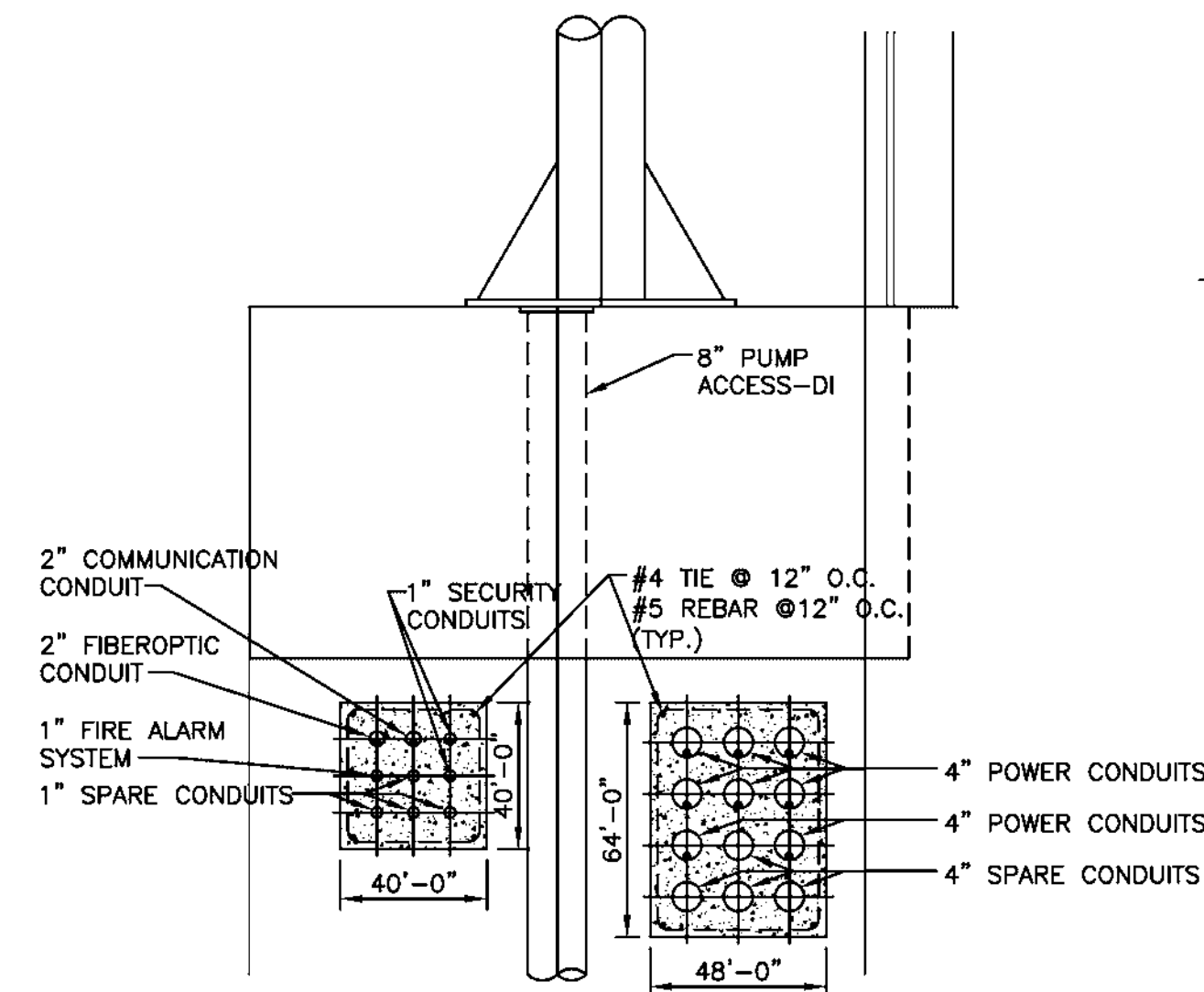
CONVENIENCE AND SPECIAL PURPOSE RECEPTACLE OUTLETS, TELE/DATA AND COMMUNICATIONS OUTLETS NOT OTHERWISE SPECIFIED
CONVENIENCE AND SPECIAL PURPOSE RECEPTACLE OUTLETS, TELE/DATA AND COMMUNICATIONS OUTLET NOT OTHERWISE SPECIFIED IN CMU WALLS
LIGHT SWITCHES, MOTOR CONTROL DEVICES AND FIRE ALARM PULL STATIONS NOT OTHERWISE SPECIFIED
FIRE ALARM HORNS, SPEAKERS, STROBES AND COMBINATION DEVICES NOT OTHERWISE SPECIFIED
GFI RECEPTACLES IN TOILET ROOMS AND JANITOR CLOSETS NOT OTHERWISE SPECIFIED
LIGHTING AND RECEPTACLE BRANCH CIRCUIT PANELBOARDS AND LIGHTING CONTROLLERS NOT OTHERWISE SPECIFIED

18" AFF TO CENTER OF BOX
24" AFF TO CENTER OF BOX
48" AFF TO CENTER OF BOX
96" AFF OR 6" BELOW CEILING
48" AFF TO CENTER OF BOX
6'-6" AFF TO TOP OF ENCLOSURE



LIGHTING DETAIL - CENTRAL STAIRWAY

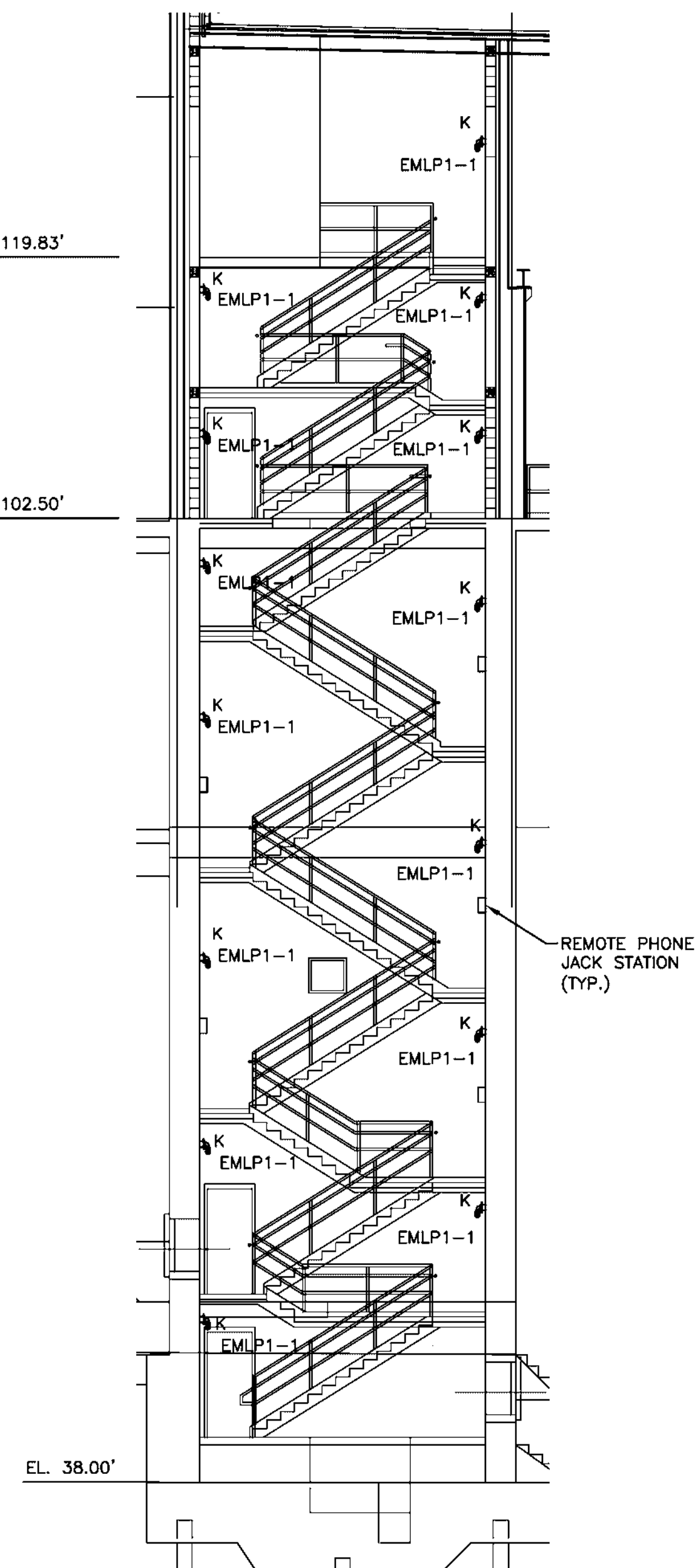
SECTION 1
1/8" = 1'-0" 717,718 791



SECTION 1
1/2" = 1'-0" 770 791

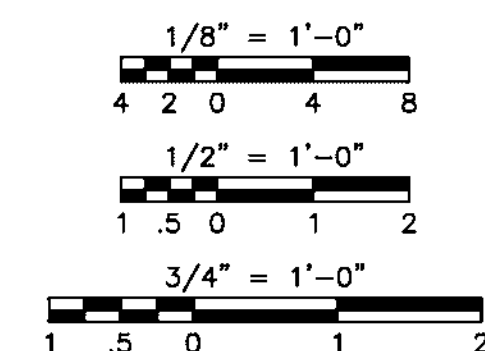
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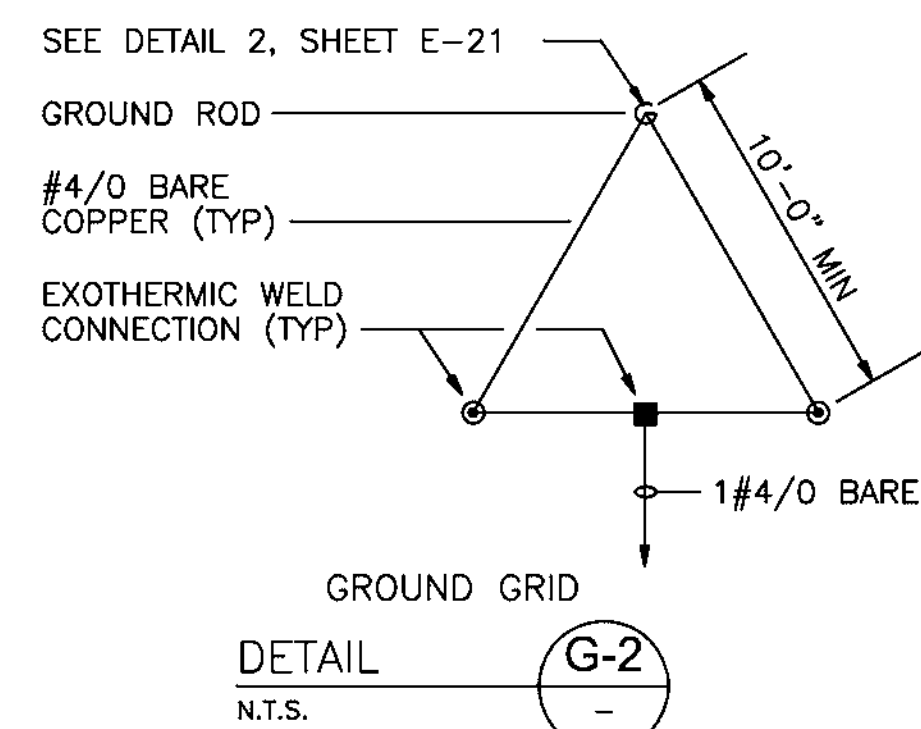
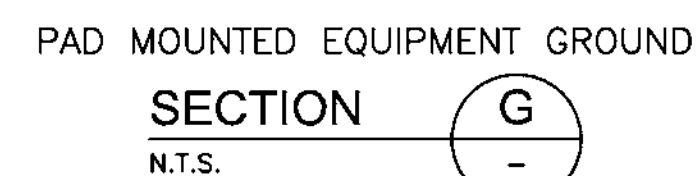
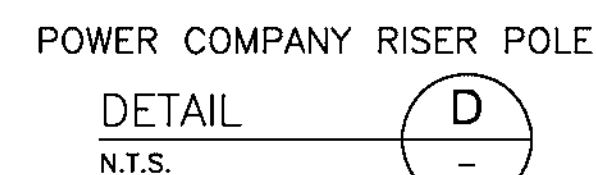
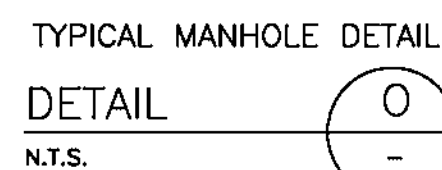
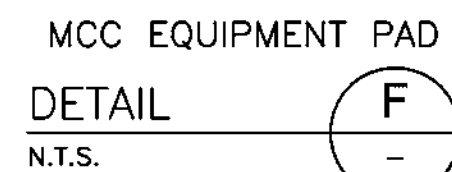
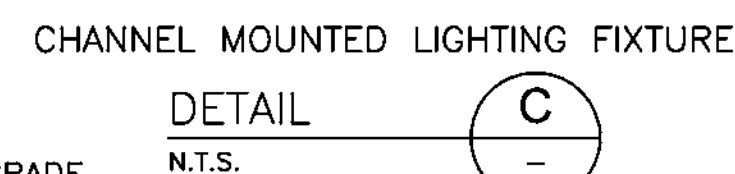
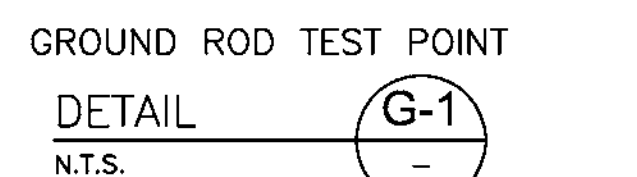
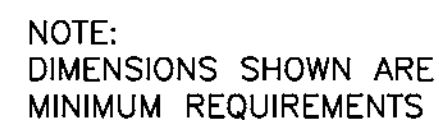
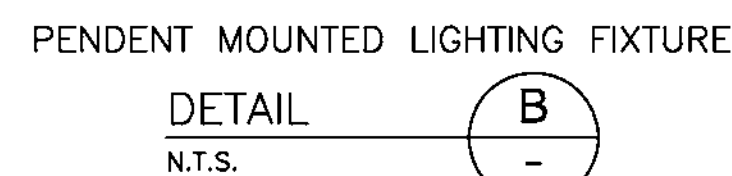
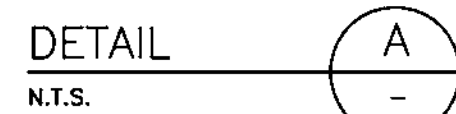
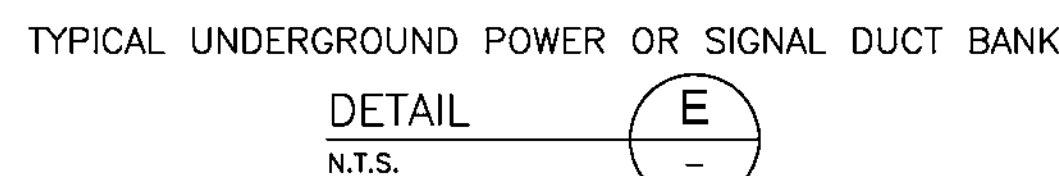
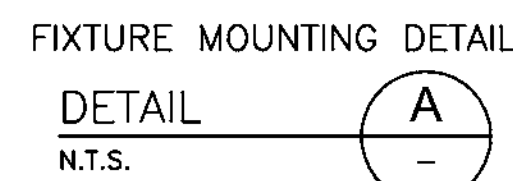
1. PROVIDE BARRIER TO SEPARATE ADJACENT 277 VOLT CIRCUITS.



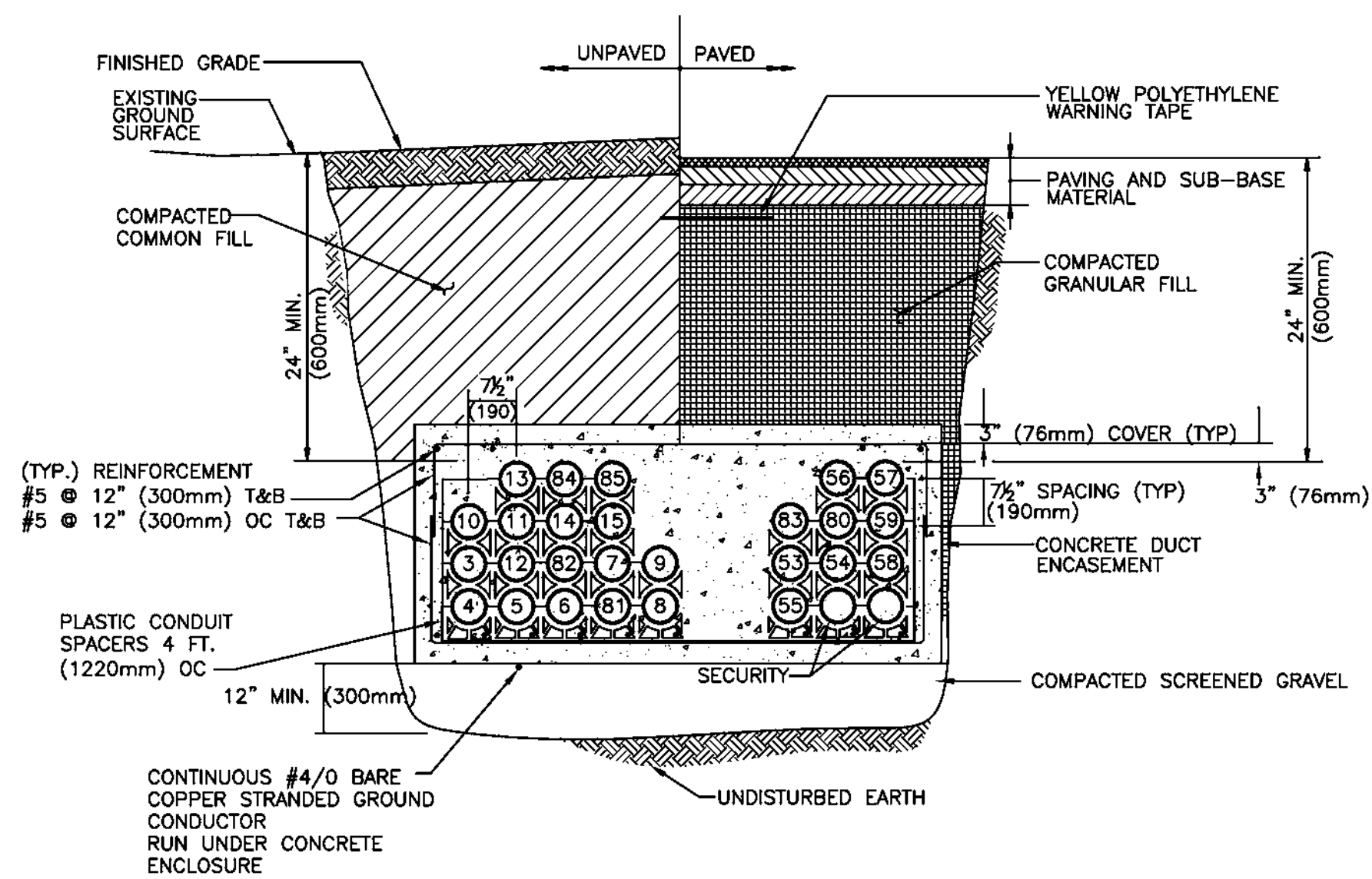
LIGHTING DETAIL - STAIR 1
(TYPICAL FOR STAIR 2)

SECTION 2
1/8" = 1'-0" 717,718 791

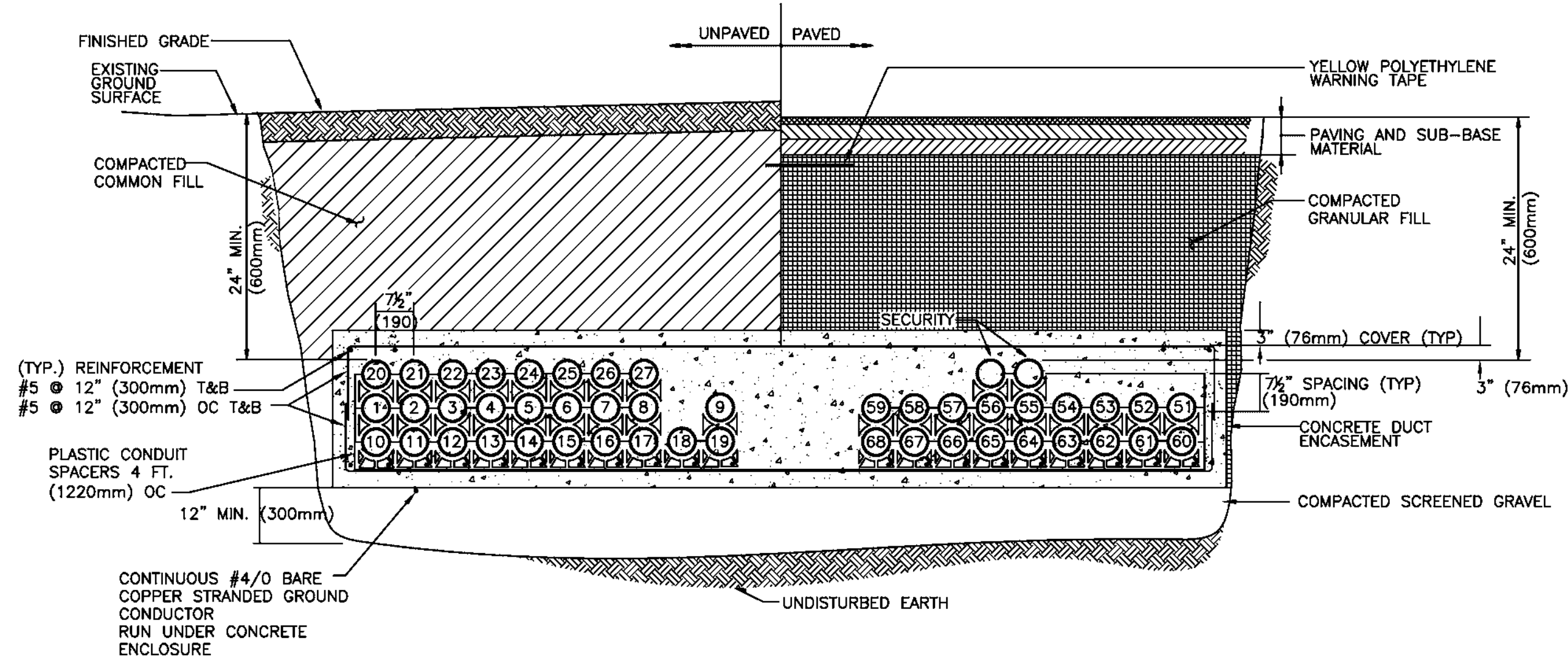


[illegible]

DRAWN BY: JRM	PROJECT NAME:
CHECKED BY: KS	OAKWOOD CSO
APPROVED BY: RAM	PUMP STATION PC-755
SCALE:	SHEET TITLE:
AS NOTED	DETAILS SHEET 1 OF 3

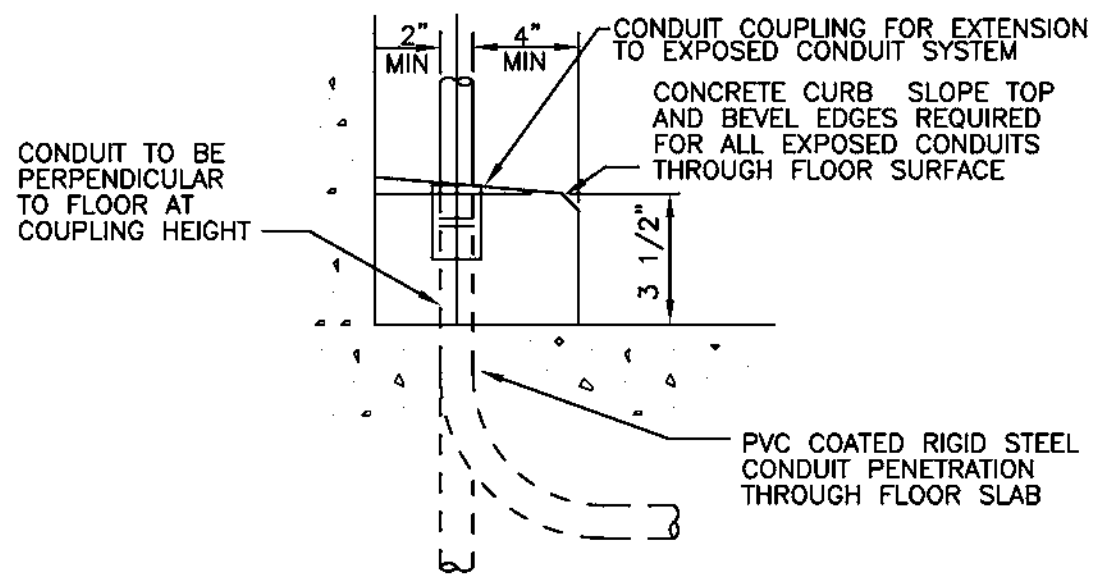


SECTION AA

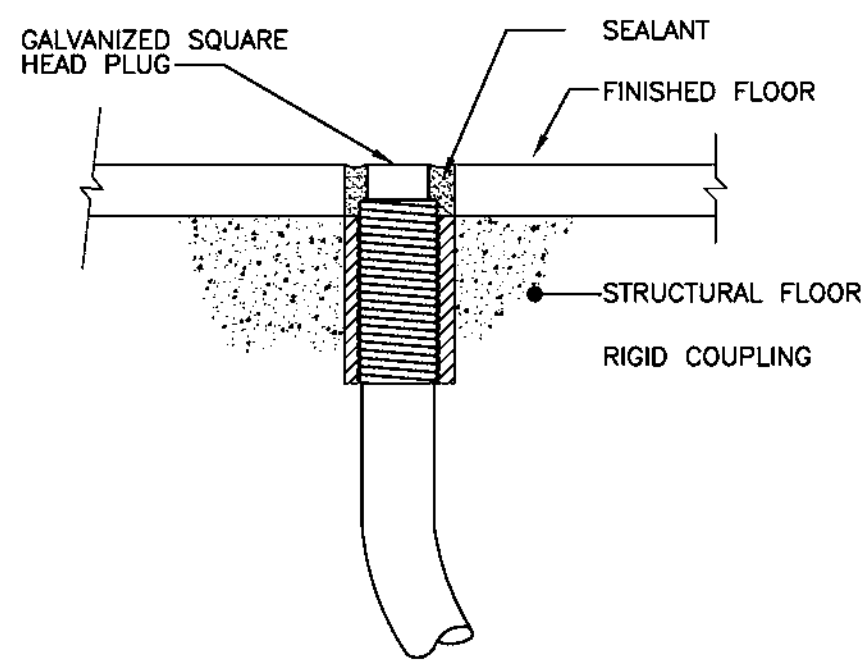


SECTION BB

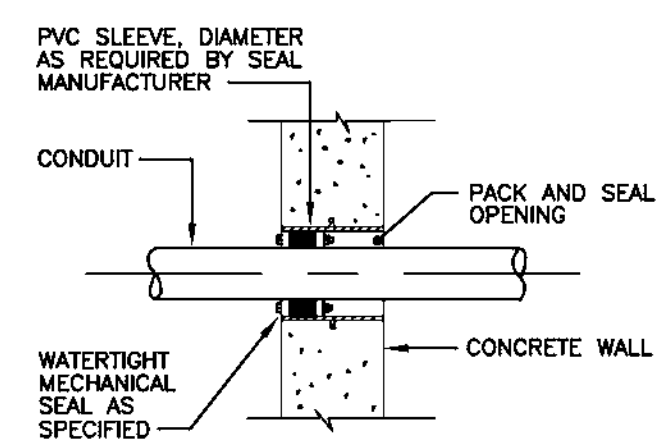
PROJECT NO: 7004s	DRAWN BY: JRM CHECKED BY: KS APPROVED BY: RAM SCALE: AS NOTED	PROJECT NAME: OAKWOOD CSO PUMP STATION PC-755 SHEET TITLE: DETAILS SHEET 2 OF 3	REV	DATE	REVISIONS
			1	4/18/08	ORIGINAL LAYOUT
			2	10/21/08	ISSUED FOR CONSTRUCTION
			3	10/25/11	SHAW ASBUILT
SHEET NO: D-04-08-792A	2012-11-13	2:41 PM	NUNES, ALLYSON	C:\USERS\NUNES\AL\DOCUMENTS\KEVIN PERRY\43250_OAKWOOD CS\DRAWINGS\IELEC 700SID-04-08-792A	



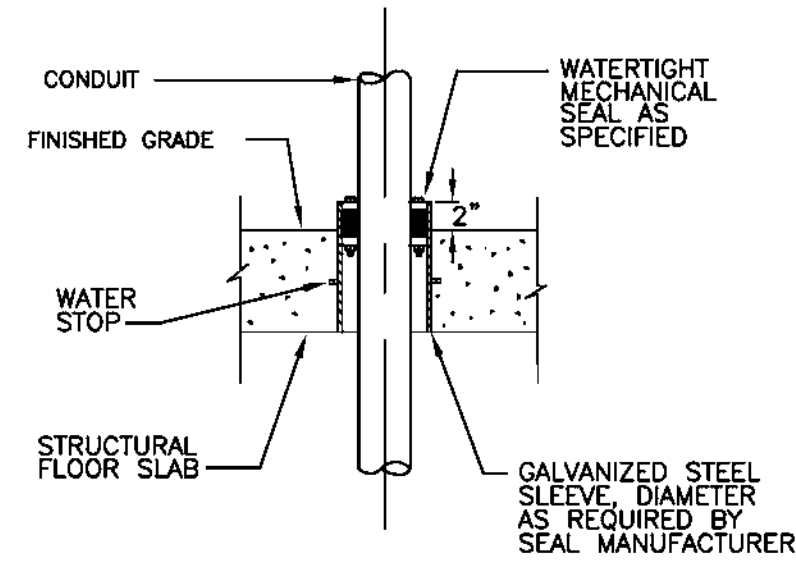
CONDUIT CURB
DETAIL
N.T.S. (M)



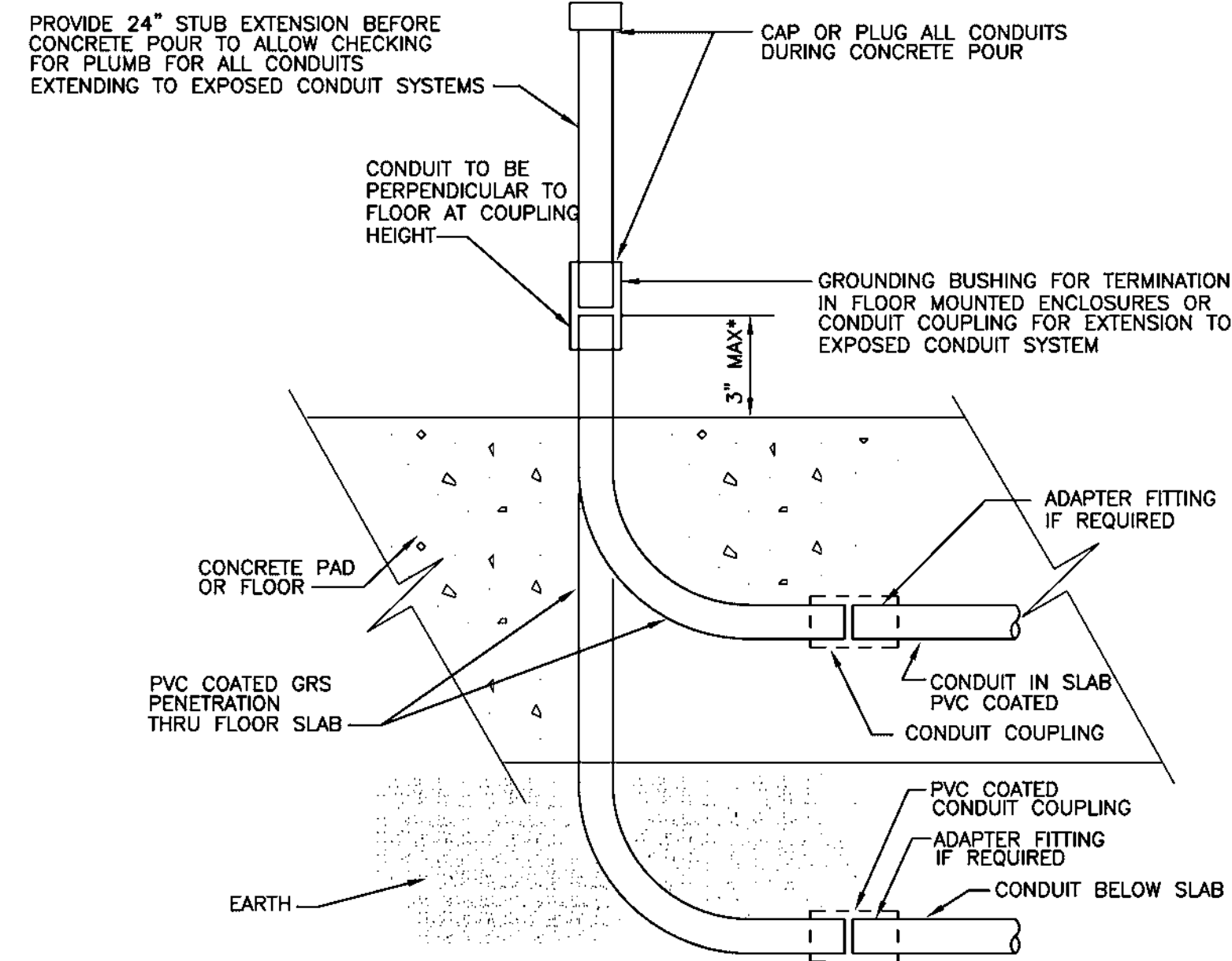
FUTURE CONDUIT TERMINATION IN FLOOR
DETAIL
N.T.S. (N)



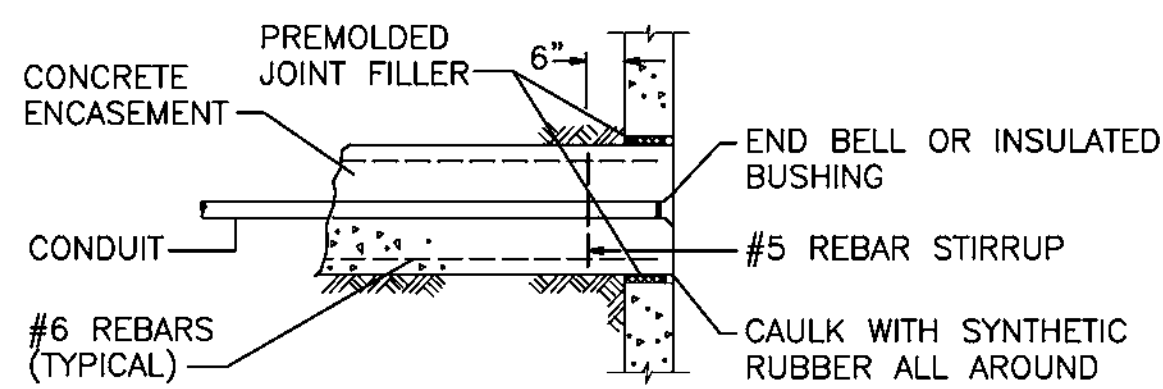
WATERTIGHT CONDUIT PENETRATION
DETAIL
N.T.S. (J)



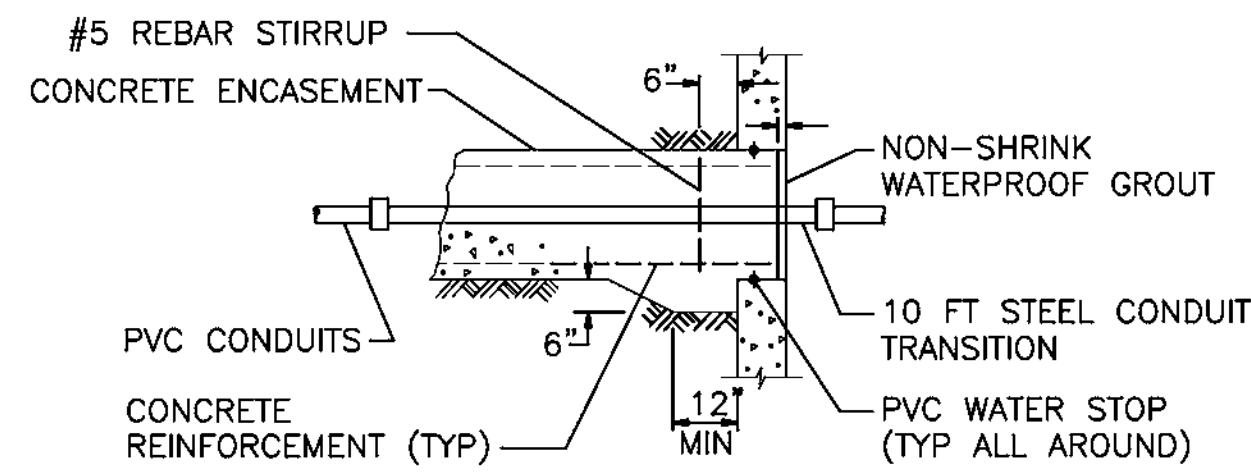
CONDUIT PENETRATION
DETAIL
N.T.S. (K)



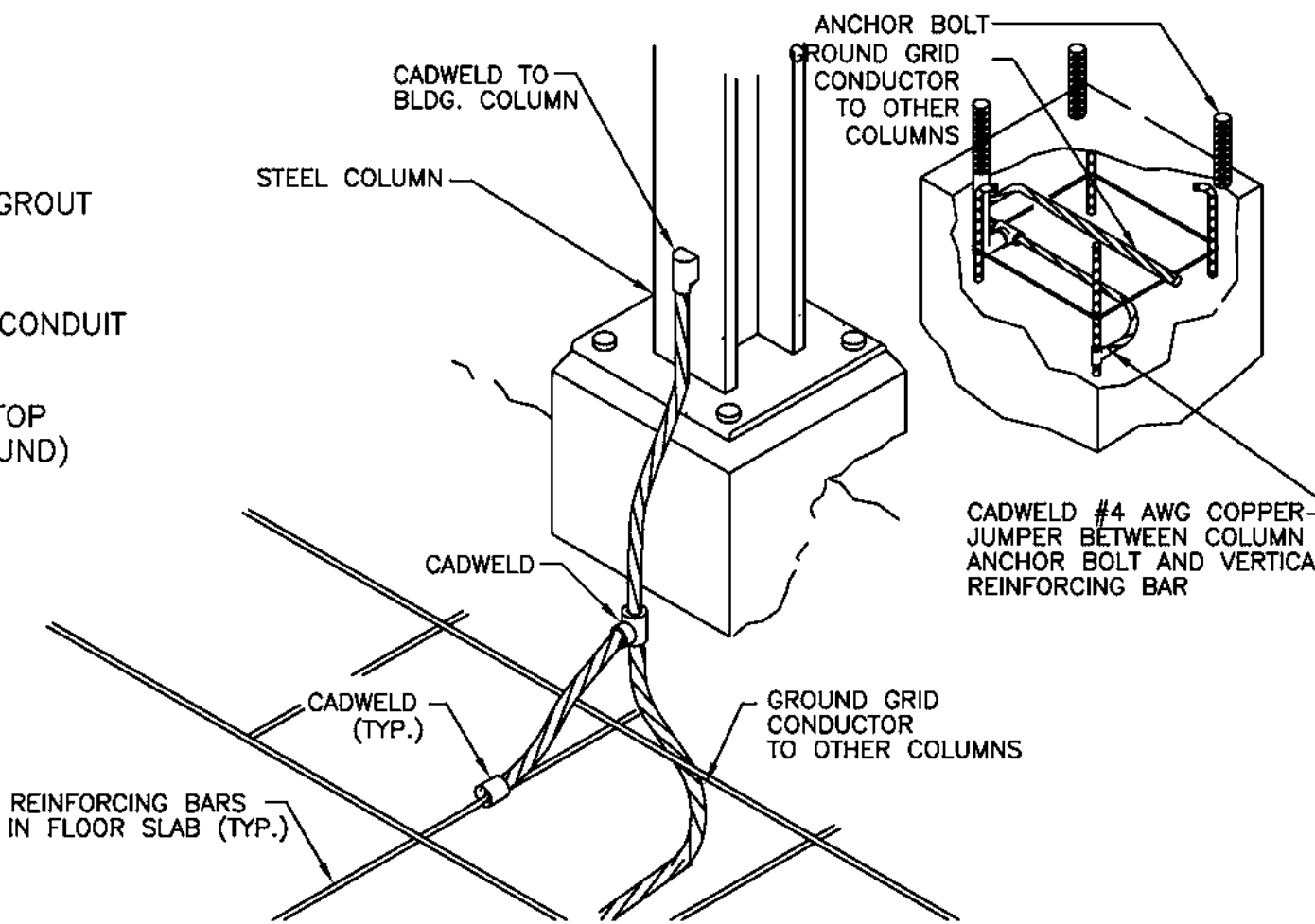
CONDUIT STUB UP/FLOOR PENETRATION
DETAIL
N.T.S. (L)



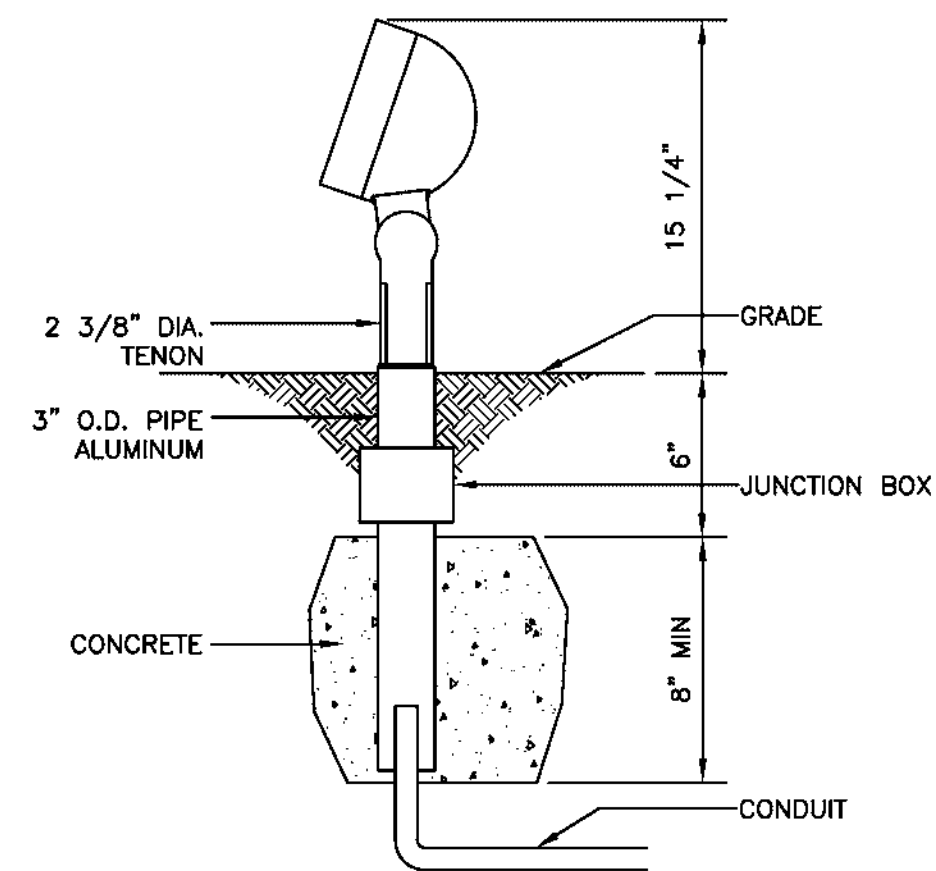
MANHOLE PENETRATION



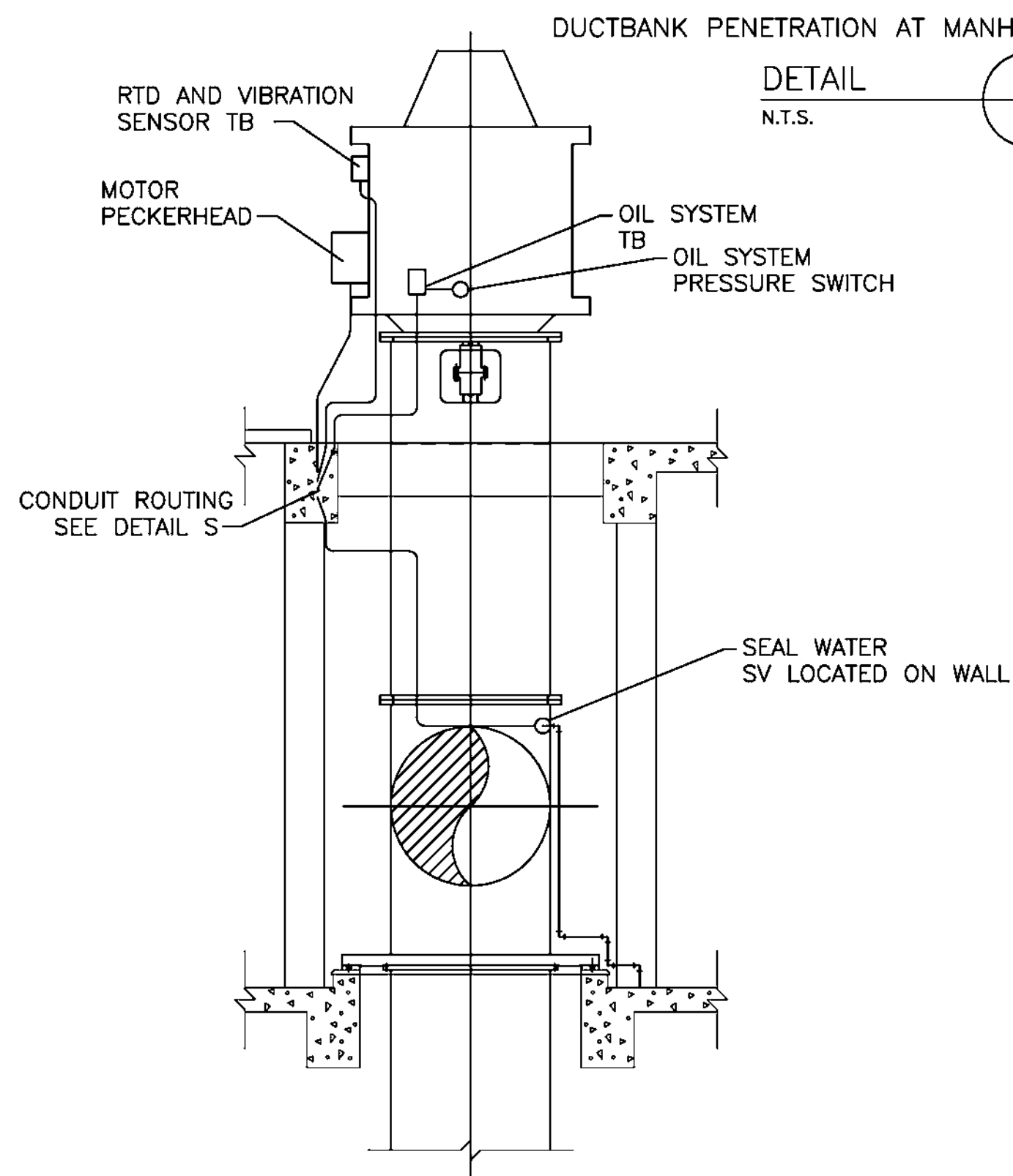
STRUCTURE PENETRATION



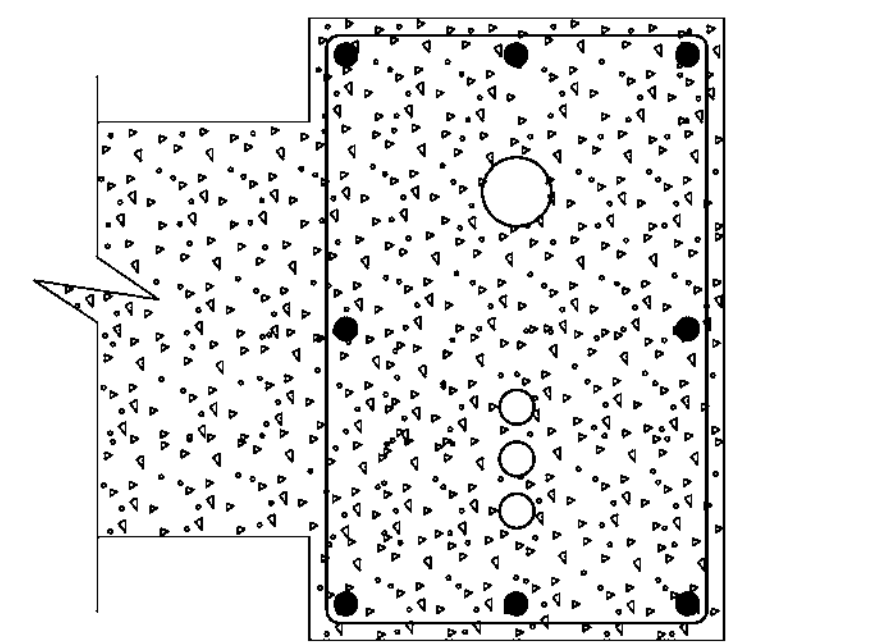
DETAIL
N.T.S. (O)



BUILDING SIGN LIGHTING
DETAIL
N.T.S. (P)



MOTOR CONDUIT ROUTING TYPICAL DETAIL
DETAIL
N.T.S. (R)



DETAIL
N.T.S. (S)

REV	DATE	REVISIONS
1	4/18/08	ORIGINAL LAYOUT
2	10/28/11	SHAW ASBUILT

PROJECT NAME:
**OAKWOOD CSO
PUMP STATION PC-755**
SHEET TITLE:
DETAILS SHEET 3 OF 3

DRAWN BY: JRM
CHECKED BY: KS
APPROVED BY: RAM
SCALE:
AS NOTED

PROJECT NO:
7004s
SHEET NO:
D-04-08-793

Appendix C-3

PC-755 100 OKW Civil

CIVIL GENERAL NOTES:

1. STORM SEWER PIPE: C76-CL IV CONCRETE PIPE FOR 12" DIA. AND ABOVE.
C14-CL III CONCRETE PIPE FOR 10" AND BELOW.

SANITARY SEWER PIPE: SCHEDULE 40 PVC PIPE.

WATER LINES: MATERIALS FOR WATER LINE PIPING (FIRE, PW, SW) SHALL BE THE FOLLOWING.
 - DUCTILE IRON PIPE-CLASS 56 WITH CEMENT MORTAR LINING AND RESTRAINED JOINTS FOR PIPE SIZES 4-INCH TO 12-INCH DIAMETER PIPE,CEMENT MORTAR LINING AND RESTRAINED JOINTS AS NOTED IN SPECIFICATION SECTION 02616.
 - PVC SCHEDULE 80 FOR 3-INCH DIAMETER PIPE.
 - K' COPPER FOR 1- $\frac{1}{2}$ INCH DIAMETER PIPE.
2. MINIMUM COVER OF UNDERGROUND UTILITIES:
WATER 6.0 FT.
NAT. GAS 2.5 FT.
SANITARY SEWER AS SHOWN ON PLANS
STORM SEWER AS SHOWN ON PLANS
ALL OTHERS 2.5 FT

PRESSURE UTILITIES MAY BE LAID APPROXIMATELY PARALLEL TO FINISH GRADE, EXCEPT AS INDICATED, WITH LOCAL DEEPENING TO AVOID OTHER UTILITIES OR OBSTRUCTIONS. MAINTAIN COVER BELOW DITCHES AND SURFACE DEPRESSIONS. PROVIDE TEMPORARY PROTECTION AS REQUIRED UNTIL COVER IS COMPLETED. INFORM OWNER'S REPRESENTATIVE IF AVAILABLE COVER AT INDICATED ELEVATIONS IS LESS THAN MINIMUM.
3. TOPOGRAPHICAL INFORMATION: EXISTING INFORMATION IS BASED ON A TOPOGRAPHICAL SURVEY BY: SPALDING DeDECKER ASSOCIATES, INC. SUPPLEMENTED BY RECORD DRAWINGS AND FIELD OBSERVATION.
4. VERTICAL CONTROL: BENCH MARKS SHOWN ON DWG. D-04-08-006
5. THE GENERAL CONTRACTOR MUST VISIT THE SITE PRIOR TO SUBMITTING A BID ON THIS PROJECT TO FAMILIARIZE HIMSELF WITH SHOWN OR NOT SHOWN EXISTING CONDITIONS. ANY EXISTING CONDITIONS FOUND AS VARIANCE WITH THESE DRAWINGS MUST BE IMMEDIATELY REPORTED TO THE OWNER.
6. THE CONTRACTOR SHALL MAINTAIN ONE (1) CLEAN SET OF MARKED PLANS SHOWING ALL CHANGES AND "AS BUILT" INFORMATION WHICH WILL BE SUBMITTED TO THE DESIGN ENGINEER UPON COMPLETION OF WORK.
7. PROVIDE TEMPORARY EROSION CONTROL MEASURES AS REQUIRED BY LOCAL AND/OR STATE AGENCIES HAVING JURISDICTION AND AS SHOWN ON PLAN.
8. ALL IMPORTED FILL MATERIAL MUST BE CLEAN GRANULAR SOIL FREE FROM TRASH, LUMBER, DELETERIOUS OR FROZEN MATERIALS.
9. ALL WORK TO BE PERFORMED AS PER CITY OF DETROIT AND WAYNE COUNTY REQUIREMENTS.
10. EXISTING UTILITIES: INFORMATION HAS BEEN OBTAINED FROM EXISTING AVAILABLE DRAWINGS AND SURFACE FEATURES SHOWN ON THE TOPOGRAPHICAL SURVEYS. VERIFY THE INFORMATION BEFORE START OF CONSTRUCTION. NOTIFY THE OWNER'S REPRESENTATIVE OF DISCREPANCIES OR INTERFERENCES.
11. CONSTRUCTION DRAINAGE: USE PUMPS, TEMPORARY DITCHES, SLOPES TO MAINTAIN A WELL DRAINED SITE, FREE OF STANDING WATER AND WATER SOFTENED SOILS.
12. LAYOUT: CONFIRM HORIZONTAL AND VERTICAL CONTROL POINTS PRIOR TO CONSTRUCTION.
13. SURFACE RESTORATION: RESTORE PAVEMENT AND OTHER SURFACES DISTURBED BY CONTRACT OPERATIONS TO THEIR ORIGINAL CONDITIONS OR BETTER.
14. SOIL BORINGS: SOILS INFORMATION IS PROVIDED. THE BORING LOGS SHOW SUBSURFACE CONDITIONS AT THE DATES AND LOCATIONS INDICATED, AND IT IS NOT WARRANTED THAT THEY ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES. THE CONTRACTOR MAY AT HIS OWN COST PERFORM ADDITIONAL SOIL BORINGS PRIOR TO BIDDING.
15. ALL ELEVATIONS SHOWN ARE SURFACE ELEVATION AND AS INDICATED ON PLANS.
16. SLOPE SMOOTHLY BETWEEN INDICATED ELEVATIONS TO PROVIDED POSITIVE DRAINAGE OF ALL AREAS GRADED OR DISTURBED BY THIS CONTRACT.
17. COMPLY WITH THE CONSTRUCTION SAFETY STANDARDS AND THE OCCUPATIONAL SAFETY STANDARDS AS ISSUED BY THE US DEPARTMENT OF LABOR AND LOCAL AUTHORITIES HAVING JURISDICTION.
18. VERIFY FIELD CONDITIONS BEFORE STARTING WORK AND REPORT VARIATIONS TO OWNER'S REPRESENTATIVE.
19. BE FAMILIAR WITH EXISTING CONDITIONS AT SITE, INCLUDING UTILITIES AND SERVICES AND BE RESPONSIBLE FOR DAMAGES CAUSED TO BOTH EXISTING AND NEW CONSTRUCTION AND PROPERTY AND FOR UNAUTHORIZED DISRUPTION TO ADJACENT OWNERS NORMAL USE OF UTILITIES, SERVICES, AND SURROUNDING FACILITIES.
20. PROVIDE BARRIER PROTECTION FOR VEHICULAR AND PEDESTRIAN TRAFFIC AT EXCAVATIONS. TEMPORARY FENCING, BARRICADING AND PEDESTRIAN ROUTING SHALL BE COORDINATED WITH AND APPROVED BY OWNER'S REPRESENTATIVE PRIOR TO CONSTRUCTION.
21. DEMOLISHED MATERIALS: TOP SOILS, ORGANIC CONTAMINATED, WET SOILS OR OTHER DELETERIOUS MATERIALS MUST BE REMOVED FROM SITE. ANY EXISTING SOILS SUITABLE FOR USE AS FILL MAY BE RETAINED AND REINSTALLED AS COMPACTED FILL. REMOVAL OF THESE MATERIALS SHALL BE DONE AT NO ADDITIONAL COST TO THE OWNER.
22. THE CONTRACTOR SHALL DISPOSE OF ALL SURPLUS EXCAVATION AND/OR PROVIDE ALL SUITABLE FILL MATERIALS AS APPROVED BY THE SOILS ENGINEER AND COST SHALL BE INCLUDED IN THE PRICE BID FOR THE RELATED ITEMS.
23. ALL DISTURBED AREAS NOT RECEIVING PAVEMENT OR GRANULAR MATERIALS SHALL RECEIVE SEED, FERTILIZE AND MULCH OR AS INDICATED ON DRAWINGS.
24. ALL MANHOLES, CATCH BASINS, INLETS, OR SIMILAR DRAINAGE STRUCTURES IN PAVED AREAS TO HAVE 4" DIA - 10 FT. LONG PERFORATED UNDERDRAIN PIPES WRAPPED IN FILTER FABRIC IN FOUR DIRECTIONS (TWO DIRECTIONS IN UNPAVED AREA) AND RECESSED BENEATH THE AGGREGATE BASE LAYER.
25. FOR ADDITIONAL BOLLARDS SEE ARCHITECTURAL DRAWINGS.

TO REPORT AN EMERGENCY FIELD CONDITION CALL:

DTE ENERGY ELECTRIC COMPANY PHONE:
(800) 477-4747

DTE ENERGY GAS COMPANY PHONE:
(800) 477-4747

SBC PHONE:
(800) 727-2273

DETROIT PUBLIC LIGHTING DEPARTMENT PHONE:
(313) 224-0500

DETROIT WATER AND SEWERAGE DEPARTMENT PHONE:
(313) 833-4077

COMCAST CABLEVISION PHONE:
(313) 934-1608

ABBREVIATIONS

APPROX.	APPROXIMATELY
B	BOLLARD INDUSTRIAL
B/S	BOTTOM OF SWALE
BLDG	BUILDING
CB	CATCH BASIN
CNTR	CENTER POINT
CONC	CONCRETE
DIA	DIAMETER
DS	DRAINAGE STRUCTURE
ELEC	ELECTRIC LINE
ELEV	ELEVATION
F-F	FACE TO FACE
FIRE	FIRE LINE
FIN	FINISH
FL	FLOOR
G	GUTTER
HYD	HYDRANT
HP	HIGH POINT
IE	INVERT ELEVATION
LP	LOW POINT
MH	MANHOLE
NIC	NOT IN CONTRACT
PCC	POINT OF COMPOUND CURVE
PRC	POINT OF REVERSE CURVE
PC	POINT OF CURVE
PVMT	PAVEMENT
PW	POTABLE WATER
R	RADIUS
RD	ROAD
SAN	SANITARY SEWER
SW	SECONDARY WATER
ST	STORM WATER
T/C	TOP OF CURB
T/P	TOP OF PAVEMENT
T/S	TOP OF SIDEWALK
T/W	TOP OF WALL
T	TELEPHONE LINE
TYP	TYPICAL
UD	UNDERDRAIN
UNO	UNLESS NOTED OTHERWISE
VERT	VERTICAL

LEGEND

SEE DWG. D-04-08-006 FOR EXISTING CONDITIONS LEGEND

PROPOSED

	FINISH GRADE ELEVATION
	TOP OF CURB ELEVATION
	GUTTER ELEVATION
	TOP OF PAVEMENT ELEVATION
	TOP OF WALL ELEVATION
	BOTTOM OF SWALE
	CONCRETE PAVEMENT
	GRAVEL ROAD
	FINISHED GRADING CONTOURS
	INTEGRAL CURB
	SEWER MANHOLE
	INLET
	AREA DRAIN
	CLEAN OUT
	SURFACE FLOW DIRECTION
	VALVE AND GATE WELL
	FIRE HYDRANT
	REDUCER
	SWALE
	STORM SEWER
	SANITARY SEWER
	FIRE WM
	SECONDARY WM
	POTABLE WM
	GAS LINE
	DISCHARGE PIPE WITH FLARED END SECTION
	FENCE - TYPE A
	FENCE - TYPE B
	SUBSTATION FENCE
	SILT FENCE

RECORD DRAWING

THIS RECORD DRAWING HAS BEEN PREPARED BASED ON A COMBINATION OF INFORMATION PROVIDED BY OTHERS AND BY CDM SMITH. THEREFORE, THE ENGINEER HAS NOT VERIFIED THE ACCURACY OF ALL THE INFORMATION. TO THE BEST OF THE ENGINEER'S BELIEF AND KNOWLEDGE, THE INCLUDED RECORD INFORMATION IS REASONABLY ACCURATE.

By DUANE D. DeDENE Date 08/2012

CDM
Smith

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					CHECKED	BB
1	REVISED FOR RECORD		8/12	DDD		
	REVISED PER BULLETIN NO. 3		3/07	AG		
NO.	DESCRIPTION	NO.	DATE	APRVD		
	REVISIONS				APPROVED	AG

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

CIVIL/SITE LEGEND, ABBREVIATIONS,
SYMBOLS, AND NOTES

SCALE: NONE

DATE: DECEMBER 15, 2006

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Applied Science, Inc.
300 River Road, Suite 5400, Detroit, MI 48207
Phone: (313) 947-2665 Fax: (313) 267-3796

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CONSULTING ENGINEERS PLANNERS
200 E. LIVING ST. SUITE 300, DETROIT, MICHIGAN 48226
TEL: (313) 963-0812 FAX: (313) 963-2108

Associates Inc.
150 W. Congress St., Suite 410
Detroit, MI 48226
Phone: 313-954-7765 Fax: 313-554-7782

SUPERIOR ENGINEERING ASSOC., INC.
65 SIOUX ST., SUITE 2101, DETROIT, MI 48226
TEL: (313) 964-2796 FAX: (313) 964-9781
WWW.SUPERIORMEC.COM

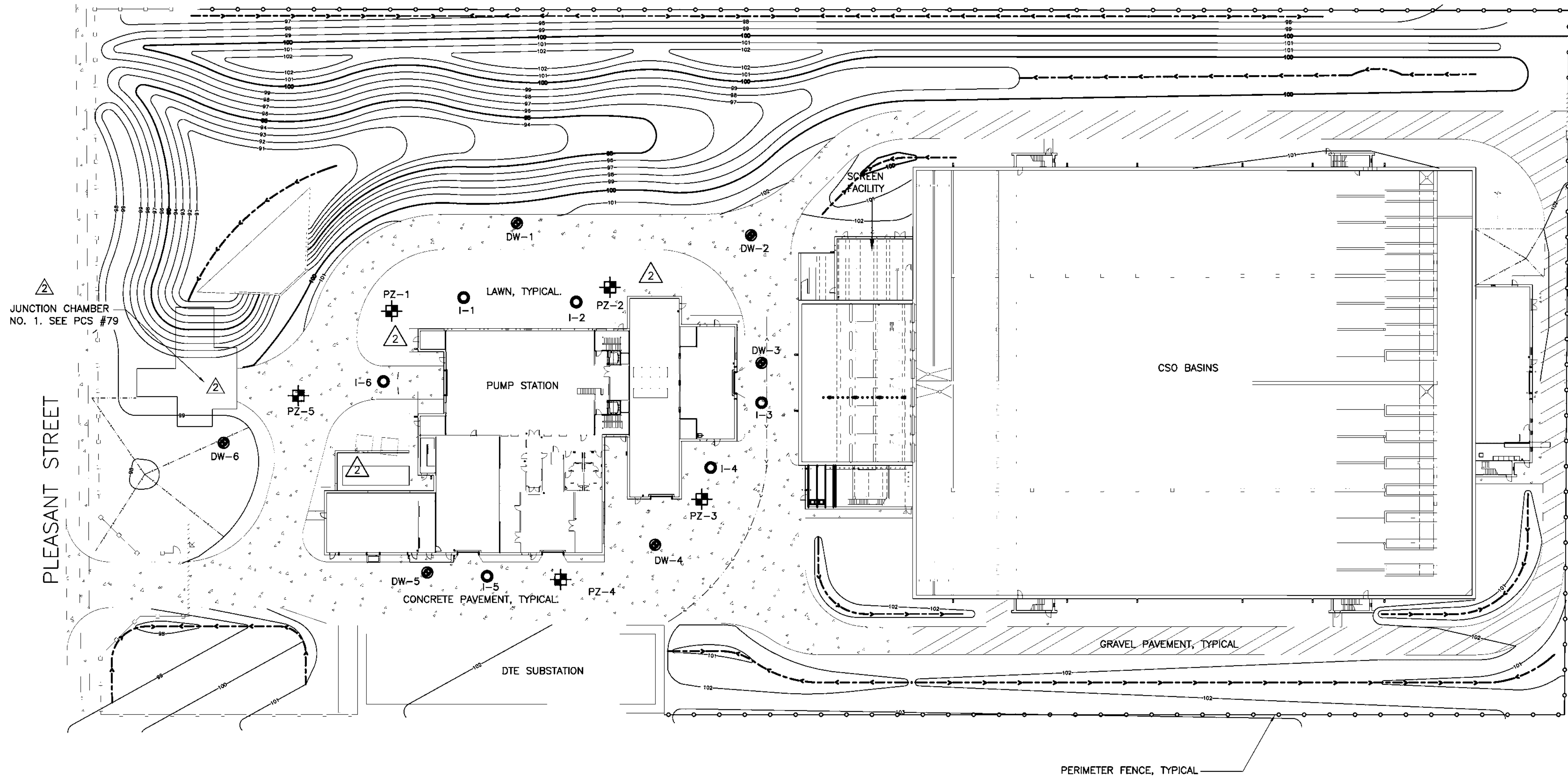
SOMAT Engineering, Inc.
CONSULTING ENGINEERS PLANNERS
600 Woodward Ave., Suite 1245, Detroit, Michigan
(313) 963-5751 • Fax: (313) 963-5758

Sigma Consulting Engineers
200 Woodward Ave., Suite 1700
Detroit, MI 48226
Tel: 313.963.9700 Fax: 313.963.9628

CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE
- - - -	- -	- -	- - -	- - -

M.D.P.H./D.N.R. PERMIT NO.	
FAMIS NO.	-
CONTRACT NO.	PC-755
FILE NO.	CSDLG100.DWG
DRAWING NO.	D-04-08-100

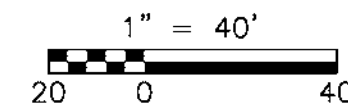


GEOTECHNICAL INSTRUMENTATION LOCATION PLAN

1" = 40'-0"

LEGEND:-

- DW-1 - PROPOSED DEWATERING WELL LOCATION
- PZ-1 - PROPOSED PIEZOMETER LOCATION
- I-1 - PROPOSED INCLINOMETER LOCATION



NOTES:

- LOCATIONS, TYPES, AND NUMBER OF PROPOSED GEOTECHNICAL INSTRUMENTATION INCLUDING DEWATERING WELLS TO BE FIELD ADJUSTED BY THE CONTRACTOR AND/OR THE ENGINEER DURING CONSTRUCTION PHASE.
- INCLINOMETERS WILL BE INSTALLED DURING CONSTRUCTION OF THE PUMP STATION AND WILL BE LOCATED APPROXIMATELY 5 TO 10 FEET FROM THE EDGE OF THE EXCAVATION.
- ALL PROPOSED LOCATIONS OF THE GEOTECHNICAL INSTRUMENTATION SHALL BE DETERMINED SUCH THAT CONFLICTS WITH ALL EXISTING AND PROPOSED NEW UTILITIES ARE AVOIDED.

RECORD DRAWING

THIS RECORD DRAWING HAS BEEN PREPARED BASED ON A COMBINATION OF INFORMATION PROVIDED BY OTHERS AND BY CDM SMITH. THEREFORE, THE ENGINEER HAS NOT VERIFIED THE ACCURACY OF ALL THE INFORMATION. TO THE BEST OF THE ENGINEER'S BELIEF AND KNOWLEDGE, THE INCLUDED RECORD INFORMATION IS REASONABLY ACCURATE.

By DUANE D. DeDENE Date 08/2012

CDM Smith

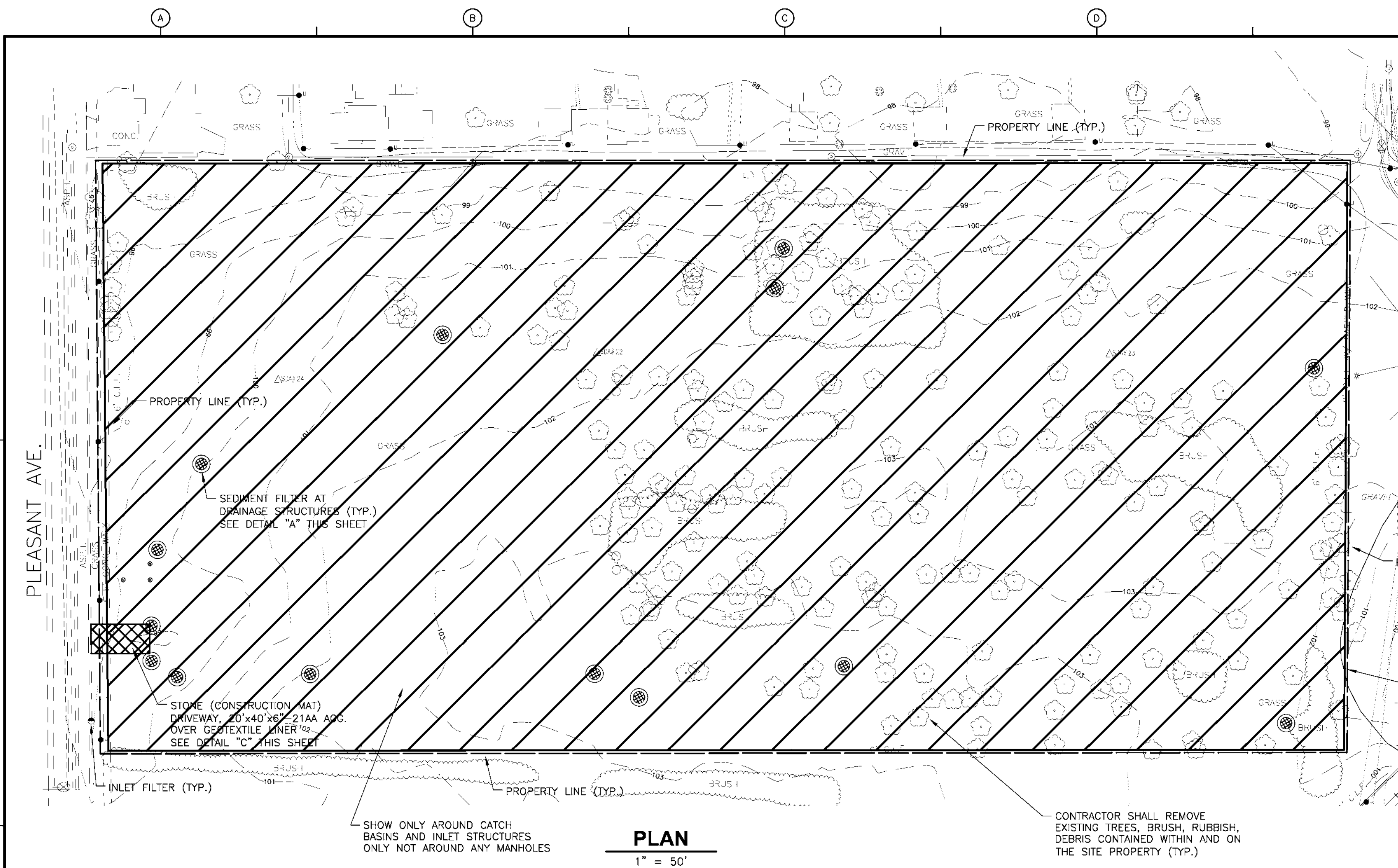
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REVISED FOR RECORD				8/12 DDD	CHECKED
CDM DIRECTIVE				8/12 DDD	ROA
CONFORMED SET				8/07 BBH	APPROVED
DESCRIPTION				NO. DATE APRVD	BBH
REVISIONS					

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

GEOTECHNICAL MONITORING PLAN
DURING CONSTRUCTION

SCALE: 1"=40'-0" DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc. One Woodward Avenue, Suite 1500 Detroit, MI 48226 PHONE: (313) 967-4700 FAX: (313) 967-4700 WWW.CDMMICHIغان.COM	hamiltonanderson Hamilton Anderson Associates 1430 Franklin Suite 200, Detroit, Michigan 48226 P 313 964 0270 F 313 964 0170 WWW.hamilton-anderson.com	TUCKER, YOUNG, JACKSON, TULL, INC. CONSULTING ENGINEERS PLANNERS 200 E. LIVING ST. SUITE 200, DETROIT, MICHIGAN 48226 P (313) 963-0812 FAX (313) 963-2108	Applied Science, Inc. 300 River Road, Suite 540, Detroit, MI 48207 Phone: (313) 967-2600 Fax: (313) 967-0790	Associates Inc. 120 W. Congress St., Suite 410 Detroit, MI 48226 Phone: 313-954-7765 Fax: 313-954-7782	SUPERIOR ENGINEERING ASSOC., INC. 65 CHURCH RD., SUITE 2101, DETROIT, MI 48226 PHONE: (313) 964-0700 FAX: (313) 964-0700 WWW.SUPERIORMECC.COM	SOMAT Engineering, Inc. GEOTECHNICAL, GEOPHYSICAL, & MATERIALS TESTING 600 Woodward Ave., Suite 1245, Detroit, Michigan (313) 963-5751 • Fax: (313) 963-5758	SIGMA CONSULTING ENGINEERS Sigma Associates, Inc. 300 Woodward Ave., Suite 1700 Detroit, MI 48226 Tel: 313.963.9700 Fax: 313.963.9628	CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION	M.D.P.H./D.N.R. PERMIT NO. FAMIS NO. - CONTRACT NO. PC-755 FILE NO. CSTPL101 DRAWING NO. D-04-08-101
SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE					
-	-	-	-	-					



SOIL EROSION CONTROL STAGING:

THE FOLLOWING STAGING IS INTENDED TO BE A GENERAL METHOD OF CONSTRUCTION. ANY OPERATIONS DESCRIBED HEREIN WHICH DO NOT ADVERSELY AFFECT SUBSEQUENT STAGING OR THE INTENT OF SOIL EROSION AND SEDIMENT CONTROL MAY BE PERFORMED AT THE CONTRACTOR'S CONVENIENCE WITH THE APPROVAL OF THE WAYNE COUNTY DEPARTMENT OF ENVIRONMENT, LAND RESOURCES MANAGEMENT DIVISION, WATERSHED MANAGEMENT DIVISION.

1. INSTALL STRAW BALE FILTER OR GEOTEXTILE SILT FENCE ALONG THE PERIMETER OF PROPERTY OR CONSTRUCTION AREA AS PER DETAILS THIS SHEET.
2. INSTALL SEDIMENT CONTROL MEASURES AT ALL EXISTING DRAINAGE STRUCTURES AS INDICATED PRIOR TO START OF WORK, AS PER DETAIL THIS SHEET.
3. PERFORM GRADING OPERATIONS AS REQUIRED.
4. TEMPORARILY MULCH ALL DISTURBED AREAS OR APPLY PERMANENT EROSION CONTROL MEASURES WITHIN 15 DAYS AFTER THE EARTH DISRUPTION.
5. ESTABLISH PERMANENT EROSION CONTROL MEASURES SUCH AS SEED AND MULCH, SOD, ETC., AS INDICATED.
6. REMOVE TEMPORARILY EROSION CONTROL MEASURES UPON PERMANENT STABILIZATION OF ALL DISTURBED AREAS.

SILT FENCE NOTES:

1. SILT FENCE AND FILTER FABRIC MATERIALS SHALL BE PURCHASED IN A CONTINUOUS ROLL. CUT TO THE LENGTH OF THE BARRIER TO AVOID THE USE OF JOINTS.
2. THE HEIGHT OF A SILT FENCE SHALL NOT EXCEED 36 INCHES (HIGHER FENCES MAY IMPOUND VOLUMES OF WATER SUFFICIENT TO CAUSE FAILURE OF THE STRUCTURE).
3. POST SHALL BE SPACED A MAXIMUM OF 6 FEET APART AT THE BARRIER LOCATION AND DRIVEN SECURELY INTO THE GROUND (MINIMUM 12 INCHES).
4. A TRENCH SHALL BE EXCAVATED APPROXIMATELY 4 INCHES WIDE AND 4 INCHES DEEP FOR THE FILTER FABRIC MATERIAL ALONG THE LINE OF POSTS, UPSLOPE FROM THE FENCE.
5. THE TRENCH SHALL BE BACKFILLED AND THE SOIL COMPACTED OVER THE FILTER MATERIAL. SILT FENCES HAVE THEIR APPLICABILITY LIMITED TO SITUATIONS WHICH ONLY SHEET OR OVERLAND FLOWS ARE EXPECTED.
6. SILT FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFUL PURPOSE, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY STABILIZED.
7. THE CONTRACTOR SHALL MAINTAIN SILT FENCE UNTIL UPSLOPE AREA HAS BEEN PERMANENTLY STABILIZED.
8. SILT FENCES SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.
9. SHOULD THE FABRIC ON THE SILT FENCE DECOMPOSE OR BECOME INEFFECTIVE PRIOR TO THE END OF THE EXPECTED USABLE LIFE AND THE FENCE IS STILL NECESSARY, THE FABRIC SHALL BE REPLACED PROMPTLY.
10. SEDIMENT DEPOSITS SHOULD BE REMOVED AFTER EACH STORM EVENT. THEY MUST BE REMOVED WHEN DEPOSITS REACH APPROXIMATELY ONE-HALF THE HEIGHT OF THE FENCE.
11. ANY SEDIMENT DEPOSITS REMAINING IN PLACE AFTER THE SILT FENCE IS NO LONGER REQUIRED SHALL BE DRESSED TO CONFIRM WITH THE EXISTING GRADE, PREPARED AND SEEDED.

EROSION CONTROL GENERAL NOTES:

1. ALL PROPOSED WORK SHALL BE IN ACCORDANCE WITH THE SOIL EROSION AND SEDIMENTATION CONTROL PERMIT AND ACT 347 OF THE PUBLIC ACTS OF 1972, AS AMENDED.
2. CONTRACTOR SHALL EMPLOY A QUALIFIED INSPECTOR/TECHNICIAN TO REGULARLY INSPECT THE PROJECT EROSION CONTROL MEASURES. THE INSPECTOR/TECHNICIAN SHALL THOROUGHLY INSPECT EVERY 7 DAYS, OR WITHIN 24 HOURS OF A ONE-HALF INCH RAINFALL, SHALL MAINTAIN A PROJECT NOTEBOOK WITH NAMES, DATES, LOCATIONS AND CORRECTIVE MEASURES. RECORDS SHALL BE MADE AVAILABLE TO THE CITY OR COUNTY INSPECTORS UPON REQUEST.
3. A DIVERSION SWALE (OPTION 'A') AND/OR A SILT FENCE (OPTION 'B') SHALL BE CONSTRUCTED AROUND THE PERIMETER ONE FOOT INSIDE THE PROPERTY LINE. FOR OPTION 'A', IF SWALE CANNOT BE CONSTRUCTED BETWEEN PROPERTY LINE AND PROPOSED EXCAVATION/WORK, THEN EXISTING GROUND SHALL BE SLOPED WITH A MINIMUM OF 2 ON 1 SLOPE FROM PROPERTY LINE TO THE EXCAVATION/WORK. OPTION 'A' SHALL HAVE A MINIMUM OF 0.50% LONGITUDINAL SLOPE.
4. SILT FENCE SHALL REMAIN IN PLACE UNTIL COMPLETION OF PAVEMENT. ALL FLOWS SHALL BE SILT-FREE PRIOR TO DISCHARGE. DISCHARGE SHALL BE DIRECTED TO STABILIZED SITES SUCH AS STREAMS, STORM SEWERS OR EXISTING GRASSED DRAINAGE WAYS NOT ONTO EXPOSED SOILED OR ANY OTHER SITE WHERE FLOWS COULD CAUSE EROSION.
5. PUMPS TO DE-WATER EXCAVATIONS AND DIVERSION SWALES SHALL BE EQUIPPED WITH A FILTER WRAP INLET SCREEN. WHEN SO EQUIPPED PUMP DISCHARGE TO EXISTING SEWER MANHOLE IS ACCEPTABLE.
6. SEDIMENT CONTROL PRACTICES SHALL BE FUNCTIONAL THROUGHOUT PHASES OF EARTH DISTURBING ACTIVITY AND SHALL CONTINUE TO FUNCTION UNTIL DISTURBED AREA IS PERMANENTLY RESTABILIZED.
7. INLET FILTERS SHALL BE INSTALLED AT ALL INLETS AND CATCH BASINS. FILTERS TO REMAIN IN PLACE UNTIL PAVING OCCURS.
8. DISTURBED AREAS WITHIN THE SITE NOT PAVED OR OTHERWISE TO BE LEFT UNDISTURBED FOR 30 DAYS OR MORE SHALL BE TEMPORARILY SEEDED, FERTILIZED AND MULCHED, TO BE APPLIED WITHIN NO MORE THAN SEVEN (7) DAYS AFTER COMPLETION OF EARTHWORK OPERATIONS.
9. EROSION CONTROL SHALL BE INSPECTED BY WAYNE COUNTY DEPARTMENT OF ENVIRONMENT PRIOR TO COMMENCING WITH CONSTRUCTION.
10. SEDIMENT CAUSED BY ACCELERATED SOIL EROSION SHALL BE REMOVED FROM RUNOFF WATER BEFORE IT LEAVES THE SITE.
11. MEASURES SHALL BE TAKEN TO PREVENT SOIL TRANSPORT ONTO SURFACES WHERE RUNOFF IS NOT CHECKED BY SEDIMENT CONTROLS, OR ONTO PUBLIC ROADS. WHERE SOIL IS TRANSPORTED ONTO A PUBLIC ROAD SURFACE, THE ROAD SHALL BE CLEANED THOROUGHLY AT THE END OF EACH DAY, OR MORE FREQUENTLY AS NECESSARY. SOIL SHALL BE REMOVED FROM PAVED SURFACES BY SHOVELING OR SWEEPING. STREET WASHING SHALL BE ALLOWED ONLY AFTER MOST SEDIMENT HAS BEEN REMOVED BY SHOVELING OR SWEEPING.
12. THE ABOVE SPECIFIED EROSION CONTROL STANDARDS ARE GENERAL GUIDELINES AND SHALL NOT LIMIT THE RIGHT OF THE CITY OR THE COUNTY TO IMPOSE, AT ANY TIME, ADDITIONAL, MORE STRINGENT REQUIREMENTS, NOR SHALL THE STANDARDS LIMIT THE RIGHT OF THE CITY OR COUNTY TO WAIVE, IN WRITING, INDIVIDUAL REQUIREMENTS.
13. CONTRACTOR SHALL COORDINATE WORK WITH THE CONSTRUCTION MANAGER AND OTHER CONTRACTORS.

GENERAL SITE/DEMOLITION NOTES:

1. THE GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR THE FOLLOWING:

A-OBTAINING NECESSARY SOIL EROSION AND SEDIMENTATION CONTROL PERMIT, PLACEMENT AND MAINTENANCE OF SOIL EROSION SEDIMENTATION CONTROL MEASURES.

B-COORDINATING ALL SITE WORK WITH DWSO.

C-LOCATION AND EXTENT OF PROJECT FENCING.

D-LOCATION AND EXTENT OF CONSTRUCTION SPOILS AND STAGING AREAS.

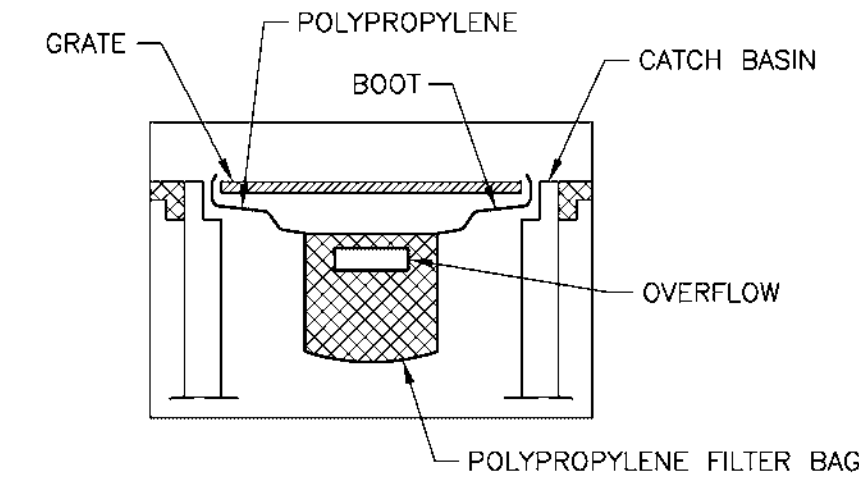
E-LOCATION OF SAWCUTTING/REMOVING EXISTING CURBS, GUTTERS, WALKS AND PAVEMENT.

F-COORDINATING REMOVAL AND/OR TEMPORARY RELOCATION OF EXISTING TREES.

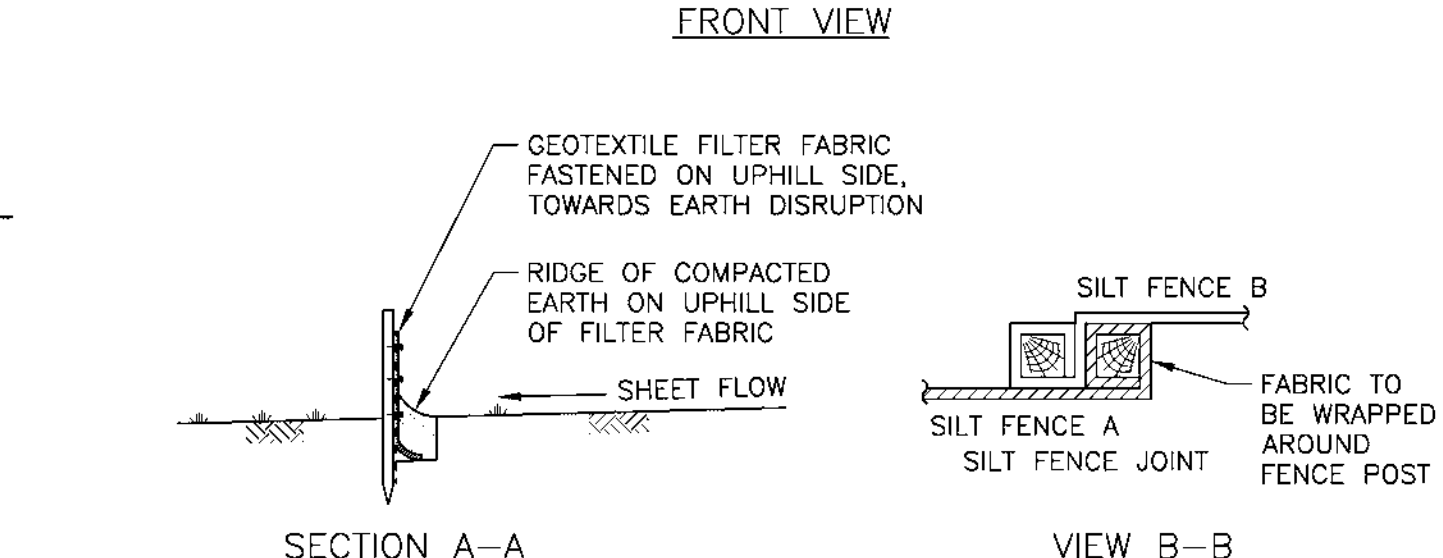
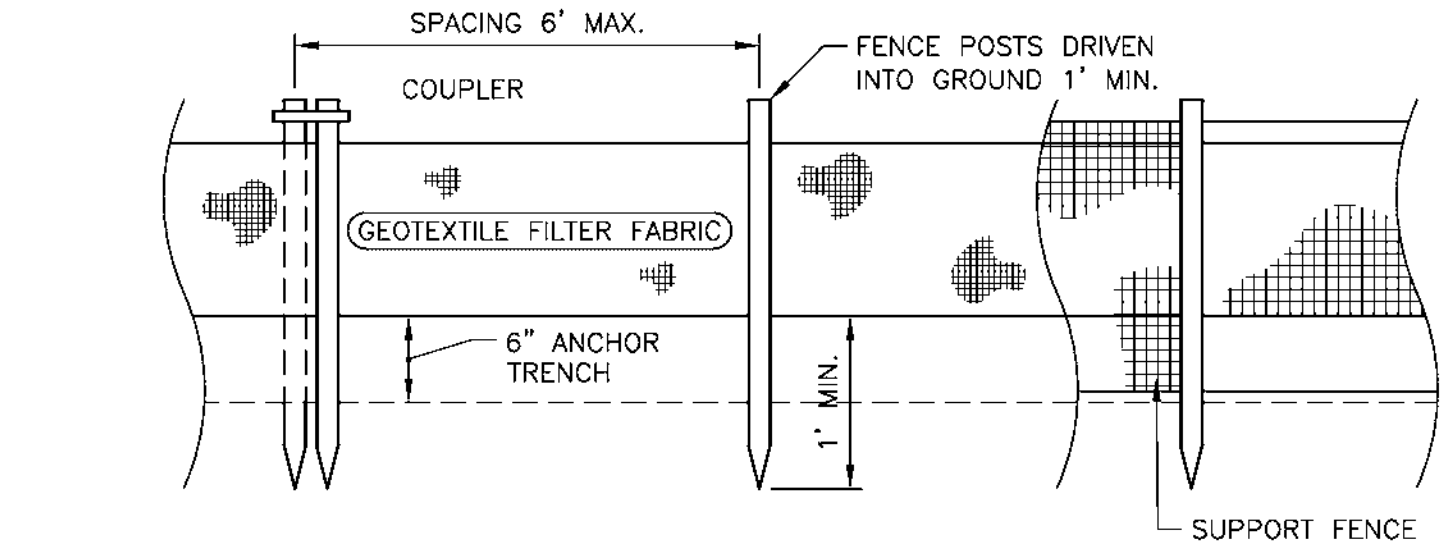
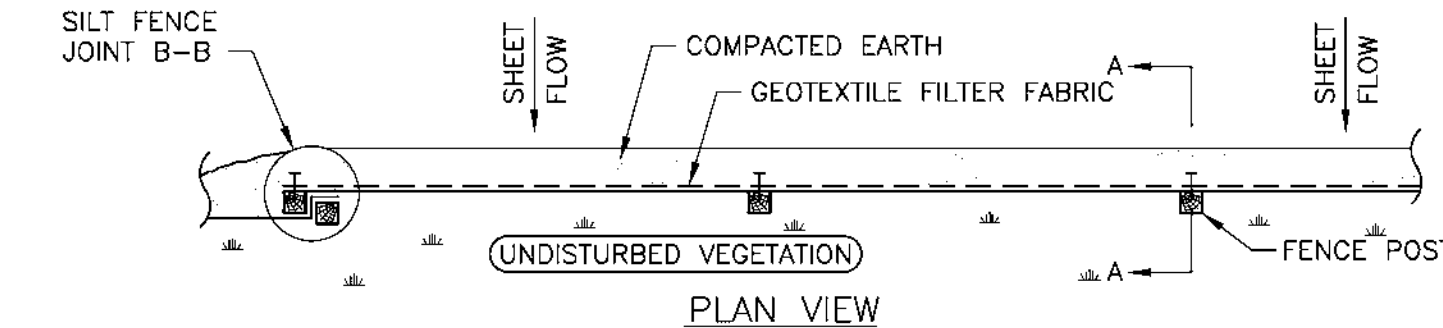
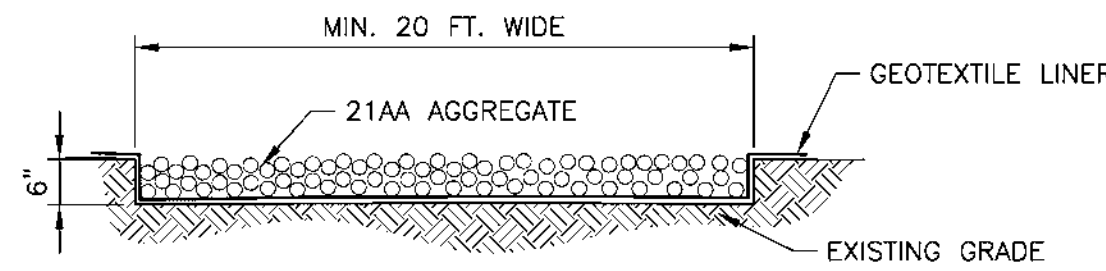
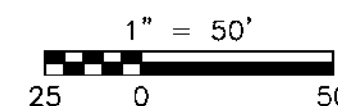
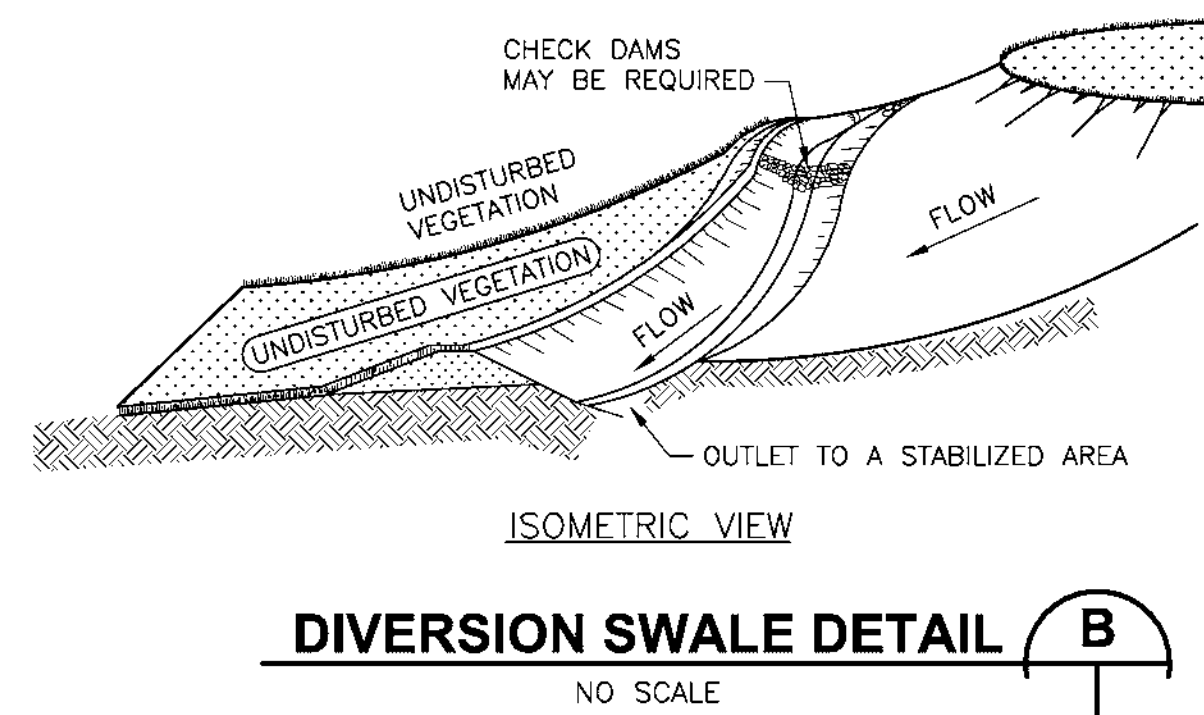
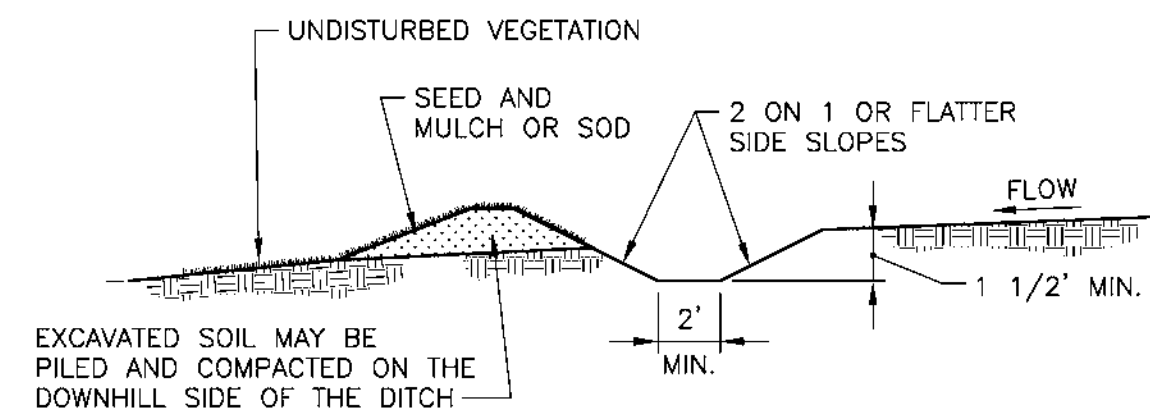
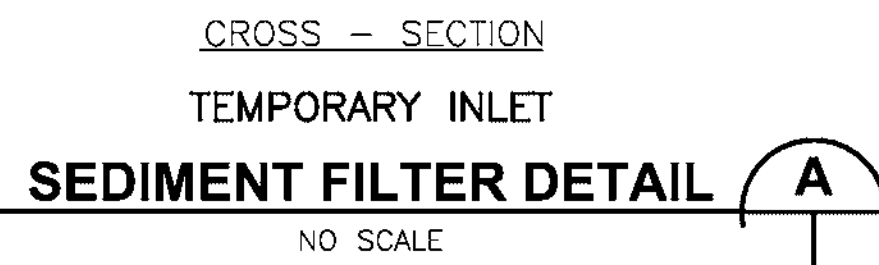
SOIL EROSION CONTROL SEQUENCE OF CONSTRUCTION

START DATE	END DATE
-/-/-	-/-/-
-/-/-	-/-/-
-/-/-	-/-/-
-/-/-	-/-/-
-/-/-	-/-/-
-/-/-	-/-/-
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-/-/-	-/-/-
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-/-/-	-/-/-

1. STONE TRACKING PAD ATOP GEOTEXTILE LINER (MUD-MAT).
2. INSTALL SILT FENCING AND PROTECTIVE FENCING.
3. GRADE AND BALANCE AS REQUIRED.
4. EXCAVATE
5. INSTALL UNDERGROUND UTILITIES.
6. PLACE INLET FILTERS.
7. INSTALL ALL PUBLIC UTILITIES COMPLETE.
8. INSTALL PAVEMENT COMPLETE.
9. ESTABLISH RESTORATION FOR ALL DISTURBED AREAS WITHIN ROAD R.O.W.S.
10. CLEAN OUT STORM SEWERS SYSTEM.
11. CLEAN OUT & RESTORE SEDIMENT/OIL/WATER SEPARATOR TO DESIGN SPECS.
12. REMOVE SILT FENCE AND CATCH BASIN FILTERS FOLLOWING W.C.D.O.E. APPROVAL (CALL FOR FINAL INSPECTION)



NOTE: TEMPORARY INLET SEDIMENT FILTER TO BE INSTALLED ON ALL PAVED CATCH BASINS OR STORM INLETS. INLET FILTER TO BE SIMILAR TO "STREAMGUARD" AS MANUFACTURED BY STORMWATER SERVICES CORP. (206-767-0441) OR "SILTSACK" AS MANUFACTURED BY ATLANTIC CONSTRUCTION FABRICS, INC. (800-448-3636) CLEAN FILTERS AS NEEDED.



RECORD DRAWING

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By DUANE D. DeDENE Date 08/2012

CDM Smith

DESIGN	MEL
DRAFTING	MV
CHECKED	BB
APPROVED	AG
NO.	
DESCRIPTION	
REVISIONS	

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

SITE PREPARATION AND SOIL EROSION PLAN
OVERALL SITE LAYOUT - PUMP STATION & CSO BASINS

SCALE: AS NOTED DATE: DECEMBER 15, 2006

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hiltonanderson
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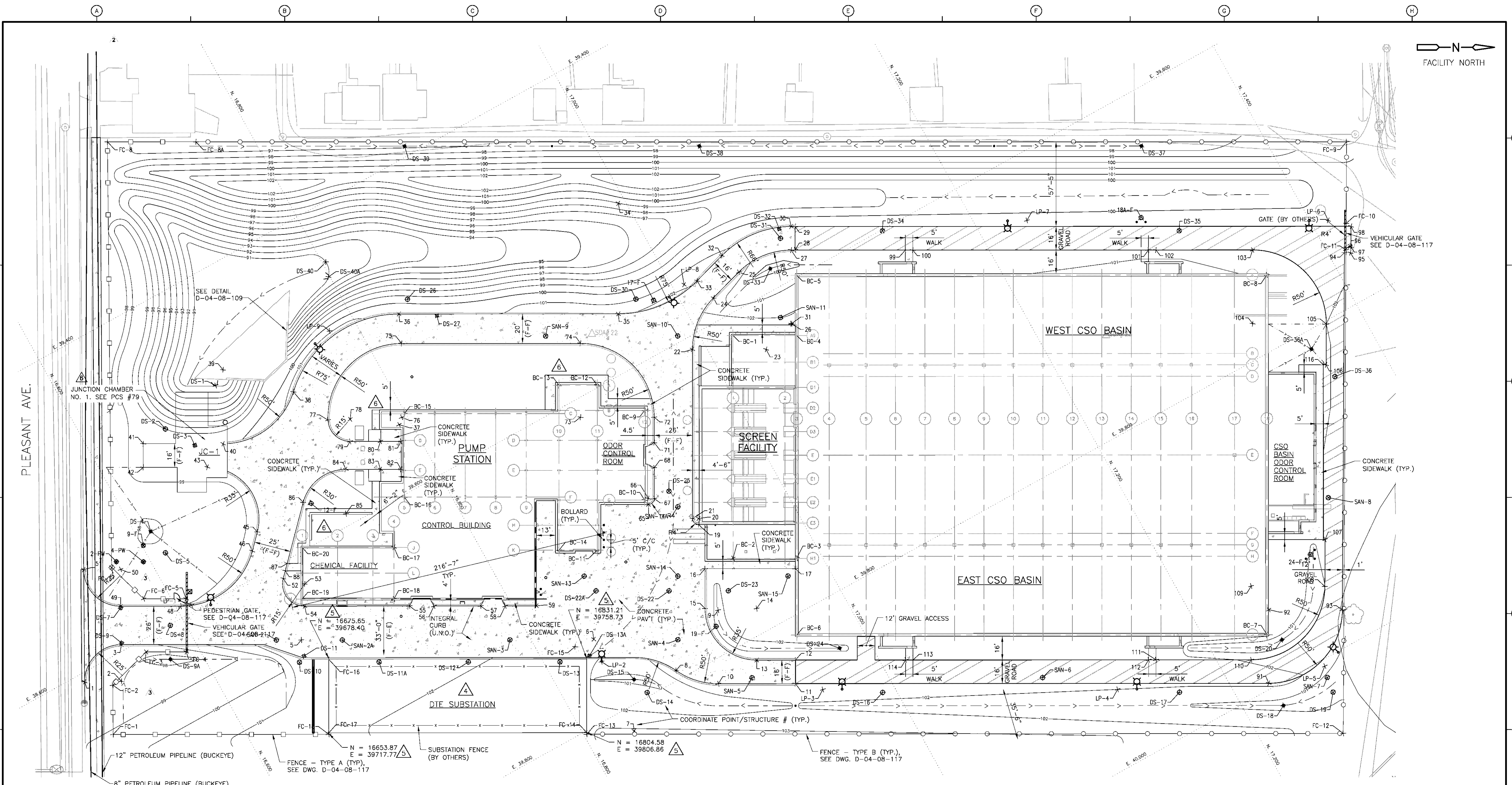
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Phone: 313-964-7765, Fax: 313-964-7762

CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

M.D.P.H./D.N.R. PERMIT NO.
FAMIS NO.
CONTRACT NO. PC-755
FILE NO. CSTPL102.DWG
DRAWING NO. D-04-08-102



- NOTES:
- FOR PROJECT COORDINATES DESCRIPTIONS, NORTHINGS AND EASTINGS, SEE SHEETS D-04-08-104A AND D-04-08-104B.
 - COORDINATES AND DIMENSIONS ARE TO THE FACE OF CURB OR BUILDING COLUMN COORDINATES, SEE TABLE ON SHEET D-04-08-104A (U.N.O.)
 - FOR SIGNS ON VEHICULAR GATE SEE DETAIL DRAWING D-04-08-124.
- NOTE: ADDED PETROLEUM PIPELINE FROM BUCKEYE RECORDS

PLAN
1" = 30'

3 WORKING DAYS BEFORE YOU DIG CALL MISS DIG. 1-800-482-7171

For free location of public utility lines, ALTERNATE NUMBER (810) MISS-DIG COLOR CODES FOR UTILITY LOCATING:

Yellow	OIL & GAS	Blue	WATER
Orange	PURGE & CATV	Green	STORM DRAIN
Red	ELECTRIC	Brown	SEWER
		Pink	SURVEYING

IF YOU ARE GOING TO WORK NEAR OVERHEAD WIRE, CALL VESS DIG

- NOTES:
- FOR INTEGRAL CURB DETAIL-SEE DETAIL "C" DRAWING NO. D-04-08-106.
 - FOR INTEGRAL CURB W/SIDEWALK DETAIL-SEE DETAIL "B" DRAWING NO. D-04-08-106.
 - FOR CONCRETE SIDEWALK DETAIL-SEE DETAIL "D" DRAWING NO. D-04-08-106.
 - FOR CONCRETE PAVEMENT DETAIL-SEE DETAIL "A" DRAWING NO. D-04-08-106.
 - FOR GRAVEL ROAD DETAIL-SEE DETAIL "E" DRAWING NO. D-04-08-106.

RECORD DRAWING

THIS RECORD DRAWING HAS BEEN PREPARED BASED ON A COMBINATION OF INFORMATION PROVIDED BY OTHERS AND BY CDM SMITH. THEREFORE, THE ENGINEER HAS NOT VERIFIED THE ACCURACY OF ALL THE INFORMATION. TO THE BEST OF THE ENGINEER'S BELIEF AND KNOWLEDGE, THE INCLUDED RECORD INFORMATION IS REASONABLY ACCURATE.

By DUANE D. DeDENE Date 08/2012

CDM Smith

REVISED FOR RECORD		8/12	DDD	DESIGN	KJ
CDM DIRECTIVE		8/12	DDD	DRAFTING	MV
RFI # 00363		8/12	DDD		
RFI # 00228		8/12	DDD		
2	REVISED PER BULLETIN NO. 3	3/14	AG	CHECKED	BB
1	REVISED PER BULLETIN NO. 2	2/07	AG		
DESCRIPTION		NO.	DATE	APPROVED	AG
REVISIONS					

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

SITE LAYOUT PLAN FOR FACILITY LOCATIONS

SCALE: 1" = 30'

DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc. One Woodward Avenue, Suite 1500 Detroit, MI 48226 Tel: (313) 963-1313 Fax: (313) 963-1313 www.cdm-michigan.com	hamiltonanderson Hamilton Anderson Associates 1430 Franklin Ave., Suite 200, Detroit, MI 48226 Tel: (313) 963-1313 Fax: (313) 963-1313 www.hamilton-anderson.com	Applied Science, Inc. 300 W. Congress St., Suite 410 Detroit, MI 48226 Phone: (313) 963-1313, Fax: (313) 963-1313	TUCKER, YOUNG, JACKSON, TULL, INC. CONSULTING ENGINEERS PLANNERS 1430 Franklin Ave., Suite 200, Detroit, MI 48226 Tel: (313) 963-1313, Fax: (313) 963-1313	Associates Inc. 120 W. Congress St., Suite 410 Detroit, MI 48226 Phone: (313) 963-1313, Fax: (313) 963-1313	SIGMA CONSULTING ENGINEERS 120 W. Congress St., Suite 410 Detroit, MI 48226 Phone: (313) 963-1313, Fax: (313) 963-1313	SUPERIOR ENGINEERING ASSOC., INC. 55 Grosse Pointe Ave., Suite 200, Detroit, MI 48226 Tel: (313) 963-1313, Fax: (313) 963-1313 www.superior-engineering.com	SOMAT Engineering, Inc. 600 Woodward Ave., Suite 1200, Detroit, MI 48226 Tel: (313) 963-1313, Fax: (313) 963-1313 www.somat-engineering.com	CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION	M.D.P.H./D.N.R. PERMIT NO. FAMIS NO. CONTRACT NO. PC-755 FILE NO. CSTPL103.DWG DRAWING NO. D-04-08-103
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PAVEMENT COORDINATE TABLE			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
1	16,521.29	39,605.78	PC 25' RAD.
2	16,543.26	39,617.72	CNTR 25' RAD.
3	16,555.36	39,595.84	PT 25' RAD. △
4	16,639.66	39,642.48	TRANSITION OF PVMT
5	16,658.48	39,663.18	TRANSITION OF PVMT
6	16,855.33	39,772.08	PC 50' RAD.
7	16,831.13	39,815.83	CNTR 50' RAD.
8	16,875.98	39,793.74	PRC 50' RAD.
9	16,920.84	39,771.66	CNTR 50' RAD.
10	16,896.68	39,815.43	PT 50' RAD.
11	16,942.48	39,840.72	END CONC. PVMT
12	16,950.23	39,826.72	END CONC. PVMT
13	16,927.20	39,813.98	PC 35' RAD.
14	16,944.14	39,783.35	CNTR 35' RAD.
15	16,913.52	39,766.40	PT 35' RAD.
16	16,926.60	39,742.77	EDGE OF SIDEWALK
17	16,980.26	39,772.48	EDGE OF SIDEWALK
19	16,937.70	39,714.63	PC 4' RAD.
20	16,939.20	39,710.89	CNTR 4' RAD.
21	16,935.70	39,708.95	PT 4' RAD.
22	16,991.24	39,608.60	PC 50' RAD.
23	17,034.99	39,632.81	CNTR 50' RAD.
24	17,020.76	39,584.88	PT 50' RAD.
25	17,044.07	39,577.96	PC 50' RAD.
26	17,058.30	39,625.89	CNTR 50' RAD.
27	17,082.46	39,582.12	PT 50' RAD.
28	17,084.86	39,583.44	END CONC. PVMT
29	17,092.60	39,569.44	END CONC. PVMT
30	17,090.20	39,568.12	PT 66' RAD.
31	17,058.30	39,625.89	CNTR 66' RAD.
32	17,039.51	39,562.62	PT 66' RAD.
33	17,016.62	39,569.42	PC 75' RAD.
34	16,995.28	39,497.52	CNTR 75' RAD.
35	16,958.95	39,563.14	PT 75' RAD.
36	16,828.69	39,491.04	PC 75' RAD.
37	16,792.37	39,556.66	CNTR 75' RAD.
38	16,740.52	39,502.47	PRC 50' RAD.
39	16,705.95	39,466.34	CNTR 50' RAD.
40	16,681.74	39,510.09	PT 50' RAD.

O'BRIEN DRAIN COORDINATE TABLE			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
OB-1	17,672.73	40,272.61	PC 50' RAD.
OB-2	17,701.27	40,231.55	CNTR 50' RAD.
OB-3	17,689.91	40,280.25	PT 50' RAD.
OB-4	17,708.17	40,284.51	PC 50' RAD.
OB-5	17,696.81	40,333.20	CNTR 50' RAD.
OB-6	17,731.14	40,296.84	PT 50' RAD.
OB-7	17,659.98	40,292.97	PC 50' RAD.
OB-8	17,688.52	40,251.91	CNTR 50' RAD.
OB-9	17,675.00	40,300.05	PT 50' RAD.
OB-10	17,689.84	40,304.22	PC 50' RAD.
OB-11	17,676.32	40,352.36	CNTR 50' RAD.
OB-12	17,710.65	40,316.00	PT 50' RAD.

PAVEMENT COORDINATE TABLE (CONT.)			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
41	16,634.35	39,483.85	END OF CURB
42	16,626.60	39,497.85	END OF CURB
43	16,664.67	39,518.93	PC 35' RAD.
44	16,647.72	39,549.55	CNTR 35' RAD.
45	16,673.03	39,573.73	PT 35' RAD.
46	16,663.74	39,583.45	PC 50' RAD.
47	16,627.58	39,548.91	CNTR 50' RAD.
48	16,603.37	39,592.66	PT 50' RAD.
49	16,567.45	39,572.78	PC 25' RAD.
50	16,579.55	39,550.91	CNTR 25' RAD.
51	16,557.58	39,538.97	PT 25' RAD. △
52	16,673.15	39,609.80	PT 15' RAD.
53	16,683.99	39,620.16	CNTR 15' RAD.
54	16,676.73	39,633.28	PC 15' RAD.
55	16,738.92	39,667.69	CURB POINT
56	16,753.51	39,675.76	CURB POINT
57	16,781.20	39,691.07	CURB POINT
58	16,795.79	39,699.14	CURB POINT
59	16,814.28	39,709.37	CURB POINT
65	16,914.13	39,685.96	PT 4' RAD.
66	16,916.07	39,682.47	CNTR 4' RAD.
67	16,919.57	39,684.40	PC 4' RAD.
68	16,929.60	39,666.27	CURB POINT
71	16,937.95	39,651.20	CURB POINT
72	16,946.29	39,636.14	PT 50' RAD.
73	16,902.54	39,611.92	CNTR 50' RAD.
74	16,926.75	39,568.18	PC 50' RAD.
75	16,820.60	39,509.43	PT 50' RAD.
76	16,796.39	39,553.18	CNTR 50' RAD.
77	16,751.76	39,530.64	PC 50' RAD.
78	16,765.14	39,537.40	CNTR 15' RAD.
79	16,757.88	39,550.52	PT 15' RAD.
80	16,775.84	39,560.46	EDGE OF SIDEWALK
81	16,788.16	39,567.28	EDGE OF SIDEWALK
82	16,778.96	39,583.91	EDGE OF SIDEWALK

O'BRIEN DRAIN COORDINATE TABLE (CONT.)			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
OB-13	17,770.95	40,334.44	PC 50' RAD.
OB-14	17,805.28	40,298.09	CNTR 50' RAD.
OB-15	17,780.80	40,341.68	PT 50' RAD.
OB-16	18,028.83	40,496.01	CNTR DRAIN
OB-17	18,286.71	40,660.17	CNTR DRAIN AT 5+00

ACCESS DRIVE COORDINATE TABLE			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
AD-1	17,785.91	40,422.85	CNTR OF DRIVE
AD-2	18,161.59	40,630.77	PC 20' RAD.
AD-3	18,151.90	40,648.27	CNTR 20' RAD.
AD-4	18,169.52	40,638.80	PT 20' RAD.

PAVEMENT COORDINATE TABLE (CONT.)			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
83	16,766.64	39,577.08	EDGE OF SIDEWALK
84	16,746.16	39,565.75	PT 30' RAD.
85	16,731.64	39,592.00	CNTR 30' RAD.
86	16,709.94	39,571.28	PC 30' RAD.
87	16,680.44	39,602.16	EDGE OF SIDEWALK
88	16,676.87	39,605.90	EDGE OF SIDEWALK
91	17,223.45	39,996.24	PT 50' RAD.
92	17,247.67	39,952.50	CNTR 50' RAD.
93	17,291.26	39,976.98	PC 50' RAD.
94	17,409.97	39,765.64	PC 4' RAD.
95	17,413.45	39,767.60	CNTR 4' RAD.
96	17,415.41	39,764.11	PT 4' RAD.
97	17,415.80	39,764.33	END OF GRAVEL DRIVE
98	17,422.53	39,752.20	END OF GRAVEL DRIVE
99	17,150.27	39,619.70	EDGE OF SIDEWALK
100	17,154.65	39,622.12	EDGE OF SIDEWALK
101	17,294.57	39,699.61	EDGE OF SIDEWALK
102	17,298.95	39,702.04	EDGE OF SIDEWALK
103	17,356.38	39,733.85	PC 50' RAD.
104	17,332.15	39,777.58	CNTR 50' RAD.
105	17,375.74	39,802.07	PT 50' RAD.
106	17,362.20	39,826.18	EDGE OF GRAVEL DRIVE
107	17,304.18	39,929.48	EDGE OF GRAVEL DRIVE
108	17,288.60	39,957.22	PC 50' RAD.
109	17,245.00	39,932.74	CNTR 50' RAD.
110	17,220.79	39,976.48	PT 50' RAD.
111	17,164.27	39,945.20	EDGE OF SIDEWALK
112	17,159.90	39,942.78	EDGE OF SIDEWALK
113	17,020.02	39,865.35	EDGE OF SIDEWALK
114	17,015.64	39,862.93	EDGE OF SIDEWALK
115	17,303.16	39,928.92	EDGE OF SIDEWALK
116	17,360.54	39,825.25	EDGE OF SIDEWALK

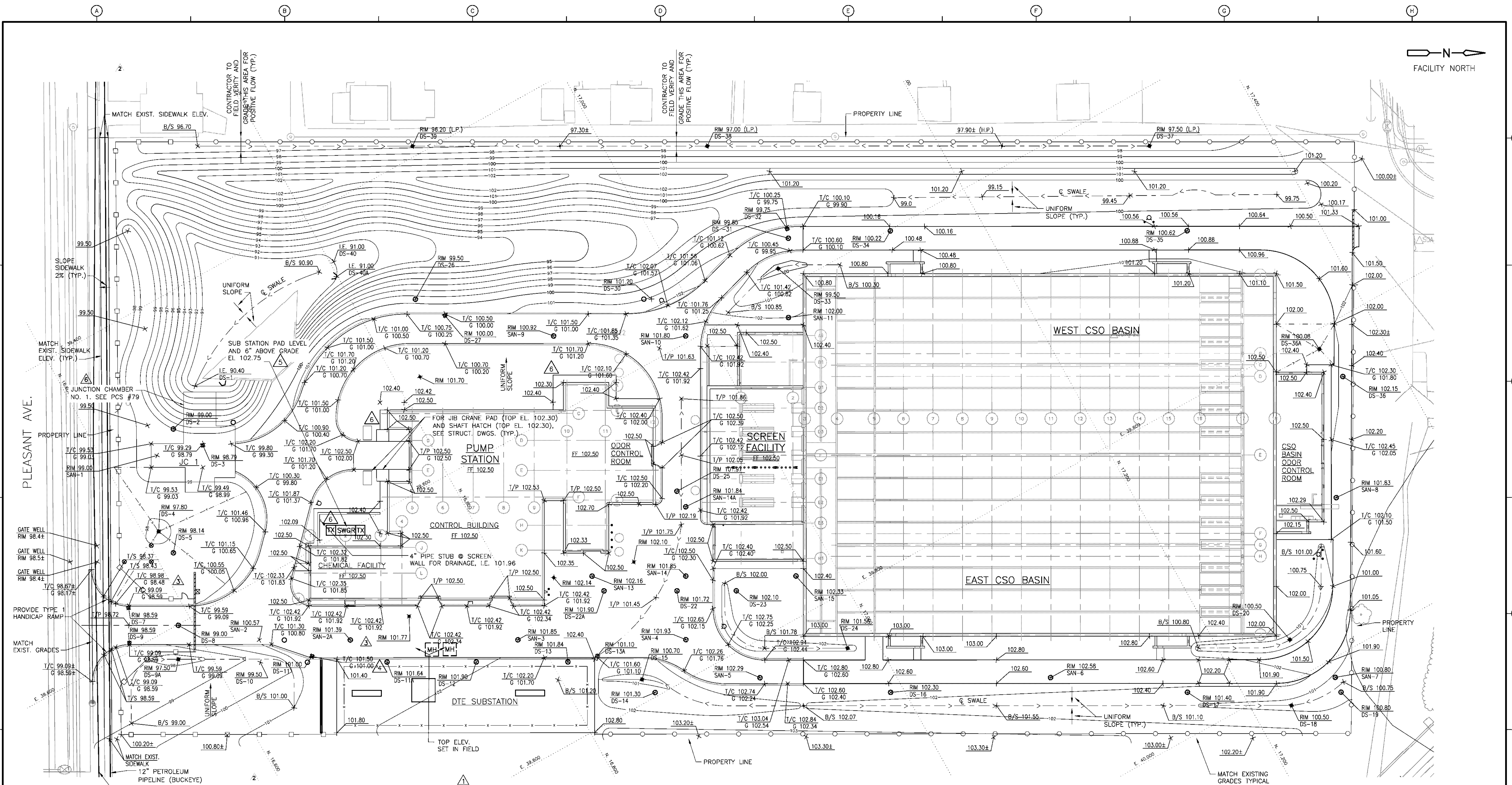
SITE LIGHT POLE COORDINATE TABLE			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
LP-1	16,626.73	39,639.90	BASE OF LP-1
LP-2	16,805.02	39,748.82	BASE OF LP-2
LP-3	16,956.80	39,853.22	BASE OF LP-3
LP-4	17,131.78	39,950.07	BASE OF LP-4
LP-5	17,262.42	40,004.44	BASE OF LP-5
LP-6	17,410.91	39,741.19	BASE OF LP-6
LP-7	17,232.06	39,642.12	BASE OF LP-7
LP-8	17,007.59	39,567.45	BASE OF LP-8
LP-9	16,781.97	39,478.34	BASE OF LP-9

ACCESS DRIVE COORDINATE TABLE (CONT.)			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
AD-5	18,177.93	40,654.45	PC 20' RAD.
AD-6	18,195.55	40,644.98	CNTR 20' RAD.
AD-7	18,186.21	40,662.67	PT 20' RAD.
AD-8	18,234.66	40,688.24	CNTR END OF DRIVE

FENCE COORDINATE TABLE			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
FC-1	16,520.87	39,646.49	CORNER OF FENCE
FC-2	16,536.85	39,616.99	CORNER OF FENCE
FC-3	16,567.57	39,608.28	CORNER OF FENCE
FC-4	16,591.37	39,621.45	FENCE AT GATE
FC-5	16,608.77	39,589.94	FENCE AT GATE
FC-6	16,583.57	39,575.99	CORNER OF FENCE
FC-7	16,574.88	39,546.78	CORNER OF FENCE
FC-8	16,712.36	39,293.01	CORNER OF FENCE
FC-8A	16,764.84	39,322.10	TRANSITION OF FENCE
FC-9	17,447.69	39,700.60	CORNER OF FENCE
FC-10	17,420.57	39,748.87	FENCE AT GATE
FC-11	17,411.76	39,764.57	FENCE AT GATE
FC-12	17,251.17	40,050.48	CORNER OF FENCE
FC-13	16,773.23	39,786.09	CORNER OF FENCE
FC-14	16,775.40	39,782.15	CORNER OF FENCE
FC-15	16,794.77	39,747.15	CORNER OF FENCE
FC-16	16,654.76	39,669.70	FENCE AT WALL
FC-17	16,635.40	39,704.70	FENCE AT WALL
FC-18	16,633.22	39,708.64	CORNER OF FENCE

BUILDING COLUMN COORDINATE TABLE			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
BC-1	17,019.84	39,613.67	SCREEN FACILITY ⊗ COL. A9/1
BC-2	16,946.66	39,745.88	SCREEN FACILITY ⊗ COL. H1/1
BC-3	16,984.50	39,766.82	SCREEN FACILITY ⊗ COL. H1/3
BC-4	17,057.68	39,634.62	SCREEN FACILITY ⊗ COL. A9/3
BC-5	17,077.48	39,598.84	CSO BASINS ⊗ COL. A/3
BC-6	16,959.32	39,812.32	CSO BASINS ⊗ COL. J/3
BC-7	17,238.41	39,966.81	CSO BASINS ⊗ COL. J/18
BC-8	17,356.58	39,753.33	CSO BASINS ⊗ COL. A/18
BC-9	16,942.79	39,628.97	CSO BASINS ODOR CONTROL ROOM ⊗ COL. B/12
BC-10	16,913.33	39,682.19	CSO BASINS ODOR CONTROL ROOM ⊗ COL. G/12
BC-11	16,868.84	39,696.33	PUMP STATION ⊗ COL. K/11
BC-12	16,922.92	39,598.63	PUMP STATION ⊗ COL. A/11
BC-13	16,900.17	39,586.04	PUMP STATION ⊗ COL. A/10
BC-14	16,846.09	39,683.73	PUMP STATION ⊗ COL. K/10
BC-15	16,799.18	39,551.85	PUMP STATION ⊗ COL. C/5
BC-16	16,771.73	39,601.43	PUMP STATION ⊗ COL. F/5
BC-17	16,749.06	39,627.76	CHEMICAL FACILITY ⊗ COL. J/4
BC-18	16,732.11	39,658.38	CHEMICAL FACILITY ⊗ COL. M/4
BC-19	16,677.57	39,628.20	CHEMICAL FACILITY ⊗ COL. M/1
BC-20	16,694.52	39,597.58	CHEMICAL FACILITY ⊗ COL. J/1

FIRE, POTABLE, AND SECONDARY WATER COORDINATE TABLE			
POINT #	COORDINATES		DESCRIPTION
	NORTHING	EASTING	
1-PW	16,543.85	39,525.44	16"x16"x12" TEE
2-PW	16,547.44	39,527.35	12" VALVE & WELL
3-PW	16,557.35	39,532.91	12"x10"x10" TEE
4-PW	16,563.47	39,536.29	10" VALVE & WELL
5-PW	16,583.90	39,547.60	10" 22 1/2' BEND
6-PW	16,662.05	39,645.73	10" 22 1/2' BEND
7-PW	16,801.33	39,722.78	10" 90° BEND
8-F	16,562.60	39,523.24	10" 90° BEND
9-F	16,568.72	39,526.63	10" VALVE & WELL
10-F	16,577.42	39,531.44	10" 22 1/2' BEND
11-F	16,651.55	39,624.51	10"x8"x6" TEE
12-F	16,714.39	39,574.46	FIRE HYDRANT
13-F	16,666.97	39,643.88	8" 22 1/2' BEND
14-F	16,795.32	39,714.88	8"x8"x6" TEE
15-F	16,882.78	39,763.26	8"x8"x6" TEE
16-F	16,989.90	39,569.74	6"x6"x6" TEE
16A-F	16,995.66	39,559.33	6" 45° BEND
17-F	16,984.34	39,566.66	FIRE HYDRANT
17A-F	17,055.49	39,542.14	6" 45° BEND
18-F	16,896.78	39,771.01	8"x6"x6" TEE
18A-F	17,300.85	39,677.94	FIRE HYDRANT
19-F	16,914.26	39,780.68	FIRE HYDRANT
20-F	16,892.97	39,779.89	6" 22 1/2' BEND
21-F	16,920.64	39,812.63	6" 22 1/2' BEND
22-F	17,237.91	39,988.25	6" 45° BEND
23-F	17,263.84	39,980.88	6" 45° BEND
24-F	17,290.53	39,933.36	FIRE HYDRANT
25-F	16,663.10	39,615.31	6"x6"x4" TEE
26-F	16,666.50	39,619.60	4" 22 1/2' BEND
25-SW	16,675.65	39,502.15	8" 90° BEND
26-SW	16,666.52	39,619.60	8"x6"x6" TEE
27-SW	16,642.75	39,561.59	8" 22 1/2' BEND
28-SW	16,638.40	39,599.98	8" 45° BEND
29-SW	16,671.89	39,642.03	8" 22 1/2' BEND
30-SW	16,802.58	39,714.33	8" 90° BEND
31-PW	16,807.40	39,716.99	6" 90° BEND
32-PW	16,902.21	39,769.44	6"x3"x6" TEE
33-PW	16,922.62	39,732.57	6" 90° BEND
34-PW	16,919.47	39,778.99	3" 45° BEND
35-PW	16,929.58	39,814.14	3" 45° BEND
36-PW	17,235.80	39,983.65	3" 45° BEND
37-PW	17,293.24	39,967.33	3" 45° BEND
37A-PW	17,328.67	39,904.25	3" 90° BEND
38-SW	16,923.10	39,773.52	2" 45° BEND
39-SW	16,934.59	39,813.49	2" 45° BEND
40-SW	17,012.83	39,856.80	2"x2"x2" TEE
41-SW	17,171.02	39,944.36	2" 90° BEND
42-SW	17,026.16	39,586.98	2" 45° BEND
43-SW	17,071.62	39,573.92	2" 45° BEND
44-SW	17,146.62	39,615.44	2"x2"x2" TEE
45-SW	17,304.67	39,702.92	2" 90° BEND



PLAN

1" = 30'

2.

NOTE: ADDED PETROLEUM PIPELINE
FROM BUCKEYE RECORDS

	REVISED FOR RECORD		8/12	DDD	
	CDM DIRECTIVE	△	8/12	DDD	DESIGN
	RFI # 00351	△	8/12	DDD	KJ
	RFI # 00318	△	8/12	DDD	DRAFTING
3	REVISED PER BULLETIN NO. 3	△	3/07	AG	MV
2	REVISED PER BULLETIN NO. 2	△	2/07	AG	CHECKED
1	REVISED PER BULLETIN NO. 1	△	1/07	AG	BB
NO.	DESCRIPTION	NO.	DATE	APRVD	APPROVED
REVISIONS					AG

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION
FINISHED SITE GRADING AND DRAINAGE PLAN

SCALE: 1" = 30' DATE: DECEMBER 15, 2006

3 WORKING DAYS BEFORE YOU DIG CALL MISS DIG. 1-800-482-7171

ALTERNATE NUMBER (810) WISS-DIG

COLOR CODES FOR UTILITY LOCATING:

Yellow	OIL & GAS	Blue	WATER
Orange	PHONE & CATV	Green	STORM DRAIN
Red	ELECTRIC	Brown	SEWER
		Pink	SURVEYING

IF YOU ARE GOING TO WORK NEAR OVERHEAD WIRES - CALL VESS INC.

1" = 30'

15 0 30

RECORD DRAWING

THIS RECORD DRAWING HAS BEEN PREPARED BASED ON A COMBINATION OF INFORMATION PROVIDED BY OTHERS AND BY CDM SMITH. THEREFORE, THE ENGINEER HAS NOT VERIFIED THE ACCURACY OF ALL THE INFORMATION. TO THE BEST OF THE ENGINEER'S BELIEF AND KNOWLEDGE, THE INCLUDED RECORD INFORMATION IS REASONABLY ACCURATE.

By DUANE D. DeDENE Date 08/2012

CDM Smith

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CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP TOWN RANGE SECTION PORTION CODE

SECTION MAP TOWN RANGE SECTION PORTION CODE

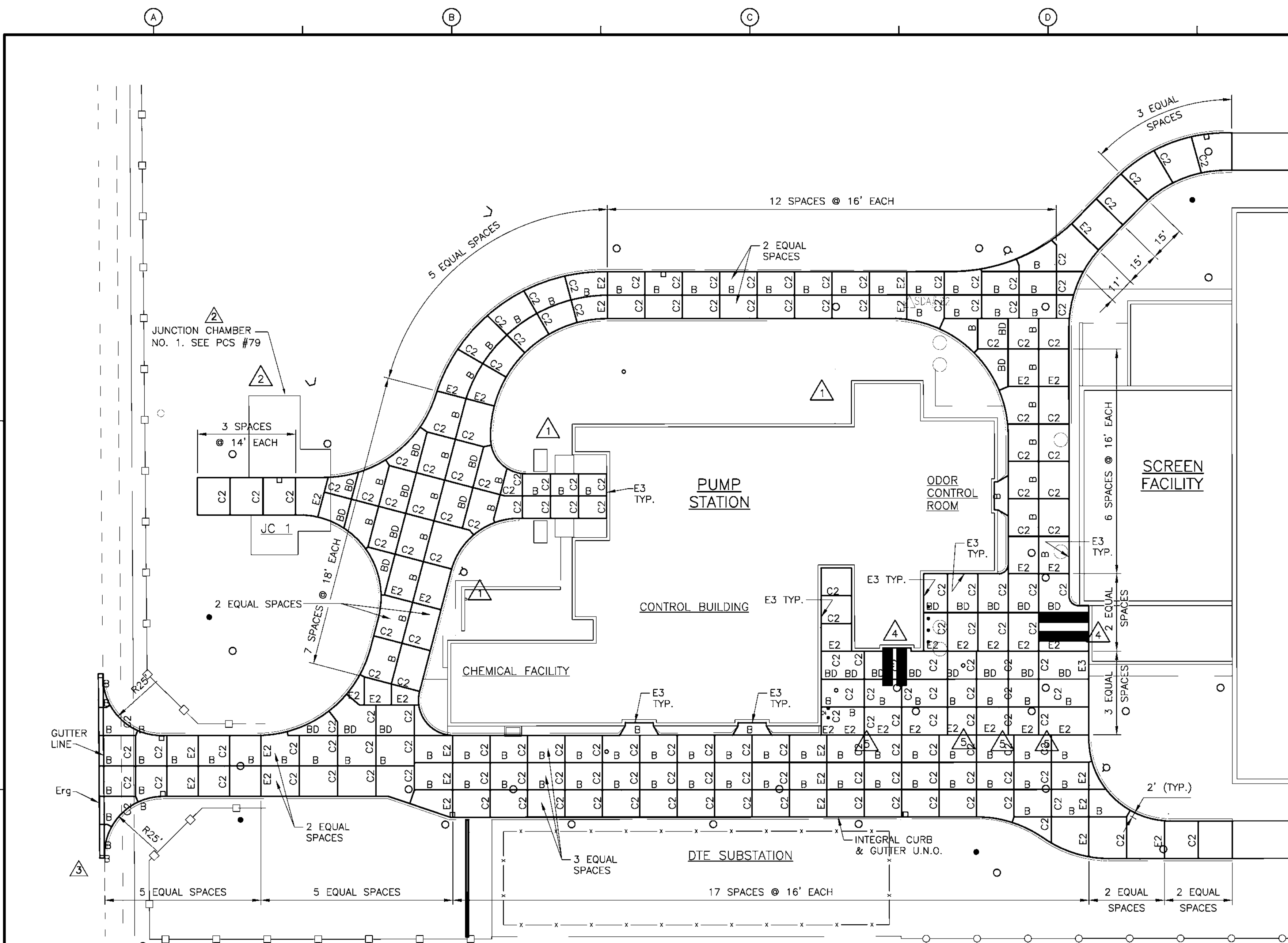
M.D.P.H./D.N.R. PERMIT NO.

FAMIS NO.

CONTRACT NO. **PC-755**

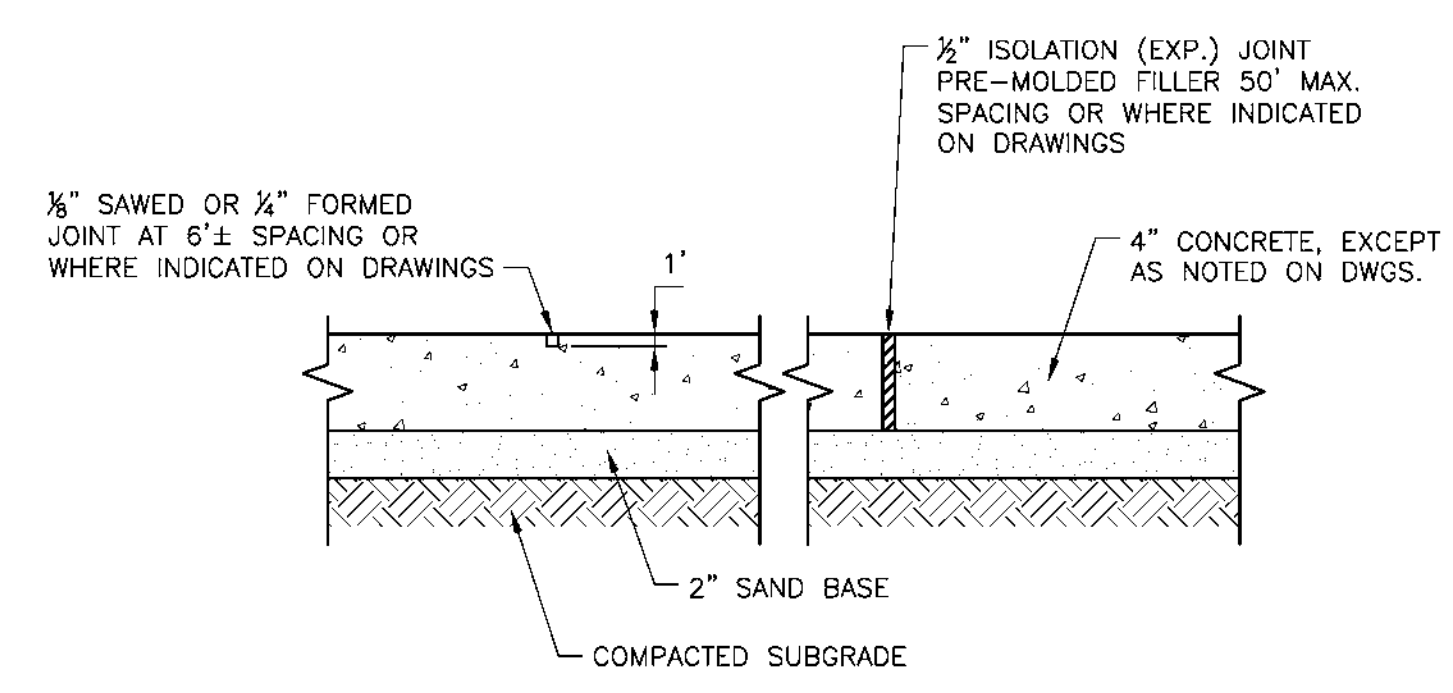
FILE NO. **CSTPL105.DWG**

DRAWING NO. **D-04-08-105**

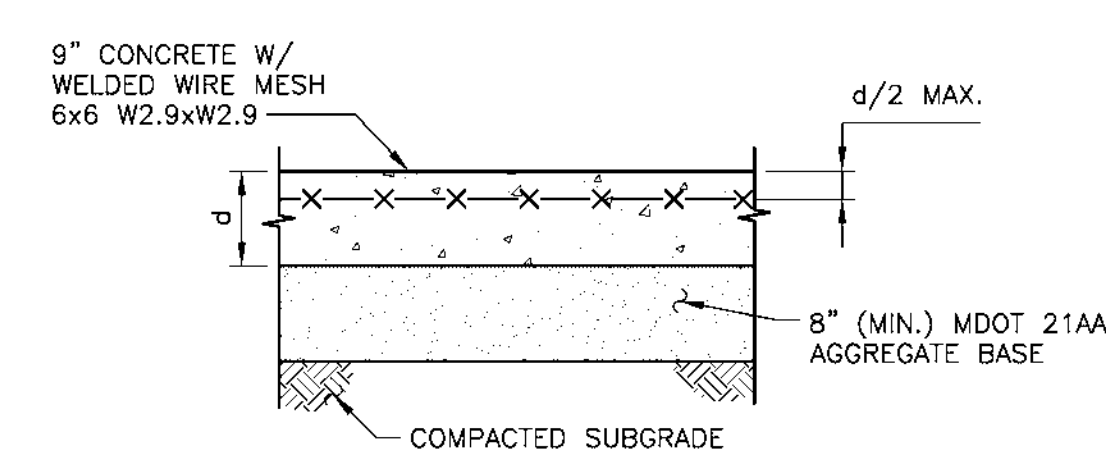


PLAN
1" = 30'

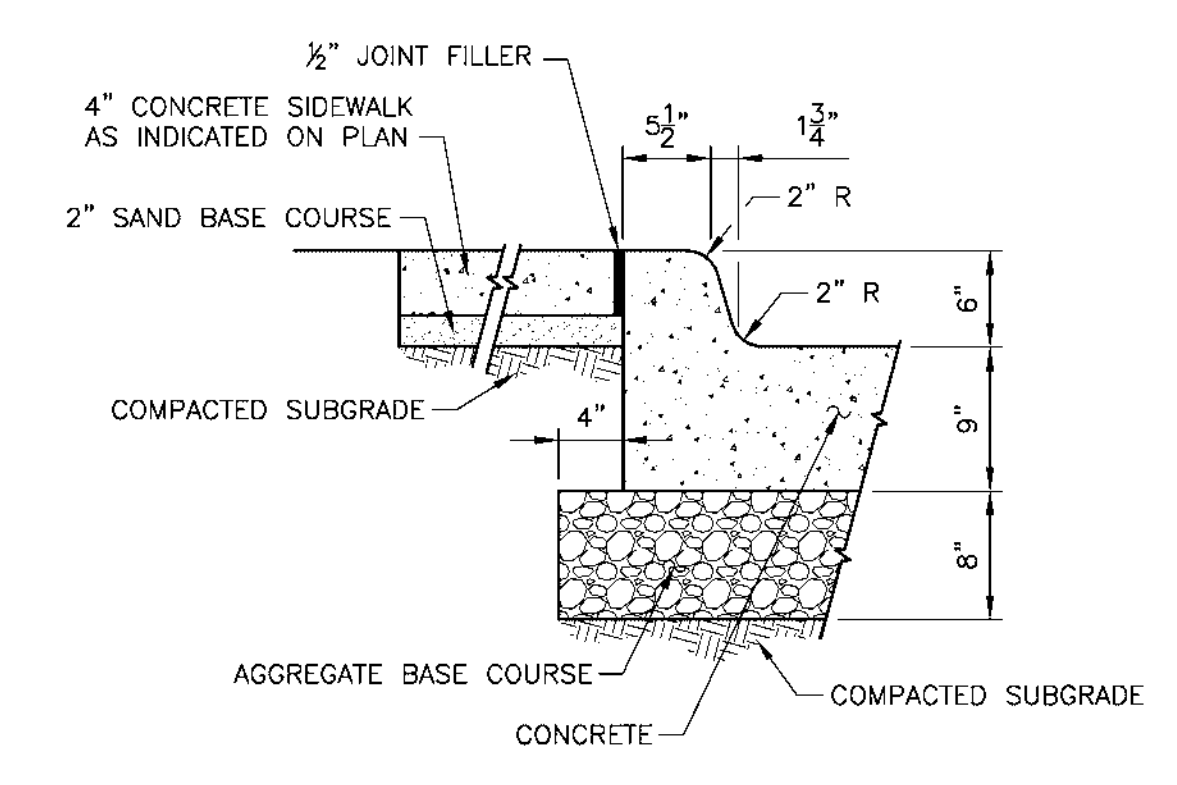
- NOTES:**
1. FOR JOINTING DETAILS, SEE DWG. D-04-08-125.
 2. PROVIDE EXPANSION JOINT MATERIAL @ ALL STRUCTURES.



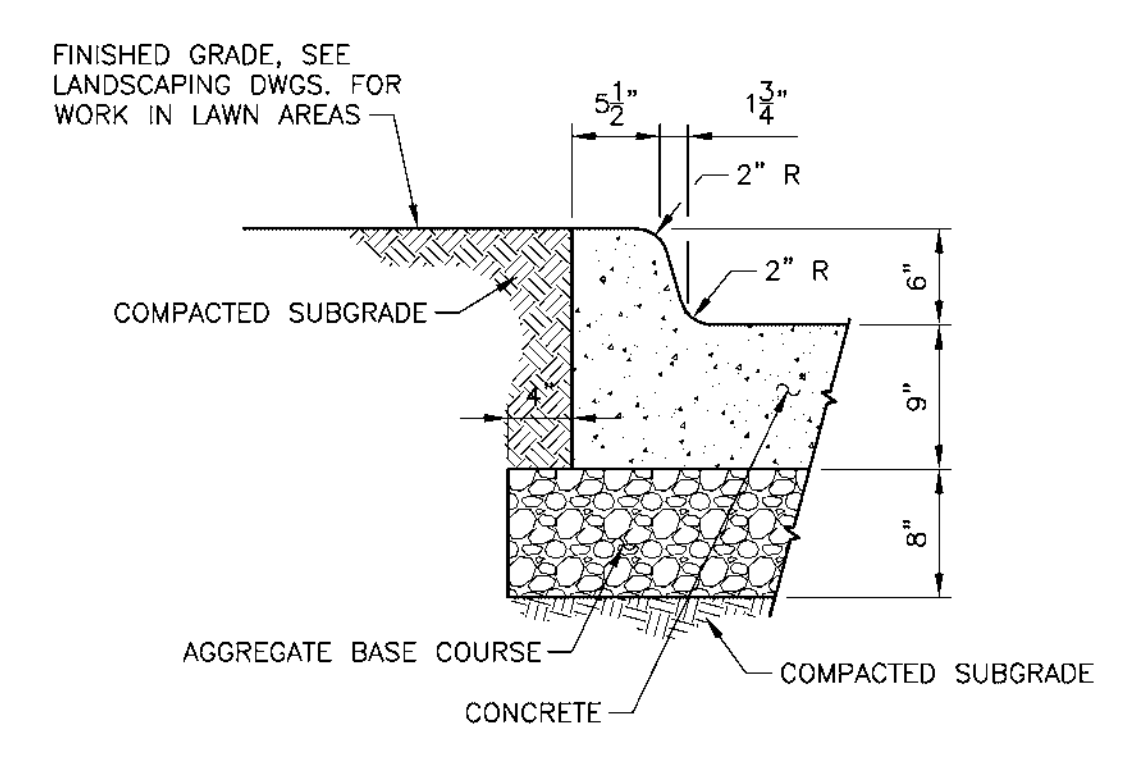
SIDEWALK DETAIL D
1 1/2" = 1'-0"



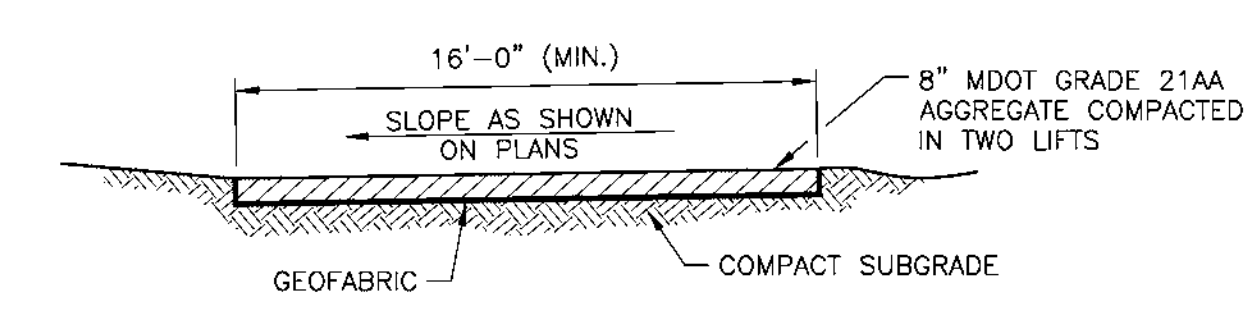
CONCRETE PAVEMENT DETAIL A
NOT TO SCALE



INTEGRAL CURB DETAIL W/ SIDEWALK B
NOT TO SCALE



INTEGRAL CURB DETAIL C
NOT TO SCALE



GRAVEL ROAD DETAIL E
NOT TO SCALE

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ALTERNATE NUMBER (810) MISS-DIG
COLOR CODES FOR UTILITY LOCATING:

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Red	ELECTRIC	Brown	SEWER
		Pink	SURVEYING

IF YOU ARE GOING TO WORK NEAR OVERHEAD WIRES - CALL MISS DIG

RECORD DRAWING

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By DUANE D. DeDENE Date 08/2012

CDM Smith

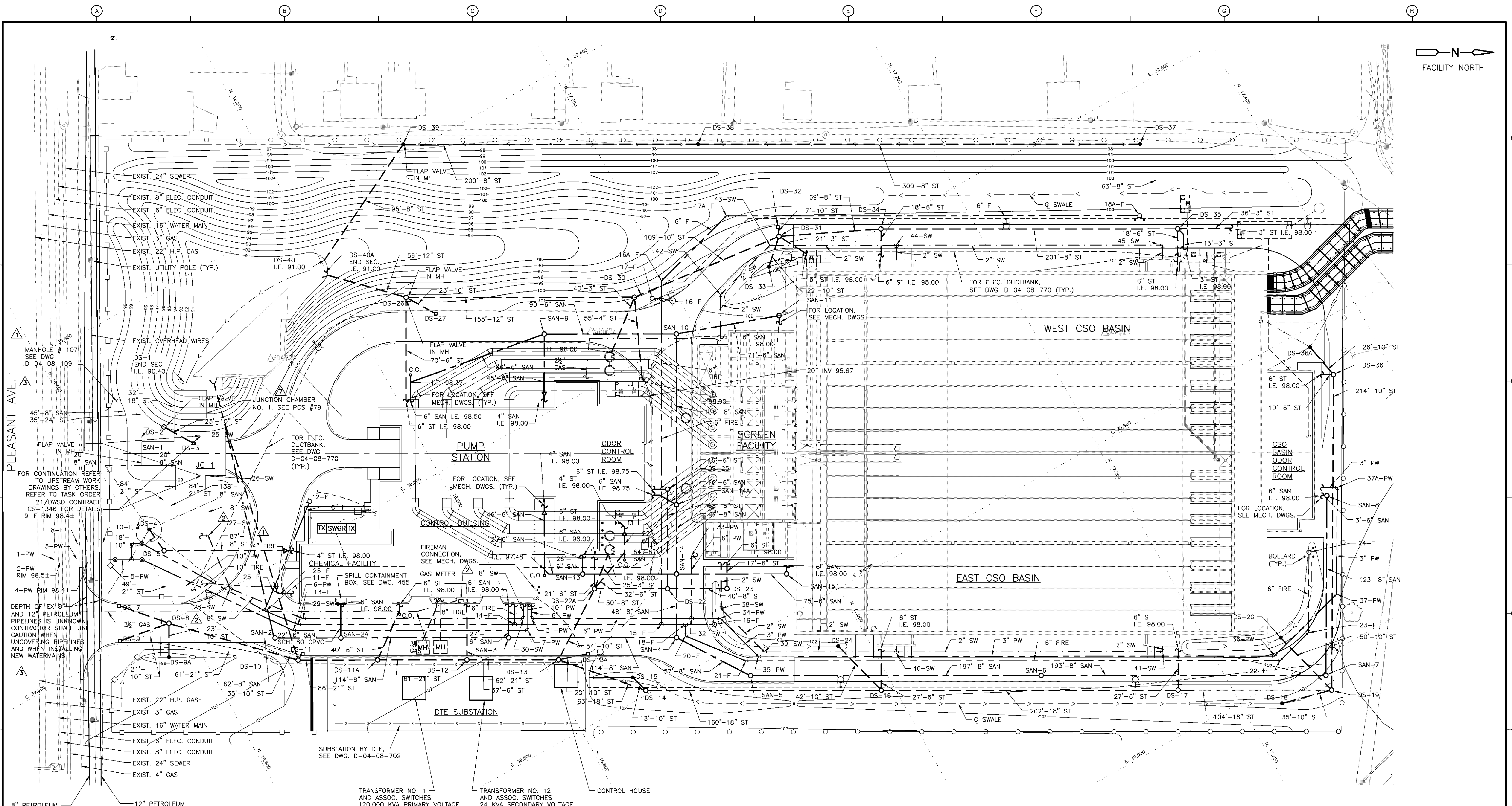
REVISED FOR RECORD		8/12	DDD	DESIGN	KJ
JOINT LAYOUT FIELD MODIFICATIONS		8/12	DDD	DRAFTING	JPF
ADD SKIDS PER STRUCTURAL DWGS		8/12	DDD	CHECKED	BB
PCS-79		8/12	DDD	APPROVED	AG
CDM E-MAIL 10/20/11		8/12	DDD		
REVISED PER BULLETIN NO. 3		3/07	AG		
NO.	DESCRIPTION	NO.	DATE	APPROVED	
REVISIONS					

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

SITE PAVING
PLANS, SECTIONS, DETAILS, AND NOTES

SCALE: AS NOTED
DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc. One Woodward Avenue, Suite 1500 Detroit, MI 48226 Tel: (313) 963-1313 Fax: (313) 963-1313 www.cdm-michigan.com	hamiltonanderson Hamilton Anderson Associates 1430 Franklin Suite 200, Detroit, Michigan 48226 P: 313.964.9270 F: 313.964.2170 www.hamilton-anderson.com	Applied Science, Inc. 300 New River, Suite 5400, Detroit, MI 48207 Phone: (313) 967-2800 Fax: (313) 967-2790	TUCKER, YOUNG, JACKSON, TULL, INC. CONSULTING ENGINEERS PLANNERS 1430 Franklin Suite 200, Detroit, Michigan 48226 P: 313.964.9270 F: 313.964.2170 www.tyji.com	Associates Inc. 150 W. Congress St., Suite 410 Detroit, MI 48226 Phone: 313-964-7765 Fax: 313-964-7782	SUPERIOR ENGINEERING ASSOC., INC. 600 Woodward Ave., Suite 1200, Detroit, MI 48226 Tel: (313) 964-2790 Fax: (313) 964-2791 www.superioreng.com	SOMAT Engineering, Inc. CONSULTING ENGINEERS 600 Woodward Ave., Suite 1200, Detroit, Michigan 48226 Tel: (313) 964-2790 Fax: (313) 964-2791	SIGMA CONSULTING ENGINEERS 300 Woodward Ave., Suite 1200 Detroit, MI 48226 Tel: (313) 964-2790 Fax: (313) 964-2791	CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION	M.D.P.H./D.N.R. PERMIT NO. FAMIS NO. CONTRACT NO. PC-755 FILE NO. CSTPL106.DWG DRAWING NO. D-04-08-106
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NOTE: ADDED PETROLEUM PIPELINE FROM BUCKEYE RECORDS

REVISED FOR RECORD	8/12	DDD
FIELD CHANGE	8/12	DDD
PCS-79	8/12	DDD
CDM DIRECTIVE	8/12	DDD
RFI # 00544	8/12	DDD
LP-2 LOCATION FIELD CHANGE	8/12	DDD
REVISED PER BULLETIN NO. 3	3/07	AG
REVISED PER BULLETIN NO. 2	2/07	AG
REVISED PER BULLETIN NO. 1	1/07	AG
DESCRIPTION	NO.	DATE
APPROVED	AG	

SCALE: 1" = 30'

DATE: DECEMBER 15, 2006

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CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

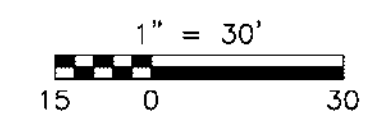
RECORD DRAWING
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By DUANE D. DeDENE Date 08/2012

CDM Smith

M.D.P.H./D.N.R. PERMIT NO.
FAMIS NO. -
CONTRACT NO. **PC-755**
FILE NO. **CSTPL107A.DWG**
DRAWING NO. **D-04-08-107A**

SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE
-	-	-	-	-



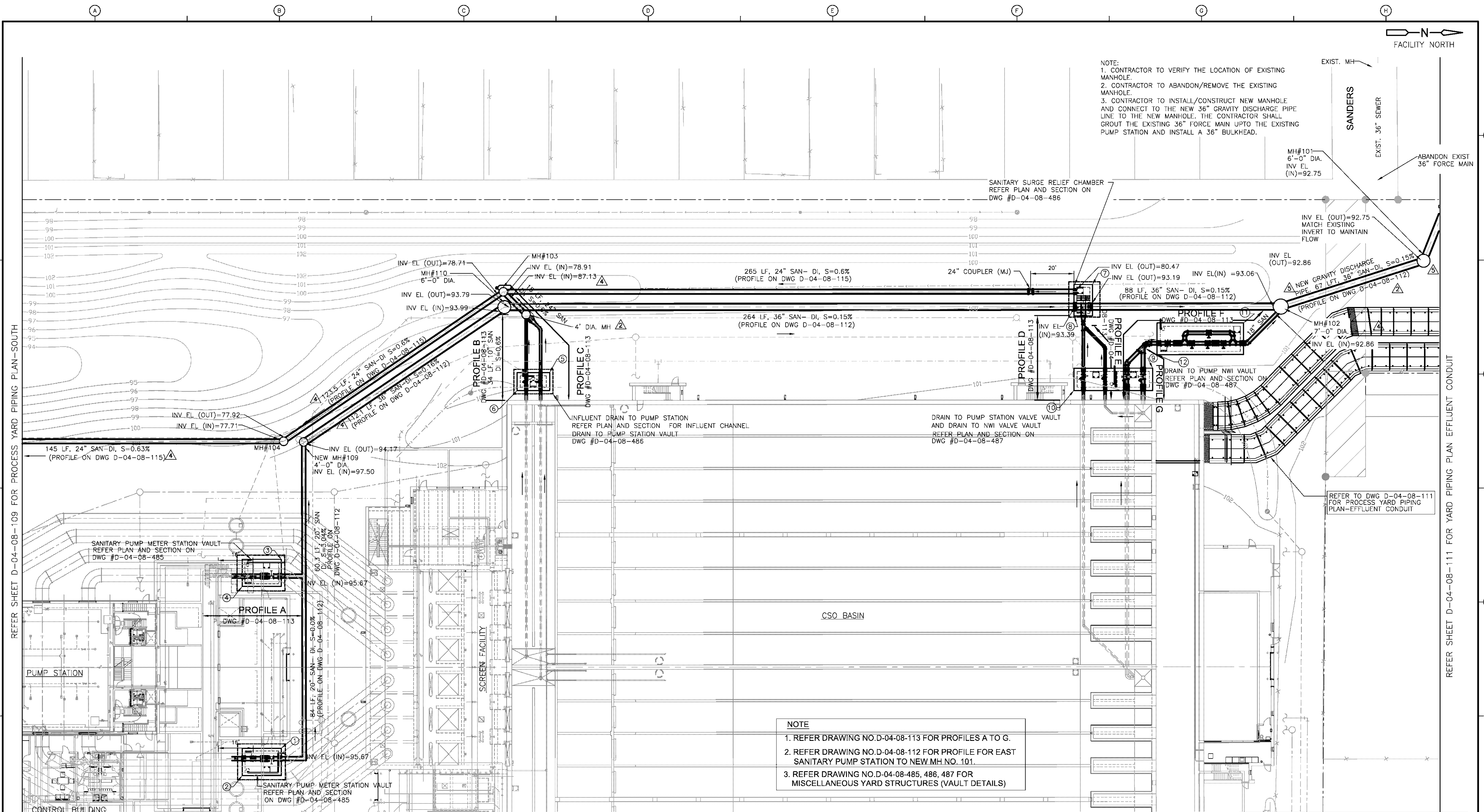
M.D.P.H./D.N.R. PERMIT NO.	
FAMIS NO.	-
CONTRACT NO.	PC-755
FILE NO.	CSTPL107B.DWG
DRAWING NO.	D-04-08-107B



③

- 4

- D-04-08-108



PROJECT COORDINATES (SANITARY SEWER)			
COORD NO.	NORTHING	EASTING	COORDINATE DESCRIPTION
401	17476.11	39706.86	MANHOLE NO. 101
402	17409.78	39732.54	MANHOLE NO. 102
403	17099.72	39552.91	MANHOLE NO. 103
404	16969.61	39577.69	MANHOLE NO. 104A
405	16820.43	39495.13	MANHOLE NO. 105A
406	16717.85	39498.64	MANHOLE NO. 106

PROJECT COORDINATES (SANITARY SEWER)			
COORD NO.	NORTHING	EASTING	COORDINATE DESCRIPTION
407	16634.01	39559.25	MANHOLE NO. 107
408	16636.22	39448.25	MANHOLE NO. 108 (NOT USED)
409	16985.13	39569.85	MANHOLE NO. 109A
410	17096.74	39559.26	MANHOLE NO. 110

PROJECT COORDINATES (REFER DWG #D-04-08-109 AND 110)			
COORD NO.	NORTHING	EASTING	COORDINATE DESCRIPTION
①	16908.27	39687.24	EAST SANITARY PUMP STATION METER VAULT
②	16886.47	39689.46	EAST SANITARY PUMP STATION METER VAULT
③	16950.44	39611.06	WEST SANITARY PUMP STATION METER VAULT
④	16928.64	39613.28	WEST SANITARY PUMP STATION METER VAULT
⑤	17100.35	39595.78	INFLUENT DRAIN TO PUMP STATION
⑥	17083.23	39595.73	INFLUENT DRAIN TO PUMP STATION

PROJECT COORDINATES (REFER DWG #D-04-08-109 AND 110)			
COORD NO.	NORTHING	EASTING	COORDINATE DESCRIPTION
⑦	17338.87	39681.57	SANITARY SURGE RELIEF CHAMBER
⑧	17324.41	39690.14	SANITARY SURGE RELIEF CHAMBER
⑨	17344.42	39728.72	DRAIN TO PUMP STATION AND NWI VALVE VAULT
⑩	17307.67	39720.09	DRAIN TO PUMP STATION AND NWI VALVE VAULT
⑪	17391.14	39730.81	DRAIN TO NWI VALVE VAULT
⑫	17349.22	39724.28	DRAIN TO NWI VALVE VAULT
⑬	16703.11	39474.55	SE CORNER OF EAST WINGWALL
⑭	16760.39	39459.99	NW CORNER OF WEST WINGWALL

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By **DUANE D. DeDENE** Date 08/2012

CDM Smith

REVISED FOR RECORD		NO.		DATE		DESCRIPTION	
PCS - 79 AND PCS - 755		8/12		DDD		DESIGN	
FIELD CHANGE		8/12		DDD		DRAFTING	
RFI # 00525		8/12		DDD		CHECKED	
RFI # 00497		8/12		DDD		APPROVED	
CONFORMED SET		8/07		MH		APPROVED	
DESCRIPTION		NO.		DATE		APPROVED	
REVISIONS		NO.		DATE		APPROVED	

DETROIT WATER AND SEWERAGE DEPARTMENT

OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

PROCESS YARD PIPING PLAN - NORTH

SCALE: 1"=20'

DATE: DECEMBER 15, 2006

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CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP TOWN RANGE SECTION PORTION CODE

M.D.P.H./D.N.R. PERMIT NO.
FAMIS NO. -
CONTRACT NO. **PC-755**
FILE NO. **CSTPL110**
DRAWING NO. **D-04-08-110**

- REFERENCE NOTES
1. REFER TO DRAWING NO.D-04-08-114A AND 114B FOR PROFILES FOR EFFLUENT CONDUIT.
 2. REFER TO DRAWING NO.D-04-08-399D AND 399E FOR EFFLUENT CONDUIT HEADWALL AND COLLAR STRUCTURAL DETAILS.
 3. REFER TO DRAWING NO.D-04-08-009 FOR EXISTING OUTFALL AND O'BRIAN SITE TOPOGRAPHY SURVEY

PROJECT COORDINATES (EAST EFFLUENT CONDUIT)			
COORD NO.	STATION ALONG C/L CONDUIT	NORTHING	EASTING
1	1+0	17347.05	39772.63
2	1+22.72	17366.94	39783.64
3	1+30.78	17374.93	39784.54
4	1+81.81	17423.97	39770.45
5	1+89.85	17431.96	39771.35
6	3+26.76	17639.24	39886.09
7	3+34.81	17644.38	39892.27
8	3+42.85	17646.93	39899.90
9	8.04.73	17629.22	40261.34
10	8+12.77	17632.77	40268.56
11	8.40.73	17656.0	40284.71
25	8+39.90 OFFSET=8.98'	17649.91	40291.42

COORDINATES ARE TAKEN ALONG
THE CENTER LINE OF THE CONDUITS

PROJECT COORDINATES (WEST EFFLUENT CONDUIT)			
COORD NO.	STATION ALONG C/L CONDUIT	NORTHING	EASTING
12	1+0	17354.30	39759.50
13	1+16.53	17368.77	39767.50
14	1+24.57	17376.76	39768.41
15	1+81.67	17431.64	39752.64
16	1+89.71	17439.62	39753.56
17	4+42.88	17661.12	39876.17
18	4+50.88	17666.23	39882.33
19	4+58.92	17668.77	39889.95
20	4+75.56	17667.96	39906.57
21	8+15.28	17651.33	40245.88
22	8+27.49	17650.76	40258.08
23	8+35.53	17654.31	40265.29
24	8+47.74	17664.33	40272.26
26	8+46.57 OFFSET=8.98'	17668.50	40264.22

COORDINATES ARE TAKEN ALONG
THE CENTER LINE OF THE CONDUITS

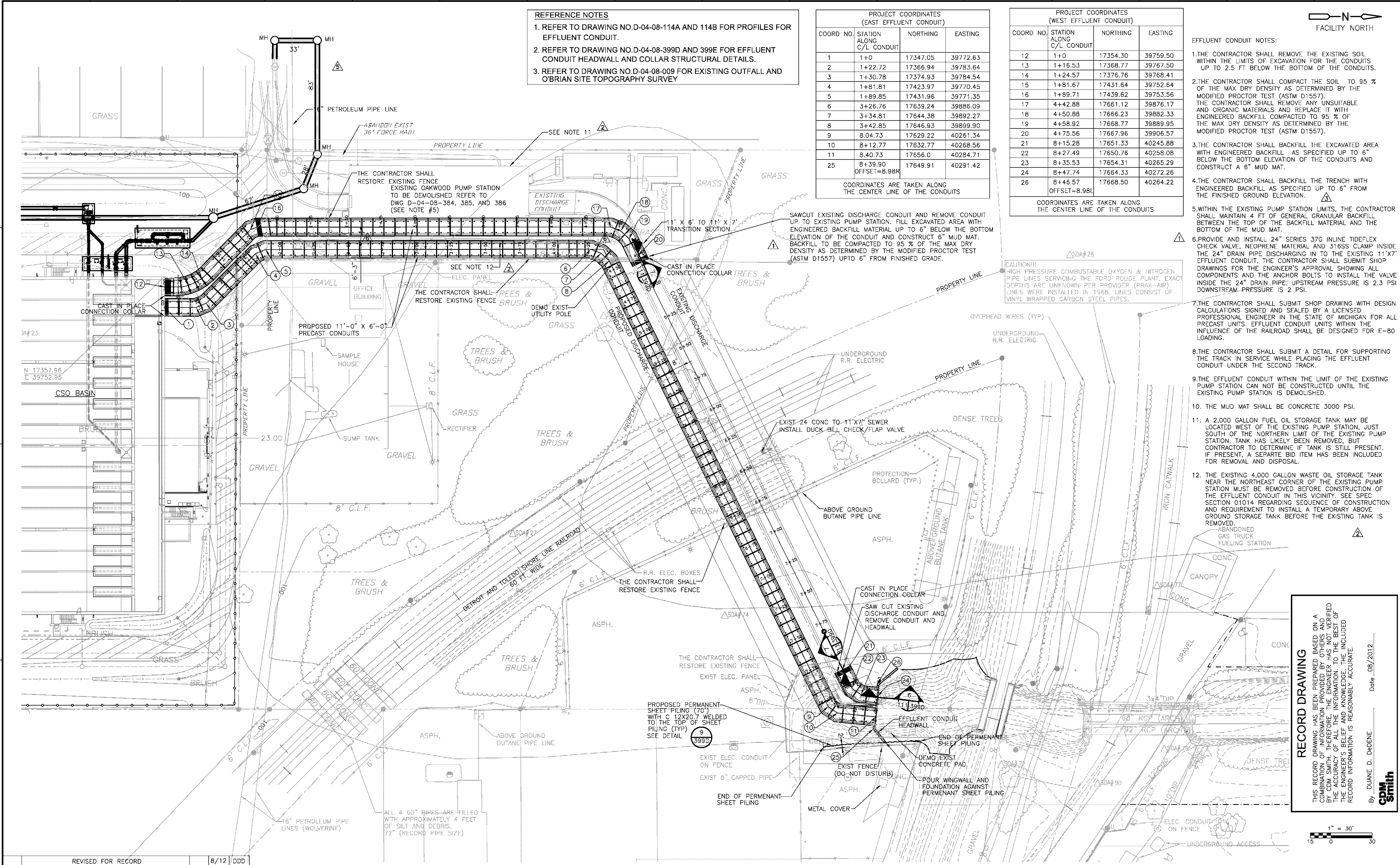
- EFFLUENT CONDUIT NOTES:
1. THE CONTRACTOR SHALL REMOVE THE EXISTING SOIL WITHIN THE LIMITS OF EXCAVATION FOR THE CONDUITS UP TO 2.5 FT BELOW THE BOTTOM OF THE CONDUITS.
 2. THE CONTRACTOR SHALL COMPACT THE SOIL TO 95 % OF THE MAX DRY DENSITY AS DETERMINED BY THE MODIFIED PROCTOR TEST (ASTM D1557). THE CONTRACTOR SHALL REMOVE ANY UNSUITABLE AND ORGANIC MATERIALS AND REPLACE IT WITH ENGINEERED BACKFILL COMPACTED TO 95 % OF THE MAX DRY DENSITY AS DETERMINED BY THE MODIFIED PROCTOR TEST (ASTM D1557).
 3. THE CONTRACTOR SHALL BACKFILL THE EXCAVATED AREA WITH ENGINEERED BACKFILL AS SPECIFIED UP TO 6" BELOW THE BOTTOM ELEVATION OF THE CONDUITS AND CONSTRUCT A 6" MUD MAT.
 4. THE CONTRACTOR SHALL BACKFILL THE TRENCH WITH ENGINEERED BACKFILL AS SPECIFIED UP TO 6" FROM THE FINISHED GROUND ELEVATION.
 5. WITHIN THE EXISTING PUMP STATION LIMITS, THE CONTRACTOR SHALL MAINTAIN 4 FT OF GENERAL GRANULAR BACKFILL BETWEEN THE TOP OF THE BACKFILL MATERIAL AND THE BOTTOM OF THE MUD MAT.
 6. PROVIDE AND INSTALL 24" SERIES 37G INLINE TIDEFLEX CHECK VALVE, NEOPRENE MATERIAL AND 316SS CLAMP INSIDE THE 24" DRAIN PIPE DISCHARGING IN TO THE EXISTING 11"x7' EFFLUENT CONDUIT. THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS FOR THE ENGINEER'S APPROVAL SHOWING ALL COMPONENTS AND THE ANCHOR BOLTS TO INSTALL THE VALVE INSIDE THE 24" DRAIN PIPE. UPSTREAM PRESSURE IS 2.3 PSI DOWNSTREAM PRESSURE IS 2 PSI.
 7. THE CONTRACTOR SHALL SUBMIT SHOP DRAWING WITH DESIGN CALCULATIONS SIGNED AND SEALED BY A LICENSED PROFESSIONAL ENGINEER IN THE STATE OF MICHIGAN FOR ALL PRECAST UNITS. EFFLUENT CONDUIT UNITS WITHIN THE INFLUENCE OF THE RAILROAD SHALL BE DESIGNED FOR E-80 LOADING.
 8. THE CONTRACTOR SHALL SUBMIT A DETAIL FOR SUPPORTING THE TRACK IN SERVICE WHILE PLACING THE EFFLUENT CONDUIT UNDER THE SECOND TRACK.
 9. THE EFFLUENT CONDUIT WITHIN THE LIMIT OF THE EXISTING PUMP STATION CAN NOT BE CONSTRUCTED UNTIL THE EXISTING PUMP STATION IS DEMOLISHED.
 10. THE MUD MAT SHALL BE CONCRETE 3000 PSI.
 11. A 2,000 GALLON FUEL OIL STORAGE TANK MAY BE LOCATED WEST OF THE EXISTING PUMP STATION, JUST SOUTH OF THE NORTHERN LIMIT OF THE EXISTING PUMP STATION. TANK HAS LIKELY BEEN REMOVED, BUT CONTRACTOR TO DETERMINE IF TANK IS STILL PRESENT. IF PRESENT, A SEPARATE BID ITEM HAS BEEN INCLUDED FOR REMOVAL AND DISPOSAL.
 12. THE EXISTING 4,000 GALLON WASTE OIL STORAGE TANK NEAR THE NORTHEAST CORNER OF THE EXISTING PUMP STATION MUST BE REMOVED BEFORE CONSTRUCTION OF THE EFFLUENT CONDUIT IN THIS VICINITY. SEE SPEC SECTION 01014 REGARDING SEQUENCE OF CONSTRUCTION AND REQUIREMENT TO INSTALL A TEMPORARY ABOVE GROUND STORAGE TANK BEFORE THE EXISTING TANK IS REMOVED.

RECORD DRAWING

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By: DUANE D. DeBENE Date: 08/2012

CDM Smith



REVISED FOR RECORD		8/12	DDD	
FIELD CHANGE		8/12	DDD	DESIGN
FIELD REVISIONS PER PCS - 79 AND PCS - 755		8/12	DDD	MH
RFI # 00146		8/12	DDD	DRAFTING
3	REVISED PER BULLETIN NO. 3	3/07	MH	KBD
2	REVISED PER BULLETIN NO. 2	2/07	MH	CHECKED
1	REVISED PER BULLETIN NO. 1	1/07	MH	MH
NO.	DESCRIPTION	NO.	DATE	APPROVED
				MH

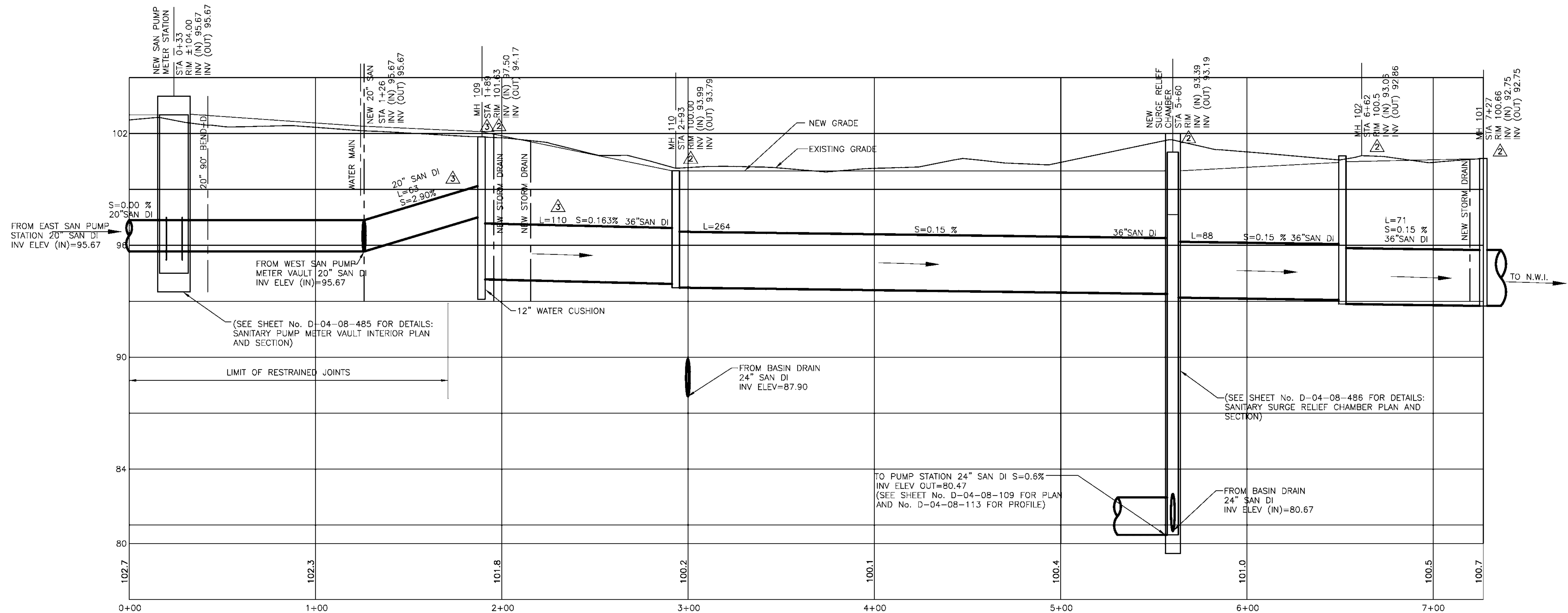
REVISIONS

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION
YARD PIPING PLAN-EFFLUENT CONDUIT

SCALE: 1"=30'

DATE: DECEMBER 15, 2006

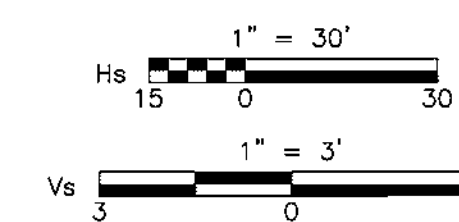
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PROFILE FOR EAST SANITARY PUMP STATION TO NEW MH 101

NOTE

1. REFER DRAWING No. D-04-08-110 FOR PLAN.
2. REFER DRAWING No. D-04-08-485 FOR DETAILS.



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By DUANE D. DeDENE Date 08/2012

CDM
Smith

				DESIGN	MH
	REVISED FOR RECORD	8/12	DDD	DRAFTING	TSJ
	FIELD CHANGE	8/12	DDD		
	RFI # 00168	8/12	DDD	CHECKED	MH
1	CONFORMED SET	8/07	MH		
NO.	DESCRIPTION	NO.	DATE	APRVD	
				APPROVED	MH
REVISIONS					

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

YARD PIPING PROFILES-SANITARY SEWER/BASIN
DEWATERING SHEET 1 OF 2

SCALE: AS NOTED

DATE: DECEMBER 15, 2006

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Tel: 313.963.2700 Fax: 313.963.2628



CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE
-	-	-	-	-

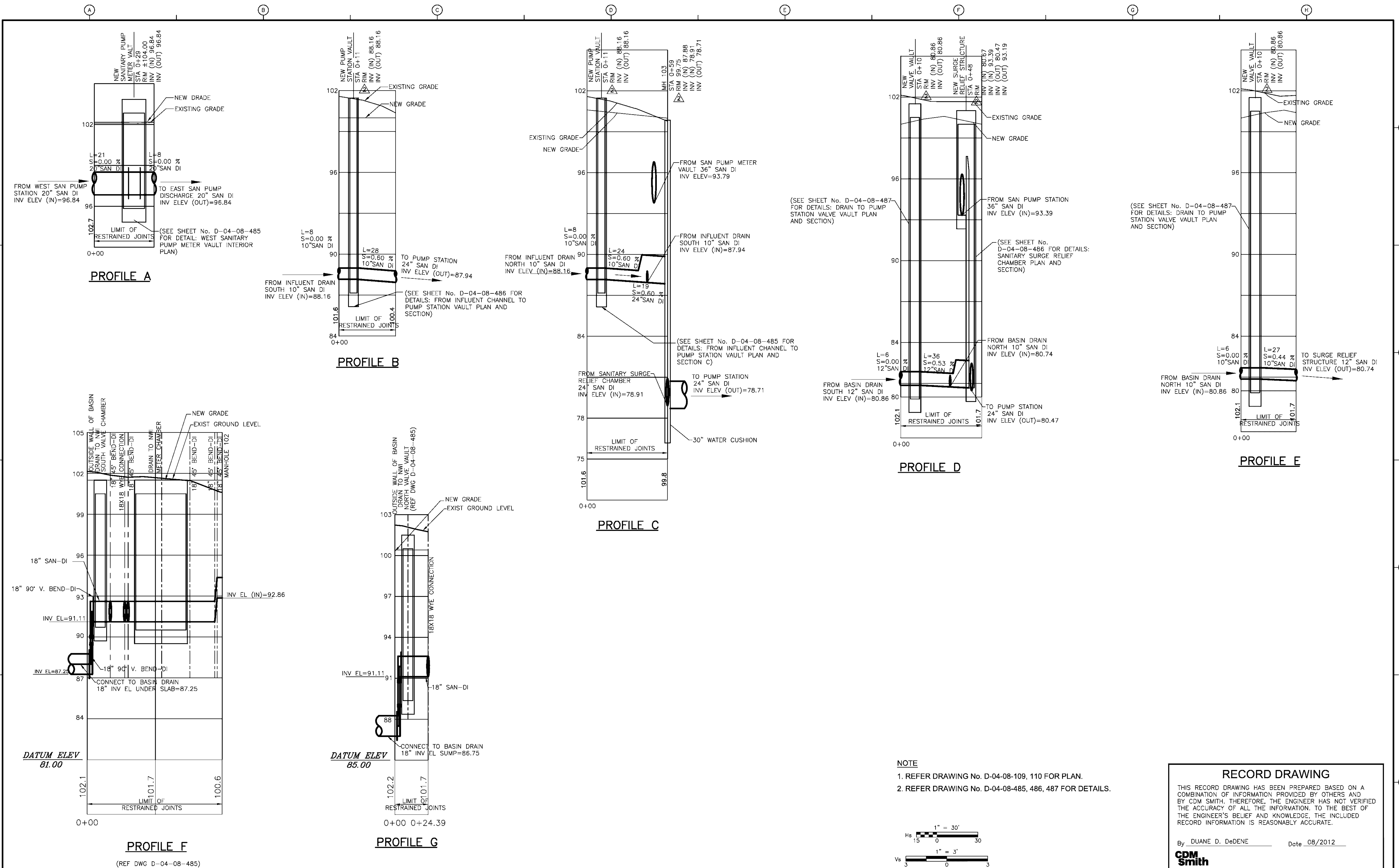
M.D.P.H./D.N.R. PERMIT NO.

FAMIS NO. -

CONTRACT NO. PC-755

FILE NO. CHYPR112

DRAWING NO. D-04-08-112



				DESIGN	MH
				DRAFTING	TSJ
	REVISED FOR RECORD	8/12	DDD	CHECKED	MH
	RFI # 00168	8/12	DDD	APPROVED	MH
1	CONFORMED SET	8/07	MH		
NO.	DESCRIPTION	NO.	DATE	APRVD	
REVISIONS					

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION
3

YARD PIPING PROFILES SANITARY SEWER/BASIN
DEWATERING SHEET 2 OF 2

SCALE: AS NOTED

DATE: DECEMBER 15, 2006

CDM
CDM Michigan Inc.
One Woodward Avenue, Suite 1500
Detroit, MI 48226
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Applied Science, Inc.
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SIGMA CONSULTING ENGINEERS
300 Woodward Ave., Suite 1700
Detroit, MI 48226
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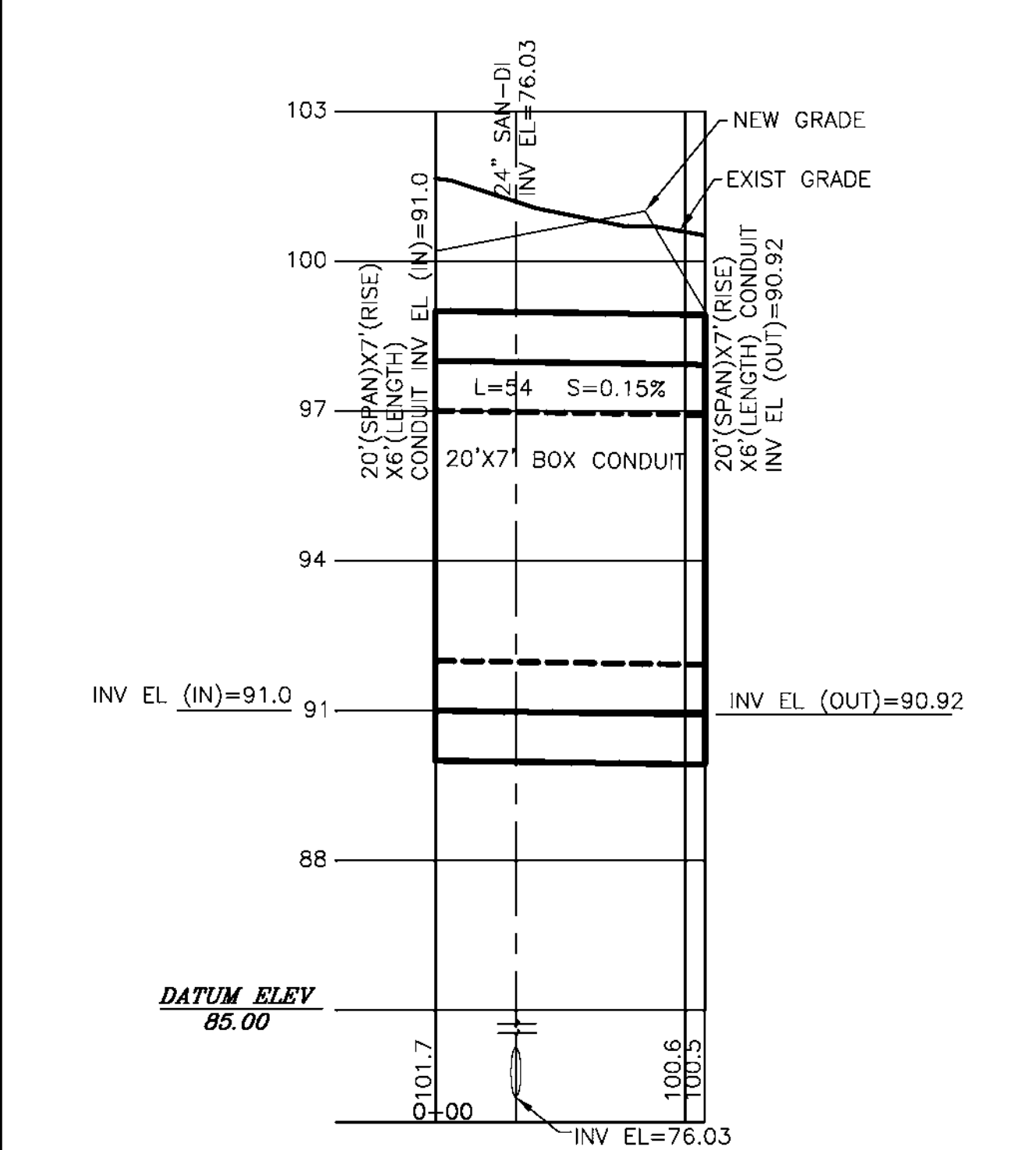
CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP
TOWN
RANGE
SECTION
PORTION CODE

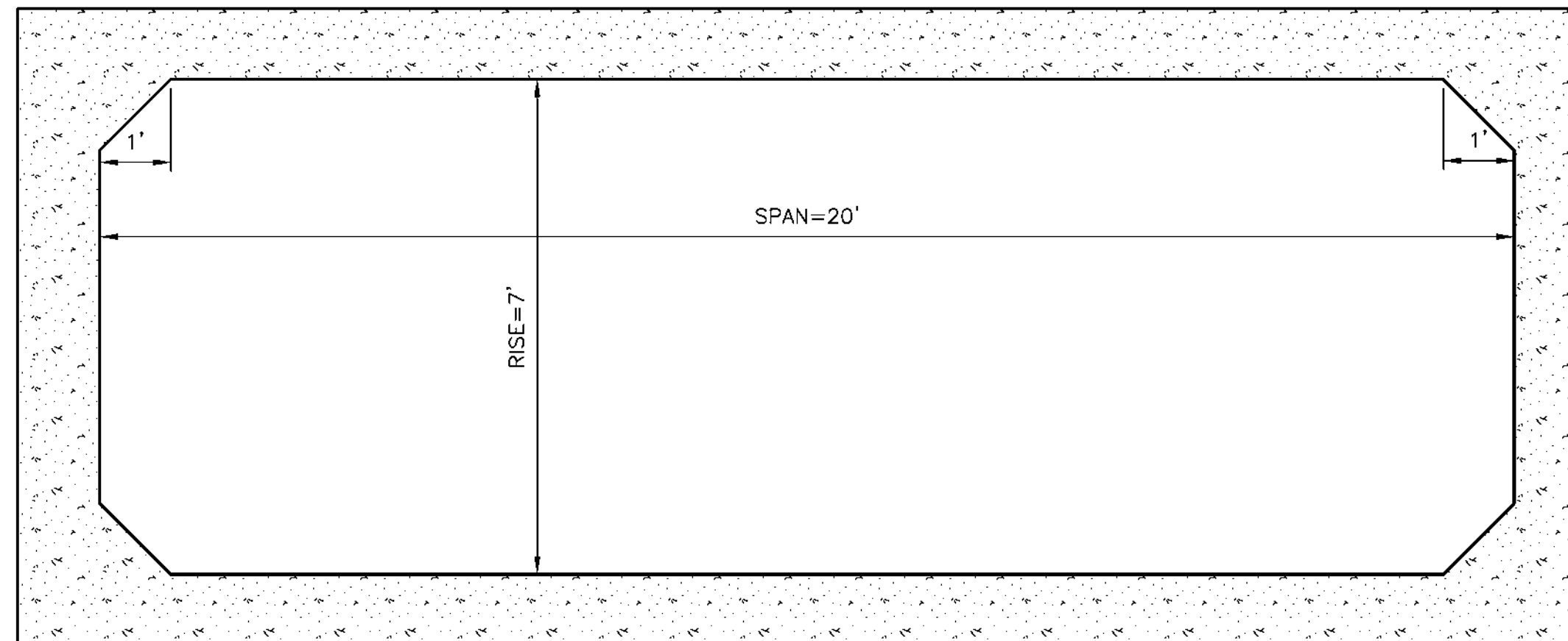
M.D.P.H./D.N.R. PERMIT NO.

FAMIS NO.
CONTRACT NO.
FILE NO.
DRAWING NO.

PC-755
CHYPR113
D-04-08-113



TYPICAL SECTION OF SURGE RELIEF CONDUIT
(SCALE 1/2"=1'-0")



RECORD DRAWING

THIS RECORD DRAWING HAS BEEN PREPARED BASED ON A COMBINATION OF INFORMATION PROVIDED BY OTHERS AND BY CDM SMITH. THEREFORE, THE ENGINEER HAS NOT VERIFIED THE ACCURACY OF ALL THE INFORMATION. TO THE BEST OF THE ENGINEER'S BELIEF AND KNOWLEDGE, THE INCLUDED RECORD INFORMATION IS REASONABLY ACCURATE.

By DUANE D. DeDENE Date 08/2012

**CDM
Smith**

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION
YARD PIPING-SURGE CONTROL CONDUITS

SCALE: AS NOTED

DATE: DECEMBER 15, 2006

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Sigma CONSULTING ENGINEERS
Sigma Associates, Inc.
535 Griswold Street, Suite 1700
Detroit, MI 48226
Tel: 313.663.7600

SECTION

MAP		TOWN		RANGE		SECTION				PORTION CODE	
-		-		-		-		-		-	

M.D.P.H./D.N.R. PERMIT NO.

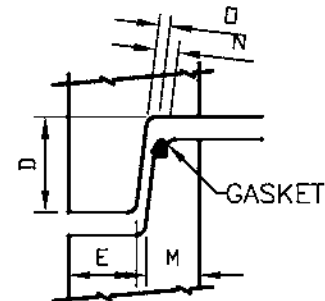
FAMIS NO.

CONTRACT NO. PC-755

FILE NO.

FILE NO. CHYPR115

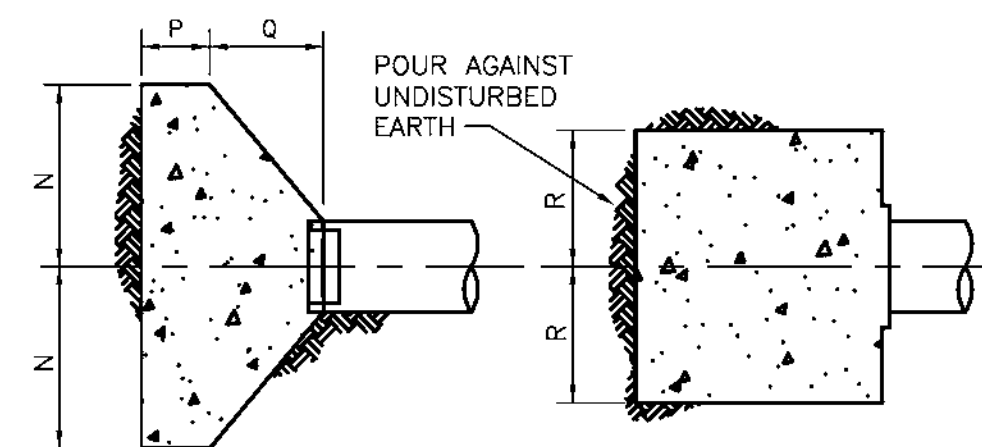
DRAWING NO. **D-01-00-115**



MANUFACTURED IN ACCORDANCE
WITH ASTM SPECIFICATION C-478.
RUBBER GASKETS CONFORMS TO
ASTM SPECIFICATION C-443.
BUTYL RUBBER JOINT SEALANT
CONFORMS TO FEDERAL
SPECIFICATION SS-S-210A.

MANHOLE, ASSEMBLY

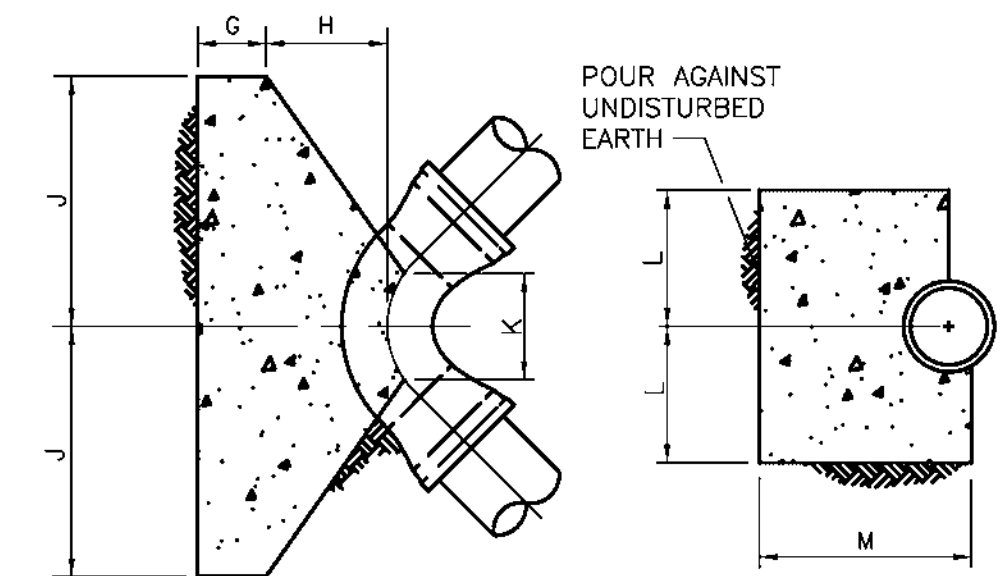
A	RISER DIAMETER	IN	24	48	60	72	84	96	108	120
B	WALL THICKNESS	IN	3	5	6	7	8	9	9	10
C	OUTSIDE DIAMETER	IN	30	58	72	86	100	114	126	140
D	JOINT DEPTH	IN	2.75	2.75	4.75	5	5	5	5.25	7.5
E	BELL THICKNESS	IN	1.31	2.75	3.28	3.88	4.48	4.93	5	4.5
F	INTEGRAL BASE	IN	6	8	8	8	8	8	8	8
G	RISER HEIGHTS	FT	2	1.33	1.33	1.33				
		FT	3	2.67	2.67	2.67	2.67	2.67	2.67	2.67
		FT		4	4	4	4	4	4	4
		FT		5.33	5.33	5.33	5.33	5.33	5.33	5.33
		FT			8	8	8	8	8	8
H	BASE HEIGHT RISER HEIGHTS CAN ALSO BE USED AS BASE SECTIONS	FT	2		2	2	2	2	2	2
		FT	3		3	3	3	3	3	3
		FT	4	3.33	3.33	3.33	3.33	3.33	3.33	3.33
		FT	4.5		3.67	3.67	3.67	3.67	3.67	3.67
		FT		4.67	4.67	4.67	4.67	4.67	4.67	4.67
		FT		5	5	5	5	5	5	5
I	CONE HEIGHT TO 24"	FT			2.5	3				
					Con. Con.					
					3					
					4					
		FT			2.67	2.67				
J	CONE HEIGHT TO 48"	FT								
		FT								
K	"6" THK. 8" THK. 12" THK.	IN	44							
		IN	48	72	84	96				
		IN			84	96	108	120		156
L	STEP SPACING	IN		16	16	16	16	16	16	16
M	SPIGOT THICKNESS	IN	1.5	2.52	3.06	3.06	3.57	3.88	2.75	3.5
N	GASKET ANNULAR SPACE	IN	0.19	0.708	0.56	0.56	0.46	0.56	N/A	0.56
O	CONCRETE ANNULAR SPACE	IN	0.19	0.453	0.09	0.09	0.09	0.12	0.50	0.50
	APPROX. WEIGHT / FT.	LB	264	867	295	181	2409	3090	3400	4200



* IN SOFT CLAY DOUBLE THE TABULAR "N" DIMENSION

CONCRETE THRUST BLOCK SCHEDULE FOR PLUGS & CAPS				
SIZE	N*	P-MIN.	Q	R
8"	1'-4"	0'-9"	0'-9"	1'-0"
12"	2'-0"	0'-9"	1'-3"	1'-6"
16"	2'-4"	1'-0"	1'-4"	2'-4"
20"	2'-8"	1'-0"	1'-5"	2'-8"
24"	3'-2"	1'-0"	1'-6"	3'-2"

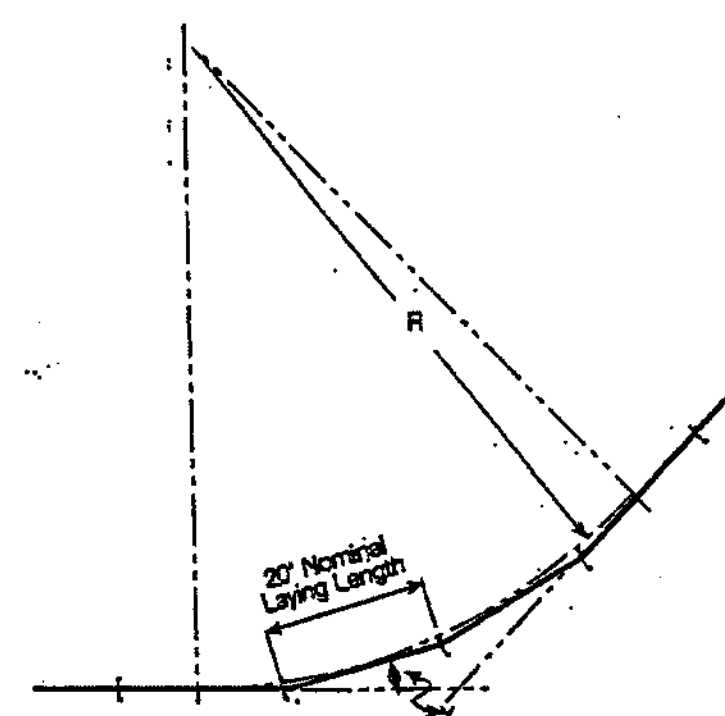
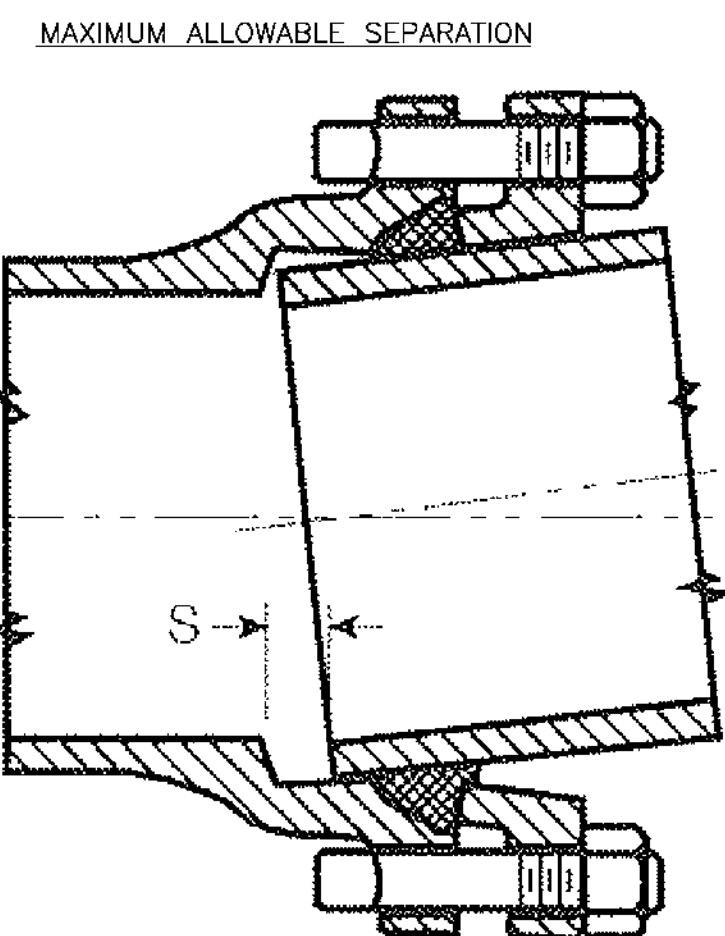
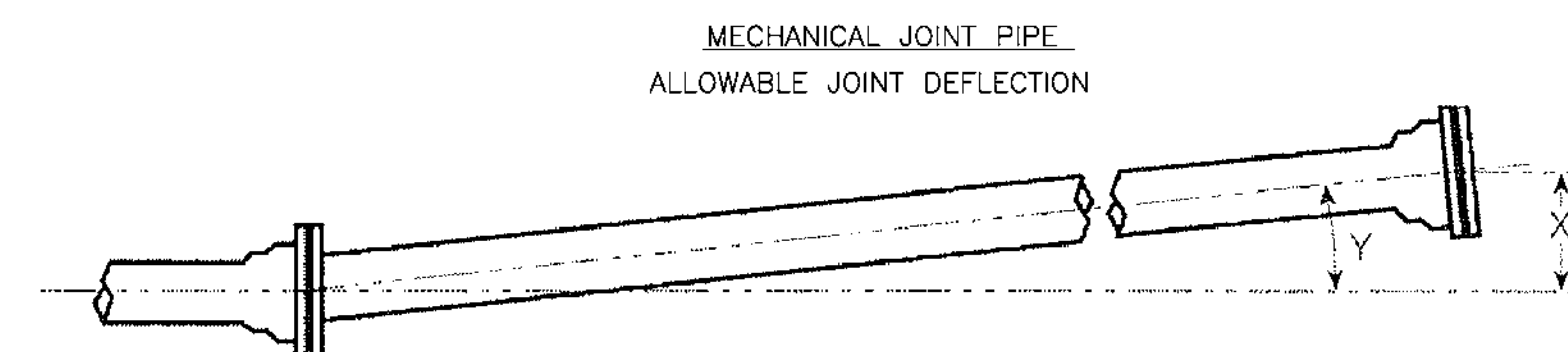
CONCRETE THRUST BLOCKS FOR PLUGS & CAPS



* IN SOFT CLAY DOUBLE THE TABULAR "J" DIMENSION

CONCRETE THRUST BLOCK SCHEDULE FOR HORIZONTAL BENDS							
SIZE	ANGLE	G-MIN	H	J*	K	L	M-MIN.
6"	45°	0'-9"	0'-9"	0'-9"	0'-6"	0'-9"	1'-8"
	90°	0'-9"	0'-9"	1'-0"	0'-8"	1'-0"	1'-8"
	22½°	0'-9"	1'-0"	0'-9"	0'-10"	0'-7"	1'-11"
8"	45°	0'-9"	1'-0"	1'-2"	0'-6"	1'-0"	1'-11"
	90°	0'-9"	1'-0"	1'-8"	0'-10"	1'-3"	1'-11"
	22½°	0'-9"	1'-0"	1'-3"	0'-10"	1'-0"	2'-0"
12"	45°	0'-9"	1'-4"	1'-9"	0'-10"	1'-3"	2'-4"
	90°	0'-9"	1'-4"	2'-9"	1'-2"	1'-6"	2'-4"
	22½°	1'-0"	1'-8"	1'-8"	0'-10"	1'-3"	3'-0"
16"	45°	1'-0"	1'-8"	2'-8"	0'-10"	1'-6"	3'-0"
	90°	1'-0"	1'-8"	3'-0"	1'-6"	2'-6"	3'-0"
	22½°	1'-0"	2'-6"	2'-0"	1'-2"	1'-3"	3'-6"
20"	45°	1'-0"	2'-6"	3'-0"	1'-0"	1'-9"	3'-6"
	90°	1'-0"	2'-6"	4'-0"	1'-10"	2'-6"	4'-0"
	22½°	1'-0"	3'-7"	2'-6"	1'-3"	1'-6"	4'-0"
24"	45°	1'-0"	3'-7"	3'-0"	1'-2"	2'-6"	5'-0"
	90°	1'-0"	3'-7"	5'-0"	2'-2"	2'-6"	5'-4"

CONCRETE THRUST BLOCK FOR BENDS

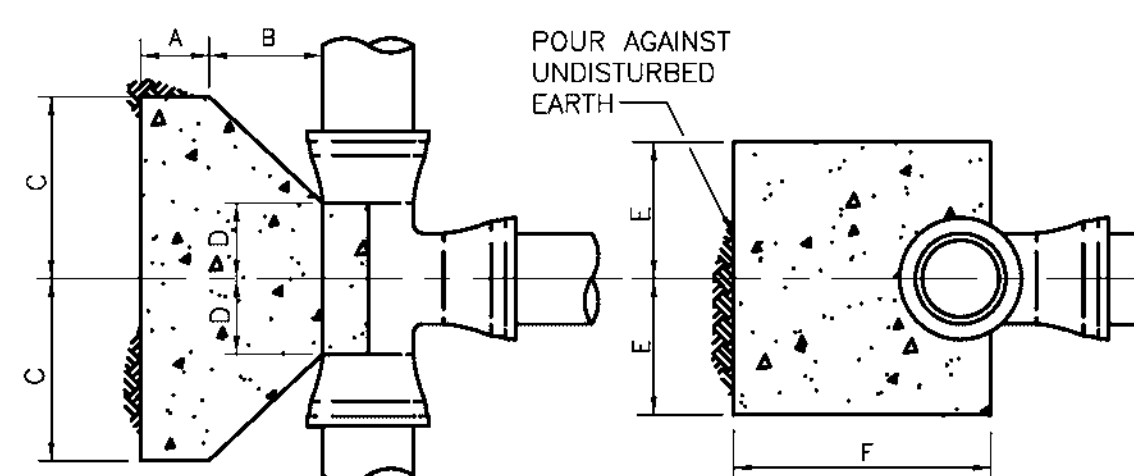


R = Radius of Curve (ft.)

Y = Deflection Angle (degrees)

$$\text{Radius of Curve} = \frac{\text{Nominal Laying Length}}{2 \times \text{Tangent } (Y/2)}$$

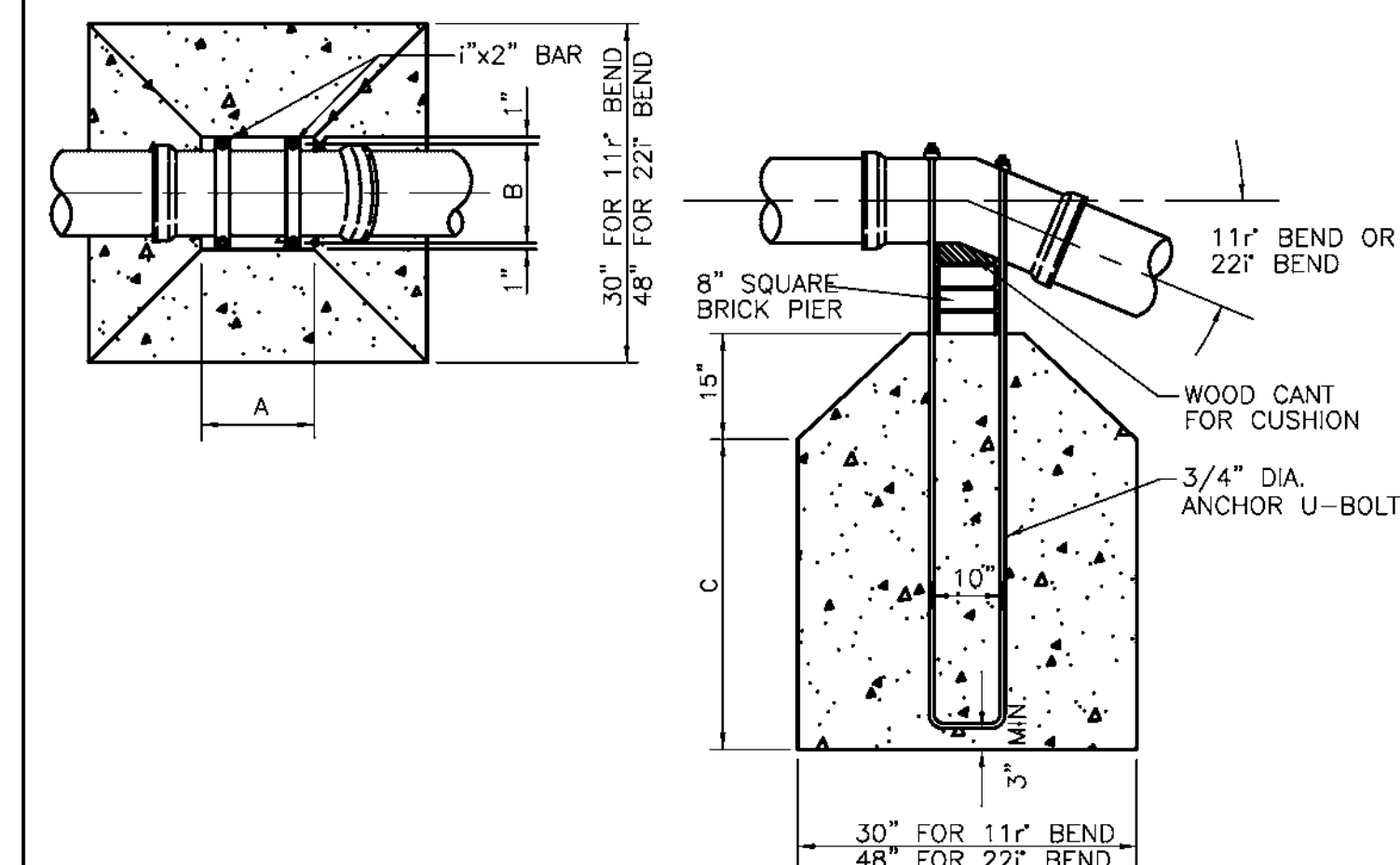
MECHANICAL JOINT PIPE FITTINGS



* IN SOFT CLAY DOUBLE THE TABULAR "C" DIMENSION

CONCRETE THRUST BLOCK SCHEDULE FOR TEES							
RUN	BRANCH	A	B	C*	D	E	F
8"	8"	0'-9"	0'-9"	1'-4"	0'-7"	1'-0"	2'-2"
	8"	0'-9"	0'-9"	1'-4"	0'-8"	1'-0"	2'-6"
	12"	0'-9"	1'-3"	2'-0"	0'-10"	1'-6"	2'-1"
16"	8"	0'-9"	0'-9"	1'-4"	0'-8"	1'-0"	2'-1"
	12"	0'-9"	1'-3"	2'-0"	0'-10"	1'-6"	3'-4"
	16"	1'-0"	1'-4"	2'-4"	1'-0"	2'-4"	3'-6"
20"	8"	0'-9"	0'-9"	1'-4"	0'-8"	1'-0"	3'-2"
	12"	0'-9"	1'-3"	2'-0"	0'-10"	1'-6"	3'-8"
	16"	1'-0"	1'-4"	2'-4"	1'-0"	2'-4"	3'-1"
24"	20"	1'-0"	1'-5"	2'-8"	1'-2"	2'-8"	4'-0"
	8"	0'-9"	0'-9"	1'-4"	0'-8"	1'-0"	4'-0"
	12"	0'-9"	1'-3"	2'-0"	0'-10"	1'-6"	4'-6"
24"	16"	1'-0"	1'-4"	2'-4"	1'-0"	2'-4"	4'-2"
	20"	1'-0"	1'-5"	2'-6"	1'-6"	2'-6"	5'-0"
	24"	1'-0"	1'-6"	3'-2"	1'-8"	3'-2"	5'-6"

CONCRETE THRUST BLOCK FOR TEES



ANCHORAGE FOR VERTICAL BENDS

RECORD DRAWING

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By DUANE D. DeDENE Date 08/2012

**CDM
Smith**

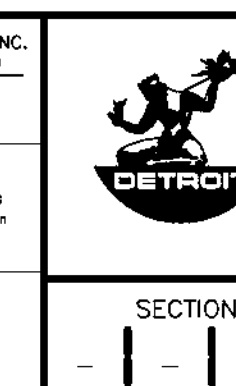
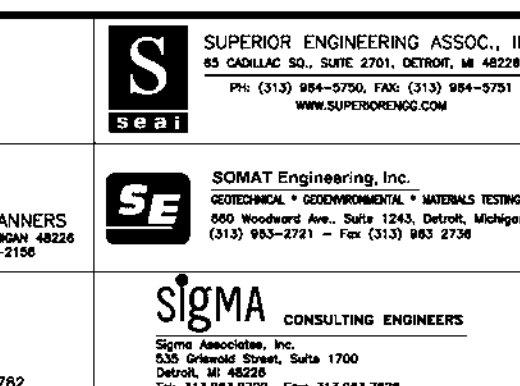
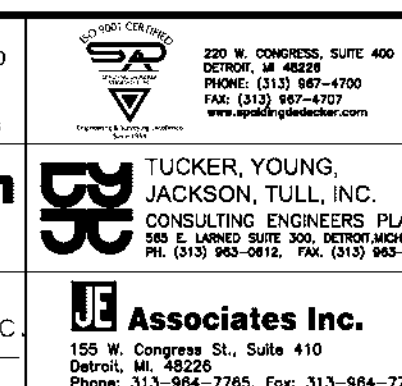
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						DRAFTING	KBD
						CHECKED	
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		CONFORMED SET		8/07	MH		MH
NO.		DESCRIPTION	NO.	DATE	APRVD	APPROVED	MH
		REVISIONS					

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

YARD PIPING-DETAILS

SCALE: N.T.S.

DATE: DECEMBER 15, 2006

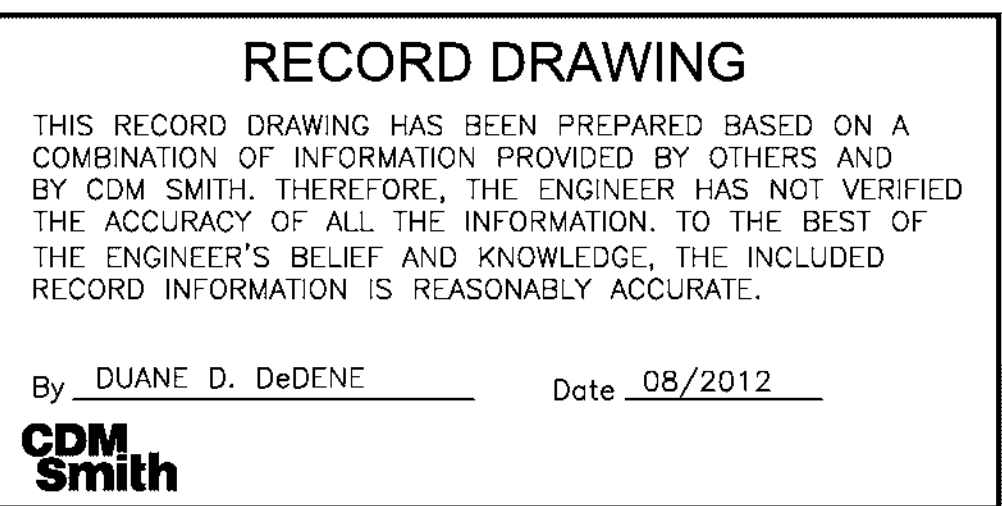


CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

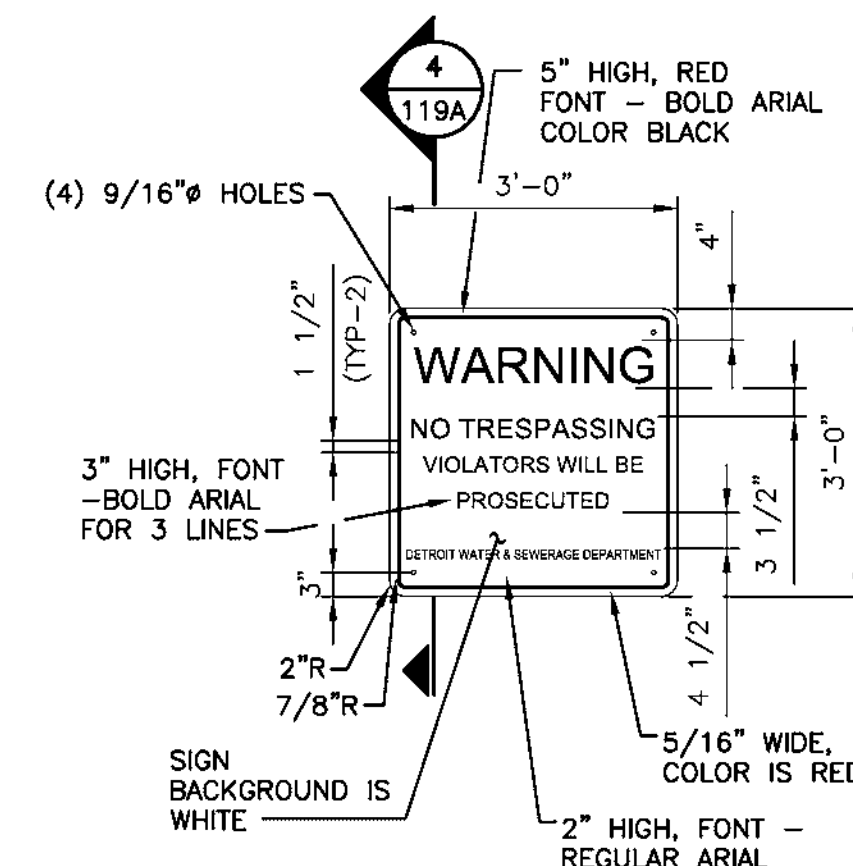
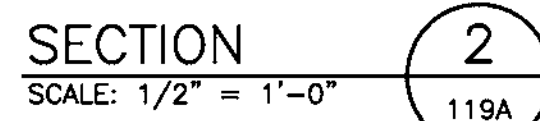
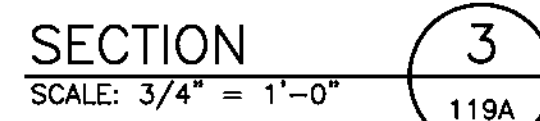
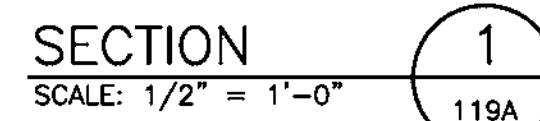
SECTION MAP				TOWN		RANGE		SECTION			PORTION CODE		
-		-		-		-		-		-		-	

M.D.P.H./D.N.R. PERMIT NO.	
FAMIS NO.	-
CONTRACT NO.	PC-755
FILE NO.	CYPDTT116
DRAWING NO.	D-04-08-116

CIVIL

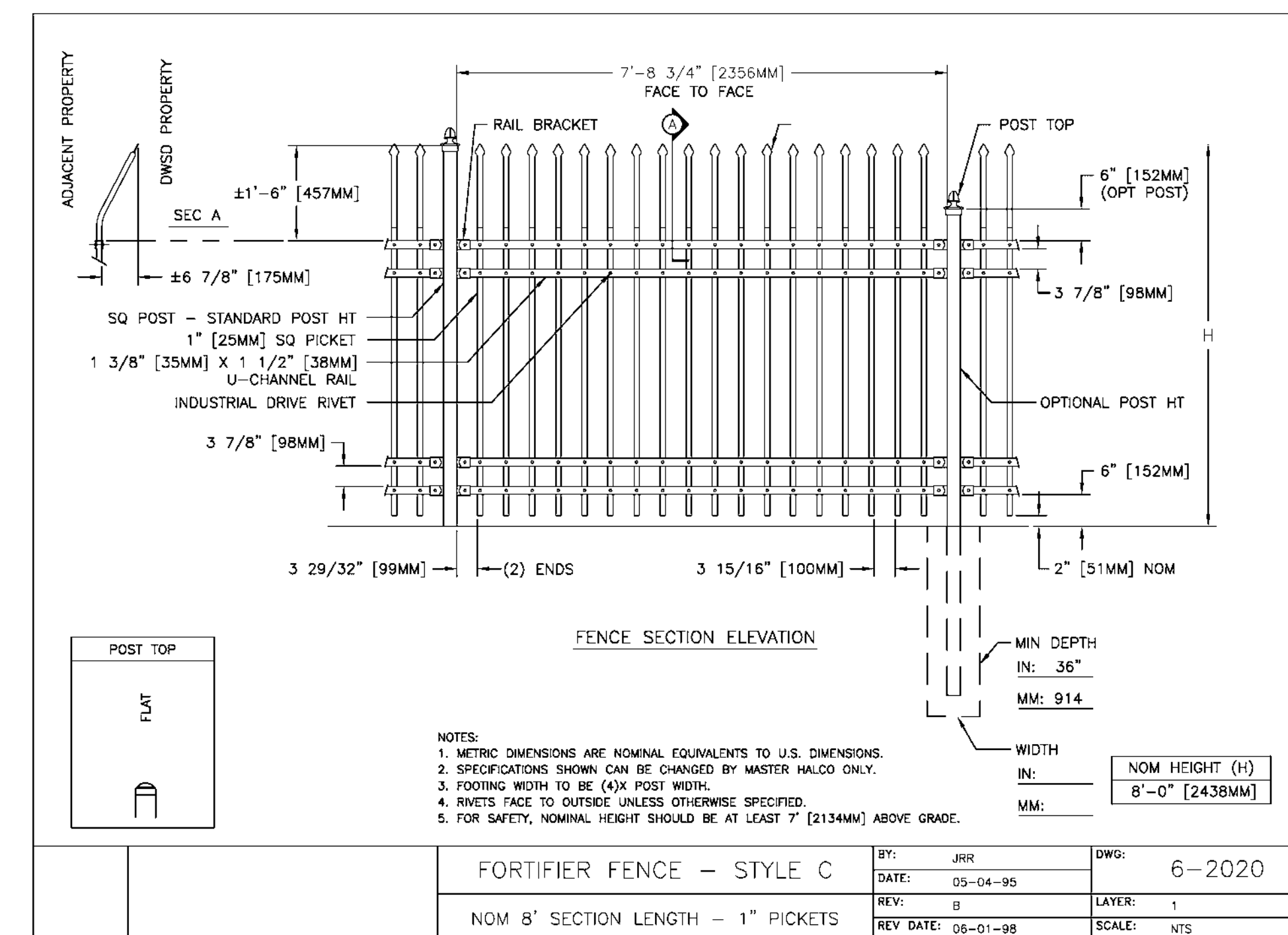


M.D.P.H./D.N.R. PERMIT NO.
FAMIS NO. -
CONTRACT NO. PC-755
FILE NO. CLSPL117
DRAWING NO. D-04-08-117



NOTES:

1. BOLTS SHALL BE INSTALLED ON ALL FOUR SIGN MOUNTING HOLES.
2. SIGNS ARE TO BE PLACED EVERY 50 YARDS ALONG THE PERIMETER FENCE LINE AND WITHIN 15 YARDS OF CORNERS
3. BOTTOM OF SIGNS SHALL BE LOCATED 4' ABOVE FINISHED GRADE.



RECORD DRAWING

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By DUANE D. DeDENE Date 08/2012

**CDM
Smith**

						DESIGN	PK
						DRAFTING	PK
		REVISED FOR RECORD		8/12	DDD	CHECKED	BJ
1		CONFORMED SET		8/07	RH		
NO.		DESCRIPTION	NO.	DATE	APRVD	APPROVED	RH
		REVISIONS					

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION
FENCING DETAILS

SCALE: AS NOTED

DATE: DECEMBER 15, 2006

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Detroit, MI 48226
Fax: 313.663.3888



SECTION	
—	—

CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

MAP	TOWN	RANGE	SECTION	PORTION	CODE
-	-	-	-	-	-

M.D.P.H./D.N.R. PERMIT NO.

FAMIS NO.

CONTRACT NO.	
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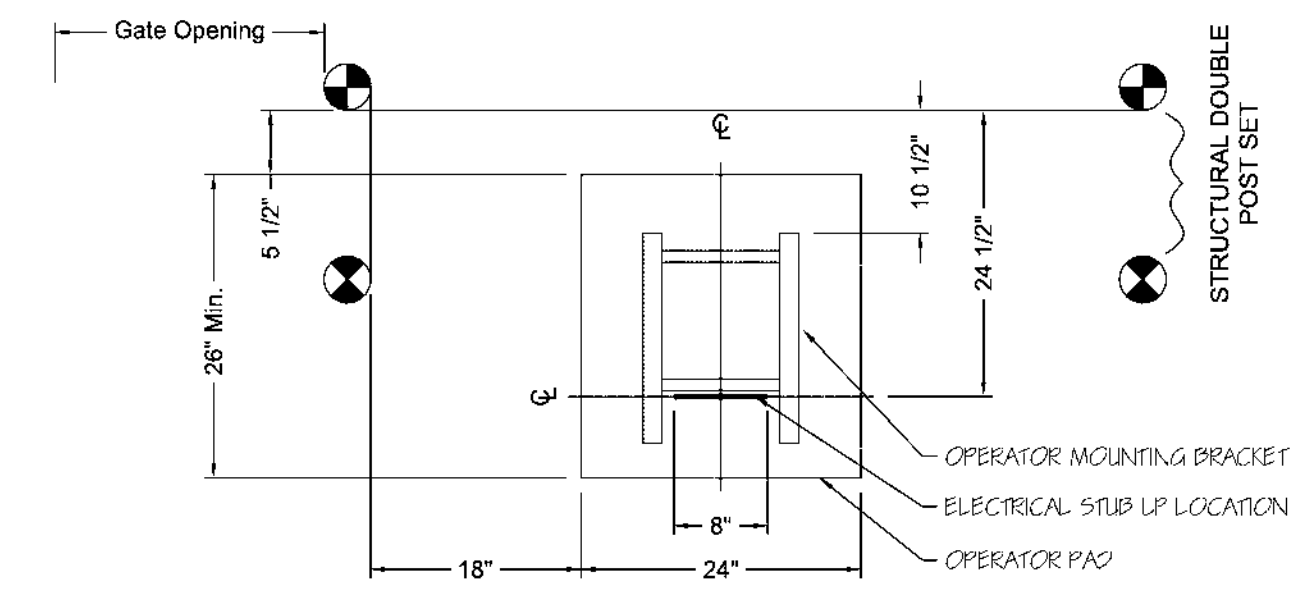
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FILE NO.

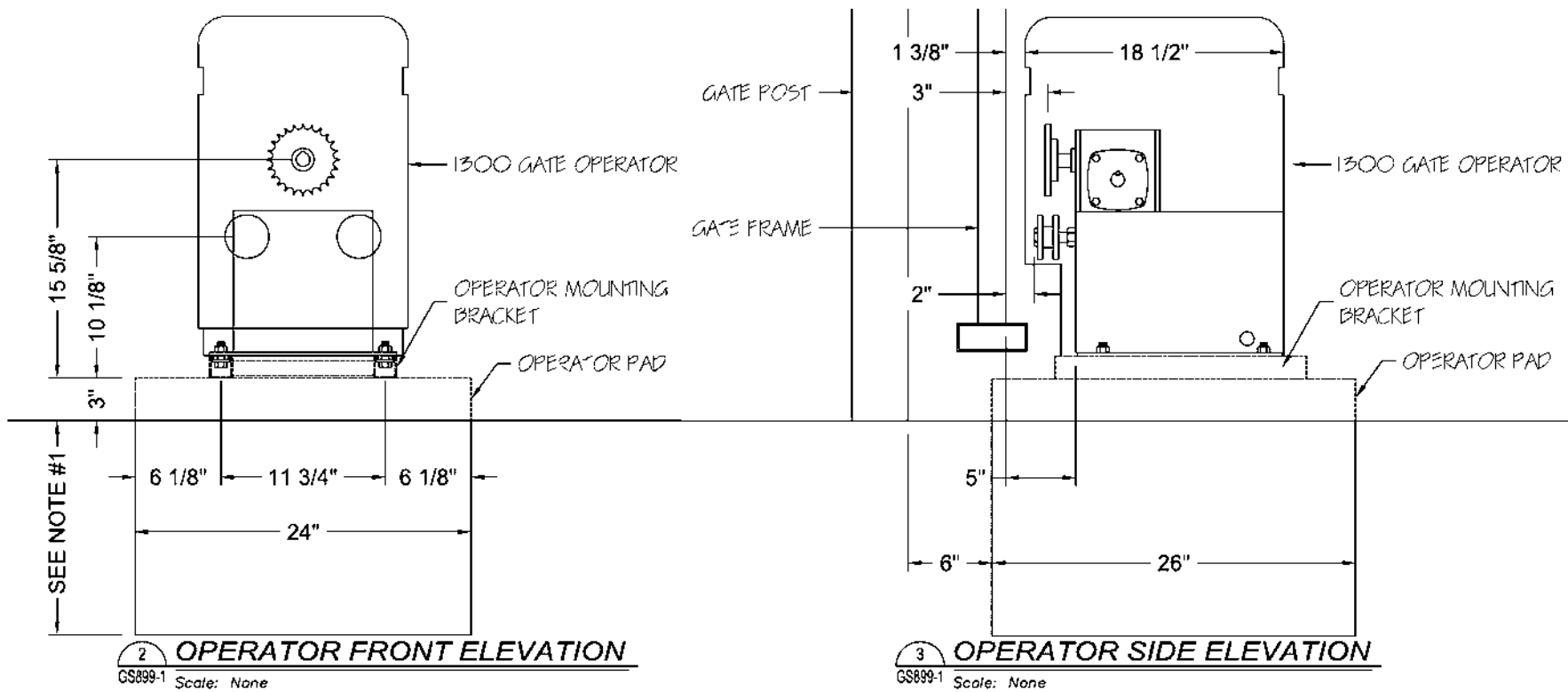
CLSDT119

DRAWING NO. D 04 08 1

LANDSCAPE



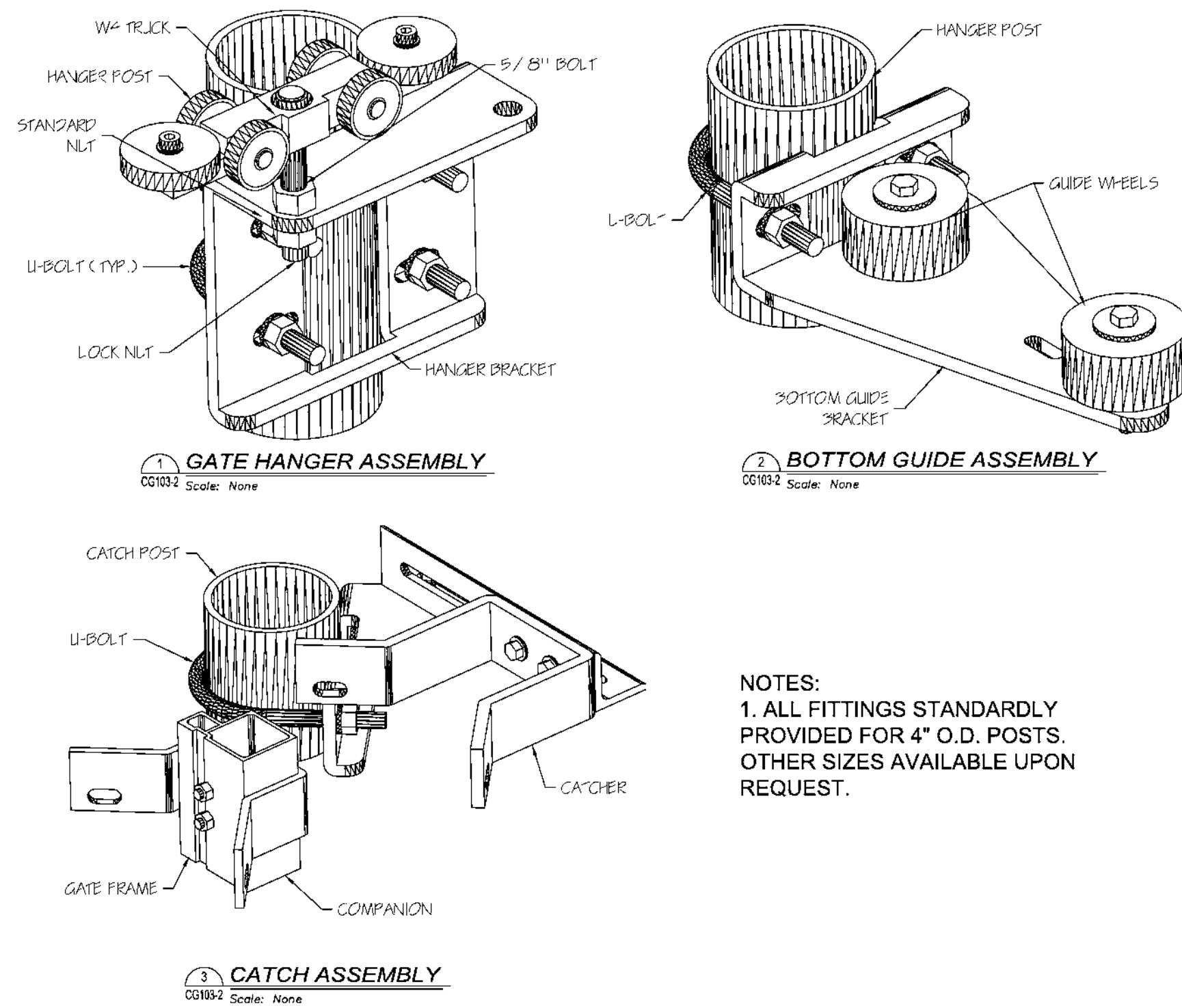
OPERATOR PAD LAYOUT PLAN
Scale: None



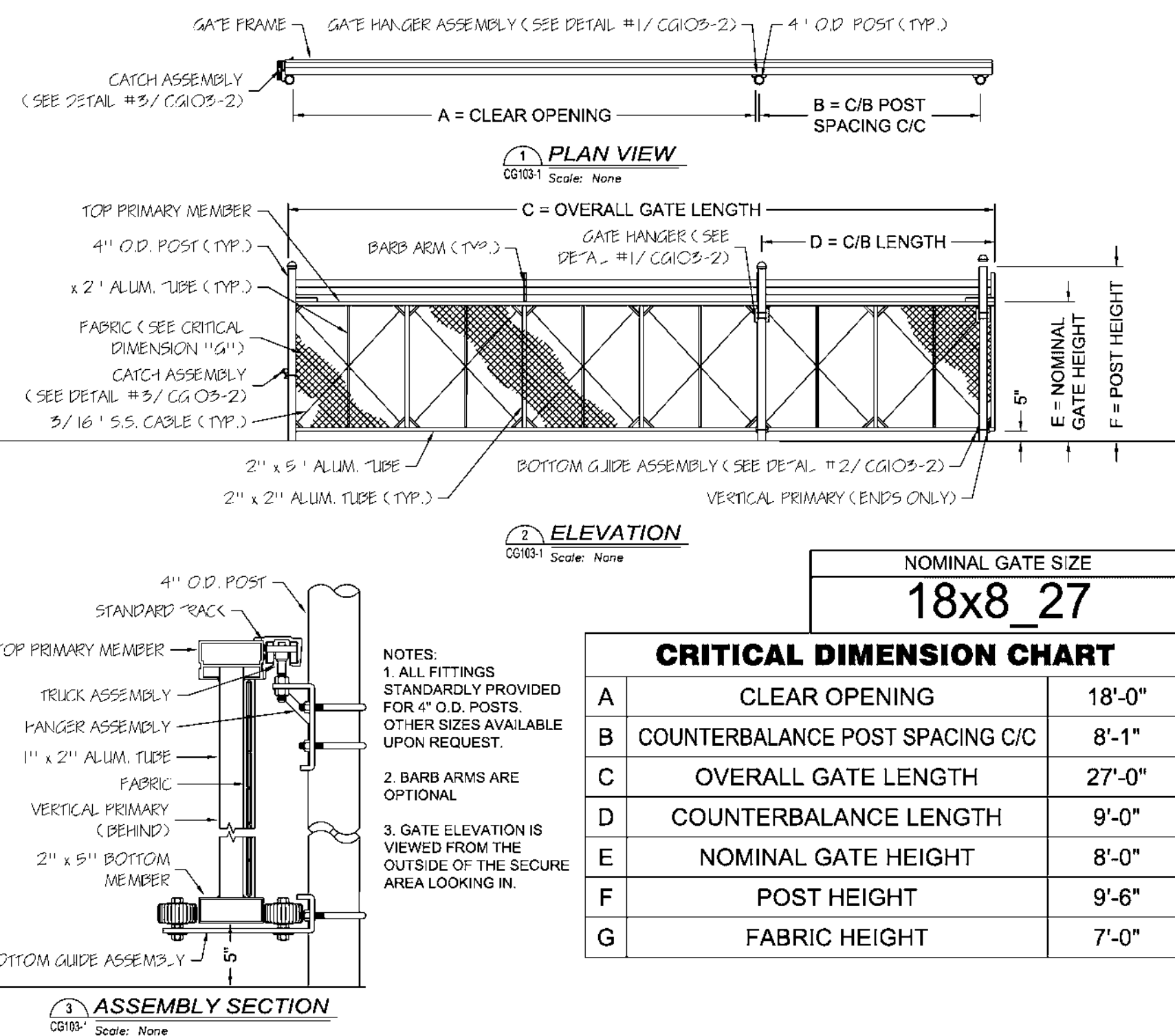
OPERATOR FRONT ELEVATION
Scale: None

OPERATOR SIDE ELEVATION
Scale: None

C VEHICULAR GATE OPERATOR
119B DETAIL SCALE: NTS

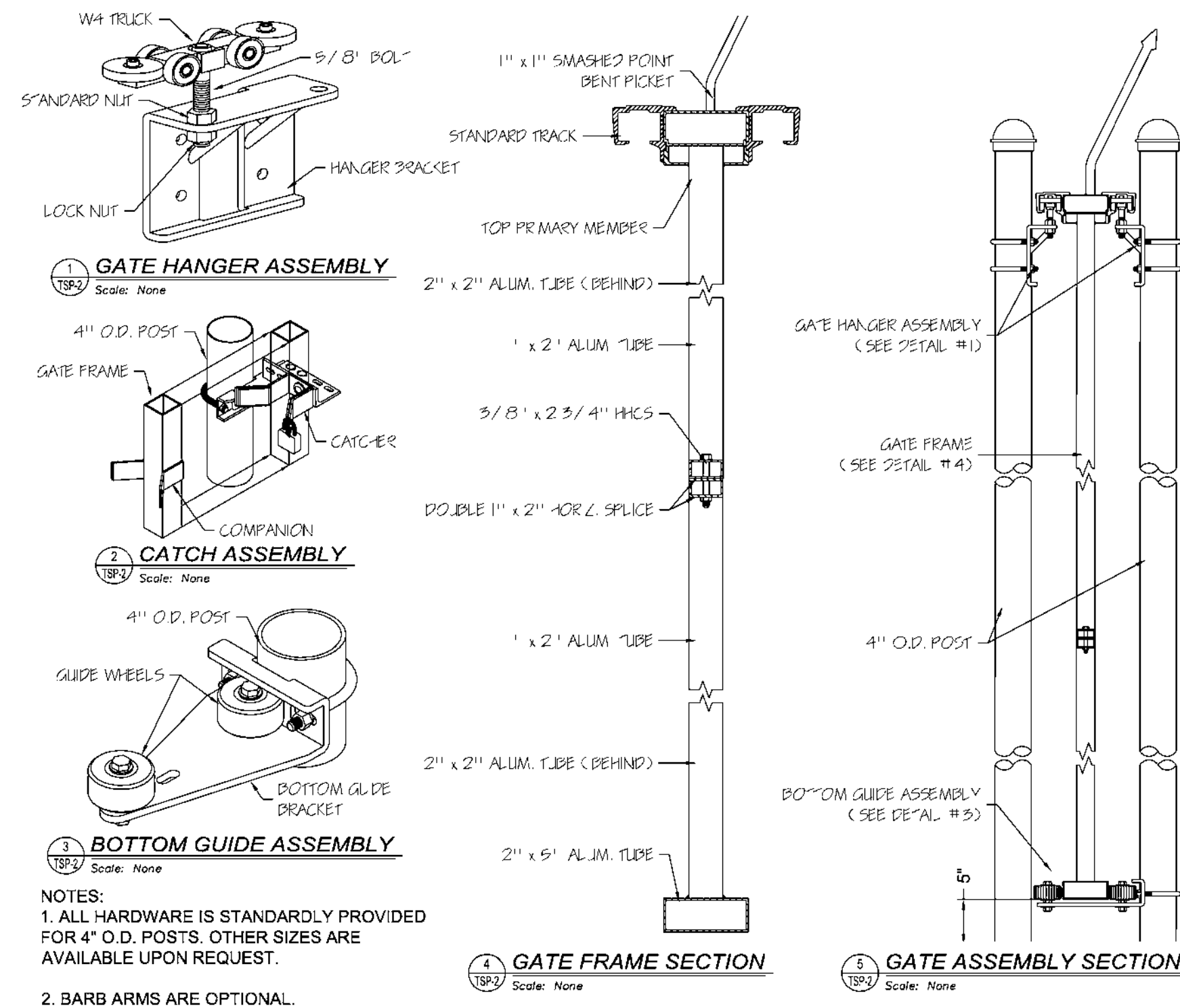


NOTES:
1. ALL FITTINGS STANDARDLY PROVIDED FOR 4" O.D. POSTS. OTHER SIZES AVAILABLE UPON REQUEST.

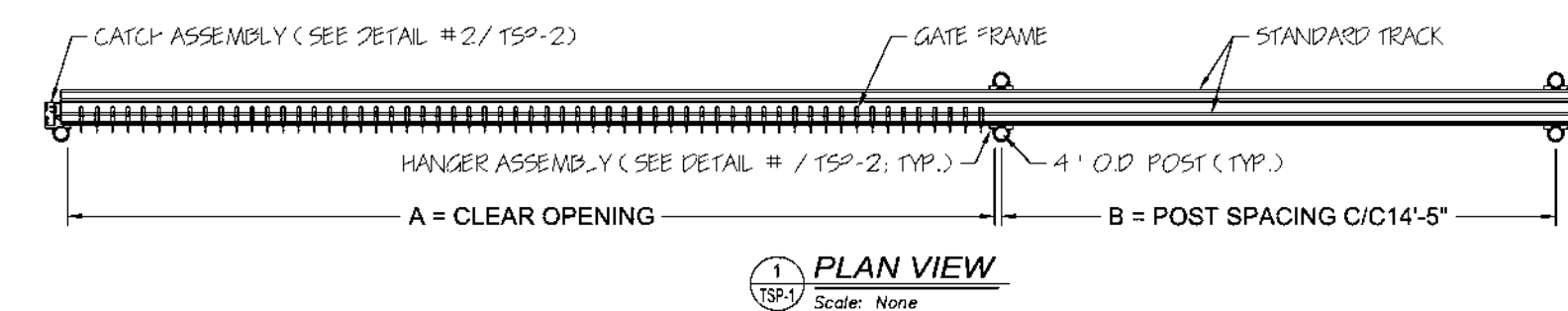


NOMINAL GATE SIZE		
18x8_27		
CRITICAL DIMENSION CHART		
A	CLEAR OPENING	18'-0"
B	COUNTERBALANCE POST SPACING C/C	8'-1"
C	OVERALL GATE LENGTH	27'-0"
D	COUNTERBALANCE LENGTH	9'-0"
E	NOMINAL GATE HEIGHT	8'-0"
F	POST HEIGHT	9'-6"
G	FABRIC HEIGHT	7'-0"

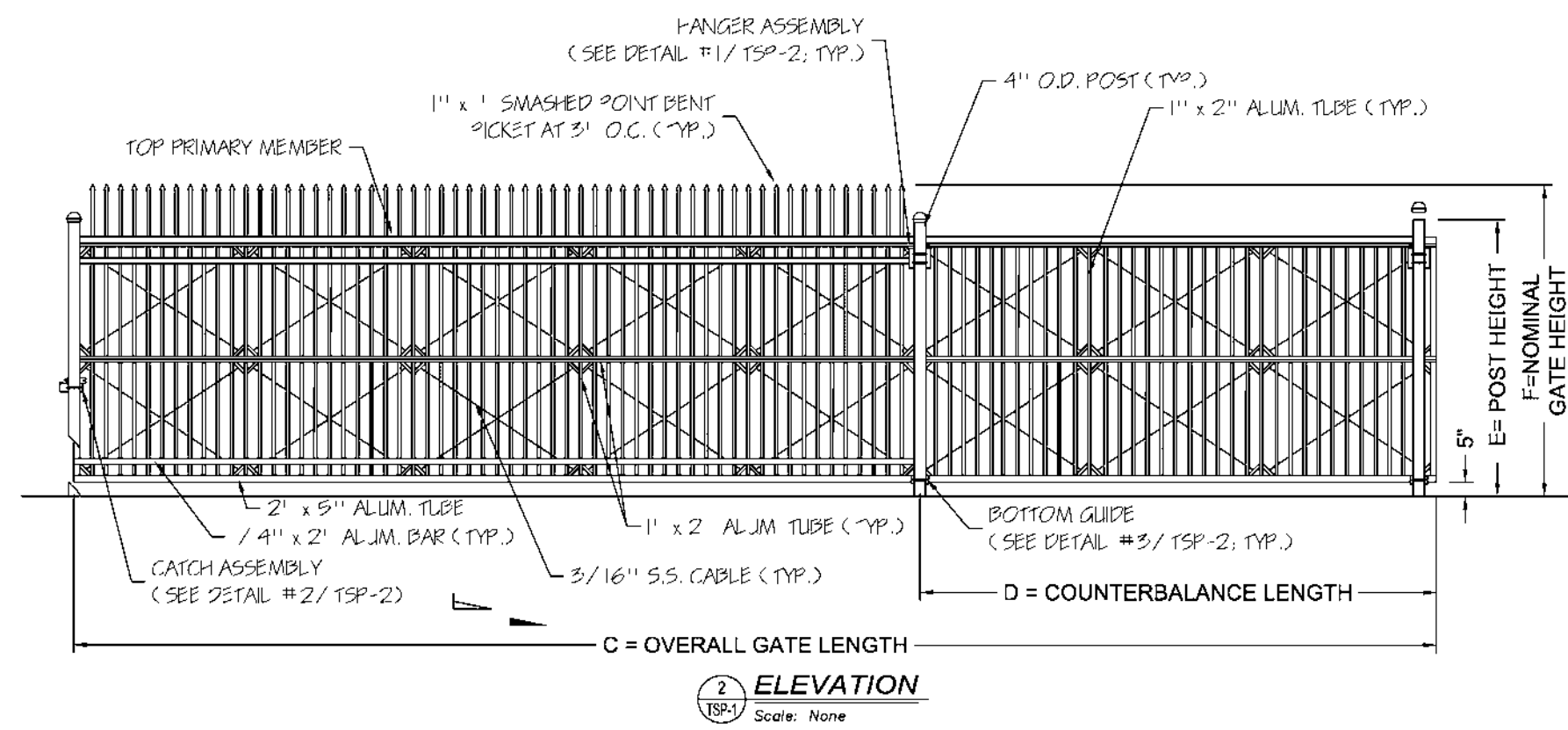
B VEHICULAR GATE - TYPE B
119B DETAIL SCALE: NTS



NOTES:
1. ALL HARDWARE IS STANDARDLY PROVIDED FOR 4" O.D. POSTS. OTHER SIZES ARE AVAILABLE UPON REQUEST.
2. BARB ARMS ARE OPTIONAL.



PLAN VIEW
Scale: None



ELEVATION
Scale: None

CRITICAL DIMENSION CHART					
A	CLEAR OPENING WIDTH	36'-0"	D	COUNTERBALANCE LENGTH	18'-0"
B	POST SPACING C/C	17'-1"	E	POST HEIGHT	8'-0"
C	OVERALL GATE LENGTH	54'-0"	F	NOMINAL GATE HEIGHT	9'-0"
			G	PICKET HEIGHT	1'-6"

A VEHICULAR GATE - TYPE A
119B DETAIL SCALE: NTS

RECORD DRAWING

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By DUANE D. DeDENE Date 08/2012

CDM Smith

DESIGN	DK
DRAFTING	PK
CHECKED	BJ
APPROVED	RH
1	REVISOR
NO.	DESCRIPTION
1	REVISOR
NO.	DESCRIPTION
1	REVISOR
NO.	DESCRIPTION

DETROIT WATER AND SEWERAGE DEPARTMENT OAKWOOD CSO CONTROL FACILITY AND PUMP STATION FENCING DETAILS

SCALE: AS NOTED

DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc.
One Woodward Avenue, Suite 1500
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Phone: 313-964-7765 Fax: 313-964-7782

SUPERIOR ENGINEERING ASSOC., INC.
650 Woodward Ave., Suite 2100, Detroit, MI 48226
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www.superioreng.com

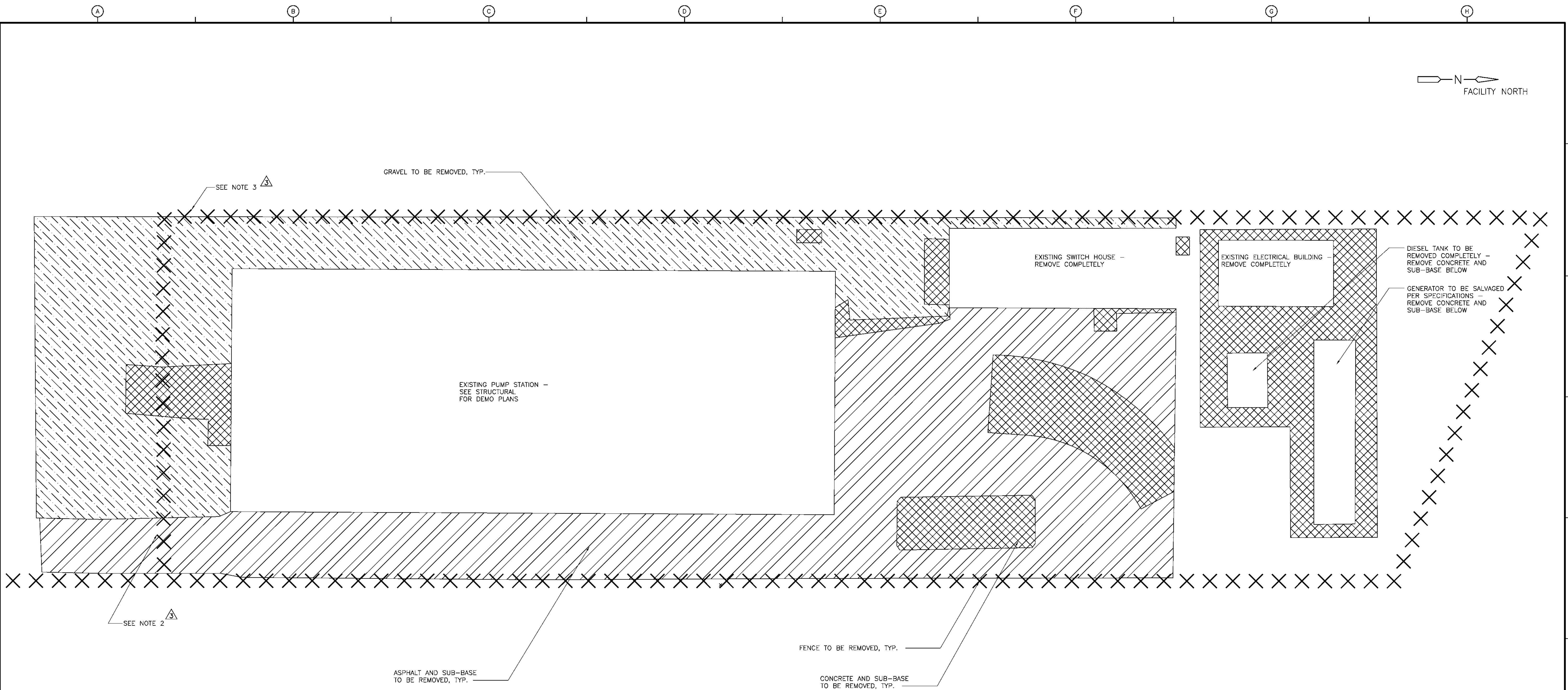
SOMAT Engineering, Inc.
600 Woodward Ave., Suite 1200, Detroit, Michigan 48226
Phone: (313) 963-0812 Fax: (313) 963-2108

Sigma Consulting Engineers
200 Woodward Ave., Suite 1700
Detroit, MI 48226
Phone: (313) 963-0700 Fax: (313) 963-0701

**CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION**

SECTION MAP TOWN RANGE SECTION PORTION CODE

M.D.P.H./D.N.R. PERMIT NO.
FAMIS NO.
CONTRACT NO. **PC-755**
FILE NO. **CLSDT119B**
DRAWING NO. **D-04-08-119B**



3

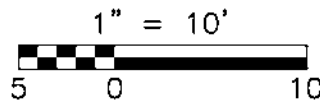
NOTES:

- EXISTING PUMP STATION SITE PERIMETER FENCE SHALL REMAIN IN SERVICE UNTIL EXISTING PUMP STATION TAKEN OFF-LINE.
- REMOVE EXISTING DWSD MOTORIZED GATE SECURITY EQUIPMENT AND PROVIDE TO DWSD. PROVIDE TEMPORARY MANUALLY OPERATED DOUBLE LEAF GATE SECURED WITH PADLOCK ON THE WESTERN END OF THE SOUTH FENCE TO ALLOW TEMPORARY ACCESS TO THE PUMP STATION DURING CONSTRUCTION OF THE EAST EFFLUENT CONDUIT.
- PRIOR TO EFFLUENT CONDUIT CONSTRUCTION, RELOCATE EXISTING WEST WOLVERINE FENCE AND MOTORIZED GATE TO TEMPORARY EASEMENT LIMIT SHOWN ON DWG 004A. MOTORIZED GATE TO REMAIN MOTOR OPERATED IN THIS TEMPORARY LOCATION. ADD FENCE OF THE SAME TYPE AS EXIST, AS NEEDED, TO WRAP AROUND THE S, N AND W SIDES OF EXIST BUILDING. RELOCATE FENCE AND GATE TO PERMANENT WEST EASEMENT LIMIT AT COMPLETION OF CONSTRUCTION IN THIS AREA. MOTOR OPERATED GATE TO REMAIN MOTOR OPERATED IN PERMANENT LOCATION. THE ABOVE APPLIES TO THE FENCE/GATE BETWEEN THE EXIST SOUTH AND NORTH WOLVERINE FENCES.

EXISTING PUMP STATION DEMOLITION

PLAN

1" = 10'



LEGEND

- ASPHALT AND ALL SUB-BASE TO BE REMOVED AND DISPOSED OF LAWFULLY
- CONCRETE AND ALL SUB-BASE TO BE REMOVED AND DISPOSED OF LAWFULLY
- GRAVEL TO BE REMOVED AND DISPOSED OF LAWFULLY
- FENCE, FENCE POSTS AND CONCRETE FOOTINGS TO BE REMOVED AND DISPOSED OF LAWFULLY

NOTES

- ALL SUITABLE EXISTING TOPSOIL SHALL BE STRIPPED AND STOCKPILED FOR PROJECT USE.

RECORD DRAWING

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By DUANE D. DeDENE Date 08/2012

CDM
Smith

					DESIGN	PK
					DRAFTING	PK
					CHECKED	BJ
					APPROVED	RH
1	REVISED FOR RECORD	8/12	DDD			
	REVISED PER BULLETIN NO. 3	3/07	RH			
NO.	DESCRIPTION	NO.	DATE	APRVD		
REVISIONS						

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

EXISTING OAKWOOD PS
DEMOLITION PLAN

SCALE: 1"=10'-0"

DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc.
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CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP TOWN RANGE SECTION PORTION CODE

SECTION MAP TOWN RANGE SECTION PORTION CODE

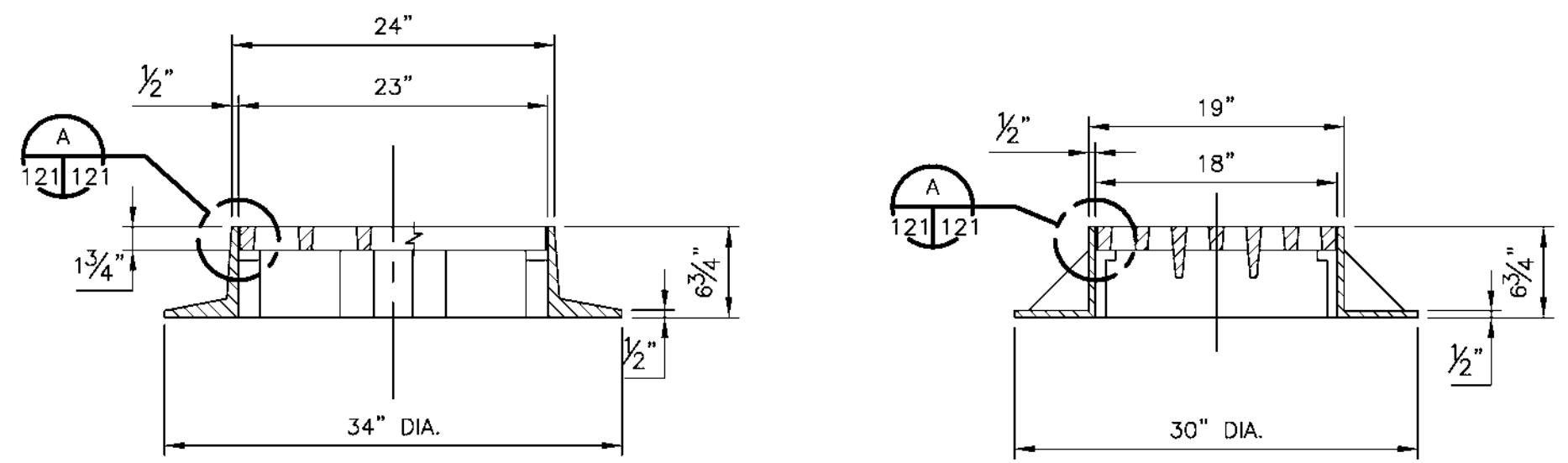
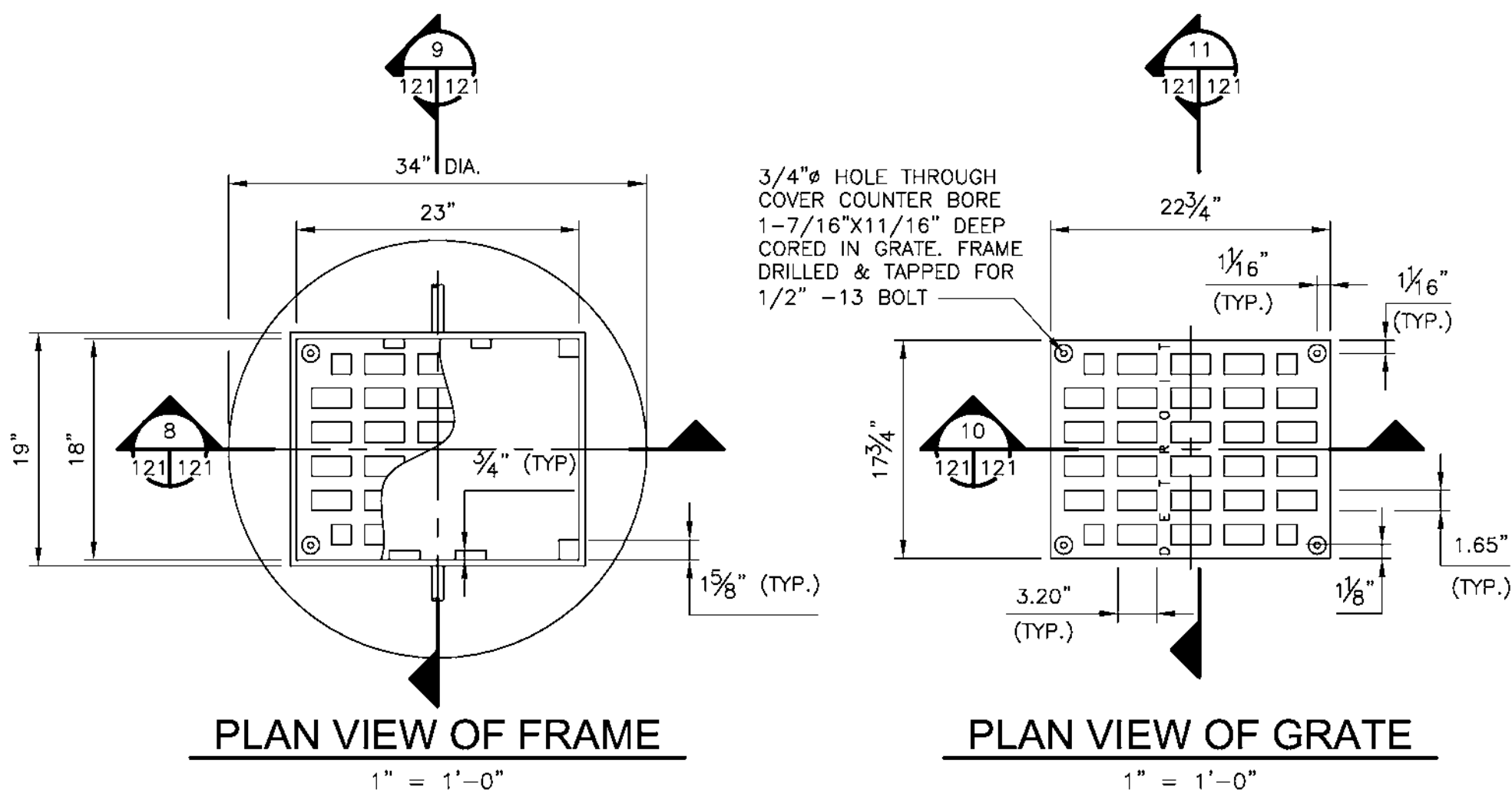
M.D.P.H./D.N.R. PERMIT NO.

FAMIS NO. -

CONTRACT NO. PC-755

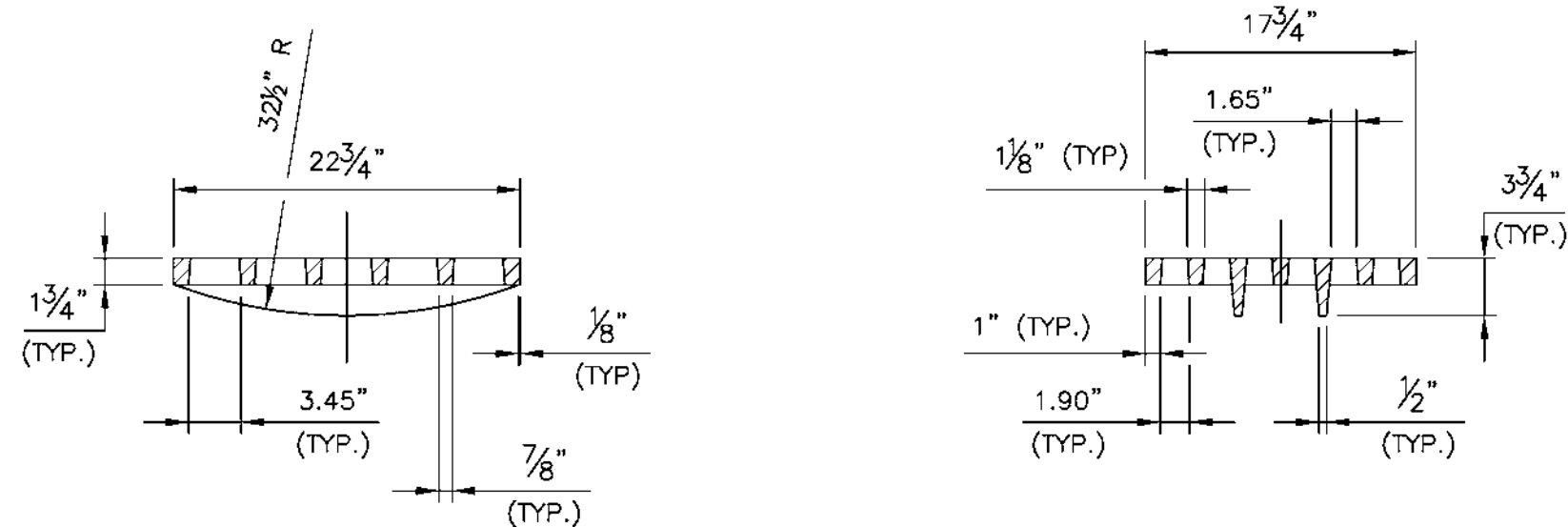
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DRAWING NO. D-04-08-120



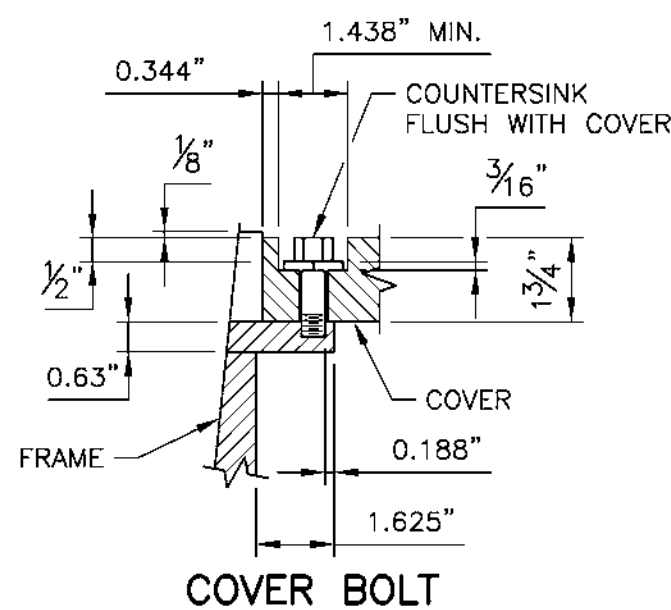
SECTION 8
1" = 1'-0"

SECTION 9
1" = 1'-0"



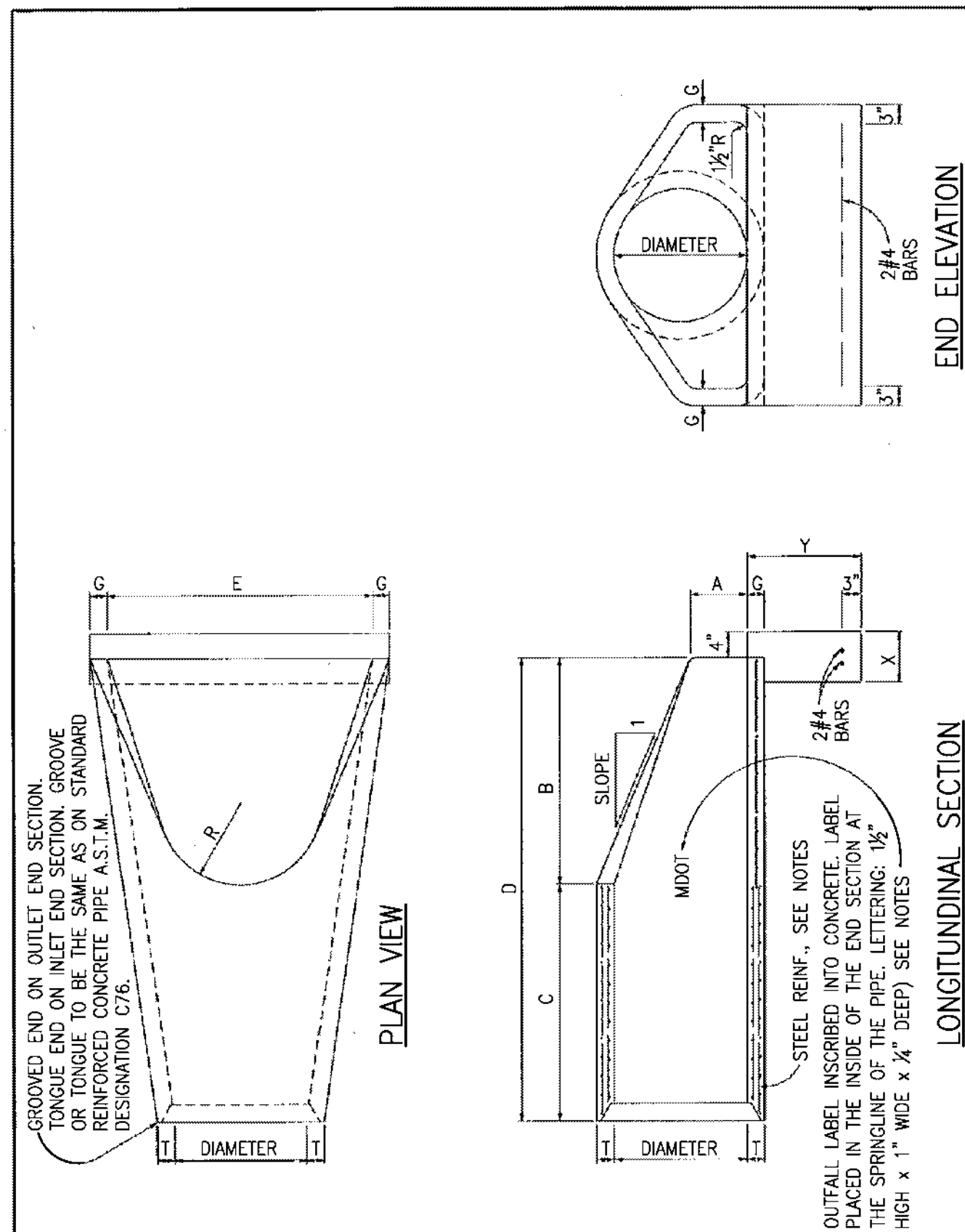
SECTION 10
1" = 1'-0"

SECTION 11
1" = 1'-0"

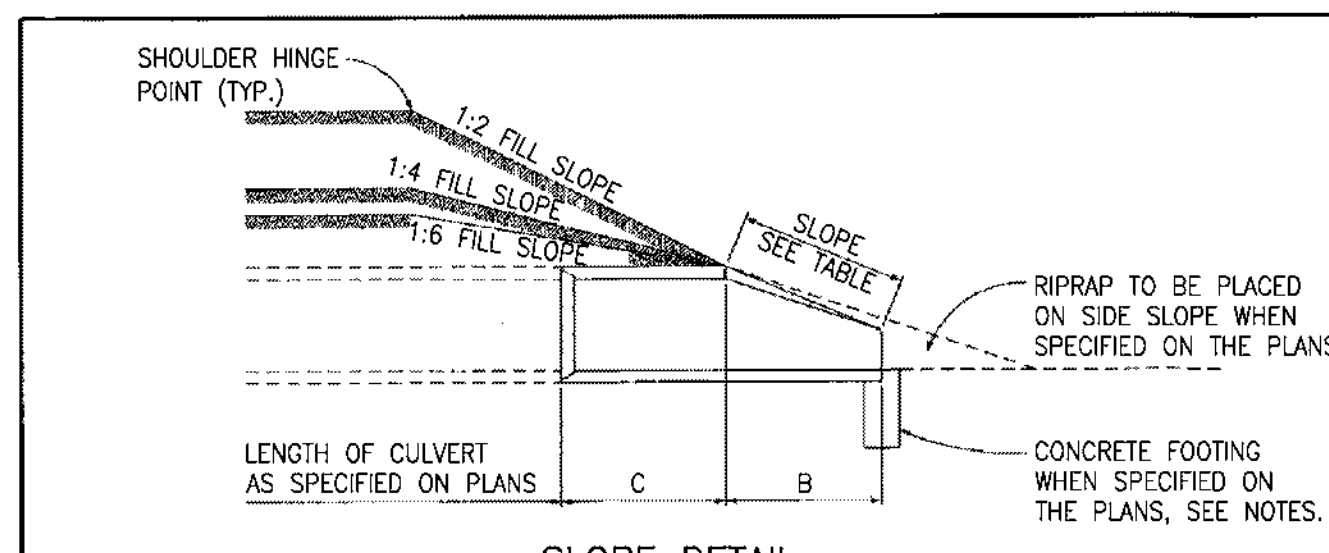


FLAT GRATE AND FRAME DETAILS
AS NOTED

MATERIAL:
GRAY IRON A.S.T.M. STD. SPEC. A-48, CLASS 30 BEARING SURFACES OF COVER AND FRAME SHALL BE GRIND TO PREVENT ROCKING, CASTING SHALL NOT BE COATED.



PRECAST CONCRETE END SECTION FOR PIPE CULVERT
1" = 1'-0"



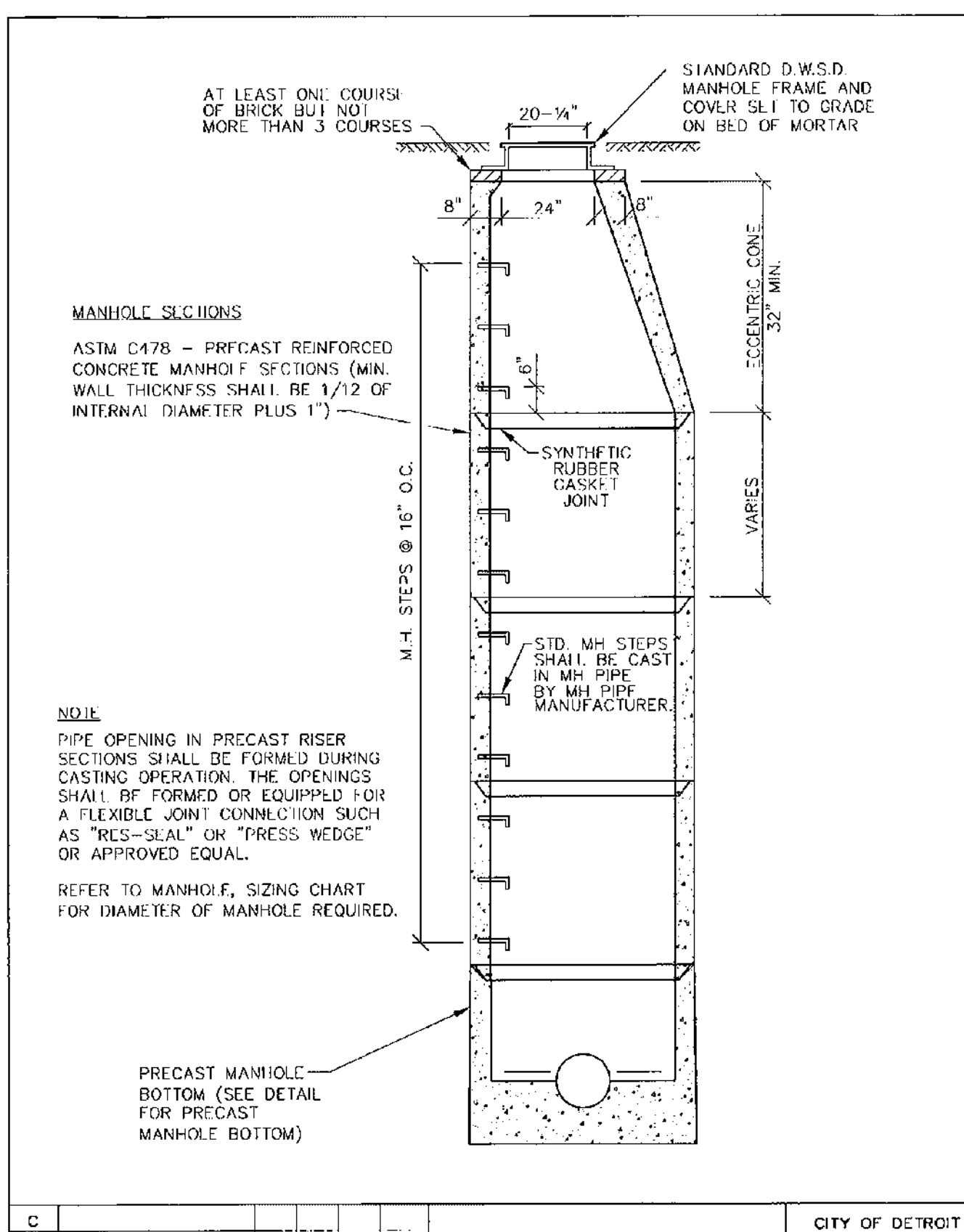
SLOPE DETAIL
1" = 1'-0"

PIPE DIA. (IN.)	APPROX. SLOPE	T (IN.)	A (IN.)	B (IN.)	C (IN.)	D (IN.)	E (IN.)	G (IN.)	R (IN.)	X (IN.)	Y (IN.)
12	2.4 TO 1	2	4	24	49	73	24	2	9	8	18
15	2.4 TO 1	2 1/4	6	27	46	73	30	2 1/4	11	8	18
18	2.3 TO 1	2 1/2	9	27	46	73	36	2 1/2	12	8	18

* AS FURNISHED BY THE MANUFACTURER.

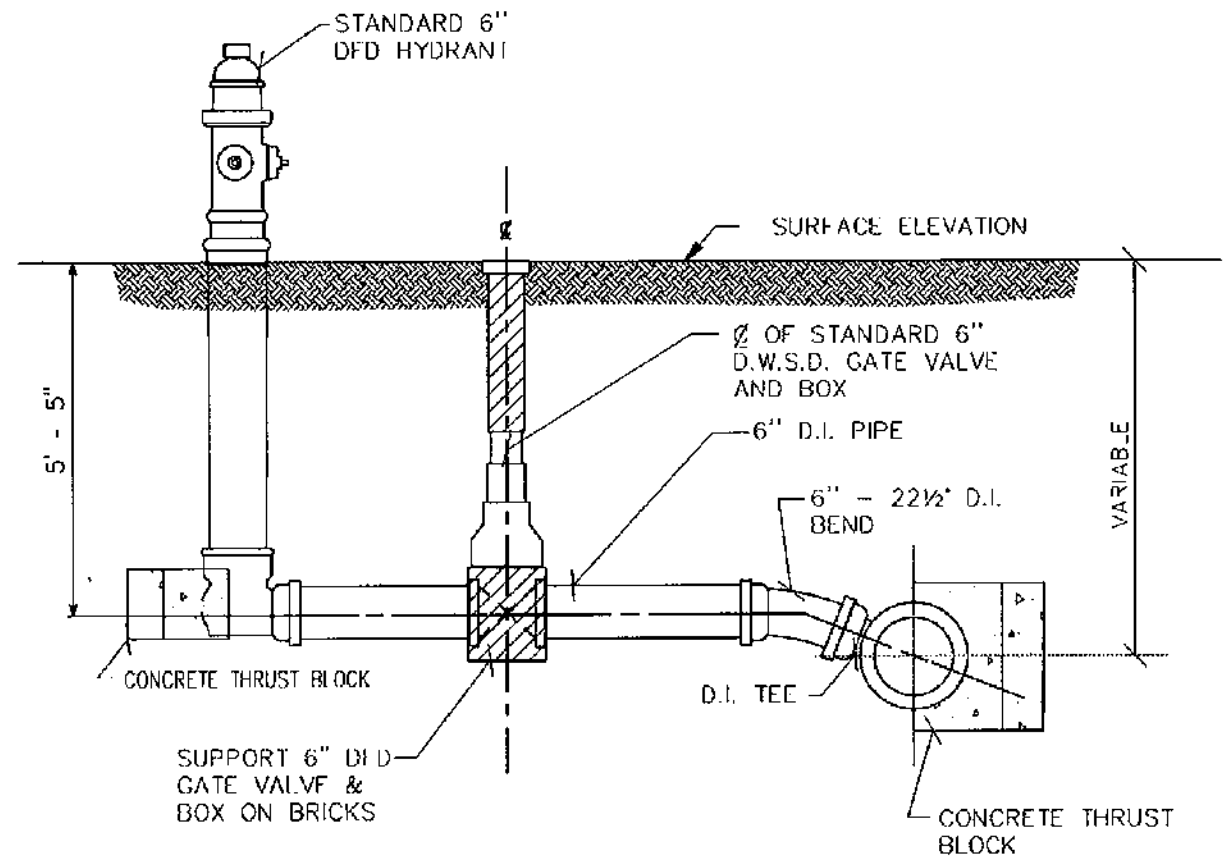
- NOTES:**
- CONCRETE IN THESE END SECTIONS SHALL BE THE SAME GRADE AND STRENGTH AS SPECIFIED FOR REINFORCED CONCRETE PIPE, A.S.T.M. DESIGNATION C76 CLASS II, EXCEPT AS MODIFIED BY THE STANDARD SPECIFICATION.
 - REINFORCEMENT IN THE "C" PORTION SHALL BE THE SAME AS SPECIFIED FOR REINFORCED CONCRETE, A.S.T.M. DESIGNATION C76 CLASS II FOR THE SIZE OF CONNECTING PIPE.
 - REINFORCEMENT IN THE "B" PORTION SHALL HAVE A CROSS-SECTIONAL AREA EQUAL TO THAT OF ONE LAYER OF STEEL IN THE "C" PORTION.
 - THE END OF THE PIPE CULVERT SHALL BE PLACED IN THE CONCRETE END SECTION SO THAT THE FLOW LINES ARE FLUSH. THE JOINT SHALL BE COMPLETELY FILLED WITH MORTAR.
 - TO CHANGE THE FILL SLOPE TO THE SLOPE OF THE END SECTION, USE A TRANSITION SLOPE OF APPROXIMATELY 10' IN LENGTH TO PROVIDE A PLEASING APPEARANCE.
 - VARIATIONS IN DIMENSIONS - THE THICKNESS OF CONCRETE, THE POSITION OF STEEL, AND THE INTERNAL DIAMETER OF THE PIPE SHALL CONFORM WITH THE VARIATIONS IN DIMENSIONS AS PROVIDED IN THE SPECIFICATIONS FOR REINFORCED CONCRETE CULVERT, STORM DRAINS, AND SEWER PIPE, A.S.T.M. DESIGNATION C76.
 - PLACE CONCRETE FOOTING WHEN CULVERT GRADE IS 4% OR MORE, OR WHEN SPECIFIED ON THE ROAD PLANS.
 - OUTFALL LABEL TO BE USED ONLY WHERE STORMWATER WILL DISCHARGE DIRECTLY TO THE WATERS OF THE STATE.

PRECAST CONCRETE END SECTION FOR PIPE CULVERT
1" = 1'-0"



MANHOLE, PRECAST
1" = 1'-0"

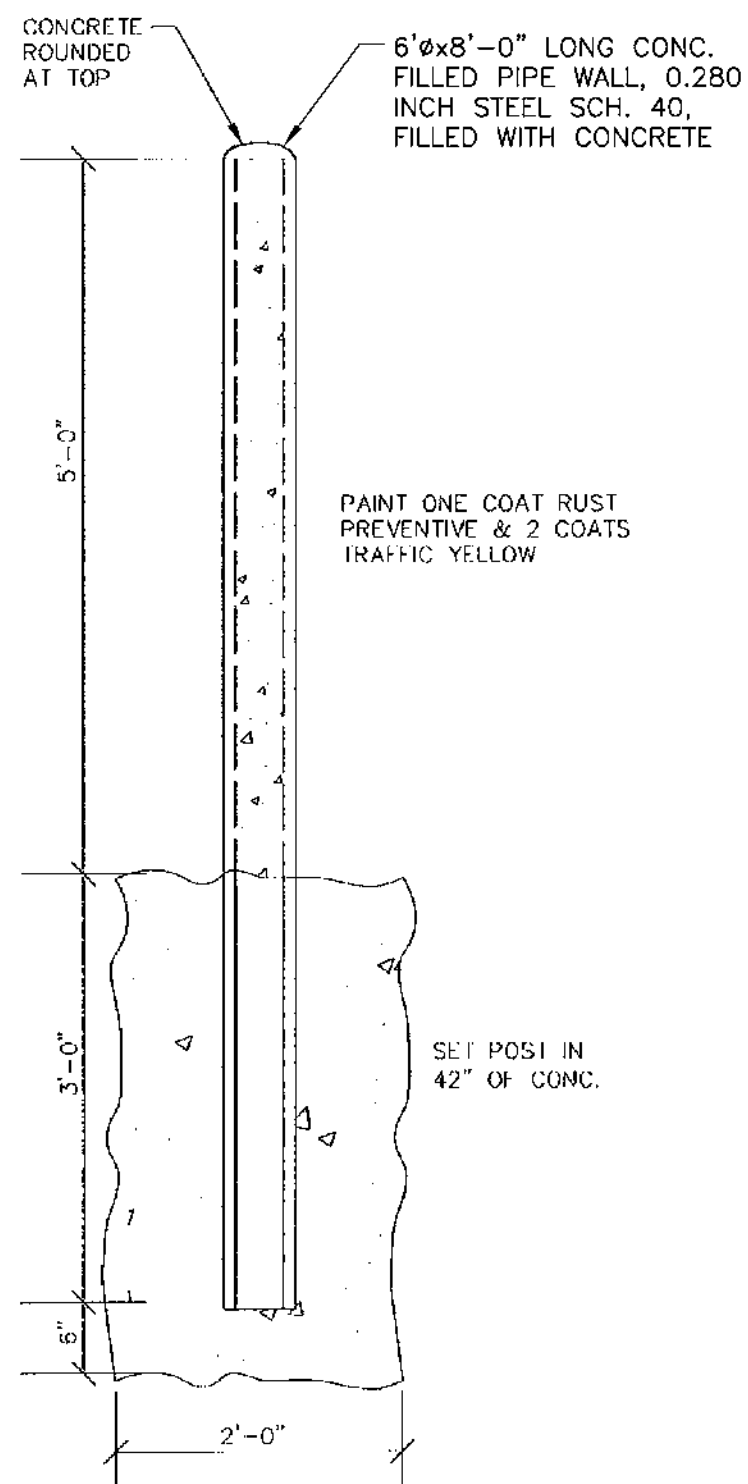
MANHOLES ASTM C-478											
WEIGHTS AND DIMENSIONS-US CUSTOMARY											
A	RISER DIAMETER	IN	24	48	60	72	84	96	108	120	
B	WALL THICKNESS	IN	3	5	6	7	8	9	10		
C	OUTSIDE DIAMETER	IN	50	58	72	86	100	114	126	140	
D	JOINT DEPTH	IN	2.75	2.75	4.75	5	5	5	5.25	7.5	
E	BELL THICKNESS	IN	1.31	2.75	3.28	3.88	4.48	4.93	5	5.5	
F	INTEGRAL BASE	IN	6	8	8	8	8	8	8	8	
G	RISER HEIGHTS	FT	2	3.33	3.33	3.33					
		FT	3	2.67	2.67	2.67	2.67	2.67	2.67	2.67	
		FT	4	4	4	4	4	4	4	4	
		FT	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33	



- NOTE:
1. HYDRANT TO BE A MINIMUM OF 3 FEET BEHIND CURB.
 2. THRUST BLOCKS TO BE SIZED ACCORDING TO THRUST BLOCK STANDARD DETAIL DRAWING NOS. 02620-01, 02, 03, 04, 05 AND 06 AS APPLICABLE.

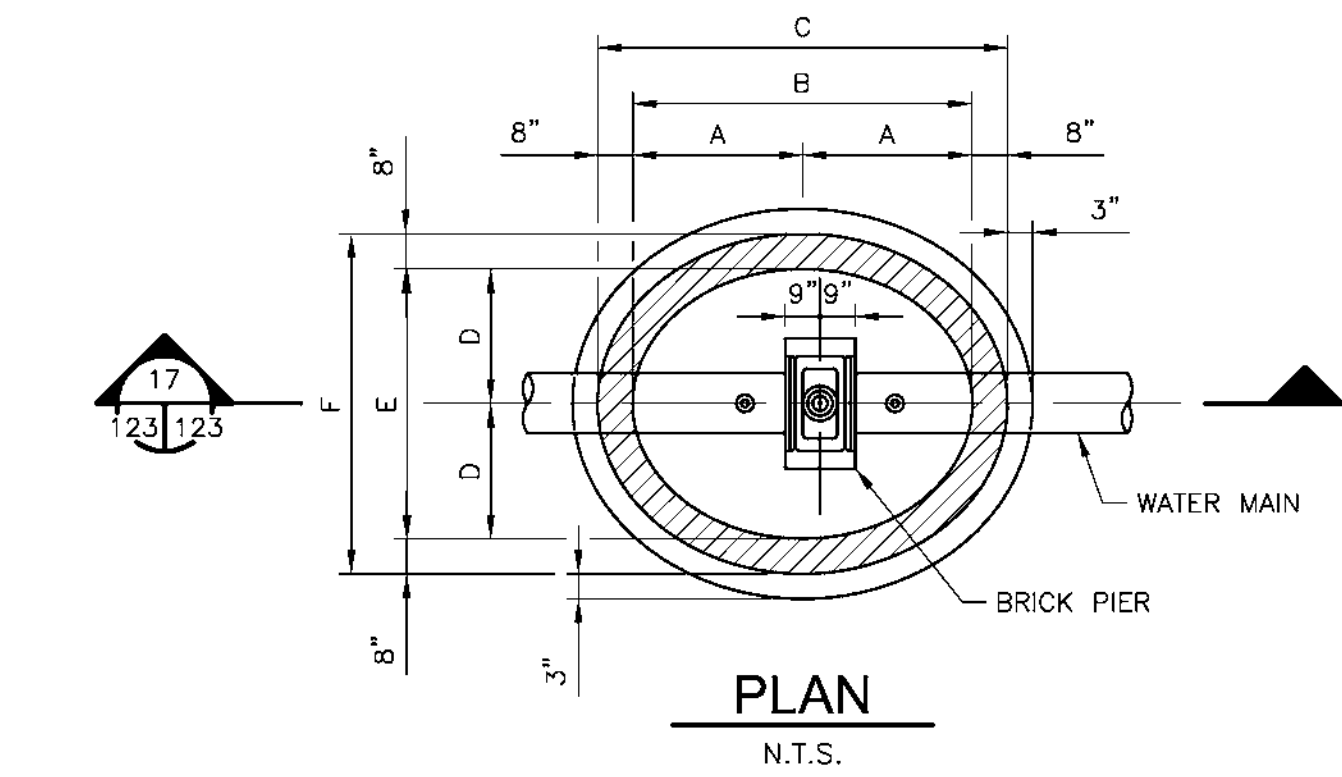
CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION				
DESCRIPTION	DRW	CKD	APP	DATE
REVISIONS				
DRAWN BY: S.D.A.				
CHECKED BY: S.D.A.				
APPROVED:				
SCALE: NONE				
SHEET 1 OF 1				
DWG. No. 02620-15				

HYDRANT, 6 INCH INSTALLATION STRAIGHT AWAY

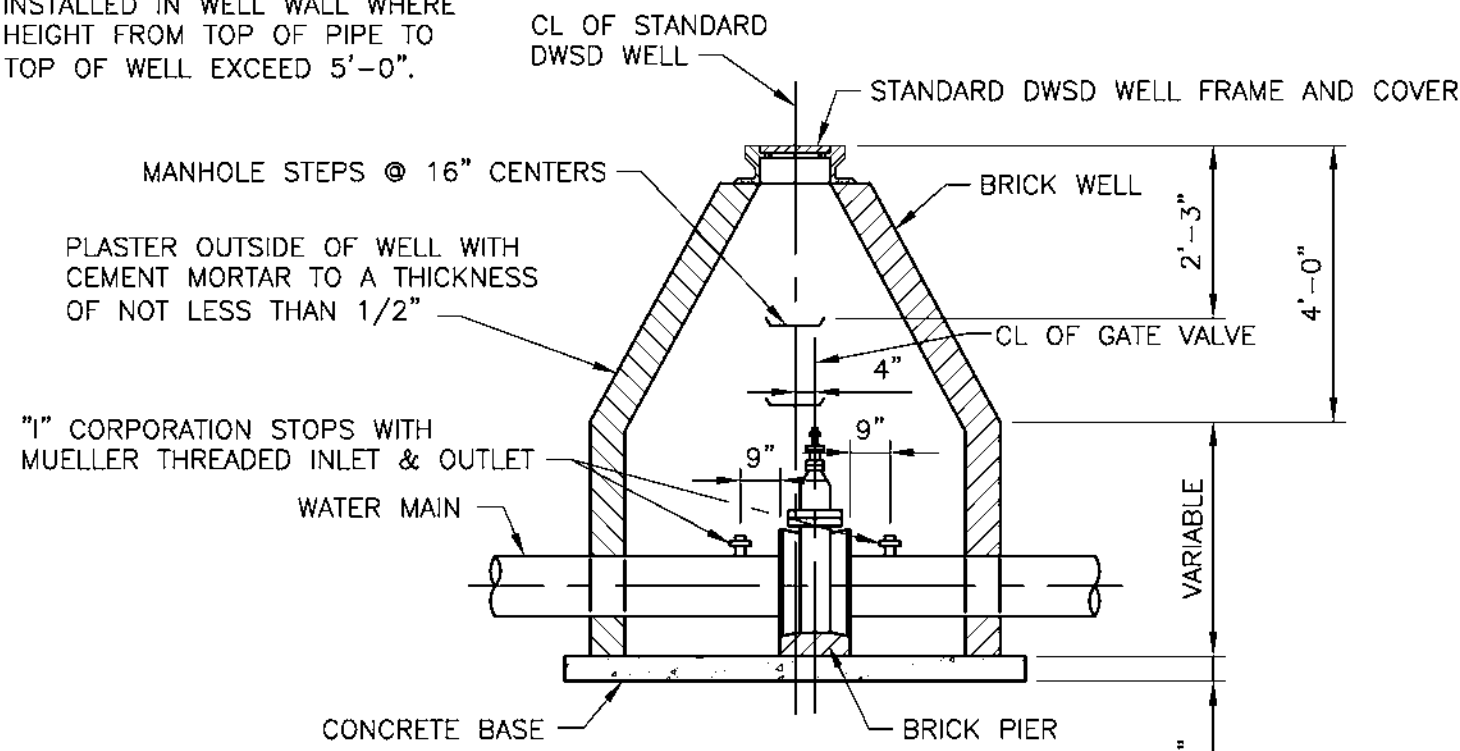


CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION				
DESCRIPTION	DRW	CKD	APP	DATE
REVISIONS				
DRAWN BY: S.D.A.				
CHECKED BY: S.D.A.				
APPROVED:				
SCALE: NONE				
SHEET 1 OF 1				
DWG. No. 03500-01				

BOLLARD, INDUSTRIAL



NOTE:
MANHOLE STEPS SHALL BE
INSTALLED IN WELL WALL WHERE
HEIGHT FROM TOP OF PIPE TO
TOP OF WELL EXCEED 5'-0".



SECTION 17
N.T.S.

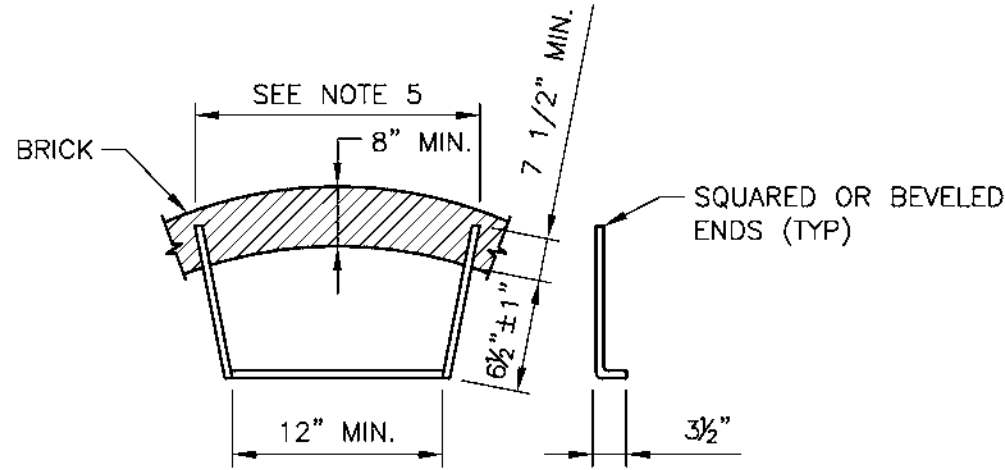
SCHEDULE OF GATE WELL DIMENSIONS						
SIZE	A	B	C	D	E	F
6" & 8"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"
12"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"
12"	2'-9"	5'-6"	6'-10"	2'-3"	4'-6"	5'-10"
16"	3'-0"	6'-0"	7'-4"	2'-9"	5'-6"	6'-10"

BRICK CONSTRUCTION NOTE:

WHERE A REDUCER/OMNI COUPLING IS CALLED FOR ON THE DRAWINGS, THE FACE OF THE NEAREST JOINT ON THE REDUCER/OMNI COUPLING SHALL BE APPROX. 2 FT. OR AS SHOWN ON THE DRAWING FROM THE OUTSIDE FACE OF THE WELL WALL.

FOR USE WITH DUCTILE IRON PIPE DETAIL OF STANDARD GATE WELL

NOT TO SCALE



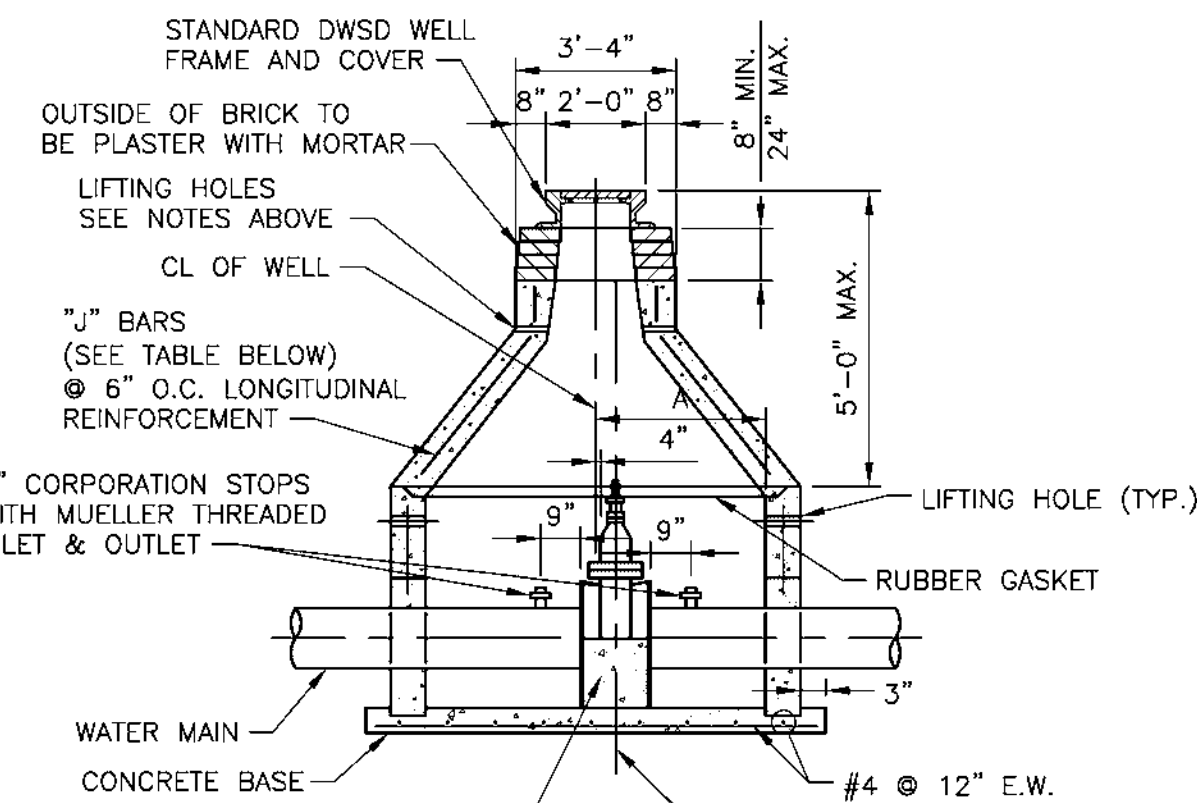
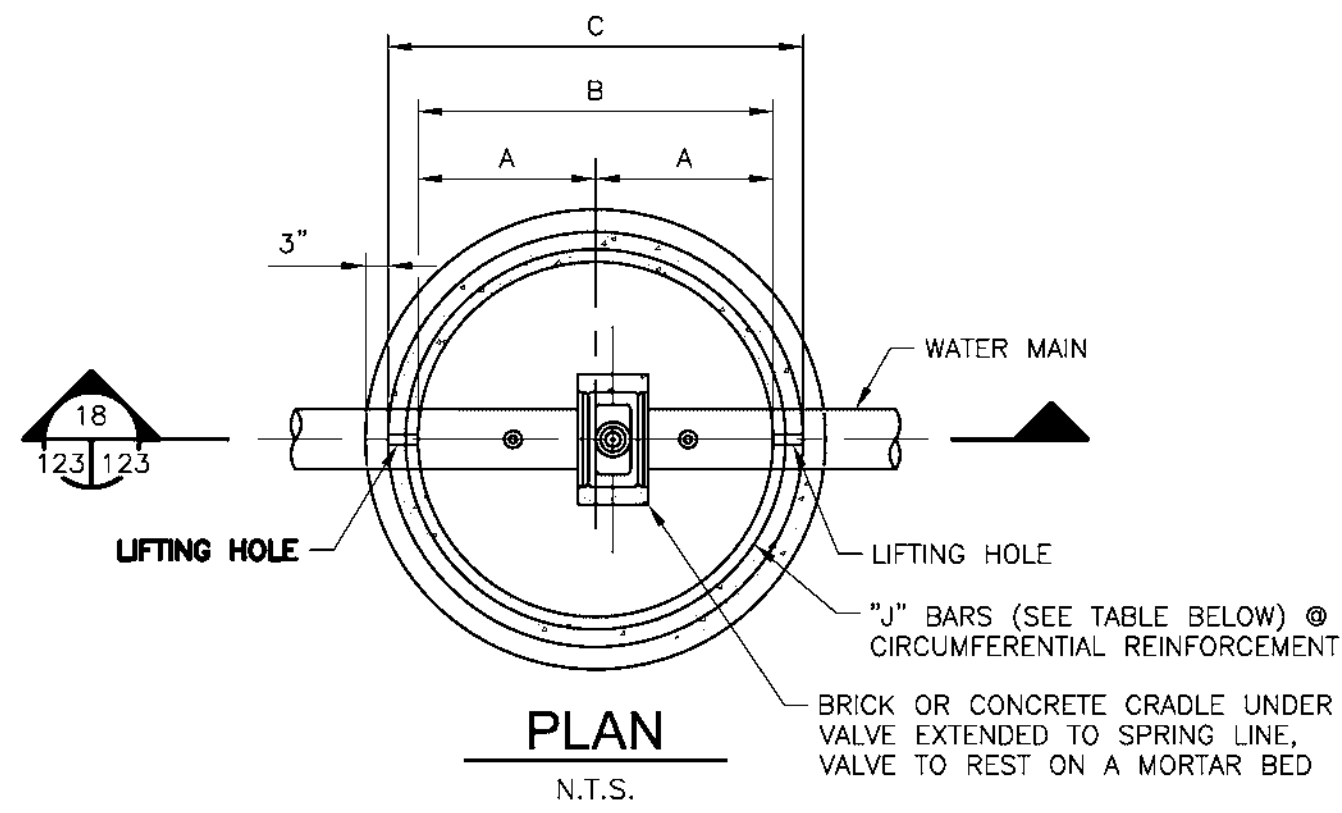
PLAN

(FOR USE WITH BRICK CONSTRUCTION)



PLAN

(FOR USE WITH PRECAST CONCRETE CONSTRUCTION)



SECTION 18
N.T.S.

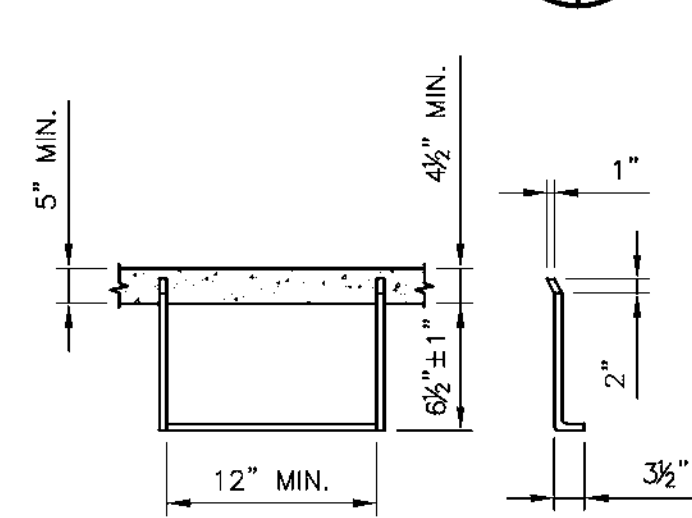
SCHEDULE OF PRECAST GATE WELL DIMENSIONS									
SIZE	A	B	C	D	E	F	G	H	J
6" & 8"	2'-6"	5'-0"	5'-10"	1'-3"	7 1/2"	10 1/2"	6"	5"	1/2"
12"	3'-0"	6'-0"	7'-2"	1'-7 1/2"	9 3/4"	1'-0 7/8"	8"	7"	5/8"
16"	3'-0"	6'-0"	7'-2"	2'-1"	1'-0 1/2"	1'-3 1/2"	8"	7"	5/8"

PRECAST CONCRETE NOTES:

1. PRECAST CONCRETE MANHOLE SECTIONS SHALL CONFORM TO ALL THE REQUIREMENTS OF "SPECIFICATIONS FOR PRECAST REINFORCED CONCRETE MANHOLE RISERS AND TOPS" A.S.T.M. C-478 WITH MODIFIED GROOVED TONGUE JOINTS AND RUBBER GASKETS.
2. EACH SECTION SHALL HAVE NOT MORE THAN TWO HOLES FOR HANDLING PURPOSES. THESE HOLES SHALL BE SATISFACTORILY PLUGGED AFTER INSTALLATION.

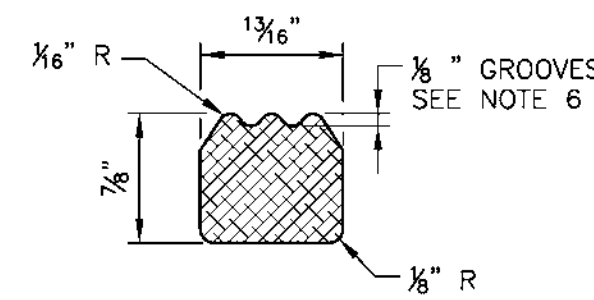
DETAIL OF PRECAST GATE WELL

NOT TO SCALE

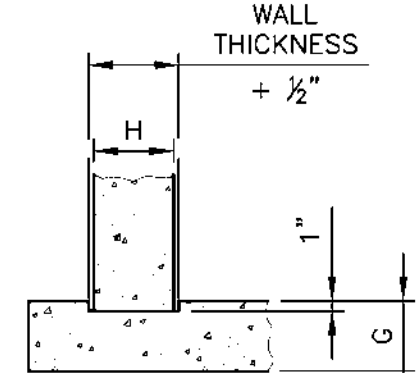


PLAN

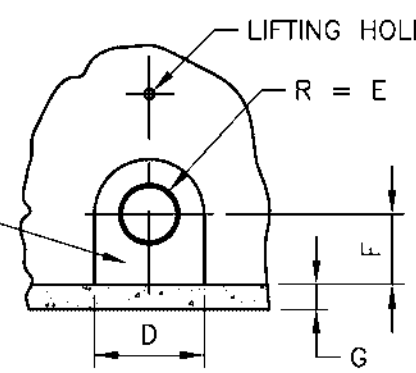
(FOR USE WITH POURED IN PLACE CONSTRUCTION)



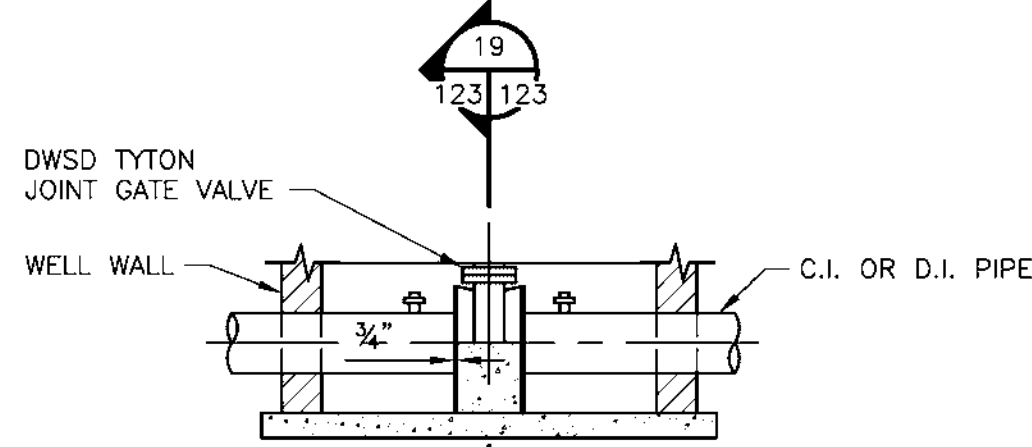
TYP. STEP CROSS SECTION
NO SCALE



KEYWAY AT BASE
DETAIL
N.T.S.

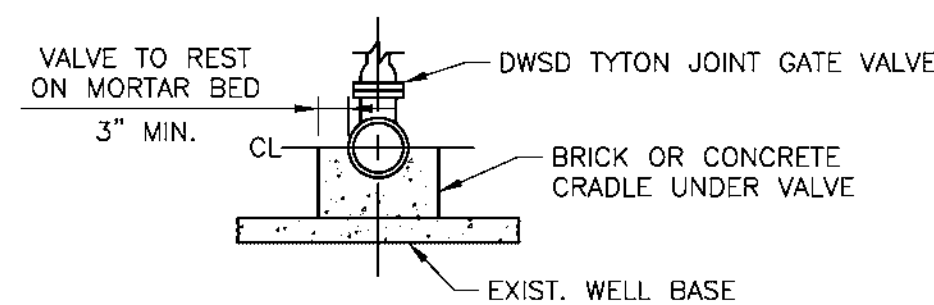


SIDE VIEW
N.T.S.



PLAN

N.T.S.



SECTION 19
N.T.S.

BRICK OR CONCRETE CRADLE SUPPORT DWSD TYTON JOINT GATE VALVE

NOT TO SCALE

RECORD DRAWING

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By DUANE D. DeDENE Date 08/2012

**CDM
Smith**

DESIGN				
				MEL
DRAFTING				
				JB
CHECKED				
				BB
APPROVED				
				AG

DETROIT WATER AND SEWERAGE DEPARTMENT OAKWOOD CSO CONTROL FACILITY AND PUMP STATION GENERAL DETAILS AND SECTIONS

SCALE: AS NOTED

DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc. One Woodward Avenue, Suite 1500 Detroit, MI 48226 Tel: (313) 963-1313 Fax: (313) 963-1313 www.cdm.com	hamiltonanderson Hamilton Anderson Associates 1430 Riverchase Suite 200, Detroit, Michigan 48226 P: 313.964.9270 F: 313.964.9170 www.hamilton-anderson.com	Applied Science, Inc. 300 New River, Suite 5400, Detroit, MI 48207 Phone: (313) 967-2665 Fax: (313) 267-2766
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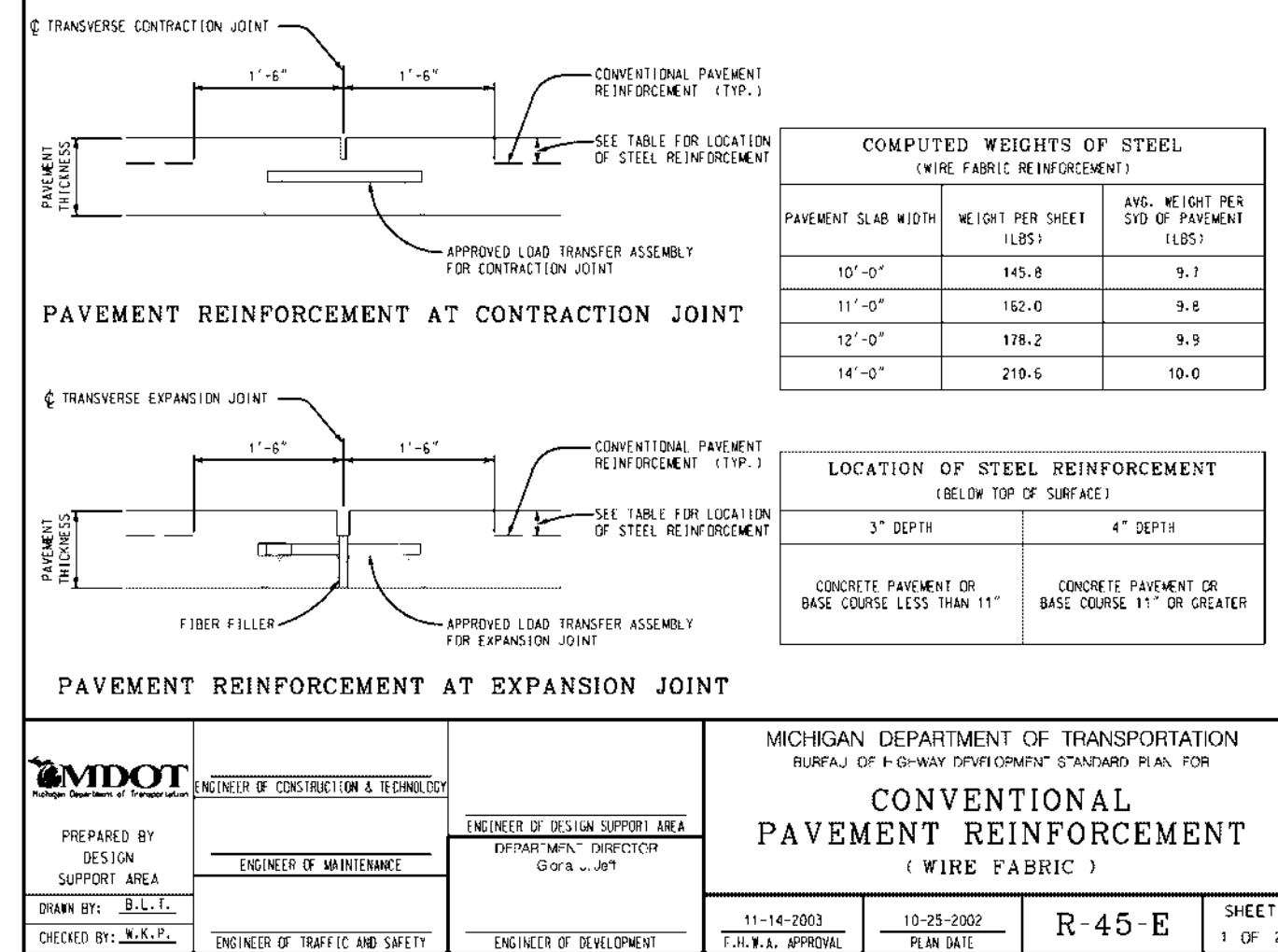
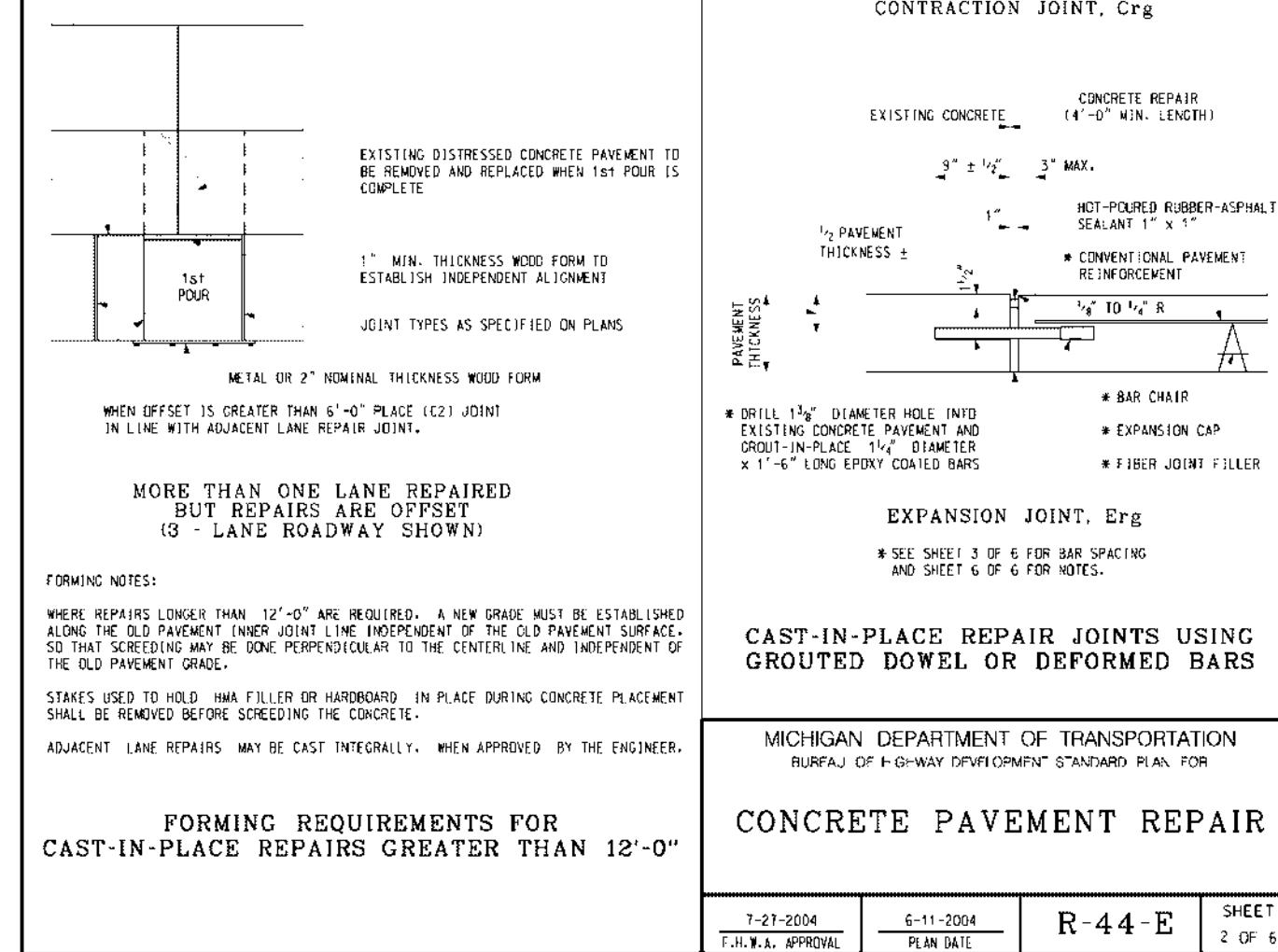
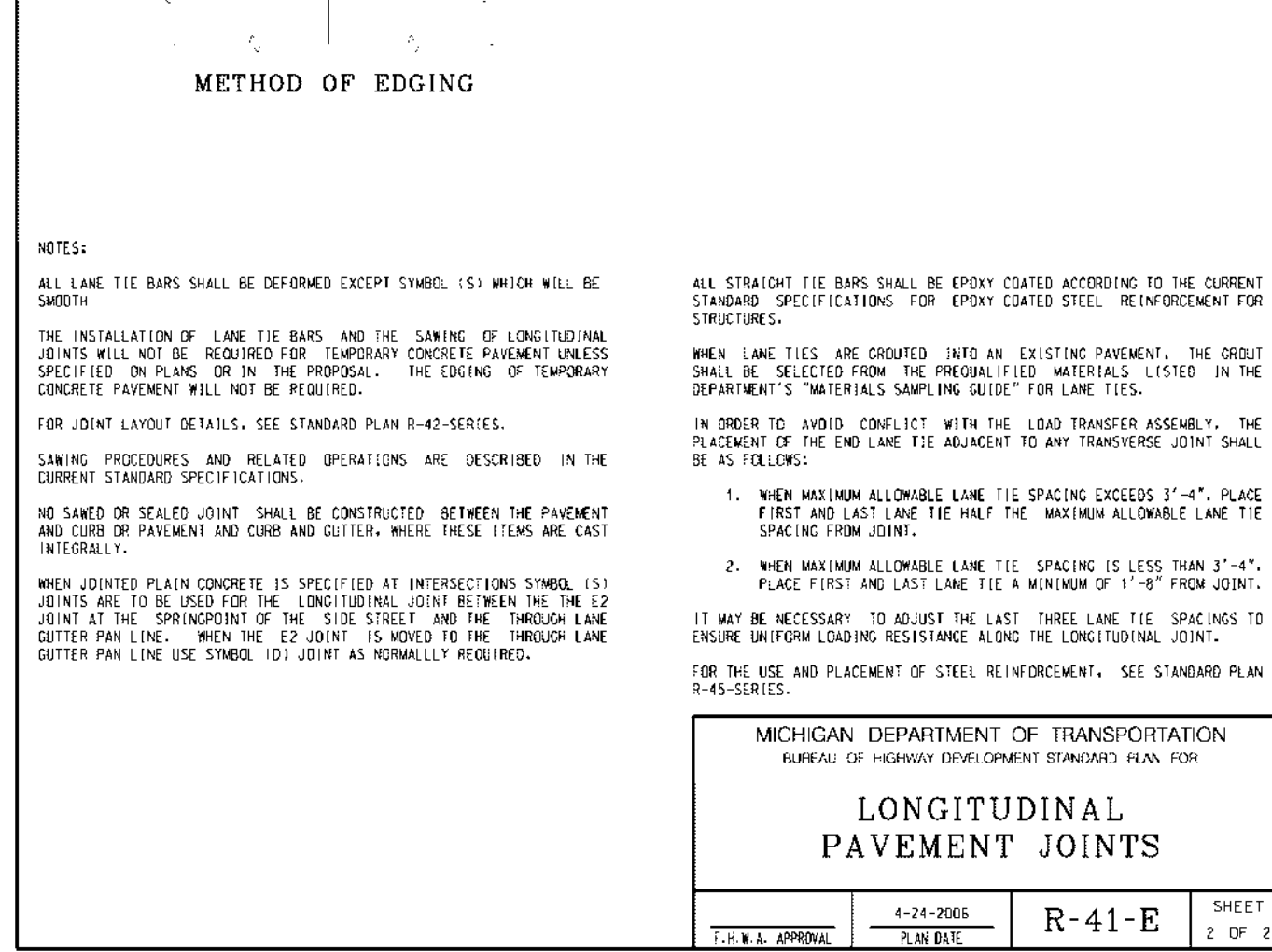
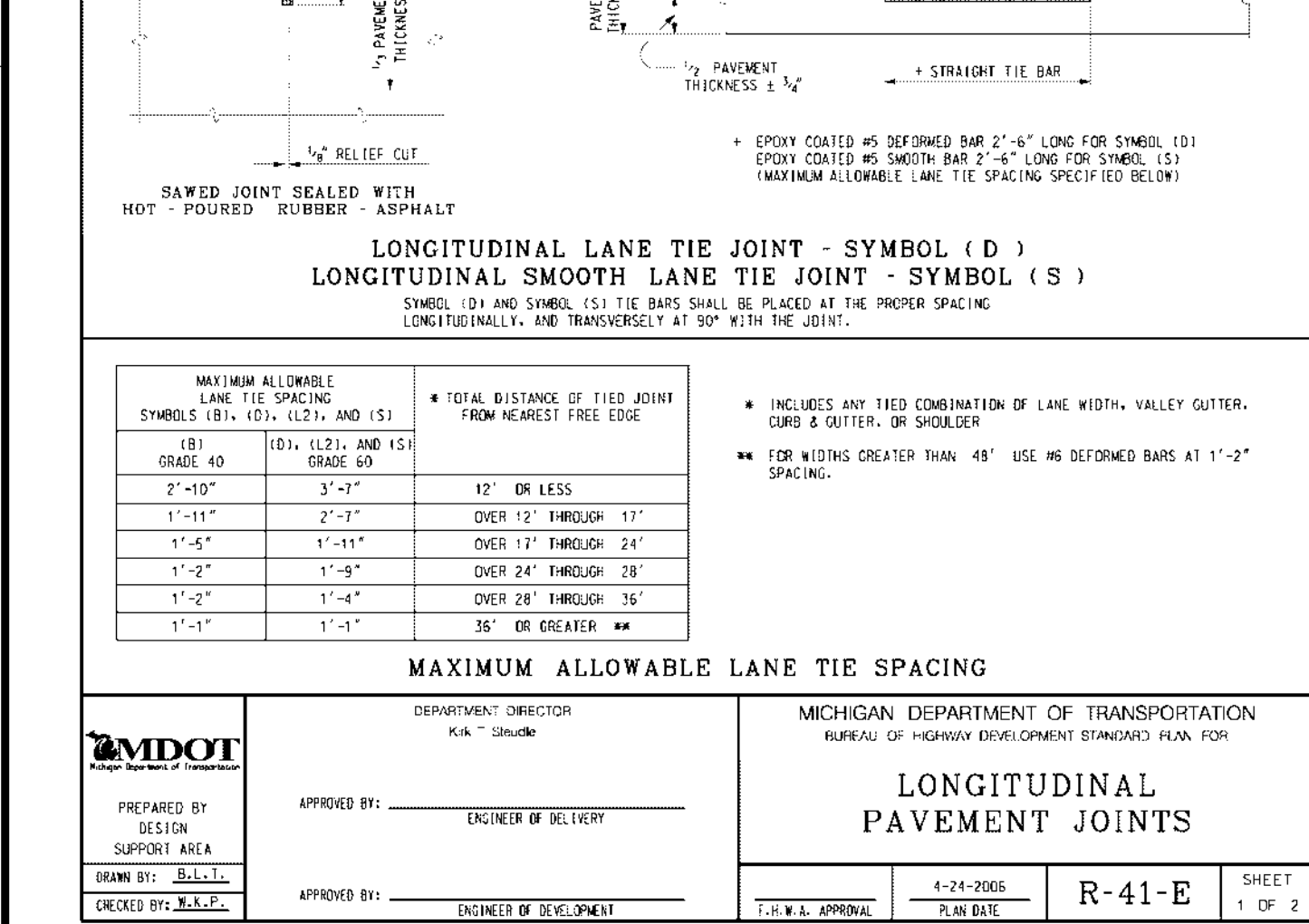
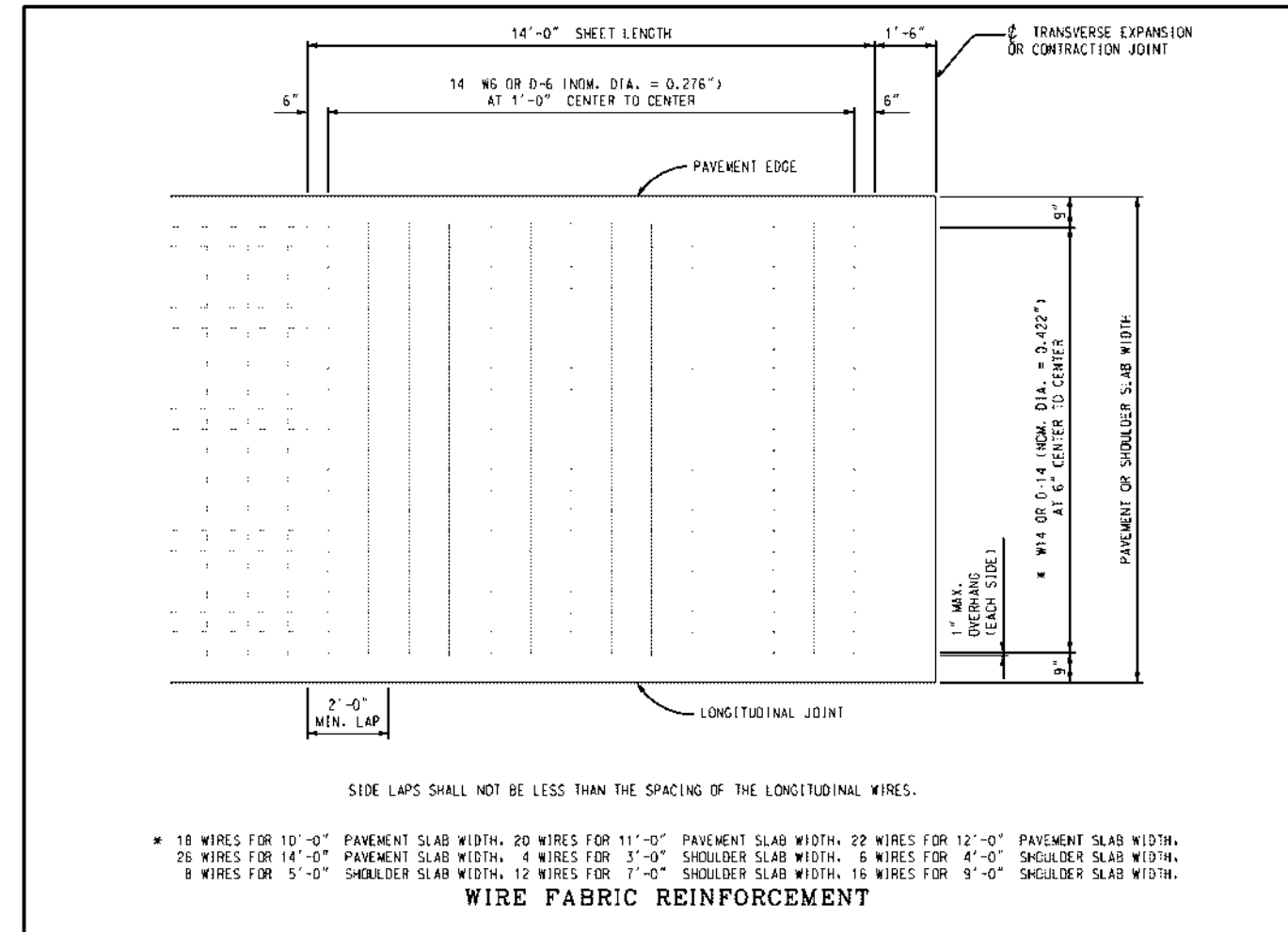
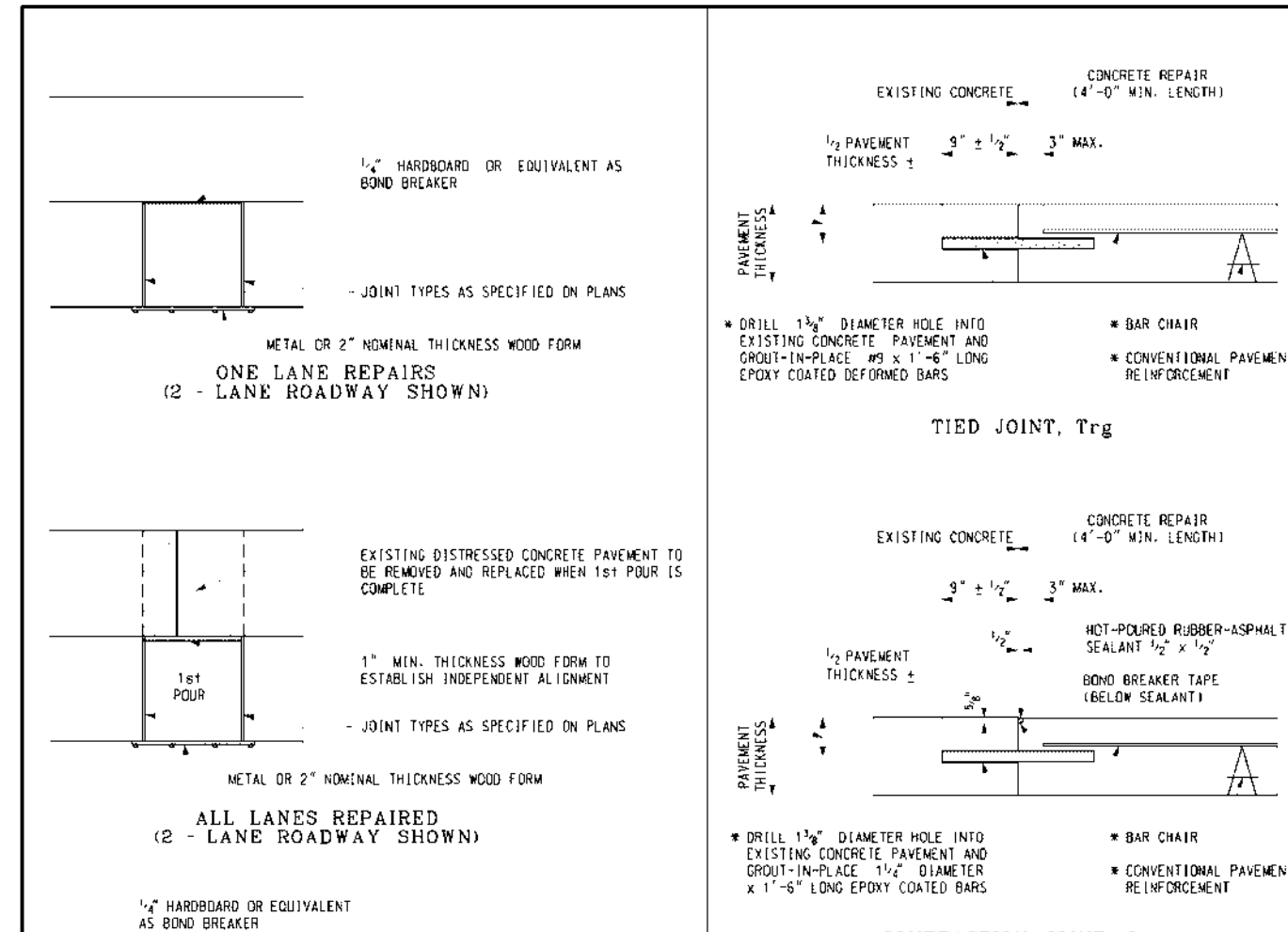
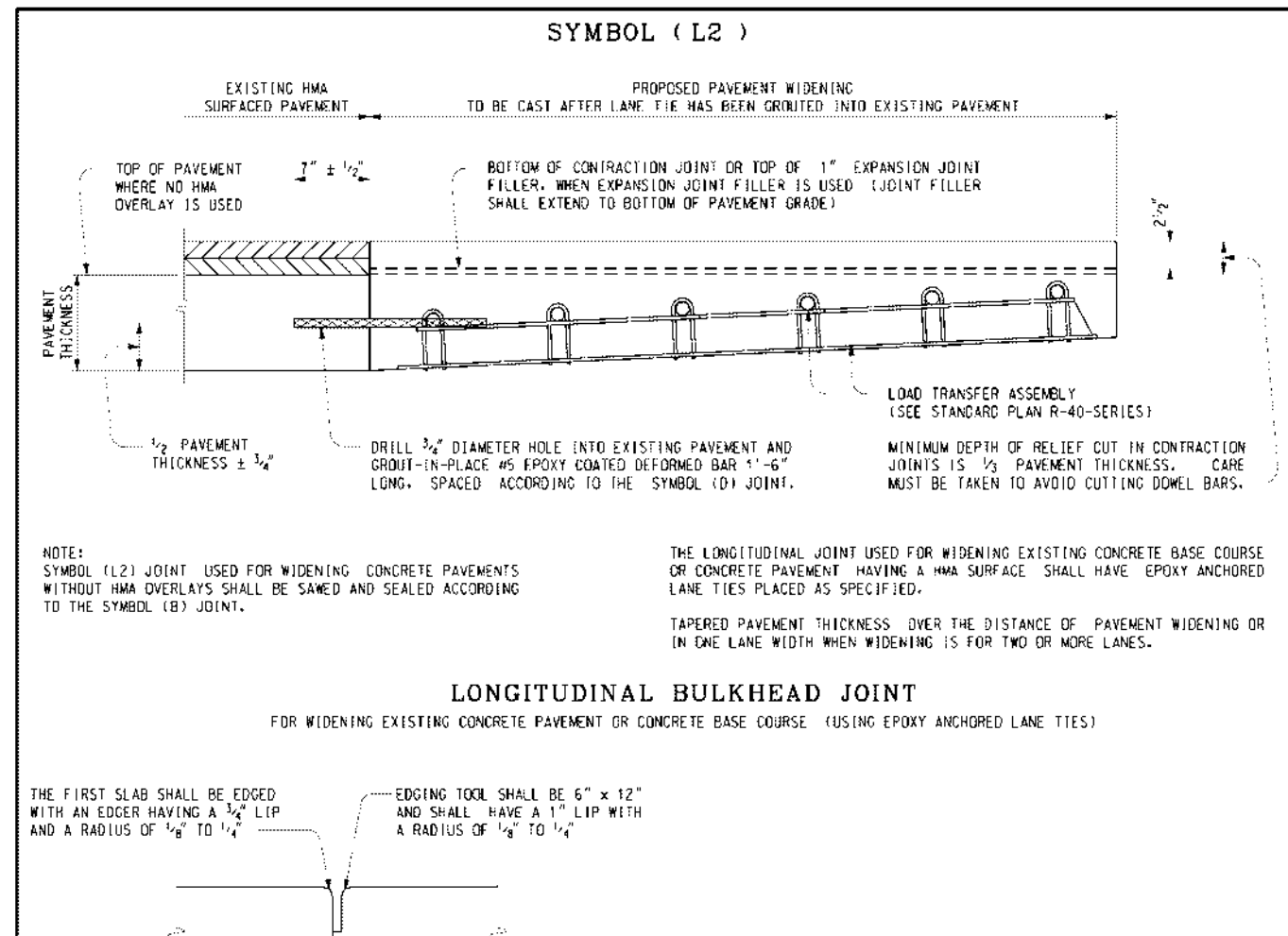
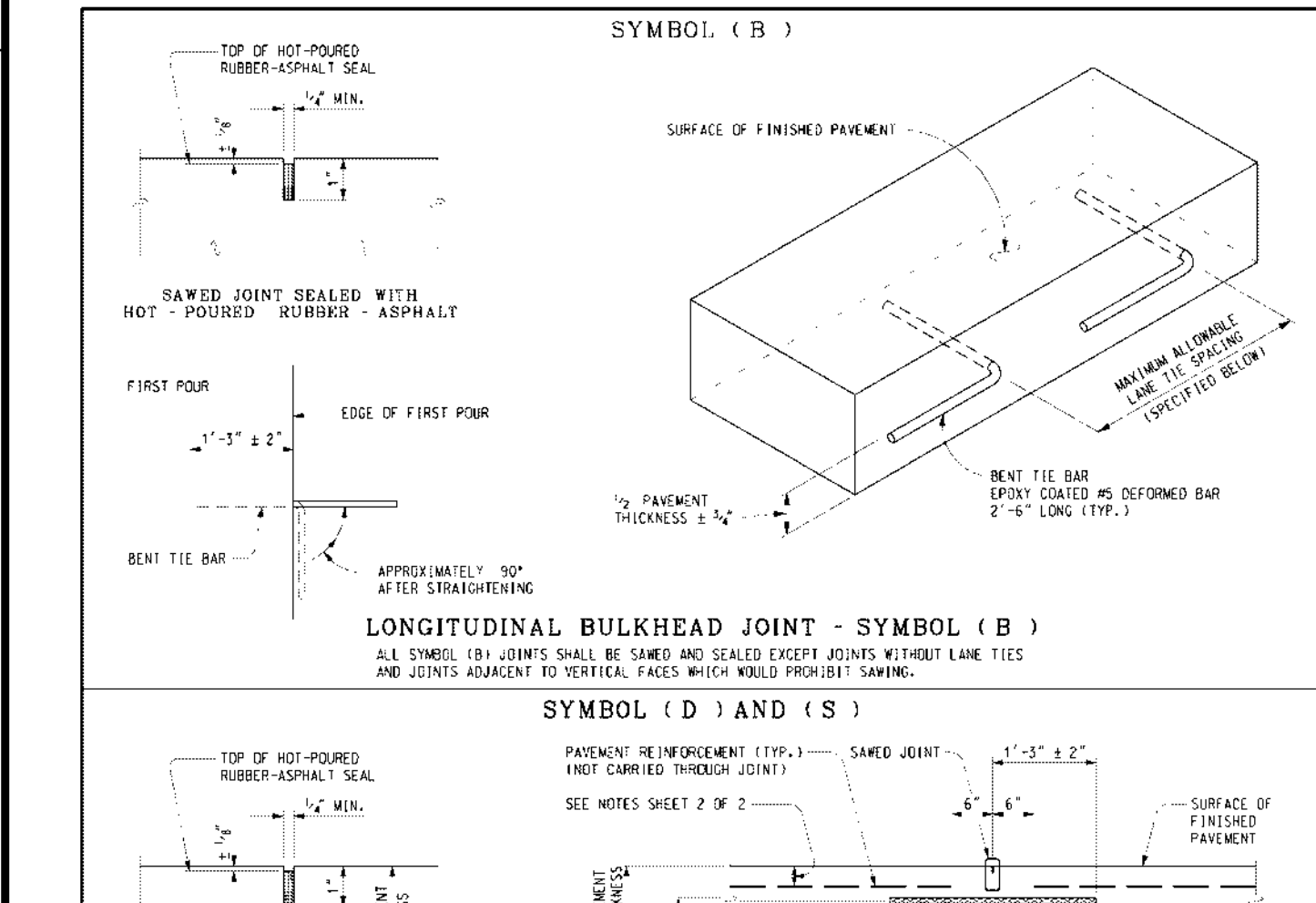
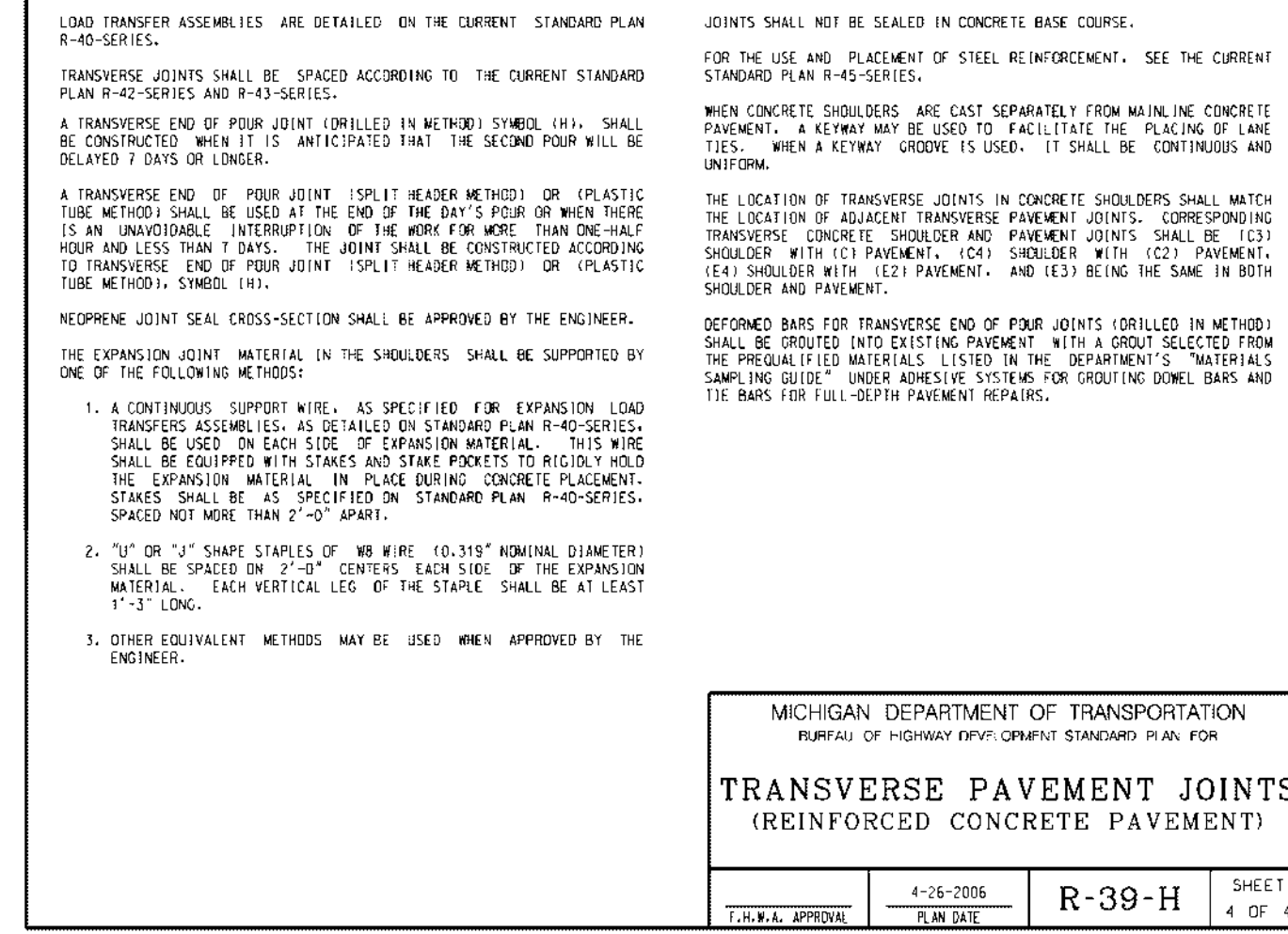
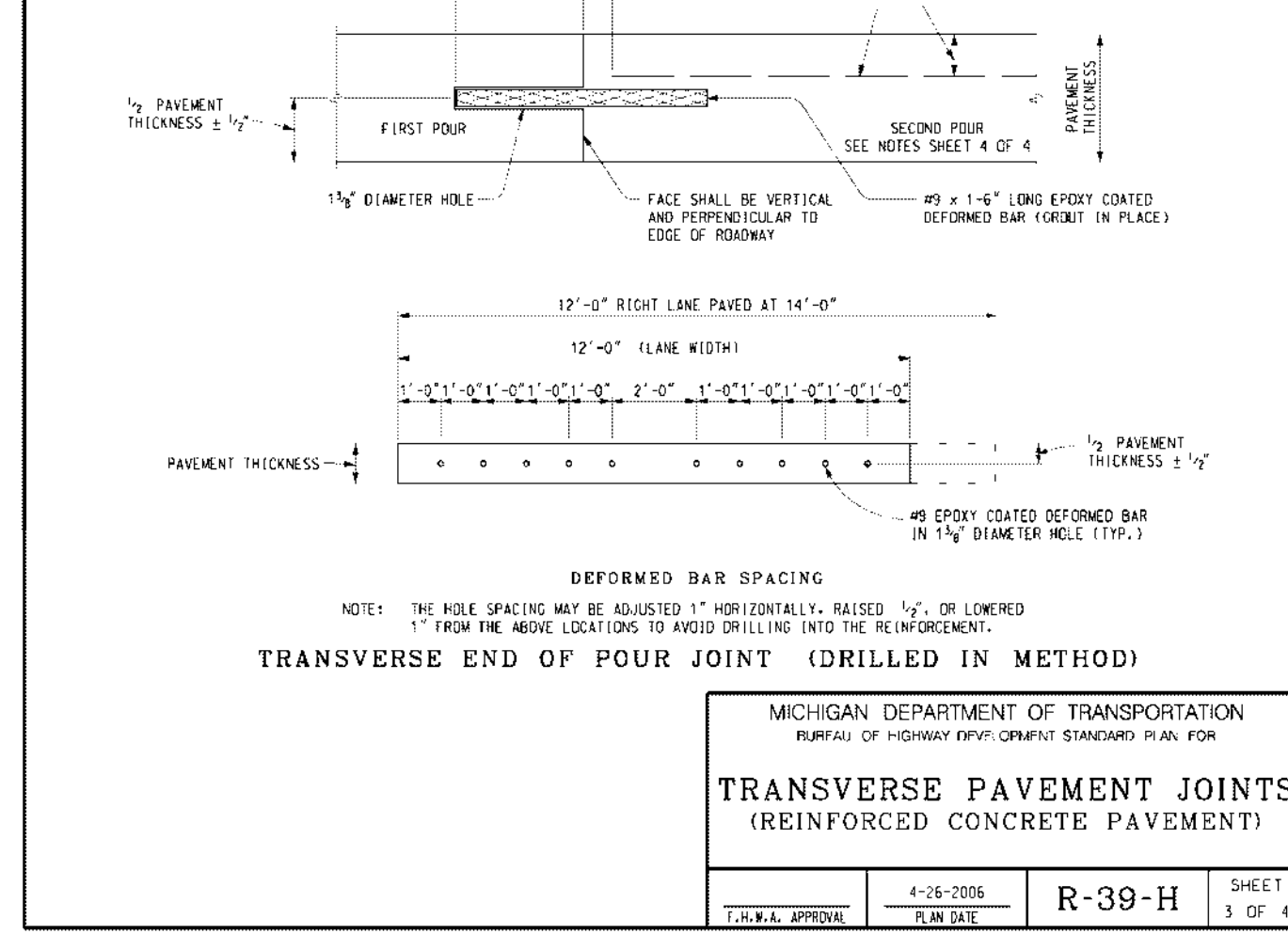
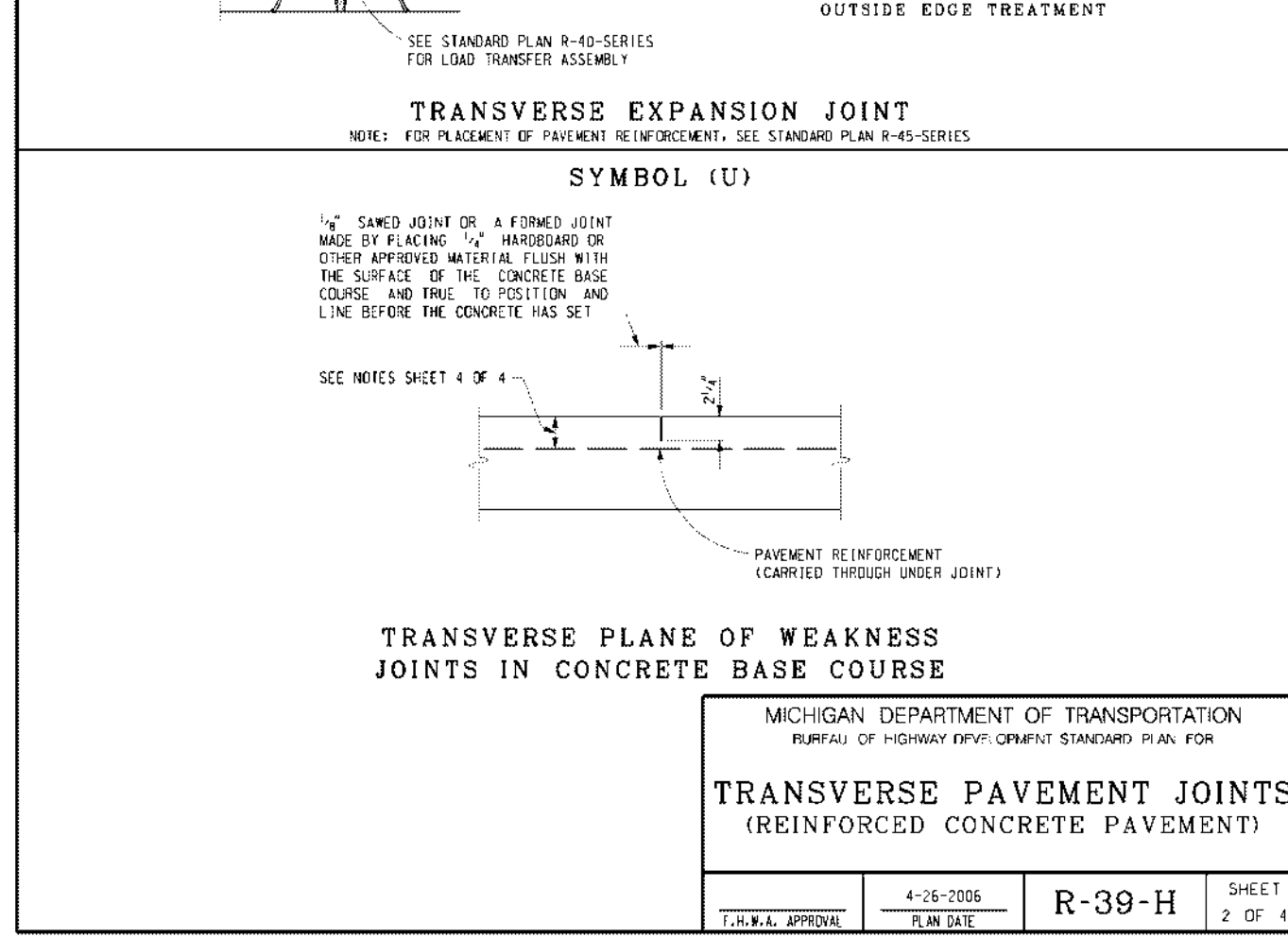
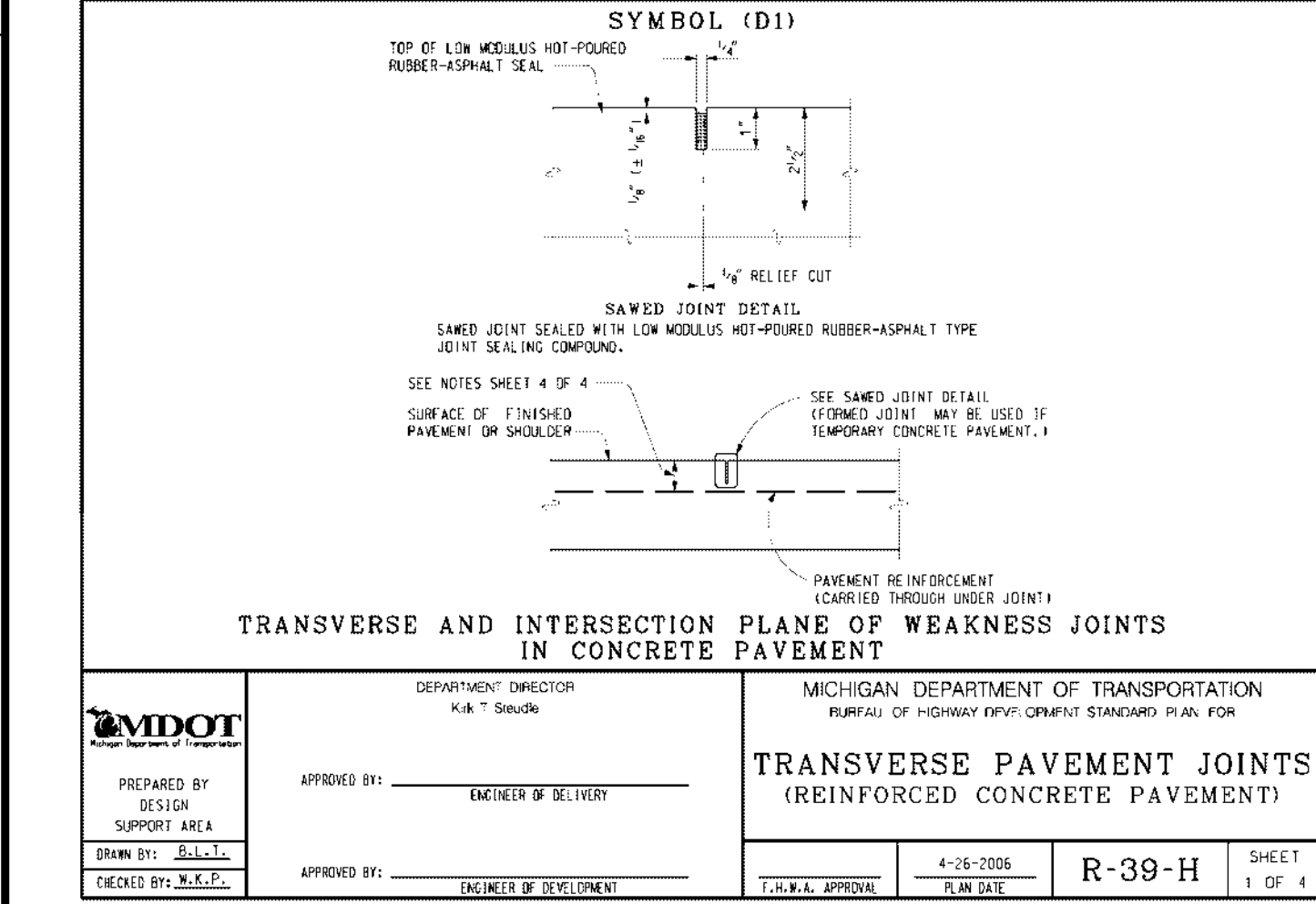
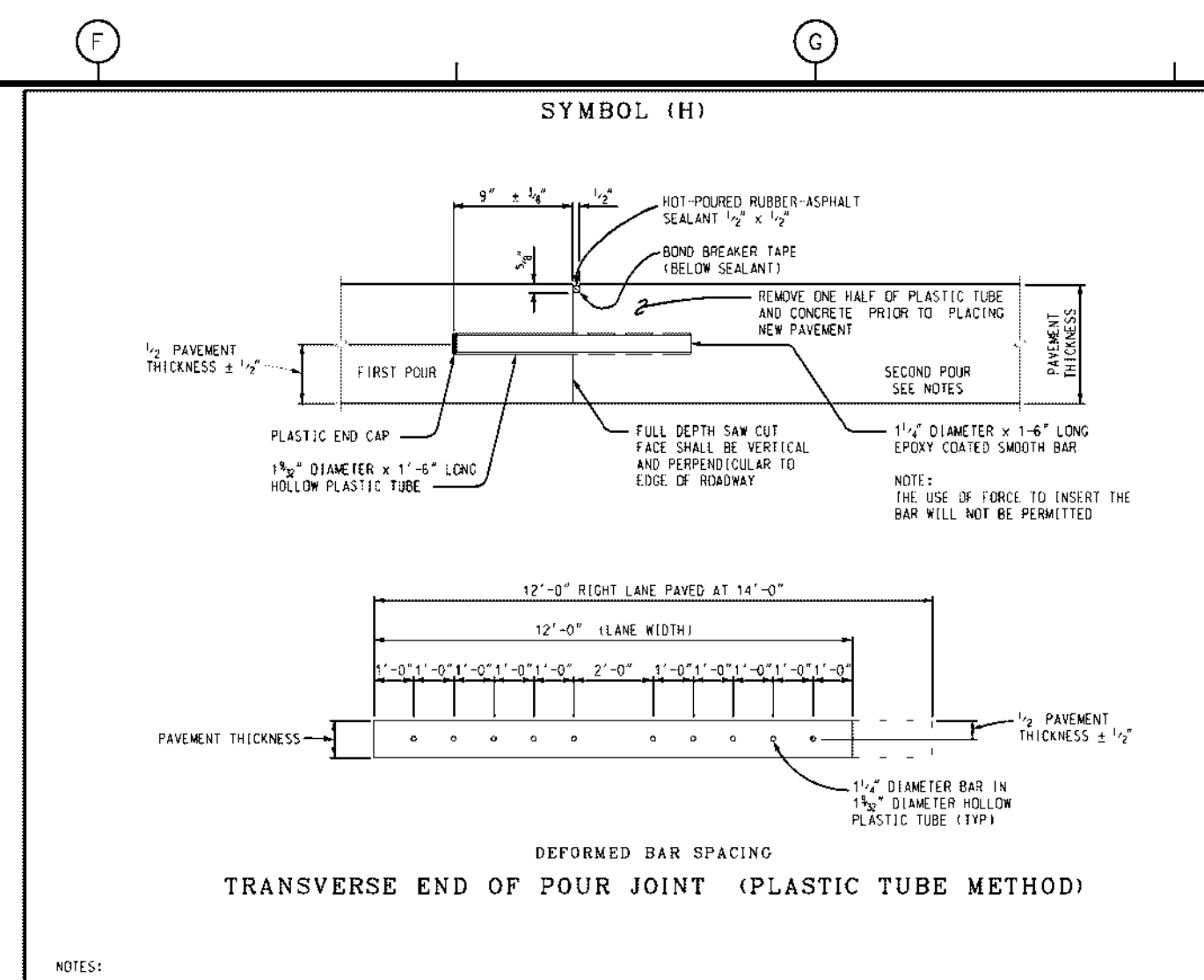
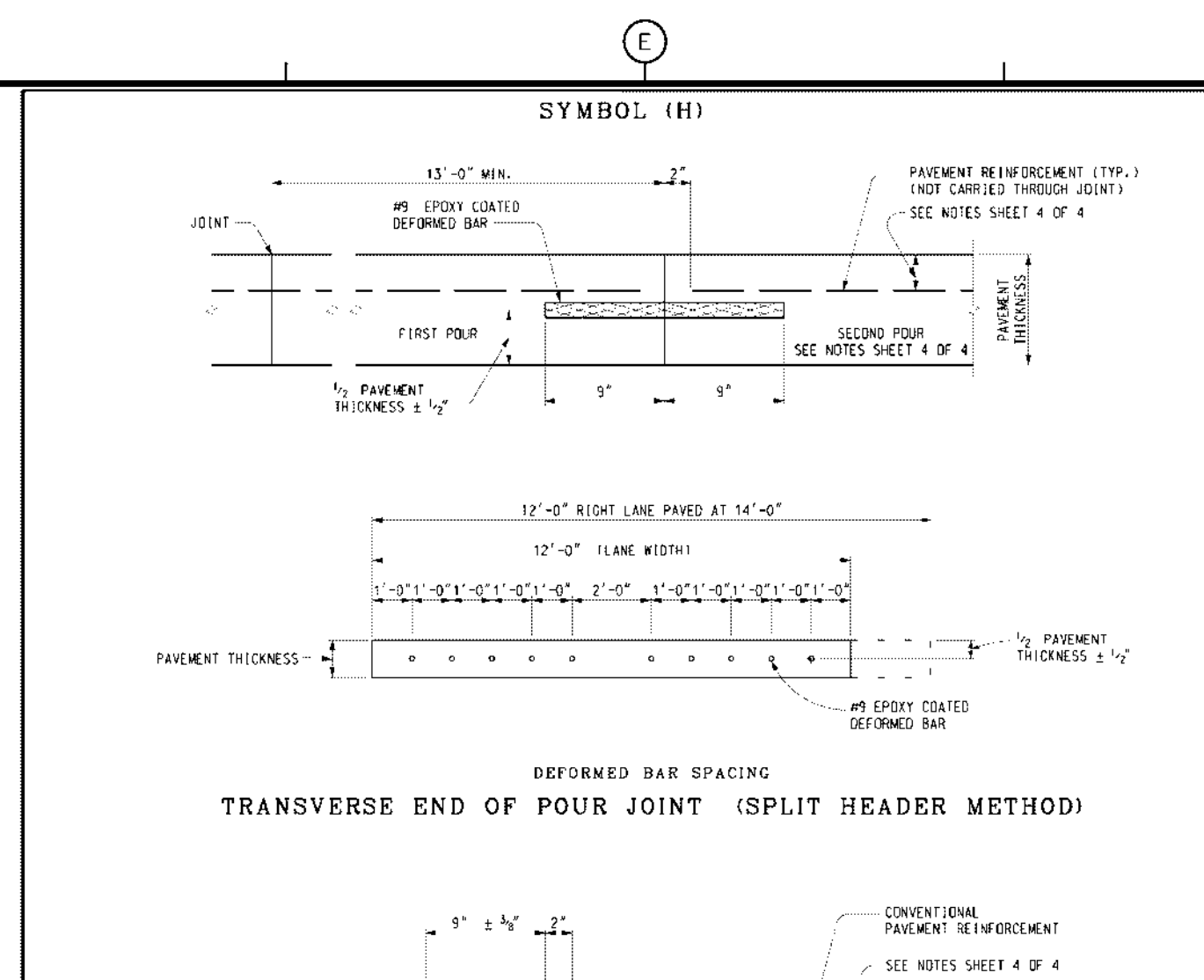
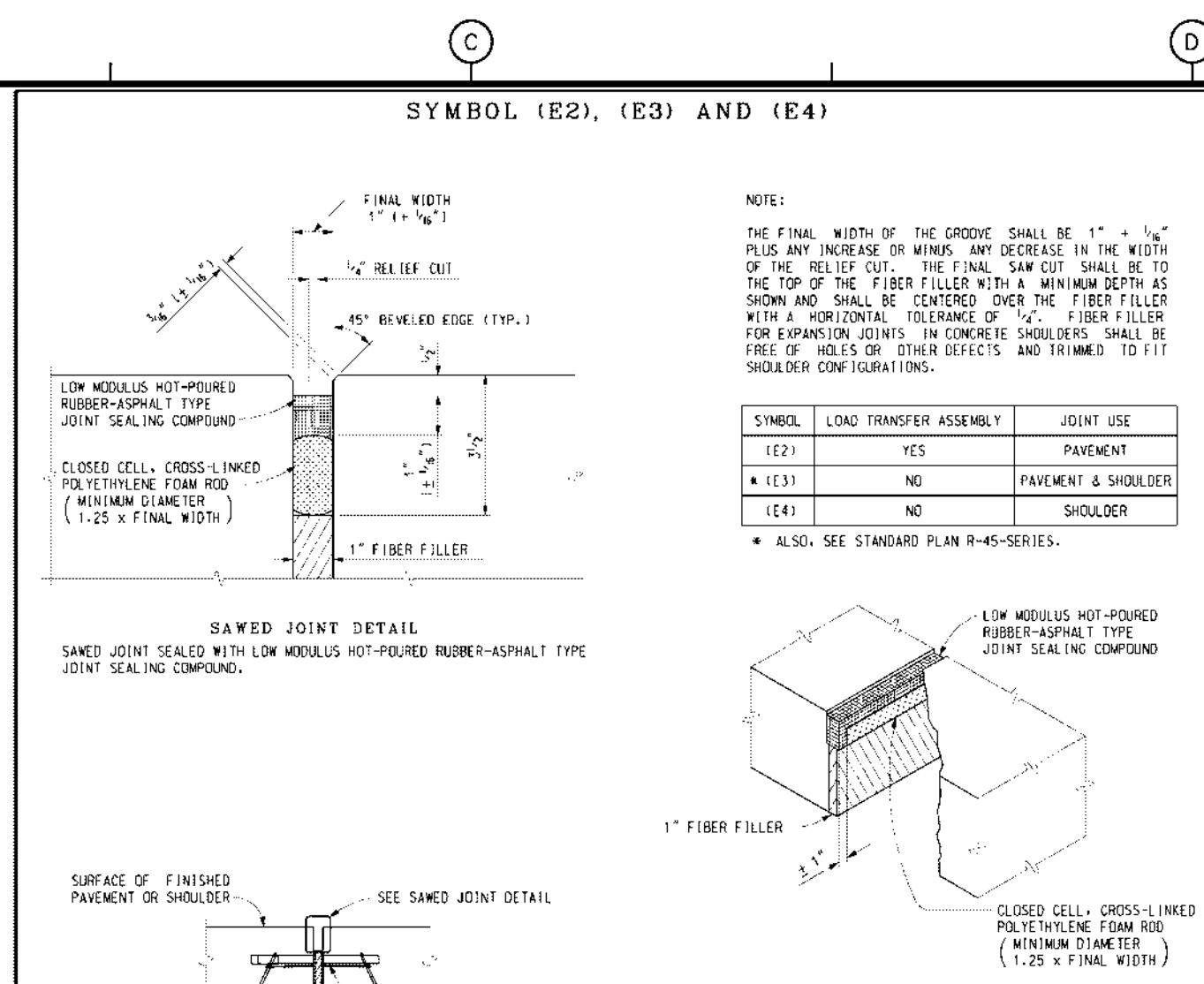
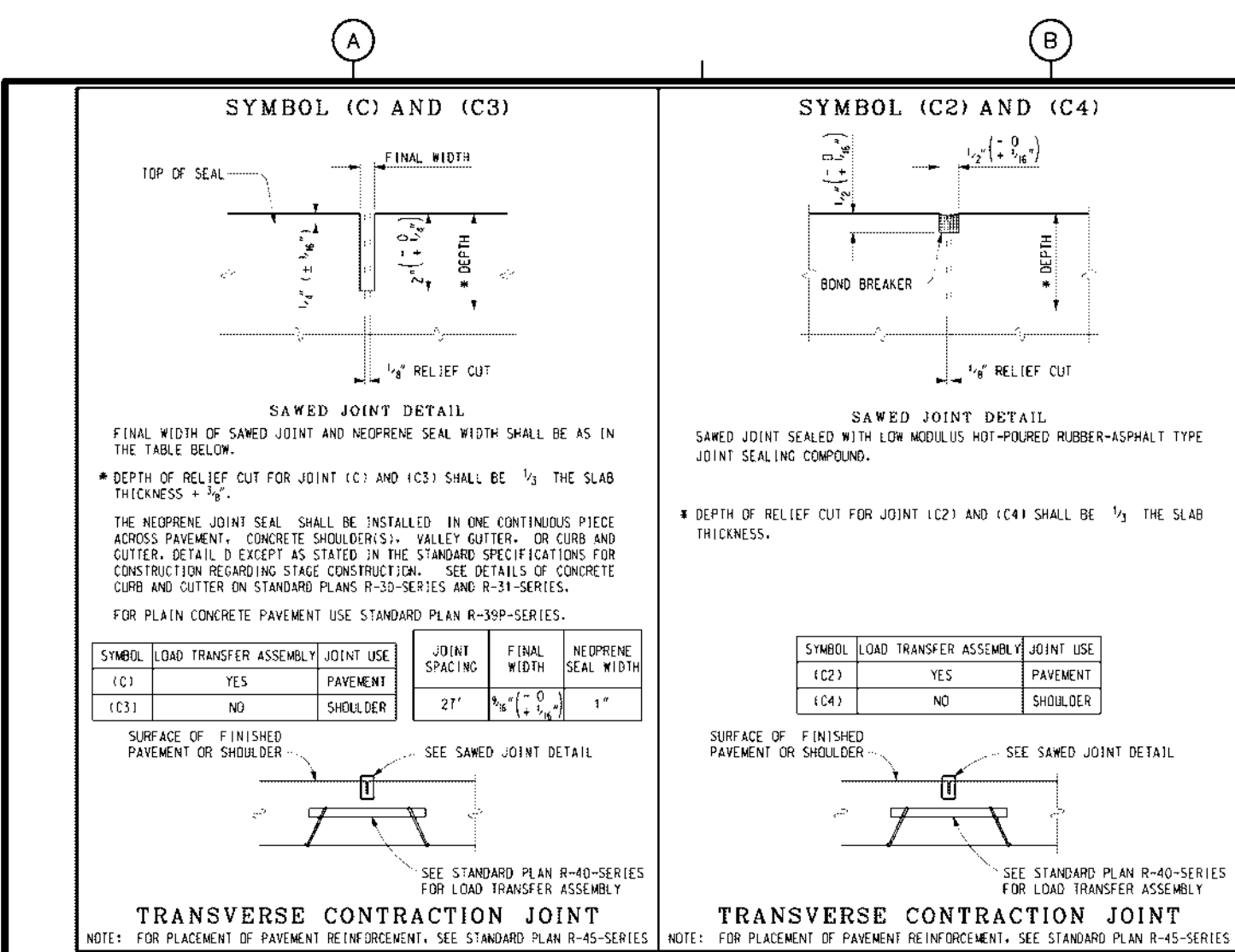
SUPERIOR ENGINEERING ASSOC., INC. 55 GORDON RD., SUITE 2101, DETROIT, MI 48226 Tel: (313) 964-4700 Fax: (313) 964-4701 www.superioreng.com	SOMAT Engineering, Inc. 600 Woodward Ave., Suite 1245, Detroit, Michigan 48226 Tel: (313) 964-4700 Fax: (313) 964-4701
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CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION

SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE
-	-	-	-	-

M.D.P.H./D.N.R. PERMIT NO.	
FAMIS NO.	-
CONTRACT NO.	
PC-755	
FILE NO.	
CSDDT123.DWG	
DRAWING NO.	
D-04-08-123	



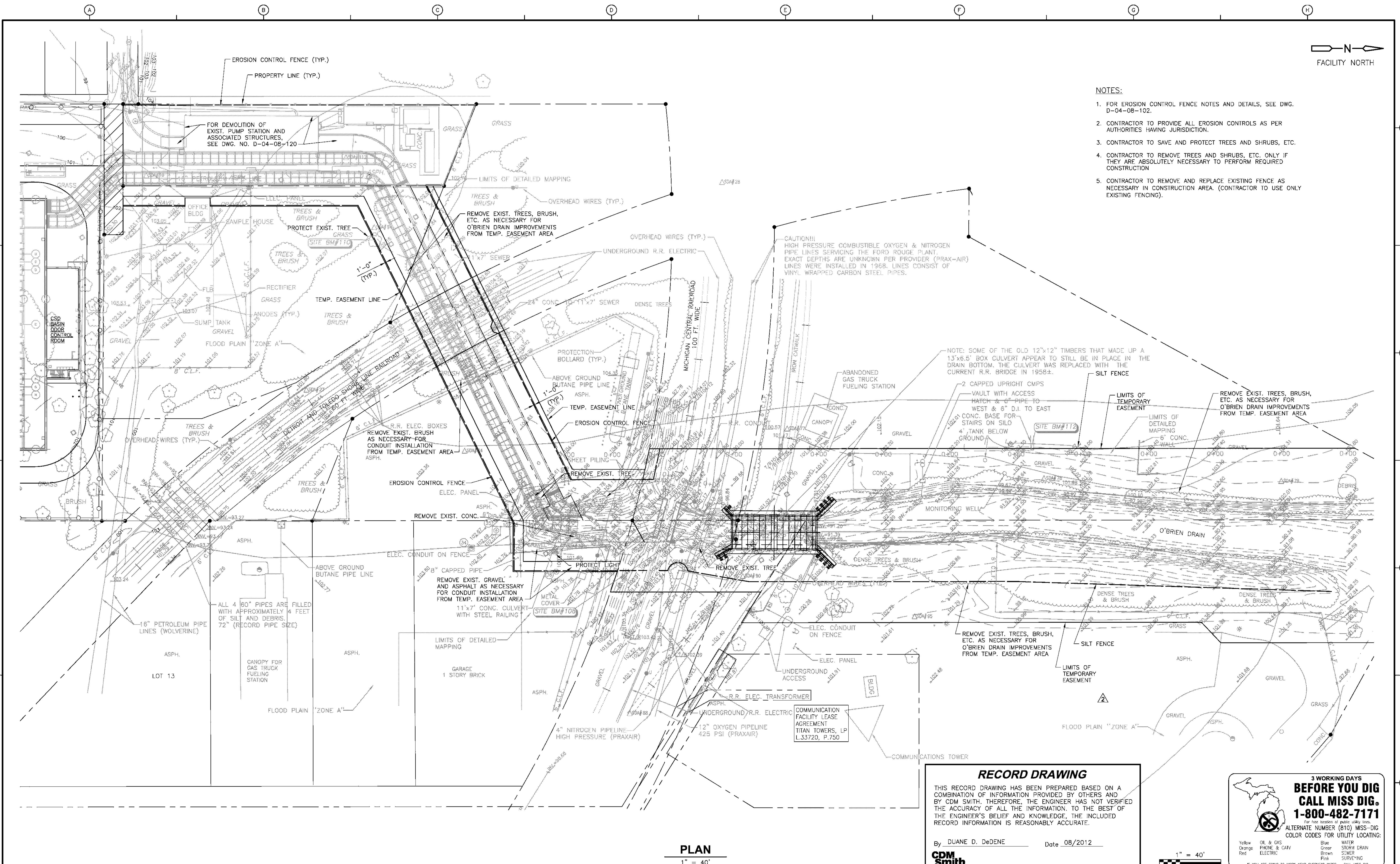
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	REVISIONS				

NO.	DESCRIPTION	NO.	DATE	APPROVED	AG
1	CONFORMED SET	8/07	AG		
	REVISIONS				

NO.	DESCRIPTION	NO.	DATE	APPROVED	AG
1	CONFORMED SET	8/07	AG		
	REVISIONS				

NO.	DESCRIPTION	NO.	DATE	APPROVED	AG
1	CONFORMED SET	8/07	AG		
	REVISIONS				

NO.	DESCRIPTION	NO.	DATE	APPROVED	AG
1	CONFORMED SET	8/07	AG		
	REVISIONS				



- NOTES:
1. FOR EROSION CONTROL FENCE NOTES AND DETAILS, SEE DWG. D-04-08-102.
 2. CONTRACTOR TO PROVIDE ALL EROSION CONTROLS AS PER AUTHORITIES HAVING JURISDICTION.
 3. CONTRACTOR TO SAVE AND PROTECT TREES AND SHRUBS, ETC.
 4. CONTRACTOR TO REMOVE TREES AND SHRUBS, ETC. ONLY IF THEY ARE ABSOLUTELY NECESSARY TO PERFORM REQUIRED CONSTRUCTION
 5. CONTRACTOR TO REMOVE AND REPLACE EXISTING FENCE AS NECESSARY IN CONSTRUCTION AREA. (CONTRACTOR TO USE ONLY EXISTING FENCING).

RECORD DRAWING

THIS RECORD DRAWING HAS BEEN PREPARED BASED ON A COMBINATION OF INFORMATION PROVIDED BY OTHERS AND BY CDM SMITH. THEREFORE, THE ENGINEER HAS NOT VERIFIED THE ACCURACY OF ALL THE INFORMATION. TO THE BEST OF THE ENGINEER'S BELIEF AND KNOWLEDGE, THE INCLUDED RECORD INFORMATION IS REASONABLY ACCURATE.

By DUANE D. DeDENE Date 08/2012

CDM Smith

3 WORKING DAYS BEFORE YOU DIG CALL MISS DIG. 1-800-482-7171

ALTERNATE NUMBER (810) MISS-DIG COLOR CODES FOR UTILITY LOCATING:

Yellow	OIL & GAS	Blue	WATER
Orange	PHONE & CATV	Green	STORM DRAIN
Red		Brown	SEWER
		Pink	SURVEYING

IF YOU ARE GOING TO WORK NEAR OVERHEAD WIRES... CALL MISS DIG.

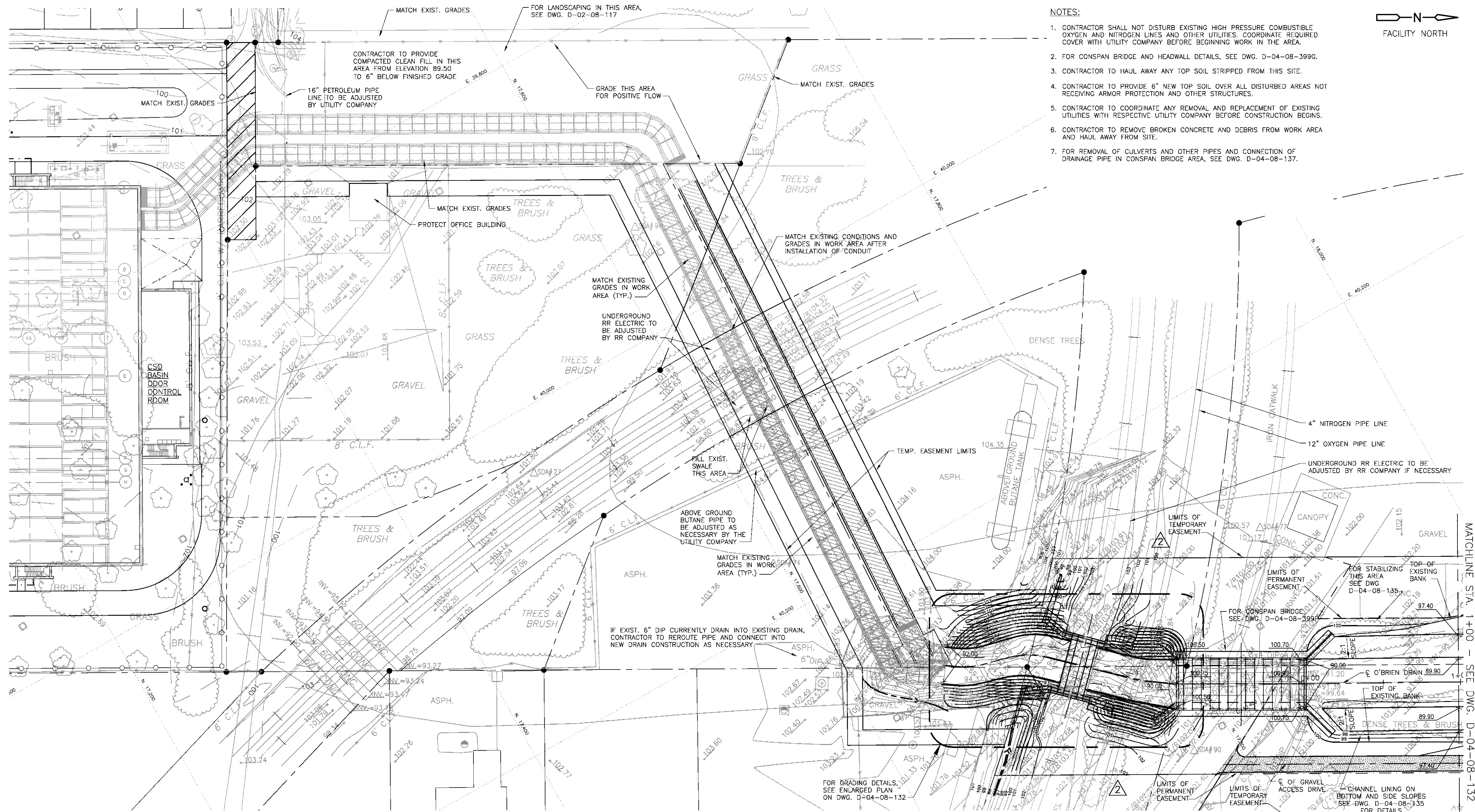
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DRAFTING		MV
2	REVISED FOR RECORD	8/12 DDD
1	O'BRIEN DRAIN REALIGNMENT	8/08 AG
1	CONFORMED SET	8/07 AG
NO.	DESCRIPTION	NO. DATE APRVD
REVISIONS		APPROVED AG

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

EFFLUENT CONDUIT/ O'BRIEN DRAIN
SITE PREPARATION / SOIL EROSION PLAN

SCALE: 1" = 40' DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc. One Woodward Avenue, Suite 1500 Detroit, MI 48226 Tel: (313) 963-1313 Fax: (313) 963-1313 www.cdm-smith.com	hamiltonanderson Hamilton Anderson Associates 1430 Woodward Suite 200, Detroit, Michigan 48226 P: 313.964.0270 F: 313.964.0170 www.hamilton-anderson.com	TUCKER, YOUNG, JACKSON, TULL, INC. CONSULTING ENGINEERS PLANNERS 1430 Woodward Suite 200, Detroit, Michigan 48226 P: (313) 963-0812 Fax: (313) 963-2166	Applied Science, Inc. 300 New River, Suite 5400, Detroit, MI 48207 Phone: (313) 967-2965 Fax: (313) 967-2796	Associates Inc. 150 W. Congress St., Suite 410 Detroit, MI 48226 Phone: 313-954-7765 Fax: 313-954-7782	SIGMA CONSULTING ENGINEERS 150 W. Congress St., Suite 410 Detroit, MI 48226 Tel: 313.954.7765 Fax: 313.954.7782	SUPERIOR ENGINEERING ASSOC., INC. 650 Woodward St., Suite 2101, Detroit, MI 48226 Tel: (313) 964-0796 Fax: (313) 964-0791 www.superioreng.com	SOMAT Engineering, Inc. 150 W. Congress St., Suite 410 Detroit, MI 48226 Tel: 313.954.7765 Fax: 313.954.7782	CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION	M.D.P.H./D.N.R. PERMIT NO. FAMIS NO. CONTRACT NO. PC-755 FILE NO. CSTPL130.DWG DRAWING NO. D-04-08-130
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NOTES:

1. CONTRACTOR SHALL NOT DISTURB EXISTING HIGH PRESSURE COMBUSTIBLE OXYGEN AND NITROGEN LINES AND OTHER UTILITIES. COORDINATE REQUIRED COVER WITH UTILITY COMPANY BEFORE BEGINNING WORK IN THE AREA.
2. FOR CONSPAN BRIDGE AND HEADWALL DETAILS, SEE DWG. D-04-08-399G.
3. CONTRACTOR TO HAUL AWAY ANY TOP SOIL STRIPPED FROM THIS SITE.
4. CONTRACTOR TO PROVIDE 6" NEW TOP SOIL OVER ALL DISTURBED AREAS NOT RECEIVING ARMOR PROTECTION AND OTHER STRUCTURES.
5. CONTRACTOR TO COORDINATE ANY REMOVAL AND REPLACEMENT OF EXISTING UTILITIES WITH RESPECTIVE UTILITY COMPANY BEFORE CONSTRUCTION BEGINS.
6. CONTRACTOR TO REMOVE BROKEN CONCRETE AND DEBRIS FROM WORK AREA AND HAUL AWAY FROM SITE.
7. FOR REMOVAL OF CULVERTS AND OTHER PIPES AND CONNECTION OF DRAINAGE PIPE IN CONSPAN BRIDGE AREA, SEE DWG. D-04-08-137.



PLAN

1" = 30'

RECORD DRAWING

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By DUANE D. DeDENE Date 08/2012

CDM Smith

CAUTION:
HIGH PRESSURE COMBUSTIBLE
OXYGEN AND NITROGEN,
SEE NOTE #1 THIS SHEET

1" = 30'
15 0 30

**3 WORKING DAYS
BEFORE YOU DIG
CALL MISS DIG.
1-800-482-7171**

ALTERNATE NUMBER (810) MISS-DIG
COLOR CODES FOR UTILITY LOCATING:

Yellow	OIL & GAS	Blue	WATER
Orange	PHONE & CATV	Green	STORM DRAIN
Red	ELECTRIC	Brown	SEWER
		Pink	SURVEYING

IF YOU ARE GOING TO WORK NEAR OVERHEAD WIRES... CALL MISS DIG

REVISIONS		NO.	DATE	APPROVED	DESCRIPTION
3	REVISED FOR RECORD	8/12	DD		
3	O'BRIEN DRAIN REALIGNMENT	8/08	AG		
2	REVISED GRADING	11/07	AG		
1	CONFORMED SET	8/07	AG		
NO.	DESCRIPTION	NO.	DATE	APPROVED	

DESIGN	KJ
DRAFTING	MV-RI
CHECKED	BB
APPROVED	AG

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

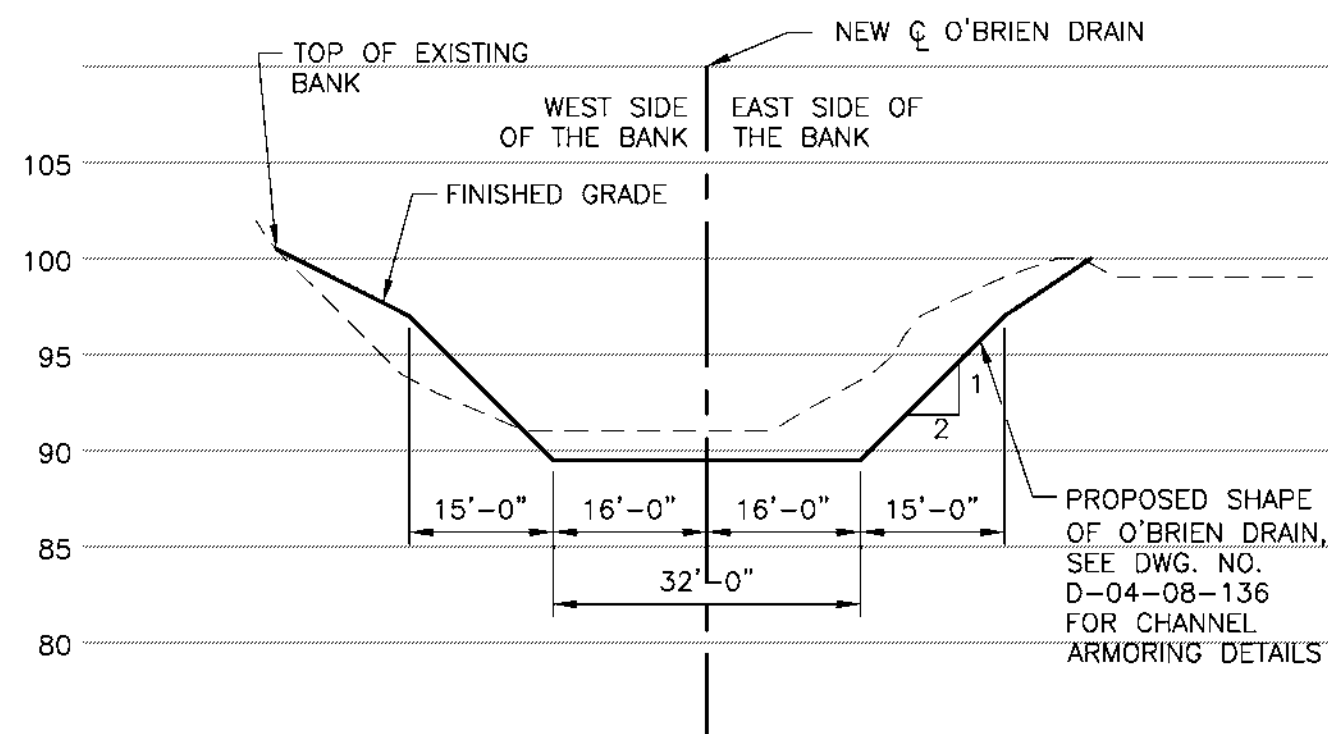
EFFLUENT CONDUIT/ O'BRIEN DRAIN
FINISHED SITE GRADING, DRAINAGE AND UTILITY PLAN

SCALE: 1" = 30' DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc. One Woodward Avenue, Suite 1500 Detroit, MI 48226 Tel: (313) 963-1313 Fax: (313) 963-1313 www.cdm-smith.com	hamiltonanderson Hamilton Anderson Associates 1430 Franklin Suite 200, Detroit, Michigan 48226 P: 313 664 5270 F: 313 664 2170 www.hamilton-anderson.com	TUCKER, YOUNG, JACKSON, TULL, INC. CONSULTING ENGINEERS PLANNERS 1430 Franklin Suite 200, Detroit, Michigan 48226 P: (313) 963-0812 Fax: (313) 963-2166	Applied Science, Inc. 300 New River, Suite 540, Detroit, MI 48207 Phone: (313) 964-2665 Fax: (313) 267-5796	Associates Inc. 126 W. Congress, Suite 400 Detroit, MI 48226 Phone: 313-964-7765 Fax: 313-964-7782	SUPERIOR ENGINEERING ASSOC., INC. 650 Woodward Ave., Suite 2101, Detroit, MI 48226 Tel: (313) 968-2196 Fax: (313) 968-9381 www.superioreng.com	SOMAT Engineering, Inc. 600 Woodward Ave., Suite 1245, Detroit, Michigan 48226 Tel: (313) 963-5711 Fax: (313) 963-5708	SIGMA CONSULTING ENGINEERS 300 Woodward Ave., Suite 1700 Detroit, MI 48226 Tel: (313) 963-2100 Fax: (313) 963-2108
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CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION	SECTION MAP - - - - -	TOWN - - - - -	RANGE - - - - -	SECTION - - - - -	PORTION CODE - - - - -
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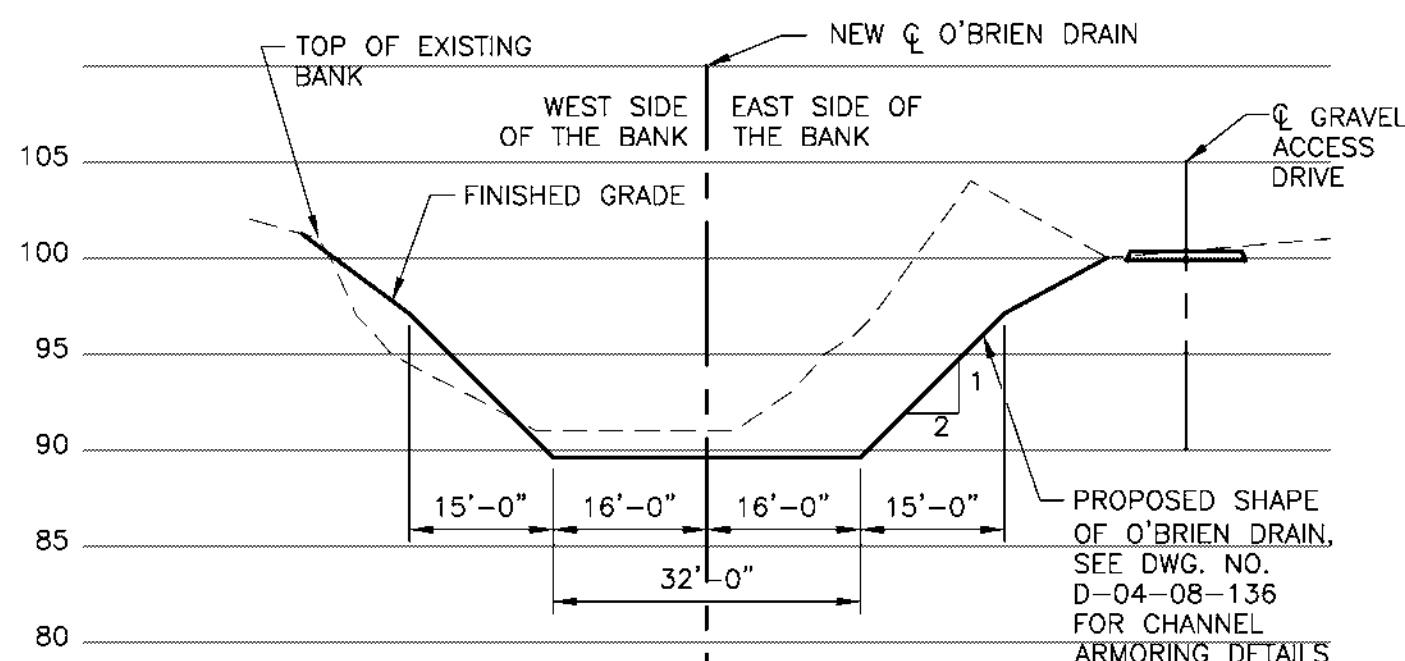
M.D.P.H./D.N.R. PERMIT NO.	FAMIS NO.	CONTRACT NO.	FILE NO.	DRAWING NO.
	-	PC-755	CSTPL131.DWG	D-04-08-131



STATION 5+00

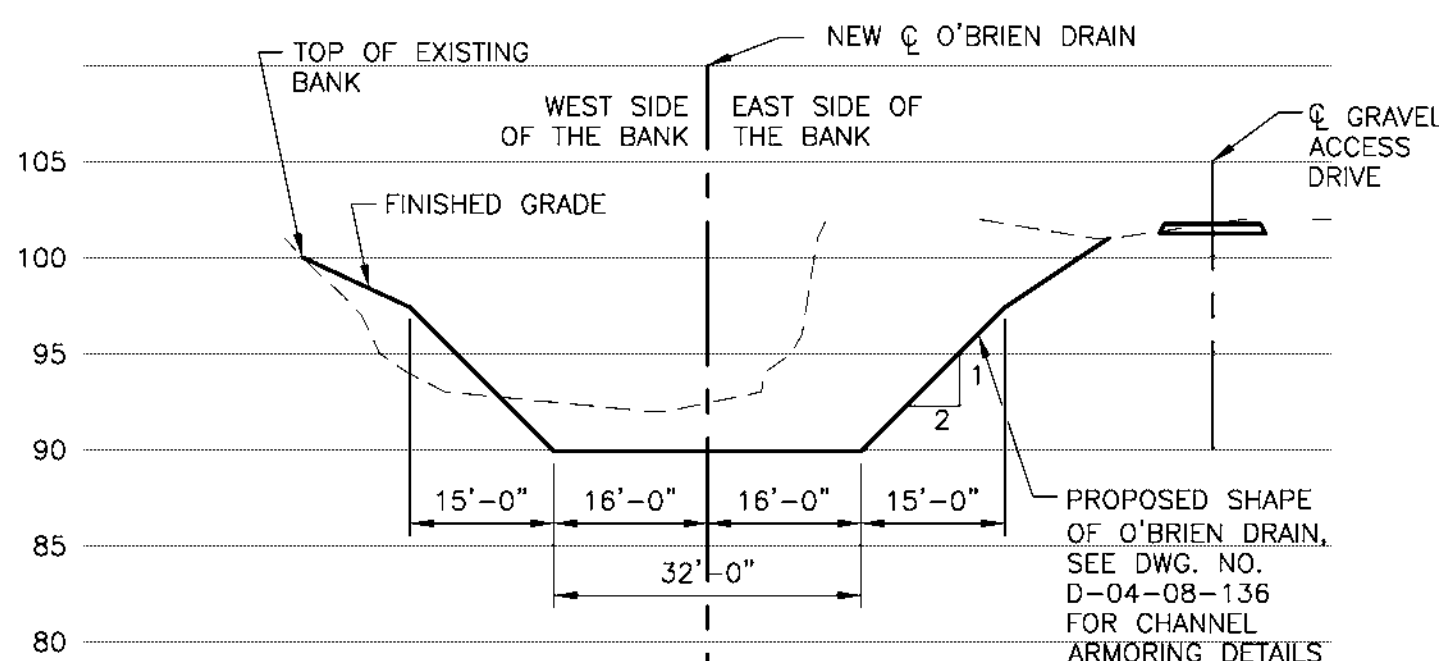
SCALE: HORZ. 1" = 20'
VERT. 1" = 10'

STATION	AREA (SFT)		LENGTH (FT)	VOLUME (CFT)	
	CUT	FILL		CUT	FILL
0+00 TO 1+00	296	38	50	14800	1900
1+00 TO 2+00	296	38	100	29600	3800
2+00 TO 3+00	252	66	100	25200	6600
3+00 TO 4+00	223	45	100	22300	4500
4+00 TO 5+00	225	32	100	22500	3200
5+00 TO 5+20	127	45	70	8890	3150
TOTAL				123290	23150



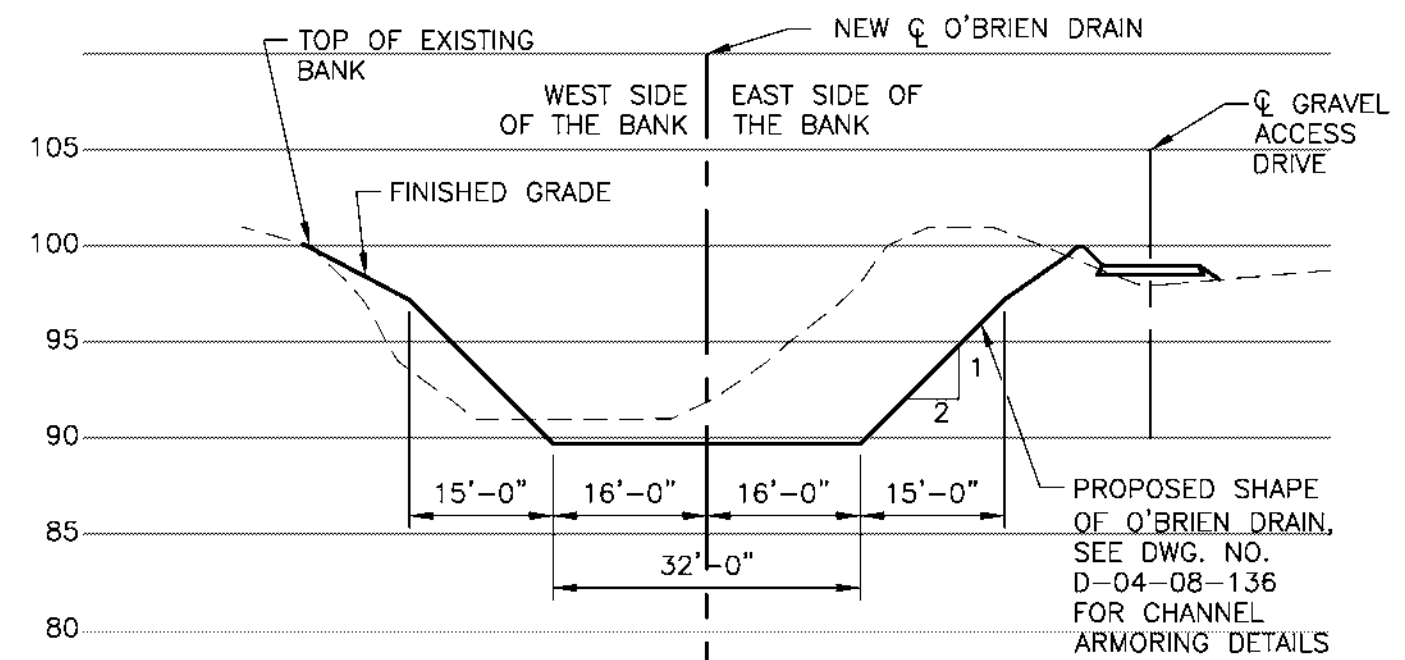
STATION 4+00

SCALE: HORZ. 1" = 20'
VERT. 1" = 10'



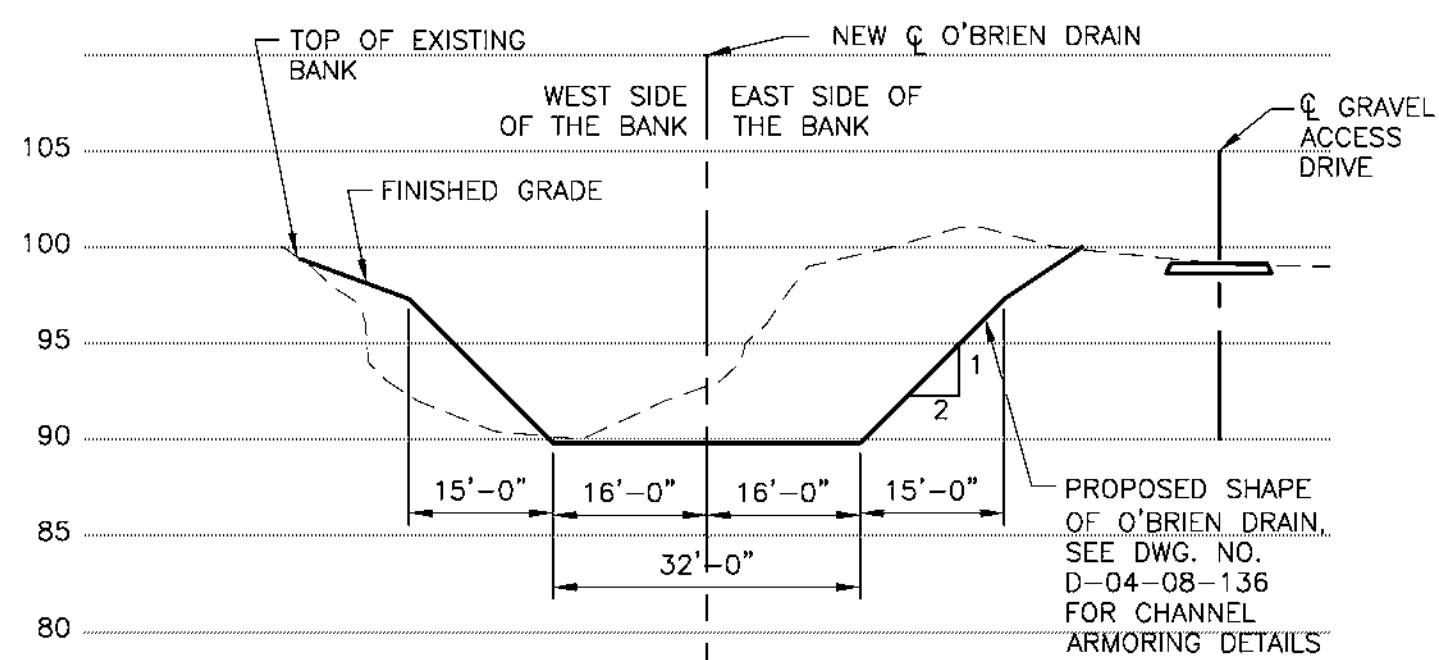
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SCALE: HORZ. 1" = 20'
VERT. 1" = 10'



STATION 3+00

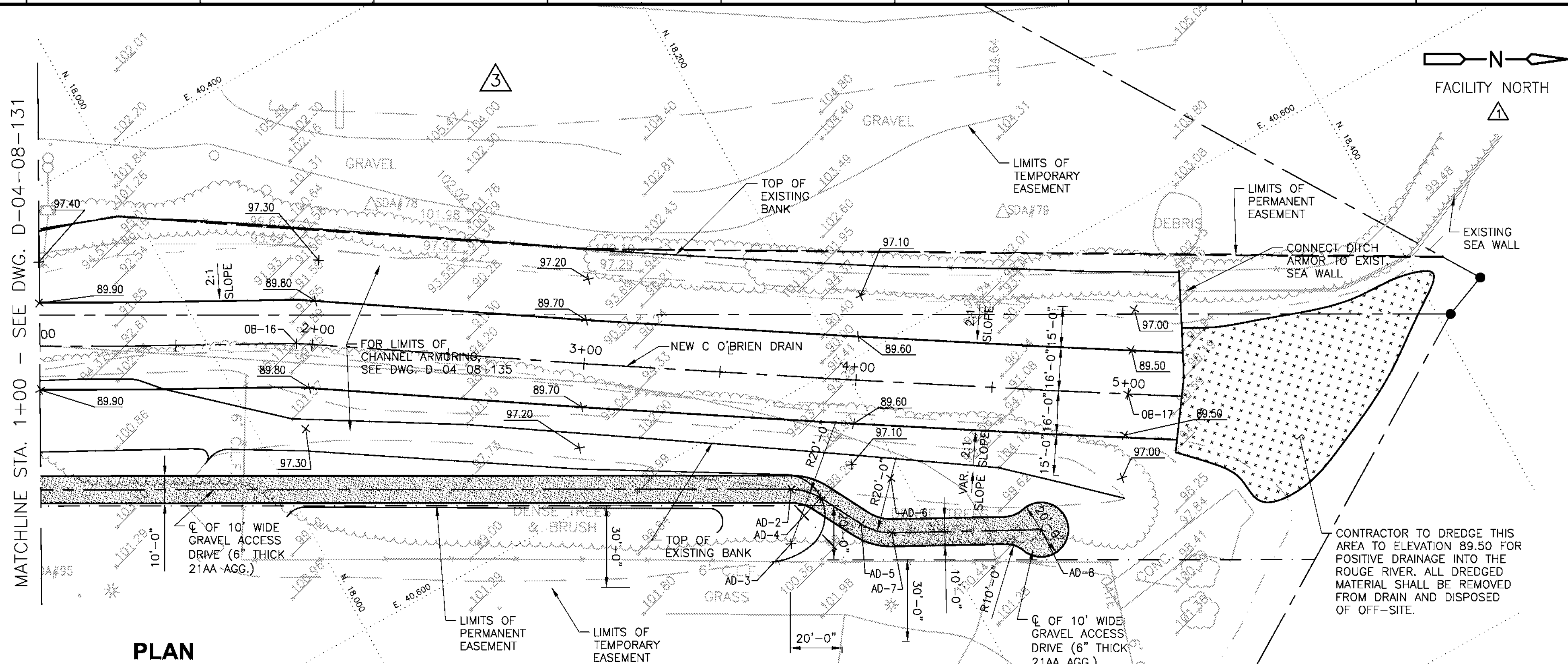
SCALE: HORZ. 1" = 20'
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STATION 2+00

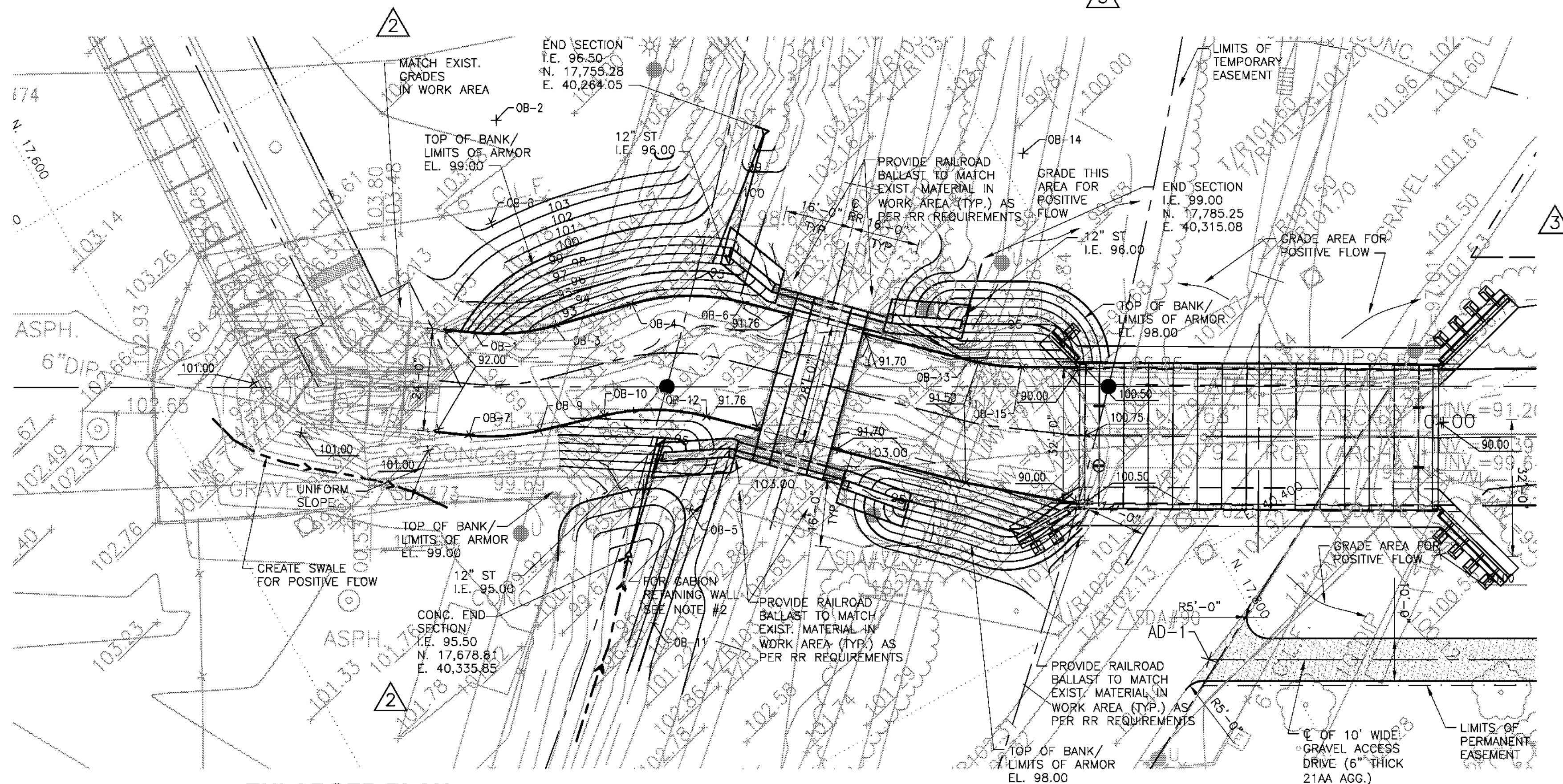
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VERT. 1" = 10'

CROSS SECTIONS



PLAN

1" = 30'



ENLARGED PLAN

SCALE: 1" = 20'

RECORD DRAWING

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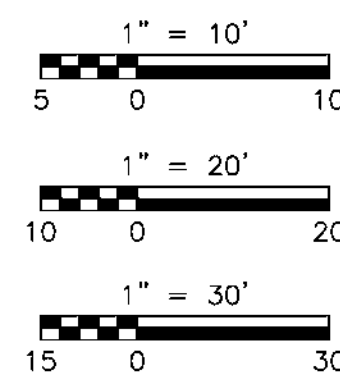
By DUANE D. DeDENE

Date 08/2012

CDM
Smith

NOTES:

- FOR PROJECT COORDINATES DESCRIPTIONS, NORTHINGS AND EASTINGS, SEE SHEET D-04-08-104A.
- CONTRACTOR TO FIELD CHECK, DESIGN AND PROVIDE GABION RETAINING WALL. GABION RETAINING WALL TO BE DESIGNED BY REGISTERED ENGINEER AND SUBMITTED TO ENGINEER FOR REVIEW.



3 WORKING DAYS BEFORE YOU DIG CALL MISS DIG. 1-800-482-7171

ALTERNATE NUMBER (810) MISS-DIG COLOR CODES FOR UTILITY LOCATING:

Yellow	OIL & GAS	Blue	WATER
Orange	PHONE & CATV	Green	STORM DRAIN
Red	ELECTRIC	Brown	SEWER
		Pink	SURVEYING

IF YOU ARE GOING TO WORK NEAR OVERHEAD WIRES... CALL MISS DIG

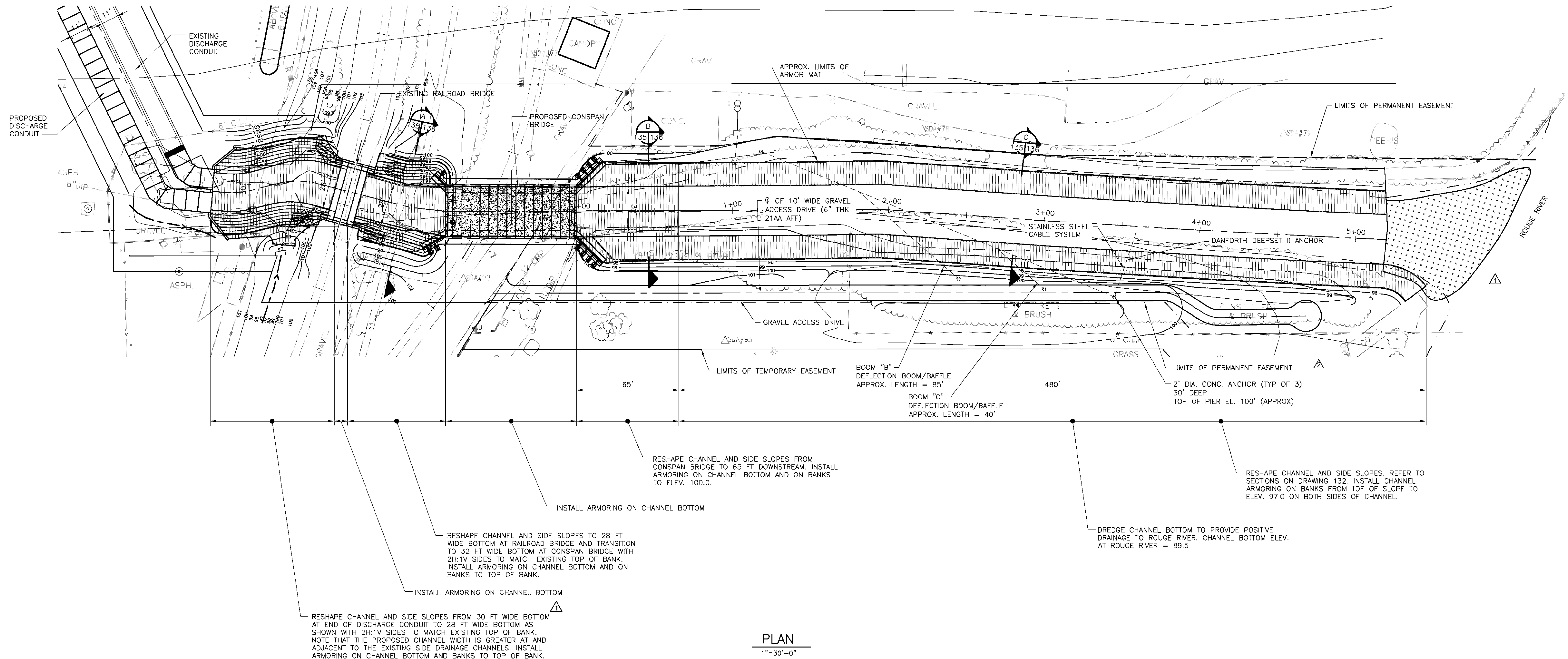
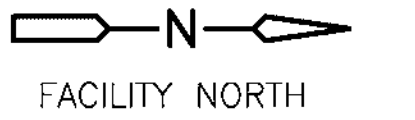
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1	REVISED GRADING	11/07	AG	
2	REVISED PER BULLETIN NO. 1	1/07	AG	
NO.	DESCRIPTION	NO.	DATE	APPROVED
				AG

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

EFFLUENT CONDUIT/ O'BRIEN DRAIN
FINISHED SITE GRADING, DRAINAGE AND UTILITY PLAN

SCALE: AS NOTED
DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc. One Woodward Avenue, Suite 1500 Detroit, MI 48226
hamiltonanderson Hamilton Anderson Associates 1430 Woodward Ave., Suite 200, Detroit, MI 48226
Applied Science, Inc. 300 New River, Suite 500, Detroit, MI 48207
TUCKER, YOUNG, JACKSON, TULL, INC. CONSULTING ENGINEERS PLANNERS 1430 Woodward Ave., Suite 200, Detroit, MI 48226
Associates Inc. 300 New River, Suite 500, Detroit, MI 48207
SIGMA CONSULTING ENGINEERS 300 New River, Suite 500, Detroit, MI 48207
SUPERIOR ENGINEERING ASSOC., INC. 650 Woodward Ave., Suite 200, Detroit, MI 48226
SOMAT Engineering, Inc. 650 Woodward Ave., Suite 200, Detroit, MI 48226
CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION
SECTION MAP TOWN RANGE SECTION PORTION CODE
M.D.P.H./D.N.R. PERMIT NO. FAMIS NO. CONTRACT NO. PC-755 FILE NO. CSTPL132.DWG DRAWING NO. D-04-08-132



PLAN

1"=30'-0"

NOTES:

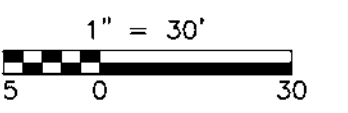
- REFER TO DRAWING NUMBER D-04-08-136 FOR CHANNEL ARMORING DETAILS.
- REFER TO DRAWING D-04-08-130 FOR THE SOIL EROSION CONTROL PLAN.
- REFER TO DRAWINGS D-04-08-131 & 132 FOR THE SITE GRADING, DRAINAGE AND UTILITY PLANS.
- EARTHWORK SHALL CONFORM TO THE REQUIREMENTS OF SECTION 02200.
- DREDGING SHALL CONFORM TO THE REQUIREMENTS OF SECTION 02482.
- THE DREDGING WORK SHALL INCLUDE REMOVAL OF EXISTING DEBRIS WITHIN THE CHANNEL, PIECES OF CONCRETE, RIPRAP, ETC., THAT INTERFERES WITH INSTALLATION OF THE ARTICULATED CONCRETE MATTRESS.
- THE ARTICULATED CONCRETE MATTRESS SHALL CONFORM TO THE REQUIREMENTS OF SECTION 02300.

RECORD DRAWING

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By DUANE D. DeDENE Date 08/2012

CDM Smith



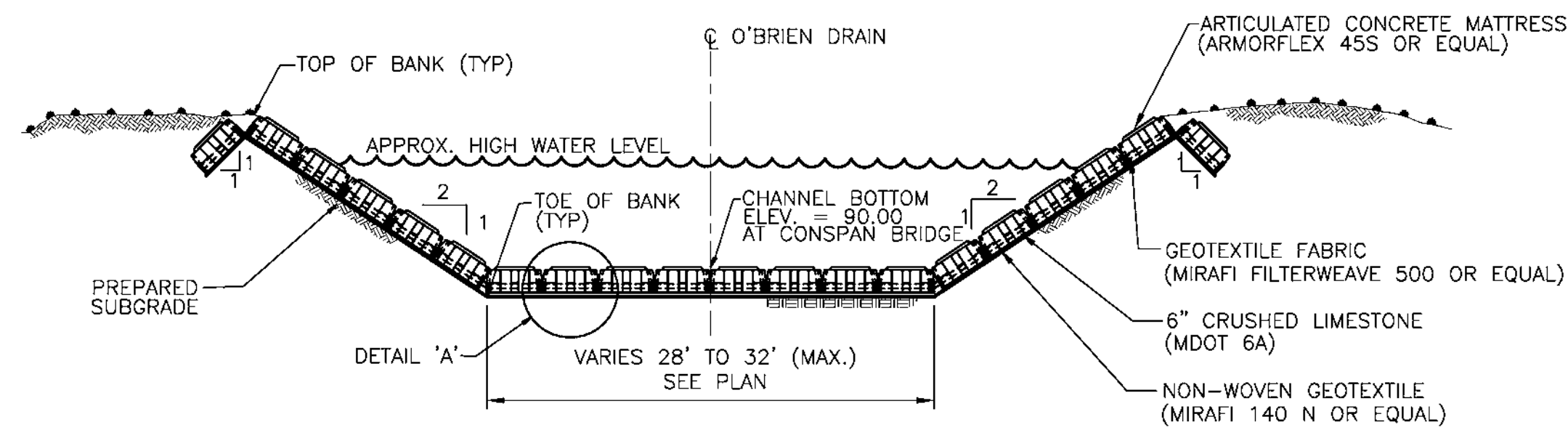
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1	REVISED PER BULLETIN NO. 1	1/07	MJT	CHECKED	JRM
				APPROVED	MJT

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

O'BRIEN DRAIN
CHANNEL ARMORING SITE PLAN

SCALE: 1"=30'
DATE: DECEMBER 15, 2006

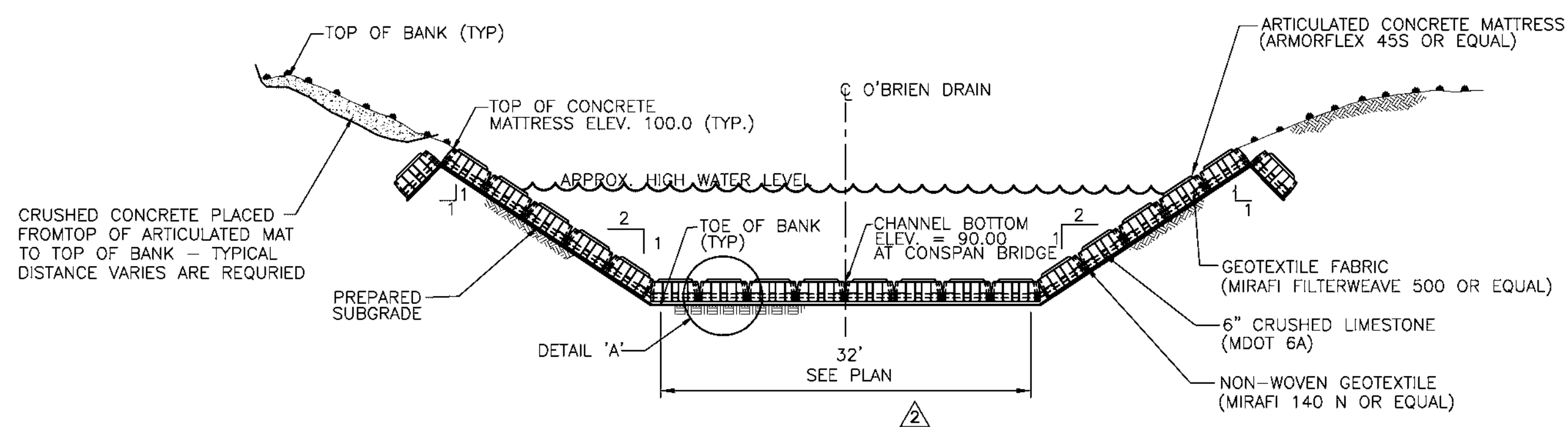
CDM CDM Michigan, Inc. One Woodward Avenue, Suite 1500 Detroit, MI 48226 PHONE: (313) 567-4700 FAX: (313) 567-4700 WWW.CDM-MICHIGAN.COM	hamiltonanderson Hamilton Anderson Associates 1430 Hastings Suite 200, Detroit, Michigan 48226 P 313 564 9270 F 313 564 2170 www.hamilton-anderson.com	JACKSON, YOUNG JACKSON, YOUNG, INC. CONSULTING ENGINEERS PLANNERS 1430 Hastings Suite 200, Detroit, Michigan 48226 P 313 963-0812 F 313 963-0812 FAX 313 963-2188	Applied Science, Inc. 200 New River, Suite 540, Detroit, MI 48207 Phone: (313) 947-2600 Fax: (313) 947-2700	Associates Inc. 155 W. Congress St., Suite 410 Detroit, MI 48226 Phone: 313-564-7765 Fax: 313-564-7782	SUPERIOR ENGINEERING ASSOC., INC. 65 SHELBOURNE RD., SUITE 2101, DETROIT, MI 48226 PHONE: (313) 968-5796 FAX: (313) 968-5791 WWW.SUPERIORMICH.COM	SOMAT Engineering, Inc. SOMAT Engineering, Inc. 600 Woodward Ave., Suite 1245, Detroit, Michigan (313) 963-5751 F 313 963 5758	City of Detroit WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION	M.D.P.H./D.N.R. PERMIT NO. FAMIS NO. - CONTRACT NO. PC-755 FILE NO. CSTDT135 DRAWING NO. D-04-08-135
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CHANNEL ARMORING - BOTTOM AND BANKS

TYPICAL SECTION A
NOT TO SCALE
135 136

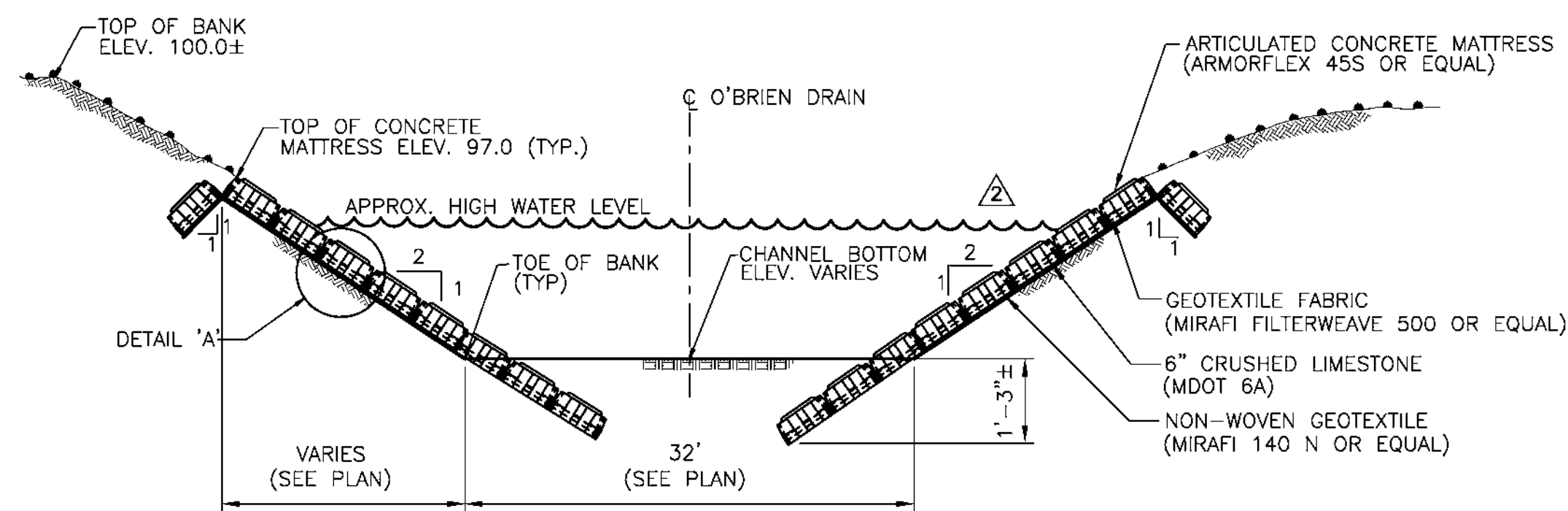
* SEE NOTE 1



CHANNEL ARMORING - BOTTOM AND BANKS

TYPICAL SECTION B
NOT TO SCALE
135 136

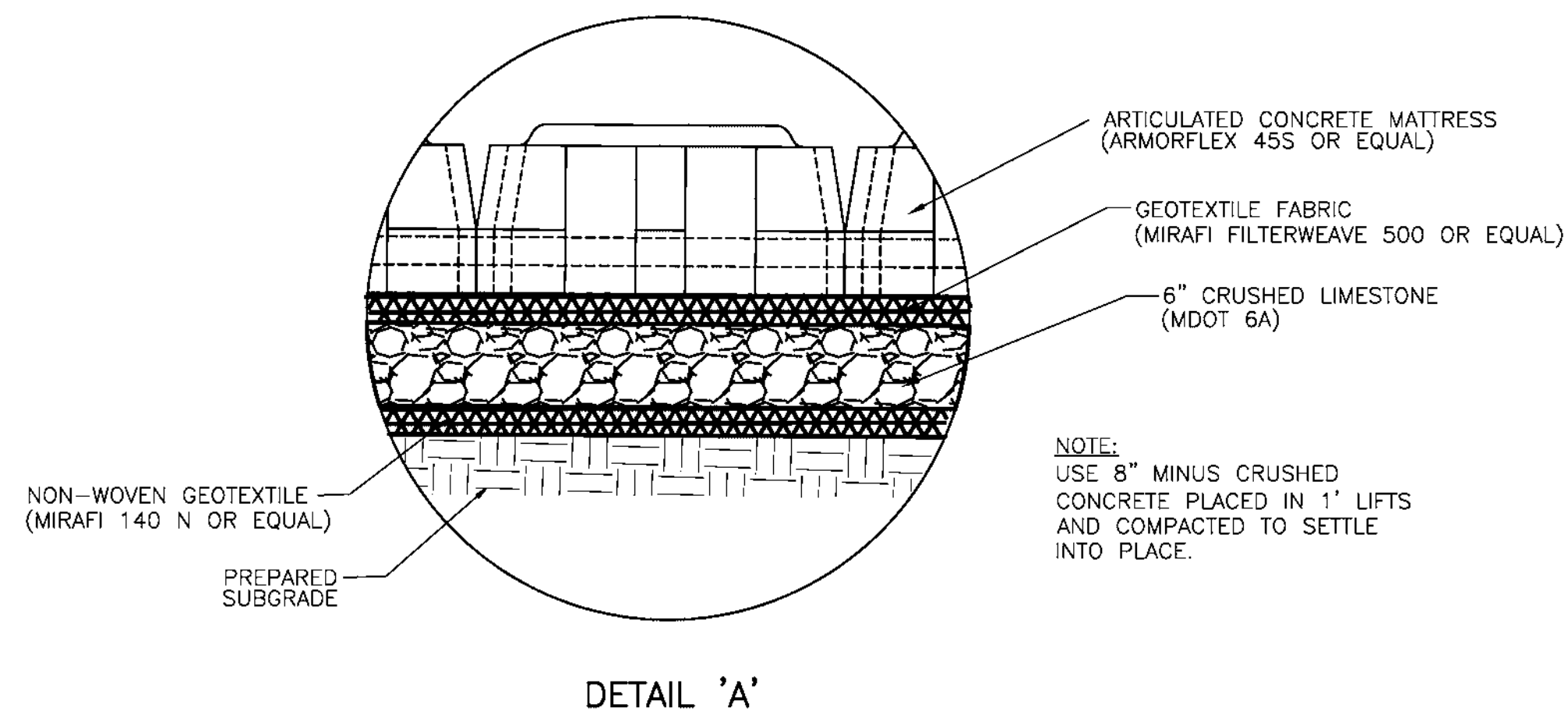
* SEE NOTE 1



CHANNEL ARMORING - BANKS

TYPICAL SECTION C
NOT TO SCALE
135 136

* SEE NOTE 1



NOTE:
USE 8" MINUS CRUSHED
CONCRETE PLACED IN 1' LIFTS
AND COMPACTED TO SETTLE
INTO PLACE.

RECORD DRAWING

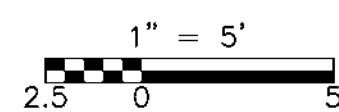
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By DUANE D. DeDENE Date 08/2012

CDM Smith

NOTES:

- REFER TO DRAWING NUMBER D-04-08-135 FOR THE LIMITS OF CHANNEL ARMORING WITHIN THE O'BRIEN DRAIN.
- THE ARTICULATED CONCRETE MATTRESS SHALL CONFORM TO THE REQUIREMENTS OF SECTION 02300.
- GEOTEXTILE FILTER FABRICS SHALL CONFORM TO THE REQUIREMENTS OF SECTION 02275.
- THE SUBGRADE AND BEDDING SHALL BE INSPECTED AND APPROVED BY AN ENGINEER PRIOR TO INSTALLATION OF THE GEOTEXTILE FABRIC.
- NO MECHANICAL EQUIPMENT SHALL BE DRIVEN DIRECTLY ON TOP OF THE FABRIC.
- THE FABRIC SHALL BE STORED IN SUCH A WAY THAT IT IS PROTECTED FROM PROLONGED EXPOSURE TO ULTRAVIOLET RADIATION.
- NO FABRIC SHALL BE COVERED UNTIL INSPECTED AND APPROVED BY THE ENGINEER.
- ALL ARTICULATED CONCRETE MATTRESS SHALL BE PRE-MANUFACTURED AS AN ASSEMBLY OF CONCRETE BLOCKS BOUND INTO MATS BY THE USE OF RETENTION CABLES.
- ALL CONCRETE MAT UNITS SHALL BE SOUND AND FREE OF DEFECTS THAT WOULD INTERFERE WITH THE PROPER PLACING OF THE UNIT OR IMPAIR THE STRENGTH OR PERMANENCE OF THE CONSTRUCTION.



				DESIGN	BCC
				DRAFTING	JWS
				CHECKED	JDS
				APPROVED	MJT
2	REVISED FOR RECORD	8/12	DDD		
1	O'BRIEN DRAIN RE-ALIGNMENT 8/08	8/29	MJT		
1	CONFORMED SET	8/07	MJT		
NO.	DESCRIPTION	NO.	DATE	APRVD	
REVISIONS					

DETROIT WATER AND SEWERAGE DEPARTMENT OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

O'BRIEN DRAIN CHANNEL ARMORING DETAILS & SECTIONS

SCALE: NTS

DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc.
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Detroit, MI 48226
Tel: (313) 963-1313
Fax: (313) 963-1313
www.cdm-smith.com

hamiltonanderson
Hamilton Anderson Associates
1430 Riverchase Suite 200, Detroit, Michigan 48226
P: 313.964.9270 F: 313.964.9170 www.hamilton-anderson.com

Applied Science, Inc.
300 River Road, Suite 5400, Detroit, MI 48207
Phone: (313) 967-2600 Fax: (313) 967-2700

TUCKER, YOUNG, JACKSON, TULL, INC.
CONSULTING ENGINEERS PLANNERS
200 E. LAMAR SUITE 200, DETROIT, MICHIGAN 48226
TEL: (313) 963-0812 FAX: (313) 963-2108

Associates Inc.
150 W. Congress St., Suite 410
Detroit, MI 48226
Phone: 313-954-7765 Fax: 313-954-7782

SUPERIOR ENGINEERING ASSOC., INC.
6500 Woodward Ave., Suite 2100, Detroit, MI 48202
Tel: (313) 964-0796 Fax: (313) 964-0791
www.superioreng.com

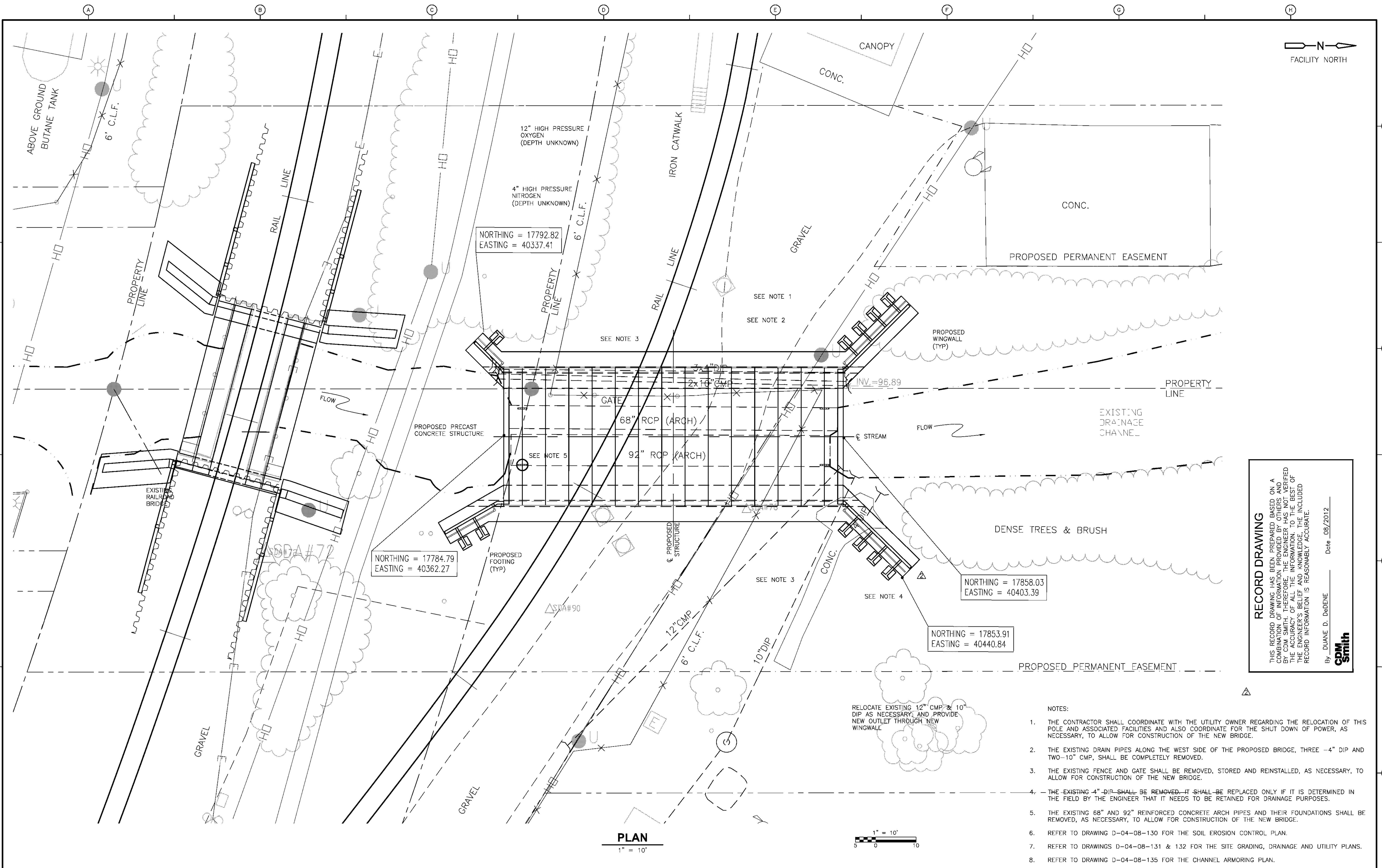
SOMAT Engineering, Inc.
GEOTECHNICAL & GEOPHYSICAL SERVICES
600 Woodward Ave., Suite 1250, Detroit, Michigan
(313) 963-5711 Fax: (313) 963-5708

Sigma Consulting Engineers
1000 Woodward Ave., Suite 1700
Detroit, MI 48226
Tel: 313.963.9700 Fax: 313.963.9628

**CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT**
ENGINEERING DIVISION

SECTION MAP TOWN RANGE SECTION PORTION CODE

M.D.P.H./D.N.R. PERMIT NO.	
FAMIS NO.	-
CONTRACT NO.	PC-755
FILE NO.	CSTD136
DRAWING NO.	D-04-08-136



		DESIGN	JDS
		DRAFTING	JWS
2	REVISED FOR RECORD	8/12	DDD
2	O'BRIEN DRAIN RE-ALIGNMENT 8/08	8/29/08	MJT
1	CONFORMED SET	8/07	MJT
NO.	DESCRIPTION	NO.	DATE
		APPROVED	MJT
REVISIONS			

DESIGN	JDS
DRAFTING	JWS
CHECKED	BCC
APPROVED	MJT

DETROIT WATER AND SEWERAGE DEPARTMENT
OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

O'BRIEN DRAIN
GENERAL BRIDGE PLAN

SCALE: 1"=10'

DATE: DECEMBER 15, 2006

CDM
CDM Michigan Inc.
One Woodward Avenue, Suite 1500
Detroit, MI 48226
Tel: (313) 963-1313
Fax: (313) 963-1313
www.cdm.com

hamiltonanderson
Hamilton Anderson Associates
1430 Woodward Ave., Suite 200, Detroit, Michigan 48226
Tel: (313) 963-1313
Fax: (313) 963-1313
www.hamilton-anderson.com

Applied Science, Inc.
300 New River, Suite 500, Detroit, MI 48207
Phone: (313) 967-2600, Fax: (313) 967-2700

TUCKER, YOUNG, JACKSON, TULL, INC.
CONSULTING ENGINEERS PLANNERS
200 E. Larned Street, Suite 200, Detroit, Michigan 48226
Tel: (313) 963-0812, Fax: (313) 963-2188
www.tyji.com

Associates Inc.
150 W. Congress St., Suite 410
Detroit, MI 48226
Phone: 313-954-7765, Fax: 313-954-7782

SUPERIOR ENGINEERING ASSOC., INC.
85 GORDON RD., SUITE 2101, DETROIT, MI 48226
Tel: (313) 968-0796, Fax: (313) 968-0791
www.superioreng.com

SOMAT Engineering, Inc.
CONSULTING ENGINEERS
600 Woodward Ave., Suite 1245, Detroit, Michigan 48226
Tel: (313) 963-0751, Fax: (313) 963-0758

Sigma Consulting Engineers
1000 Woodward Ave., Suite 1700
Detroit, MI 48226
Tel: (313) 963-0751, Fax: (313) 963-0758

CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP
TOWN
RANGE
SECTION
PORTION CODE

M.D.P.H./D.N.R. PERMIT NO.
FAMIS NO.
CONTRACT NO.
FILE NO.
DRAWING NO.

-
PC-755
CSTPL137
D-04-08-137

RECORD DRAWING

THIS RECORD DRAWING HAS BEEN PREPARED BASED ON A COMBINATION OF INFORMATION PROVIDED BY OTHERS AND BY CDM SMITH. THEREFORE, THE ENGINEER HAS NOT VERIFIED THE ACCURACY OF ALL THE INFORMATION. TO THE BEST OF THE ENGINEER'S BELIEF AND KNOWLEDGE, THE INCLUDED RECORD INFORMATION IS REASONABLY ACCURATE.

By DUANE D. DeDENE Date 08/2012

CDM Smith

Appendix D

Oakwood Utility Files

UTILITY PROVIDER	CONTACT #	MISS DIG RESULTS	DATE
AT&T TELEPHONE	(231) 409-7939	RECEIVED	10/26/2022
BUCKEYE PARTNER LP PIPELINE	(800) 331-4115	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (WATER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (SEWER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT PUBLIC LIGHTING ELECTRIC	(313) 267-5130	NOT RECEIVED	
DTE ENERGY (ELECTRIC) ELECTRIC	(313) 407-5364	RECEIVED	11/8/2022
DTE ENERGY (GAS) GAS	(248) 318-7839	RECEIVED	10/26/2022
GREAT LAKES WATER AUTHORITY (SEWER)	(313) 799-0289	RECEIVED	11/8/2022
INTERNATIONAL TRANSMISSION CO. (FIBER OPTICS)	(888) 269-8740	RECEIVED	11/4/2022
KINDER MORGAN COCHIN, LLC PIPELINE	(713) 369-9795	RECEIVED	10/26/2022
LINDE, INC. GAS	(313) 849-4326	RECEIVED	10/26/2022
MARATHON PIPELINE, LLC PIPELINE	(800) 537-6644	RECEIVED	10/27/2022

JOB #: SM22-200
JOB NAME: GLWA - OAKWOOD

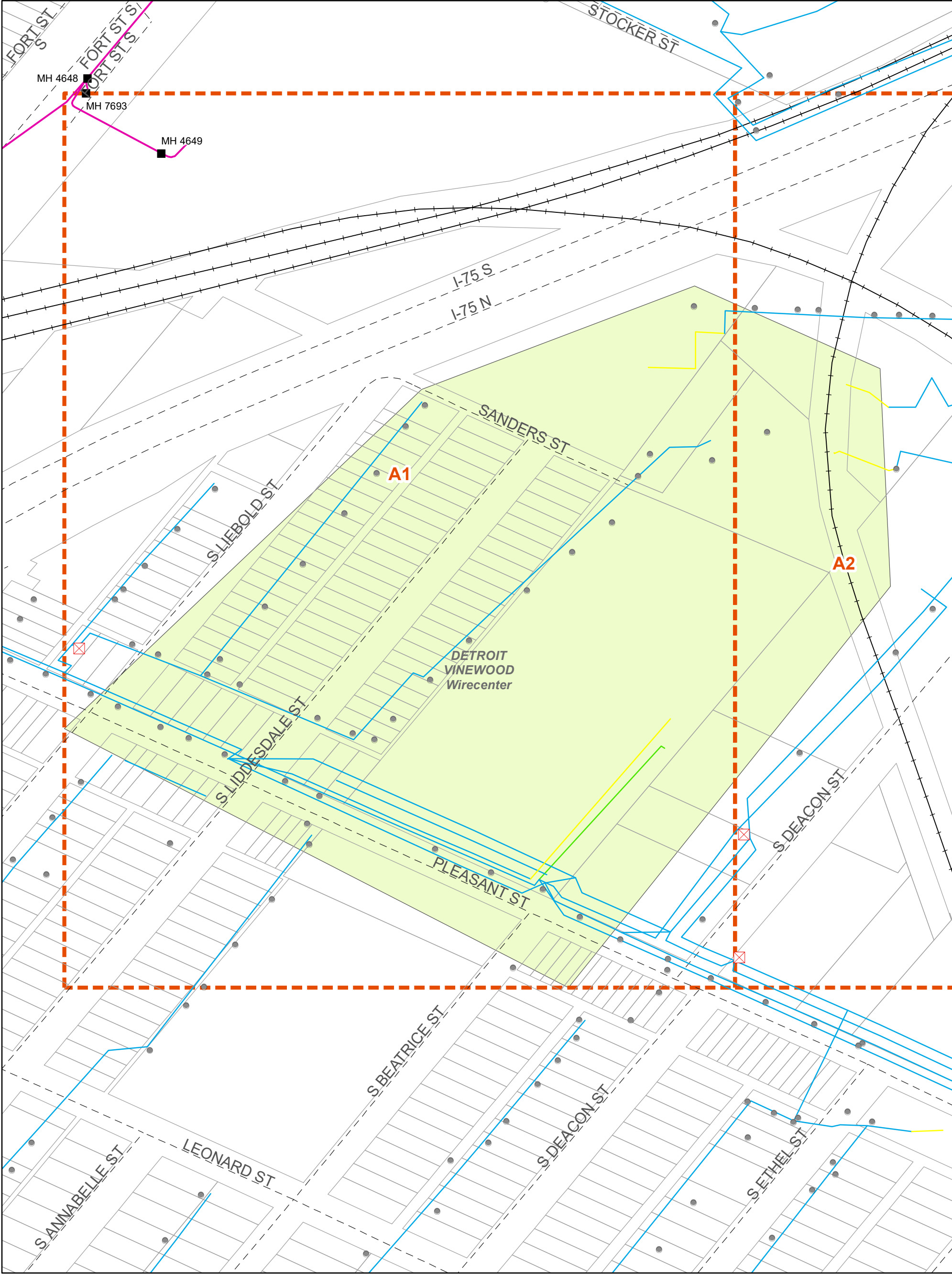
MISS DIG TICKET #: 2022102503611
TICKET CREATED ON: 10/25/2022
TICKET CLOSE DATE:



External Map Request for Spalding Dedecker

Ticket 2022102503611 Project

Date: 10/28/2022
Index Map



1:2,464



- Poles
- SAls
- Manholes
- Aerial
- Building
- Conduit
- Railroads
- Street Centerlines

- Mapping Index
- Wirecenter Boundary
- Parcels
- JobAOI

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Location of facilities shown herein are subject to field verification. No liability is assumed by AT&T as to the accuracy of location facilities. Please call USA at 811 two working days in advance of any grading or excavation in vicinity of our underground facilities. AT&T propriety (internal use only). Not for use or disclosure outside the AT&T companies except under written agreement. Telco proprietary data is not to be disclosed to siloed employees.

AT&T PROPRIETARY-This information constitutes confidential trade secrets and commercial or financial information owned by AT&T and is shared for Critical Infrastructure Protection purposes only. It is exempt from disclosure under the Freedom of Information Act(5 USC 552), Exemptions (b)(3)&(4), and its disclosure is prohibited under the Trade Secrets Act(18 USC 1905), the Critical Infrastructure Information Act of 2002, 6 USC 133, and any State or local law requiring disclosure of information or records. This information must not be copied or distributed to others not agreed upon by AT&T, but in all events do not copy or distribute to such others without notification pursuant to Executive Order 12600.



S, Keith <ksirois@sda-eng.com>

Ticket 2022102503611 - Response to Dig Request

1 message

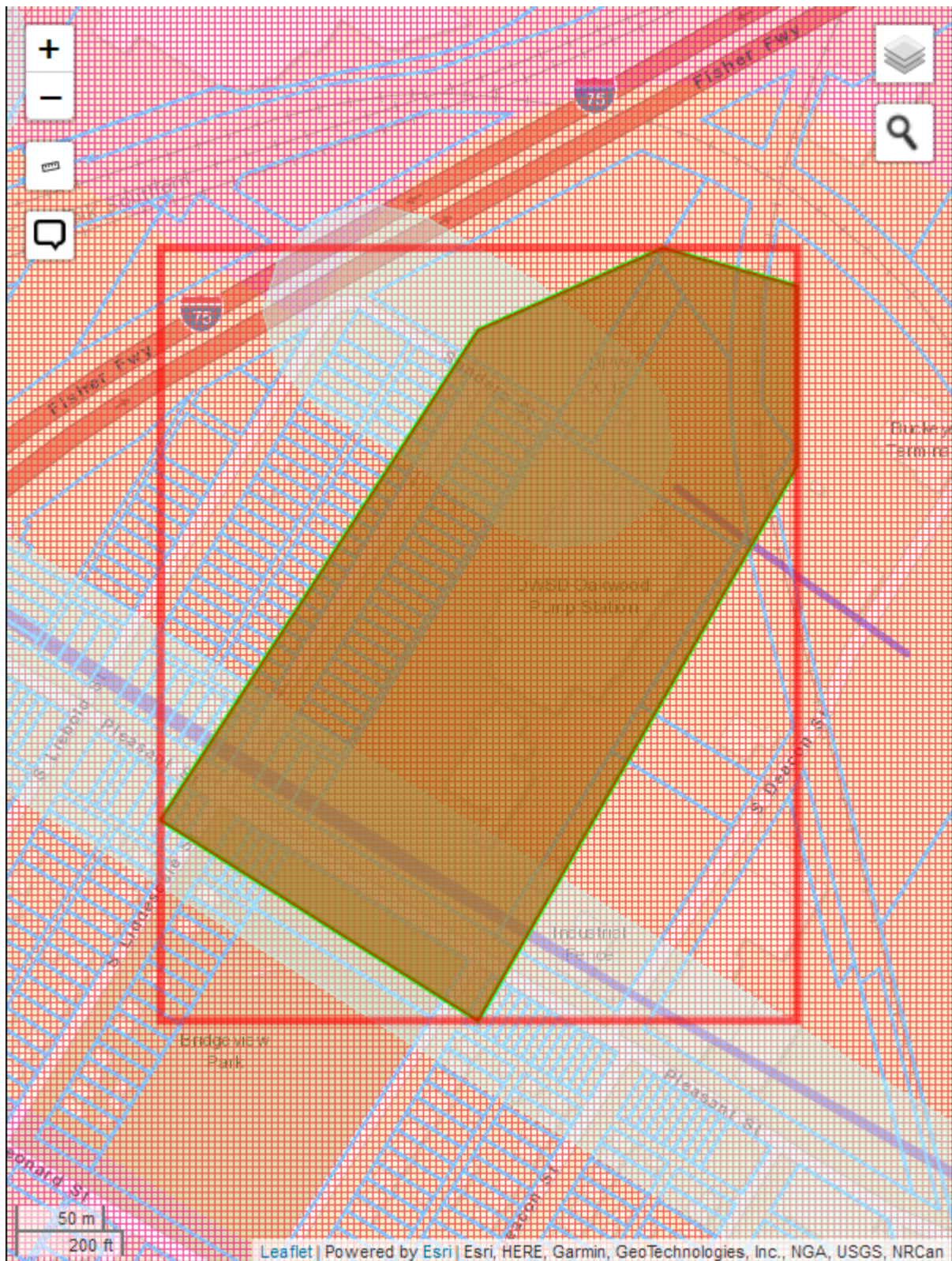
agt_comm@irth.com <agt_comm@irth.com>
To: ksirois@sda-eng.com

Wed, Oct 26, 2022 at 8:51 AM

Keith Sirois**SPALDING DEDECKER****905 E South Blvd****Rochester Hills****MI****48307**Dear **Keith Sirois**

This letter is in response to your request for Buckeye Partners involvement with the proposed construction of the above-mentioned project.

Upon review of your request it has been determined that Buckeye Partners ("Buckeye") does have pipeline facilities within the limits of the proposed project. A drawing depicting the approximate location of the pipeline facility has been included for your reference.



Additionally, a copy of Buckeye's Right of Way Use Restrictions Specification (ROWURS) has been included for your review. The ROWURS provides specific guidance on various property development activities useful for your plan design and also includes Buckeye's Application for Design Plan Submission and Encroachment Review. Before any preliminary field work or construction begins in the vicinity of Buckeye's pipeline, a determination of the exact location and elevation of the pipeline must be made. To coordinate this procedure, please contact our 811 Damage Prevention Team at 610-904-4940.

Once the exact pipeline location and elevation has been added to your drawings/plans along with a profile sheet for all proposed encroachments, submit the drawings/plans, Application for Design Plan Submission and Encroachment Review, and the appropriate review fee to Buckeye's Right of Way Department for review. Buckeye's encroachment review team will determine to what extent, if any, the pipeline right-of-way will be affected by the proposed construction.

Should you have any questions or need any additional information, please do not hesitate to contact me at (610)-904-4475 or you can email me at tmccclernon@buckeye.com.

Please mail all correspondence to:

Buckeye Partners
6161 Hamilton Blvd
Allentown, PA 18106

ATTN: Dave Jones / Senior ROW Specialist

You may e-mail plans to: encroachmentreviews@buckeye.com.

You can contact Dave at **610-904-4409**, should you require anything further.

Sincerely,

Traci L McClernon
811 Damage Prevention Lead
Cc: D. Jones



BUCKEYE PARTNERS, L.P. AND AFFILIATES
Five TEK Park, 9999 Hamilton Boulevard
Breinigsville, PA 18031

Right-of-Way Use Restrictions Specification
Revision 6

Table of Contents

SECTION PAGE NO.

Purpose and Scope	2
1.0 General Guidelines	2
2.0 Excavation and Construction Restrictions	4
3.0 Specific Guidelines	5
3.1 Cover, Grading, and Drainage	5
3.1.1 Cover and Grading	5
3.1.2 Drainage	5
3.2 Aboveground and Underground Structures	6
3.2.1 General Requirements	6
3.2.2 Gardening and Landscaping	6

S, Keith <ksirois@sda-eng.com>

2022102503611 2022102503675 MISS DIG Information for Requested Area

1 message

Kenosha Davison <Kenosha.Davison@detroitmi.gov>

Wed, Oct 26, 2022 at 8:09 AM

To: "ksirois@sda-eng.com" <ksirois@sda-eng.com>Cc: David Ridgeway <David.Ridgeway@detroitmi.gov>, Norma Leonard <Norma.Leonard@detroitmi.gov>

Good morning,

Attached is our Water and Sewer utilities in the area.
Screen shots are given from GIS maps attached to word document.

Thanks,

Kenosha Davison*Field Service Coordination Specialist***Detroit Water and Sewerage Department •**

6425 Huber St. • Detroit, MI 48211

P: 313-267-1261

C: 313-267-1262

E: kenosha.davison@detroitmi.gov

Customer Care: 313-267-8000



MICHAEL DUGGAN, MAYOR

From: Kenosha Davison <Kenosha.Davison@detroitmi.gov>**Sent:** Thursday, September 29, 2022 10:35 AM**To:** ksirois@sda-eng.com <ksirois@sda-eng.com>**Cc:** David Ridgeway <David.Ridgeway@detroitmi.gov>; Norma Leonard <Norma.Leonard@detroitmi.gov>**Subject:** 2022092900817 MISS DIG Information for Requested Area

Good morning,

Attached is our Water and Sewer utilities in the area.
Screen shots are given from GIS maps attached to word document.

Thanks,

Kenosha Davison*Field Service Coordination Specialist***Detroit Water and Sewerage Department •**

6425 Huber St. • Detroit, MI 48211

P: 313-267-1261

C: 313-267-1262

E: kenosha.davison@detroitmi.gov

Customer Care: 313-267-8000



MICHAEL DUGGAN, MAYOR

From: Kenosha Davison <Kenosha.Davison@detroitmi.gov>

Sent: Thursday, September 29, 2022 10:21 AM

To: ksirois@sda-eng.com <ksirois@sda-eng.com>

Cc: David Ridgeway <David.Ridgeway@detroitmi.gov>; Norma Leonard <Norma.Leonard@detroitmi.gov>

Subject: 2022092900912 2022092900866 2022092900841 MISS DIG Information for Requested Area

Good morning,

Attached is our Water and Sewer utilities in the area.
Screen shots are given from GIS maps attached to word document.

Thanks,

Kenosha Davison

Field Service Coordination Specialist

Detroit Water and Sewerage Department •

6425 Huber St. • Detroit, MI 48211

P: 313-267-1261

C: 313-267-1262

E: kenosha.davison@detroitmi.gov

Customer Care: 313-267-8000



MICHAEL DUGGAN, MAYOR

From: Kenosha Davison

Sent: Thursday, September 29, 2022 10:19 AM

To: ksirois@sda-eng.com <ksirois@sda-eng.com>

Cc: David Ridgeway <David.Ridgeway@detroitmi.gov>; Norma Leonard <Norma.Leonard@detroitmi.gov>

Subject: 2022092900945 MISS DIG Information for Requested Area

Good morning,

Attached is our Water and Sewer utilities in the area.
Screen shots are given from GIS maps attached to word document.

Thanks,

Kenosha Davison

Field Service Coordination Specialist

Detroit Water and Sewerage Department •

6425 Huber St. • Detroit, MI 48211

P: 313-267-1261

C: 313-267-1262

E: kenosha.davison@detroitmi.gov

Customer Care: 313-267-8000



MICHAEL DUGGAN, MAYOR

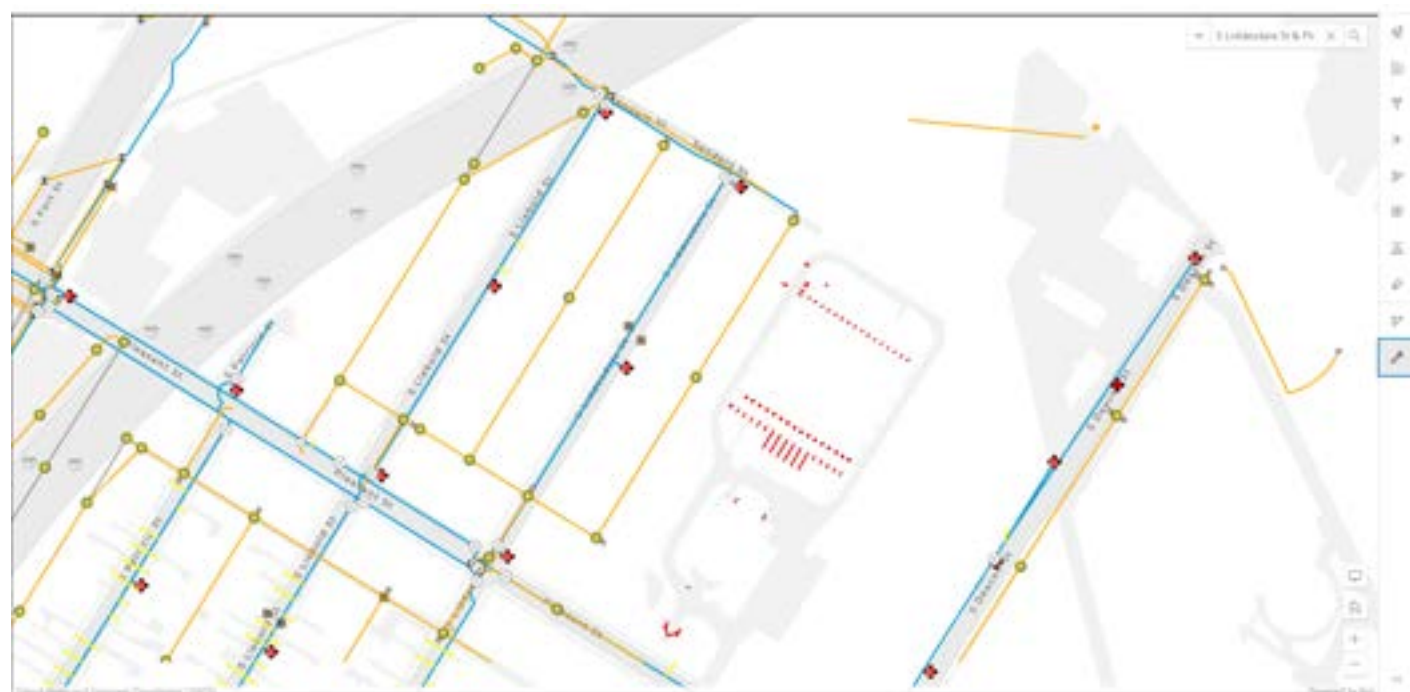
2 attachments



2022102503675 Mt Elliott and Kercheval.docx
869K



2022102503611 Liddesdale and Pleasant.docx
394K



Planning and Design Service Area map

 Satellite Office Location

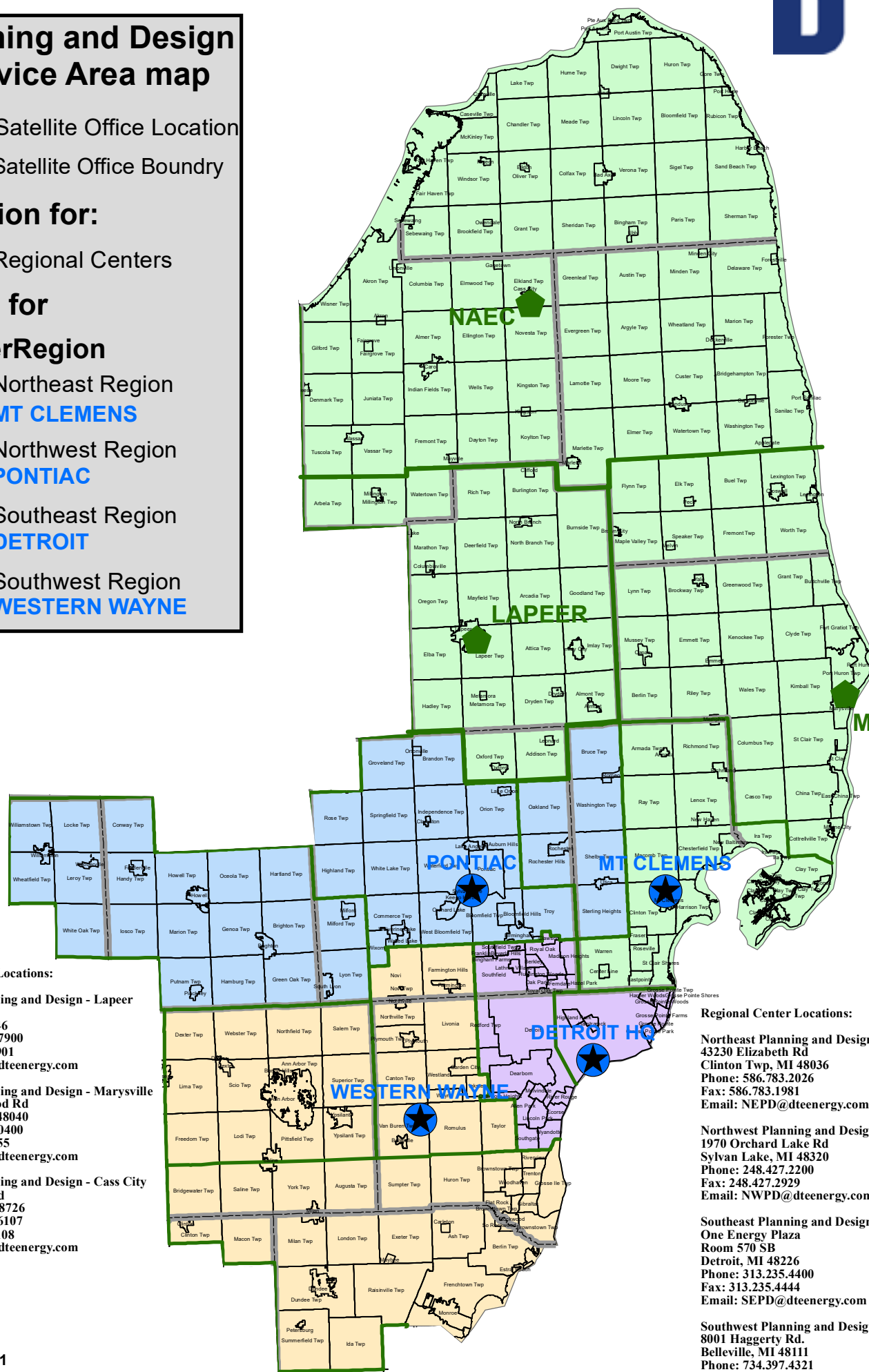
 Satellite Office Boundry

Location for:

 Regional Centers

**Areas for
ClusterRegion**

-  Northeast Region
MT CLEMENS
-  Northwest Region
PONTIAC
-  Southeast Region
DETROIT
-  Southwest Region
WESTERN WAYNE



Satellite Office Locations:

Northeast Planning and Design - Lapeer
1100 Clark Rd
Lapeer, MI 48446
Phone: 810.667.7900
FAX: 810.667.7901
Email: NEPD@dteenergy.com

Northeast Planning and Design - Marysville
3223 Ravenswood Rd
Marysville, MI 48040
Phone: 810.364.0400
Fax: 810.364.0455
Email: NEPD@dteenergy.com

Northeast Planning and Design - Cass City
4100 Doerr Road
Cass City, MI 48726
Office: 989.872.6107
FAX: 989.872.6108
Email: NEPD@dteenergy.com

Regional Center Locations:

Northeast Planning and Design - Mt Clemens
43230 Elizabeth Rd
Clinton Twp, MI 48036
Phone: 586.783.2026
Fax: 586.783.1981
Email: NEPD@dteenergy.com

Northwest Planning and Design - Pontiac
1970 Orchard Lake Rd
Sylvan Lake, MI 48320
Phone: 248.427.2200
Fax: 248.427.2929
Email: NWPDP@dteenergy.com

Southeast Planning and Design - Downtown Detroit
One Energy Plaza
Room 570 SB
Detroit, MI 48226
Phone: 313.235.4400
Fax: 313.235.4444
Email: SEPD@dteenergy.com

Southwest Planning and Design - Belleville
8001 Haggerty Rd.
Belleville, MI 48111
Phone: 734.397.4321
FAX: 734.397.4338
Email: SWPD@dteenergy.com

22-OCT-2021

Revised 09-30-2015 by Data Integrity/Mapping Tech
File: PIng_Des_Bdry_w_Emails_Sept_2015.mxd

Please note:

All documentation to be reviewed at the Utility Coordination Meeting must be received at least 10 business days prior to the meeting date: Send all information to the Regional Planning Office where your project is located. **See Planning and Design Service Area Map.**

For all future correspondence on this request, please contact the Regional Planning Office for your project.

To help facilitate timely electric utility coordination, please note the following:

Provide conflict list and associated drawings.

Specifically identify conflicts and provide locations of conflicts.

Poles and/or wire conflicts.

Street lighting posts and/or underground cable.

Underground facilities, i.e. cable, conduit, manholes and ground mounted equipment.

Send documents to the Regional Planning Office.

Documents must be received no less than 10 days before the Utility Coordination Meeting.

Requesting Company / Owner Agency to conduct Utility Coordination Meeting

The purpose of this meeting is to confirm design conflicts and discuss design options and/or relocation options.

Meeting should occur as soon as possible, but after the following have been completed.

Utilities have been plotted on Requesting Company / Owner Agency's design documents.

Conflicts have been identified by Requesting Company / Owner Agency.

Conflict list has been created by Requesting Company / Owner Agency.

Requesting Company / Owner Agency to conduct Pre-Construction Meeting

The purpose of this meeting is to confirm or coordinate the resolution of conflicts/relocations identified at the Utility Coordination Meeting.

Conflict information must be communicated prior to the Utility Coordination Meeting. Failure to do so will likely prevent DTE from meeting the project's utility relocation time line.

Things to Remember

Designers should be instructed to make every effort to avoid utility relocations.

Underground relocations can take up to 18 months or longer.

Overhead relocations can take 6 months or longer depending on the facilities involved.

LEGEND

Lights   

DTE Poles 

Foreign Poles 

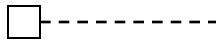
UG Transformers 

OH Transformers 

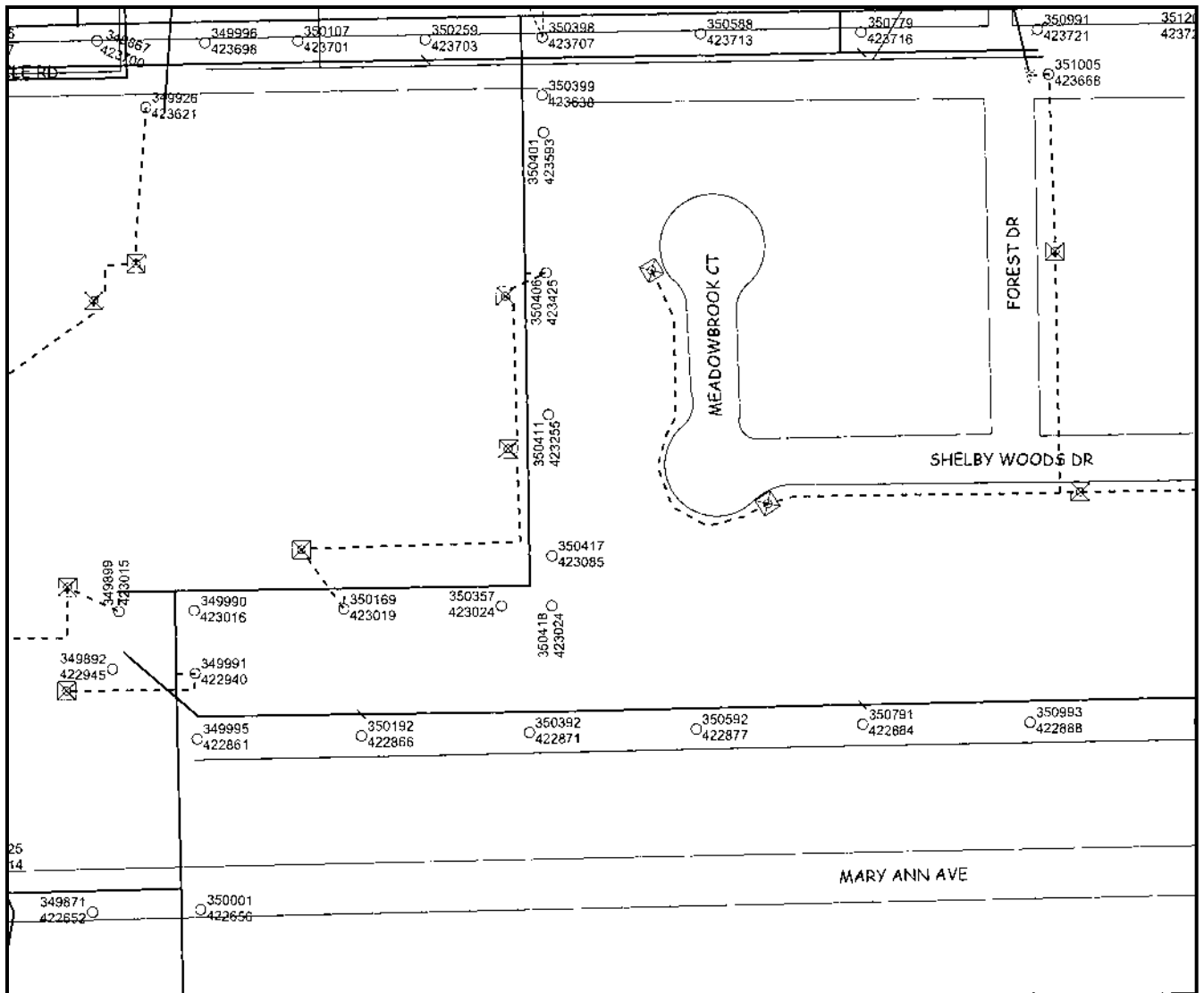
Overhead Lines 

Underground Lines 

Coordinate System for Poles 329081
411668

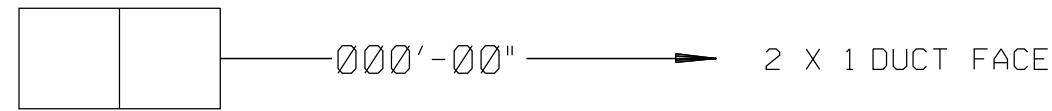
Pedestals 

SAMPLE OF OUTSIDE SALES MAP

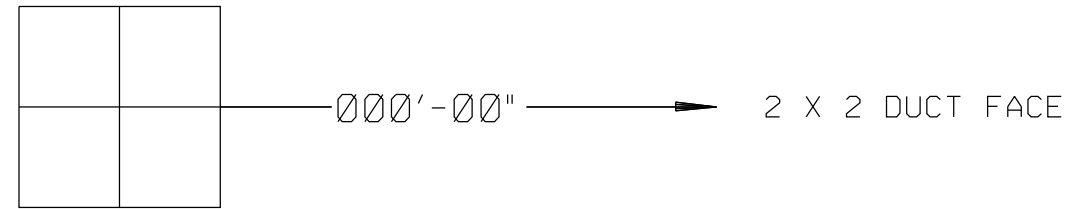


000'-00" 1 X 1 DUCT FACE

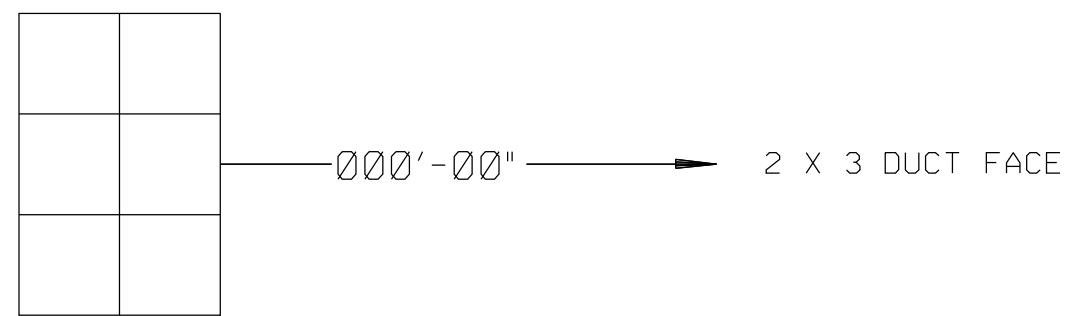
1 X 1 DUCT FACE



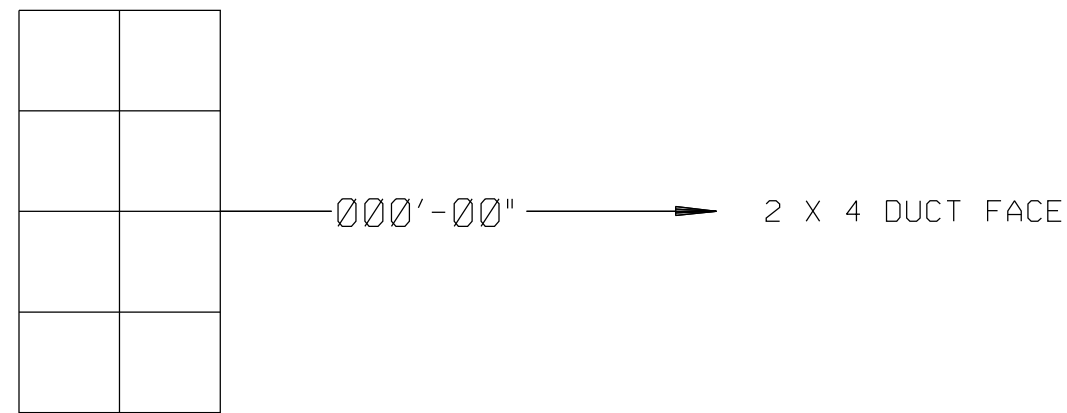
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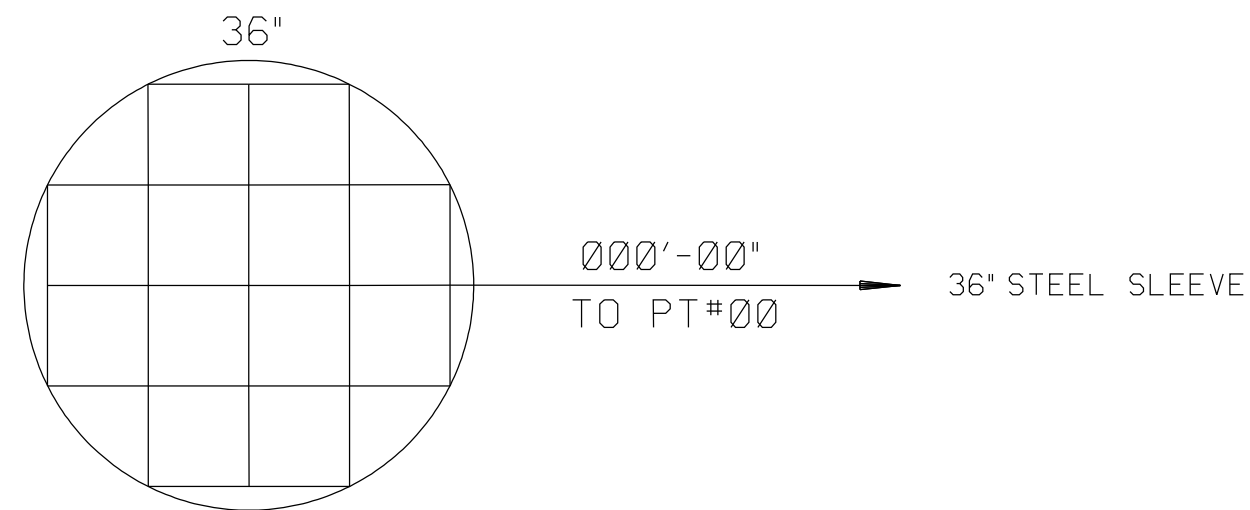
2 X 2 DUCT FACE



2 X 3 DUCT FACE



2 X 4 DUCT FACE



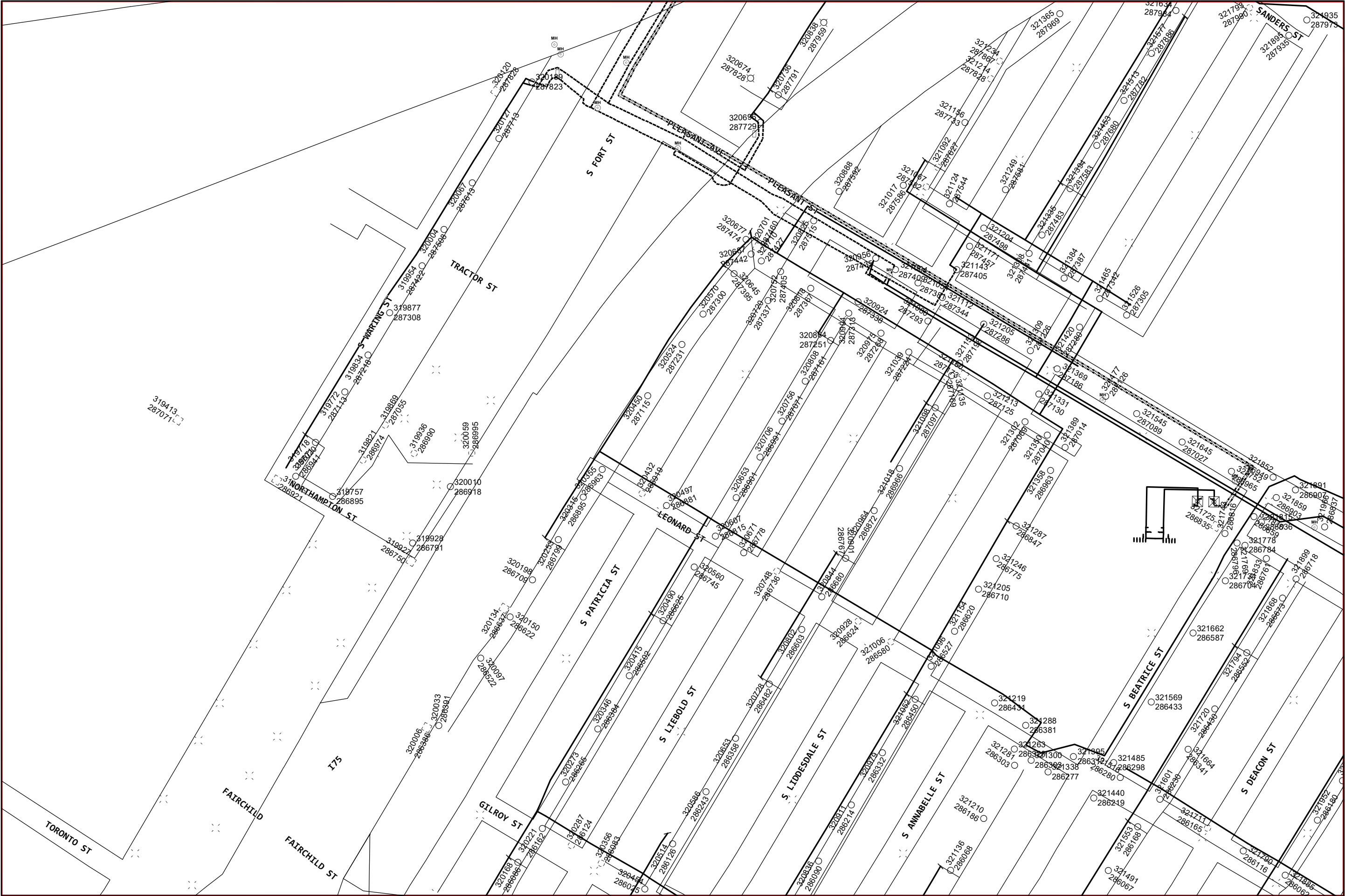
36" STEEL SLEEVE

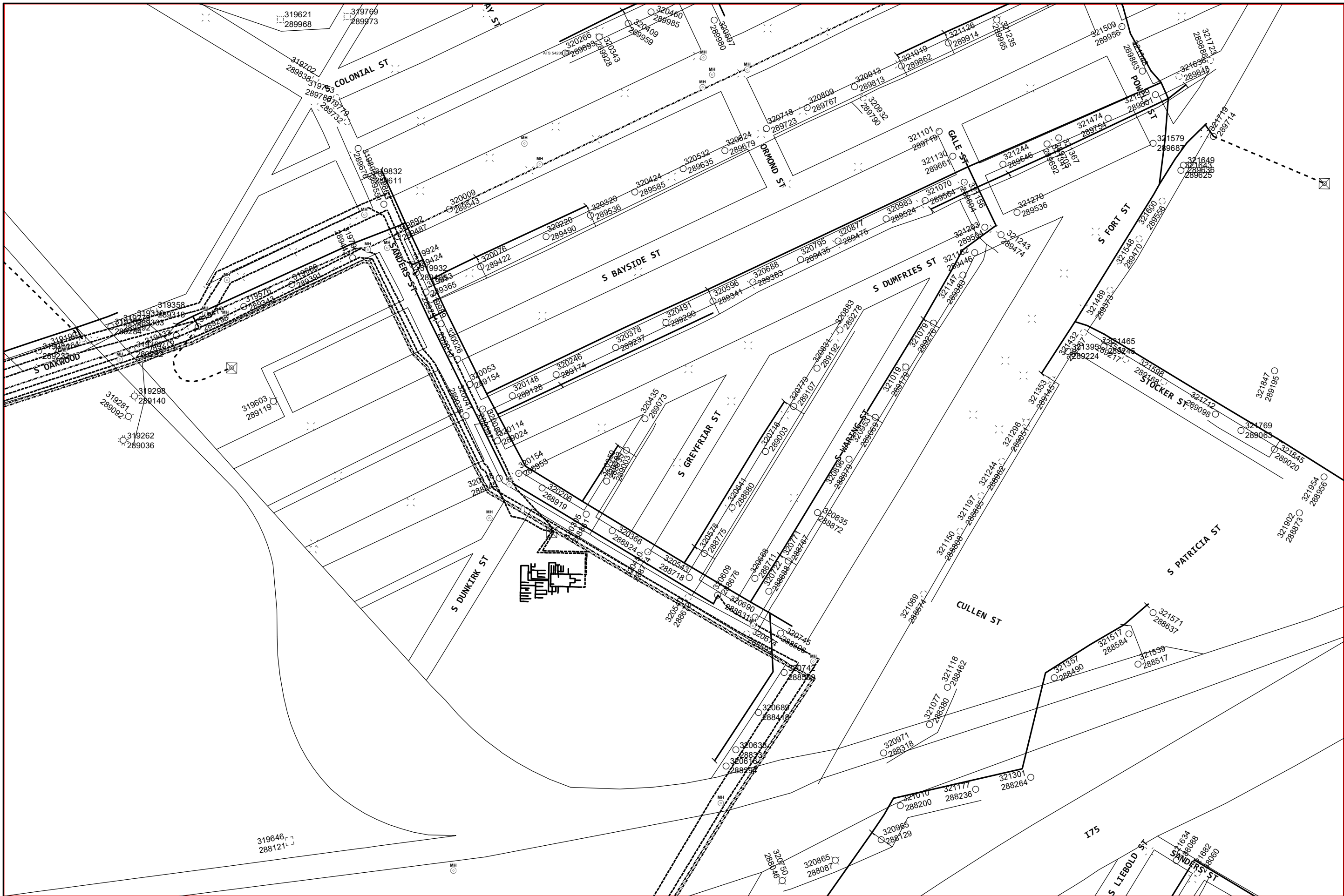
BORDER

00-0 ADJACENT MAP #

LINE SYMBOLOGY		RGB NUMBER		
		RED	GREEN	BLUE
	DECO (PROPOSED)	255	0	255
	DECO (EXISTING)	255	0	0
CELL SYMBOLOGY		RGB NUMBER		
		RED	GREEN	BLUE
LV=52,CO=22,LC=0,WT=2	FIBER OPTIC LEGENDS	255	0	255
LV=53,CO=5,LC=6,WT=3	DECO (PROPOSED)	255	0	255
LV=54,CO=0,LC=0,WT=2	CABLE NOMENCLATURE, CABLE NEUTRAL,120KV CABLE	255	255	255
LV=55,CO=0,LC=0,WT=2	FIBER OPTIC SLEEVES	255	255	255
LV=56,CO=6,LC=0,WT=2	BUILDING, PROPERTY LINE, ASSOC. TEXT	255	127	0
LV=57,CO=5,LC=0,WT=2	FIELD BOOK NUMBER	255	0	255
LV=58,CO=2,LC=0,WT=2	PRIMARY SWITCH CABINET	0	255	0
LV=59,CO=0,LC=0,WT=2	DUCT FACE, ASSOC. TEXT, ASSOC. DIMENSIONS	255	255	255
LV=60,CO=3,LC=0,WT=3	MANHOLE, C. POLE, JT. HOLE, CONDUIT RUN, ASSOC. TEXT	255	0	0
LV=61,CO=1,LC=0,WT=2	STREET NAME, R.O.W.	0	0	255
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LV=63,CO=31,LC=0,WT=5	TITLE SHEET	0	225	225

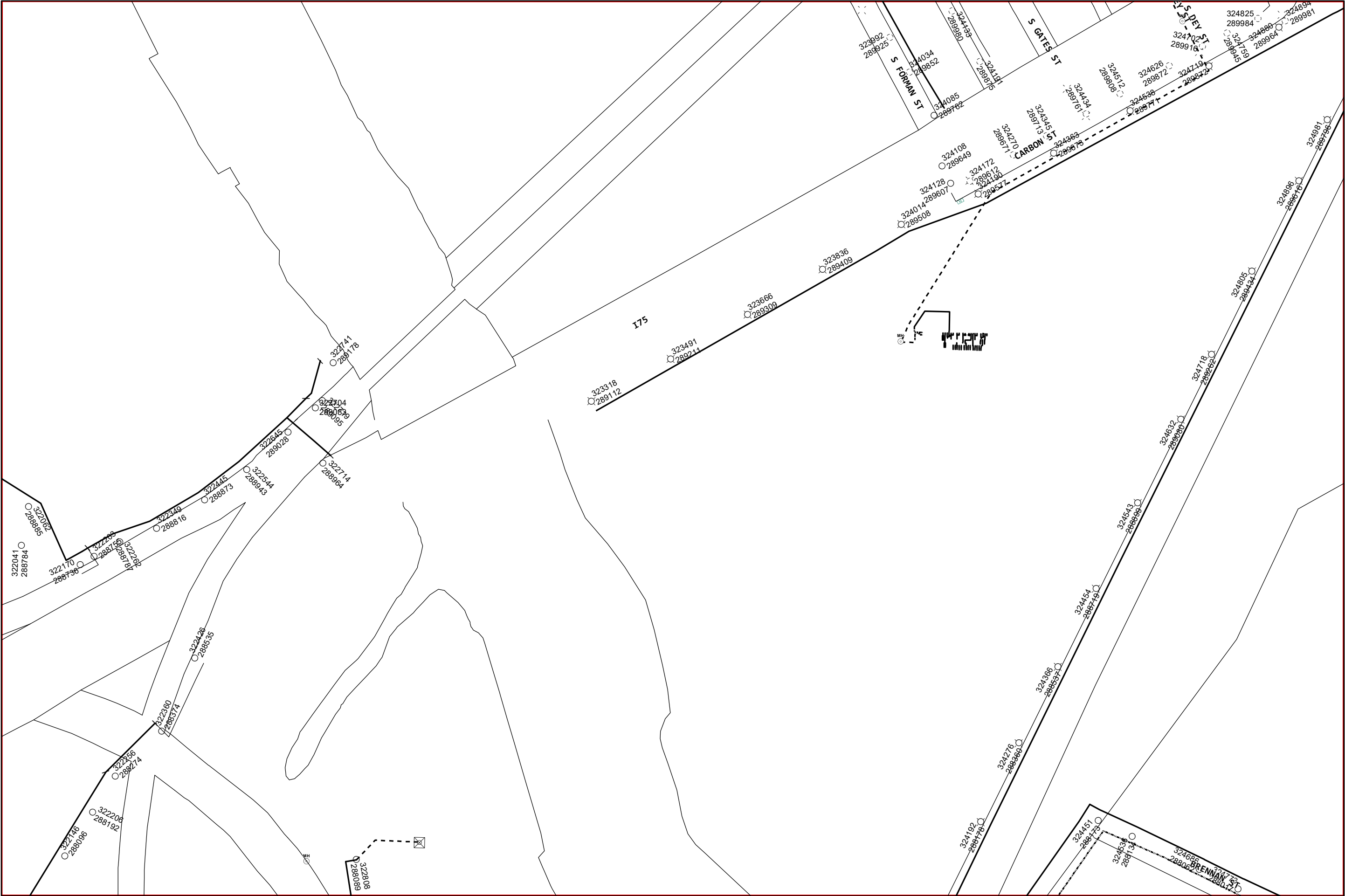


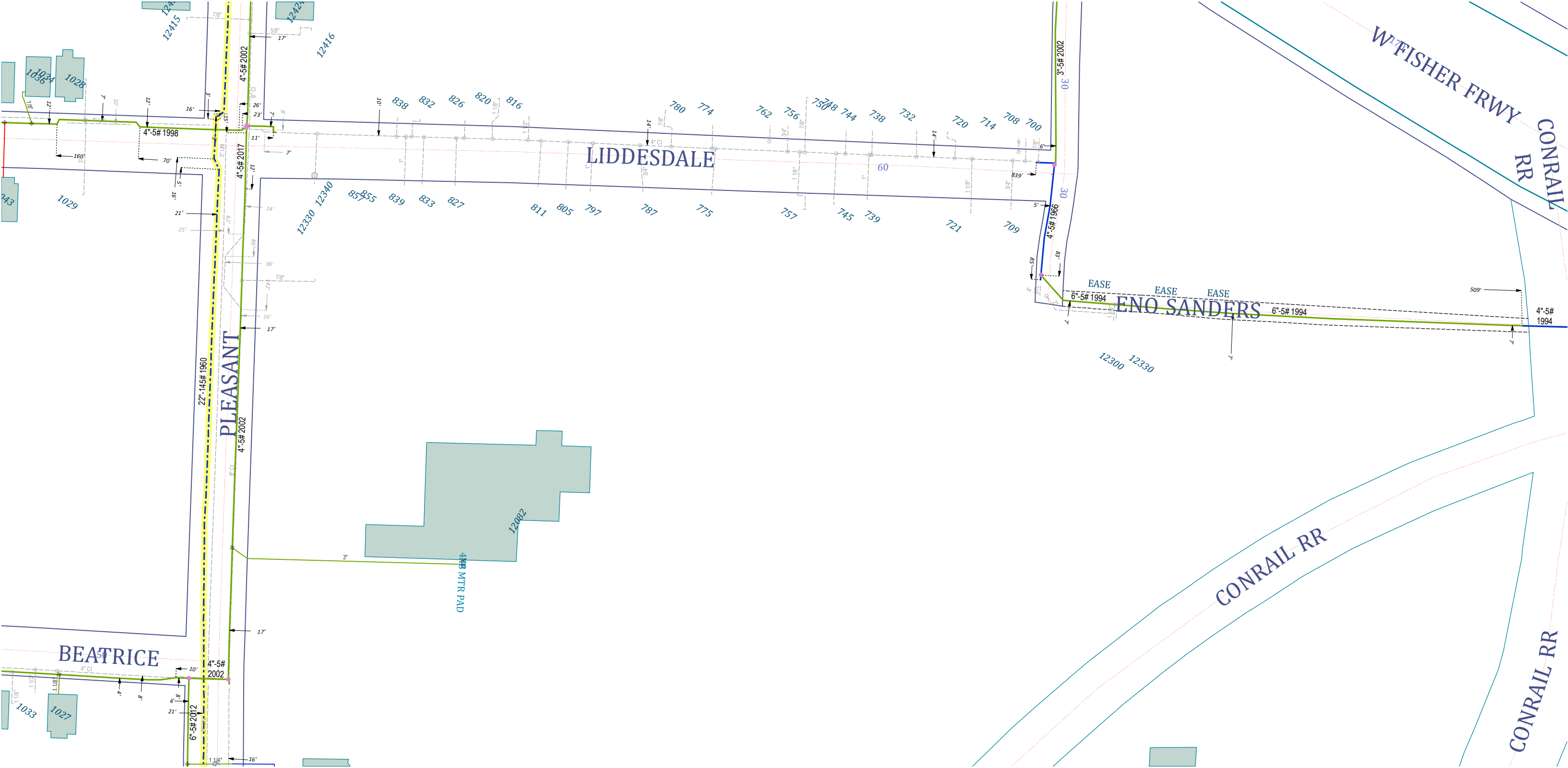




DTE ELECTRIC FACILITY MAP

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PROPRIETARY INFORMATION - FOR INTERNAL USE ONLY. THE INFORMATION AND FACILITY LOCATIONS ARE FOR REFERENCE ONLY. FIELD VERIFICATION REQUIRED.
CALL MISS DIG 3 DAYS BEFORE YOU DIG.





DTE GAS COMPANY FACILITIES AS SHOWN
INDICATE APPROXIMATE LOCATIONS ONLY AS DISCLOSED BY THE
COMPANY'S RECORDS AND NO GUARANTEE IS MADE EITHER AS
TO COMPLETENESS OR ACCURACY.

DTE GAS COMPANY

October 26, 2022

CONSTRUCTION PLANS MADE SUBSEQUENT TO THIS DATE
SHOULD BE CHECKED WITH DTE GAS COMPANY

Pipe Material

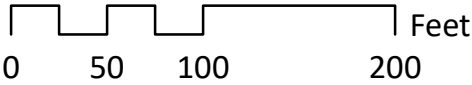
- CU - Copper
- PLA - Plastic
- STL - Bare Steel
- STL - Coated Steel
- CI - Cast Iron
- WI - Wrought Iron
- UN - Unknown
- Inactive
- Abandoned

Main Line Styles

- In Design Main (Proposed)
- Distribution Main
- Joint Trench
- Exposed Pipe
- Pipe Lining (CI or WI)
- Transmission Main
- Subtransmission Main
- Main dimensions are to ROW line unless otherwise noted.



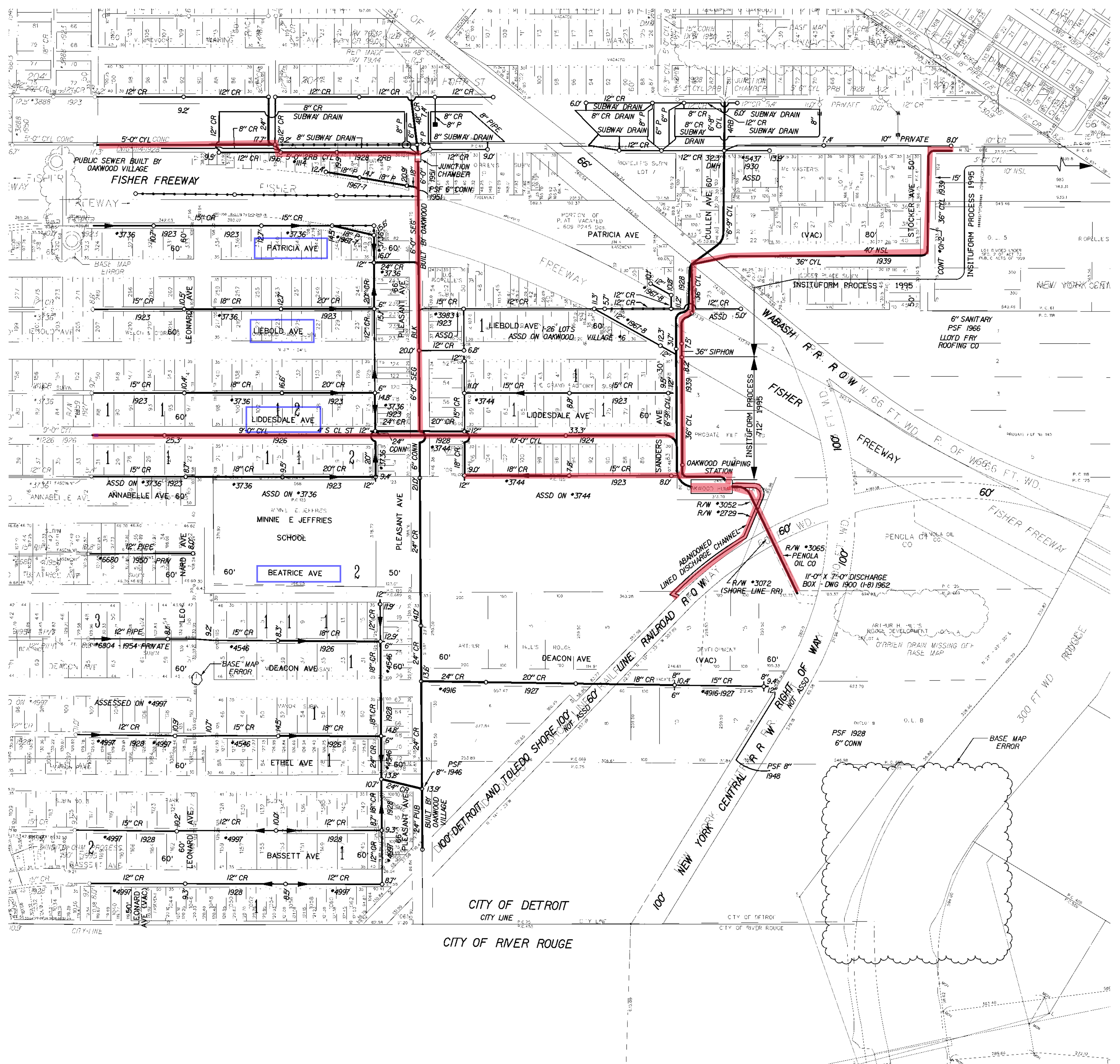
STATE LAW ACT 174
3 WORKING DAYS
BEFORE YOU DIG
DIAL TOLL FREE
1-800-482-7171 OR 811



WARNING

HIGH PRESSURE MAINS ARE HIGHLIGHTED
THEY SUPPLY GAS TO A LARGE NUMBER OF HOMES AND
INDUSTRIES OF DETROIT AND VICINITY

IT IS OF THE UTMOST IMPORTANCE THAT EVERY PRECAUTION
BE TAKEN SO AS NOT TO ENDANGER ITS USE DURING OR
FOLLOWING YOUR CONSTRUCTION
DTE GAS COMPANY



SEWER MAP

CITY OF DETROIT

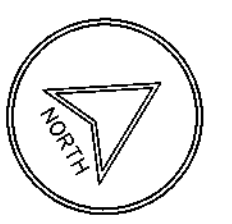
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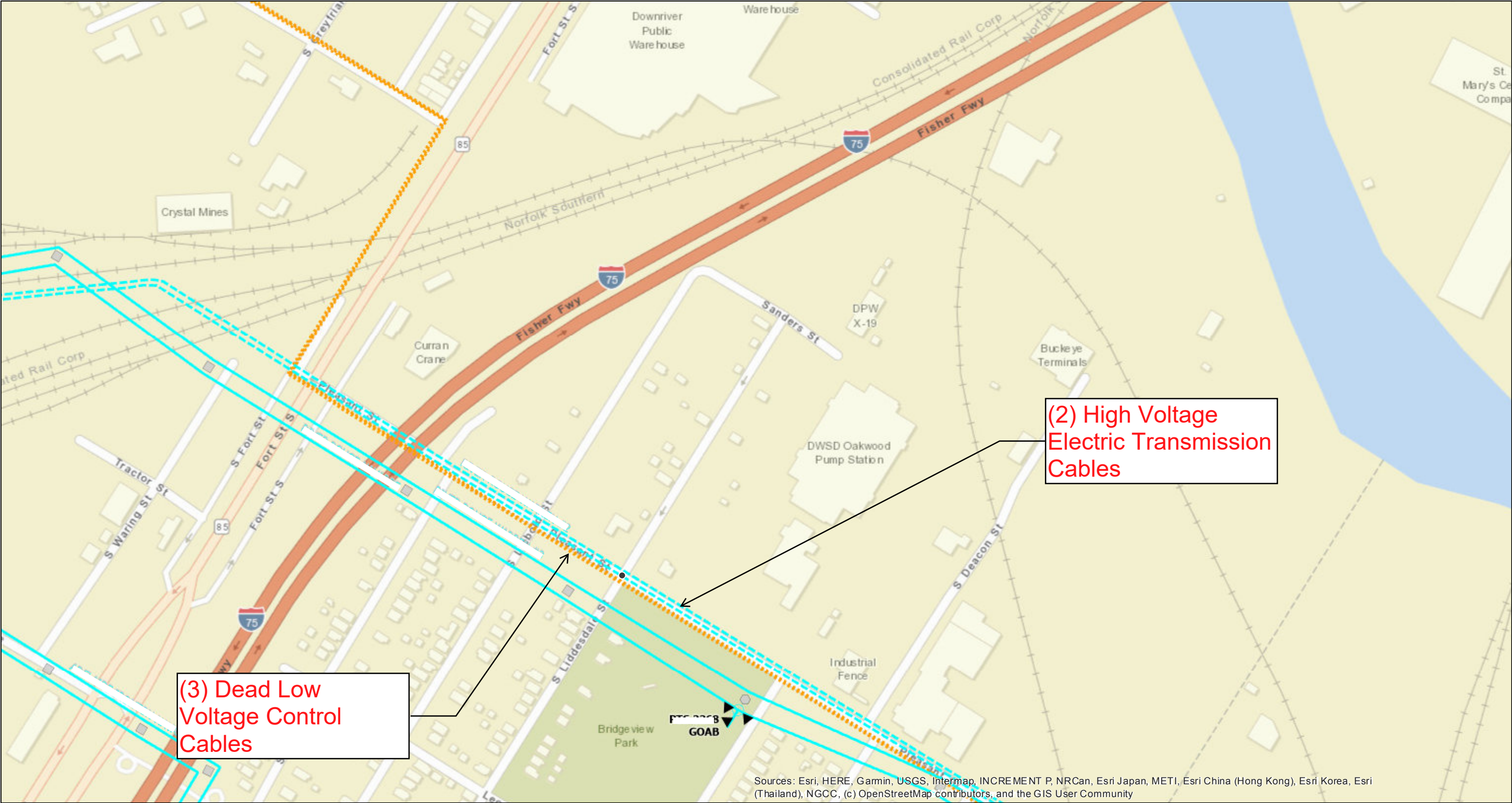
S-72-E

NOTES:

NAME	DATE
DIGITIZED BY: CEA, INC.	11-21-96
CHECKED BY: DWSD	11-21-96
LOG	
REVISED THRU:	12-31-03
PRINT DATE:	02-23-00



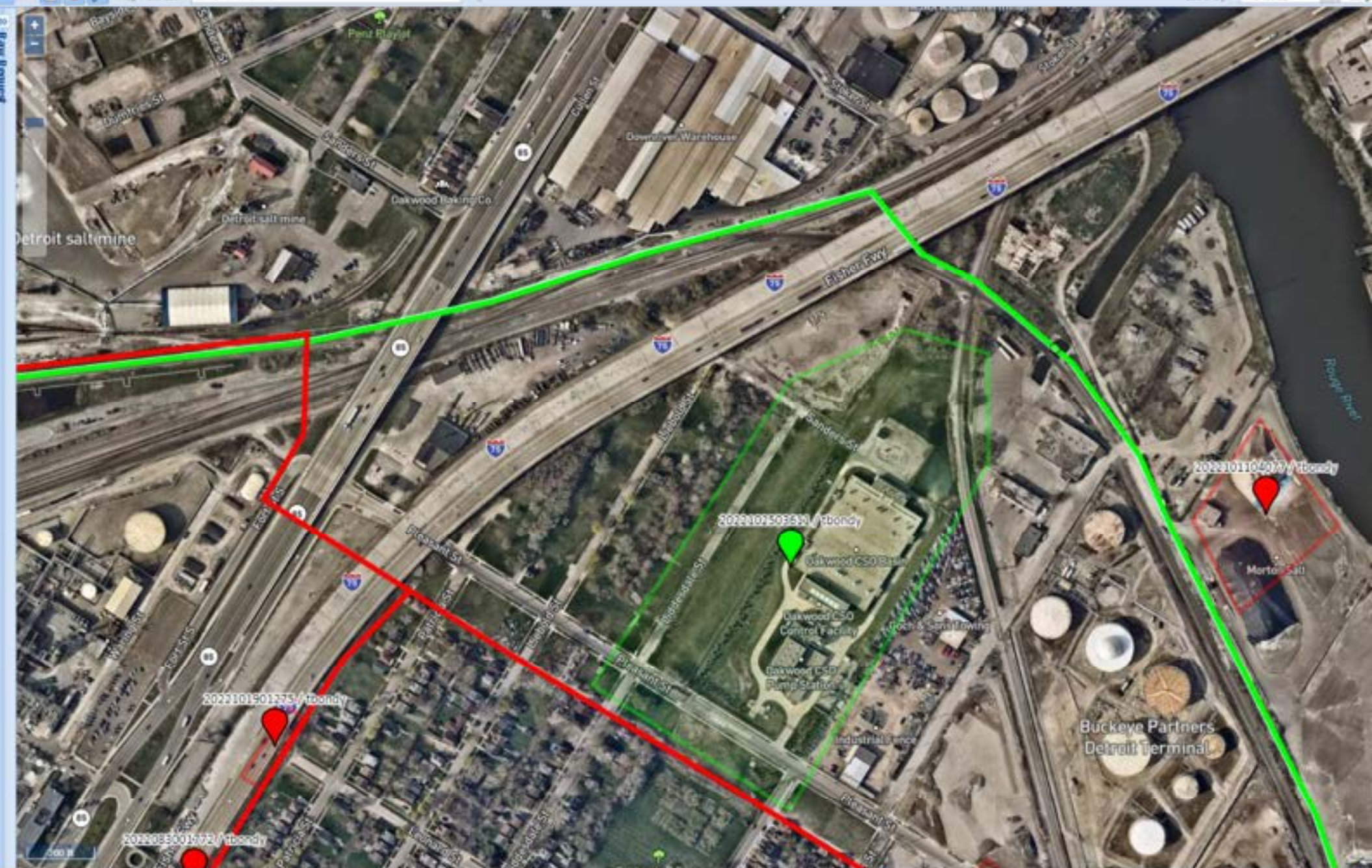
STATE PLANE



2022102503611-000

GEMINI Web Application

Time: 11/4/2022 4:54:44 PM



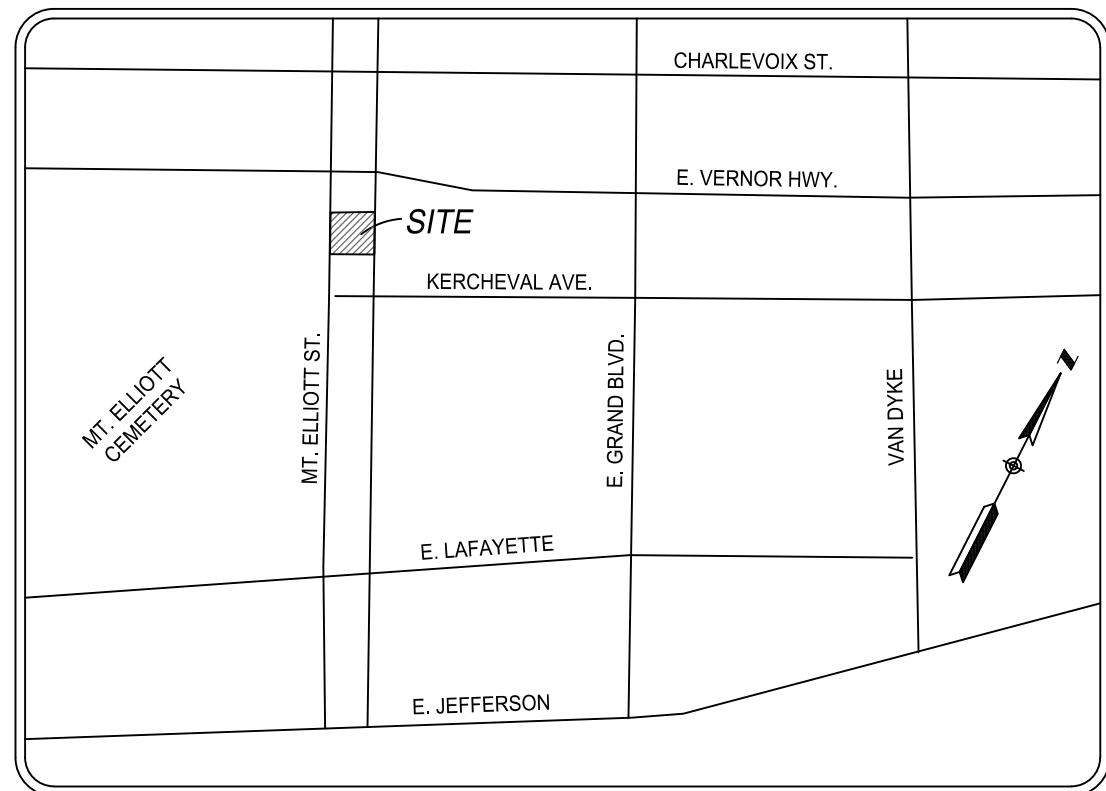
Appendix E

Leib Site - Existing Conditions Base Survey



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STRUCTURE TABLE



LOCATION MAP

NOT TO SCALE

BENCHMARK DESCRIPTIONS

MASTER BM#1	CITY OF DETROIT BENCHMARK No. 47-250, BRASS DISK LOCATED AT THE NORTHEAST CORNER OF ST. PAUL AND MT. ELLIOTT.	ELEV.=133.64
	SOURCE: CITY OF DETROIT VERTICAL CONTROL SYSTEM (1960 ADJUSTMENT), ADD 479.215' TO OBTAIN ELEVATIONS ON THE NAVD'83 DATUM.	
SITE BM#100	ARROW ON HYDRANT, LOCATED ON THE EAST SIDE OF MELDRUM ST. ±235' SOUTH OF WATERLOO ST.	ELEV.=141.83
SITE BM#101	ARROW ON HYDRANT, LOCATED ON THE WEST SIDE OF MT. ELLIOTT ACROSS THE STREET FROM OF #2198.	ELEV.=140.28

CONTROL TABLE

NO.	NORTHING	EASTING	ELEV.	DESCRIPTION
10	314340.299	13488503.917	139.819	CP SET IRON WITH CAP
11	314187.088	13488581.224	140.397	CP SET IRON WITH CAP
12	314164.932	13488167.804	138.996	CP SET IRON WITH CAP
13	314022.706	13488240.550	138.196	CP SET IRON WITH CAP
BM 100	314280.683	13488591.715	141.833	ARROW ON HYD
BM 101	314118.749	13488194.811	140.280	ARROW ON HYD

PROPERTY CORNER TABLE

No.	NORTHING	EASTING	DESCRIPTION
737	314286.45	13488533.58	COMPUTED CORNER
738	314313.18	13488519.94	COMPUTED CORNER
740	314359.24	13488496.43	COMPUTED CORNER
754	314224.12	13488411.43	COMPUTED CORNER
755	314250.85	13488397.79	COMPUTED CORNER
757	314296.91	13488374.28	COMPUTED CORNER
774	314287.82	13488356.47	COMPUTED CORNER
791	314215.10	13488213.95	COMPUTED CORNER
817	314273.88	13488386.04	COMPUTED CORNER
818	314336.21	13488508.19	COMPUTED CORNER
819	314027.40	13488309.73	COMPUTED CORNER
820	314100.13	13488452.25	COMPUTED CORNER

#	TYPE	RIM	SIZE	MTRL	INVERT	DIRECTION	CONNECT
1	SQUARE CATCH BASIN	138.60	8"		N/A	SOUTH	2 (REC)
	FILLED WITH WATER - NO PIPES VISIBLE						
	TOP / WATER	134.80					
	TOP / DEBRIS	131.00					
2	SQUARE CATCH BASIN	138.54	8"		N/A	NORTH	1 (REC)
	FILLED WITH WATER - NO PIPES VISIBLE		8"		N/A	SE (REC)	
	TOP / WATER	132.24					
	TOP / DEBRIS	131.34					
3	SANITARY MANHOLE	139.59					
	FLOOR VAULT (PER HRC SURVEY)	117.85					
4	SANITARY MANHOLE	139.56					
	FLOOR VAULT (PER HRC SURVEY)	117.95					
5	SQUARE CATCH BASIN	138.87	6"	PVC	133.17	NORTH	
	6" PVC ELBOW GOES DOWN INTO CB						
	TOP / WATER	133.17					
	TOP / DEBRIS	132.07					
6	SQUARE CATCH BASIN	138.85	6"	PVC	132.65	SSW	
	6" PVC ELBOW GOES DOWN INTO CB						
	TOP / WATER	132.65					
	BOTTOM	131.25					
7	SANITARY MANHOLE	139.78	12"	CLAY	127.88	WSW	8
			12"	CLAY	128.08	ENE	
			6"	PVC	129.68	SSW	
	TOP / DEBRIS	127.88					
	BOTTOM	127.88					
	FLOW DIRECTION:	WEST					
8	SANITARY MANHOLE	139.66	10"	CLAY	126.46	ENE	7
			12"	CLAY	126.26	NNW	10
			10"	RCP	126.46	SE	19
	BOTTOM	126.26					
9	SQUARE CATCH BASIN	139.09	12"	RCP	N/A	SSE	10 (REC)
	FILLED WITH DEBRIS - NO PIPES VISIBLE						
	TOP / DEBRIS	136.99					
10	SANITARY MANHOLE	139.40	10"	CLAY	126.20	ENE	8
			12"	CLAY	125.60	NNW	
			12"	RCP	135.40	NNW	9
	BOTTOM	125.50					
11	SQUARE CATCH BASIN	137.82	12"	RCP	131.32	SSE	15
			6"	PVC	131.42	WEST	
	TOP / WATER	131.32					
	TOP / DEBRIS	131.32					
12	SANITARY MANHOLE	138.21	36"X48"		N/A	NNW (REC)	
	COULD NOT OPEN - LOCKED		36"X48"		N/A	SSE (REC)	
13	SANITARY MANHOLE	137.97	36"X48"	RCP	N/A	SE	
	BOTTOM IS +25' DEEP		36"X48"	RCP	N/A	NNW	
	FLOW DIRECTION:	EAST					
14	SANITARY MANHOLE	138.06					
	COULD NOT OPEN - DOUBLE LID						
15	SQUARE CATCH BASIN	137.26	12"	RCP	133.26	NNW	11
	TOP / DEBRIS	133.06					
16	SQUARE CATCH BASIN	137.26					
	FILLED WITH DEBRIS - NO PIPES VISIBLE						
	TOP / DEBRIS	136.26					
17	SANITARY MANHOLE	138.75	12"	PVC	132.65	SSE	
			18"	RCP	124.70	NNW	19
	15"X20" PER RECORD		15"	RCP	124.70	ENE	
	15"X20" PER RECORD		15"	RCP	124.55	WSW	
	FLOW DIRECTION:	WSW					
18	SANITARY MANHOLE	136.94	84"	RCP	93.11	NNW	
			84"	RCP	93.11	ENE	
19	SANITARY MANHOLE	N/A	10"	RCP	N/A	NNW	8
	SHOWN PER RECORD		18"	RCP	N/A	SSE	17
	NOT FIELD LOCATED						
20	SANITARY MANHOLE	N/A	36"X48"	RCP	N/A	NNW	
	SHOWN PER RECORD		36"X48"	RCP	N/A	SSE	
	NOT FIELD LOCATED						
21	SANITARY MANHOLE	138.94					
22	SANITARY MANHOLE	139.08					

SURVEYOR'S COMMENTS

1. THIS TOPOGRAPHICAL MAP IS BASED UPON A FIELD SURVEY PERFORMED BY SPALDING DEDECKER INC. DURING DECEMBER OF 2022 AND JANUARY 2023.
2. SPALDING DEDECKER HAS BASED THE PROPERTY LINES AND RIGHT OF WAY LINES UPON A COMBINATION OF CITY OF DETROIT TAX (LEGAL) DESCRIPTIONS AVAILABLE ON THE CITY "BS&A ON-LINE" WEBSITE, FOUND FIELD MONUMENTATION AND OCCUPATION.
3. THIS SURVEY HAS BEEN PREPARED WITHOUT THE BENEFIT OF A CURRENT TITLE SEARCH THAT WOULD IDENTIFY ANY RECORDED EASEMENTS THAT ENCUMBER OR BENEFIT THIS PROPERTY. THEREFORE, THIS PROPERTY MAY BE SUBJECT TO EASEMENTS, RIGHT-OF-WAY TAKINGS AND RESTRICTIVE COVENANTS THAT ARE NOT SHOWN.
4. THE BASIS OF BEARINGS IS THE STATE PLANE GRID.
5. THE COORDINATE SYSTEM FOR THIS SURVEY IS THE STATE PLANE COORDINATE SYSTEM, MICHIGAN SOUTH ZONE (2113), BASED ON NAD83 (NSRS2011). UNITS ARE INTERNATIONAL FEET. COORDINATES WERE ESTABLISHED USING A DATA LINK TO THE MDOOT CONTINUOUSLY OPERATING REFERENCE STATIONS (CORS).
6. THE VERTICAL DATUM OF THIS SURVEY IS BASED UPON THE LOCAL CITY OF DETROIT DATUM BASED ON THE MASTER BENCHMARK LISTED. THE CONVERSION TO NAVD88 IS +479.215 WHICH AGREES WITH THE COMPUTED VALUE FOR THIS AREA. THE PRIOR SITE PLAN FOR THE SITE INDICATES A PROPOSED FINISH FLOOR OF 140.00' FOR THE BUILDING. WE MEASURED THE DOOR LEASE ELEVATION AT VARIOUS OPENINGS WHICH VARY FROM 139.84' TO 140.01' AND VALIDATE THE PROPER ESTABLISHMENT OF THE PRIOR PLAN DATUM.
7. THE UTILITY INFORMATION SHOWN ON THIS SURVEY IS BASED UPON A COMBINATION OF RECORD INFORMATION AND FIELD MEASUREMENTS. A MISS DIG DESIGN TICKET NUMBER OF 2022102503675 HAS BEEN REFERENCED TO THIS PROJECT AND A UTILITY PROVIDER CHART IS SHOWN ON THIS DRAWING. THERE ARE NO ASSURANCES THAT ALL PROVIDERS HAVE RESPONDED AND THE SURVEYOR DOES NOT GUARANTEE THAT ALL UNDERGROUND UTILITIES ARE SHOWN AND/OR POSITIONED PROPERLY ON THIS DRAWING DUE TO AMBIGUOUS PLANS AND RECORDS PROVIDED TO US. THE INFORMATION SHOWN ON THIS DRAWING IS INTENDED TO BE USED AS A GUIDE FOR POSSIBLE UNDERGROUND UTILITY CONFLICTS. IT IS THE RESPONSIBILITY OF OTHERS TO RESOLVE THE ACTUAL LOCATION OF ANY UNDERGROUND UTILITY THROUGH THE MISS DIG FIELD VERIFICATION SYSTEM PRIOR TO ANY SITE EXCAVATION. CALL 811 OR 800-482-7171.
9. BUILDING FACES AND EXTERIOR COLUMNS HAVE BEEN LOCATED TO A PRECISION ACCEPTABLE FOR TOPOGRAPHICAL MAPPING. IF THEY EXIST, DECORATIVE ARCHITECTURAL BRICK AND STONE FEATURES ARE TYPICALLY NOT INCLUDED. ADDITIONAL HIGH-PRECISION DETAILED MEASUREMENTS OF BOTH EXTERIOR WALL LINES AND INTERIOR COLUMNS ARE SUGGESTED FOR ANY AREAS WHERE BUILDING ADDITIONS ARE PLANNED.
10. THE ALLEY ADJACENT TO THE LOTS HAS BEEN VACATED BASED ON DOCUMENTATION WE RECEIVED IN JANUARY, 2023. THE SURVEY HAS BEEN UPDATED ACCORDINGLY TO REFLECT THIS.
11. THE 10' AND 20' ALLEYS THAT ABOUT LOTS 21-23 ARE COVERED WITH GRASS THAT IS BEING MOVED. IT IS POSSIBLE THAT THERE ARE STILL CONCRETE, ASPHALT, OR BRICK STREETS BURIED BELOW THE CURRENT GRASS SURFACE.

LEGAL DESCRIPTIONS

SOURCE: CITY OF DETROIT "BS&A ON-LINE" WEBSITE

2219 MELDRUM
PARCEL NO 15-013-789
OWNER: CITY OF DETROIT WATER DEPT.

LOT 21 AND NORTH 4.14 FT OF LOT 22 "HURT'S SUBDIVISION" L.14, P.92 OF PLATS, WAYNE COUNTY RECORDS

2211 MELDRUM
PARCEL NO 15-013-790
OWNER: CITY OF DETROIT WATER DEPT.

SOUTH 25.86 FT OF LOT 22 "HURT'S SUBDIVISION" L.14, P.92 OF PLATS, WAYNE COUNTY RECORDS

2207 MELDRUM
PARCEL NO 15-013-791
OWNER: CITY OF DETROIT WATER DEPT.

LOT 23 "HURT'S SUBDIVISION" L.14, P.92 OF PLATS, WAYNE COUNTY RECORDS

2198 MT. ELLIOT
PARCEL NO 15-013-934-8
OWNER: DETROIT WATER & SEWERAGE DEPT.

NORTH 9 FT OF LOT 33 AND LOTS 34 THRU 40 "HURT'S SUBDIVISION" L.14, P.92 OF PLATS,
WAYNE COUNTY RECORDS

LEVEL SENSORS

LS No.	REF. POINT ELEV.	DESCRIPTION
FM-1	138.94	MH 21 RIM
FM-1	139.08	MH 22 RIM
LE-1	118.00	SCRIBE '+' IN CONCRETE FLOOR MARKED WITH BLACK AND YELLOW AND LABELED No. 1
LE-2	113.09	SCRIBE '+' IN CONCRETE FLOOR MARKED WITH BLACK AND YELLOW AND LABELED No. 2

SOIL BORINGS

NO.	NORTHING	EASTING	ELEV
1	314274.35	13488414.42	140.09
2	314319.56	13488504.55	140.30

UTILITY CHART

UTILITY PROVIDER	CONTACT #	MISS DIG RESULTS	DATE
AT&T TELEPHONE	(231) 409-7939	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (WATER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (SEWER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT PUBLIC LIGHTING ELECTRIC	(313) 267-5130	NOT RECEIVED	
DTE ENERGY (ELECTRIC) ELECTRIC	(313) 407-5364	RECEIVED	11/8/2022
DTE ENERGY (GAS) GAS	(248) 318-7839	RECEIVED	10/26/2022
GREAT LAKES WATER AUTHORITY (WATER)	(313) 799-0289	RECEIVED	11/8/2022
GREAT LAKES WATER AUTHORITY (SEWER)	(313) 799-0289	RECEIVED	11/8/2022
INTERNATIONAL TRANSMISSION CO. (FIBER OPTICS)	(888) 269-8740	RECEIVED	11/4/2022
MCIVERIZON BUSINESS FIBER OPTICS	(800) 624-9675	NOT RECEIVED	
NEXTEL COMMUNICATIONS FIBER OPTIC	(816) 309-4004	NOT RECEIVED	

						DESIGNED BY:	SEAL/STAMP	FACILITY GLWA CSO IMPROVEMENTS PROJECT LEIB SCREENING AND DISINFECTION FACILITY	FIRM NAME		EGLE PERMIT No.
						S.BROWN					N/A
						DRAWN BY:					GLWA CONTRACT No.
						S.BROWN					N/A
						CHECKED BY:					GLWA CIP No.
						M.DeDECKER					N/A
						APPROVED BY:		PROJECT TITLE TOPOGRAPHICAL SURVEY	SUB CONSULTANT		DRAWING No.
						M.DEDECKER					
No.	DESCRIPTIONS/REVISIONS	CHK'D	APPR	DATE				SCALE: 1" = 20'	DATE: MAY 1, 2023		
A	I		B				C	D	E	F	G
											H

Appendix F

Leib Site - Geotechnical Report



REPORT ON GEOTECHNICAL INVESTIGATION

GREAT LAKES WATER AUTHORITY (GLWA)
DESIGN SERVICES FOR COMBINED SEWER OUTFALL
IMPROVEMNETS PROJECTS– CONTRACT NO. 2101475
GLWA LEIB CSO FACILITY
DETROIT, MICHIGAN

Owner:
Great Lakes Water Authority (GLWA)
Detroit, Michigan

Prepared for:
CDM Smith
535 Griswold Street, Suite 930
Detroit, Michigan 48226

May 01, 2023
2022136A



May 01, 2023
2022136A

Mr. Ali Khraizat, P.E.
CDM Smith
535 Griswold St., Suite 930
Detroit, Michigan 48226

RE: Report on Geotechnical Investigation
Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO) Improvements Project
GLWA Leib CSO Facility - Contract Number 2101475
Detroit, Michigan

Dear Mr. Khraizat:

We have completed the Report on Geotechnical Investigation for the GLWA Leib CSO Facility Project in the City of Detroit, Michigan. This report presents the results of our observations and results of the geotechnical.

The soil samples collected during our field investigation will be retained in our laboratory for 90 days from the date of the final report, at which time these samples will be discarded unless otherwise directed by you.

It was a pleasure working with you on this project. If you have any questions regarding this report, please do not hesitate to contact us 313-963-2721.

Sincerely,
Somat Engineering, Inc.

A handwritten signature in black ink, appearing to read 'Sean Panetta'.

Sean Panetta
Staff Geologist

A handwritten signature in blue ink, appearing to read 'Jane Abadir'.

Jane M. Abadir, P.E. LEED A.P
Principal Engineer

SP/JA/aer

**REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA LEIB CSO FACILITY
DETROIT, MICHIGAN**

REPORT SUMMARY

A general summary of the report conclusions is provided below:

1. The field exploration program consisted of performing a total of 2 soil borings for the GLWA Leib CSO Facility Project in Detroit, Michigan. The borings extended to a depth of 10 feet below existing grades.
2. Generalized soil profile: fill soils was encountered in boring SB-02 and extended to a depth of 1.3 feet below existing grades.
3. The long-term groundwater table is estimated to be situated at about 7 feet (EL. 133.1 feet) below existing grades. Perched groundwater trapped in the granular fill soils within close proximity of any excavations should also be expected.
4. We recommend undercutting the upper topsoil and underlying granular fill soils to a minimum depth of about 1.5 feet below existing grades and replacing with engineered granular fill soils (such as MDOT 21AA or Class II sand), new base course, and pavement. Based on our analysis we checked that the proposed pavement section design consisting of 9 inches of Portland cement concrete over a minimum of 8 inches of new aggregate base course that is similar in gradation to MDOT 21AA over the compacted new engineered fill subgrade soils prepared as noted in this report; should be adequate to support the proposed HS-20 traffic loading for the access drive.

The summary presented above is general in nature and should not be considered apart from the entire text of the report with all the qualifications and considerations mentioned therein. Details of our findings and recommendations are discussed in the following sections and in the appendices of this report.

REPORT PREPARED BY:

Sean Panetta
Staff Geologist

REPORT REVIEWED BY:

Jane M. Abadir, P.E. LEED A.P.
Principal Engineer, Geotechnical Services



**REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA LEIB CSO FACILITY
DETROIT, MICHIGAN**

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**REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA LEIB CSO FACILITY
DETROIT, MICHIGAN**

1.0 INTRODUCTION

1.1 GENERAL

Upon authorization from CDM Smith, Somat Engineering, Inc. (Somat) has completed the geotechnical investigation for the development of the Great Lakes Water Authority (GLWA) Design Services for Combined Sewer Outfall (CSO) Improvements Project at the Leib CSO Facility in the City of Detroit, Wayne County, Michigan.

Somat was retained by CDM Smith to perform a pre-design geotechnical investigation for the referenced project within the project limits. The geotechnical investigation was performed in general accordance with Somat Proposal No. P210314B dated January 12, 2022. The results of the investigation will be used to support the design of the project and development of construction specifications.

1.2 PROJECT INFORMATION

The overall project includes design services required to implement a series of improvements at the Leib CSO Screening and Disinfection (SDF) facility located at 2200 Mt. Elliott, Detroit, Michigan. The site improvements include constructing a new alternate access road shall be about 176 feet long and 24 feet wide, and will require minimal reconfiguration of the existing parking lot.

The following sections of this report provide a description of our field investigation, the results of the field and laboratory tests, the logs of auger probes, our interpretation of subsoil and groundwater conditions, recommendations related to the proposed construction.



2.0 SUBSURFACE INVESTIGATION

2.1 FIELD EXPLORATION

The field exploration program consisted of performing a total of two (2) soil borings. Borings SB-01 and SB-02 were performed along the grass covered parcel on the east side of the Leib gated facility. The borings extended to a depth of 10 feet below existing grades.

The soil borings were drilled using Geoprobe 3126GT drill rig. The soil borings were drilled by advancing hollow stem augers to the termination depths of the soil borings. Upon completion, all the boreholes were backfilled with soil cuttings to the surface. The soil boring logs are presented as logs of test borings in Appendix B. Soil boring coordinates and the ground surface elevations (included in the soil boring logs) were provided by the Project Surveyor based on City of Detroit Datum.

2.2 STANDARD PENETRATION TEST

Soil samples collected during the field portion of the subsoil exploration were labeled with the soil boring designation and a unique sample number. Soil samples were obtained from the soil borings by Standard Penetration Tests (SPT) in accordance with ASTM D1586 procedures, whereby a conventional 2-inch O.D. split-spoon sampler is driven into the soil with a 140-pound hammer repeatedly dropped through a free-fall distance of 30 inches. The sampler is generally driven three successive 6-inch increments, with the blows for each 6-inch increment being recorded. The number of blows required to advance the sampler through 12 inches after an initial penetration of 6 inches is termed the Standard Penetration Test resistance (N-value) and is presented graphically on the individual Logs of Test Borings. As added information, the number of blows for each 6-inch increment is also presented on the boring logs.

The N-values reported on the Logs of Test Borings are the direct blow counts from the field and are uncorrected. The efficiency of each specific hammer is dependent on many factors, including type (auto vs. manual), material quality, regularity of maintenance, drill rig mechanics, etc., and can change with time. As such, SPT hammers on each drill rig are required to be calibrated. Certificates are provided to us indicating each hammer's measured energy transfer



ratio. For this project, the geotechnical driller (DLZ American Drilling) used a Geoprobe 3126GT drill rig (serial number: 52110001). Based on the current certificate for this drill rig, the energy transfer ratio for the SPT hammer is 101.3%.

2.3 SAMPLING

Soil boring samples were recovered using split-spoon sampling procedures in accordance with ASTM Standard D1586 (“Standard Method for Penetration Tests and Split Barrel Sampling of Soils”). In general, the samples were obtained continuously to a depth of 5 feet and every 2.5 feet intervals to the termination depth of the borings. The samples were sealed in glass jars in the field to protect the soil and maintain the soil’s natural moisture content.

2.4 GROUNDWATER LEVEL OBSERVATION PROCEDURES

Whenever possible, groundwater level observations were made during the drilling operations and are shown on the individual Logs of Test Borings. During drilling, the depth at which free water was observed, where drill cuttings became saturated or where saturated samples were collected, was indicated as the groundwater level during drilling. In granular, pervious soils, the indicated water levels are considered relatively reliable when solid or hollow-stem augers are used for drilling. However, in cohesive soils, groundwater observations are not necessarily indicative of the static water table due to the low permeability rates of the soils, and due to the sealing off of natural paths of groundwater flow during drilling operations.

It should be noted that seasonal variations and recent precipitation conditions may influence the level of the groundwater table significantly. Groundwater observation wells are generally used if precise groundwater table information is needed, however the installation of groundwater monitoring wells was not included in the scope of the investigation. Therefore, the discussion and recommendations provided within the report are based on our knowledge of the soil and groundwater conditions in this area, as well as the reported design water levels of water bodies located at the bridge locations, which should provide for a reasonable approximation of the groundwater level.



2.5 GEOTECHNICAL LABORATORY TESTING

All soil samples were classified in accordance with the Unified Soil Classification System (USCS). Cohesive soil samples were subjected to laboratory tests consisting of moisture content determinations, and hand penetrometer tests. Loss-on-ignition (LOI) tests are performed on any samples that appear to contain significant organic content.

The results of the soil classifications and the laboratory tests are included on the respective logs in Appendix B. All laboratory tests were performed in accordance with their applicable ASTM procedures.

2.6 LIMITATIONS

The scope of our services was strictly geotechnical and did not include environmental investigation. Our scope of services did not include investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on, below or around this site.

Somat has made no observations or recommendations with regard to the presence or absence of mold or other biological contaminants (such as spores, fungi, bacteria, viruses, and the byproducts of such organisms), now or in the future, on this site or within or on any structures to be constructed on this site. Any consideration with regard to the presence of mold, or the possibility of mold growth in or on the structure to be constructed on this site are not within our scope of services on this project.

Some soils have been identified on the Logs of Test Borings as “fill” or “possible fill” if a soil deposit is suspected to have been placed by human activity, versus having been deposited by natural means. These designations were based on our professional engineering judgment considering factors such as our visual classification, the presence of foreign materials (i.e., bricks, concrete, plastic, etc.), and/or site topography, among many other possibilities. As such, the “fill” or “possible fill” descriptions should be considered as secondary information to the standardized soil classification. Due to the large variation of types of fill, methods of fill



placement, potential changes of historical use of the site, and soil sample size, it is difficult to discern whether the subject soil sample is native to this site, or fill material based on visual classification alone. As such, the designation of “fill” may not be reliable and hence should be considered as informational only. Conversely, where a soil is not designated as “fill” on the boring logs, it does not necessarily mean it is not a fill soil, only that there were no apparent observations indicating a fill material. Therefore, we cannot guarantee that our description of “fill” soils is accurate, or that we have identified all types of fill material encountered with our sampling on the site.

3.0 SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

Soil conditions encountered at the boring locations have been evaluated and presented in the form of logs of auger probes. The logs of auger probes include approximate soil stratification with detailed soil descriptions and selected physical properties for each stratum encountered in the auger probes. In addition to the observed subsoil stratigraphy, the auger logs present information relating to sample data, groundwater level conditions observed in the probing, personnel involved, and other pertinent data. For information, and to aid in understanding the data as presented on the auger logs, General Notes defining nomenclature used in soil descriptions are presented immediately following the Logs of Test Borings. It should be noted that the Logs of Test Borings included with this report have been prepared on the basis of laboratory classifications and testing as well as field logs of the soils encountered.

A generalized description of the soils and pavement encountered in the six (6) auger probes beginning at the existing ground surface and proceeding downward, is provided below:

Stratum 1: Surface Material:

- **Topsoil:** Clayey topsoil was encountered at the surface of SB-01 and SB-02 and had a thickness of 6 inches.



Stratum 2: Fill Soils:

- **Granular Fill:** Granular fill soils consisting of sand with silt was encountered below the topsoil in boring SB-02 and extended to a depth of 1.3 below existing grades. The apparent density of the fill soils was dense.

Stratum 3: Native Cohesive Soils

- Native sandy lean clay was encountered below the topsoil or fill soils in both borings and extended to a depth of 2 to 3.5 feet below existing grades. The consistency of the clay was hard and had a moisture content ranging between 9 and 14%.

Stratum 4: Native Granular Soils

- Native granular soils consisting of sand and silty sand were encountered below the native clays in both borings and extended to the termination depth of 10 feet in boring SB-01 and to a depth of 8 feet in boring SB-02. The apparent density of the native granular soils ranged between medium dense and very dense.

Stratum 5: Native Cohesive Soils

- Native lean clay was encountered below the native granular soils in boring SB-02 and extended to the explored depth of 10 feet below existing grades. The consistency of the clay was very stiff and had a moisture content of 15%.

The logs of soil borings are presented in Appendix B and the soil boring location diagram is presented in Appendix A. It is emphasized that the stratification lines shown on the logs are approximate indications of change from one soil type to another at the locations of the boreholes. The actual transition from one stratum to the next may be gradual and may vary within the area represented by the test boring.

3.2 GROUNDWATER LEVEL OBSERVATIONS

Groundwater was not encountered in boring SB-01. Groundwater was encountered at a depth of 7 feet during drilling and 8.5 feet after completion of drilling in boring SB-02.

A lack of groundwater in some of the auger holes, does not necessarily mean there is no groundwater in this area, due to the sealing off of natural flow paths during the drilling process. Oftentimes, a change in color from brown to gray in cohesive soils is a good indication of the long-



term groundwater level (indicating oxidation). As such the long-term groundwater table is estimated to be situated at about 7 feet below existing grades (EL. 133.1 feet).

Perched groundwater within the granular and fill soils above the less permeable clay layers should be expected and the Contractor should be prepared to handle. Water trapped in existing utility trenches in the area, which are often sand backfill within the native clay soils, should be expected.

It should be noted that the elevation of the long-term groundwater table is likely to vary throughout the year depending on the amount of precipitation, runoff, evaporation, and percolation in the area, as well as on the water level in any surface water bodies in the vicinity affecting the groundwater flow pattern.

4.0 GEOTECHNICAL RECOMMENDATIONS

4.1 PROPOSED ACCESS DRIVE

The project includes the construction of a new paved alternate access road that is about 176 feet long and 24 feet wide. The proposed pavement section will be Portland cement concrete and gutter and the thickness of the pavement is anticipated to consist of 9-inch-thick reinforced concrete pavement over a minimum of 8-inch-thick aggregate base in conformance to MDOT 21AA gradation. The pavement will be designed to support HS-20 loading.

4.1.1 Subgrade Preparation and Groundwater Control Recommendations

Based on the soil borings, the subgrade soils consist of existing granular fill soils over native hard lean clay. We do not recommend constructing new pavement on undocumented fill soils. As such we recommend undercutting the upper topsoil and underlying granular fill soil to a minimum depth of about 1.5 feet below existing grades and replacing with engineered granular fill soils (similar in gradation to MDOT 21AA or Class II sand), new base course, and Portland cement concrete pavement.



Once a rough subgrade has been achieved, the exposed pavement subgrade along the entire sections of access drive to be constructed should be visually checked for the presence of debris, organic matter, and other unsuitable material.

If unsuitable or highly organic subgrade soils (organic contents greater than 4%) are encountered during construction, the material should be assessed by the on-site geotechnical engineer to determine the depth and extent of the material and whether it should be fully undercut.

All of the pavement subgrade areas should be thoroughly proof rolled before placement of the new base course and pavement. The purpose of the proof rolling is to locate overly loose or soft areas as well as to uniformly compact the subgrade surface. In granular soils, proof rolling should be performed with a heavy (minimum 30 ton) self-propelled vibratory roller. Loose or soft areas revealed during compaction or during the proof rolling should either be suitably compacted and aerated if necessary. Any areas that exhibit excessive pumping or yielding should be stabilized, scarified, and re-compacted, if weather conditions permit, or by the removal of the yielding soils and their replacement with engineered fill.

The pavement subgrade will need to be compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D-1557 (Modified Proctor). It may be necessary in some areas to undercut unsuitable soils and replace them with a stabilization layer of engineered fill.

The long-term groundwater table is estimated to be situated at a depth of about 7 feet below existing grades (EL. 133.1 feet). Perched groundwater within the granular and fill soils above the less permeable clay layers should be expected and the Contractor should be prepared to handle. Water trapped in existing utility trenches in the area, which are often sand backfill within the native clay soils, should be expected. We do not expect the excavations required to construct the access drive would extend below the estimated long-term groundwater. As such, we believe the groundwater should be adequately controlled using standard sump pits and pumping methods.



4.1.2 Drainage Considerations

The effects of frost heave are anticipated to be more significant in areas where water is not allowed to drain freely either due to subsoil conditions, site grades, or other factors. We recommend including a new drainage system within the new base course to drain water away from the pavement. The pavement and subgrade will need to be positively graded towards these drainage features or away from the center of the roadway to allow for gravity flow of groundwater.

For all new pavements, final pavement elevations should be designed to provide positive surface drainage. The minimum surface slope of 2 percent is recommended. The pavement surface should be smooth, free of roller marks or depressions, and should not contain any irregularities which would pond or impede water flow

4.1.3 Pavement Design Recommendations

4.1.3.1 Subgrade Design Values

We anticipate the subgrade soils for the proposed pavement construction will consist of existing fill soils. The recommended subgrade resilient modulus (M_R) and vertical subgrade reaction (K_v) provided below assumes the soil conditions encountered in the auger probes are representative of the soil conditions within the proposed pavement construction areas. This also assumes the recommended earthwork operations will have been incorporated into the project specifications and that the subgrade soils will have been compacted. If during construction, the subgrade is found to vary from the expected soil conditions, we should be contacted so we may re-evaluate our soil design parameters.

For Portland cement concrete pavement design, based on our experience with similar soil conditions and the results of the in-situ SPT tests, we recommend the following coefficients of subgrade reaction (K_v), subgrade resilient moduli (M_R), and CBR's be used as representation for the conditions of the soils at the new base course and subgrade levels compacted to project specifications.



Table 4.1.3.1 Recommended Pavement Subgrade Design Parameters

Soil Type	Coefficient of Vertical Subgrade Reaction, (K_v)	Subgrade Resilient Moduli (M_R)	CBR
Existing Native Clay Soils	85 pci	6,000 psi	4
New Engineered Sand Fill (MDOT Class II)	235 pci	22,500 psi	15
New Engineered Aggregate Base (MDOT 21AA)	340 pci	37,500 psi	25

Other factors should also be considered in the final pavement design, in addition to the subgrade modulus values. These factors may include, but are not limited to, adequate subgrade preparation, adequate placement of engineered fill and pavement layers, and surface and subsurface drainage.

4.1.3.2 Pavement Section Design Recommendations

As we understand, the proposed pavement section will be Portland cement concrete and gutter and the thickness of the pavement is anticipated to consist of 9-inch-thick reinforced concrete pavement over a minimum of 8-inch-thick aggregate base in conformance to MDOT 21AA gradation. The pavement will be designed to support HS-20 loading.

We performed pavement analysis utilizing the AASHTO 1993 Guide for Design of Pavement Structures and the associated design charts and nomographs. The following list summarizes our input parameters and assumptions based on AASHTO guidelines and our observations:

Pavement Design Life	20 years (7 days per week)
Loading	HS-20 (8,000 lb/ front axle and two 32,000 lb/ rear axles (Given)
Load Equivalent Factor (LEF)	2.985 (calculated based on HS-20 loading using AASHTO LEF tables for terminal serviceability of 2.5)
Maximum Average Daily Traffic (ADT)	185 vehicles per day with HS-20 loading criteria (Back calculated)
Maximum Design ESAL's:	4,000,000 ESAL (Back calculated)
Percent Trucks:	100 %



Reliability:	90 % (Arterial road)
Standard Deviation:	0.35 (Rigid pavement)
Drainage Coefficient:	1.0
Initial Serviceability:	4.5 (Rigid pavement)
Terminal Serviceability:	2.5 (Major collectors)
Growth Rate	3%
Load Transfer Coefficient	2.7 (Dowel and mesh)
Concrete Elastic Modulus	6,000,000 psi (Assumed)
Effective Modulus of Subgrade Reaction of new base course (MDOT 21AA)	340 pci (CBR =25)
Effective Modulus of Subgrade Reaction of clay subgrade	85 pci (CBR =4)
Mean Concrete Modulus of Rapture	650 psi

Based on our analysis we checked that the proposed pavement section design consisting of 9 inches of Portland cement concrete over a minimum of 8 inches of new aggregate base course that is similar in gradation to MDOT 21AA over the compacted existing granular fill soils prepared as noted in this report; should be adequate to support the proposed traffic loading for the access drive.

5.0 GENERAL QUALIFICATIONS

All construction activities should be monitored under the direction of a qualified Geotechnical Engineer to verify conditions as interpreted in this report. This report and the attached Logs of Soil Borings are instruments of service, which have been prepared in accordance with generally accepted soil and foundation engineering practices. We make no other warranties either expressed or implied as to the professional advice included in this report.

The contents of this report have been selected in order to aid in the evaluation of expected subsoil properties to assist the Engineer in the design of this project. In the event that any changes are made in the geotechnical aspects of this project, however slight, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and the conclusions of this report are modified in writing by our office.



Since the information obtained from auger probes is specific to the exact test locations, soil and water information could be different from those occurring at other locations of the site. This report does not reflect variations which may occur between the test holes. The nature and extent of these variations may not become evident until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate the recommendations provided in this report.

This report and the associated soil logs should be made available to bidders prior to submitting their proposals and to the successful Contractor and subcontractors for their information only, and to supply them with facts relative to the subsurface investigation, laboratory tests, etc.

The discussions and recommendations submitted in this report are based on the soil information contained in the Logs of Soil Borings and test results appended to this report. We expect that the logs of auger probes, test results, and the soil profiles included in this report along with our discussions and conclusions will assist you in designing the proposed pavement. Please refer to Appendix C for important information about this geotechnical investigation report. If you have any questions regarding this report, please contact us.



APPENDIX A

SOIL BORING LOCATION DIAGRAM



Adapted from Google Earth satellite imagery

Drawing Scale as noted



Project Site – Vicinity Map
Great Lakes Water Authority (GLWA)
GLWA Leib CSO Facility
Detroit, Michigan

APPENDIX B

LOGS OF TEST BORINGS AND GENERAL NOTES

PROJECT NO. 2022136A

DATE STARTED: 12/14/2022

DATE COMPLETED: 12/14/2022

LOG OF TEST BORING
SB-01 (Leib)

LOG OF SOIL PROFILE			FIELD DATA			LABORATORY DATA							▼ SPT N VALUE ▼						
ELEVATION ft			DEPTH (ft)	SAMPLE NO.	SAMPLE RECOVERY (in)	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	10	20	30	40	
															● MOISTURE CONTENT (%) ●				
															■ UCC STRENGTH (psf) ■				
															2000	4000	6000	8000	
		Ground Surface Elevation 140.09 ft	0																
139.59		Approximate 6 inches of brown sandy TOPSOIL	0.5																
138.09		Hard SANDY LEAN CLAY, trace gravel, gray-brown (CL)	2.0	SS1	24	6-14-14-12	28	2.0	9000+*	8.8									
				SS2	18	12-14-12	26	3.5											
		Dense to medium dense SILTY FINE SAND sand, trace gravel, frequent sandy clay seams, gray-brown, moist (SM)		SS3	14	6-7-7	14	5.0											
135.09			5.0																
				SS4	18	11-17-18	35	7.5											
		Dense to very dense poorly graded fine SAND with silt, trace gravel, brown, moist (SP-SM)																	
				SS5	18	8-15-38	53	10.0											
130.09			10.0																
		End of Boring at 10 feet																	

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Northing: 314274.4
Easting: 13488414.4Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed SampleDrilling Company: DLZ American Drilling
Drill Rig: Geoprobe 3126GT (Rig 10001)
Logged By: P. Cody
Drilling Method: 3 1/4 inch HSA
Method Notes: ---
Hammer Type:
Backfilled With: Cuttings
Checked By: ALOG
QA/QC By: JA
Remarks:

Somat Engineering Inc.

Great Lakes Water Authority (GLWA)
Combined Sewer Outfall (CSO) Improvements
Project
Leib CSO Facility
Detroit, Michigan

PROJECT NO. 2022136A

DATE STARTED: 12/14/2022

DATE COMPLETED: 12/14/2022

LOG OF TEST BORING
SB-02 (Leib)

LOG OF SOIL PROFILE			FIELD DATA			LABORATORY DATA							▼ SPT N VALUE ▼					
ELEVATION ft			DEPTH (ft)	SAMPLE NO.	SAMPLE RECOVERY (in)	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	10	20	30	40
															10	20	30	40
															2000	4000	6000	8000
		Ground Surface Elevation 140.30 ft	0															
139.80		Approximate 6 inches of brown sandy TOPSOIL	0.5															
138.97		FILL - Dense poorly graded fine sand with silt, with gravel, trace brick debris, brown, moist (SP-SM)	1.3	SS1	24	9-12-18-18	30	2.0		10.2								
136.80		Hard SANDY LEAN CLAY, few gravel, dark brown (CL)	3.5	SS2	12	11-12-9	21	3.5	9000*	13.7								
135.30		Medium dense poorly graded fine SAND, trace silt, brown, moist (SP)	5.0	SS3	16	4-4-6	10	5.0										
132.30		Medium dense SILTY FINE SAND, brown, moist to wet (SM)	8.0	SS4	18	6-8-10	18	7.5										
130.30		Very stiff LEAN CLAY, few sand, trace gravel, gray (CL)	10.0	SS5	18	3-2-3	5	10.0	4000*	14.9								
		End of Boring at 10 feet																

GROUNDWATER READINGS

First Encountered: 7 feet
Upon Completion: 8.5 feet

BORING LOCATION INFORMATION

Northing: 314319.6
Easting: 13488504.6

Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company: DLZ American Drilling
Drill Rig: Geoprobe 3126GT (Rig 10001)
Logged By: P. Cody
Drilling Method: 3 1/4 inch HSA
Method Notes: ---
Hammer Type:
Backfilled With: Cuttings
Checked By: ALOG
QA/QC By: JA
Remarks:



Somat Engineering Inc.

Great Lakes Water Authority (GLWA)
Combined Sewer Outfall (CSO) Improvements
Project
Leib CSO Facility
Detroit, Michigan



GENERAL NOTES

Unified Soil Classification System (USCS) ASTM D2488 (Modified)

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon – 1 3/8" I.D., 2" O.D. (standard)	BS:	Bulk Sample	RC:	Rock Core with diamond bit, NX size, (unless otherwise noted)
S:	Split Spoon – non-standard size, as noted	HSA:	Hollow Stem Auger		
ST:	Thin-Walled Tube – 3" O.D., (unless otherwise noted)	DP:	Direct Push	RB:	Rock Bit/Roller Bit
LS:	Liner Sample	PS:	Piston Sample	WR:	Wash Rotary
PA:	Power Auger	PT:	Pitcher Sample	NR:	No Recovery
HA:	Hand Auger	WS:	Wash Sample	VS:	Vane Shear Test
AU:	Auger Sample			ER:	Hammer Energy Ratio

Standard Penetration Test Resistance, N-Value: Sum of 2nd and 3rd 6-inch increments, in blows per foot of a 140-pound hammer falling 30 inches and driving an 18-inch to 30-inch long, 2-inch OD split spoon.

WATER LEVEL MEASUREMENT:

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. In pervious soils, the indicated levels may reflect the location of a groundwater table. In low permeability soils (clays and silts), the accurate determination of groundwater levels may not be possible with only short-term observations. Groundwater levels at times and locations other than when and where individual borings were performed could vary.

DESCRIPTIVE SOIL CLASSIFICATION:

Soil classification is based on the Unified Soil Classification (USC) System and ASTM Standards D-2487 and D-2488. Coarse-grained soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are generally described as: clays, if they are plastic, and silts, if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their apparent in-place density and fine-grained soils on the basis of their apparent in-place density (silty soils) or consistency (clayey soils).

CONSISTENCIES OF COHESIVE SOILS:

The pocket penetrometer, pocket torvane, and in-situ vane shear tests are converted into an estimated unconfined compressive strength, in pounds per square feet (psf), for presentation on the logs. The unconfined compressive strength is estimated to be about two time the shear strength.

DESCRIPTORS OF MINOR CONSTITUENTS

Primary Constituent	Fine-Grained (Silt & Clay)	Coarse-Grained (Sand & Gravel)	
Descriptor of Other Constituents	Relative Portion of Coarse Grained Soils as a % of Dry Weight	Relative Portion of Fine Grained Soils as a % of Dry Weight	Relative Portion of Coarse Grained Soils as a % of Dry Weight
Trace	<5%	<5%	<5%
Few	≥5% - <15%	N/A	≥5% - <15%
With	≥15% - <30%	≥5% - 12%	≥15%
Modifier	≥30%	>12%	N/A

FINE-GRAINED SOILS

Unconfined Compressive Strength Q_u , psf	Consistency	N-Value	Apparent Density
< 500	Very Soft	0 – 4	Very Loose
500 - <1,000	Soft	5 – 9	Loose
1,000 - <2,000	Medium	10 – 29	Medium Dense
2,000 - <4,000	Stiff	30 – 49	Dense
4,000 - <8,000	Very Stiff	50 – 80	Very Dense
≥ 8,000	Hard	>80	Extremely Dense

COARSE-GRAINED SOILS

DEFINITIONS OF STRUCTURAL AND DEPOSITIONAL FEATURES

Term	Definition
Parting	≤ 1/16 inch (1.6 mm) thick
Seam	> 1/16 inch (1.6 mm) → 1/2 inch (12.7 mm) thick
Layer	> 1/2 inch (12.7 mm) to ≤ 12 inches (305 mm) thick
Pocket	Small, erratic deposits of limited lateral extent
Lens	Lenticular deposit
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Varved	Alternating partings or seams (1 mm – 12 mm) of silt and/or clay and sometimes fine sand
Stratified	Alternating layers of varying material or color with layers ≥ 6 mm thick
Laminated	Alternating layers of varying material or color with layers < 6 mm thick
Fissured	Contains shears or separations along planes of weakness
Slickensided	Shear planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Homogeneous	Same color and appearance throughout
Occasional	One or less per foot (305 mm) of thickness
Frequent	More than one per foot (305 mm) of thickness
Interbedded	Applied to strata of soil lying between or alternating with other strata of a different nature

DEFINITIONS OF PAVEMENT CONDITION

Condition	Description
Good	ACC Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks and transverse cracks (open 1/4 inch). No patching or very few patches in excellent condition.
	PCC Moderate scaling in several locations. A few isolated surface spalls. Shallow reinforcement causing cracks. Several corner cracks, tight or well sealed. Open (1/4 inch wide) longitudinal or transverse joints.
Fair	ACC Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (1/2 inch deep or less).
	PCC Severe polishing, scaling, map cracking, or spalling over 50% of the area. Joints and cracks show moderate to severe spalling. Pumping and faulting of joints (1/2 inch with fair ride). Several slabs have multiple transverse or meander cracks with moderate spalling.
Poor	ACC Alligator cracking (over 25% of surface). Severe distortions (over 2 inches deep) Extensive patching in poor condition. Potholes.
	PCC Extensive slab cracking, severely spalled and patched. Joints failed. Patching in very poor condition. Severe and extensive settlement or frost heaves.

GRAIN SIZE TERMINOLOGY

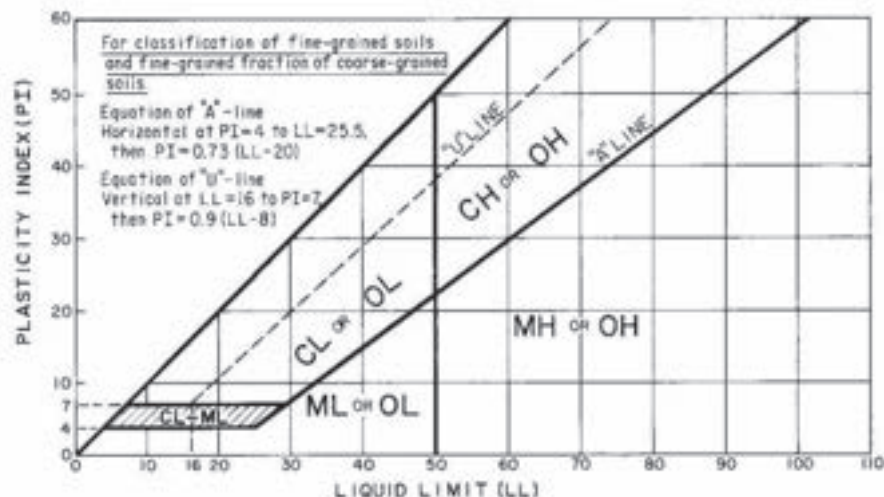
Major Component of Sample	Size Range
Boulders	≥ 12" (300 mm)
Cobbles	< 12" - 3" (300 mm – 75 mm)
Gravel - Coarse	< 3" - 3/4" (75 mm – 19 mm)
Gravel - Fine	< 3/4" - #4 (19 mm – 4.75 mm)
Sand - Coarse	< #4 - #10 (4.75 mm – 2 mm)
Sand - Medium	< #10 - #40 (2 mm - 0.425 mm)
Sand - Fine	< #40 - #200 (0.425 mm - 0.074 mm)
Silt	< 0.074 mm - 0.005 mm
Clay	< 0.005 mm



GENERAL NOTES

Unified Soil Classification System (USCS) ASTM D2487

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification			
				Group Symbol	Group Name <i>B</i>		
COARSE-GRAINED More than 50 % retained on No. 200 sieve	Gravels (More than 50 % of coarse fraction retained on No. 4 sieve)	Clean Gravels	$Cu \geq 4$ and $1 \leq Cc \leq 3^D$	GW	Well-graded gravel ^E		
		(Less than 5% fines ^C)	$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3]^D$	GP	Poorly graded gravel ^E		
		Gravels with Fines	Fines classify as ML or MH	GM	Silty gravel ^{E,F,G}		
		(More than 12 % fines ^C)	Fines classify as CL or CH	GC	Clayey gravel ^{E,F,G}		
	Sands (50 % or more of coarse fraction passes No. 4 sieve)	Clean Sands	$Cu \geq 6$ and $1 \leq Cc \leq 3^D$	SW	Well-graded sand ^F		
		(Less than 5 % fines ^H)	$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3]^D$	SP	Poorly graded sand ^F		
		Sands with Fines	Fines classify as ML or MH	SM	Silty sand ^{F,G,I}		
		(More than 12 % fines ^H)	Fines classify as CL or CH	SC	Clayey sand ^{F,G,I}		
FINE-GRAINED SOILS 50 % or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	$PI > 7$ and plots on or above "A" line ^J	CL	Lean clay ^{K,L,M}		
			$PI < 4$ or plots below "A" line ^J	ML	Silt ^{K,L,M}		
		organic	(Liquid Limit - oven dried) / (Liquid Limit - not dried) < 0.75	OL	Organic clay ^{K,L,M,N} Organic silt ^{K,L,M,O}		
			inorganic	PI plots on or above "A" line	CH	Fat clay ^{K,L,M}	
	Silts and Clays Liquid limit more than 50	inorganic	PI plots below "A" line	MH	Elastic silt ^{K,L,M}		
			organic	(Liquid Limit - oven dried) / (Liquid Limit - not dried) < 0.75	OH	Organic clay ^{K,L,M,P} Organic silt ^{K,L,M,Q}	
		HIGHLY ORGANIC SOILS Primarily organic matter, dark in color, and organic odor				Pt	Peat
		^A Based on the material passing the 3-in. (75-mm) sieve. ^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name. ^C Gravels with 5 to 12 % fines require dual symbols: GW-GM well-graded gravel with silt GW-GC well-graded gravel with clay GP-GM poorly graded gravel with silt GP-GC poorly graded gravel with clay ^D $Cu = D_{60}/D_{10}$ $Cc = (D_{30})^2 / (D_{10} \times D_{60})$ ^E If soil contains ≥ 15 % sand, add "with sand" to group name. ^F If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM. ^G If fines are organic, add "with organic fines" to group name. ^H Sands with 5 to 12 % fines require dual symbols: SW-SM well-graded sand with silt SW-SC well-graded sand with clay SP-SM poorly graded sand with silt SP-SC poorly graded sand with clay ^I If soil contains ≥ 15 % gravel, add "with gravel" to group name. ^J If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay. ^K If soil contains 15 to < 30 % plus No. 200, add "with sand" or "with gravel," whichever is predominant. ^L If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name. ^M If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name. ^N $PI \geq 4$ and plots on or above "A" line. ^O $PI < 4$ or plots below "A" line. ^P PI plots on or above "A" line. ^Q PI plots below "A" line.					



Order of Classification: 1) Consistency or Apparent Density, 2) Type of Soil, 3) Minor Soil Type(s), 4) Inclusions, 5) Layered Soils, 6) Color, 7) Water Content, 8) USCS Symbol, 9) Geological Name

Description of Frequently Used Laboratory Testing Procedures

Visual Engineering Classification

Visual classification was performed on all samples (though other means of refining the classification may also be used). The General Notes provided immediately following the Logs of Test Borings include a brief discussion of the general method used to visually classify the soil, which is based on the visual-manual procedure (ASTM D2488). The visual classification is used to assign an appropriate Unified Soil Classification System (USCS) group symbol. The USCS symbol is shown in parentheses following the textural description of the various strata on the boring logs.

Where more laboratory testing is performed (requiring both grain size and Atterberg limit tests), the classification may also be refined further based on USCS ASTM D2487.

Moisture Content (ASTM D2216)

Moisture content determination tests were performed in accordance with ASTM D2216. Samples were sealed in the field to retain the natural moisture content of the soil specimen. Samples were then dried at a constant temperature (approximately 110° C) overnight in an oven. After drying, the samples were weighed to determine the dry weight of the sample (and the loss in weight representing the water contained in the original sample). The moisture content of the specimen is expressed as a percent and is the weight of the water compared to the dry weight of the specimen.

Hand Penetrometer

A hand/pocket penetrometer was used to estimate the unconfined compressive strength of cohesive (clay) samples. In the hand penetrometer test, the shear strength of a cohesive soil sample is estimated by measuring the resistance of the sample to the penetration of a small, calibrated spring-loaded cylinder. The maximum capacity of the penetrometer is 4.5 tons per square foot. The shear strength is doubled and reported on the soil boring logs as an estimate of the unconfined compressive strength.

Grain Size Analyses (ASTM D6913, D7928, and/or D422-2017)

Grain size analyses were performed in accordance with ASTM D6913, D7928, and/or D422-2017 on selected soil samples to evaluate the gradation of the soil represented by the sample. The distribution of particle sizes larger than 75 micrometers (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 micrometers is determined by a sedimentation process using a hydrometer.

Atterberg Limits Tests (ASTM D4318)

Determination of the Liquid Limit, Plastic Limit, and Plasticity Index of cohesive soils (known as Atterberg Limits) were performed in accordance with ASTM D4318. Fine-grained soils are tested to determine the Liquid Limit (LL) and Plastic Limits (PL), which are moisture contents that define boundaries between material consistency states. The LL and PL values define the transitional boundaries between non-plastic, plastic, and viscous fluid states. The plasticity index (PI) defines the complete range in water content for the plastic state.

Description of Frequently Used Laboratory Testing Procedures (continued)

Organic Content (Loss-On-Ignition) Tests (ASTM D7348)

The organic content of a soil is determined through a Loss-On-Ignition test performed in accordance with ASTM D2974 on soil samples suspected to contain significant organics. After the sample has been oven-dried, the soil sample is super-heated in a 440°C muffle furnace as a means to burn off all present organic matter. The weight of the remaining ash is used to calculate the percentage of organic matter as compared to the dry weight of the sample.



APPENDIX F

GEO-PROFESSIONAL BUSINESS ASSOCIATION (GBA) MESSAGE

Important Information about This Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual site-wide subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists.*



GEOPROFESSIONAL
BUSINESS
ASSOCIATION

Telephone: 301/565-2733

e-mail: info@geoprofessional.org www.geoprofessional.org

Appendix G

Leib Record Drawings from Recent Projects

Appendix G-1

1902040 Site Improvements at LEIB As-Builts ALTA Survey



GREAT LAKES WATER AUTHORITY

GLWA CONTRACT NO. 1902040

CIP 260615

SITE IMPROVEMENTS AT PURITAN-FENKELL
CSO DETENTION FACILITY AND
LEIB SCREENING &
DISINFECTION FACILITY

DESIGN CONSULTANT:



PE SEAL

GLWA BOARD OF DIRECTORS

Freman Hendrix

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Manager, CSO Control Program

Philip Kora, P.E.

Manager, CSO Construction Engineering

Dan Alford, P.E.

Director, Engineering

AS-BUILT

OCTOBER 2021

GENERAL

THIS PROJECT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

THE CONTRACTOR SHALL BE REQUIRED TO NOTIFY THE LOCAL
FIRE AND POLICE DEPARTMENTS 24 HOURS IN ADVANCE OF
PROPOSED WORK.

THE CONTRACTOR AND/OR HIS SUBCONTRACTOR SHALL
NOTIFY "MISS DIG", (1-800-482-7171 OR 811).

CONTRACTOR TO PROTECT EXISTING ABOVE GROUND AND BELOW GROUND FACILITIES INCLUDING: UTILITIES, POLES, TREES, SHRUBS AND OTHER VEGETATION UNLESS NOTED FOR REMOVAL ON THE PLANS, AND SHALL REPAIR OR REPLACE DAMAGED FACILITIES AT NO COST TO THE OWNER. TREES SHALL BE NEATLY TRIMMED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT AND MAINTAIN EXISTING SERVICES TO EXISTING HOMES AND BUSINESSES, INCLUDING SANITARY, WATER, GAS, CABLE AND OTHER UTILITIES.

CONTRACTOR SHALL PROTECT ALL COMMERCIAL AND INDUSTRIAL SITE FEATURES SUCH AS PLANTERS, MAIL BOXES, FENCES, LANDSCAPING, WALLS, WALKS, PORCHES, ETC, AND RESTORE TO ORIGINAL CONDITION IF DAMAGED EXCEPT AS NOTED. NO ADDITIONAL PAYMENT WILL BE ALLOWED FOR THIS WORK.

ALL CONSTRUCTION STAGING AREAS SHALL BE APPROVED BY THE GREAT LAKE WATER AUTHORITY (GLWA) PRIOR TO START OF CONSTRUCTION. ANY AREAS BEYOND CONSTRUCTION LIMITS SECURED BY THE CONTRACTOR FOR USE AS CONSTRUCTION STAGING SHALL BE AT HIS OWN EXPENSE. THE RESTORATION OF ALL STAGING AREAS SHALL BE COMPLETED PRIOR TO FINAL ACCEPTANCE OF THE WORK OF THIS PROJECT. NO ADDITIONAL PAYMENT WILL BE ALLOWED FOR THIS WORK.

THE CONTRACTOR SHALL REMOVE ALL SPRINKLER HEADS, LINES, ETC. THAT ARE WITHIN THE PROPOSED WORK AREA. THIS PIPE AND VALVE WORK SHALL BE CONSIDERED INCIDENTAL TO THE PROJECT.

UNDER CONSTRUCTION

WHEN EXCAVATING FOR CONSTRUCTION, THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT THE EXISTING UTILITIES AND STRUCTURES.

ALL SEWER TRENCHES SHALL BE BACKFILLED OR OTHERWISE PROTECTED OVERNIGHT.

STORM SEWER

SUMP DEPTH IS FROM LOWEST PROPOSED INVERT. CATC
BASIN (CB) MEANS 2 FT SUMP INCLUDED IN DRAINAGE
STRUCTURE PAY ITEM. INLETS (INL) DO NOT HAVE SUMPS.

MAINTAINING TRAFFIC

CONTRACTOR SHALL MAINTAIN SAFE, DUST FREE CONDITIONS ON EXISTING STREETS WHICH SHALL REQUIRE DAILY REMOVAL OF EARTH TRACKED OR SPILLED ON ROAD SURFACE, AND OTHER DUST CONTROL MEASURES AS REQUIRED BY THE PROJECT ENGINEER. EXCESSIVE DUST WILL NOT BE TOLERATED AT ANY TIME DURING CONSTRUCTION. PAYMENT FOR DUST CONTROL SHALL BE INCLUDED IN THE COST OF THE PROJECT.

EARTHWORK AND GRADING

ON-SITE FILL MATERIAL CAN BE USED IF THE SPECIFIED COMPACTION REQUIREMENTS CAN BE ACHIEVED. IF ON-SITE MATERIAL IS USED, IT SHALL BE CLEAN AND FREE OF FROZEN SOIL, ORGANICS, SOFT, OR OTHER DELETERIOUS MATERIALS.

A 6" TOPSOIL LAYER MUST BE MAINTAINED WHERE ALL PROPOSED RE-GRADING WORK IS LOCATED.

SEE SHEET C-2 AND C-6 FOR SOIL EROSION AND
SEDIMENTATION CONTROL INFORMATION.

UTILITIES

THE EXISTING UTILITIES LISTED BELOW AND SHOWN ON THESE PLANS REPRESENT THE BEST INFORMATION AVAILABLE AS OBTAINED FROM SURVEYS AND FROM UTILITY RECORD MAPS. THIS INFORMATION DOES NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY TO NOTIFY THE PROPER UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR IS RESPONSIBLE TO VERIFY ALL EXISTING UTILITIES AND THEIR LOCATIONS AS PART OF THE CONSTRUCTION OF THIS PROJECT. ANY OMISSION OR VARIATION FROM THE LOCATIONS SHOWN PURSUANT TO ACTS OF THE CPA OF 1974 OR ANY CONDITION OF THIS CONTRACT NOTICE SHALL BE GIVEN TO MISS DIG PRIOR TO UNDERGROUND WORK TO BE PERFORMED. THE CONTRACTOR IS RESPONSIBLE TO LOCATE ALL EXISTING UTILITIES AND FIELD VERIFY BOTH LOCATIONS AND DEPTHS PRIOR TO ANY PROPOSED WORK BEING PERFORMED.

THE FOLLOWING UTILITY COMPANIES HAVE FACILITIES WITHIN THE PROJECT LIMITS:

DTE GAS
DTE ELECTRIC
DETROIT WATER AND SEWER DEPARTMENT

THE CONTRACTOR SHALL, BEFORE EACH DAYS WORK, OR WHEN MOVING TO A NEW AREA OF WORK, DETERMINE AND EVALUATE THE LOCATION OF ALL UNDERGROUND FACILITIES IN THE AREA. IF LOCATION STAKES HAVE BEEN MOVED OR DO NOT APPEAR CORRECT, THE CONTRACTOR SHALL NOT EXCAVATE UNTIL ALL UTILITIES HAVE HAD AN OPPORTUNITY TO CHECK OR RESTAKE THEIR LOCATIONS. ANY DELAYS INCURRED DUE TO CHECKING OR RESTAKING OF UTILITIES SHALL NOT BE A BASIS FOR ADDITIONAL COMPENSATION.

ALL UTILITIES SHALL BE PROTECTED DURING THE DURATION OF THE PROJECT.

PRIOR TO WORK ON FACILITIES BELONGING TO THE ABOVE AGENCIES, A MINIMUM OF 72 HOURS NOTICE MUST BE GIVEN IN ORDER TO INSURE PROPER INSPECTION BY THE RESPECTIVE AGENCIES.

THE CONTRACTOR SHALL LOCATE ALL ACTIVE UNDERGROUND UTILITIES PRIOR TO STARTING WORK, AND SHALL CONDUCT HIS OPERATIONS IN SUCH A MANNER AS TO INSURE THAT THOSE UTILITIES NOT REQUIRING RELOCATION WILL NOT BE DISTURBED.

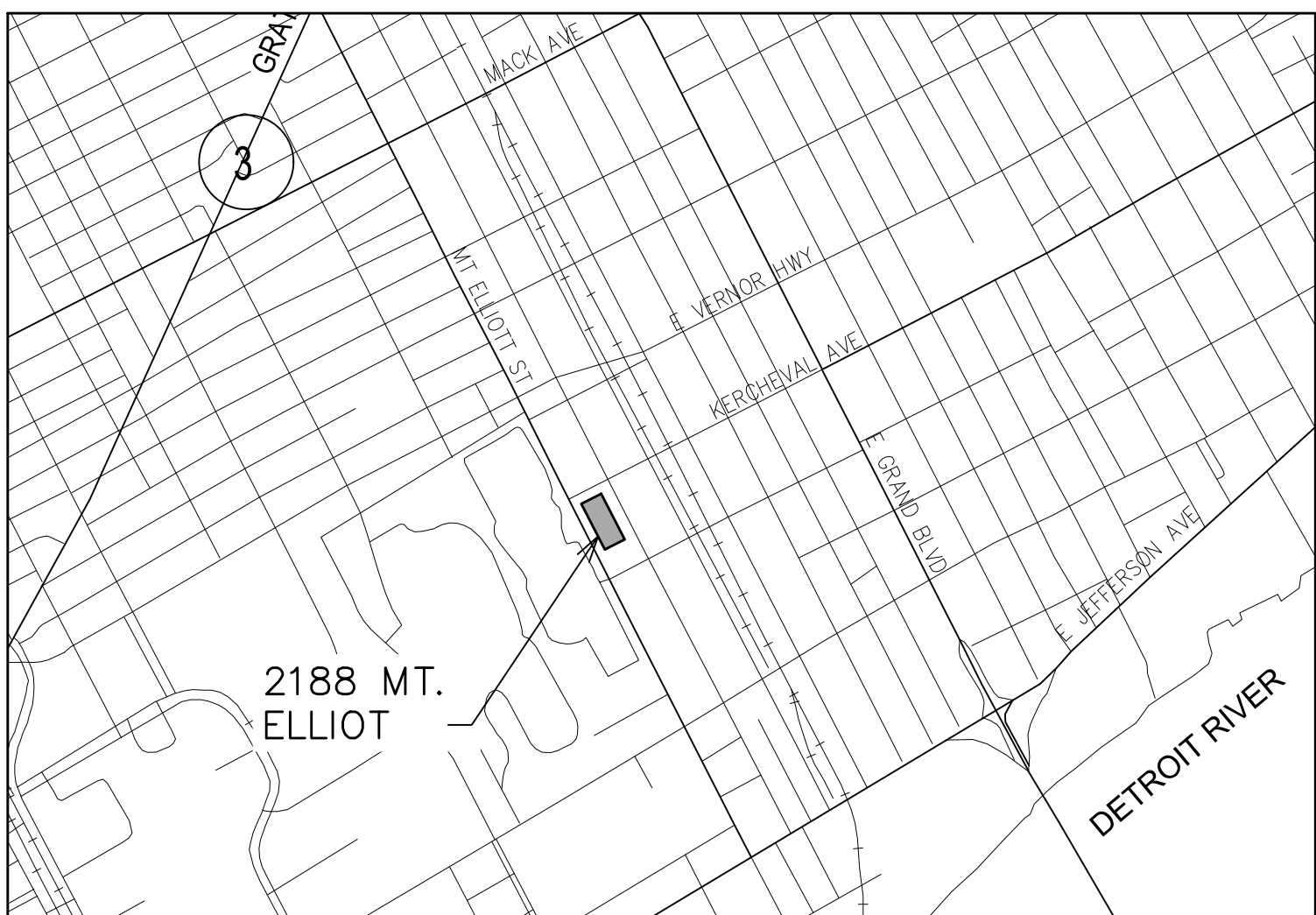
FOR PROTECTION OF UNDERGROUND UTILITIES, THE CONTRACTOR SHALL DIAL (800) 482-7171, OR 811 A MINIMUM OF 3 FULL WORKING DAYS, EXCLUDING SATURDAY, SUNDAY, AND HOLIDAYS, PRIOR TO EXCAVATING IN THE VICINITY OF UTILITY LINES. ALL "MISS DIG" PARTICIPATING MEMBERS WILL BE ROUTINELY NOTIFIED. THIS DOES NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY OF NOTIFYING UTILITY OWNERS WHO MAY NOT BE A PART OF THE "MISS DIG" ALERT SYSTEM.

RESTORATION

RESTORE AND STABILIZE ALL SLOPES IN ACCORDANCE WITH THE PLANS AND AS DESCRIBED IN THE CONTRACT DOCUMENTS.

ALL FINAL GRADES SHALL SLOPE TO DRAIN TOWARD CATCH BASINS, DITCHES, SWALES, CURBS, AND DRAINAGEWAYS UNLESS OTHERWISE NOTED.

THE CONTRACTOR SHALL NOT PERFORM ANY SIDE WORK
CONTRACTED PRIVATELY WITHIN THE CONSTRUCTION AREA.



SITE LOCATION MAP— LEIB



SITE LOCATION MAP- PURITAN-FENKELL

ABBREVIATIONS

GENERAL

E/M	EDGE OF METAL
EX./EXIST.	EXISTING
P.O.B.	POINT OF BEGINNING
H.C.P.	HORIZONTAL CONTROL POINT
B.M.	BENCH MARK
STM.	STORM SEWER
SA.	SANITARY SEWER
CS	COMBINED SEWER
W.M.	WATER MAIN
R.O.W.	RIGHT-OF-WAY
T/C	TOP OF CURB
RM	TOP OF DRAINAGE STRUCTURE COVER
S.S.L.	SLOPE STAKE LINE
C.I.P.	COMPACTED IN PLACE
C.S.B.	COMPLETE SAND BACKFILL
SME	SOILS MATERIALS ENGINEERS (PAVEMENT CORES)
GLWA	GREAT LAKES WATER AUTHORITY (OWNER)

ITEM

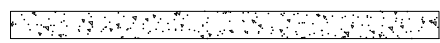
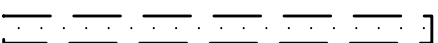
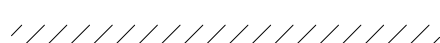
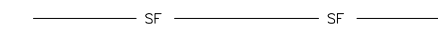
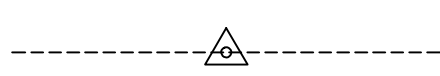
ASPHALT
CONCRETE SIDEWALK
BRICK PAVERS
STAGING AREA
BUILDING
FLOODWAY
STORM SEWER > 15"
STORM SEWER < 15"
SANITARY SEWER
WATER MAIN
GAS MAIN
U.G. TELEPHONE
U.G. ELECTRIC
U.G. ELEC. & TELE.
U.G. CABLE TV
FENCE
SILT FENCE
GRADE

LEGEND

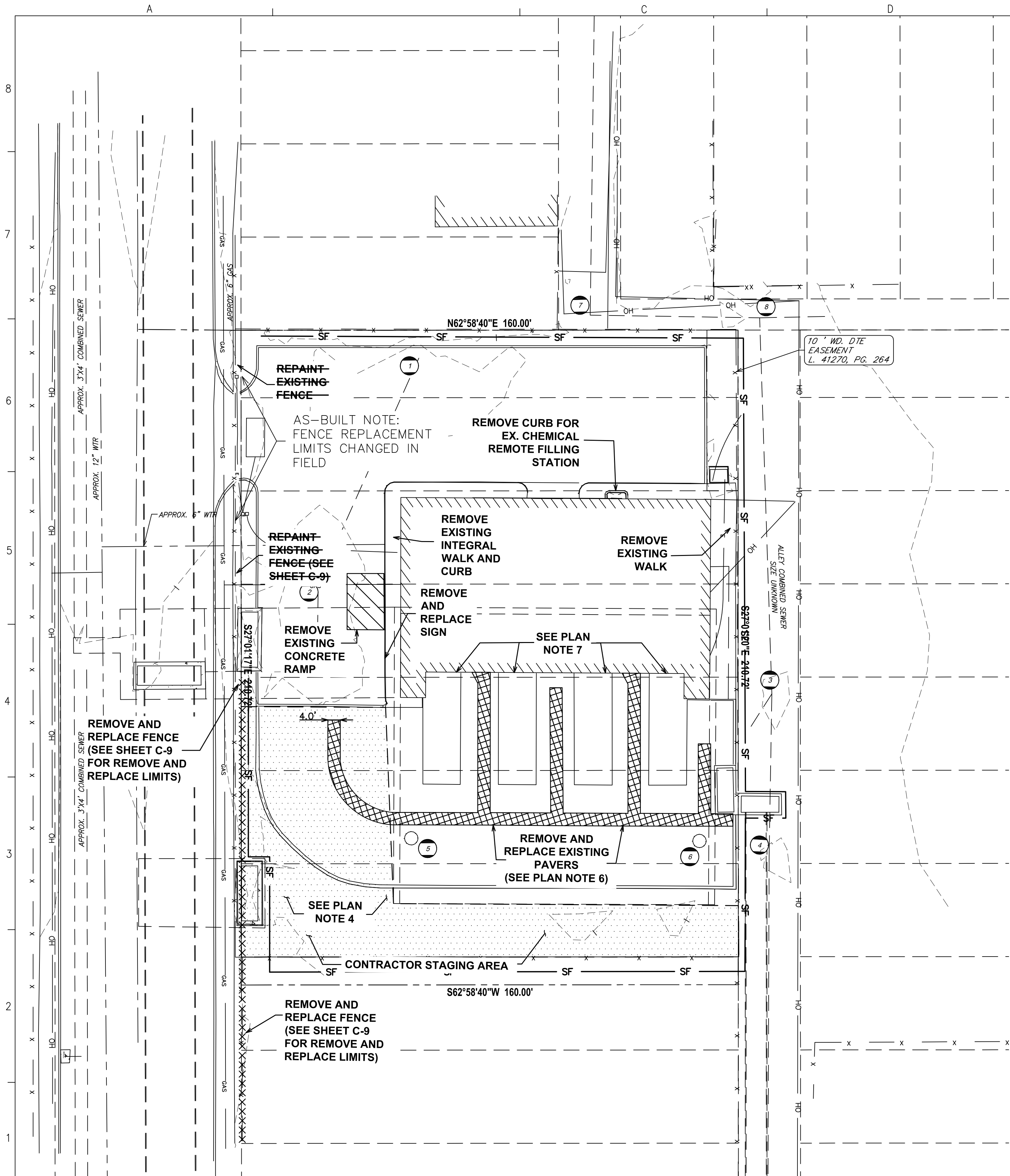
SYMBOL

EXISTING

PROPOSED

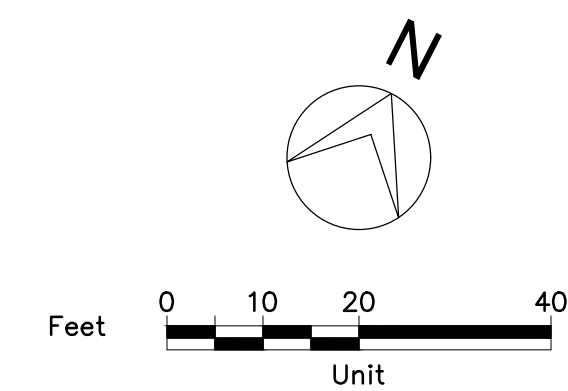
ASPHALT		
CONCRETE SIDEWALK		
BRICK PAVERS		
STAGING AREA		
BUILDING		
FLOODWAY		
STORM SEWER > 15"	EX. 42" STM. SWR. 	
STORM SEWER < 15"	EX. 12" CMP ST 	
SANITARY SEWER	EX. 12" SAN. SWR. SA 	
WATER MAIN	EX. 12" D.I. W.M. WM 	
GAS MAIN	EX. 6" S-MP GAS MAIN G 	
U.G. TELEPHONE	T 	
U.G. ELECTRIC	E 	
U.G. ELEC. & TELE.	ET 	
U.G. CABLE TV	CTV 	
FENCE	X X 	
SILT FENCE		
GRADE	142 	140 
REMOVE FENCE	XXXXXXXXXXXXXXXXXX 	
TRAVERSE LINE & TRAVERSE POINT		
BENCH MARK SYMBOL		
DECIDUOUS TREE		
DECIDUOUS SHRUB		
CONIFEROUS TREE		
CONIFEROUS SHRUB		
SQUARE/ROUND CATCHBASINS & INLETS IN PAVEMENT	  	
STORM MANHOLE & PIPE END	 	
RISER & DOWN SPOUT	 	
DRAIN CLEANOUT		
FIRE HYDRANT		
GATE VALVE, GATE WELL & WELL	  	  
WATER STOP BOX & SPRINKLER HEAD	 	
METER PIT		
UTILITY POLE		
LIGHT POLE		
GUY WIRE ANCHOR		
UNDERGROUND MARKER		
GAS VALVE / PIPE END	 	
GAS BOX & BLOW OFF	 	
SOIL BORING/PAVEMENT CORE		
DRAINAGE FLOW		
RIGHT-OF-WAY		
PROPERTY LINE		
SLOPE STAKE LINE		

F					DESIGNED BY: AKJ		FACILITY			MDEQ PERMIT No. N/A	
E					DRAWN BY: EJP		PROJECT TITLE			GLWA CONTRACT No. GLWA—CON—1902040	
D	AS-BUILTS	AJ	APPR	10/15/21	CHECKED BY: THS					FILE No. 20181156	
C	100% SUBMITTAL	THS	APPR	8/14/19	APPROVED BY: THS					DRAWING No. G-1	
B	90% REVIEW	THS	APPR	7/2/19							
A	50% REVIEW	THS	APPR	5/29/19							
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE			SCALE: AS NOTED				



SOIL EROSION AND SEDIMENTATION CONTROL GENERAL NOTES AND REQUIREMENTS:

1. CONTRACTOR SHALL NOTIFY THE WAYNE COUNTY SOIL EROSION OFFICE 48 HOURS BEFORE WORK IS TO BEGIN AT 734-326-3936.
2. ALL SOIL EROSION AND SEDIMENTATION CONTROL WORK SHALL CONFORM TO THE STANDARDS AND SPECIFICATIONS OF WAYNE COUNTY. THE CONTRACTOR SHALL OBTAIN THE SOIL EROSION CONTROL PERMIT FROM WAYNE COUNTY, AND SHALL MAINTAIN COMPLIANCE WITH THE PERMIT THROUGHOUT CONSTRUCTION.
3. CONTRACTOR SHALL PROVIDE A DETAILED SCHEDULE SHOWING DATES AND DURATION FOR EACH PHASE OF EARTH DISTURBANCE TO THE WAYNE COUNTY SOIL EROSION OFFICE FOR APPROVAL.
4. EROSION AND ANY SEDIMENT FROM WORK ON THIS SITE SHALL BE CONTAINED ON THE SITE AND NOT ALLOWED TO COLLECT ON ANY OFF-SITE AREAS OR IN WATERWAYS. WATERWAYS INCLUDE BOTH NATURAL AND MAN-MADE OPEN DITCHES, STREAMS, STORM DRAINS, LAKES, AND PONDS
5. CONTRACTOR SHALL PROVIDE AND INSTALL SOIL EROSION AND SEDIMENTATION CONTROL (SESC) DEVICES, AS SHOWN, BEFORE PROCEEDING WITH ANY OTHER SITE WORK. CONTRACTOR SHALL MAINTAIN ALL SESC DEVICES FOR THE DURATION OF THE CONSTRUCTION. AT THE END OF CONSTRUCTION, CONTRACTOR SHALL RESTORE ALL DISTURBED AREAS. ONCE GRASS IS ESTABLISHED, CONTRACTOR SHALL REMOVE AND DISPOSE OF ALL TEMPORARY SESC DEVICES AND COLLECTED DEBRIS. TEMPORARY CONTROLS SHALL BE REMOVED ONLY AFTER GETTING APPROVAL BY THE WAYNE COUNTY SOIL EROSION INSPECTOR.
6. CONTRACTOR SHALL INSPECT AND MAINTAIN SESC DEVICES ON A WEEKLY BASIS AND WITHIN 24 HOURS AFTER A STORM EVENT. THE CONTRACTOR SHALL REMOVE ACCUMULATED DEBRIS AND MAKE NECESSARY REPAIRS AS-DIRECTED BY THE ENGINEER.
7. CONTRACTOR IS TO MAINTAIN DRAINAGE OF THE SITE FOR THE DURATION OF CONSTRUCTION. DRAINAGE MATERIALS AND COLLECTED DEBRIS ARE REMOVED AT THE END OF CONSTRUCTION AND THE AREA RESTORED. ALL EXCESS EXCAVATED MATERIALS SHALL BE REMOVED FROM THE SITE AND DISPOSED OF PROPERLY. OWNER SHALL BE INFORMED OF THE DISPOSAL AREA(S), PRIOR TO ANY MATERIALS LEAVING THE SITE.
8. ALL STORM SEWERS USED TO CONVEY DISCHARGES FROM EXCAVATION DE-WATERING SYSTEMS SHALL BE FLUSHED AND CLEANED.
9. CONTRACTOR SHALL SWEEP ROADWAYS AT LEAST ONCE PER WEEK AND SCRAPE THE ROAD AT THE END OF EACH WORKDAY THROUGHOUT THE PROJECT WHILE EARTHWORK ACTIVITIES ARE IN PROGRESS. ANY MUD/DIRT TRACKED ONTO EXISTING CITY/COUNTY/STATE ROADS FROM THIS SITE, DUE TO CONSTRUCTION, SHALL BE PROMPTLY REMOVED BY THE CONTRACTOR/BUILDER. THIS WORK SHALL BE INCLUDED IN THE UNIT BID COSTS FOR SESC.
10. CONTRACTOR SHALL MAINTAIN SAFE, DUST FREE CONDITION ON EXISTING STREETS WHICH SHALL REQUIRE DAILY REMOVAL OF EARTH TRACKED OR SPILLED ON ROAD SURFACE, AND OTHER DUST CONTROL MEASURES AS REQUIRED BY THE PROJECT ENGINEER. EXCESSIVE DUST WILL NOT BE TOLERATED AT ANY TIME DURING CONSTRUCTION. NO ADDITIONAL PAYMENT WILL BE ALLOWED FOR THIS WORK.
11. WHEN THE SITE IS READY FOR FINAL GRADING, RE-GRADE THE SITE AND COMPLETE ALL PAVEMENT WORK, THEN PERMANENTLY STABILIZE THE SITE PER CONTRACT REQUIREMENTS BY SEEDING.
12. PERMANENT SOIL EROSION AND SEDIMENTATION CONTROL MEASURES FOR ALL SLOPES, CHANNELS, DITCHES, OR ANY DISTURBED LAND AREA SHALL BE COMPLETED WITHIN 5 CALENDAR DAYS AFTER FINAL GRADING OR THE FINAL EARTH CHANGE HAS BEEN COMPLETED. WHEN IT IS NOT POSSIBLE TO PERMANENTLY STABILIZE A DISTURBED AREA AFTER AN EARTH CHANGE HAS BEEN COMPLETED OR WHERE SIGNIFICANT EARTH CHANGE ACTIVITY CEASES, TEMPORARY SOIL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE IMPLEMENTED WITHIN 30 CALENDAR DAYS. ALL TEMPORARY SOIL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE MAINTAINED UNTIL PERMANENT SOIL EROSION AND SEDIMENTATION CONTROL MEASURES ARE IMPLEMENTED.
13. DITCHES, SWALES, AND OTHER AREAS THAT WILL CHANNEL CONCENTRATED RUNOFF MUST BE STABILIZED WITHIN 15 DAYS OF EARTH DISTURBANCE. TEMPORARY ROCK CHECK DAMS WILL BE REQUIRED TO SLOW WATER TO NON-EROSIVE VELOCITIES IN AREAS OF CONCENTRATED FLOW.
14. AREAS OF EARTH CHANGE THAT ARE NOT STABILIZED BEFORE FALL SEEDING DEADLINE (NOV. 1) MUST BE TEMPORARILY STABILIZED WITH A STRAW MULCH SECURELY CRIMPED TO THE GROUND OR ALTERNATE METHOD APPROVED BY THE ENGINEER.

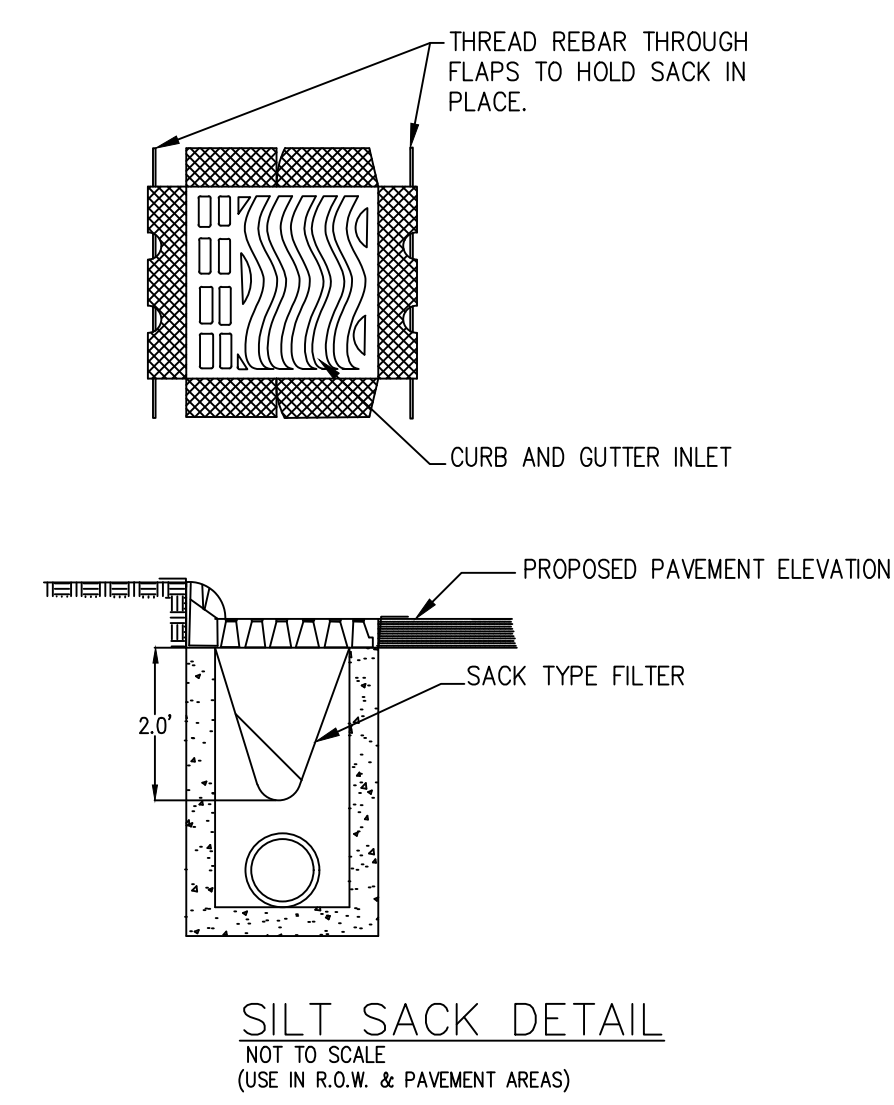
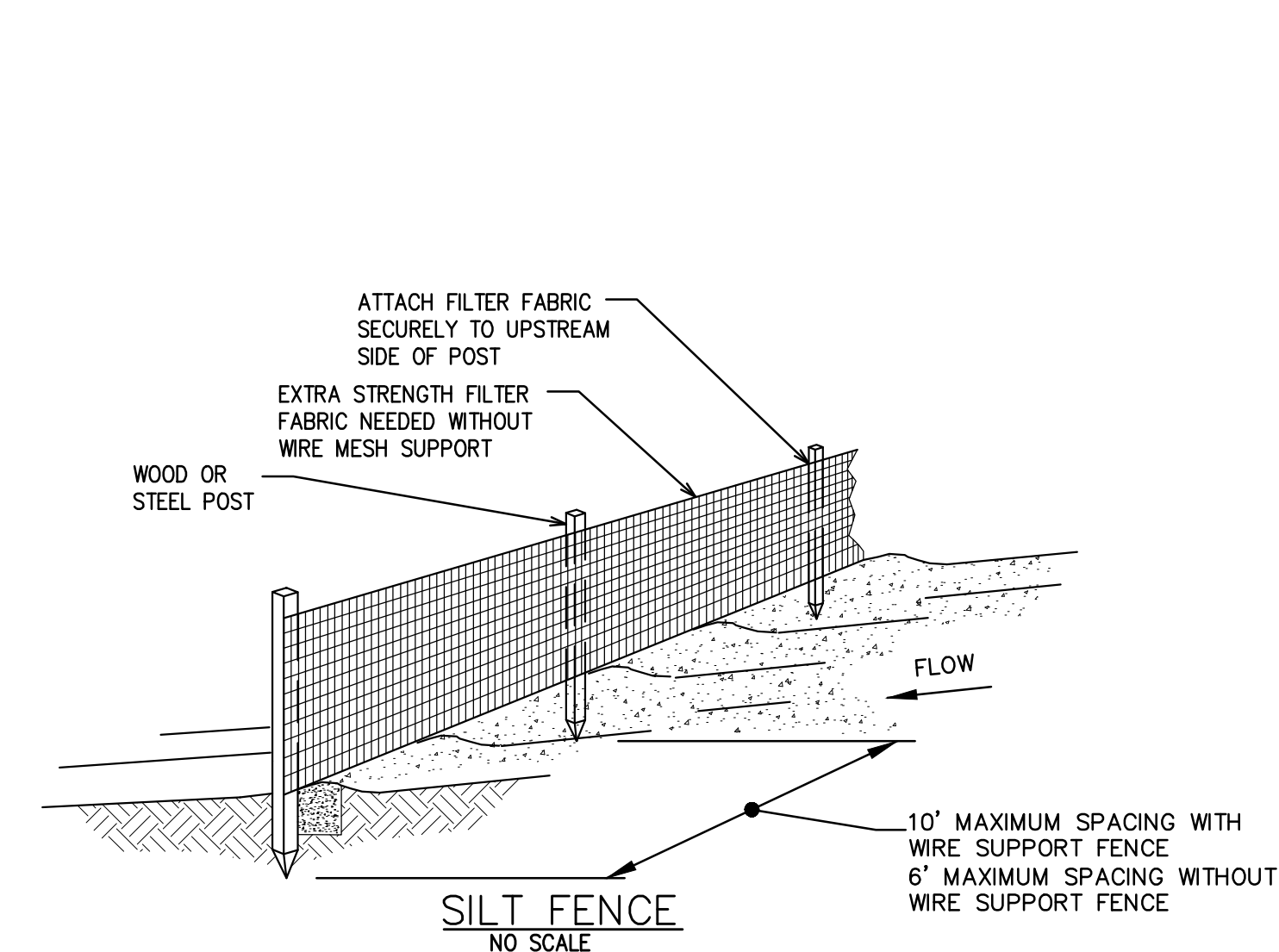


REMOVAL LEGEND

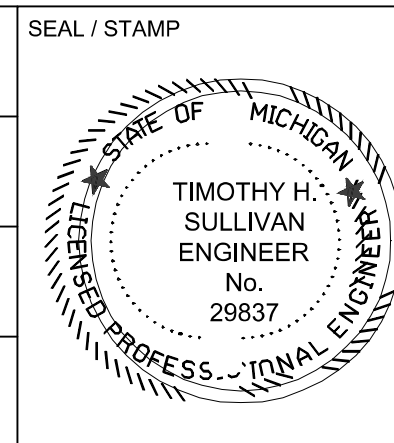
- REMOVE SIDEWALK
- REMOVE BRICK PAVERS
- REMOVE FENCE
- REMOVE CONCRETE PAVEMENT
- REMOVE ASPHALT
- CSO BASIN LIMITS

PLAN NOTES:

1. REFER TO SME ALTA SURVEY PLAN SHEET 2-LEIB FOR EXISTING ONSITE STORM SEWER INFORMATION.
2. EXISTING SITE INFORMATION NOT FOUND ON THIS SHEET CAN BE FOUND IN ALTA SURVEY PLAN SHEETS 2-LEIB AND 3-LEIB.
3. THE CONTRACTOR SHALL CONFINE ALL CONSTRUCTION OPERATIONS TO THE STAGING AREAS SHOWN ON THIS SHEET.
4. THE EXISTING UNDERGROUND CSO BASIN LIMITS ARE SHOWN ON THIS SHEET. MAXIMUM LOAD LIMIT ON THE BASIN TOP SLAB IS 300 PSF. THIS INCLUDES COMBINATIONS OF LOADS AT ANY ONE POINT IN TIME- EQUIPMENT, SOIL, ETC. THE CONTRACTOR IS RESPONSIBLE FOR THE EVALUATION OF THE EFFECTS OF ALL LOADS DUE TO CONSTRUCTION-RELATED ACTIVITIES ON THE BASIN AND OTHER EXISTING STRUCTURES ON THE SITE. SEE STRUCTURAL CAPACITY EVALUATION SPECIAL PROVISION FOR REQUIREMENTS.
5. SITE MUST BE SECURE AT THE END OF EACH WORK DAY. CONTRACTOR SHALL ONLY REMOVE AS MUCH FENCE AS HE CAN REPLACE THAT DAY. TEMPORARY FENCE SHALL MATCH OR EXCEED EXISTING FENCE.
6. UNDAMAGED BRICK PAVERS ARE TO BE SALVAGED WHERE POSSIBLE. DAMAGED BRICK PAVERS ARE TO BE REPLACED.
7. CONTRACTOR SHALL NOT EXERT ANY LOAD ON CONCRETE AREA INCLUDING ANY EQUIPMENT, DEBRIS, DIRT, ETC.



F					DESIGNED BY: AKJ
E					DRAWN BY: EJP
D	AS-BUILTS	AJ	APPR	10/15/21	CHECKED BY: THS
C	100% SUBMITTAL	THS	APPR	8/14/19	APPROVED BY: THS
B	90% REVIEW	THS	APPR	7/2/19	
A	50% REVIEW	THS	APPR	5/29/19	
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE	

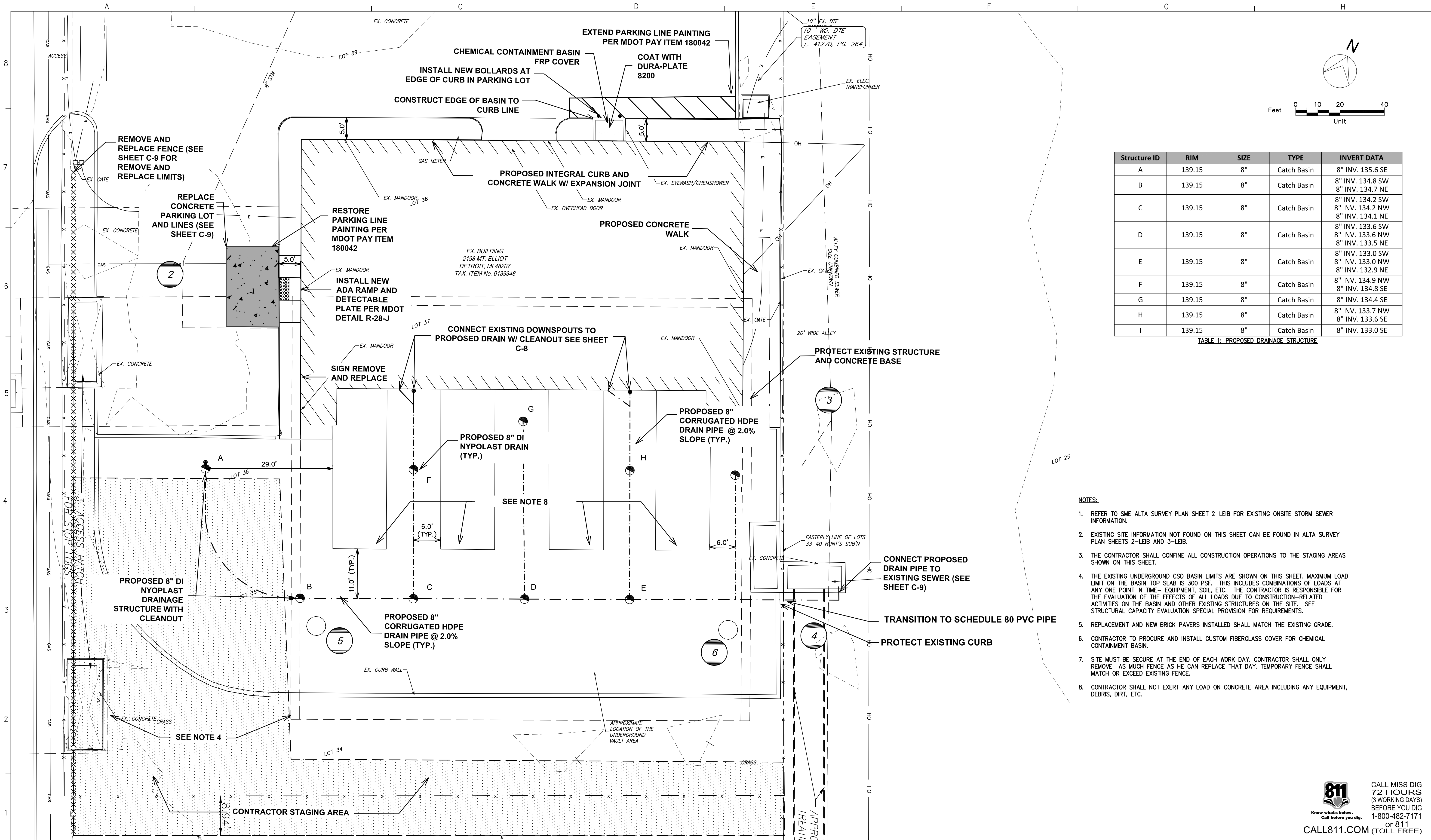


FACILITY	SITE IMPROVEMENTS AT PURITAN-FENKELL AND LEIB FACILITIES
PROJECT TITLE	SOIL EROSION AND SEDIMENTATION CONTROL AND DEMOLITION PLAN-LEIB
SCALE:	AS NOTED
DATE	August, 2019

FIRM NAME	HRC HUBBELL, ROTH & CLARK, INC CONSULTING ENGINEERS SINCE 1915
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SECTION MAP	TOWN	RANGE	STATION	PORTION CODE
- - - -	1 S	10 E	- - - -	- - - -

MDEQ PERMIT No.	N/A
GLWA CONTRACT No.	GLWA-CO-1902040
FILE No.	20181156
DRAWING No.	C-6

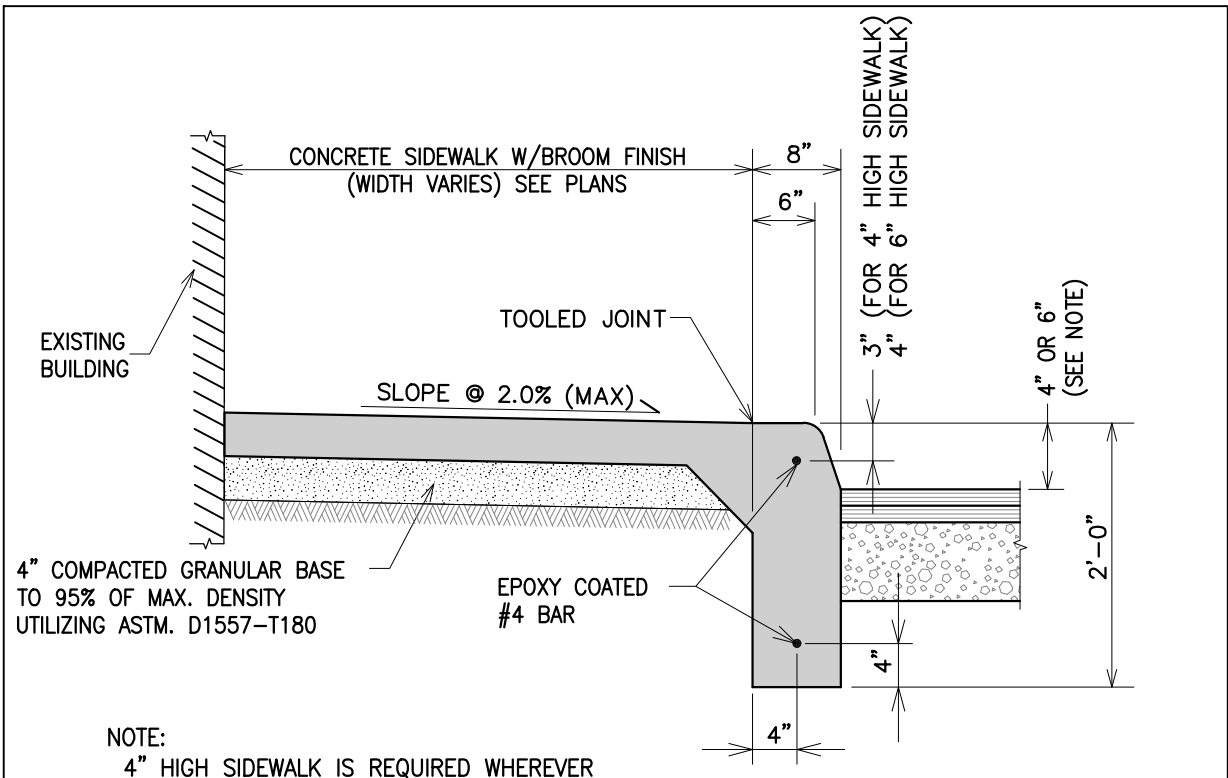


Structure ID	RIM	SIZE	TYPE	INVERT DATA
A	139.15	8"	Catch Basin	8" INV. 135.6 SE
B	139.15	8"	Catch Basin	8" INV. 134.8 SW 8" INV. 134.7 NE
C	139.15	8"	Catch Basin	8" INV. 134.2 SW 8" INV. 134.2 NW 8" INV. 134.1 NE
D	139.15	8"	Catch Basin	8" INV. 133.6 SW 8" INV. 133.6 NW 8" INV. 133.5 NE
E	139.15	8"	Catch Basin	8" INV. 133.0 SW 8" INV. 133.0 NW 8" INV. 132.9 NE
F	139.15	8"	Catch Basin	8" INV. 134.9 NW 8" INV. 134.8 SE
G	139.15	8"	Catch Basin	8" INV. 134.4 SE
H	139.15	8"	Catch Basin	8" INV. 133.7 NW 8" INV. 133.6 SE
I	139.15	8"	Catch Basin	8" INV. 133.0 SE

TABLE 1: PROPOSED DRAINAGE STRUCTURE

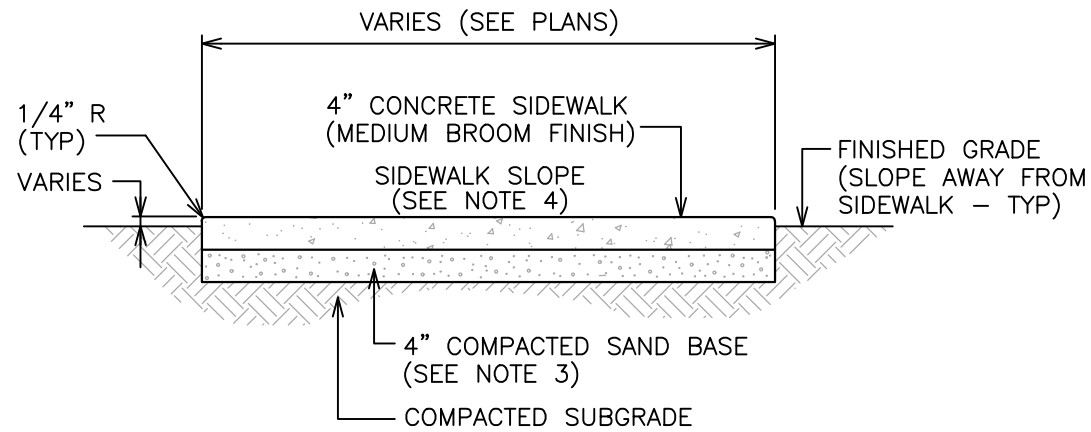
- NOTES:
- REFER TO SME ALTA SURVEY PLAN SHEET 2-LEIB FOR EXISTING ONSITE STORM SEWER INFORMATION.
 - EXISTING SITE INFORMATION NOT FOUND ON THIS SHEET CAN BE FOUND IN ALTA SURVEY PLAN SHEETS 2-LEIB AND 3-LEIB.
 - THE CONTRACTOR SHALL CONFINED ALL CONSTRUCTION OPERATIONS TO THE STAGING AREAS SHOWN ON THIS SHEET.
 - THE EXISTING UNDERGROUND CSO BASIN LIMITS ARE SHOWN ON THIS SHEET. MAXIMUM LOAD LIMIT ON THE BASIN TOP SLAB IS 300 PSF. THIS INCLUDES COMBINATIONS OF LOADS AT ANY ONE POINT IN TIME- EQUIPMENT, SOIL, ETC. THE CONTRACTOR IS RESPONSIBLE FOR THE EVALUATION OF THE EFFECTS OF ALL LOADS DUE TO CONSTRUCTION-RELATED ACTIVITIES ON THE BASIN AND OTHER EXISTING STRUCTURES ON THE SITE. SEE STRUCTURAL CAPACITY EVALUATION SPECIAL PROVISION FOR REQUIREMENTS.
 - REPLACEMENT AND NEW BRICK PAVERS INSTALLED SHALL MATCH THE EXISTING GRADE.
 - CONTRACTOR TO PROCURE AND INSTALL CUSTOM FIBERGLASS COVER FOR CHEMICAL CONTAINMENT BASIN.
 - SITE MUST BE SECURE AT THE END OF EACH WORK DAY. CONTRACTOR SHALL ONLY REMOVE AS MUCH FENCE AS HE CAN REPLACE THAT DAY. TEMPORARY FENCE SHALL MATCH OR EXCEED EXISTING FENCE.
 - CONTRACTOR SHALL NOT EXERT ANY LOAD ON CONCRETE AREA INCLUDING ANY EQUIPMENT, DEBRIS, DIRT, ETC.

F					DESIGNED BY: AKJ	SEAL / STAMP	FACILITY	FIRM NAME	MDEQ PERMIT No. N/A
E					DRAWN BY: EJP		SITE IMPROVEMENTS AT PURITAN-FENKELL AND LEIB FACILITIES		GLWA CONTRACT No. GLWA-CO-1902040
D	AS-BUILTS	AJ	APPR	10/15/21	CHECKED BY: THS		PROJECT TITLE		FILE No. 20181156
C	100% SUBMITTAL	THS	APPR	8/14/19	APPROVED BY: THS		PROPOSED SITE PLAN-LEIB		DRAWING No. C-7
B	90% REVIEW	THS	APPR	7/2/19					
A	50% REVIEW	THS	APPR	5/29/19					
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE			SCALE: AS NOTED	DATE August, 2019	



TYPICAL CONCRETE SIDEWALK
ADJACENT TO PARKING

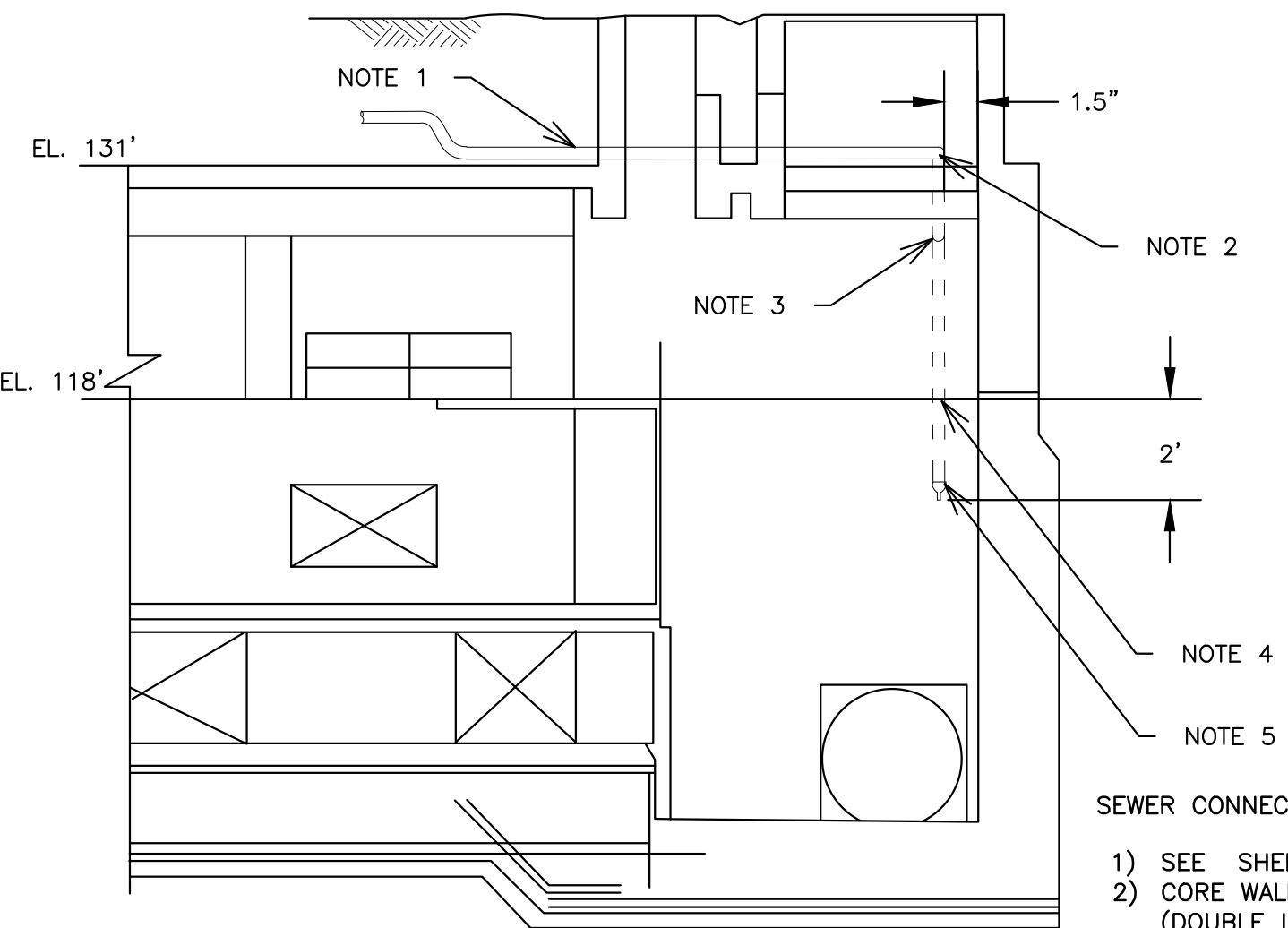
NO SCALE



CONCRETE SIDEWALK DETAIL

NO SCALE

- NOTES:
- EXPANSION JOINTS: 1/2" WIDE x FULL DEPTH, AT 25' INTERVALS TRANSVERSELY, AROUND EMBEDDED ITEMS SUCH AS LIGHT BASES AND AT ABUTTING STRUCTURES SUCH AS BUILDINGS OR CURBS.
 - CONTRACTION JOINTS: 1/4" WIDE x 1" DEEP, ARRANGE TO FORM PANELS 6' MAXIMUM IN EITHER DIRECTION.
 - SAND BASE MATERIAL SHALL MEET THE MICHIGAN DEPARTMENT OF TRANSPORTATION (MDOT) SPECIFICATIONS FOR GRADATION AND OTHER SPECIFIED MATERIAL REQUIREMENTS.
 - SIDEWALK SLOPE SHALL NOT EXCEED A MAXIMUM CROSS SLOPE OF 2.0% AND A MAXIMUM LONGITUDINAL SLOPE OF 5.0%.
 - CONTRACTOR SHALL SUBMIT A JOINTING PLAN FOR GLWA REVIEW.



SEWER CONNECTION AT
ITS JUNCTION CHAMBER

NO SCALE

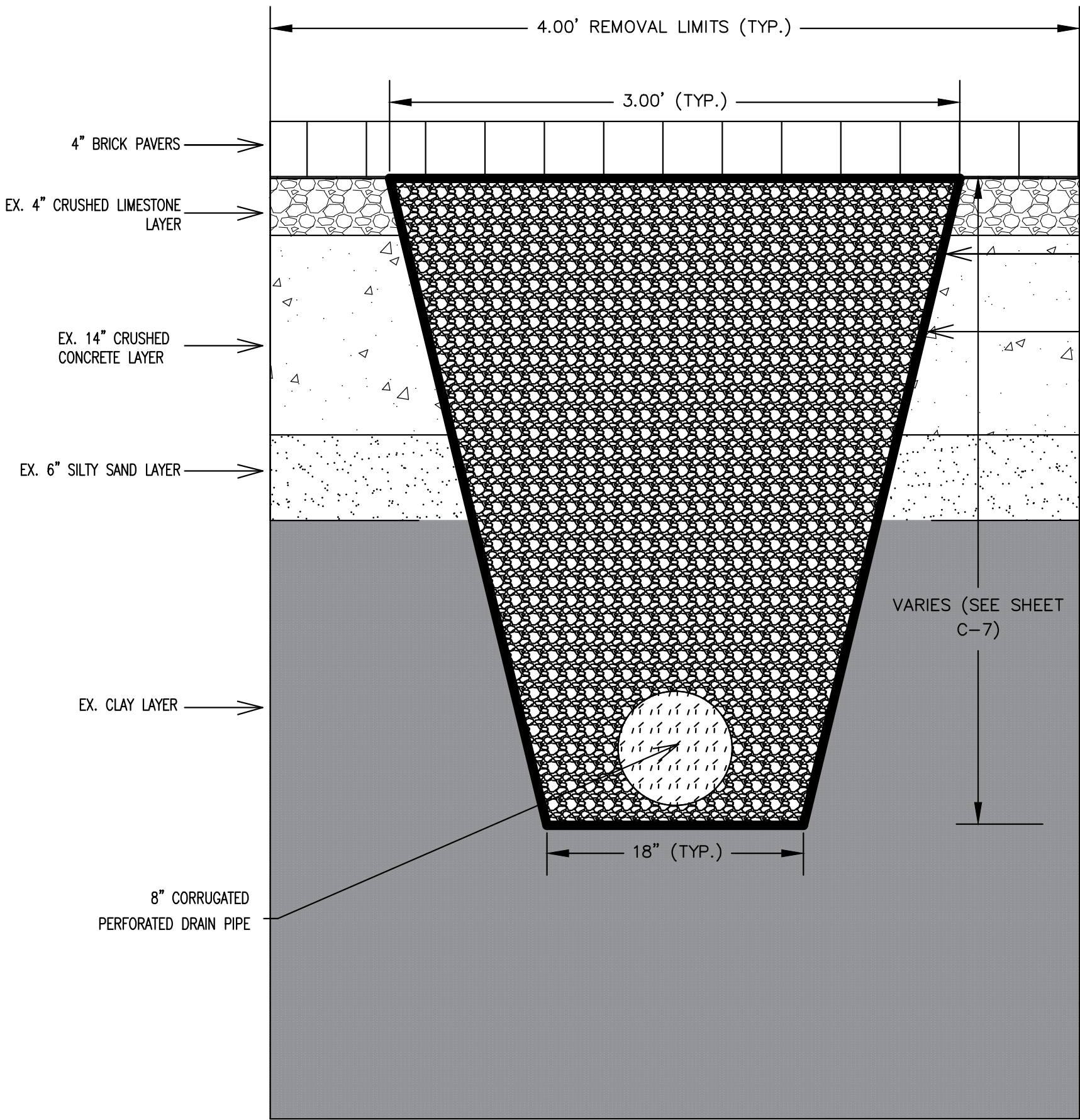
SEWER CONNECTION NOTES:

- SEE SHEET C-7 FOR INVERT ELEVATIONS
- CORE WALL AND SEAL WITH COMPRESSIBLE SEGMENTED LINKS (DOUBLE LINK SEAL) WITH 30455 HARDWARE
- INSTALL HORIZONTALLY ALONG THE WALL AND DOWN IN THE NORTHEAST CORNER OF THE CHAMBER
- CUT GRATING AS NECESSARY FOR PIPE INSTALLATION
- PROVIDE DUCKBILL TYPE CHECK VALVE TIDEFLEX SERIES TF-2 OR EQUAL WITH 304 SS CLAMP AND HARDWARE
- PIPE SHALL BE SCHEDULE 80 PVC AND SHALL BE SECURED TO THE WALL WITH 304 SS HARDWARE



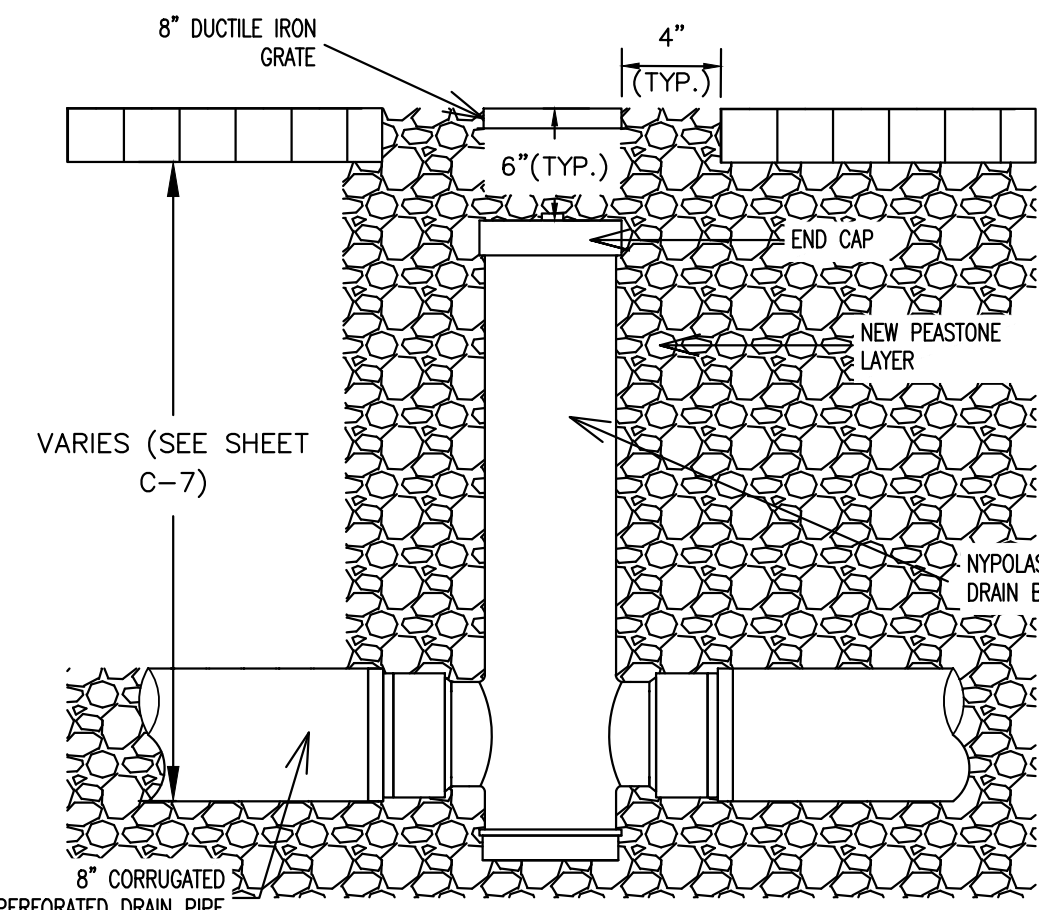
NOTES:

- CONTRACTOR TO INSTALL A SLEEVE FOR ALL EXISTING UTILITIES THAT PENETRATE THROUGH THE CONCRETE



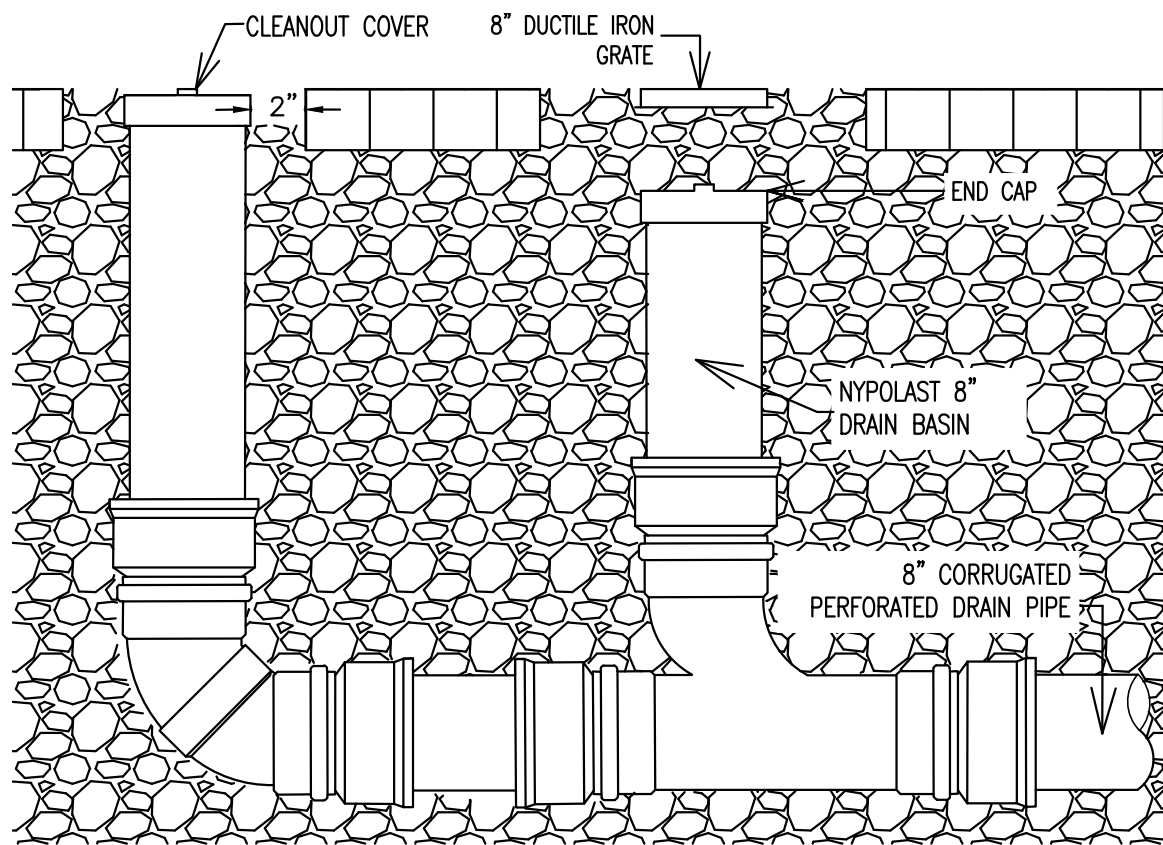
CORRUGATED TRENCH
DRAIN DETAIL

NO SCALE



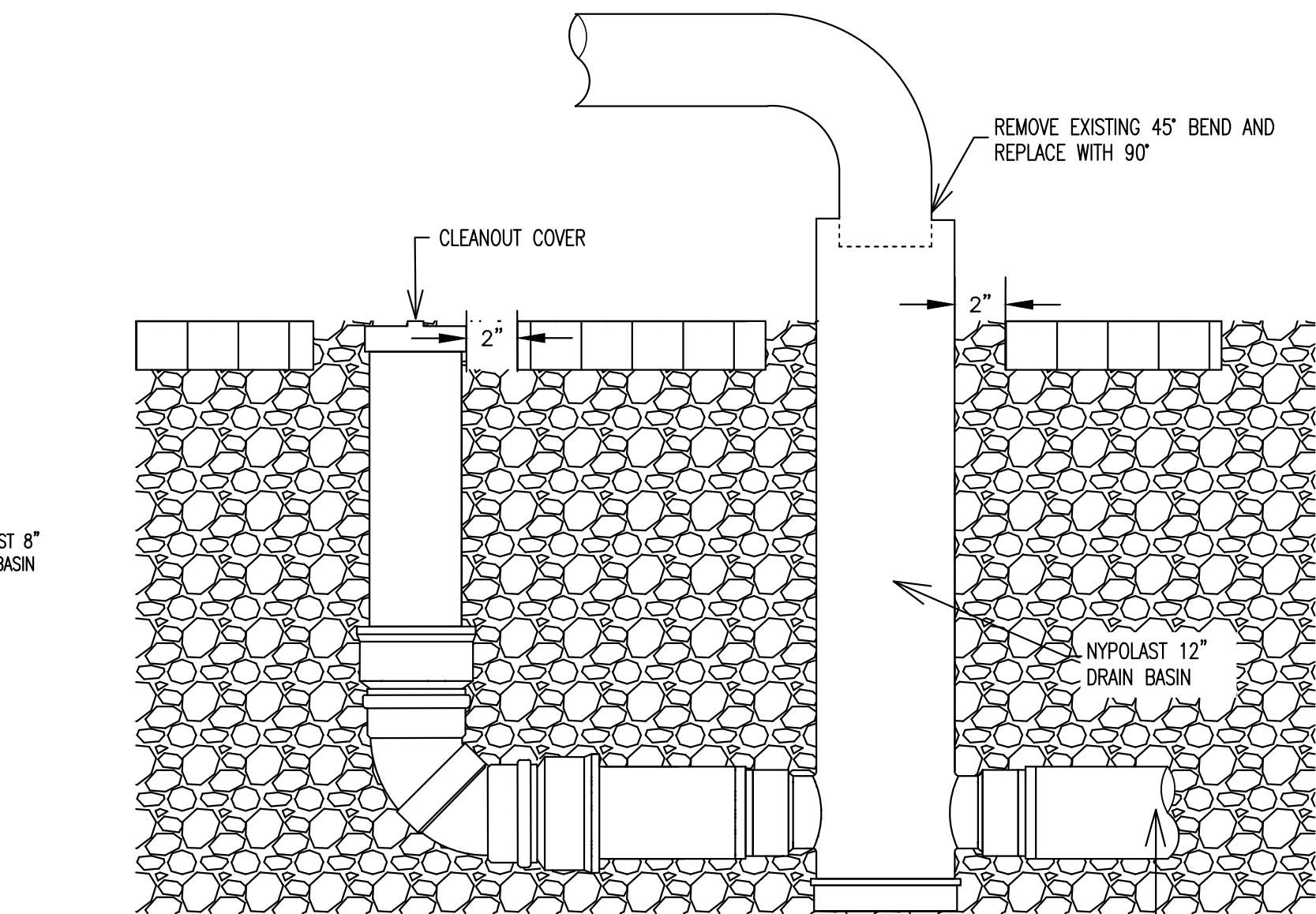
8" NYOPLAST DRAINAGE
CATCH BASIN-2 PIPE DETAIL

NO SCALE



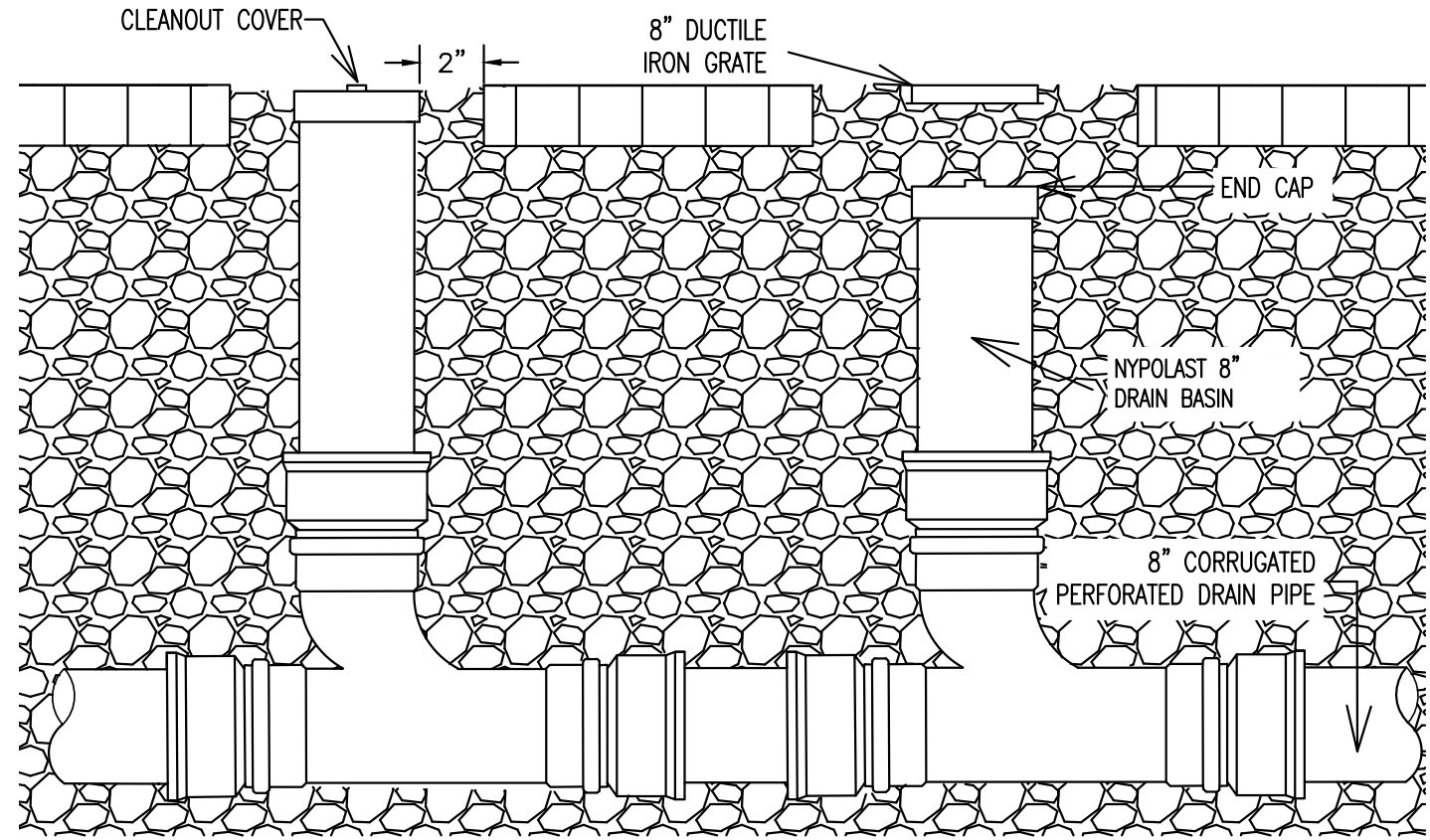
CATCH BASIN WITH
CLEANOUT DETAIL

NO SCALE



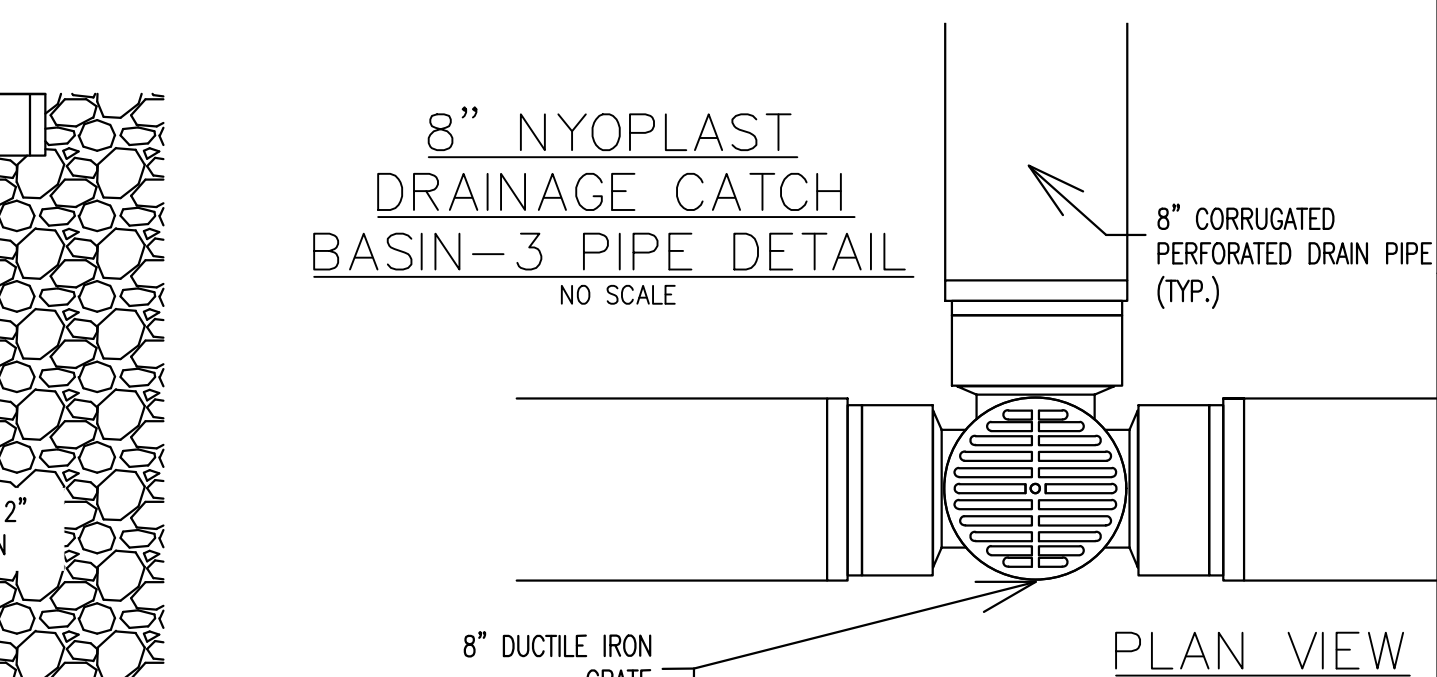
ROOF CONNECTION WITH
CLEANOUT DETAIL

NO SCALE



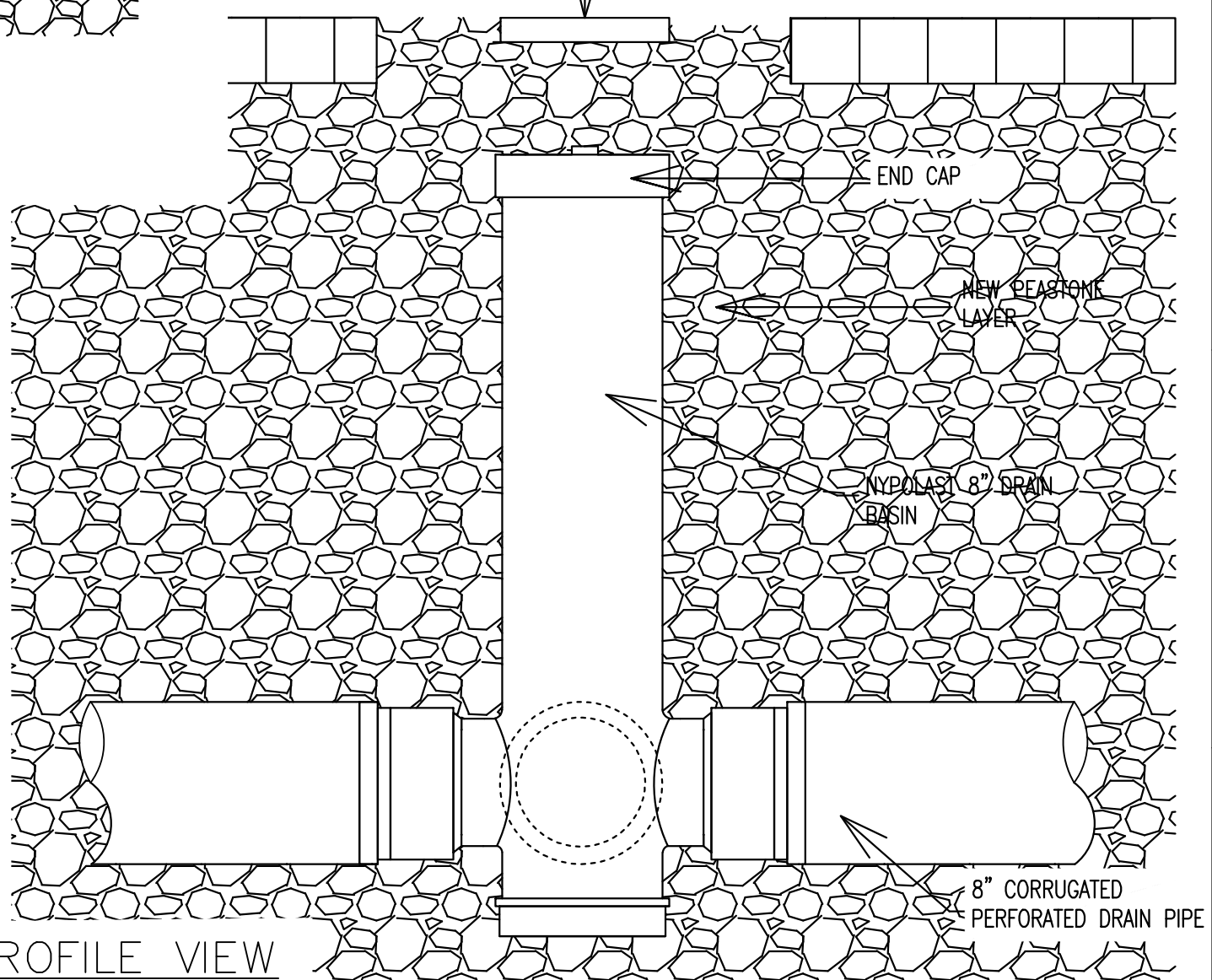
CATCH BASIN WITH CLEANOUT- 2 PIPE DETAIL

NO SCALE



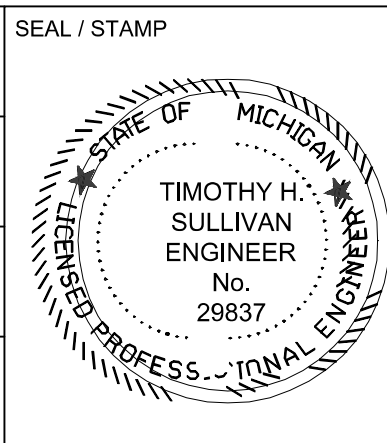
8" NYOPLAST
DRAINAGE CATCH
BASIN-3 PIPE DETAIL

NO SCALE



PROFILE VIEW

F					DESIGNED BY: AKJ
E					DRAWN BY: EJP
D	AS-BUILTS	AJ	APPR	10/15/21	CHECKED BY: THS
C	100% SUBMITTAL	THS	APPR	8/14/19	APPROVED BY: THS
B	90% REVIEW	THS	APPR	7/2/19	
A	50% REVIEW	THS	APPR	5/29/19	
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE	

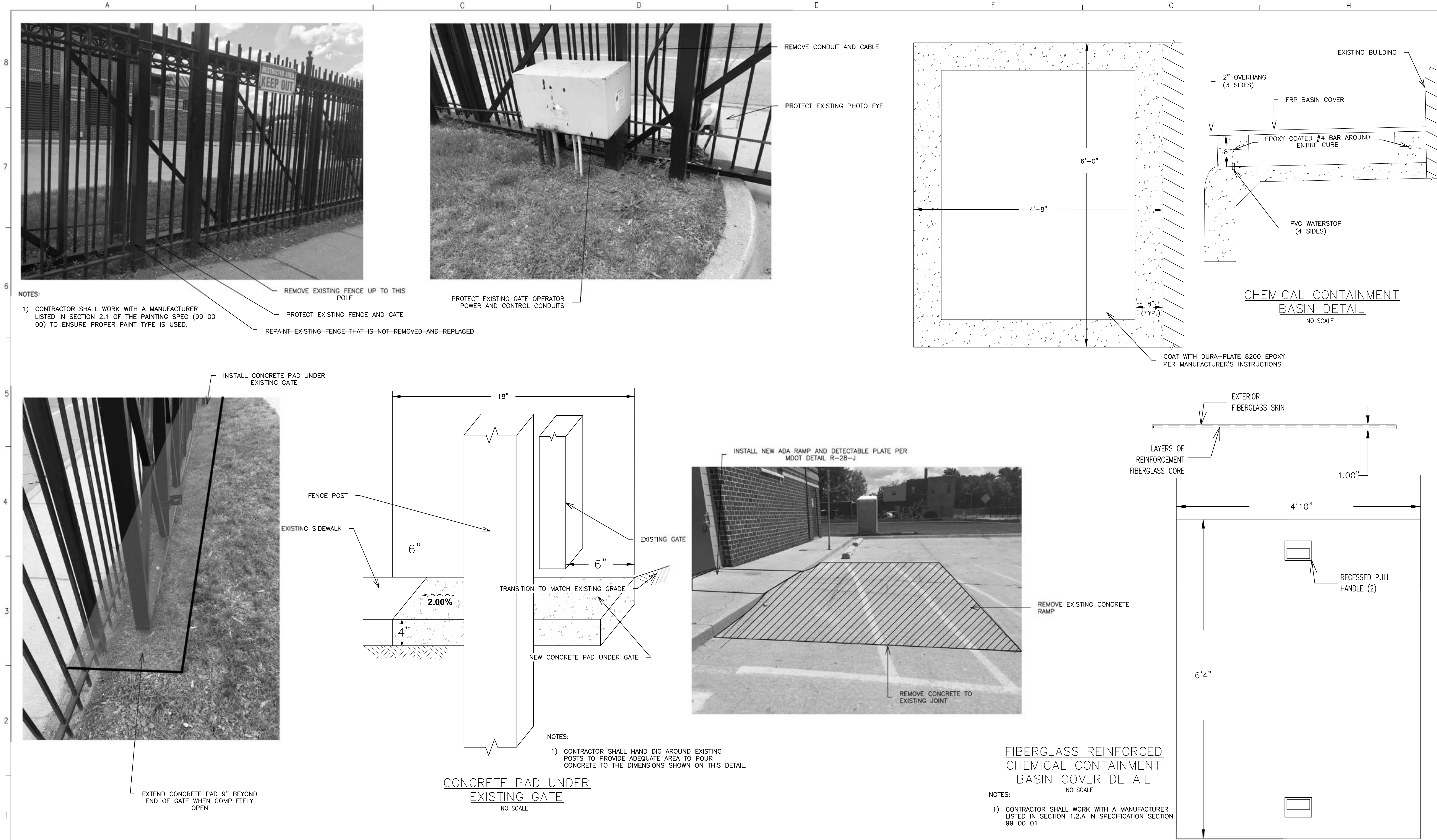


FACILITY	SITE IMPROVEMENTS AT PURITAN-FENKELL AND LEIB FACILITIES
PROJECT TITLE	PROPOSED PROJECT DETAILS - LEIB
SCALE:	AS NOTED
DATE	August, 2019

FIRM NAME	HRC HUBBELL, ROTH & CLARK, INC CONSULTING ENGINEERS SINCE 1915
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SECTION MAP	TOWN	RANGE	STATION	PORTION CODE
- - - -	1 S	10 E	- - - -	- - - -

MDEQ PERMIT No.	N/A
GLWA CONTRACT No.	GLWA-CON-1902040
FILE No.	20181156
DRAWING No.	C-8



E					DESIGNED BY: AKJ	SEAL / STAMP 	FACILITY	SITE IMPROVEMENTS AT PURITAN-FENKELL AND LEIB FACILITIES	FIRM NAME	 HUBBELL, ROTH & CLARK, INC CONSULTING ENGINEERS SINCE 1915	 Great Lakes Water Authority	MDEQ PERMIT No. N/A							
D	AS-BUILTS	AJ	APPR	10/15/21	DRAWN BY: EJP		PROJECT TITLE					GLWA CONTRACT No. GLWA—CON—1902040							
C	100% SUBMITTAL	THS	APPR	8/14/19	CHECKED BY: THS							FILE No. 20181156							
B	90% REVIEW	THS	APPR	7/2/19	APPROVED BY: THS							DRAWING No. C—9							
A	50% REVIEW	THS	APPR	5/29/19															
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE			SCALE: AS NOTED	PROPOSED PROJECT DETAILS - LEIB	DATE August, 2019			SECTION MAP - - - -		TOWN 1 S	RANGE 10 E	STATION - -	PORTION CODE - -		



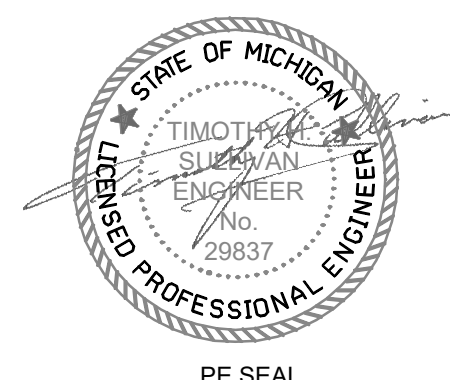
GREAT LAKES WATER AUTHORITY

GLWA CONTRACT NO. 1902040

CIP 260615

SITE IMPROVEMENTS AT PURITAN-FENKELL
CSO DETENTION FACILITY AND
LEIB SCREENING &
DISINFECTION FACILITY

DESIGN CONSULTANT:



GLWA BOARD OF DIRECTORS

Freman Hendrix

Brian Baker

Abe Munfakh, P.E.

Gary A. Brown

Robert J. Daddow

Craig Hupy, P.E.

GLWA STAFF

Sue McCormick

Chief Executive Officer

Navid Mehram, P.E.

Chief Operating Officer, Wastewater

Chris Nastally, P.E.

Manager, CSO Control Program

Philip Kora, P.E.

Manager, CSO Construction Engineering

Dan Alford, P.E.

Director, Engineering

ISSUED FOR BIDS

August 14th, 2019

GENERAL

THIS PROJECT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

THE CONTRACTOR SHALL BE REQUIRED TO NOTIFY THE LOCAL FIRE AND POLICE DEPARTMENTS 24 HOURS IN ADVANCE OF PROPOSED WORK.

THE CONTRACTOR AND/OR HIS SUBCONTRACTOR SHALL NOTIFY "MISS DIG", (1-800-482-7171 OR 811).

CONTRACTOR TO PROTECT EXISTING ABOVE GROUND AND BELOW GROUND FACILITIES INCLUDING: UTILITIES, POLES, TREES, SHRUBS AND OTHER VEGETATION UNLESS NOTED FOR REMOVAL ON THE PLANS; AND SHALL REPAIR OR REPLACE DAMAGED FACILITIES AT NO COST TO THE OWNER. TREES SHALL BE NEATLY TRIMMED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT AND MAINTAIN EXISTING SERVICES TO EXISTING HOMES AND BUSINESSES, INCLUDING SANITARY, WATER, GAS, CABLE AND OTHER UTILITIES.

CONTRACTOR SHALL PROTECT ALL COMMERCIAL AND INDUSTRIAL SITE FEATURES SUCH AS PLANTERS, MAIL BOXES, FENCES, LANDSCAPING, WALLS, WALKS, PORCHES, ETC. AND RESTORE TO ORIGINAL CONDITION IF DAMAGED EXCEPT AS NOTED. NO ADDITIONAL PAYMENT WILL BE ALLOWED FOR THIS WORK.

ALL CONSTRUCTION STAGING AREAS SHALL BE APPROVED BY THE GREAT LAKE WATER AUTHORITY (GLWA) PRIOR TO START OF CONSTRUCTION. ANY AREAS BEYOND CONSTRUCTION LIMITS SECURED BY THE CONTRACTOR FOR USE AS CONSTRUCTION STAGING SHALL BE AT HIS OWN EXPENSE. THE RESTORATION OF ALL STAGING AREAS SHALL BE COMPLETED PRIOR TO FINAL ACCEPTANCE OF THE WORK OF THIS PROJECT. NO ADDITIONAL PAYMENT WILL BE ALLOWED FOR THIS WORK.

THE CONTRACTOR SHALL REMOVE ALL SPRINKLER HEADS, LINES, ETC. THAT ARE WITHIN THE PROPOSED WORK AREA. THIS PIPE AND VALVE WORK SHALL BE CONSIDERED INCIDENTAL TO THE PROJECT.

UNDER CONSTRUCTION

WHEN EXCAVATING FOR CONSTRUCTION, THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT THE EXISTING UTILITIES AND STRUCTURES.

ALL SEWER TRENCHES SHALL BE BACKFILLED OR OTHERWISE PROTECTED OVERNIGHT.

STORM SEWER

SUMP DEPTH IS FROM LOWEST PROPOSED INVERT. CATCH BASIN (CB) MEANS 2 FT SUMP INCLUDED IN DRAINAGE STRUCTURE PAY ITEM. INLETS (INL) DO NOT HAVE SUMPS.

MAINTAINING TRAFFIC

CONTRACTOR SHALL MAINTAIN SAFE, DUST FREE CONDITIONS ON EXISTING STREETS WHICH SHALL REQUIRE DAILY REMOVAL OF EARTH TRACKED OR SPILLED ON ROAD SURFACE, AND OTHER DUST CONTROL MEASURES AS REQUIRED BY THE PROJECT ENGINEER. EXCESSIVE DUST WILL NOT BE TOLERATED AT ANY TIME DURING CONSTRUCTION. PAYMENT FOR DUST CONTROL SHALL BE INCLUDED IN THE COST OF THE PROJECT.

EARTHWORK AND GRADING

ONSITE FILL MATERIAL CAN BE USED IF THE SPECIFIED COMPACTION REQUIREMENTS CAN BE ACHIEVED. IF ON SITE MATERIAL IS USED, IT SHALL BE CLEAN AND FREE OF FROZEN SOIL, ORGANICS, SOFT, OR OTHER DELETERIOUS MATERIALS.

A 6" TOPSOIL LAYER MUST BE MAINTAINED WHERE ALL PROPOSED RE-GRADING WORK IS LOCATED.

SEE SHEET C-2 AND C-6 FOR SOIL EROSION AND SEDIMENTATION CONTROL INFORMATION.

UTILITIES

THE EXISTING UTILITIES LISTED BELOW AND SHOWN ON THESE PLANS REPRESENT THE BEST INFORMATION AVAILABLE AS OBTAINED FROM SURVEYS AND FROM UTILITY RECORD MAPS. THIS INFORMATION DOES NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY TO NOTIFY THE PROPER UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR IS RESPONSIBLE TO VERIFY ALL EXISTING UTILITIES AND THEIR LOCATIONS AS PART OF THE CONSTRUCTION OF THIS PROJECT. ANY OMISSION OR VARIATION FROM THE LOCATIONS SHOWN, PURSUANT TO ACT 53 OF THE PA OF 1974 AS A CONDITION OF THIS CONTRACT NOTICE SHALL BE GIVEN TO MISS DIG PRIOR TO UNDERGROUND WORK TO BE PERFORMED. THE CONTRACTOR IS RESPONSIBLE TO LOCATE ALL EXISTING UTILITIES AND FIELD VERIFY BOTH LOCATIONS AND DEPTHS PRIOR TO ANY PROPOSED WORK BEING PERFORMED.

THE FOLLOWING UTILITY COMPANIES HAVE FACILITIES WITHIN THE PROJECT LIMITS:

DTE GAS
DTE ELECTRIC
DETROIT WATER AND SEWER DEPARTMENT

THE CONTRACTOR SHALL, BEFORE EACH DAYS WORK, OR WHEN MOVING TO A NEW AREA OF WORK, DETERMINE AND EVALUATE THE LOCATION OF ALL UNDERGROUND FACILITIES IN THE AREA. IF LOCATION STAKES HAVE BEEN MOVED OR DO NOT APPEAR CORRECT, THE CONTRACTOR SHALL NOT EXCAVATE UNTIL ALL UTILITIES HAVE HAD AN OPPORTUNITY TO CHECK OR RESTAKE THEIR LOCATIONS. ANY DELAYS INCURRED DUE TO CHECKING OR RESTAKING OF UTILITIES SHALL NOT BE A BASIS FOR ADDITIONAL COMPENSATION.

ALL UTILITIES SHALL BE PROTECTED DURING THE DURATION OF THE PROJECT.

PRIOR TO WORK ON FACILITIES BELONGING TO THE ABOVE AGENCIES, A MINIMUM OF 72 HOURS NOTICE MUST BE GIVEN IN ORDER TO INSURE PROPER INSPECTION BY THE RESPECTIVE AGENCIES.

THE CONTRACTOR SHALL LOCATE ALL ACTIVE UNDERGROUND UTILITIES PRIOR TO STARTING WORK, AND SHALL CONDUCT HIS OPERATIONS IN SUCH A MANNER AS TO INSURE THAT THOSE UTILITIES NOT REQUIRING RELOCATION WILL NOT BE DISTURBED.

FOR PROTECTION OF UNDERGROUND UTILITIES, THE CONTRACTOR SHALL DIAL (800) 482-7171, OR 811 A MINIMUM OF 3 FULL WORKING DAYS, EXCLUDING SATURDAY, SUNDAY AND HOLIDAYS, PRIOR TO EXCAVATING IN THE VICINITY OF UTILITY LINES. ALL "MISS DIG" PARTICIPATING MEMBERS WILL THUS BE ROUTINELY NOTIFIED. THIS DOES NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY OF NOTIFYING UTILITY OWNERS WHO MAY NOT BE A PART OF THE "MISS DIG" ALERT SYSTEM.

RESTORATION

RESTORE AND STABILIZE ALL SLOPES IN ACCORDANCE WITH THE PLANS AND AS DESCRIBED IN THE CONTRACT DOCUMENTS.

ALL FINAL GRADES SHALL SLOPE TO DRAIN TOWARD CATCH BASINS, DITCHES, SWALES, CURBS, AND DRAINAGEWAYS UNLESS OTHERWISE NOTED.

THE CONTRACTOR SHALL NOT PERFORM ANY SIDE WORK CONTRACTED PRIVATELY WITHIN THE CONSTRUCTION AREA.

LIST OF DRAWINGS

GENERAL-PURITAN-FENKELL

COVER SHEET
G-1 DRAWING INDEX, SITE LOCATION MAPS, NOTES & LEGEND

CIVIL-PURITAN-FENKELL

C-1 EXISTING SITE PLAN
C-2 SOIL EROSION AND SEDIMENTATION CONTROL AND DEMOLITION PLAN
C-3 PROPOSED SITE PLAN
C-4 GRADING SECTIONS
C-5 PROPOSED PROJECT DETAILS-PF

ELECTRICAL-PURITAN-FENKELL

E-1 PROPOSED ELECTRICAL SITE PLAN
E-2 PROPOSED ELECTRICAL NOTES AND DETAILS

CIVIL-LEIB

C-6 SOIL EROSION AND SEDIMENTATION CONTROL AND DEMOLITION PLAN
C-7 PROPOSED SITE PLAN
C-8 PROPOSED PROJECT DETAILS 1- LEIB
C-9 PROPOSED PROJECT DETAILS 2- LEIB

ALTA/NSPS LAND TITLE SURVEY-PURITAN-FENKELL

1-PF COVER
2-PF TOPOGRAPHIC SURVEY
3-PF ALTA SURVEY
4-PF PERMANENT CSO EASEMENT LOCATION

ALTA/NSPS LAND TITLE SURVEY-LEIB

1-Leib COVER
2-Leib TOPOGRAPHIC SURVEY
3-Leib ALTA SURVEY

REFERENCE DRAWINGS

R-1 PURITAN-FENKELL INSTRUMENTATION IMPROVEMENTS

ABBREVIATIONS

GENERAL

E/M EDGE OF METAL
EX./EXIST. EXISTING
P.O.B. POINT OF BEGINNING
H.C.P. HORIZONTAL CONTROL POINT
B.M. BENCH MARK
STM. STORM SEWER
SA. SANITARY SEWER
CS. COMBINED SEWER
W.M. WATER MAIN
R.O.W. RIGHT-OF-WAY
T/C TOP OF CURB
RIM TOP OF DRAINAGE STRUCTURE COVER
S.S.L. SLOPE STAKE LINE
C.I.P. COMPACTED IN PLACE
C.S.B. COMPLETE SAND BACKFILL
SME SOILS MATERIALS ENGINEERS (PAVEMENT CORES)
GLWA GREAT LAKES WATER AUTHORITY (OWNER)

ITEM

ASPHALT
CONCRETE SIDEWALK
BRICK PAVERS
STAGING AREA
BUILDING
FLOODWAY
STORM SEWER > 15"
STORM SEWER < 15"
SANITARY SEWER
WATER MAIN
GAS MAIN
U.G. TELEPHONE
U.G. ELECTRIC
U.G. CABLE TV
FENCE
SILT FENCE
GRADE
REMOVE FENCE
TRAVERSE LINE & TRAVERSE POINT
BENCH MARK SYMBOL
DECIDUOUS TREE
DECIDUOUS SHRUB
CONIFEROUS TREE
CONIFEROUS SHRUB
SQUARE/ROUND CATCHBASINS & INLETS IN PAVEMENT
STORM MANHOLE & PIPE END
RISER & DOWN SPOUT
DRAIN CLEANOUT
FIRE HYDRANT
GATE VALVE, GATE WELL & WELL
WATER STOP BOX & SPRINKLER HEAD
METER PIT
UTILITY POLE
LIGHT POLE
GUY WIRE ANCHOR
UNDERGROUND MARKER
GAS VALVE / PIPE END
GAS BOX & BLOW OFF
SOIL BORING/PAVEMENT CORE
DRAINAGE FLOW
RIGHT-OF-WAY
PROPERTY LINE
SLOPE STAKE LINE
SWALE/DITCH
MANHOLE, CATCH BASIN, INLET, & END SECTION SYMBOLS
ABANDON & REMOVAL SYMBOLS
ADJUSTMENT
RELOCATE
RELOCATE BY OTHERS

LEGEND

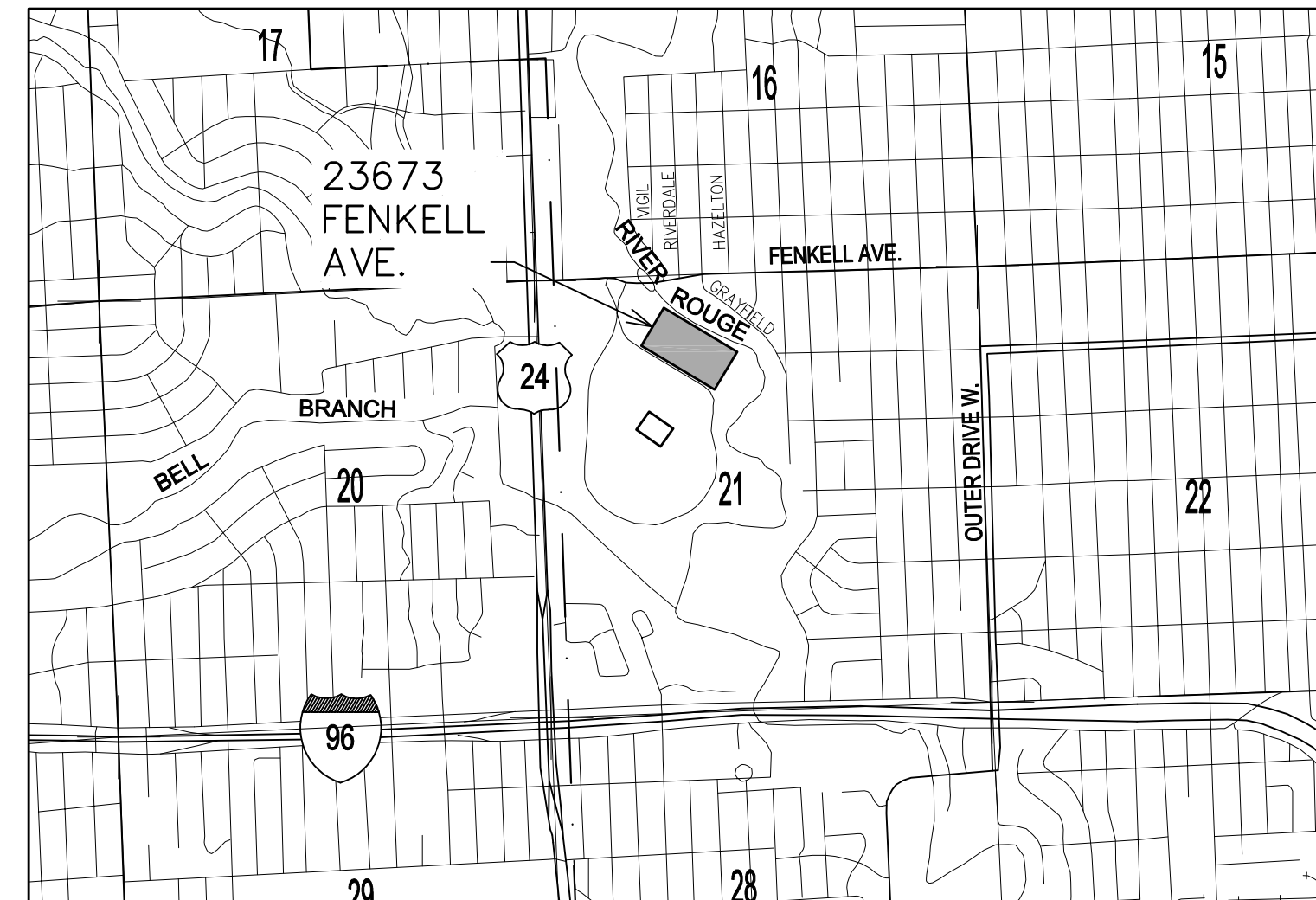
EXISTING

SYMBOL

PROPOSED



SITE LOCATION MAP- LEIB



SITE LOCATION MAP- PURITAN-FENKELL

F					DESIGNED BY: AKJ		FACILITY SITE IMPROVEMENTS AT PURITAN-FENKELL AND LEIB FACILITIES PROJECT TITLE DRAWING INDEX, SITE LOCATION MAPS, NOTES & LEGEND SCALE: AS NOTED DATE August, 2019	FIRM NAME 		MDEQ PERMIT No. N/A GLWA CONTRACT No. GLWA-CO-1902040 FILE No. 20181156 DRAWING No. G-1
E					DRAWN BY: EJP					
D					CHECKED BY: THS					
C	100% SUBMITTAL	THS	APPR	8/14/19	APPROVED BY: THS					
B	90% REVIEW	THS	APPR	7/2/19						
A	50% REVIEW	THS	APPR	5/29/19						
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE						

LEIB CSO Facility

ALTA/NSPS Land Title & Topographic Survey

2188 Mt. Elliott

Detroit, MI 48207



Orientation	Scale
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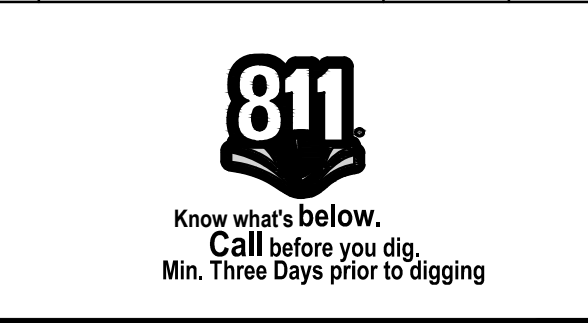
Project
LEIB CSO SITE

Project Location
2188 MT. ELLIOTT DETROIT, MI 48207

Sheet Name
COVER SHEET

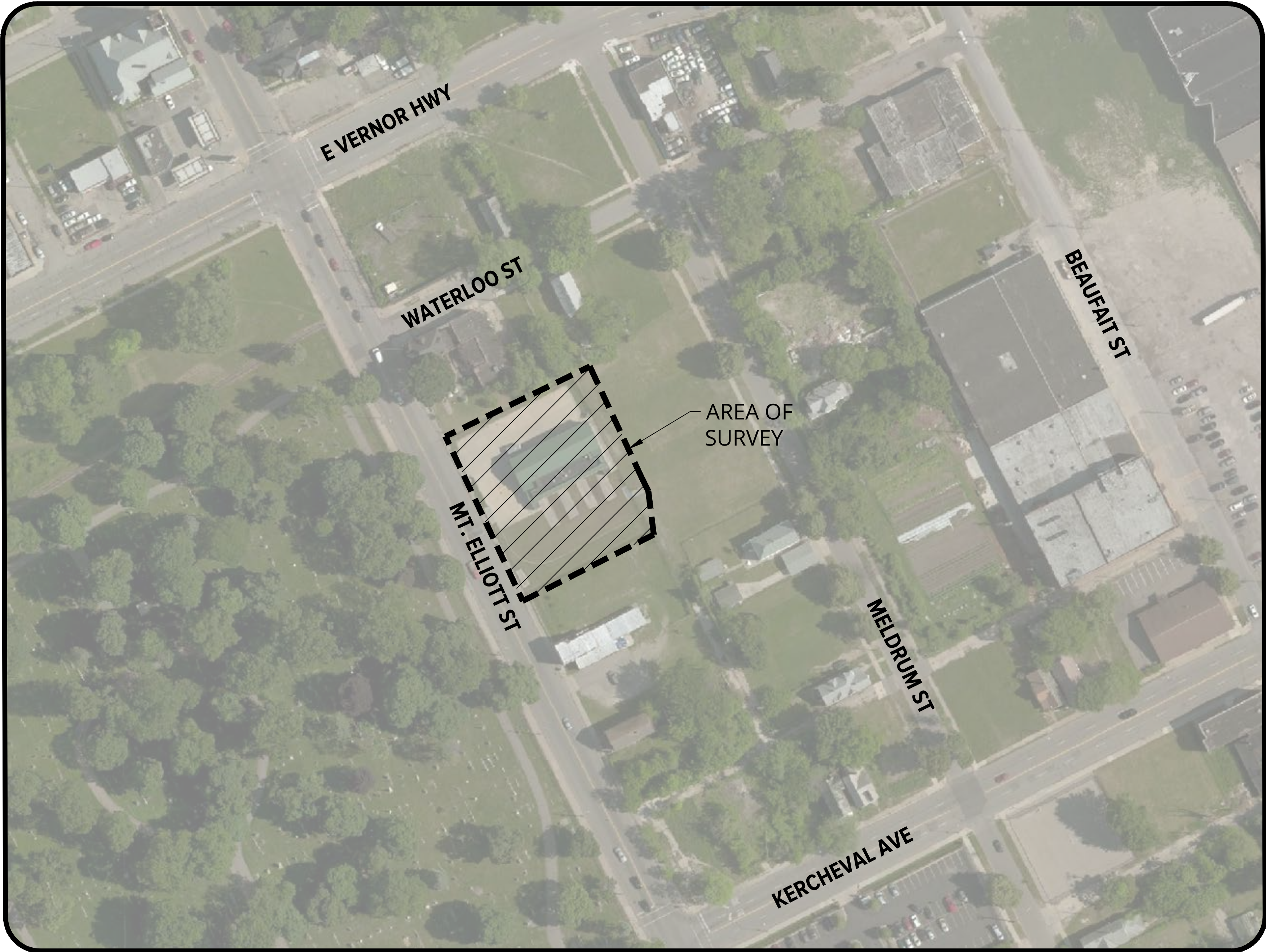


Revisions			
REV	ISSUED FOR	DATE	BY



Date	01/25/2019
SME Project No.	080672.00
Project Manager:	KMA
Technician:	ZM/MG
CADD:	SRP
Checked By:	FZ
Sheet No.	1-LEIB

WARNING!!
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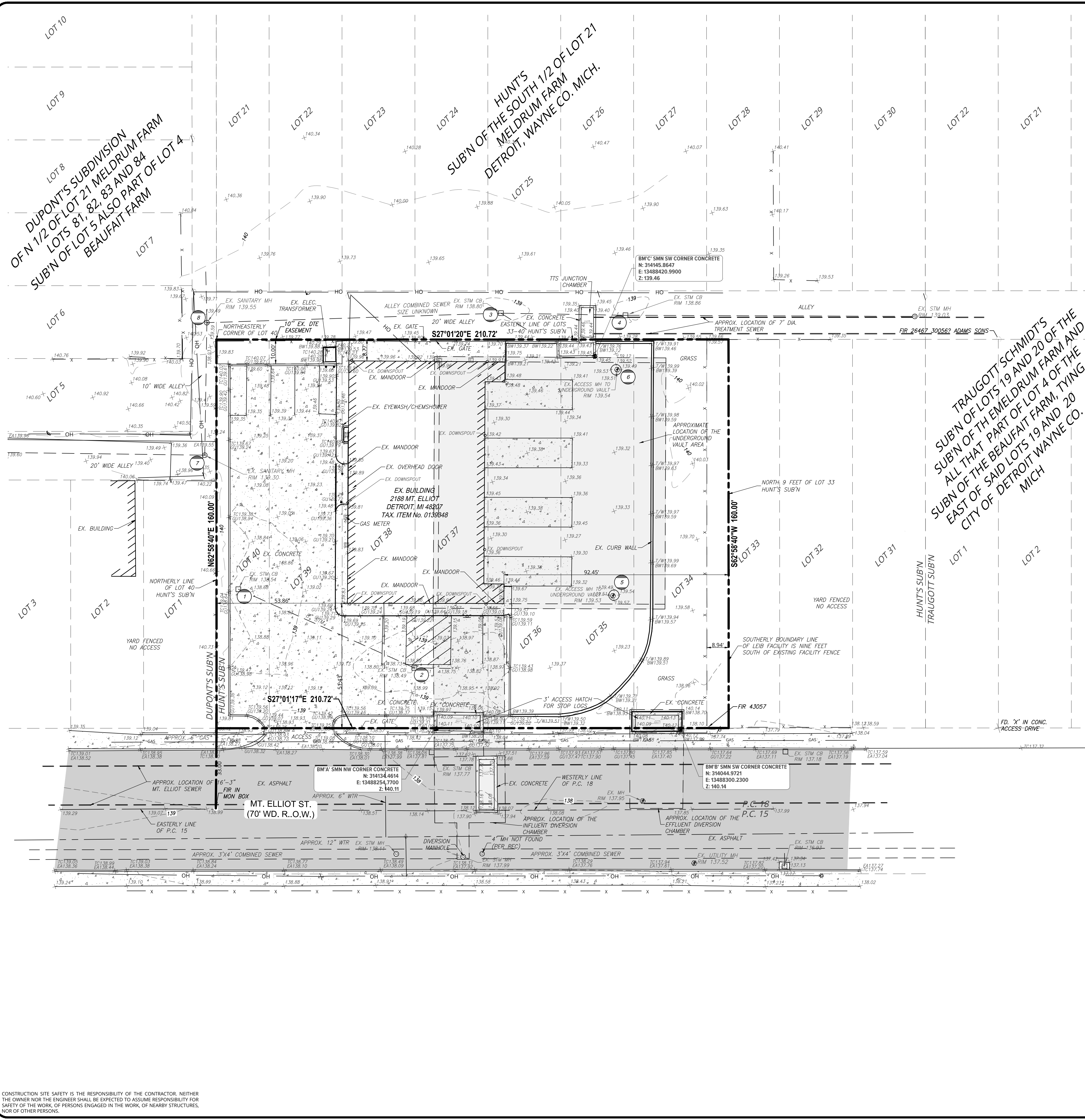


OVERALL SITE MAP
NOT TO SCALE



COUNTY MAP
NOT TO SCALE

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BENCHMARK DATA

BM A
SMN SW CORNER OF CONCRETE
ELEVATION = 140.11

BM B
SMN SW CORNER OF CONCRETE
ELEVATION = 140.14

BM C
SMN SW CORNER OF CONCRETE
ELEVATION = 139.46

NOTE:
VERTICAL DATUM REFERENCED TO THE HISTORICAL CITY OF DETROIT VERTICAL CONTROL DATUM FOR PRECISE BENCH MARKS - CITY ENGINEERING DEPARTMENT. THE CONVERSIONS FACTOR OF 479.25 FEET IS ADDED TO THE HISTORICAL CITY VERTICAL DATUM TO DEFINE THE NAVD88 VERTICAL DATUM.

SOIL TYPES ON SITE

BrmubB - Brems-Urban land complex, dense substratum, 0 to 4 percent slopes

(SOIL INFORMATION TAKEN FROM THE UNITED STATES DEPARTMENT OF AGRICULTURE SOIL SURVEY)

FLOODPLAIN NOTE

THE SUBJECT SITE IS WITHIN ZONE "X" PER THE FEMA FIRM MAP OF CITY OF DETROIT, WAYNE COUNTY MICHIGAN, PANEL NUMBER 0285E, MAP NO. 26163C0285E, EFFECTIVE DATE: FEBRUARY 2, 2012.

LEGAL DESCRIPTION

LAND SITUATED IN THE CITY OF DETROIT, COUNTY OF WAYNE, STATE OF MICHIGAN:

THE NORTH 9 FEET OF LOT 33 AND ALL OF LOTS 34 THROUGH 40, HUNTS SUBDIVISION, ACCORDING TO THE RECORDED PLAT THEREOF, AS RECORDED IN LIBER 14, PAGE 92 OF PLATS, WAYNE COUNTY RECORDS.

COMMONLY KNOWN AS: 2198 MT. ELLIOTT, DETROIT, MI 48207

PARCEL ID NUMBER: WARD 15, TAX ITEM NO. 0139348

SURVEYORS NOTES:

- THE BEARING BASIS FOR THE SITE IS NAD83 MICHIGAN STATE PLANE, SOUTH ZONE, INTERNATIONAL FEET.
- DATE OF SURVEY: JANUARY 22, AND 23 2019.
- SOME FEATURES SHOWN ON SURVEY MAY BE OUT OF SCALE FOR CLARITY.
- DIMENSIONS ON THIS SURVEY ARE EXPRESSED IN FEET AND DECIMAL PARTS THEREOF UNLESS OTHERWISE NOTED.
- ACTUAL PROPERTY ACREAGE EQUALS 0.77 ACRES.
- THE LOCATION OF THE EXISTING UTILITIES AS SHOWN WERE OBTAINED FROM MUNICIPAL AND UTILITY COMPANIES RECORDS. NO GUARANTEE CAN BE MADE REGARDING THE COMPLETENESS OR EXACTNESS OF THE UTILITIES LOCATION. IT IS THE CONTRACTORS RESPONSIBILITY TO VERIFY IN THE FIELD THE LOCATION OF ALL UTILITIES.
- STRUCTURES HAVE BEEN LOCATED WITHIN THE ALLEY THAT FALL OUTSIDE OF THE LOCATION SHOWN ON THE PLAN.



- EXISTING LEGEND**
- CONTOUR
 - INDEX CONTOUR
 - WATER MAIN
 - STORM SEWER
 - SANITARY SEWER
 - CABLETV
 - OVERHEAD UTILITY
 - FIBER OPTIC
 - GAS
 - ELECTRICAL
 - FENCE
 - HYDRANT
 - GATE VALVE
 - POST INDICATOR VALVE (PIV)
 - WATER MAIN MANHOLE
 - SQUARE CATCH BASIN
 - ROUND CATCH BASIN
 - BEEHIVE CATCH BASIN
 - SANITARY MANHOLE
 - END SECTION
 - CULVERT
 - STORM MANHOLE
 - CLEAN OUT
 - SIGN
 - UTILITY POLE
 - RISER
 - LIGHT POLE
 - LANDSCAPE LIGHT
 - SPRINKLER
 - ELECTRICAL BOX
 - ELECTRICAL MANHOLE
 - FLAG POLE
 - MAILBOX
 - TOP OF CURB
 - GUTTER
 - EX. GRADE
 - TOP OF ASPHALT
 - TOP OF WALL
 - BOTTOM OF WALL
 - TREE
 - CONCRETE
 - ASPHALT PAVEMENT
 - UNDERGROUND VAULT OR CHAMBER
 - UTILITY STRUCTURE LABEL

UTILITY STRUCTURE TABLE				
I.D.	RIM	SIZE	TYPE	INVERT DATA
1	138.54	4'	CATCH BASIN	FILLED WITH WATER AT DEBRIS TOP OF WATER = 133.16 APPROX. SUMP = 130.91
2	138.49	4'	CATCH BASIN	FILLED WITH WATER AND DEBRIS TOP OF WATER = 131.96 TOP OF DEBRIS = 130.34 APPROX. SUMP = 129.96 VERTICAL ANGLED 8" PVC TOP OF PIPE AT WALL = 131.17 SE TOP OF PIPE AT END = 131.80 SE
3	138.80	4'	CATCH BASIN	FILLED WITH WATER AND DEBRIS TOP OF WATER = 124.64 TOP OF DEBRIS = 123.05 APPROX. SUMP = 123.05 VERTICAL ANGLED 8" PVC TOP OF PIPE AT WALL = 124.66 SW TOP OF PIPE AT END = 124.84 SW 6" HDP 128.67 NW 6" HDP SE - NO INVERT
4	138.86	4'	CATCH BASIN	FILLED WITH WATER AND DEBRIS TOP OF WATER = 133.48 TOP OF DEBRIS = 132.22 6" HDP INV. 137.70 NW 6" HDP INV. 137.67 SE
5	139.53	4'	ACCESS MANHOLE TO UNDERGROUND VAULT	FLOOR 117.85
6	139.54	4'	ACCESS MANHOLE TO UNDERGROUND VAULT	FLOOR 117.95
7	139.30	4'	MANHOLE	12" INV. 125.63 NW 10" INV. 125.89 NE
8	139.55	4'	MANHOLE	10" INV. 126.17 SW 10" INV. 125.94 NE 12" INV. 126.36 SE

WARNING!!

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www.sme-usa.com

Orientation

Scale

0' 20' 40'

GRAPHIC SCALE: 1" = 20'

Project

LEIB CSO SITE

Project Location

**2188 MT. ELLIOTT
DETROIT, MI 48207**

Sheet Name

TOPOGRAPHIC SURVEY

Surveyor's Seal

Revisions

REV	ISSUED FOR	DATE	BY

811

Know what's below.
Call before you dig.
Min. Three Days prior to digging

Date

01/25/2019

SME Project No.

080672.00

Project Manager:

KMA

Technician:

ZM/MG

CADD:

SRP

Checked By:

FZ

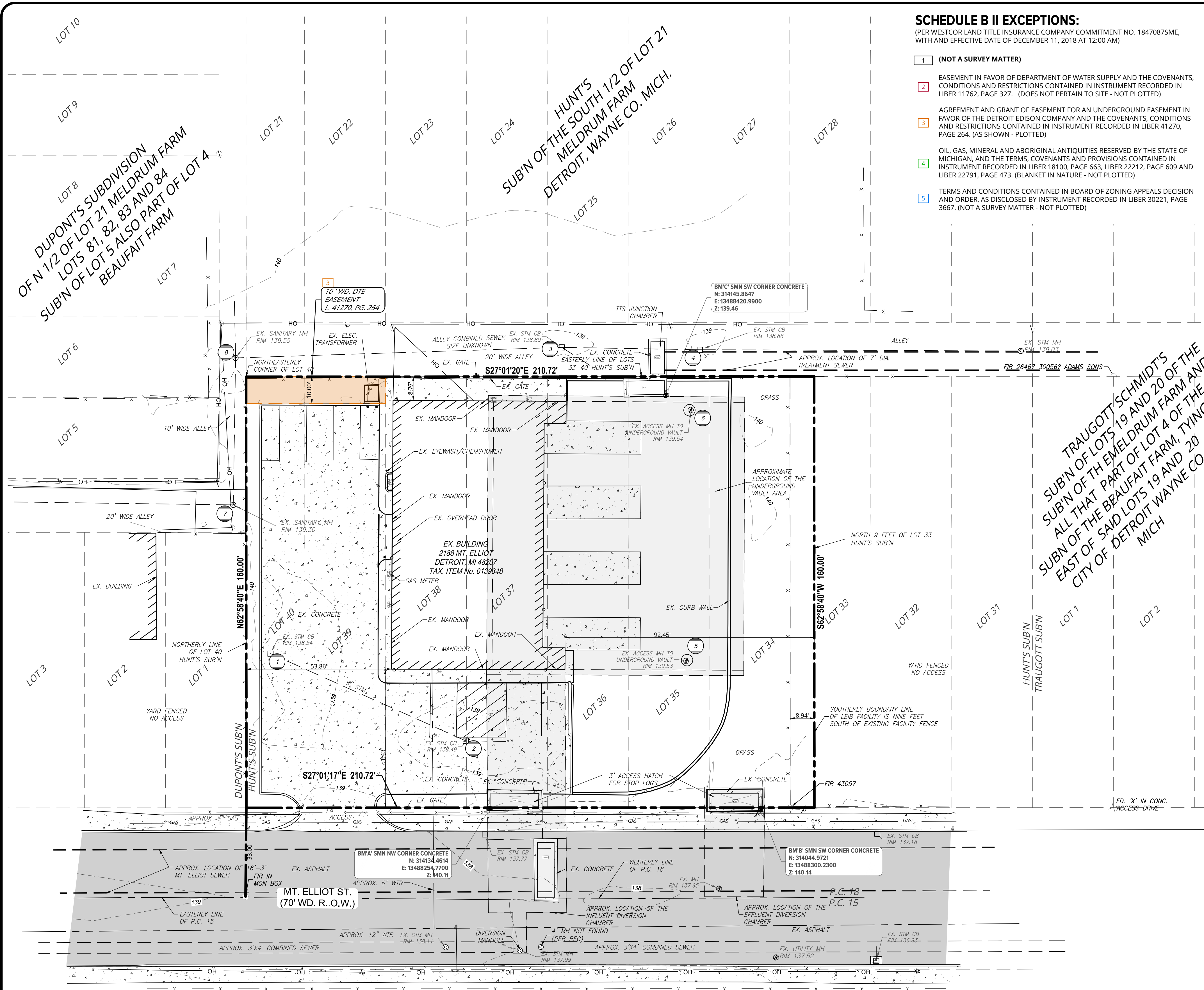
Sheet No.

2-LEIB

DRAWING NOTE: SCALE DELETED: IS MEANT FOR 24" X 36" AND WILL SCALE INCORRECTLY IF PRINTED ON ANY OTHER SIZE MEDIA.
NO REPRODUCTION SHALL BE MADE WITHOUT THE PRIOR CONSENT OF SME
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FILE LOCATION: I:\me-inc\p\WP080672.00\CAD\DWG\SURVEY\WP080672.00-AL TA-Topo.dwg
Jun 26, 2019 - 10:51am - tabcon
PLOT DATE:



SCHEDULE B II EXCEPTIONS:

(PER WESTCOR LAND TITLE INSURANCE COMPANY COMMITMENT NO. 18470875ME, WITH AND EFFECTIVE DATE OF DECEMBER 11, 2018 AT 12:00 AM)

- 1 (NOT A SURVEY MATTER)
- 2 EASEMENT IN FAVOR OF DEPARTMENT OF WATER SUPPLY AND THE COVENANTS, CONDITIONS AND RESTRICTIONS CONTAINED IN INSTRUMENT RECORDED IN LIBER 11762, PAGE 327. (DOES NOT PERTAIN TO SITE - NOT PLOTTED)
- 3 AGREEMENT AND GRANT OF EASEMENT FOR AN UNDERGROUND EASEMENT IN FAVOR OF THE DETROIT EDISON COMPANY AND THE COVENANTS, CONDITIONS AND RESTRICTIONS CONTAINED IN INSTRUMENT RECORDED IN LIBER 41270, PAGE 264. (AS SHOWN - PLOTTED)
- 4 OIL, GAS, MINERAL AND ABORIGINAL ANTIQUITIES RESERVED BY THE STATE OF MICHIGAN, AND THE TERMS, COVENANTS AND PROVISIONS CONTAINED IN INSTRUMENT RECORDED IN LIBER 18100, PAGE 663, LIBER 22212, PAGE 609 AND LIBER 22791, PAGE 473. (BLANKET IN NATURE - NOT PLOTTED)
- 5 TERMS AND CONDITIONS CONTAINED IN BOARD OF ZONING APPEALS DECISION AND ORDER, AS DISCLOSED BY INSTRUMENT RECORDED IN LIBER 30221, PAGE 3667. (NOT A SURVEY MATTER - NOT PLOTTED)

BENCHMARK DATA

BM A
SMN SW CORNER OF CONCRETE
ELEVATION = 140.11

BM B
SMN SW CORNER OF CONCRETE
ELEVATION = 140.14

BM C
SMN SW CORNER OF CONCRETE
ELEVATION = 139.46

NOTE:
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(SOIL INFORMATION TAKEN FROM THE UNITED STATES DEPARTMENT OF AGRICULTURE SOIL SURVEY)

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PARCEL ID NUMBER: WARD 15, TAX ITEM NO. 0139348

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LOCATION MAP
NOT TO SCALE

EXISTING LEGEND

- CONTOUR
- INDEX CONTOUR
- WATER MAIN
- STORM SEWER
- SANITARY SEWER
- CABLETV
- OVERHEAD UTILITY
- FIBER OPTIC
- GAS
- ELECTRICAL
- FENCE
- HYDRANT
- GATE VALVE
- POST INDICATOR VALVE (PIV)
- WATER MAIN MANHOLE
- SQUARE CATCH BASIN
- ROUND CATCH BASIN
- BEEHIVE CATCH BASIN
- SANITARY MANHOLE
- END SECTION
- CULVERT
- STORM MANHOLE
- CLEAN OUT
- SIGN
- UTILITY POLE
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- ELECTRICAL BOX
- ELECTRICAL MANHOLE
- FLAG POLE
- MAILBOX
- TOP OF CURB
- GUTTER
- EX. GRADE
- TOP OF ASPHALT
- TOP OF WALL
- BOTTOM OF WALL
- TREE
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8	139.55	4'	MANHOLE	10" INV. 126.17 SW 10" INV. 125.94 NE 12" INV. 126.36 SE

SURVEYORS CERTIFICATE:

THIS IS TO CERTIFY THAT THIS MAP OR PLAT AND THE SURVEY ON WHICH IT IS BASED WERE MADE IN ACCORDANCE WITH THE 2016 MINIMUM STANDARD DETAIL REQUIREMENTS FOR ALTA/NSPS LAND TITLE SURVEYS, JOINTLY ESTABLISHED AND ADOPTED BY ALTA AND NSPS. THE FIELDWORK AS COMPLETED IN JANUARY OF 2019.

Fredd Ziobron

FREDD ZIOBRON, PS
PROFESSIONAL SURVEYOR NO. 49352
ZIOBRON@SME-USA.COM

Dated: 01/25/2019

WARNING!!

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Orientation
Scale
0' 20' 40'
GRAPHIC SCALE: 1" = 20'

Project

LEIB CSO SITE

Project Location

2188 MT. ELLIOTT
DETROIT, MI 48207

Sheet Name

ALTA/NSPS LAND TITLE
SURVEY

Surveyor's Seal

Revisions

REV	ISSUED FOR	DATE	BY



Date

01/25/2019

SME Project No.

080672.00

Project Manager:

KMA

Technician:

ZM/MG

CADD:

SRP

Checked By:

FZ

Sheet No.

3-LEIB

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FILE LOCATION: I:\sme-inc\p\WP080672.DOC\AD\DWG\SURVEY\WP080672.00-ALTA_Type.dwg
Jun 26, 2019 - 10:51am - tlobon
PLOT DATE:

Appendix G-2

PC-732 005 LEIB As-Builts Selected Sheets

\\PROJECTS\9805\CIVIL\LC-01.DWG 02/26/99 JPF

GENERAL NOTES

1. ALL SEWER CONSTRUCTION SHALL BE PERFORMED WITH MATERIALS AND WORKMANSHIP OF THE HIGHEST QUALITY FOR THE PARTICULAR PURPOSE AND SHALL STRICTLY CONFORM TO THE CURRENT STANDARDS AND SPECIFICATIONS OF THE DETROIT WATER AND SEWERAGE DEPARTMENT.
2. PAVEMENT REMOVAL, EXCAVATION, BACKFILLING AND REPLACEMENT OF THE PAVEMENT FOR THE ENTIRE WORK SHALL BE DONE BY THE CONTRACTOR.
3. ELEVATIONS OF EXISTING SEWERS ARE NOT KNOWN. APPROXIMATE ELEVATIONS SHOWN ON THE PROFILES ARE BASED ON AVAILABLE RECORD DRAWINGS FROM THE DETROIT WATER AND SEWERAGE DEPARTMENT. ELEVATIONS OF THE PROPOSED SEWERS ARE SUBJECT TO CHANGE TO SUIT ACTUAL ELEVATIONS OF EXISTING SEWERS. CONTRACTOR SHALL VERIFY LOCATIONS AND ELEVATIONS OF EXISTING SEWERS. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS SHOWING PROPOSED SEWERS CONNECTION LOCATIONS AND ELEVATIONS (IF ANY) FOR ENGINEERS REVIEW AND APPROVAL PRIOR TO START OF WORK.
4. THE LOCATIONS AND ELEVATIONS OF EXISTING UTILITIES ARE SHOWN IN ACCORDANCE WITH THE SURVEY REFERENCE DRAWINGS ATTACHED). THE CONTRACTOR SHALL EXPOSE THESE UTILITIES, WHERE REQUIRED, TO DETERMINE ACTUAL LOCATIONS.
5. A MINIMUM CLEARANCE OF 18 INCHES VERTICALLY AND THREE AND ONE HALF FEET HORIZONTALLY SHALL BE MAINTAINED BETWEEN THE OUTSIDE SURFACE OF SEWERS AND OTHER UTILITIES, UNLESS OTHERWISE APPROVED BY THE ENGINEER AND D.W.S.D. IF A CONFLICT EXISTS BETWEEN THE SEWERS AND ANY OTHER UTILITY, THAT UTILITY AND ENGINEER SHOULD BE CONSULTED IMMEDIATELY. THE MINIMUM HORIZONTAL DISTANCE BETWEEN WATERMAIN AND SEWER SHALL BE 10 FEET UNLESS OTHERWISE APPROVED BY THE ENGINEER.
6. ELEVATION DATUM IS CITY OF DETROIT DATUM. COORDINATE SYSTEM IS CITY OF DETROIT HORIZONTAL SYSTEM.
7. IN COMPLIANCE WITH PUBLIC ACT 53 OF THE STATE OF MICHIGAN (EFFECTIVE AUG. 1, 1974). THE CONTRACTOR SHALL NOTIFY IN ADVANCE OF CONSTRUCTION ALL PUBLIC AND PRIVATE OWNERS HAVING EXISTING FACILITIES IN OR NEAR THE IMMEDIATE WORKING AREA. FOR CONVENIENCE THE KNOWN UTILITY OWNERS ARE LISTED ON THIS SHEET. THIS LISTING DOES NOT, HOWEVER, RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY OF VERIFYING LOCATIONS AND NOTIFYING ALL UTILITY OWNERS AND MISS DIG (PHONE 482-7171 IN AREA CODE 800). IN EMERGENCY CASES, CONTRACTOR SHALL NOTIFY UTILITIES AS FOLLOWS:

DETROIT EDISON COMPANY	235-8892
DETROIT PUBLIC LIGHTING DEPT.	224-0500
DETROIT WATER AND SEWERAGE DEPT.	267-7401
AMERITECH TELEPHONE COMPANY	221-2121
COMCAST CABLE COMPANY	934-1608
MICHCON	577-7236
8. BIDDER SHALL VERIFY TYPES AND LOCATIONS OF PAVEMENTS AND CURBS OF STREETS AND ALLEYS (ESPECIALLY AT INTERSECTIONS) WITH RESPECT TO THEIR INTERFERENCE WITH THE SEWER RELOCATION AND/OR INSTALLATION AND SHALL INCLUDE COST OF CROSSING AND RESTORATION IN HIS BID PRICE.
9. ALL SIDEWALKS, DRIVEWAYS, SERVICE WALKS, CURBS, UTILITY POLES, TRAFFIC SIGNAL POLES, LIGHT POLES, TREES, LAWNS, D.S.R. TRACKS, ETC. ARE BASED ON THE PROJECT SURVEY AND MAY NOT ALL BE SHOWN ON ALL THESE DRAWINGS. THE BIDDER SHALL VISIT THE PROJECT SITE AND MAKE HIS OWN DETERMINATION OF THE SITUATION AND INCLUDE ALL WORK AND RESTORATION INVOLVING THESE IMPROVEMENTS IN HIS BID PRICE.
10. SEWER CONSTRUCTION OR REPLACEMENT IN CLOSE PROXIMITY TO UTILITY POLES, CATCH BASINS, TREES, ETC., MAY REQUIRE TUNNELING AND/OR THE USE OF CARRIER PIPES AS DIRECTED BY THE ENGINEER. CONTRACTOR SHALL INVESTIGATE THE PROPOSED ROUTES OF THE SEWER AND SHALL SATISFY HIMSELF THAT HIS BID IS INCLUSIVE OF ALL COSTS FOR THE EXECUTION OF THE CONTRACT WORK INCLUDING SUCH TUNNELING AND/OR THE USE OF CARRIER PIPES.
11. DAMAGE TO EXISTING MANHOLES AND SEWERS OCCURRING DURING PIPE INSTALLATION SHALL BE REPAIRED BY THE CONTRACTOR, AS DIRECTED BY THE ENGINEER, AT NO ADDITIONAL COST TO THE OWNER.
12. THE CONTRACTOR SHALL COMPLY AS APPLICABLE WITH THE REQUIREMENTS SET FORTH BY THE CITY OF DETROIT DEPARTMENT OF PUBLIC WORKS (D.P.W.) TRAFFIC ENGINEERING DIVISION, THE WAYNE COUNTY DEPARTMENT OF PUBLIC SERVICES (WCDPS) AND THE MICHIGAN DEPARTMENT OF TRANSPORTATION (M.D.O.T.).
13. IF A CRANE, BACKHOE OR A BOOM WILL BE USED IN THE VICINITY OF DETROIT EDISON OVERHEAD LINES, THE DETROIT EDISON COMPANY MUST BE NOTIFIED THREE WORKING DAYS PRIOR TO SUCH USE.
14. THE CONTRACTOR SHALL BE RESPONSIBLE FOR AVOIDANCE AND CLEANUP OF MUD TRACKED ONTO ADJACENT CITY STREETS FROM VEHICLES LEAVING THE JOBSITE. CLEANUP SHALL BE COMPLETED DAILY AND TO THE FULL SATISFACTION OF THE CITY OF DETROIT AUTHORITIES AND CONSTRUCTION MANAGER.
15. THE CONTRACTOR SHALL BE RESPONSIBLE FOR AVOIDANCE AND CLEANUP OF STREET SPILLAGE OF EXCAVATED OR BACK FILL MATERIALS ENTERING OR LEAVING THE SITE. CLEANUP OF MAJOR SPILLS SHALL BE COMPLETED IMMEDIATELY. OTHER SPILLS SHALL BE CLEANED, CONTINUALLY. ALL CLEANUP SHALL BE COMPLETED TO THE FULL SATISFACTION OF THE CITY OF DETROIT AUTHORITIES.
16. THE CONTRACTOR SHALL USE ALL MEANS NECESSARY TO PROPERLY MOISTEN ALL SURFACES AS REQUIRED TO PREVENT SOILS FROM BECOMING AIRBORNE AND CREATING A NUISANCE TO NEIGHBORING FACILITIES, THE PUBLIC, AND ANY CONCURRENT WORK ACTIVITIES. THE FINAL DETERMINATION OF THE SUCCESS OF THESE DUST CONTROL MEASURES SHALL BE BY THE CITY OF DETROIT AUTHORITIES.
17. ANY SITE DEWATERING NECESSARY TO MAINTAIN A SAFE AND EFFICIENT WORKING ENVIRONMENT.
18. ALL CONSTRUCTION WORK SHALL BE EXECUTED AND INSPECTED IN ACCORDANCE WITH ALL LOCAL, STATE AND FEDERAL CODES, RULES, ORDINANCES AND REGULATIONS.
19. ALL EXCAVATED MATERIALS SHALL BE REMOVED FROM THE SITE AND PROPERLY AND LEGALLY DISPOSED OF AT AN APPROVED OFF SITE LOCATION. NO EXCAVATED MATERIALS SHALL BE UTILIZED FOR ANY ON-SITE FILL REQUIREMENTS.

SEWER CONSTRUCTION NOTES

1. ALL SEWER WORK PERFORMED BY THE CONTRACTOR SHALL REQUIRE INSPECTION BY THE DETROIT WATER AND SEWERAGE DEPARTMENT (D.W.S.D.).
2. THE CONTRACTOR SHALL MAINTAIN FLOWS IN ALL EXISTING SEWERS DURING CONSTRUCTION. METHODS OF REROUTING OF FLOWS, PUMPING, OR TEMPORARY BLOCKING SHALL BE SUBMITTED BY THE CONTRACTOR FOR REVIEW AND APPROVAL BY THE ENGINEER.
3. CONTRACTOR SHALL PROVIDE EARTH SUPPORTING STRUCTURES WHERE REQUIRED TO PERFORM HIS OPERATION. CONTRACTOR SHALL SUBMIT DRAWINGS FOR THE PROPOSED EARTH SUPPORTING SYSTEM SIGNED AND CERTIFIED BY A REGISTERED PROFESSIONAL ENGINEER FOR THE REVIEW AND APPROVAL OF THE ENGINEER.
4. UTILITY SERVICES TO REMAIN IN SERVICE SHALL BE ADEQUATELY SUPPORTED DURING CONSTRUCTION TO MAINTAIN UNINTERRUPTED SERVICES. INTERFERENCE WITH OTHER UTILITIES REQUIRING RELOCATION SHALL BE COORDINATED WITH PARTICULAR UTILITY. CONTRACTOR SHALL RELOCATE SUCH UTILITY TO THE SATISFACTION OF ENGINEER AND THE UTILITY COMPANY.
5. THE CONTRACTOR SHALL CUT AND PLUG OR OTHERWISE MODIFY EXISTING SEWERS TO REMAIN IN SERVICE WHERE REQUIRED. THIS WORK IS TO BE DONE TO THE SATISFACTION OF THE ENGINEER AND DWSD.
6. THE CONTRACTOR SHALL INSTALL ALL PIPE AND FITTINGS NECESSARY TO COMPLETE THE CONNECTIONS SHOWN.
7. SEE "STANDARD SPECIFICATIONS FOR PAVING RELATED CONSTRUCTION" DATED JUNE, 1984 AS AMENDED, AND "SPECIFICATIONS FOR UTILITIES CUTS, PAVEMENT REMOVAL AND REPLACEMENT", DATED MAY 1984 OR CURRENT REVISION, CITY OF DETROIT ENGINEERING DIVISION, DEPARTMENT OF PUBLIC WORKS.
8. ALL EXCAVATED TRENCHES, SHAFTS OR PITS SHALL BE BACKFILLED WITH STRUCTURAL FILL IN ACCORDANCE WITH DWSD STANDARDS AND SPECIFICATIONS AS SHOWN ON THE DRAWINGS.
9. PLACE SAND BACKFILL WITHIN THREE FEET OF ALL STRUCTURES UNLESS SPECIFIED OTHERWISE.
10. THE SEWER PIPE BEDDING AND PIPE ENVELOPE SHALL BE AS PER DWSD'S SPECIFICATIONS
11. ALL PRECAST PRODUCTS SHALL CONFORM TO THE REQUIREMENTS OF ASTM C-478 UNLESS OTHERWISE NOTED ON THE PLANS.

GEOTECHNICAL REPORT

REFER TO THE SOILS REPORT PREPARED BY NTH CONSULTANT FOR INFORMATION RELATED TO THE EXISTING SUBSURFACE SOIL CONDITIONS ON THIS SITE.

TOPOGRAPHICAL AND BOUNDARY SURVEY

PREPARED BY METCO SERVICES AND CAN BE AVAILABLE TO BIDDERS UPON REQUEST.

SOIL EROSION AND SEDIMENTATION CONTROL NOTES

1. THE CONTRACTOR'S ATTENTION IS DIRECTED TO THE SPECIFICATIONS, SECTION 01110 ARTICLE 3.01, "EROSION CONTROL", WHERE REFERENCE IS MADE TO THE CONTRACTOR'S RESPONSIBILITIES CONCERNING THIS MATTER.
2. THE CONTRACTOR SHALL ARRANGE HIS CONSTRUCTION OPERATIONS IN SUCH A MANNER THAT THE CONSTRUCTION AREA WILL NOT BE SUSCEPTIBLE TO SOIL EROSION AND THAT THE CONSTRUCTION OPERATIONS WILL NOT CREATE ANY SILTATION PROBLEMS.
3. THE CONTRACTOR SHALL EMPLOY NECESSARY MEANS AND METHODS TO PREVENT EXCAVATED AND LOOSE SOIL MATERIAL FROM BEING COLLECTED ON TIRES OF TRUCKS AND OTHER EQUIPMENT AND BEING DEPOSITED ON STREETS AND ROADS TO AND FROM THE CONSTRUCTION SITE.
4. THE CONTRACTOR SHALL CONTROL DUST AT THE CONSTRUCTION SITE AND ON ALL PUBLIC STREETS USED AS HAUL ROADS.
5. THE DISTANCE BETWEEN THE POINT OF COMPLETE BACKFILLING AND THE PIPE LAYING SHALL NOT EXCEED 40 FEET.
6. THE CONTRACTOR SHALL EMPLOY POSITIVE MEANS TO PREVENT SOIL AND OTHER DEBRIS FROM ENTERING THE EXISTING STREET DRAINAGE SYSTEM. IT IS THE CONTRACTOR'S RESPONSIBILITY TO MAINTAIN THE EXISTING CATCH BASIN AND DRAIN SYSTEM TO AT LEAST THE CONDITIONS PRIOR TO CONSTRUCTION. IN ADDITION TO THE ABOVE REQUIREMENTS, THE CONTRACTOR'S ATTENTION IS DIRECTED SPECIFICALLY TO DIVISION 146, "EROSION CONTROL PROGRAM" OF THE CITY OF DETROIT DEPARTMENT OF PUBLIC WORKS (D.P.W.) CITY ENGINEERING DIVISION'S CURRENT "STANDARD SPECS FOR PAVING AND RELATED CONSTRUCTION."
7. THE CONTRACTOR SHALL PERFORM ALL ACTIVITIES NECESSARY TO COMPLY WITH THE SOIL EROSION AND SEDIMENTATION CONTROL PROGRAM AT NO ADDITIONAL COST TO THE OWNER.

ABBREVIATIONS

AC.	ACRE
BOT.	BOTTOM
CB	CATCH BASIN
CL	CENTERLINE
CONC.	CONCRETE
CYL.	CYLINDER
DIA.	DIAMETER
D/S	DOWNSIDE
DWG.	DRAWING
EL./ELEV.	ELEVATION
EX./EXIST.	EXISTING
FT.	FEET
HORIZ.	HORIZONTAL
I.D.	INTERNAL DIAMETER
INV.	INVERT
MH.	MANHOLE
MAX.	MAXIMUM
MIN.	MINIMUM
N.L.C.	NOT IN CONTRACT
NO.	NUMBER
O/C	ON CENTER
PLD	PUBLIC LIGHTING DEPARTMENT
SAN.	SANITARY
ST.	STORM
TTS	TOWARD TREATMENT SEWER
TYP.	TYPICAL
UGDE	UNDERGROUND DETROIT EDISON
U/S	UP STREAM
VERT.	VERTICAL
WD.	WIDE
WP.	WORK POINT
WM	WATER MAIN

LEGEND

	EXISTING	PROPOSED
CATCH BASIN		
WATER MAIN		
SEWER		
GRADES	x100.00	x100.00
CHAIN LINK FENCE		
UTILITY POLE		
WATER VALVE		
CONC. CURB		
MANHOLE		
BRICK PAVERS		
CONC. PAVEMENT		
GUARD POST		
FIRE HYDRANT		
EXISTING BUILDING LINE		
EXISTING SHRUBS		
EXISTING TREE		
PARKING BUMPER		

AS-BUILT SET

CONTRACT TITLE..... CS-1285, PC 732
CONTRACTOR..... LONZO CONSTRUCTION
START DATE..... SEPTEMBER 2000
FINISH DATE..... SEPTEMBER 2004
INSPECTION..... DWSD FIELD ENGINEER
JOHN JOHNSON

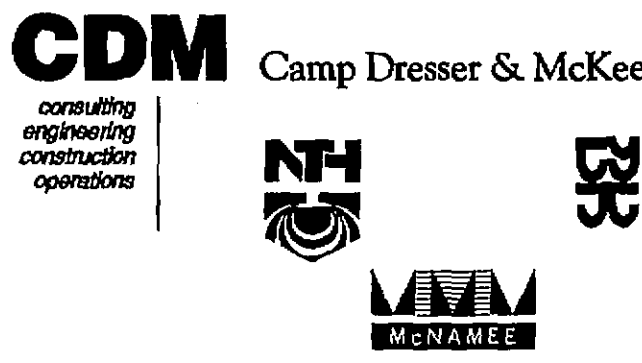
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	REVISIONS				

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CHECKED	GK
APPROVED	EY

DETROIT WATER AND SEWERAGE DEPARTMENT
WASTEWATER COLLECTION SYSTEM IMPROVEMENTS

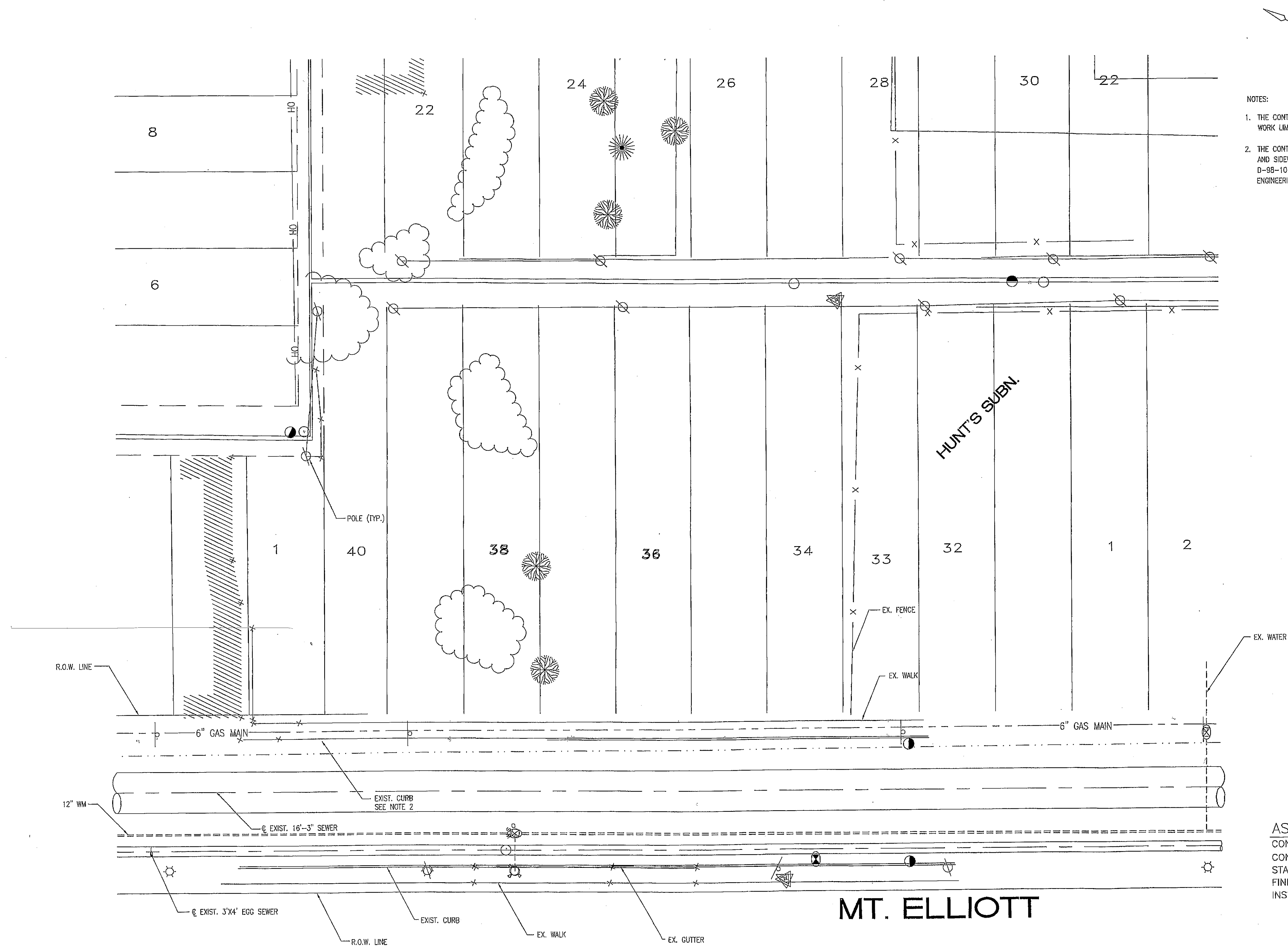
LEIB SCREENING AND DISINFECTION FACILITY
NOTES, CIVIL/SITE AND ABBREVIATIONS

SCALE: NONE



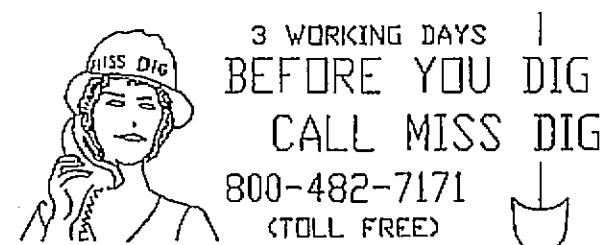
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SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE

M.O.P.H./D.N.R. PERMIT NO.	999112
FAMIS NO.	473466
CONTRACT NO.	PC-732
FILE NO.	1441
D-98-10-005	



- NOTES:
1. THE CONTRACTOR SHALL REMOVE ALL TREES AND SHRUBS LOCATED WITHIN WORK LIMITS.
 2. THE CONTRACTOR SHALL SAW CUT AND REMOVE EXISTING CURB, GUTTER AND SIDEWALK AT THE LOCATION OF THE NEW DRIVEWAY. (SEE DRAWING D-98-10-007). THE REMOVAL SHALL BE AS PER THE CITY OF DETROIT ENGINEERING DEPARTMENT GUIDELINES.

AS-BUILT SET
 CONTRACT TITLE..... CS-1285, PC 732
 CONTRACTOR..... LONZO CONSTRUCTION
 START DATE..... SEPTEMBER 2000
 FINISH DATE..... SEPTEMBER 2004
 INSPECTION..... DWSD FIELD ENGINEER
 JOHN JOHNSON



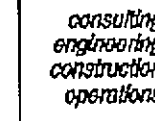
F:\PROJECTS\9805\CIVIL\LC-02.DWG 2/26/99 JE

F	AS-BUILT SET				DESIGN	TZ
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DESCRIPTION		CHECKED	APPROVED	DATE		
REVISIONS						

DETROIT WATER AND SEWERAGE DEPARTMENT
 WASTEWATER COLLECTION SYSTEM IMPROVEMENTS
 LEIB SCREENING AND DISINFECTION FACILITY
 EXISTING SITE PLAN

SCALE: 1"=20'-0"

CDM Camp Dresser & McKee



SIGMA
 associates, inc.
 engineers + architects



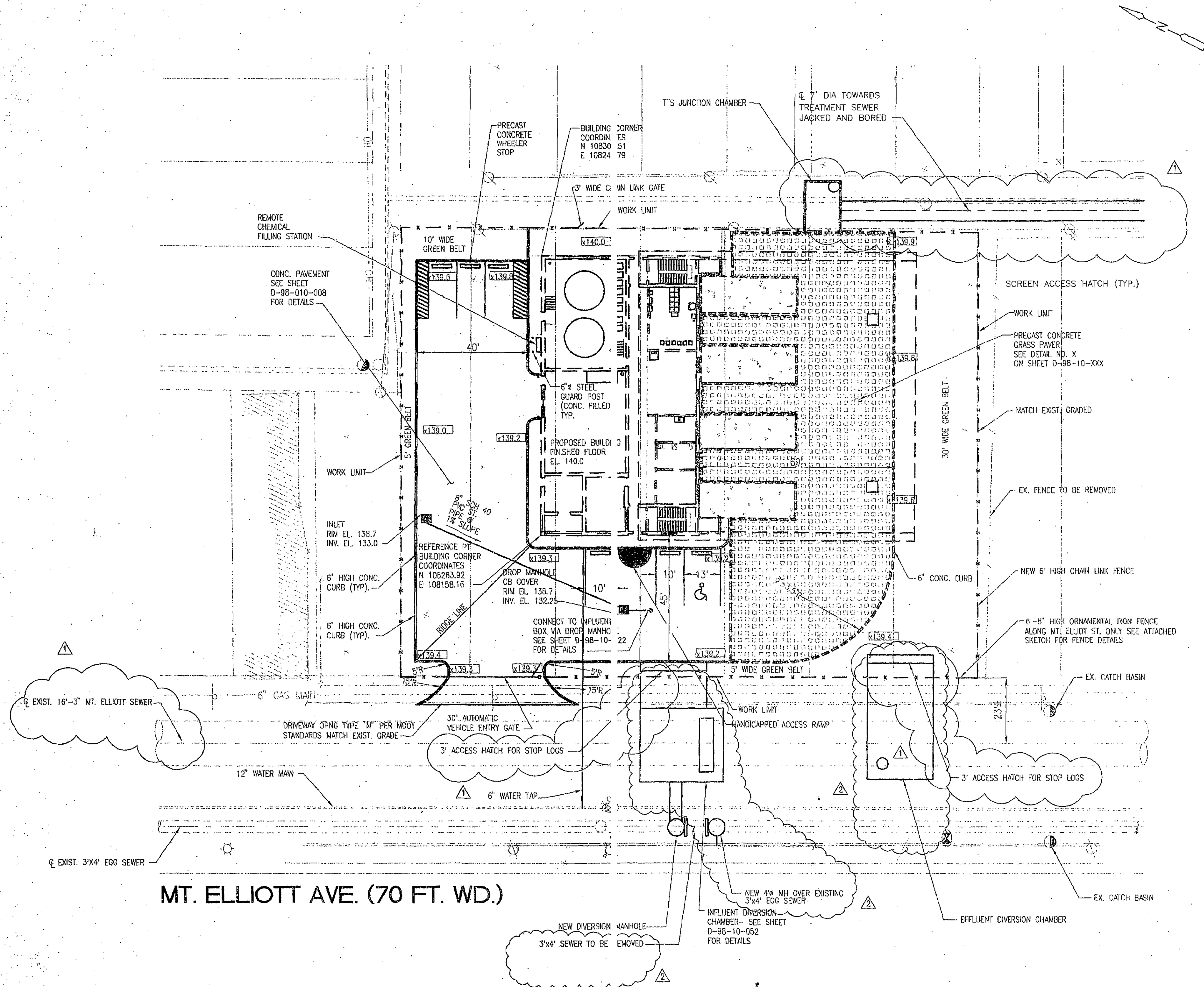
CITY OF DETROIT
 WATER AND SEWERAGE DEPARTMENT
 ENGINEERING DIVISION

SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE

M.D.P.H./D.N.R. PERMIT NO.	999112
FAMIS NO.	473466
CONTRACT NO.	PC-732
FILE NO.	1441
	D-98-10-006

SITE PLAN NOTES

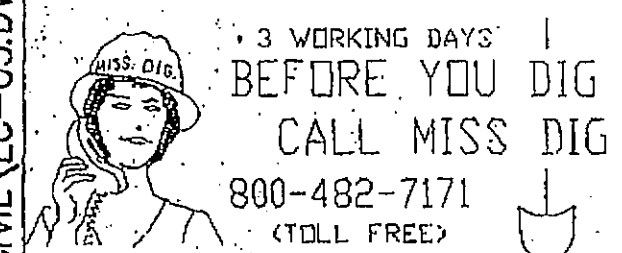
1. THE CONTRACTOR SHALL COORDINATE GAS SERVICE CONNECTION WITH MICHCON GAS CO.
2. NEW 6" WATER SERVICE SHALL BE INSTALLED PER CURRENT "DWS" AND PLUMBING STANDARDS.
3. ON SITE STORM SEWERS, CATCH BASINS, AND MANHOLES SHALL BE IN ACCORDANCE WITH THE CURRENT "DWS" AND PLUMBING STANDARDS.
4. THE CONTRACTOR SHALL SECURE ALL NECESSARY PERMITS FROM LOCAL AND STATE AUTHORITIES FOR WATER SERVICE, STORM SERVICE, GAS SERVICE, CURB CUTS AND DRIVEWAYS.
5. THE CONTRACTOR SHALL PROVIDE ALL SIGNS AND PAVEMENT MARKINGS AS SHOWN ON THE SITE PLAN AND IN THE SPECIFICATIONS.
6. THE CONTRACTOR SHALL CALL "MISS DIG" AT LEAST 72 HOURS BEFORE STARTING ANY EXCAVATION WORK.
7. ALL WORK WITHIN MT. ELLIOTT AVE RIGHT OF WAY (R.O.W.) SHALL BE IN ACCORDANCE WITH THE CITY OF DETROIT DEPARTMENT OF PUBLIC WORKS (DPW) STANDARDS.
8. THE CONTRACTOR SHALL PROVIDE A SIGN FOR PHYSICALLY HANDICAPPED PARKING SPACE.
9. THE CONTRACTOR SHALL COORDINATE HIS WORK WITH ALL UTILITIES FOR WORK WITHIN THE R.O.W.
10. LOCATIONS OF UNDERGROUND UTILITIES SHOWN ARE APPROXIMATE AND BASED ON BEST AVAILABLE DRAWINGS. THE CONTRACTOR SHALL FIELD VERIFY SIZE, DEPTH AND LOCATION OF UTILITIES PRIOR TO START OF WORK.
11. ALL SOIL EROSION AND SEDIMENTATION SHALL BE IN ACCORDANCE WITH DETAILS SHOWN ON SHEET D-98-10-010.
12. THE CONTRACTOR SHALL INSTALL 6" HIGH CHAIN LINK FENCE AROUND PERIMETER OF THE SITE INCLUDING A 3' WIDE MAN GATE AT ALLEY AND 30' CANTILEVER AUTOMATIC VEHICLE ENTRY CHAIN LINK GATE AT MT. ELLIOTT DRIVEWAY. THE CONTRACTOR SHALL COORDINATE WITH GATE MANUFACTURER FOR LOCATION OF ACCESS KEYS PEDESTALS AND GUIDES. THE PROPOSED GATE INSTALLATION SHALL BE AS PER DWS SECURITY SECTION GUIDELINES.



AS-BUILT SET

CONTRACT TITLE..... CS-1285, PC 732
 CONTRACTOR..... LONZO CONSTRUCTION
 START DATE..... SEPTEMBER 2000
 FINISH DATE..... SEPTEMBER 2004
 INSPECTION..... DWS FIELD ENGINEER
 JOHN JOHNSON

MT. ELLIOTT AVE. (70 FT. WD.)



REVISIONS	DESCRIPTION	CHECKED	APPROVED	DATE
F	AS-BUILT SET			09/04
E				
D				
C				
B	REV. NO. 2 PER CONTRACTOR RFTS			11/30/98
A	REV. NO. 1 PER CONTRACTOR RFTS			11/9/99

DETROIT WATER AND SEWERAGE DEPARTMENT
 WASTEWATER COLLECTION SYSTEM IMPROVEMENTS
 LEIB SCREENING AND DISINFECTION FACILITY
 PROPOSED SITE PLAN

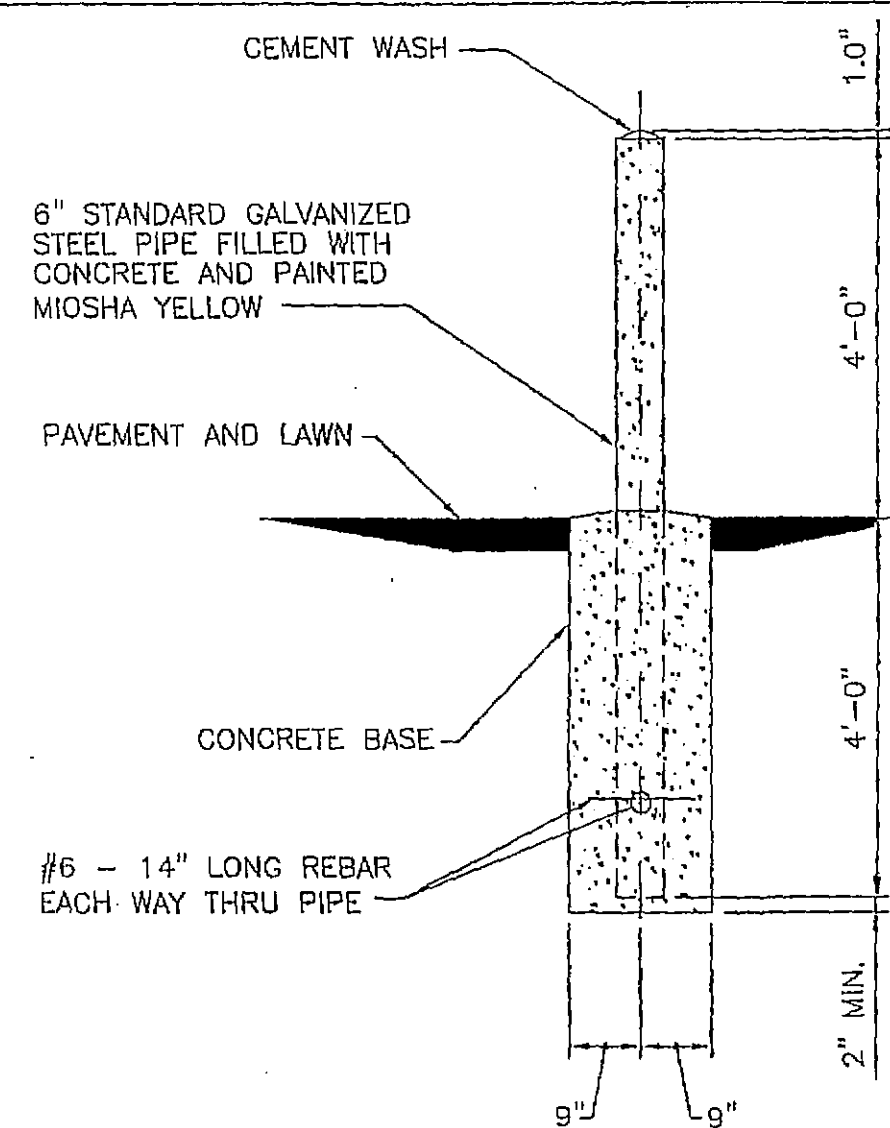
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CDM Camp Dresser & McKee



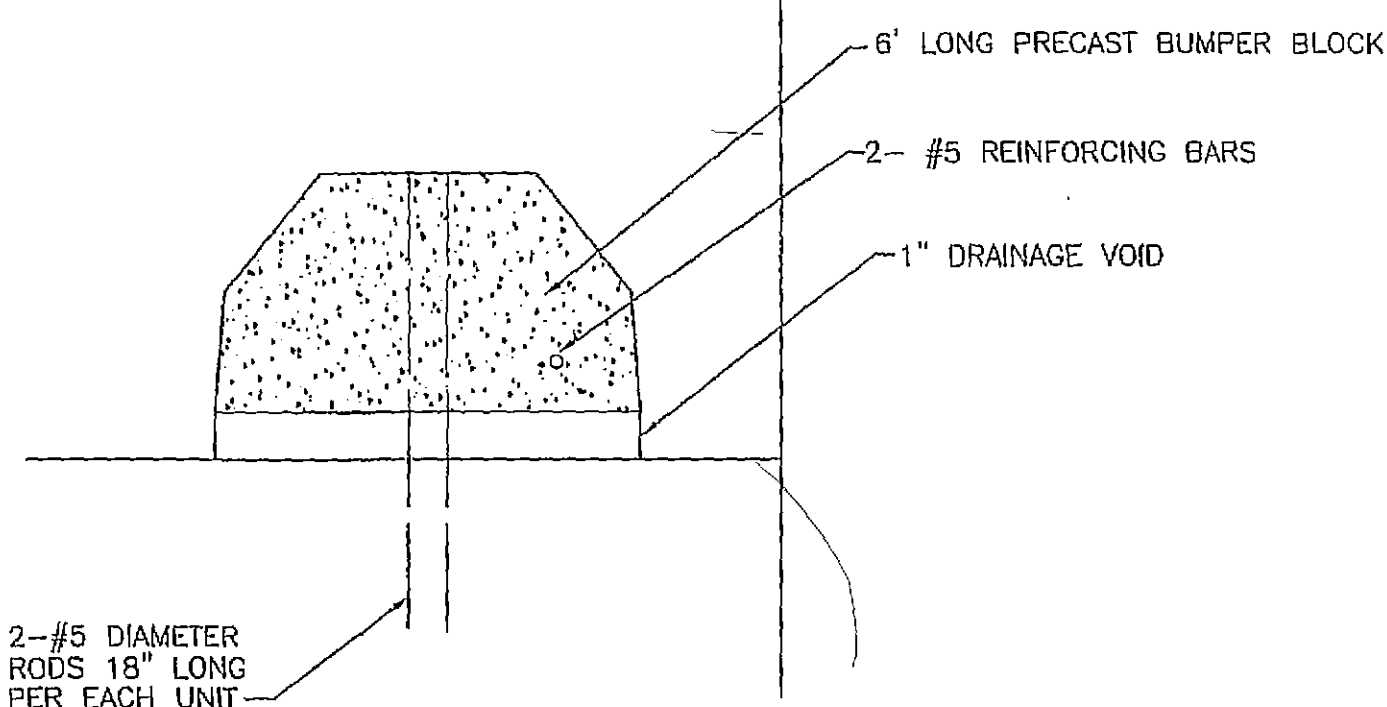
SIGMA
 ASSOCIATES, INC.
 ENGINEERS-ARCHITECTS

CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION				
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D-98-10-007				

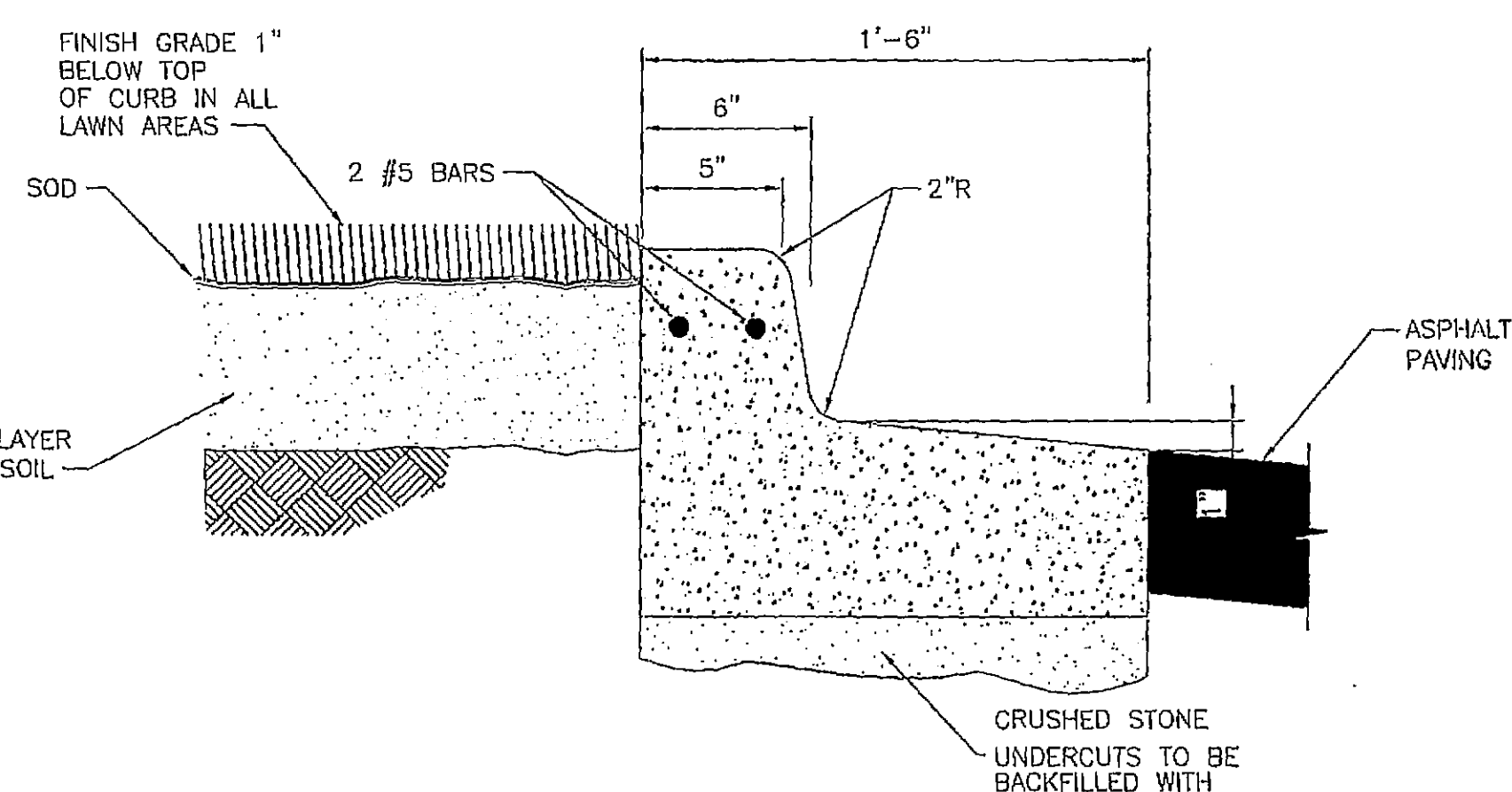


EXTERIOR GUARD POST DETAIL (TYP)
NO SCALE

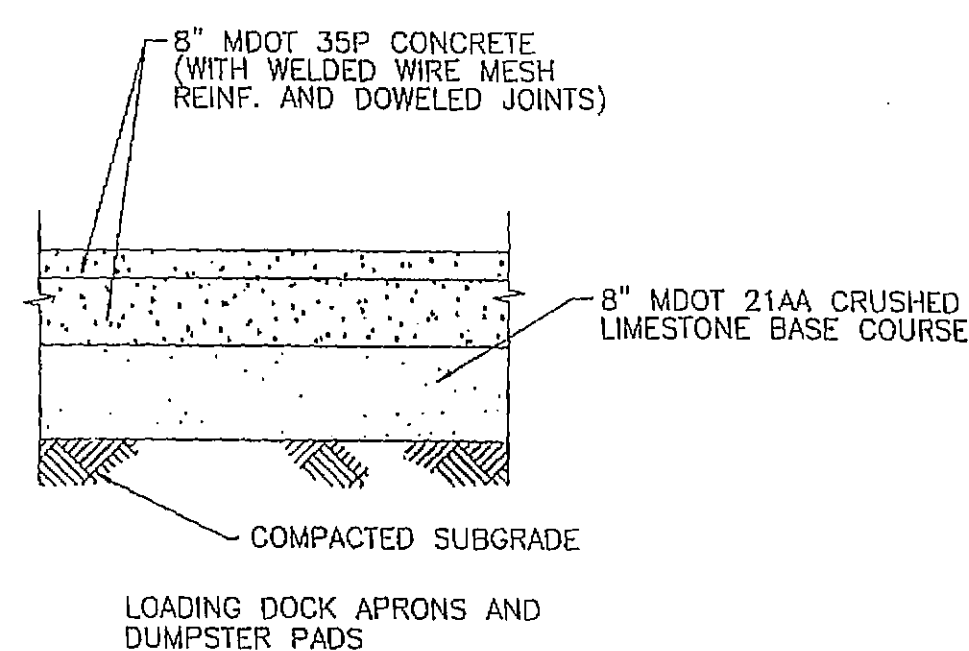
UNLESS SHOWN OTHERWISE
ALL SITE DIMENSIONS ARE
TO EDGE OF PAVEMENT WHERE
PRECAST CONC. BUMPER IS
SPECIFIED



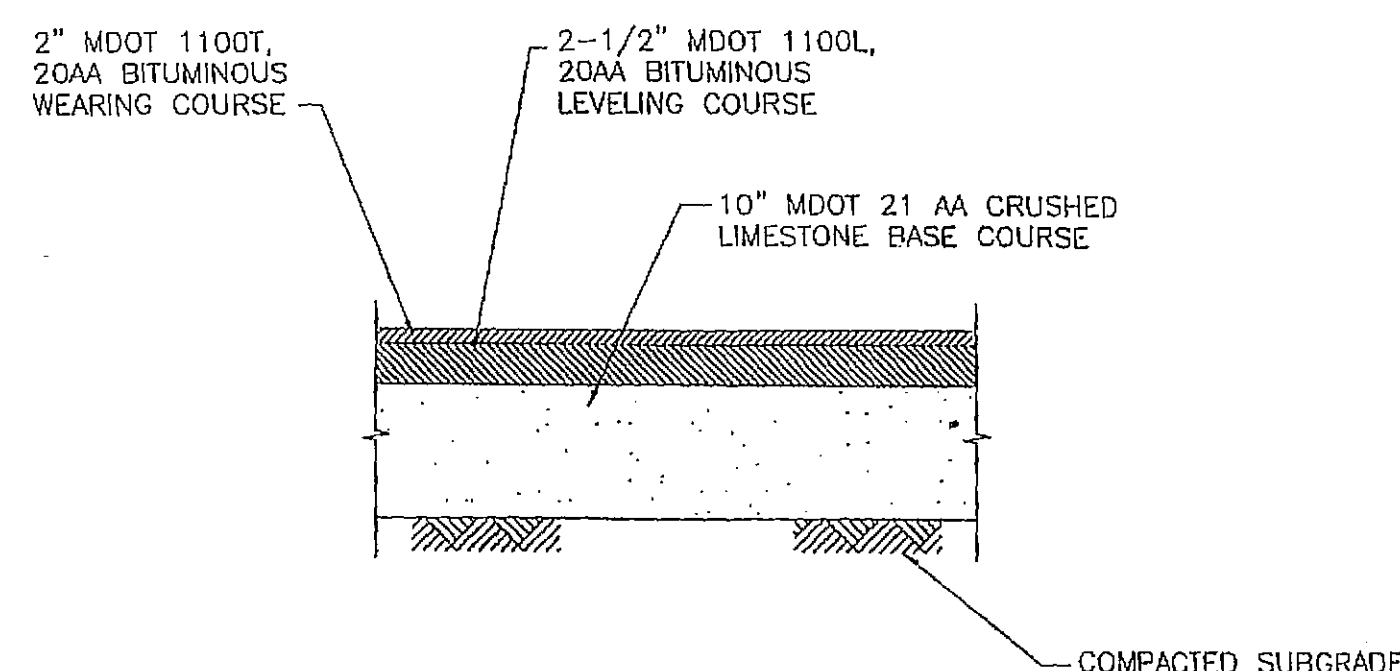
PRECAST CONCRETE WHEEL STOP
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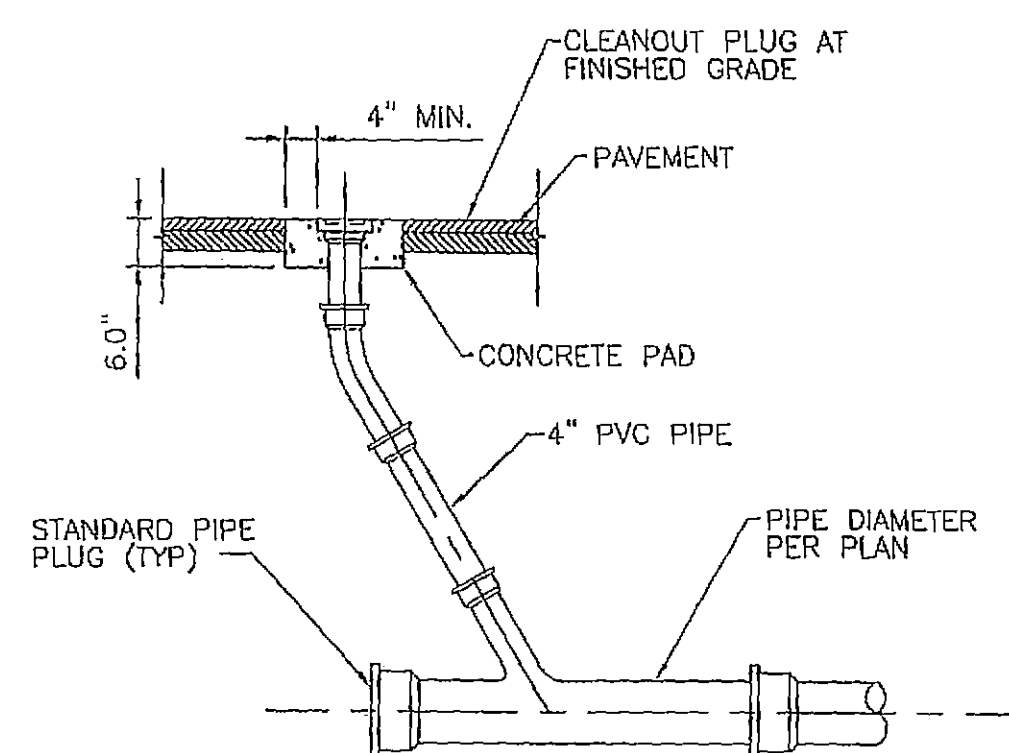
CONCRETE CURB WITH REVERSE GUTTER
SCALE: 1/8"=1'-0"



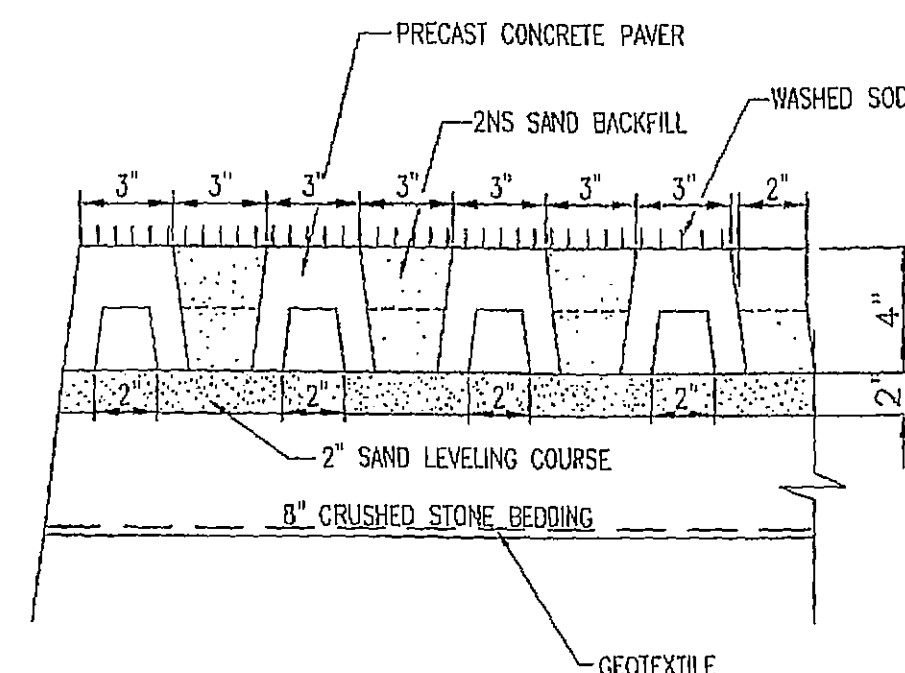
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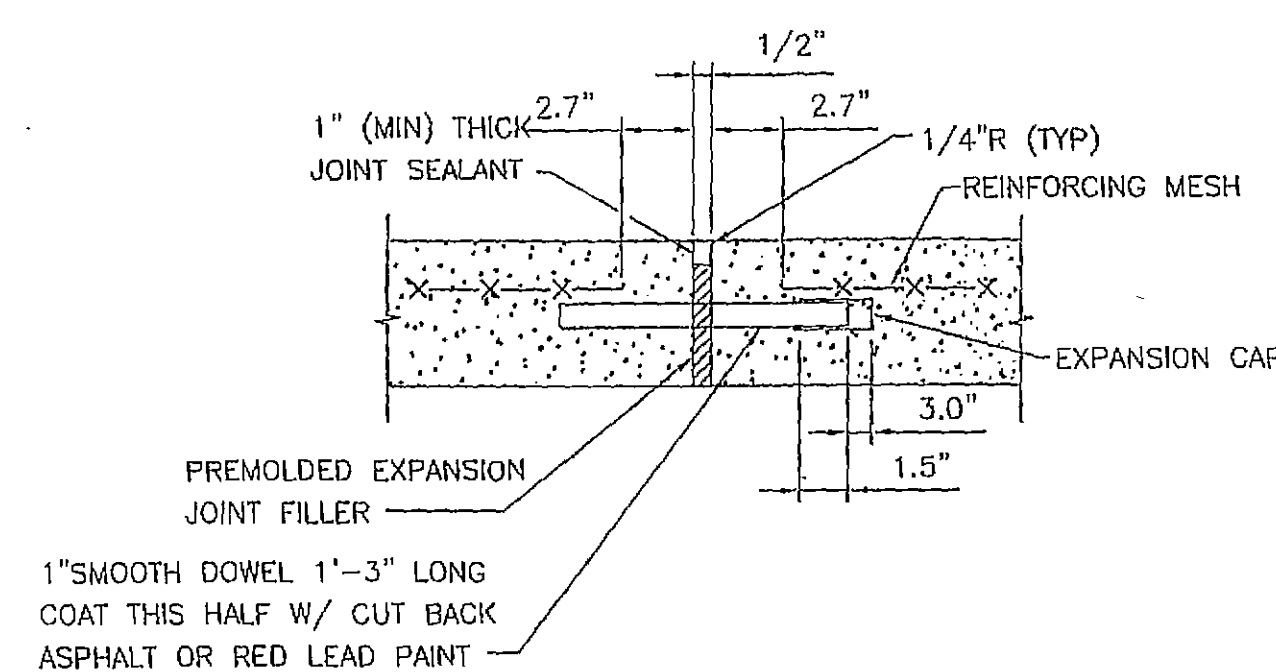
ASPHALT PAVEMENT DETAIL
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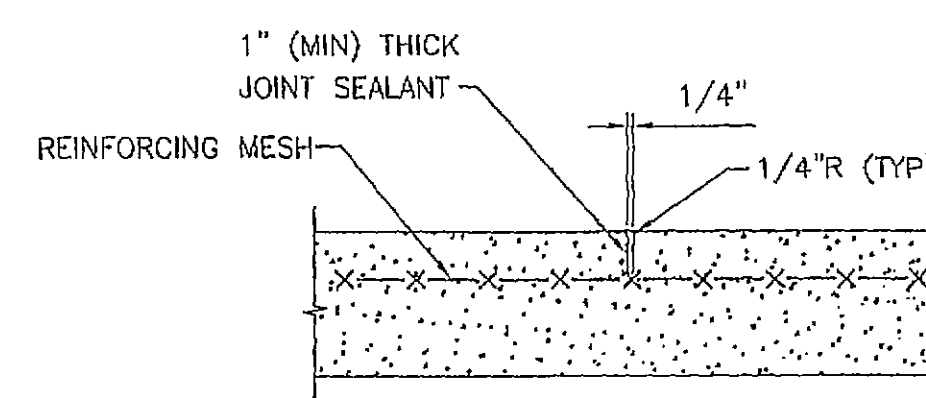
CLEANOUT DETAIL
SCALE: 1/4"=1'-0"



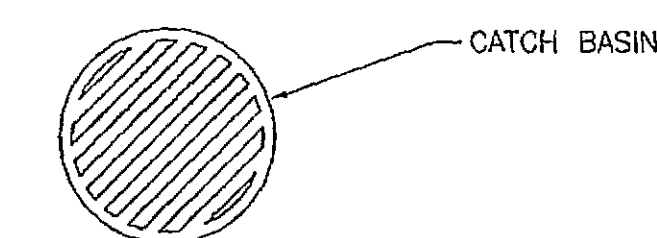
PRECAST CONCRETE GRASS PAVER DETAIL
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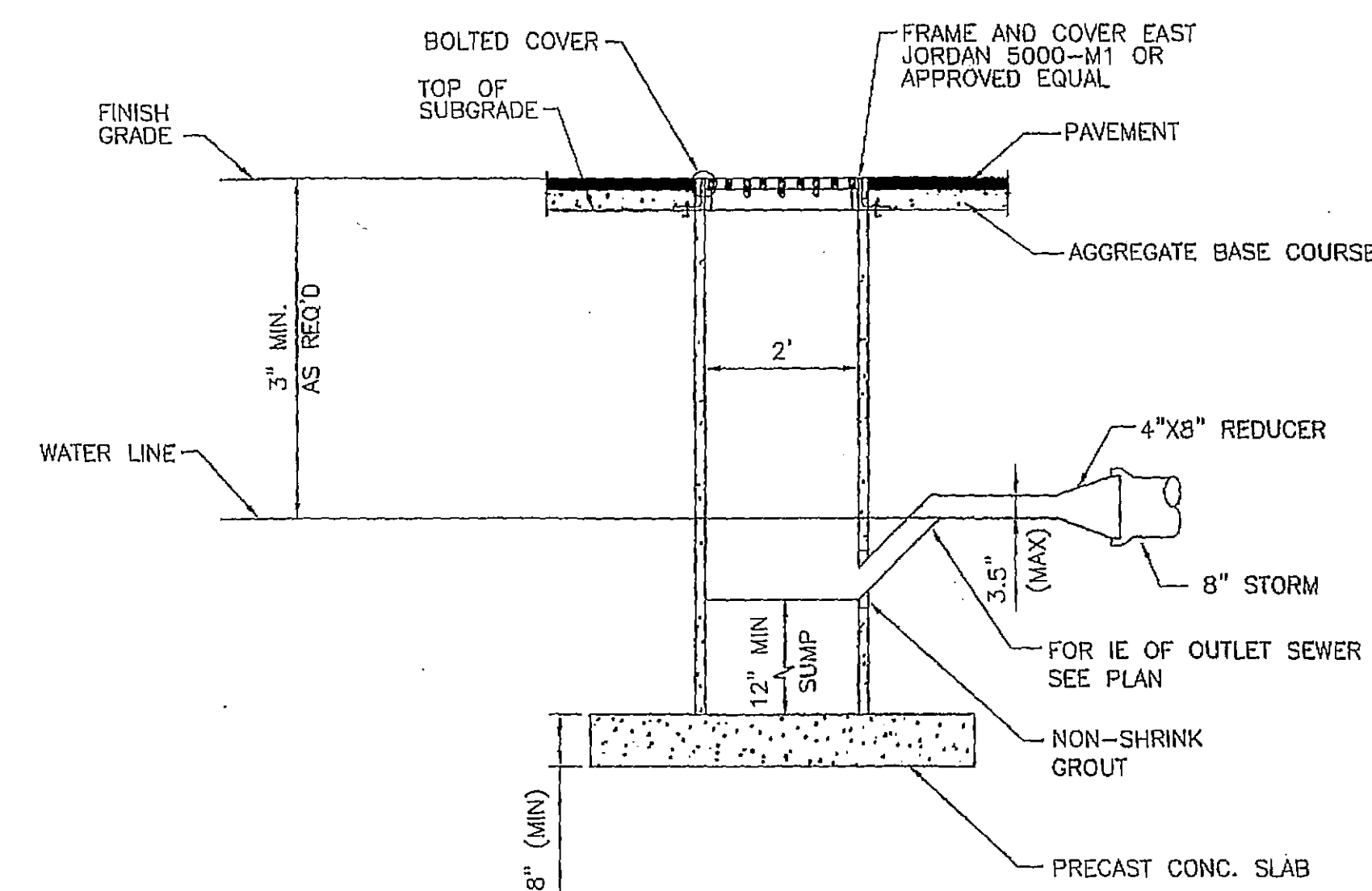
EXPANSION JOINT DETAIL
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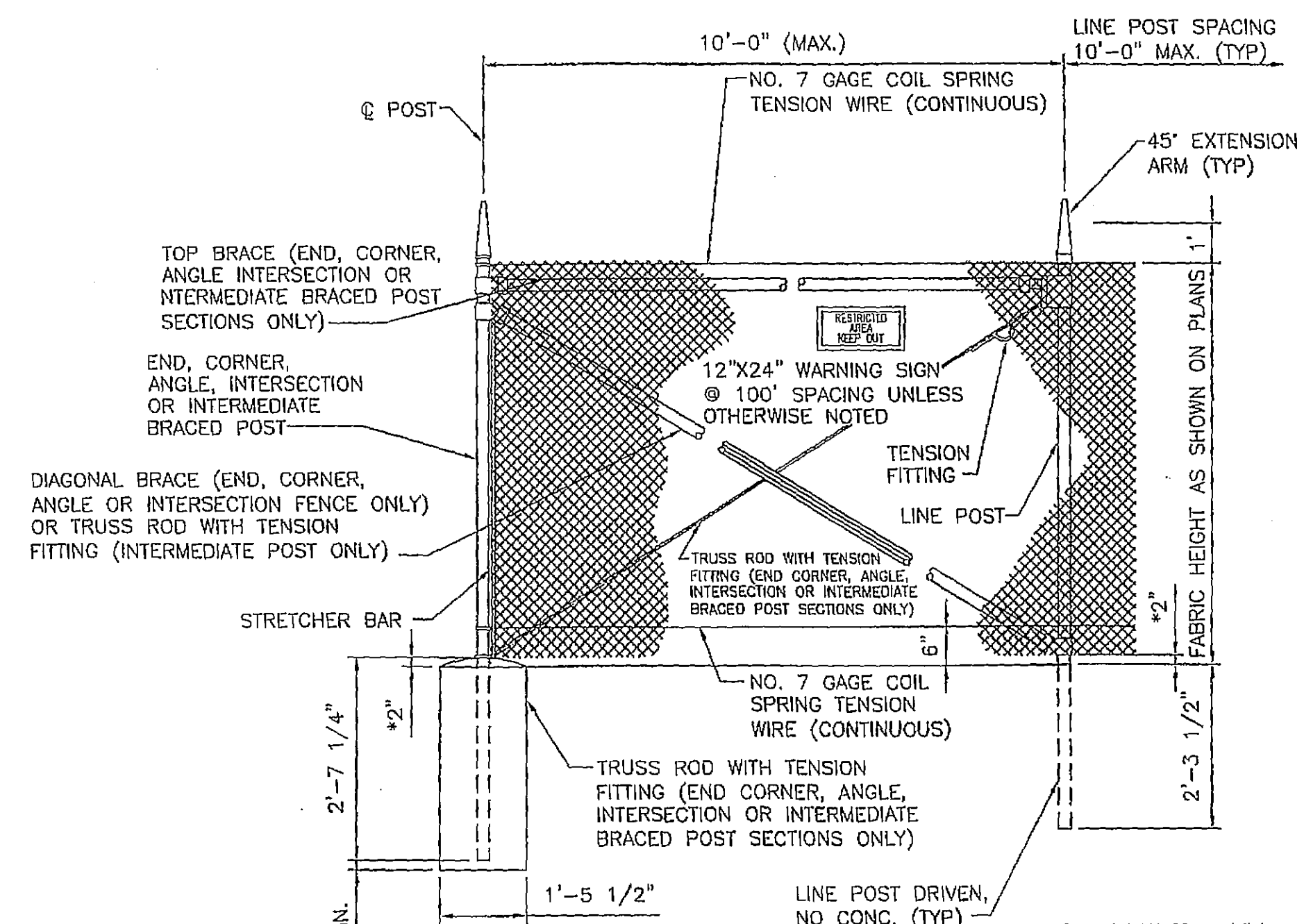
DUMMY GROOVE JOINT DETAIL
NO SCALE



PLAN CATCH BASIN
NO SCALE



SECTION-CATCH BASIN
NO SCALE



FENCE DETAIL
NO SCALE

AS-BUILT SET

CONTRACT TITLE..... CS-1285, PC 732
CONTRACTOR..... LONZO CONSTRUCTION
START DATE..... SEPTEMBER 2000
FINISH DATE..... SEPTEMBER 2004
INSPECTION..... DWSD FIELD ENGINEER
JOHN JOHNSON

PROJECTS\9805\CIVIL\LC-04.DWG 04/07/99 JPF

F	AS-BUILT SET			09/04	DESIGN	TZ
E					DRAFTING	JE
D					CHECKED	GK
C					APPROVED	EY
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DESCRIPTION		CHECKED	APPROVED	DATE		
REVISIONS						

DETROIT WATER AND SEWERAGE DEPARTMENT
WASTEWATER COLLECTION SYSTEM IMPROVEMENTS
LEIB SCREENING AND DISINFECTION FACILITY
UTILITIES AND PAVING

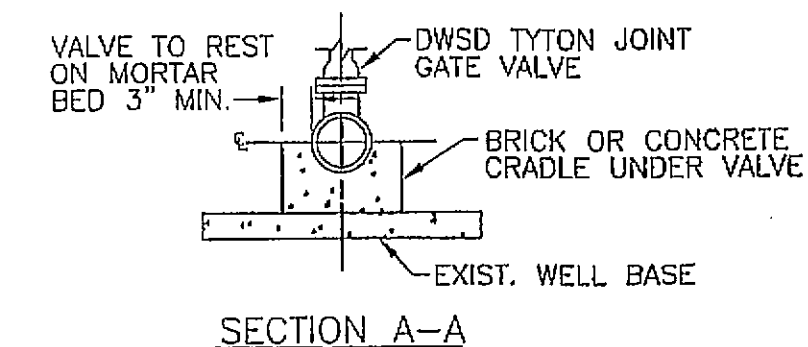
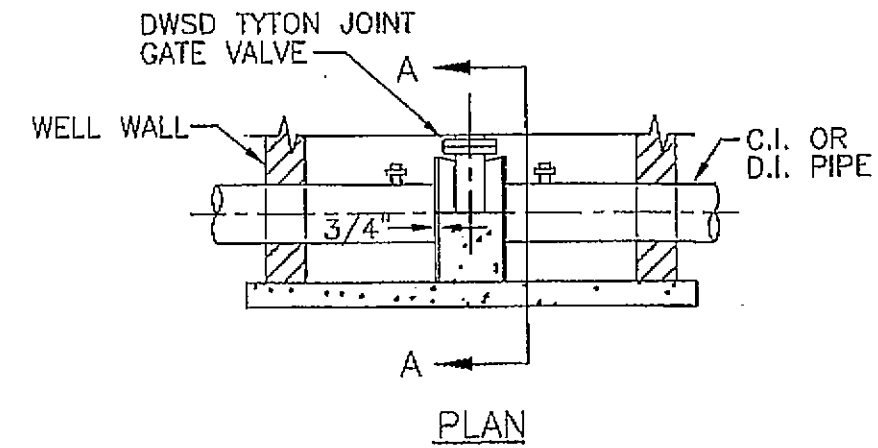
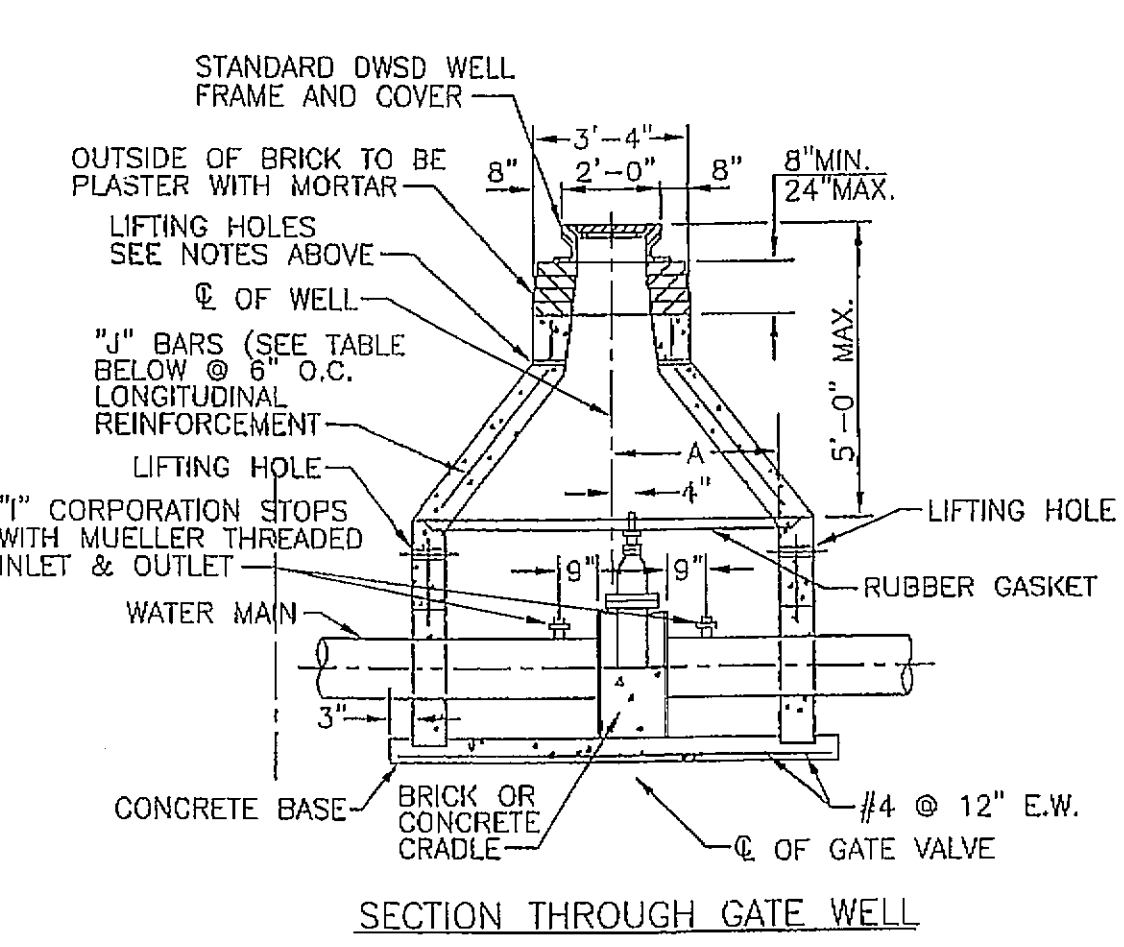
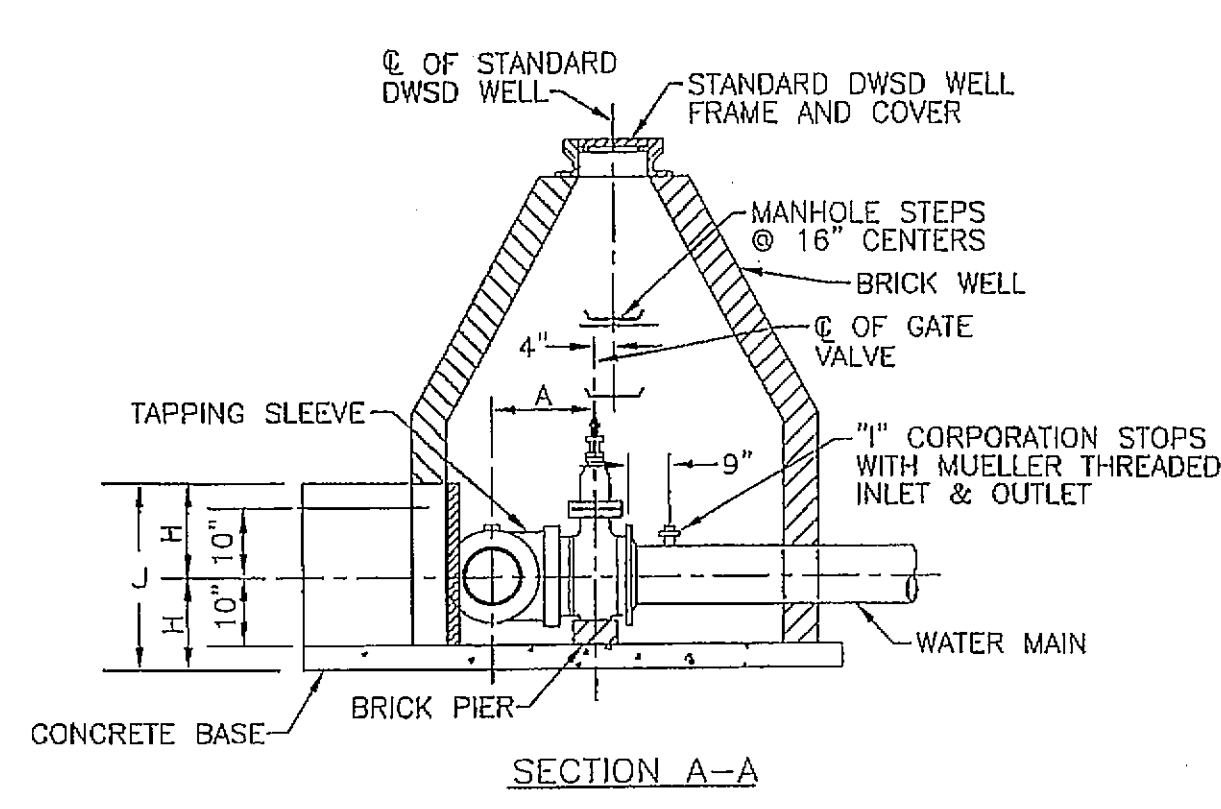
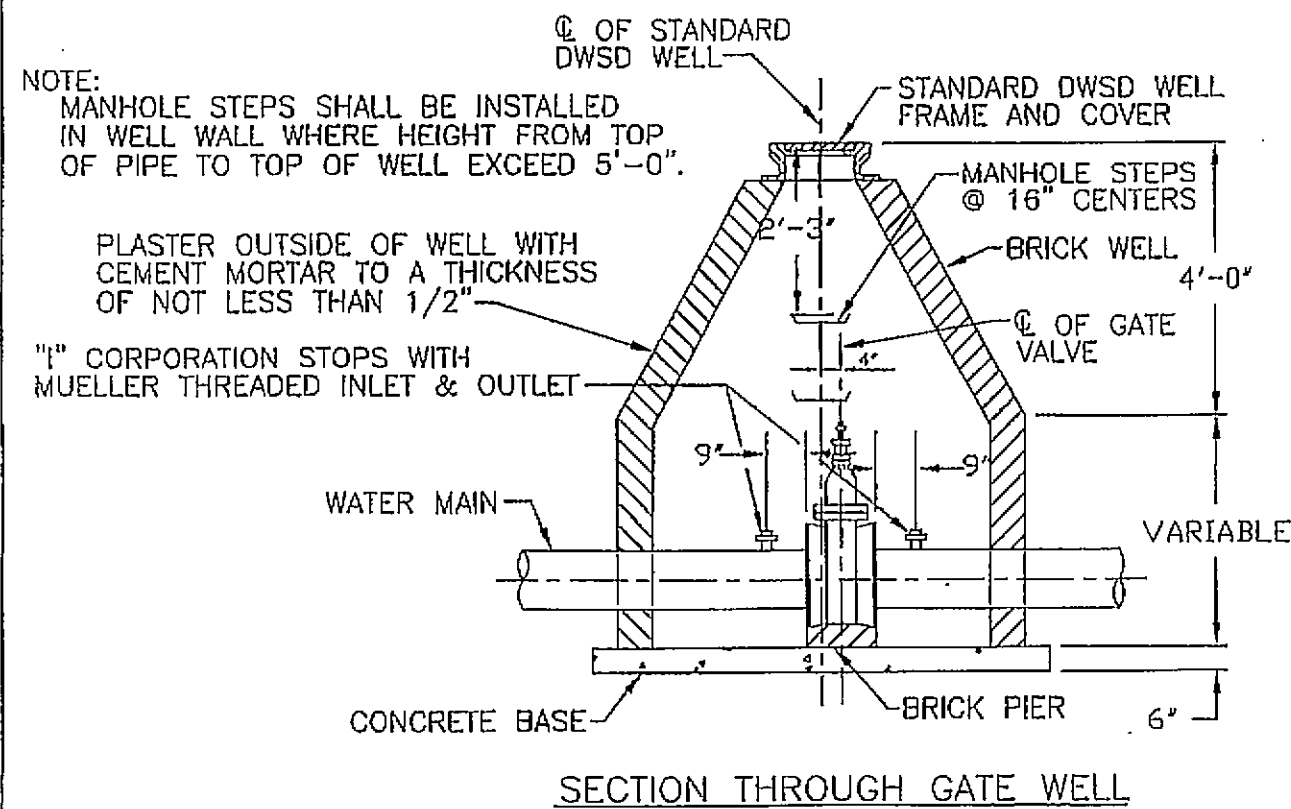
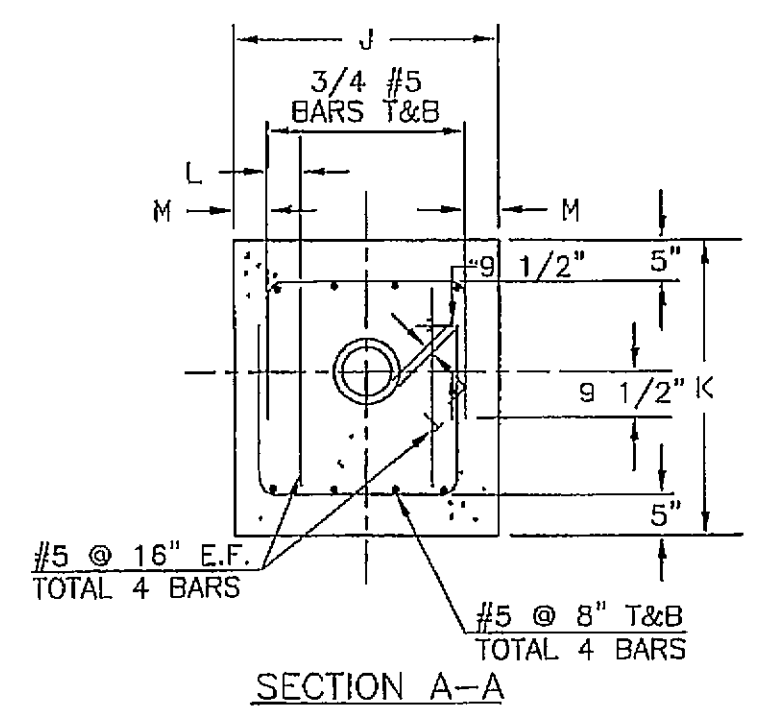
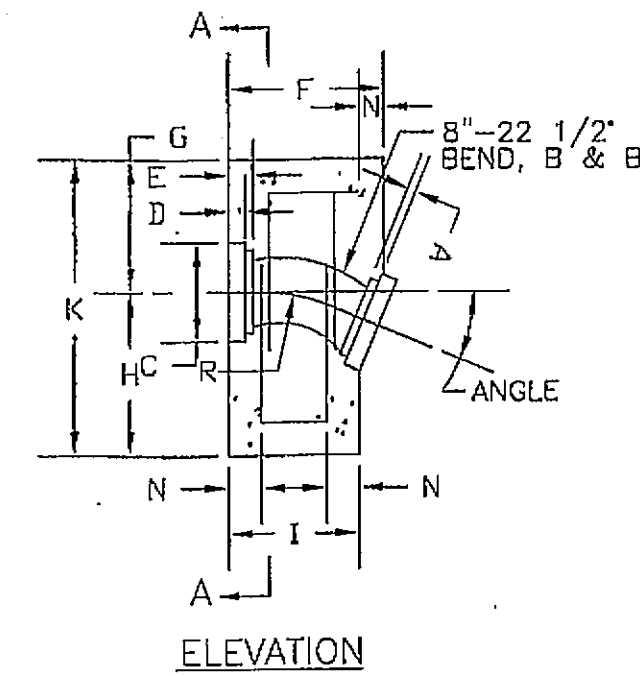
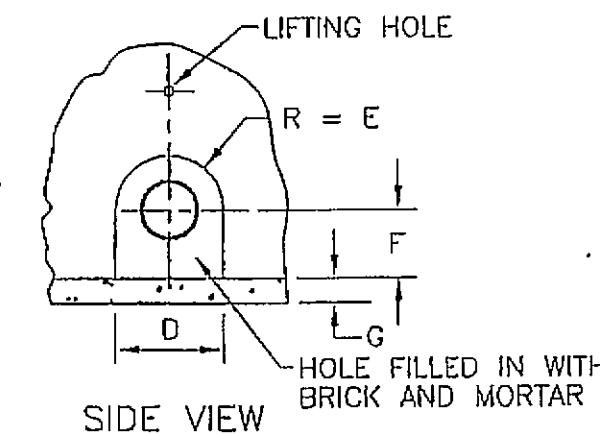
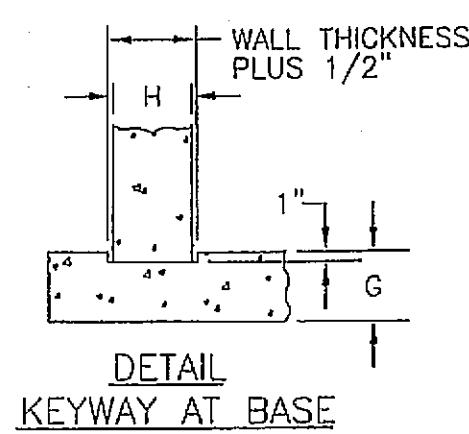
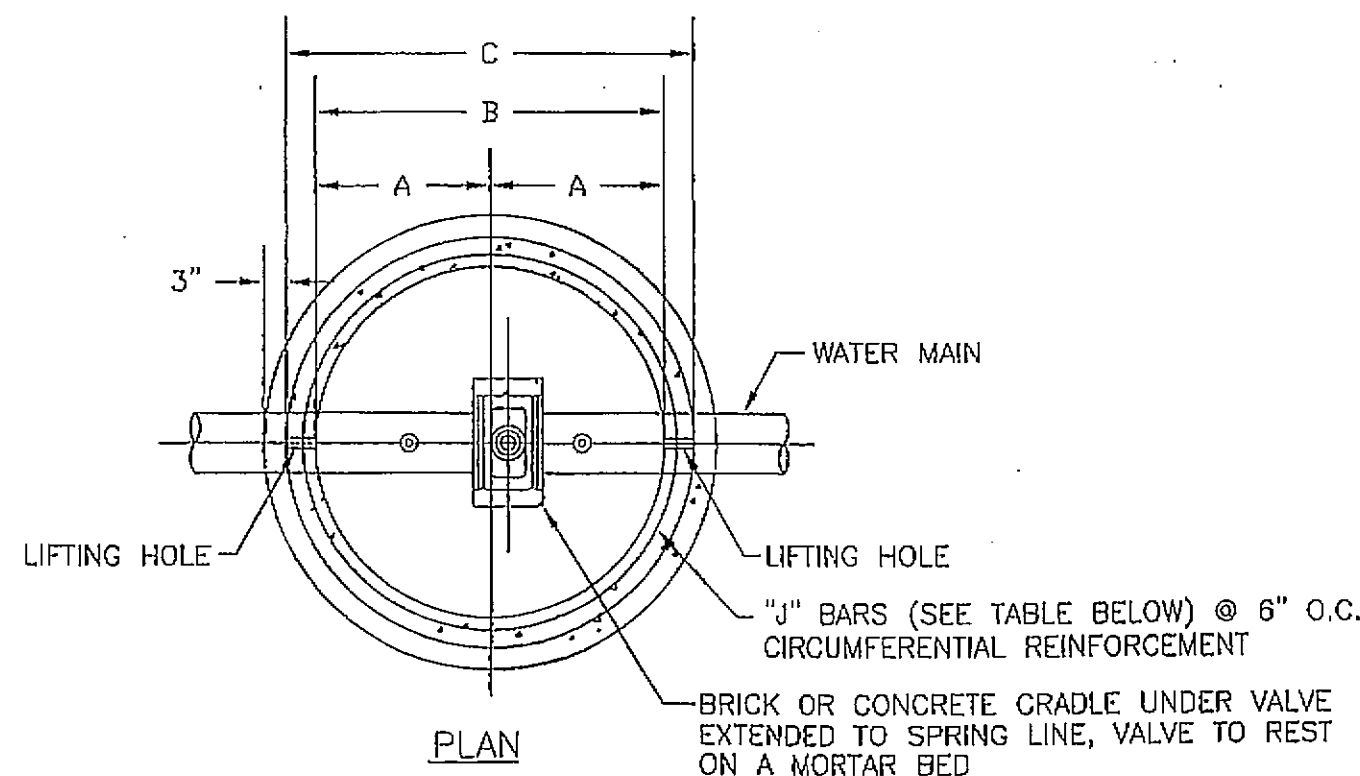
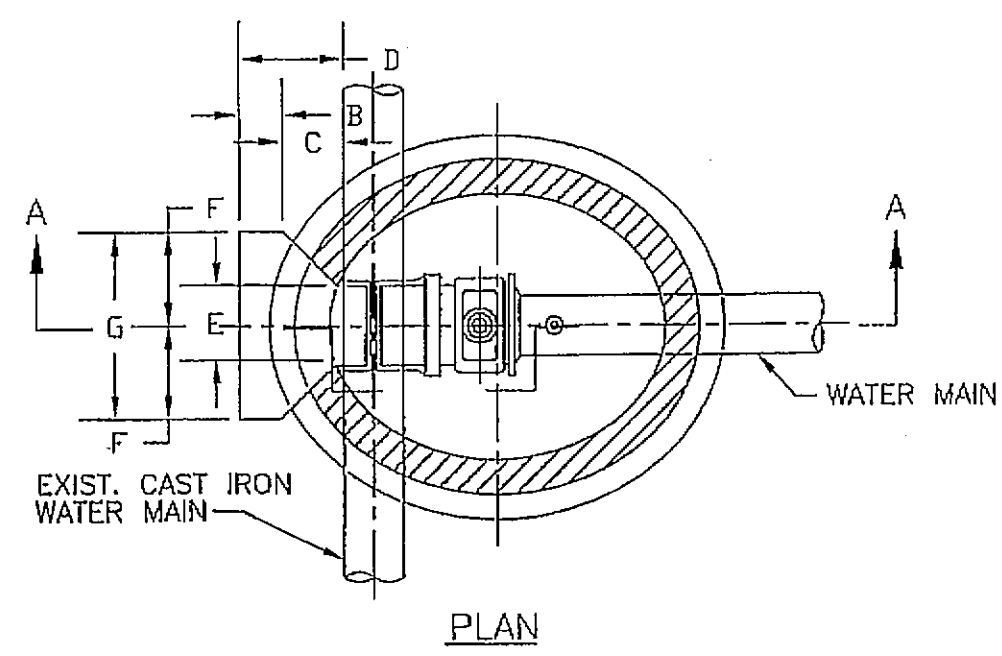
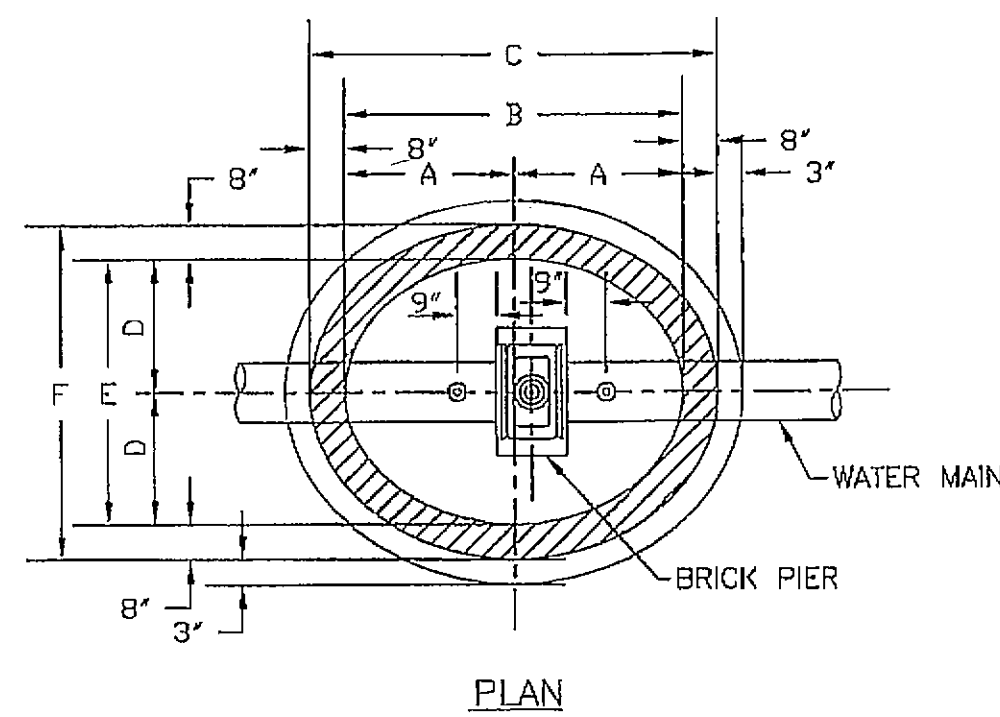
SCALE: AS SHOWN

CDM Camp Dresser & McKee
MTR
SIGMA
engineers, architects

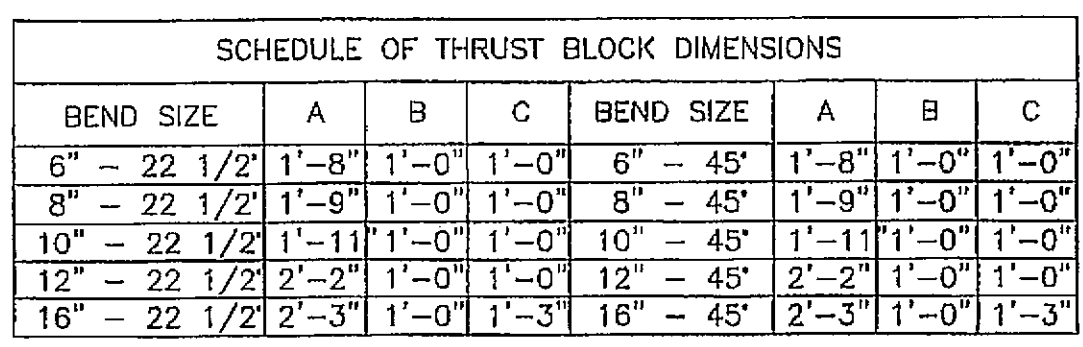
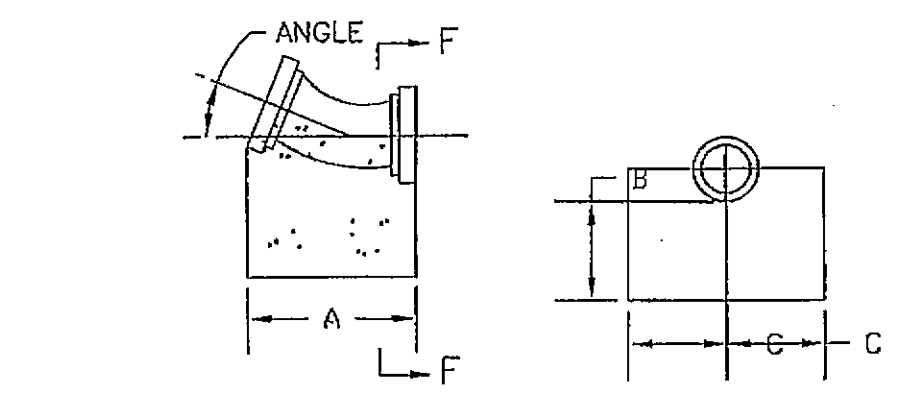
CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE
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M.D.P.H./D.N.R. PERMIT NO.
999112
FAMS NO.
473466
CONTRACT NO.
PC-732
FILE NO.
1441
D-98-10-008



BRICK OR CONCRETE CRADLE SUPPORT
DWSD TYTON JOINT GATE VALVES



SIZE	A	B	C	D	E	F
6" X 8"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"
8" X 12"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"
12" X 16"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"
16" X 24"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"
24" X 36"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"

BRICK CONSTRUCTION NOTE:
WHERE A REDUCER/OMNI COUPLING IS CALLED FOR ON THE DRAWINGS, THE FACE OF THE NEAREST JOINT ON THE REDUCER/OMNI COUPLING SHALL BE APPROX. 2 FT. OR AS SHOWN ON THE DRAWING FROM THE OUTSIDE FACE OF THE WELL WALL.

DETAIL OF STANDARD GATE WELL
FOR USE WITH CAST IRON OR DUCTILE IRON PIPE

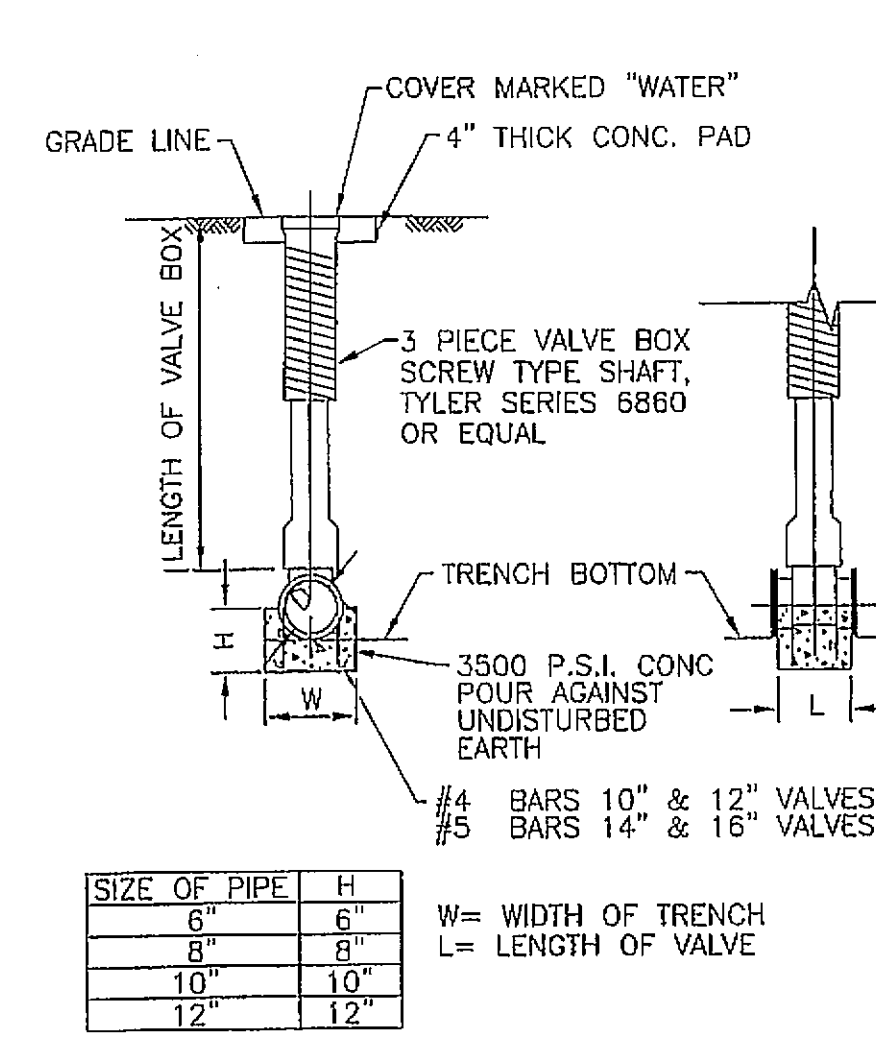
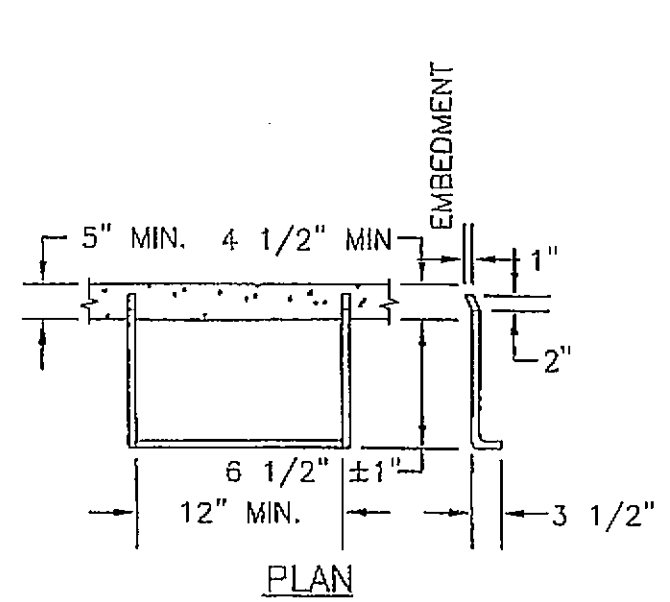
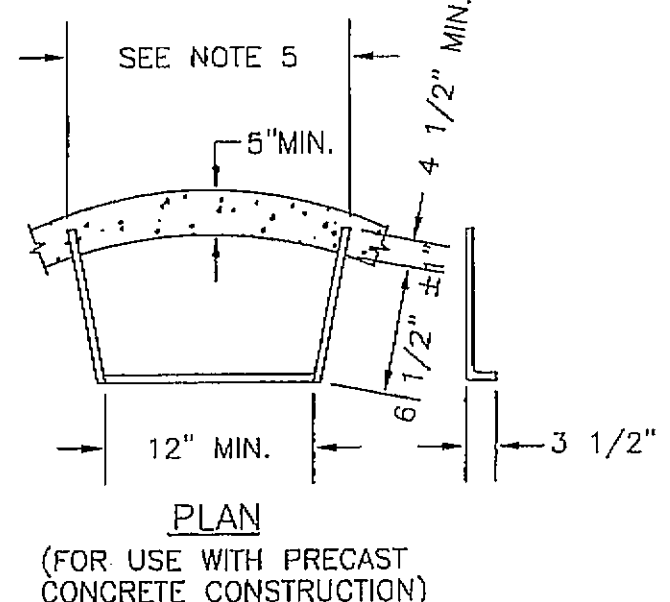
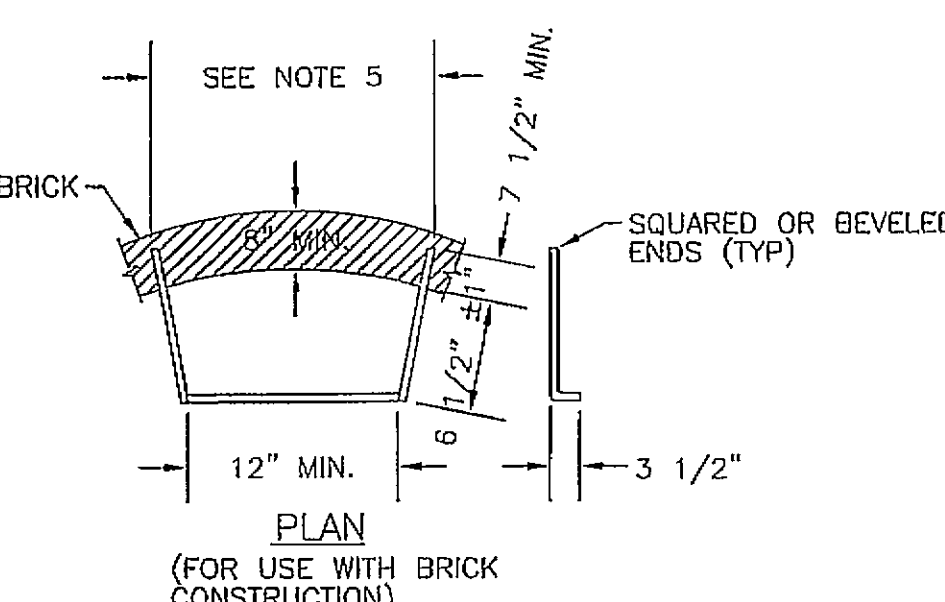
SIZE	A	B	C	D	E	F	G	H	J
8" X 8"	1'-6"	3'-4"	-	-	7"	-	-	-	-
12" X 8"	1'-6"	3'-4"	-	-	7"	-	-	-	-
16" X 8"	1'-6"	3'-4"	-	-	7"	-	-	-	-
12" X 12"	1'-6"	3'-4"	-	-	7"	-	-	-	-
16" X 12"	1'-6"	3'-4"	-	-	7"	-	-	-	-

DETAIL OF STANDARD THRUST BLOCK
FOR TAPPING VALVE

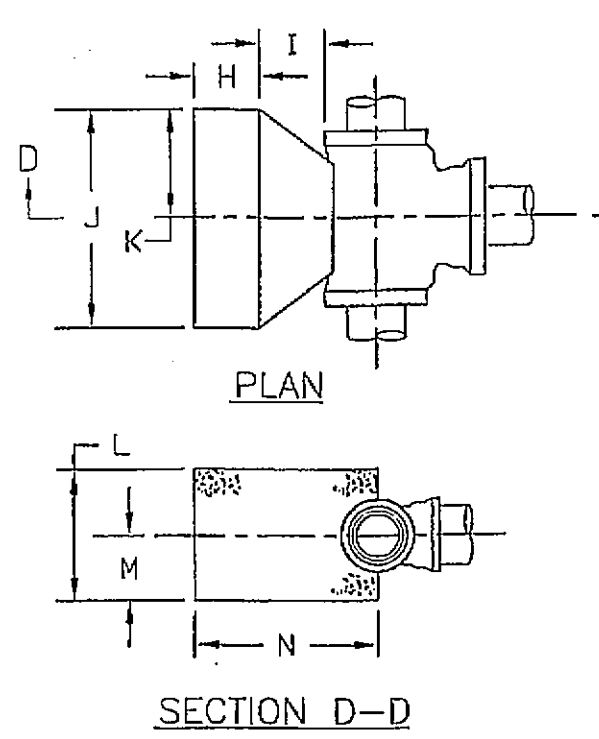
SIZE	A	B	C	D	E	F	G	H	J
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8" X 12"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"	1'-2"	1'-2"	1'-2"
12" X 16"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"	1'-2"	1'-2"	1'-2"
16" X 24"	2'-6"	5'-0"	6'-4"	2'-0"	4'-0"	5'-4"	1'-2"	1'-2"	1'-2"

PRECAST CONCRETE NOTES:
PRECAST CONCRETE MANHOLE SECTIONS SHALL CONFORM TO ALL THE REQUIREMENTS OF "SPECIFICATIONS FOR PRECAST REINFORCED CONCRETE MANHOLE RISERS AND TOPS" A.S.T.M. C-478 WITH MODIFIED GROOVED TONGUE JOINTS AND RUBBER GASKETS.
EACH SECTION SHALL HAVE NOT MORE THAN TWO HOLES FOR HANDLING PURPOSES. THESE HOLES SHALL BE SATISFACTORILY PLUGGED AFTER INSTALLATION.

DETAIL OF PRECAST GATE WELLS



VALVE BLOCK AND BOX DETAIL
SCALE: NTS



SECTION D-D

TEE SIZE	H	I	J	K	L	M	N	P
6" X 6"	0'-9"	1'-0"	2'-6"	1'-3"	1'-6"	0'-9"	2'-3"	0'-6"
8" X 8"	0'-9"	1'-0"	3'-0"	1'-6"	2'-0"	1'-0"	2'-3"	0'-6"
12" X 8"	0'-9"	1'-0"	3'-0"	1'-6"	2'-0"	1'-0"	2'-3"	0'-6"
12" X 12"	0'-9"	1'-0"	4'-0"	2'-0"	3'-0"	1'-6"	2'-9"	0'-8"
16" X 8"	0'-9"	1'-0"	3'-0"	1'-6"	2'-0"	1'-0"	2'-9"	0'-6"
16" X 12"	0'-9"	1'-0"	4'-0"	2'-0"	3'-0"	1'-6"	3'-1"	0'-8"
16" X 16"	1'-0"	1'-0"	5'-0"	2'-6"	4'-0"	2'-0"	3'-8"	0'-11"

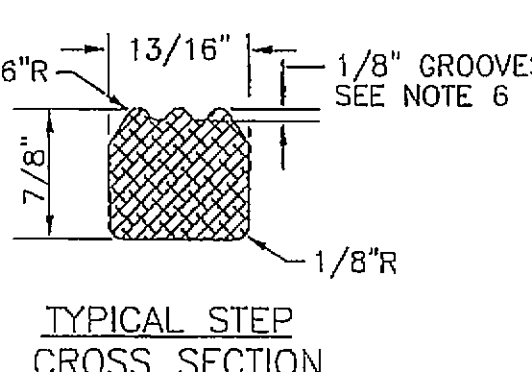
DETAIL OF STANDARD THRUST BLOCKS
FOR TEES
NO SCALE

BEND SIZE	Q	R	S	T	U	V	W	X
6" - 45°	0'-9"	1'-0"	2'-0"	1'-0"	1'-6"	0'-9"	1'-11"	1'-4"
6" - 90°	0'-9"	1'-0"	3'-0"	1'-6"	2'-0"	1'-6"	1'-11"	1'-2"
8" - 45°	0'-9"	1'-0"	2'-4"	1'-2"	2'-0"	1'-0"	1'-11"	1'-4"
8" - 90°	0'-9"	1'-0"	3'-4"	1'-8"	2'-6"	1'-3"	1'-11"	1'-2"
12" - 22 1/2°	0'-9"	1'-0"	2'-6"	1'-3"	2'-0"	1'-0"	2'-0"	1'-4"
12" - 45°	0'-9"	1'-0"	3'-6"	1'-9"	2'-6"	1'-3"	2'-4"	1'-4"
12" - 90°	0'-9"	1'-0"	5'-6"	2'-9"	3'-6"	1'-6"	2'-4"	1'-8"
16" - 22 1/2°	1'-0"	1'-8"	3'-4"	1'-8"	2'-6"	1'-3"	3'-0"	1'-2"
16" - 45°	1'-0"	1'-8"	5'-4"	2'-8"	3'-6"	1'-6"	3'-0"	2'-6"
16" - 90°	1'-0"	1'-8"	6'-0"	3'-0"	5'-0"	2'-6"	3'-0"	2'-8"

DETAIL OF STANDARD THRUST BLOCKS
FOR BENDS
NO SCALE

- MANHOLE STEP NOTES:
- MANHOLE STEPS SHALL BE INSTALLED IN WELL WALL WHERE HEIGHT FROM TOP OF PIPE TO TOP OF WELL EXCEEDS 5'-0".
 - MANHOLE STEPS SHALL CONFORM TO THE REQUIREMENTS FOR "ALUMINUM ALLOY EXTRUDED BARS, RODS, SHAPES AND TUBES", A.S.T.M. B-221 (CURRENT), ALLOY 6061, TEMPER T-6 OR APPROVED EQUAL.
 - EITHER THE FLARED LEG OR PARALLEL LEG STEP MAY BE USED FOR POURED IN PLACE CONCRETE CONSTRUCTION OR IN WETCAST MANHOLE UNITS.
 - THE PARALLEL LEG STEP SHALL BE USED IN EXISTING STRUCTURES BY PLACING IN DRILLED HOLES AND GROUTING WITH NON-SHRINK GROUT.
 - FLARED LEGS SHALL BE RADIAL TO THE MANHOLE WALL.

- IN LIEU OF GROOVES, ALTERNATE FOOTHOLD CONFIGURATION WILL BE CONSIDERED FOR APPROVAL.
- THE VERTICAL SPACING BETWEEN INSTALLED STEPS SHALL NOT BE MORE THAN SIXTEEN INCHES.
- ALL MANHOLE STEPS SHALL COMPLY WITH SAFETY STANDARDS (PART 3 FIXED LADDERS) AS ESTABLISHED BY THE OCCUPATIONAL SAFETY STANDARDS COMMISSION OF THE MICHIGAN DEPARTMENT OF LABOR.



TYPICAL STEP
CROSS SECTION

DETROIT WATER AND SEWERAGE DEPARTMENT
WASTEWATER COLLECTION SYSTEM IMPROVEMENTS
LEIB SCREENING AND DISINFECTION FACILITY
SITE STANDARD DETAILS

SCALE: NONE

CDM Camp Dresser & McKee
consulting engineering construction operations



CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE

M.D.P.H./D.N.R. PERMIT NO.
999112
FAMIS NO.
473466
CONTRACT NO.
PC-732
FILE NO. 1441

D-98-10-009

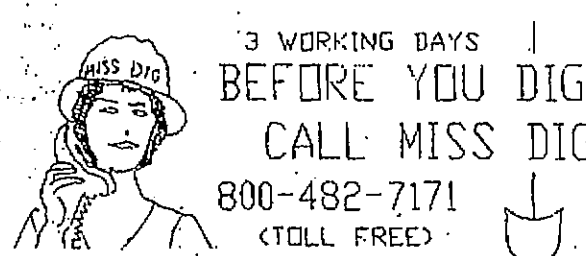
MICHIGAN UNIFIED KEYING SYSTEM
SOIL EROSION & SEDIMENTATION CONTROL MEASURES

MICHIGAN
SOIL EROSION & SEDIMENTATION CONTROL
GUIDEBOOK

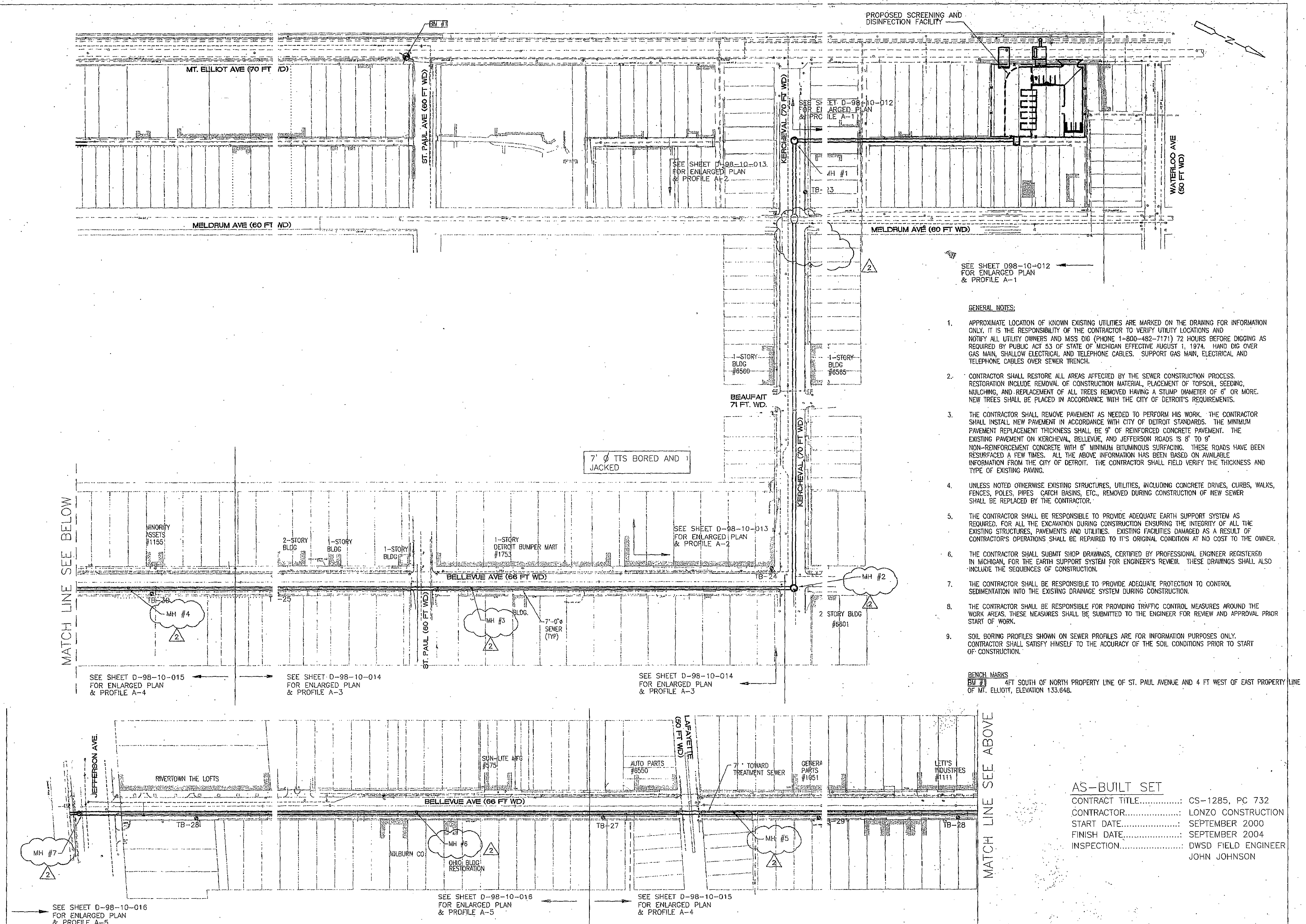
FEBRUARY 1975
FIGURE 2

Table with 3 columns: KEY, DETAIL, CHARACTERISTICS. It lists 53 erosion control measures (e.g., Strippling & Stockpiling, Selective Grazing, Grubbing Control, Vegetative Stabilization, Seeding, etc.) and their applicability to various site conditions (A-G).

PROJECTS 9805 CIVIL LC-07.DWG 02/19/99 JE



F	AS-BUILT SET		09/04	DESIGN	TZ
E				DRAFTING	JE
D				CHECKED	GK
C				APPROVED	EY
B					
A	REV. NO. 2 PER CONTRACTOR RFP'S		11/30/99		
	DESCRIPTION	CHECKED	APPROVED	DATE	



- GENERAL NOTES:**
- APPROXIMATE LOCATION OF KNOWN EXISTING UTILITIES ARE MARKED ON THE DRAWING FOR INFORMATION ONLY. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY UTILITY LOCATIONS AND NOTIFY ALL UTILITY OWNERS AND MISS DIG (PHONE 1-800-482-7171) 72 HOURS BEFORE DIGGING AS REQUIRED BY PUBLIC ACT 53 OF STATE OF MICHIGAN EFFECTIVE AUGUST 1, 1974. HAND DIG OVER GAS MAIN, SHALLOW ELECTRICAL AND TELEPHONE CABLES. SUPPORT GAS MAIN, ELECTRICAL AND TELEPHONE CABLES OVER SEWER TRENCH.
 - CONTRACTOR SHALL RESTORE ALL AREAS AFFECTED BY THE SEWER CONSTRUCTION PROCESS. RESTORATION INCLUDE REMOVAL OF CONSTRUCTION MATERIAL, PLACEMENT OF TOPSOIL, SEEDING, MULCHING, AND REPLACEMENT OF ALL TREES REMOVED HAVING A STUMP DIAMETER OF 6" OR MORE. NEW TREES SHALL BE PLACED IN ACCORDANCE WITH THE CITY OF DETROIT'S REQUIREMENTS.
 - THE CONTRACTOR SHALL REMOVE PAVEMENT AS NEEDED TO PERFORM HIS WORK. THE CONTRACTOR SHALL INSTALL NEW PAVEMENT IN ACCORDANCE WITH CITY OF DETROIT STANDARDS. THE MINIMUM PAVEMENT REPLACEMENT THICKNESS SHALL BE 9" OF REINFORCED CONCRETE PAVEMENT. THE EXISTING PAVEMENT ON KERCHEVAL, BELLEVUE, AND JEFFERSON ROADS IS 8" TO 9" NON-REINFORCEMENT CONCRETE WITH 6" MINIMUM BITUMINOUS SURFACING. THESE ROADS HAVE BEEN RESURFACED A FEW TIMES. ALL THE ABOVE INFORMATION HAS BEEN BASED ON AVAILABLE INFORMATION FROM THE CITY OF DETROIT. THE CONTRACTOR SHALL FIELD VERIFY THE THICKNESS AND TYPE OF EXISTING PAVING.
 - UNLESS NOTED OTHERWISE EXISTING STRUCTURES, UTILITIES, INCLUDING CONCRETE DRIVES, CURBS, WALKS, FENCES, POLES, PIPES, CATCH BASINS, ETC., REMOVED DURING CONSTRUCTION OF NEW SEWER SHALL BE REPLACED BY THE CONTRACTOR.
 - THE CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE ADEQUATE EARTH SUPPORT SYSTEM AS REQUIRED. FOR ALL THE EXCAVATION DURING CONSTRUCTION ENSURING THE INTEGRITY OF ALL THE EXISTING STRUCTURES, PAVEMENTS AND UTILITIES. EXISTING FACILITIES DAMAGED AS A RESULT OF CONTRACTOR'S OPERATIONS SHALL BE REPAIRED TO ITS ORIGINAL CONDITION AT NO COST TO THE OWNER.
 - THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS, CERTIFIED BY PROFESSIONAL ENGINEER REGISTERED IN MICHIGAN, FOR THE EARTH SUPPORT SYSTEM FOR ENGINEER'S REVIEW. THESE DRAWINGS SHALL ALSO INCLUDE THE SEQUENCES OF CONSTRUCTION.
 - THE CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE ADEQUATE PROTECTION TO CONTROL SEDIMENTATION INTO THE EXISTING DRAINAGE SYSTEM DURING CONSTRUCTION.
 - THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING TRAFFIC CONTROL MEASURES AROUND THE WORK AREAS. THESE MEASURES SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW AND APPROVAL PRIOR START OF WORK.
 - SOIL BORING PROFILES SHOWN ON SEWER PROFILES ARE FOR INFORMATION PURPOSES ONLY. CONTRACTOR SHALL SATISFY HIMSELF TO THE ACCURACY OF THE SOIL CONDITIONS PRIOR TO START OF CONSTRUCTION.
- BENCH MARKS**
BM #1 4 FT SOUTH OF NORTH PROPERTY LINE OF ST. PAUL AVENUE AND 4 FT WEST OF EAST PROPERTY LINE OF MT. ELLIOTT, ELEVATION 133.646.

AS-BUILT SET

CONTRACT TITLE.....	CS-1285, PC 732
CONTRACTOR.....	LONZO CONSTRUCTION
START DATE.....	SEPTEMBER 2000
FINISH DATE.....	SEPTEMBER 2004
INSPECTION.....	DWSD FIELD ENGINEER JOHN JOHNSON

DETROIT WATER AND SEWERAGE DEPARTMENT
WASTEWATER COLLECTION SYSTEM IMPROVEMENTS

LEIB SCREENING AND DISINFECTION FACILITY
TOWARD TREATMENT SEWER (TTS)

OVERALL PLAN

SCALE: 1" = 100'-0"

CDM Camp Dresser & McKee

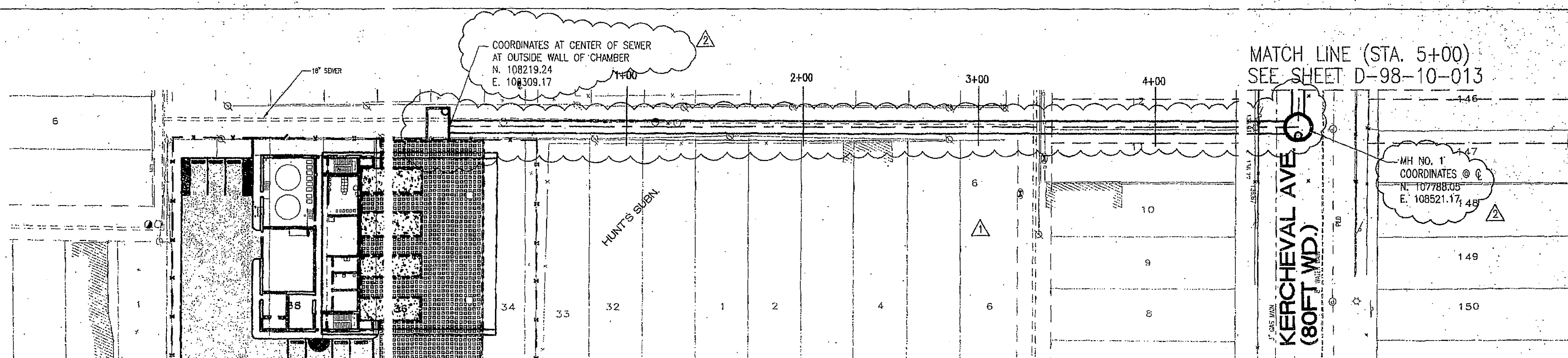
MHR

SIGMA associates, inc. engineers+architects

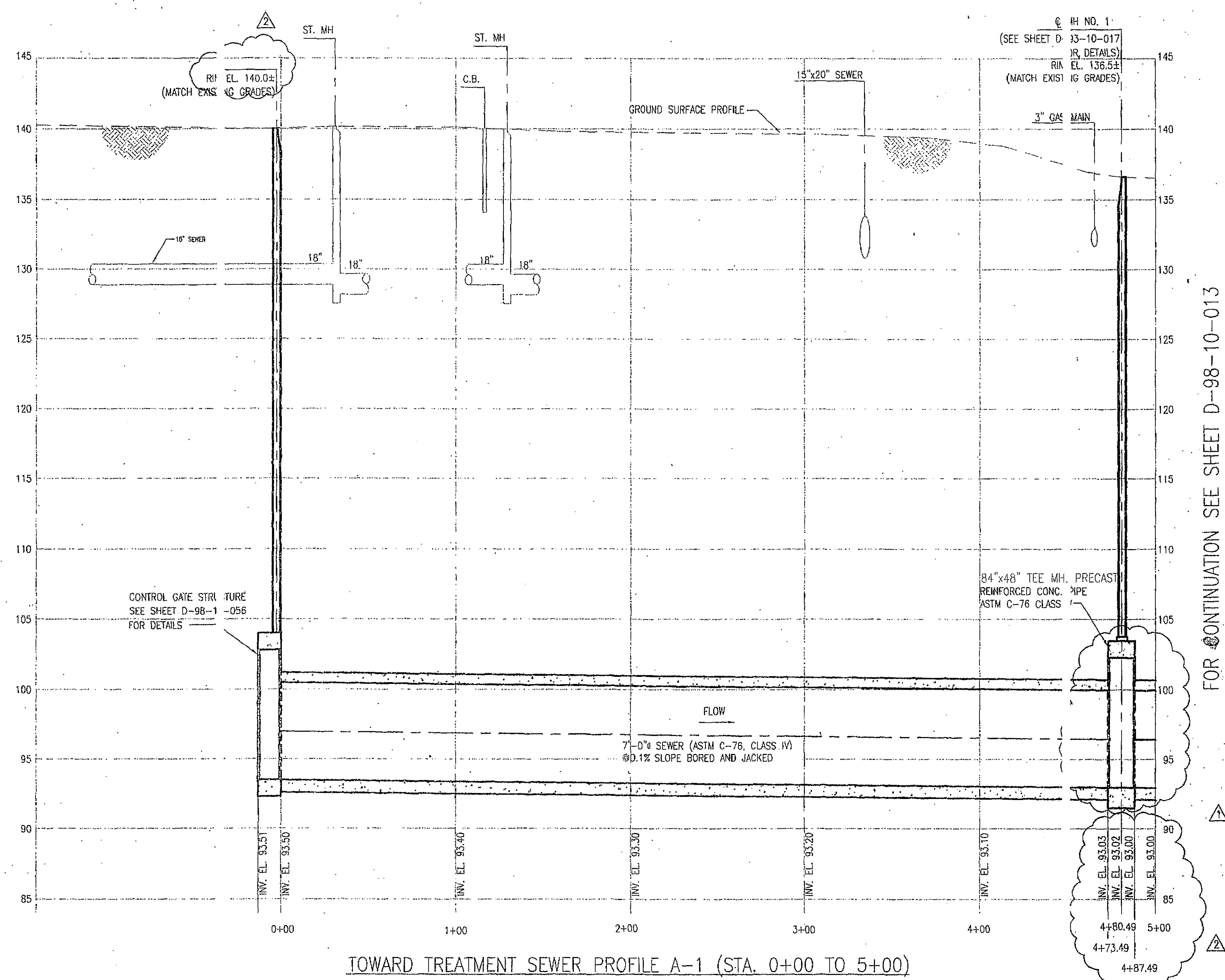
CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE
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M.D.P.H./D.N.R. PERMIT NO.	999112
FAMIS NO.	473466
CONTRACT NO.	PC-732
FILE NO.	1441
D-98-10-011	



PLAN
SCALE: 1" = 40'



FOR CONTINUATION SEE SHEET D-98-10-013

AS-BUILT SET.
CONTRACT TITLE..... CS-1285, PC 732
CONTRACTOR..... LONZO CONSTRUCTION
START DATE..... SEPTEMBER 2000
FINISH DATE..... SEPTEMBER 2004
INSPECTION..... DWSD FIELD ENGINEER
JOHN JOHNSON



F	AS-BUILT SET			09/04	DESIGN	TZ
E						
D					DRAFTING	JE
C						
B	REV. NO. 2 PER CONTRACTOR RPT'S			11/30/99	CHECKED	GK
A	REV. NO. 1 PER CONTRACTOR RPT'S			11/9/99		
	DESCRIPTION		CHECKED	APPROVED	DATE	EY

DETROIT WATER AND SEWERAGE DEPARTMENT
W/ STEWATER COLLECTION SYSTEM IMPROVEMENTS

LEIB SCREENING AND DISINFECTION FACILITY
TTS PARTIAL PLAN AND PROFILE

SHEET 1 OF 5

SCALE: AS S TOWN

CDM
consulting
engineering
construction
operations

Camp Dresser & McKee

NTH

MTF

SIGMA
associates, inc.
engineers + architects



CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP	TOWN	RANGE	SECTION	PORTION CODE

M.D.P.H./D.N.R. PERMIT NO.
999112

FAMIS NO.
473466

CONTRACT NO.
PC-732

FILE NO.
1441

D-98-10-012

Appendix H

Leib Utility Files

UTILITY PROVIDER	CONTACT #	MISS DIG RESULTS	DATE
AT&T TELEPHONE	(231) 409-7939	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (WATER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT CITY WATER & SEWER (SEWER)	(313) 999-4761	RECEIVED	10/26/2022
DETROIT PUBLIC LIGHTING ELECTRIC	(313) 267-5130	NOT RECEIVED	
DTE ENERGY (ELECTRIC) ELECTRIC	(313) 407-5364	RECEIVED	11/8/2022
DTE ENERGY (GAS) GAS	(248) 318-7839	RECEIVED	10/26/2022
GREAT LAKES WATER AUTHORITY (WATER)	(313) 799-0289	RECEIVED	11/8/2022
GREAT LAKES WATER AUTHORITY (SEWER)	(313) 799-0289	RECEIVED	11/8/2022
INTERNATIONAL TRANSMISSION CO. (FIBER OPTICS)	(888) 269-8740	RECEIVED	11/4/2022
MCI/VERIZON BUSINESS FIBER OPTICS	(800) 624-9675	NOT RECEIVED	
NEXTEL COMMUNICATIONS FIBER OPTIC	(816) 309-4004	NOT RECEIVED	

JOB #: SM22-200

JOB NAME: GLWA - LEIB

MISS DIG TICKET #: 2022102503675

TICKET CREATED ON: 10/25/2022

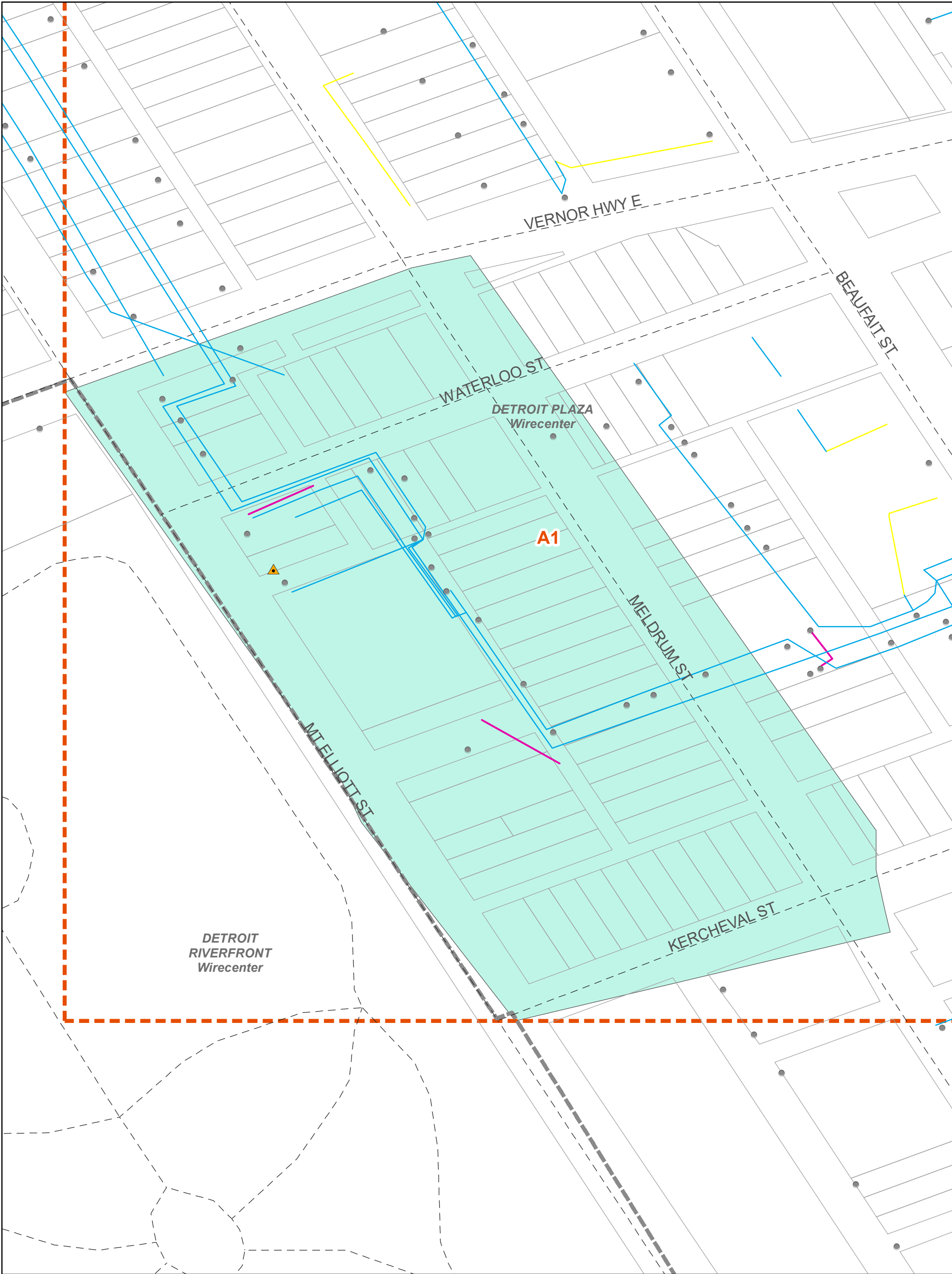
TICKET CLOSE DATE:



External Map Request for Spalding Dedecker

Mt Elliott St Project

Date: 10/28/2022
Index Map



1:1,541



- Poles
- Remote Terminals
- Aerial
- Building
- Conduit
- Street Centerlines
- Mapping Index
- Wirecenter Boundary
- Parcels
- JobAOI

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Planning and Design Service Area map

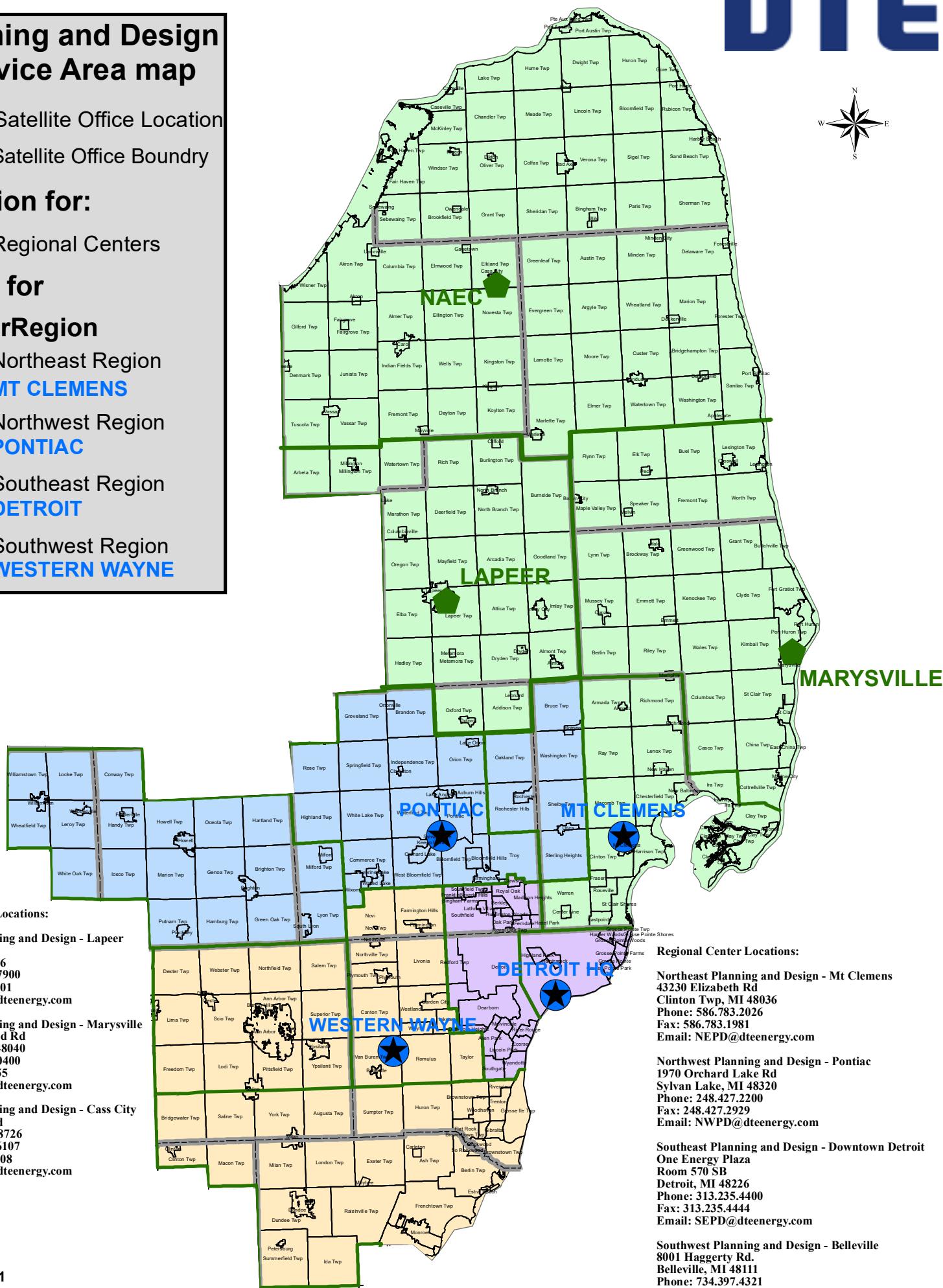
-  Satellite Office Location
-  Satellite Office Boundry

Location for:

-  Regional Centers

Areas for ClusterRegion

-  Northeast Region
MT CLEMENS
-  Northwest Region
PONTIAC
-  Southeast Region
DETROIT
-  Southwest Region
WESTERN WAYNE



Satellite Office Locations:

Northeast Planning and Design - Lapeer
1100 Clark Rd
Lapeer, MI 48446
Phone: 810.667.7900
FAX: 810.667.7901
Email: NEPD@dteenergy.com

Northeast Planning and Design - Marysville
3223 Ravenswood Rd
Marysville, MI 48040
Phone: 810.364.0400
Fax: 810.364.0455
Email: NEPD@dteenergy.com

Northeast Planning and Design - Cass City
4100 Doerr Road
Cass City, MI 48726
Office: 989.872.6107
FAX: 989.872.6108
Email: NEPD@dteenergy.com

Regional Center Locations:

Northeast Planning and Design - Mt Clemens
43230 Elizabeth Rd
Clinton Twp, MI 48036
Phone: 586.783.2026
Fax: 586.783.1981
Email: NEPD@dteenergy.com

Northwest Planning and Design - Pontiac
1970 Orchard Lake Rd
Sylvan Lake, MI 48320
Phone: 248.427.2200
Fax: 248.427.2929
Email: NWPDP@dteenergy.com

Southeast Planning and Design - Downtown Detroit
One Energy Plaza
Room 570 SB
Detroit, MI 48226
Phone: 313.235.4400
Fax: 313.235.4444
Email: SEPD@dteenergy.com

Southwest Planning and Design - Belleville
8001 Haggerty Rd.
Belleville, MI 48111
Phone: 734.397.4321
FAX: 734.397.4338
Email: SWPD@dteenergy.com

22-OCT-2021

Revised 09-30-2015 by Data Integrity/Mapping Tech
File: Png_Des_Bdry_w_Emails_Sept_2015.mxd

Please note:

All documentation to be reviewed at the Utility Coordination Meeting must be received at least 10 business days prior to the meeting date: Send all information to the Regional Planning Office where your project is located. **See Planning and Design Service Area Map.**

For all future correspondence on this request, please contact the Regional Planning Office for your project.

To help facilitate timely electric utility coordination, please note the following:

Provide conflict list and associated drawings.

Specifically identify conflicts and provide locations of conflicts.

Poles and/or wire conflicts.

Street lighting posts and/or underground cable.

Underground facilities, i.e. cable, conduit, manholes and ground mounted equipment.

Send documents to the Regional Planning Office.

Documents must be received no less than 10 days before the Utility Coordination Meeting.

Requesting Company / Owner Agency to conduct Utility Coordination Meeting

The purpose of this meeting is to confirm design conflicts and discuss design options and/or relocation options.

Meeting should occur as soon as possible, but after the following have been completed.

Utilities have been plotted on Requesting Company / Owner Agency's design documents.

Conflicts have been identified by Requesting Company / Owner Agency.

Conflict list has been created by Requesting Company / Owner Agency.

Requesting Company / Owner Agency to conduct Pre-Construction Meeting

The purpose of this meeting is to confirm or coordinate the resolution of conflicts/relocations identified at the Utility Coordination Meeting.

Conflict information must be communicated prior to the Utility Coordination Meeting. Failure to do so will likely prevent DTE from meeting the project's utility relocation time line.

Things to Remember

Designers should be instructed to make every effort to avoid utility relocations.

Underground relocations can take up to 18 months or longer.

Overhead relocations can take 6 months or longer depending on the facilities involved.

LEGEND



.....

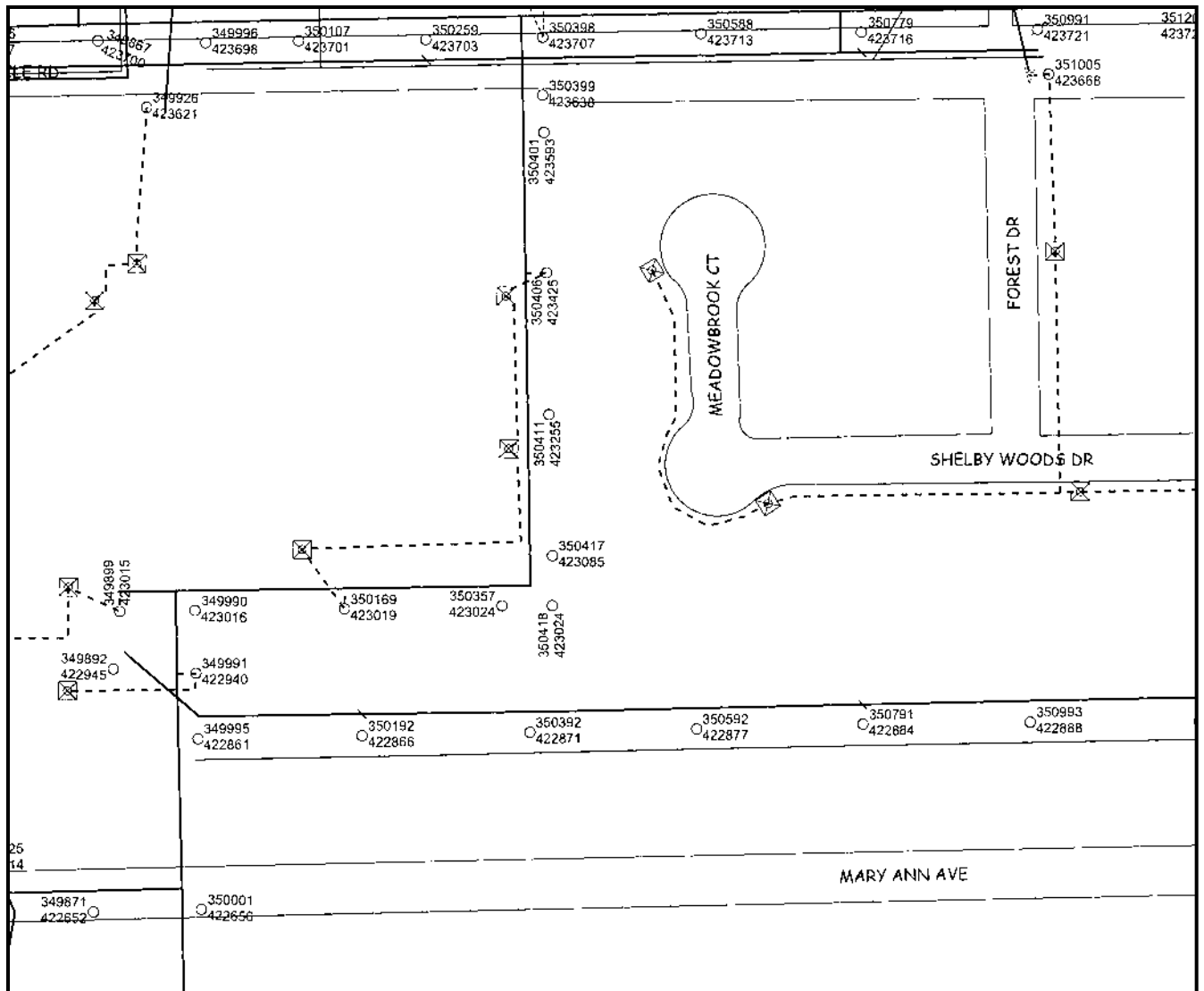


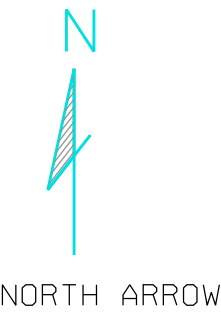
329081

411668

5

SAMPLE OF OUTSIDE SALES MAP





CONDUIT MAP CELLS

- CABLE POLE
- CP1

CABLE POLE TEXT
- 0000p000

* FIELDBOOK NUMBER
- MANHOLE
- 00000

* MANHOLE TEXT
- * 2 DIGIT PSC
- * 3 DIGIT PSC
- * 4 DIGIT PSC
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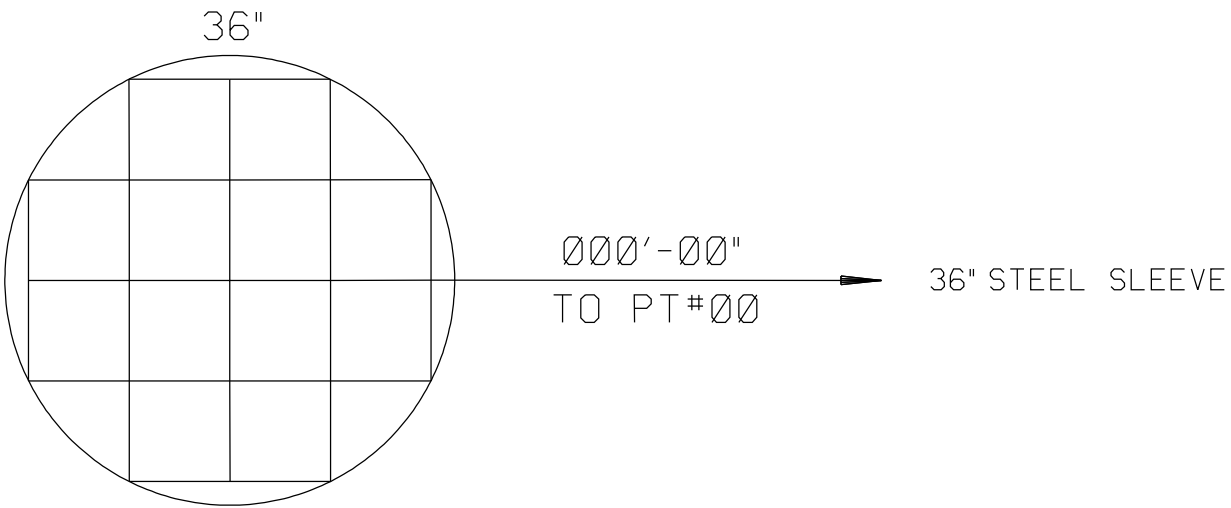
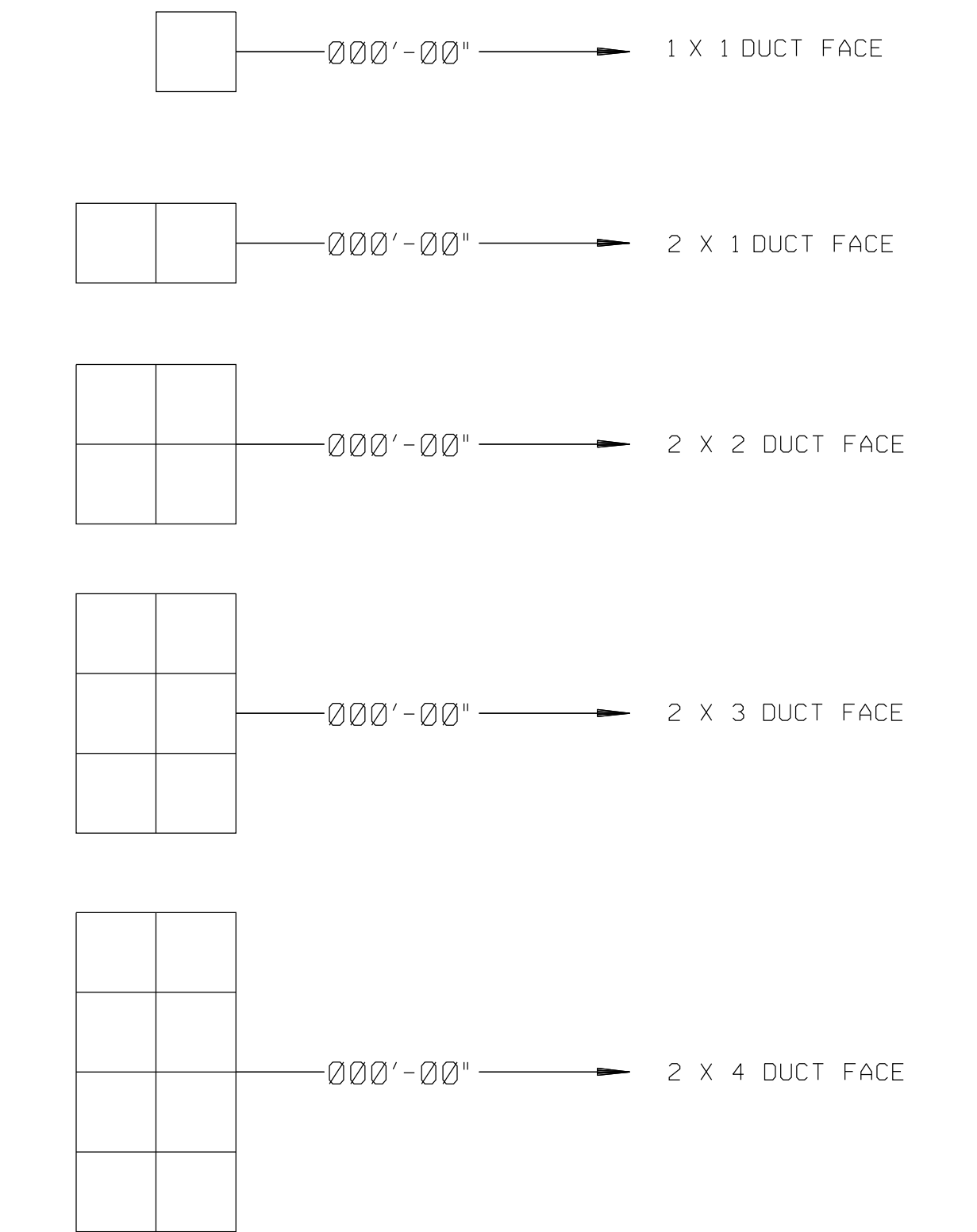
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- JOINT HOLE
- JT. HOLE

JOINT HOLE TEXT
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- * FIBER OPTIC (4 DUCT SLEEVES)
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* CABLE NOMENCLATURE
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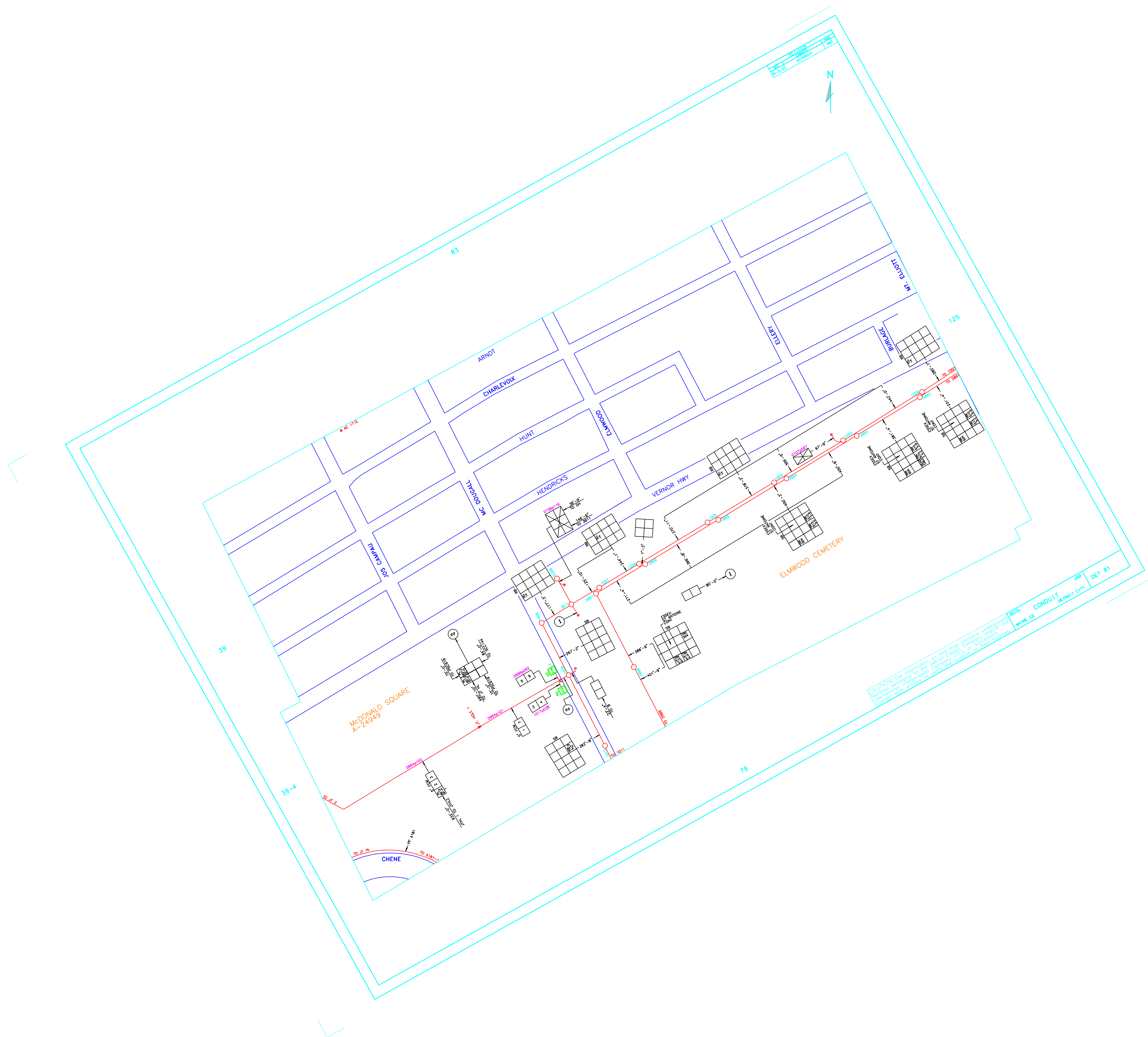
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- * FIBER OPTIC LEGEND(3 DUCT SLEEVES)
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- DO NOT DROP ELEMENT ON THESE CELLS

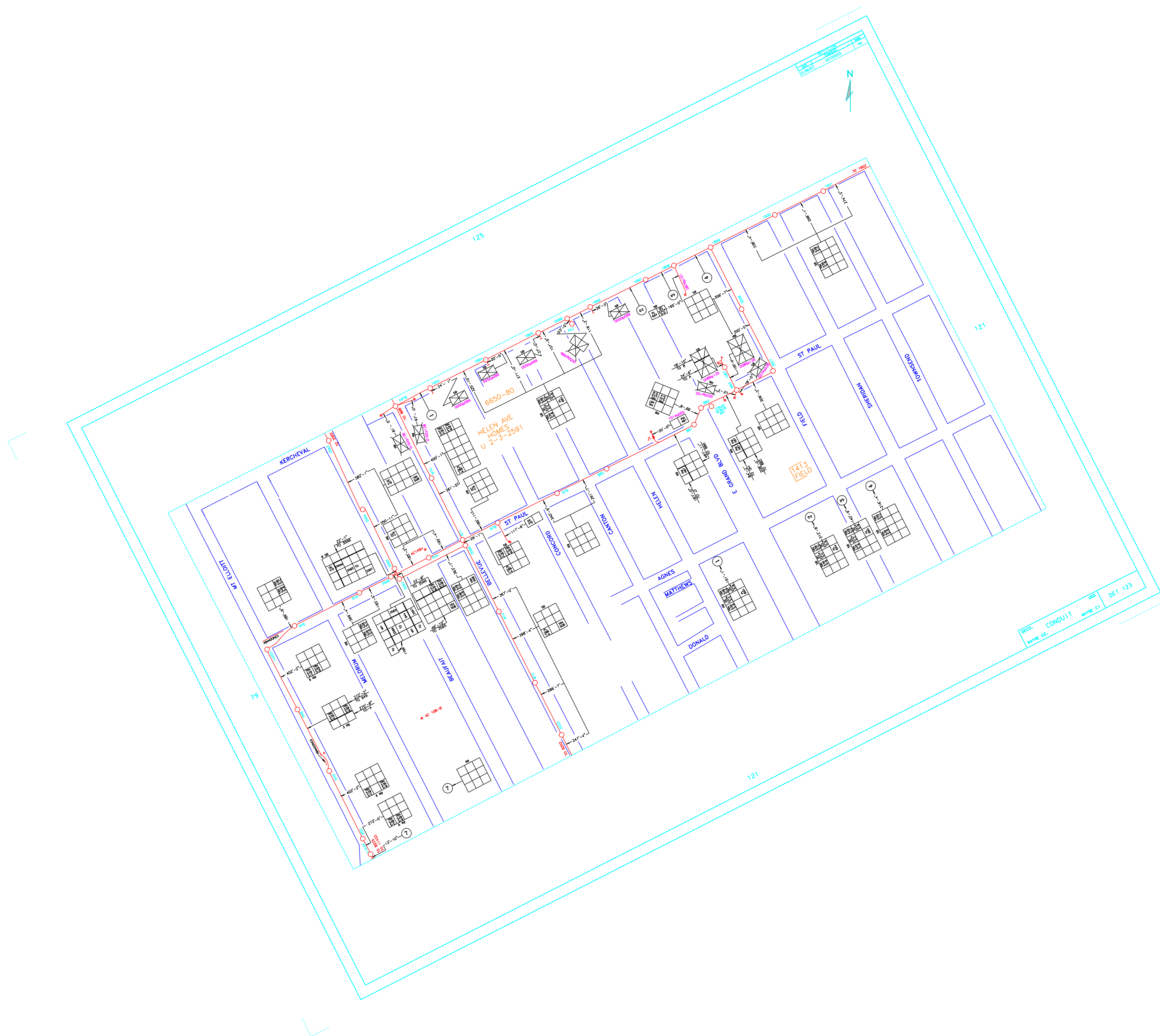


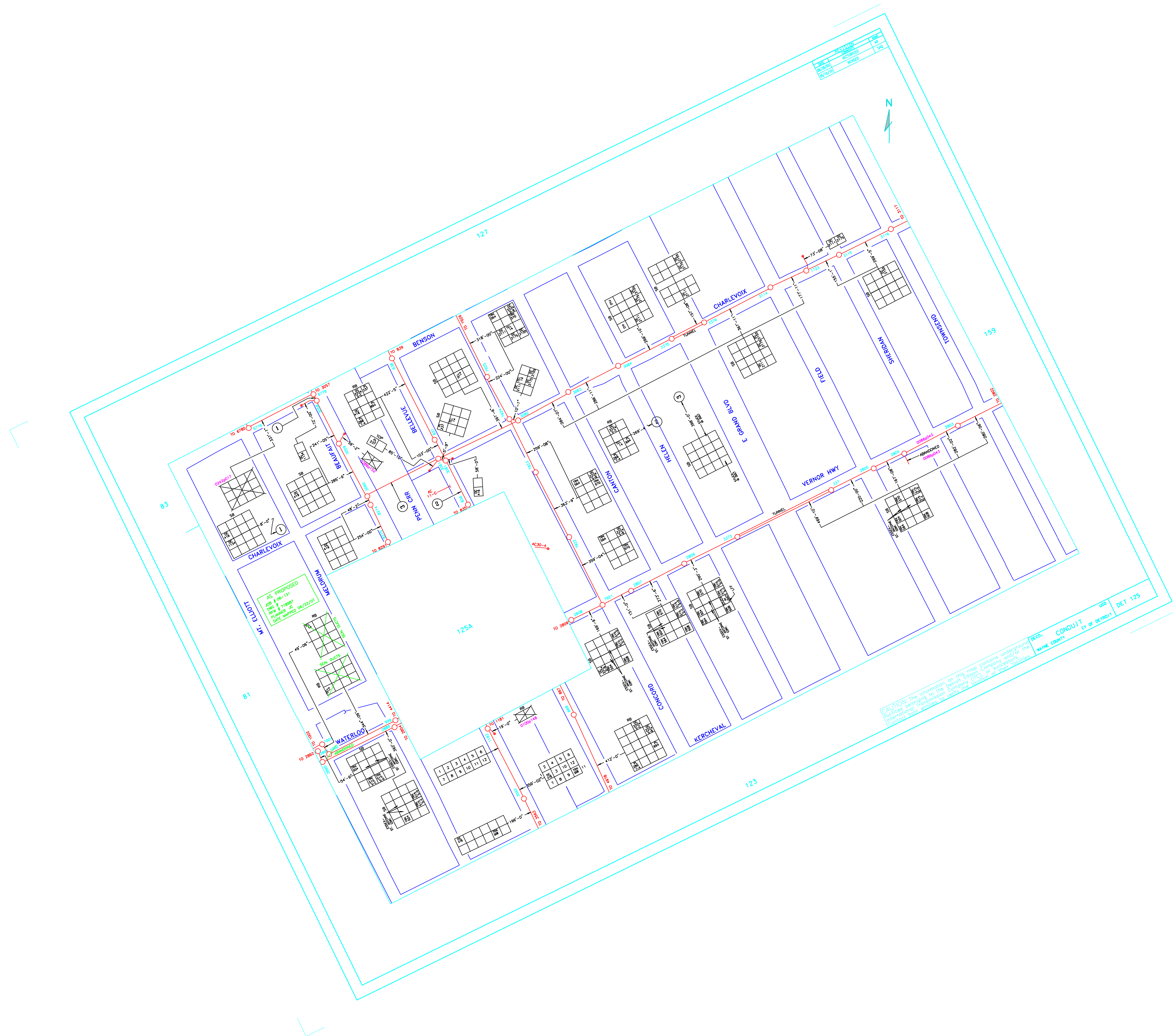
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CELLS TO BE PLACED FOR 1"=50' MAPS

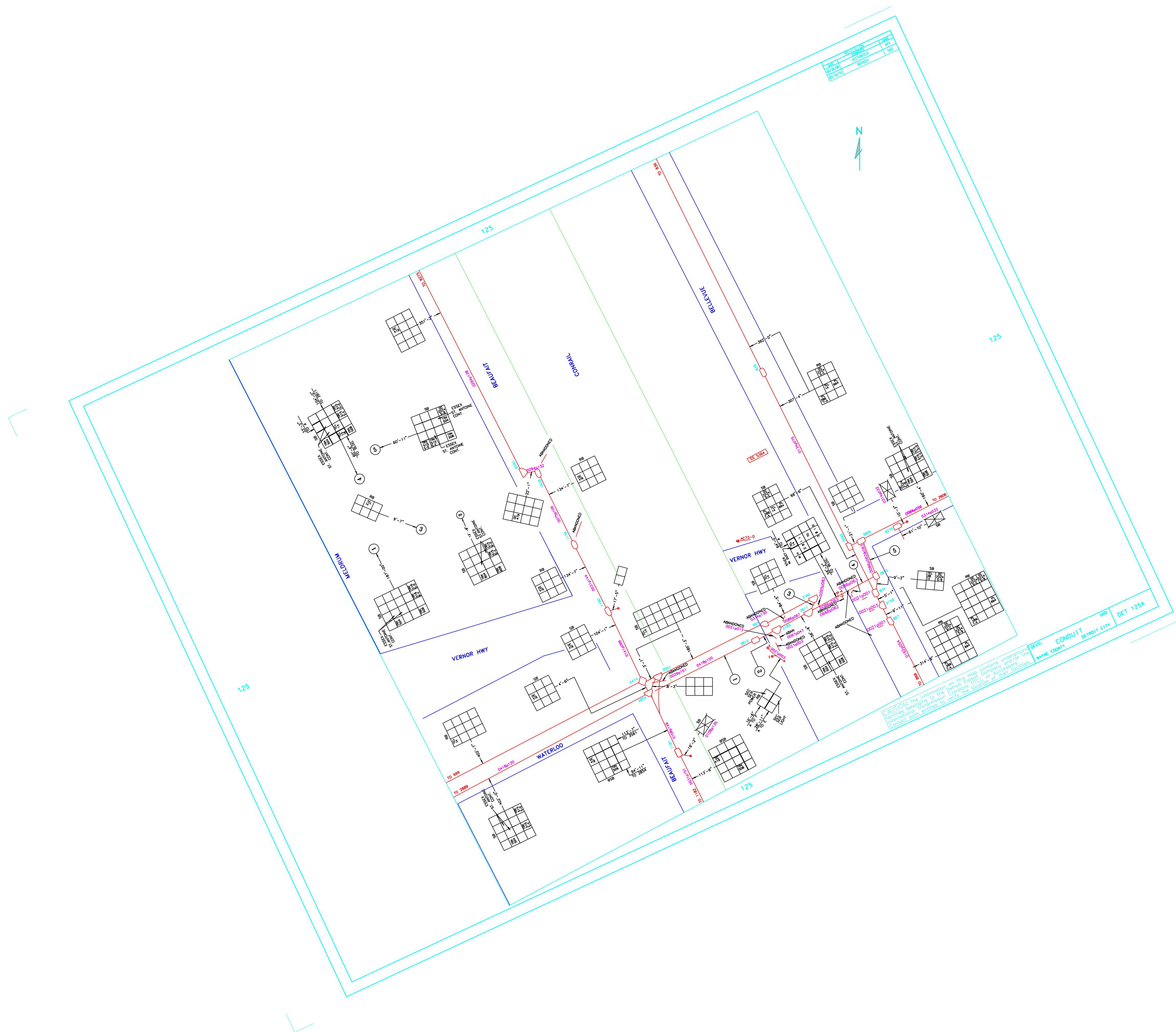
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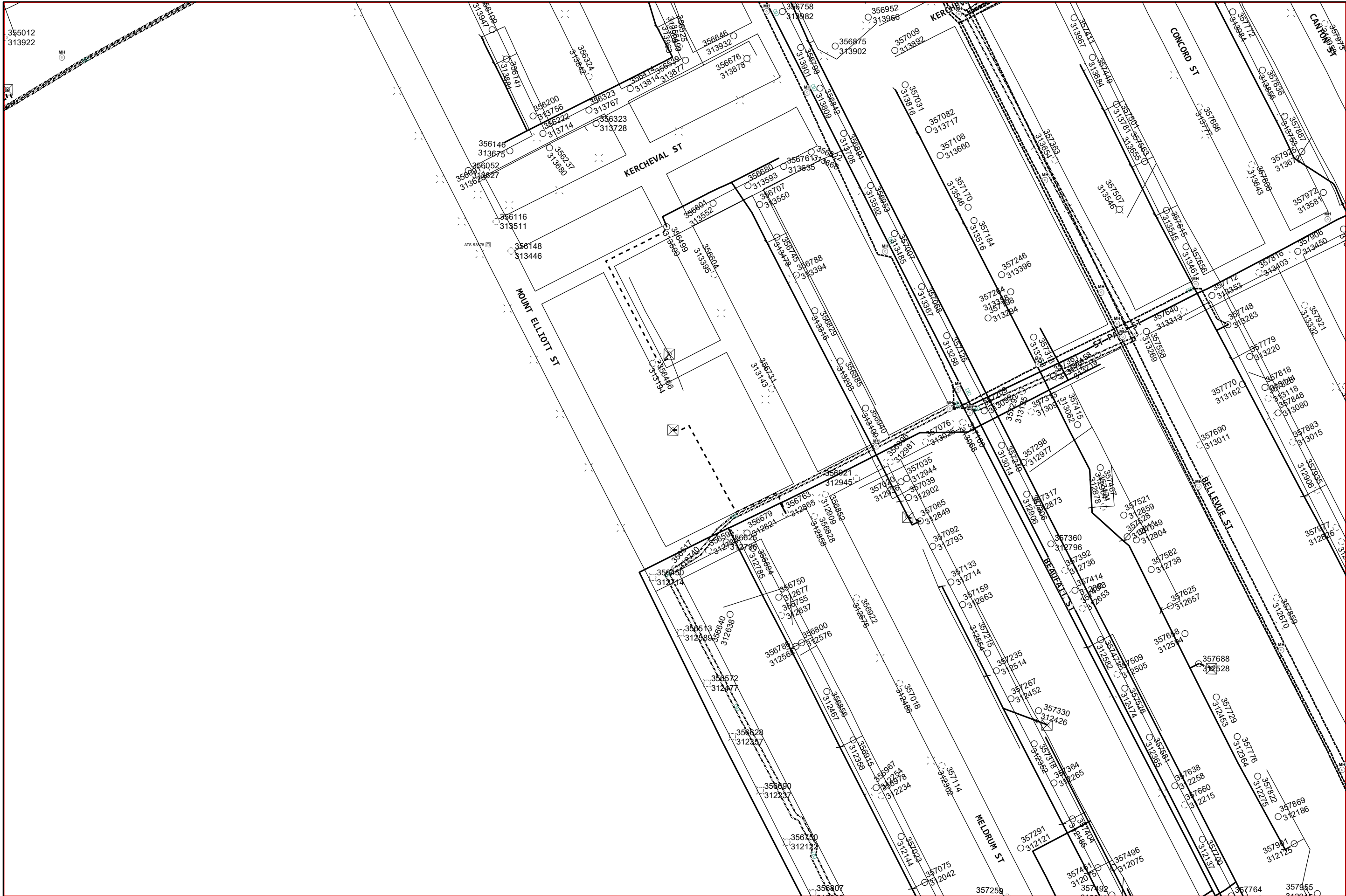
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DTE GAS COMPANY FACILITIES AS SHOWN
INDICATE APPROXIMATE LOCATIONS ONLY AS DISCLOSED BY THE
COMPANY'S RECORDS AND NO GUARANTEE IS MADE EITHER AS
TO COMPLETENESS OR ACCURACY.

DTE GAS COMPANY

October 26, 2022

CONSTRUCTION PLANS MADE SUBSEQUENT TO THIS DATE
SHOULD BE CHECKED WITH DTE GAS COMPANY

Pipe Material

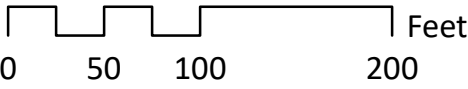
- CU - Copper
- PLA - Plastic
- STL - Bare Steel
- STL - Coated Steel
- CI - Cast Iron
- WI - Wrought Iron
- UN - Unknown
- Inactive
- Abandoned

Main Line Styles

- In Design Main (Proposed)
- Distribution Main
- Joint Trench
- Exposed Pipe
- Pipe Lining (CI or WI)
- Transmission Main
- Subtransmission Main
- Main dimensions are to ROW line unless otherwise noted.



STATE LAW ACT 174
3 WORKING DAYS
BEFORE YOU DIG
DIAL TOLL FREE
1-800-482-7171 OR 811



S, Keith <ksirois@sda-eng.com>

2022102503611 2022102503675 MISS DIG Information for Requested Area

1 message

Kenosha Davison <Kenosha.Davison@detroitmi.gov>

Wed, Oct 26, 2022 at 8:09 AM

To: "ksirois@sda-eng.com" <ksirois@sda-eng.com>Cc: David Ridgeway <David.Ridgeway@detroitmi.gov>, Norma Leonard <Norma.Leonard@detroitmi.gov>

Good morning,

Attached is our Water and Sewer utilities in the area.
Screen shots are given from GIS maps attached to word document.

Thanks,

Kenosha Davison*Field Service Coordination Specialist***Detroit Water and Sewerage Department •**

6425 Huber St. • Detroit, MI 48211

P: 313-267-1261

C: 313-267-1262

E: kenosha.davison@detroitmi.gov

Customer Care: 313-267-8000



MICHAEL DUGGAN, MAYOR

From: Kenosha Davison <Kenosha.Davison@detroitmi.gov>**Sent:** Thursday, September 29, 2022 10:35 AM**To:** ksirois@sda-eng.com <ksirois@sda-eng.com>**Cc:** David Ridgeway <David.Ridgeway@detroitmi.gov>; Norma Leonard <Norma.Leonard@detroitmi.gov>**Subject:** 2022092900817 MISS DIG Information for Requested Area

Good morning,

Attached is our Water and Sewer utilities in the area.
Screen shots are given from GIS maps attached to word document.

Thanks,

Kenosha Davison*Field Service Coordination Specialist***Detroit Water and Sewerage Department •**

6425 Huber St. • Detroit, MI 48211

P: 313-267-1261

C: 313-267-1262

E: kenosha.davison@detroitmi.gov

Customer Care: 313-267-8000



MICHAEL DUGGAN, MAYOR

From: Kenosha Davison <Kenosha.Davison@detroitmi.gov>

Sent: Thursday, September 29, 2022 10:21 AM

To: ksirois@sda-eng.com <ksirois@sda-eng.com>

Cc: David Ridgeway <David.Ridgeway@detroitmi.gov>; Norma Leonard <Norma.Leonard@detroitmi.gov>

Subject: 2022092900912 2022092900866 2022092900841 MISS DIG Information for Requested Area

Good morning,

Attached is our Water and Sewer utilities in the area.
Screen shots are given from GIS maps attached to word document.

Thanks,

Kenosha Davison

Field Service Coordination Specialist

Detroit Water and Sewerage Department •

6425 Huber St. • Detroit, MI 48211

P: 313-267-1261

C: 313-267-1262

E: kenosha.davison@detroitmi.gov

Customer Care: 313-267-8000



MICHAEL DUGGAN, MAYOR

From: Kenosha Davison

Sent: Thursday, September 29, 2022 10:19 AM

To: ksirois@sda-eng.com <ksirois@sda-eng.com>

Cc: David Ridgeway <David.Ridgeway@detroitmi.gov>; Norma Leonard <Norma.Leonard@detroitmi.gov>

Subject: 2022092900945 MISS DIG Information for Requested Area

Good morning,

Attached is our Water and Sewer utilities in the area.
Screen shots are given from GIS maps attached to word document.

Thanks,

Kenosha Davison

Field Service Coordination Specialist

Detroit Water and Sewerage Department •

10/26/22, 9:26 AM

Spalding DeDecker Mail - 2022102503611 2022102503675 MISS DIG Information for Requested Area

6425 Huber St. • Detroit, MI 48211

P: 313-267-1261

C: 313-267-1262

E: kenosha.davison@detroitmi.gov

Customer Care: 313-267-8000



MICHAEL DUGGAN, MAYOR

2 attachments



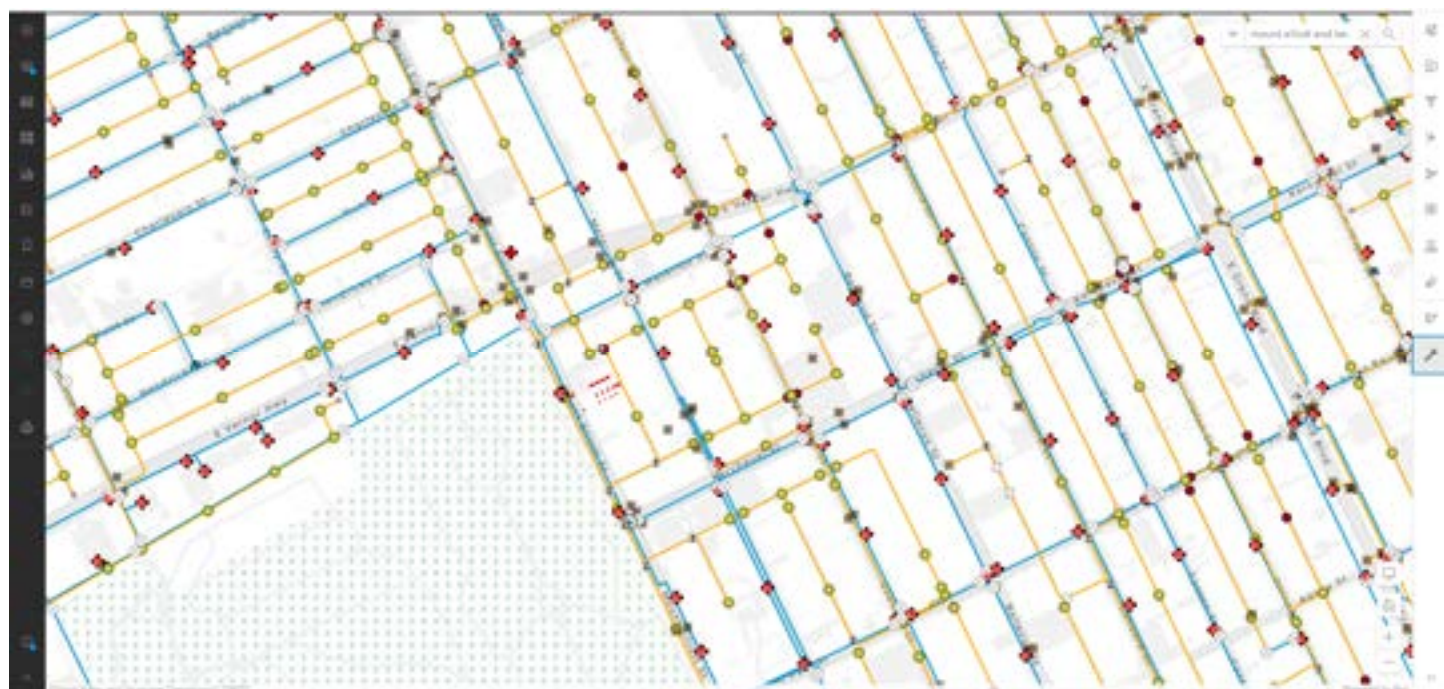
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869K

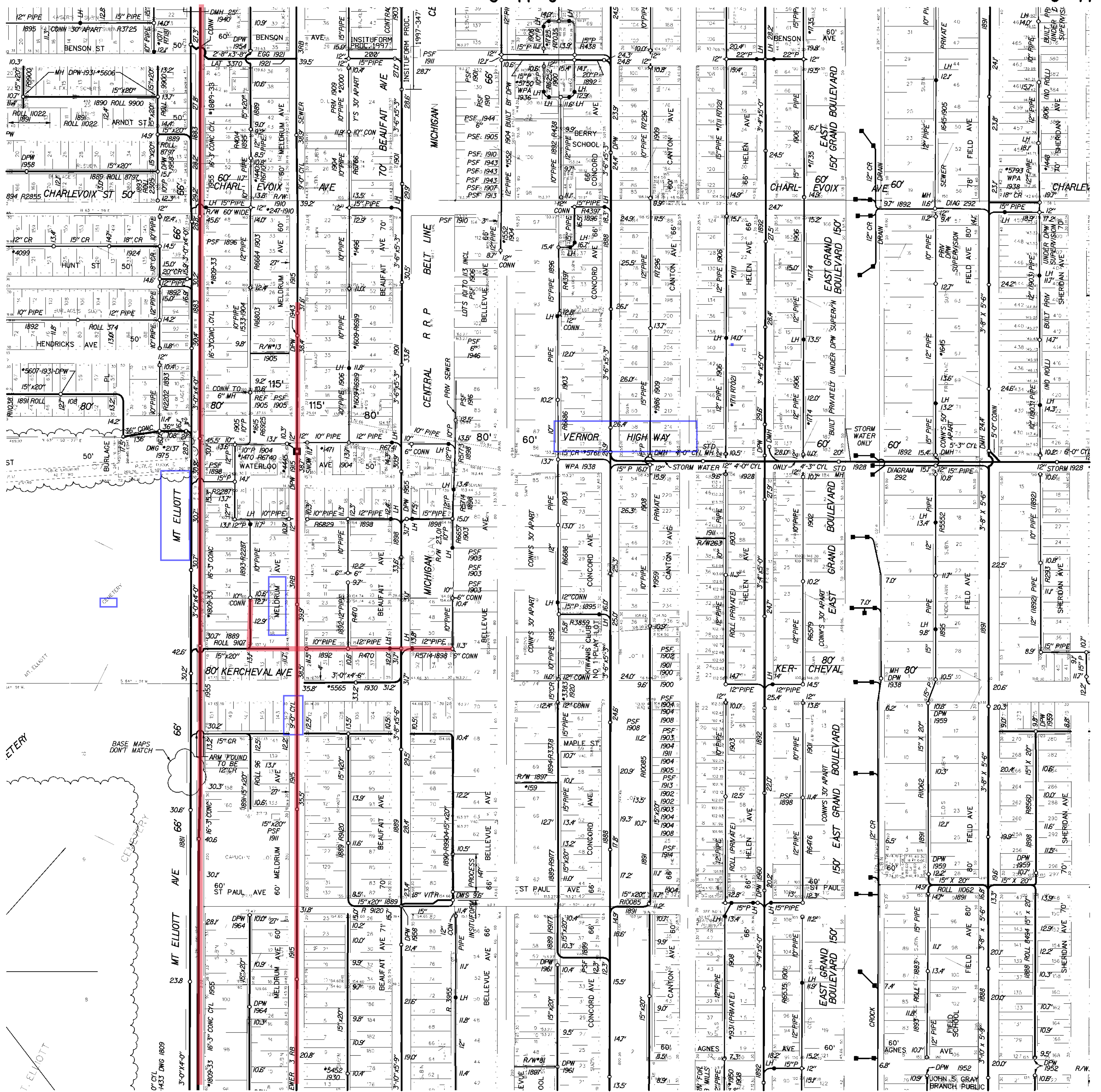


2022102503611 Liddesdale and Pleasant.docx

394K



S-39-F



doi:10.1371/journal.pone.0141001.g001



ALPHA/ALFA FORM NO.	009112
PAIR NO.	473466
CONTRACT NO.	PC-732
FILE NO.	1441
D-98-10-012	


 A WARNING DATE
 BEFORE YOU
 CALL MISS
 800-492-7171
 (CALL FREE)

[illegible]

DETROIT WATER AND SEWERAGE DEPARTMENT
W- STEWATER COLLECTION SYSTEM IMPROVEMENTS
LEIB SCREENING AND DISINFECTION FACILITY
TTS PARTIAL PLAN AND PROFILE
SHEET 1 OF 5

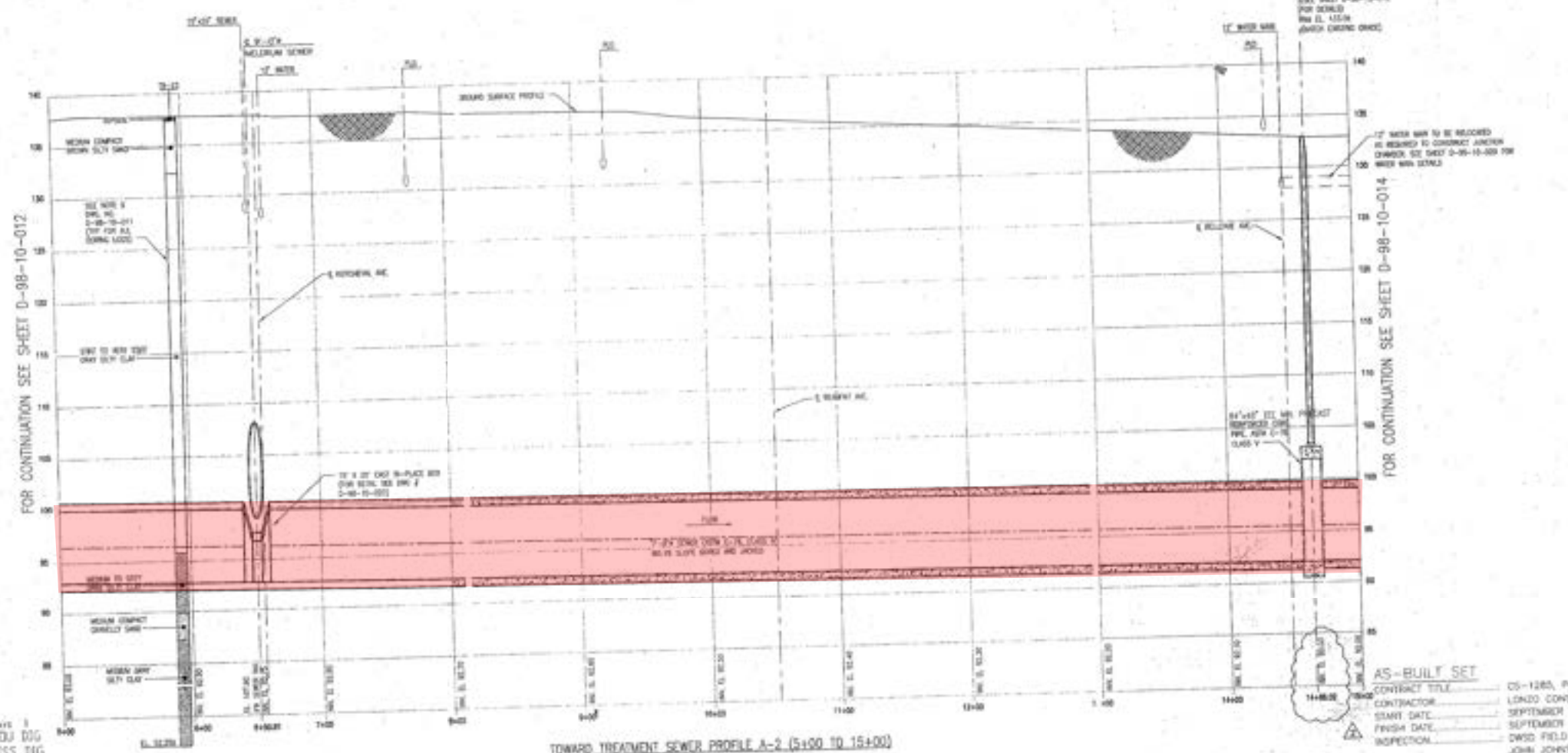
SCALE AS SHOWN



CITY OF DETROIT
WATER AND SEWERAGE DEPARTMENT
ENGINEERING DIVISION

SECTION MAP	NAME	GRADE	SECTION	SYSTEM NAME

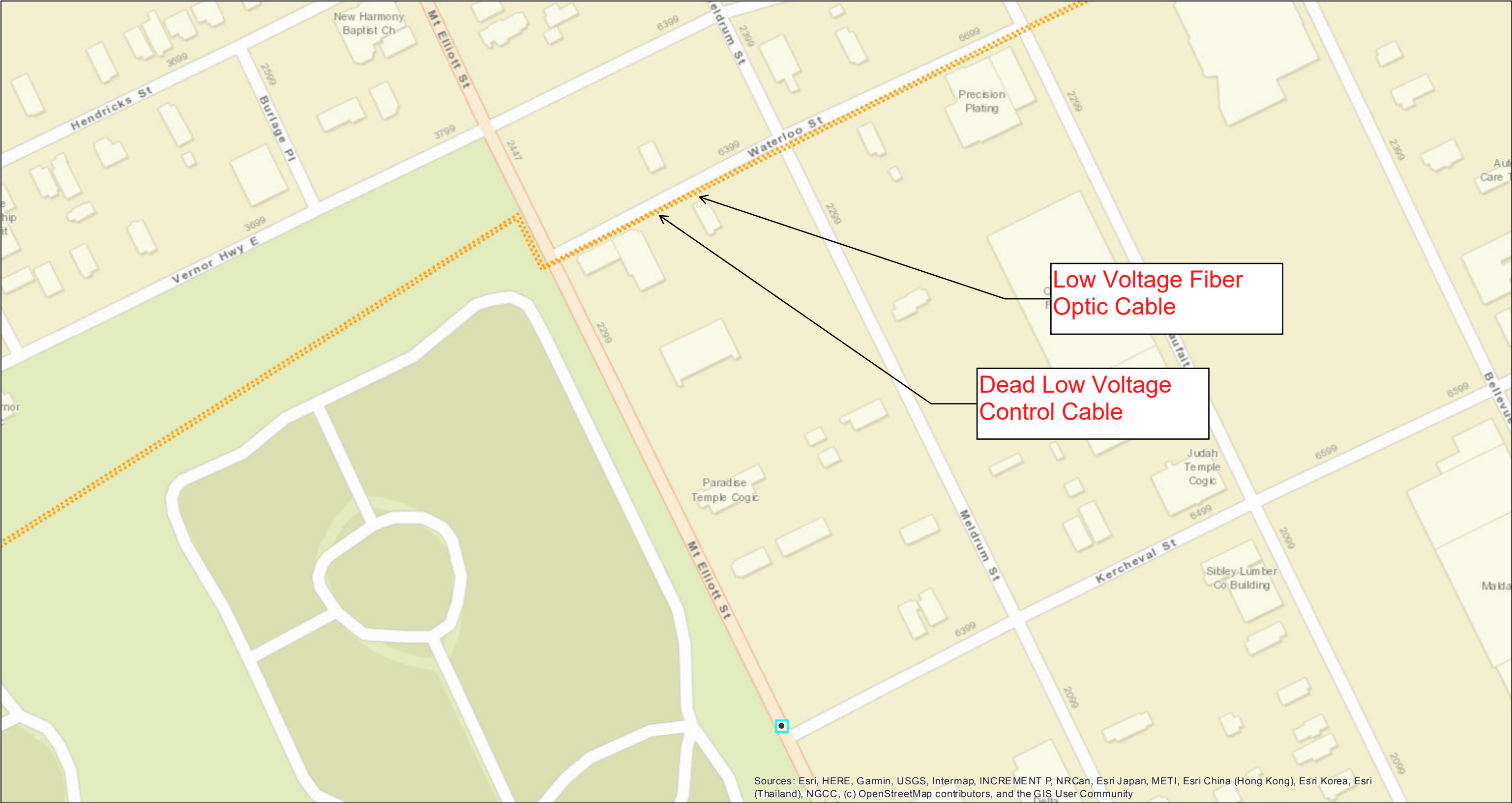
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DETROIT WATER AND SEWERAGE DEPARTMENT
WASTEWATER COLLECTION SYSTEM IMPROVEMENTS
LEIB SCREENING AND DISINFECTION FACILITY
TTS PARTIAL PLAN AND PROFILE
SHEET 2 OF 5

CDM Camp Dresser & McKee
NPH
GR
MT
SIGMA
 A COMMITMENT TO EXCELLENCE

 CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION					000112 473466 PC-732 1441
SECTION MAP	TOWN	RANGE	SECTION	PORTION AREA	D-98-10-013



2022102503675-000

GEMINI Web Application

Time: 11/4/2022 5:00:20 PM

Appendix I

Kercheval Alley Vacation Resolution

TRUE COPY CERTIFICATE

Form C of D-16-CR

STATE OF MICHIGAN, }
City of Detroit } ss.

CITY CLERK'S OFFICE, DETROIT

I, Janice M. Winfrey, City Clerk of the City of Detroit, in said
State, do hereby certify that the annexed paper is a TRUE COPY OF Resolution
adopted (passed) by the City Council at session of

November 23, 2021

and approved by Mayor

November 29, 2021

as appears from the Journal of said City Council in the office of the City Clerk of Detroit, aforesaid;
that I have compared the same with the original, and the same is a correct transcript therefrom, and of the
whole of such original.

In Witness Whereof, I have hereunto set my hand
and affixed the corporate seal of said City, at

Detroit, this 6th

day of January A.D. 2021

Janice M. Winfrey
CITY CLERK



CITY OF DETROIT
DEPARTMENT OF PUBLIC WORKS
CITY ENGINEERING DIVISION

COLEMAN A. YOUNG MUNICIPAL CENTER
2 WOODWARD AVE. SUITE 601
DETROIT, MICHIGAN 48226
PHONE: (313) 224-3949 • TTY: 711
FAX: (313) 224-3471
WWW.DETROITMI.GOV

November 4th, 2021

Honorable City Council:

RE: Petition No. 1584 – Great Lakes Water Authority request to vacate to utility easement the public alleys bounded by Waterloo Avenue, Meldrum Avenue, Kercheval Avenue, and Mt. Elliot Street.

Petition No. 1584 – Great Lakes Water Authority request to vacate to utility easement the public alleys bounded by Waterloo Avenue, 50 ft. wide, Meldrum Avenue, 60 ft. wide, Kercheval Avenue, 80 ft. wide, and Mt. Elliot Street, 66 ft. wide.

The petition was referred to the City Engineering Division – DPW for investigation (utility review) and report. This is our report.

The request is made as part of a consolidation of property by adjacent owners.

The request was approved by the Solid Waste Division – DPW, and Traffic Engineering Division – DPW, and City Engineering – DPW.

Detroit Water and Sewerage Department (DWSD) has no objection to the vacation and conversion to utility easement provided certain provisions are met. The DWSD provisions are a part of the attached resolution.

All other involved City Departments, and privately owned utility companies have reported no objections to the vacation and conversion to utility easement of the alley. Provisions protecting utility installations are part of the attached resolution.

I am recommending adoption of the attached resolution.

Respectfully submitted,

Richard Doherty, P.E., City Engineer
City Engineering Division – DPW

/JK

Cc: Ron Brundidge, Director, DPW
Mayor's Office – City Council Liaison

BY COUNCIL MEMBER

Benson

RESOLVED, the public alleys bounded by Waterloo Avenue, 50 ft. wide, Meldrum Avenue, 60 ft. wide, Kercheval Avenue, 80 ft. wide, and Mt. Elliot Street, 66 ft. wide; further described as land in the City of Detroit, Wayne County, Michigan being:

1. The north-south alley, 20 ft. wide, lying easterly of and adjacent to lots 1 through 4 and lying westerly of and adjacent to lot 5 of "DuPont's Subdivision" as recorded in Liber 3, Page 49 of Plats, Wayne County Records.
2. The east-west alley, 10 ft. wide, lying southerly of and adjacent to lot 5 through 11 of "DuPont's Subdivision" as recorded in Liber 3, Page 49 of Plats, Wayne County Records.
3. The north-south alley, 20 ft. wide, lying easterly of and adjacent to lots 31 through 40 and lying westerly of and adjacent to lots 21 through 30 of "Hunt's Subdivision" as recorded in Liber 14, Page 92 of Plats, Wayne County Records.
4. The north-south alley, 20 ft. wide, lying easterly of and adjacent to lots 1 through 6 and lying westerly of and adjacent to lots 17 through 22 of "Traugott Schmidt's Subdivision" as recorded in Liber 9, Page 86 of Plats, Wayne County Records.
5. The east-west alley, 20 ft. wide, lying southerly of and adjacent to lots 6 and 17 and lying northerly of and adjacent to lots 7 through 16 of "DuPont's Subdivision" as recorded in Liber 3, Page 49 of Plats, Wayne County Records.

Be and the same is hereby vacated as public right-of-way and converted into a private easement for public utilities of the full width of the right-of-way, which easement shall be subject to the following covenants and agreements, uses, reservations and regulations, which shall be observed by the owners of the lots abutting on said right-of-way and by their heirs, executors, administrators and assigns, forever to wit:

First, said owners hereby grant to and for the use of the public an easement or right-of-way over said vacated public alley herein above described for the purposes of maintaining, installing, repairing, removing, or replacing public utilities such as water mains, sewers, gas lines or mains, telephone, electric light conduits or poles or things usually placed or installed in a public right-of-way in the City of Detroit, with the right to ingress and egress at any time and over said easement for the purpose above set forth.

Second, said utility easement or right-of-way in and over said vacated alley herein above described shall be forever accessible to the maintenance and inspection forces of the utility companies, or those specifically authorized by them, for the purpose of inspecting, installing, maintaining, repairing, removing, or replacing any sewer, conduit, water main, gas line or main, telephone or light pole or any utility facility placed or installed in the utility easement or right-of-way. The utility companies shall have the right to cross or use the driveways and yards of the adjoining properties for ingress and egress at any time to and over said utility easement with any necessary equipment to perform the above mentioned task, with the understanding that the utility companies, other than that specifically prohibited by this resolution, shall restore the easement surface to a satisfactory condition,

ADOPTED AS FOLLOWS COUNCIL MEMBERS

	YEAS	NAYS
Janee AYERS		
Scott BENSON		
Raquel CASTANEDA-LOPEZ		
Roy MCCALISTER, JR.		
*Mary SHEFFIELD		
Andre SPIVEY		
James TATE		
Brenda PRESIDENT JONES		
*PRESIDENT PRO TEM		
	6	0
WAIVER OF RECONSIDERATION (No. _____)		
Per motions before adjournment.		



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Mark Schobert, CDM Smith
Atul Kajale, CDM Smith
John Michalski, Applied Science, Inc.
Keaton LeFevre, Applied Science, Inc.*

Date: June 1, 2023

*Subject: TM-24 Site-Civil Design
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

As a part of the scope of work, the Design Team has evaluated alternatives and design criteria which apply to the site improvements described as OKW-SITE-1, and LEIB-SITE-1 in the Engineering Services Agreement for the Combined Sewer Overflow (CSO) Facilities Improvements Project.

The Design Team's recommendation for site improvement LEIB-SITE-1 is to provide fencing and security for the new access drive and relocated parking spaces as shown in fencing and security Alternative 2, and to provide drainage as shown in drainage Alternative 4. The recommended alternatives will increase the construction cost which was initially estimated in the CS-299 report.

The Design Team's recommendation for site improvement OKW-SITE-1 is to provide the pavement cross section as identified in the CS-299 report, with shoulder on the outer edge of the road and bioswales to provide improved drainage around the facility. The recommended alternatives will increase the construction cost which was initially estimated in the CS-299 report.

1.0 Introduction and Purpose

The purpose of this technical memo is to support the design of the site improvements described as OKW-SITE-1, and LEIB-SITE-1 in the Engineering Services Agreement for the CSO Facilities Improvements Project. These improvements are also referenced in the CS-299 CSO Facility Needs Assessment Report dated April 9, 2021 (CS-299 Report). The improvements are intended to improve facility reliability, flexibility, operation, maintenance, and safety to support planned increases in utilization for the Oakwood and Leib CSO facilities upon completion of other projects

that are being planned for implementation. The Oakwood Facility is located at 12220 Pleasant Street, Detroit, MI 48217. The Leib Facility is located at 2198 Mt Elliot Street Detroit Michigan.

OKW-SITE-1 consists of paving an existing gravel drive that goes around the CSO basin, fixing drainage issues and damaged concrete around the CSO basin area, sealing the existing concrete driveway areas, and removing the overgrowth of vegetation in the surge basin area.

The above items are to be addressed by incorporating the following items into the design at this site:

- Add paved road around the basin – Engineer shall replace the gravel service road with new reinforced concrete pavement that will extend around the perimeter of the basin connecting with the existing concrete service road on either side of the basin. See CS-299 Report Figure OKW-SITE-1- ALT-2 in Volume 6 – Appendices, Appendix B (Attachment B), for the location of new pavement. The concrete pavement should have a minimum 16-foot. width. Engineer shall provide all design services including roadway design, pavement design, drainage, and other design required to implement this improvement.
- Address drainage around CSO basin – Engineer shall address the existing poor drainage around the CSO basin from the basin roof runoff and address any necessary drainage improvements as a result of paving the gravel roadway. Engineer shall ensure proper drainage and detailed grading are performed to direct drainage away from the buildings and away from site vaults or electrical manholes.
- Swale expansion - For drainage improvements, Engineer shall consider, amongst other things, the existing drainage swale be excavated to increase its volume to accept the flow that is discharged from the west side of the basin roof during wet weather. CS-299 Report Figure OKW-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, (Attachment B) presents the proposed layout for these improvements. The flat area between the basin and existing service drive is recommended to be regraded away from the basin, and new catch basins and a storm sewer be added to capture the surface runoff and direct the flow under the service drive to discharge into the new bioswale.
- Replace site concrete (drive and sidewalk) – Engineer shall provide engineering services to replace damaged concrete sidewalk or driveway sections, and to establish proper sealing against the building, expansion joints and/or other type of joints to ensure longevity of improvements.
- Remove vegetation from surge basin area – Engineer shall perform necessary engineering services to clear out the surge basin area.
- Seal site concrete drive areas – Engineer shall provide engineering services to seal existing concrete driveway.

LEIB-SITE-1 consists of confirming the size, configuration, and geometry of a new access drive from Meldrum St. and associated changes to the Leib parking lot, parking lot striping, protection of the transformer with bollards, fencing, motorized vehicle gate, security badge access, and necessary electrical needed to facilitate the improvements. Three parcels in which the driveway is intended to cross are owned by Detroit Water and Sewerage Department (DWSD). The alley in between the existing Leib Facility parcel and these three parcels has been vacated. Electrical and telecommunications providers have utilities in the influence of the proposed driveway.

The above items are to be addressed by incorporating the following items into the design at this site:

- Perform all appropriate utility coordination with associated utilities to permit the improvements to be constructed. This includes, but may not be limited to, filling out permits, holding meetings, providing drawings, responding to utility requests for information, and any other coordination necessary to successfully coordinate with them for the proposed improvements.
- Engineer shall provide all design services to construct the alternate access to the site, as shown in Attachment B, Figure LEIB-SITE-1- ALT-2, in Volume 6 Appendices, Appendix B and also make improvements along Mount Elliot at the Leib influent and effluent structures where pavement has settled. Engineer shall confirm the size, configuration, and geometry of the new access and associated changes to the parking lot, parking lot striping, protection of the transformer with bollards, fencing, motorized vehicle gate, security badge access, and necessary electrical needed to facilitate the improvements. Engineer shall perform design services to construct all necessary improvements to facilitate the new driveway. Engineer's Work shall include, at a minimum, the following:
 - Engineer shall provide necessary property boundary surveys and land acquisition services as requested by Owner. Work performed under acquisition (if necessary) shall be billed in accordance with, hourly rates and a not-to-exceed (NTE) Allowance for this Work.
 - Engineer shall provide all services required to obtain right-of-way (ROW) permits and properly coordinate with DWSD and City of Detroit departments on improvements in the road rights of way and required maintenance of traffic during construction of the improvements along Meldrum St.
 - Engineer shall provide site design, road design, pavement design, electrical design, security design (for gate badge access), and maintenance of traffic services required to construct a new entrance at the rear of the site, as shown and described in Attachment B. This includes all services required to complete the design.

- Engineer shall evaluate impact/traffic protection requirements around the existing building transformer and incorporate into the design Drawings/Specifications.
- Engineer shall coordinate with Owner's Security team for additional cameras (see LEIB-I&C-1A), and site security fencing and associated security systems.

2.0 Existing Systems Description and Conditions

Existing conditions at both sites are described and presented in Technical Memorandum (TM) -11 Survey and Site Constraints. TM – 11 provides pictures taken from site visits at both sites. The appendix of TM -11 documents the draft base map surveys, utility investigations, and geotechnical reports which have been recently completed at both sites, as well as relevant record drawings and property information which are relevant to the proposed paving and drainage at each site.

Topographic surveys of the Oakwood and Leib sites, as well as adjoining ROWs and parcels were performed in Fall of 2022 utilizing aerial imagery and conventional ground surveying methods. Digital terrain models were computed, and contours developed at one-foot intervals. Facility records and third-party utility information obtained from MISS DIG requests were obtained and checked against the survey field information to develop site base maps of existing conditions to be used for conceptual design. Underground utilities are shown based upon a combination of record information along with actual field measurements for above-ground manifestations of underground utilities. Mapping in both pdf and CAD formats is provided and a set of base map drawings have been produced for each site using Civil 3D.

Two Draft Geotechnical Reports have been prepared, one for each site. At the Oakwood Site, the field exploration program consisted of six hand-auger probes which were extended to depths approximately 4 to 6 feet below existing grades to support the design of new pavement and a potential bioswale feature. At the Leib Site, the field exploration program consisted of two soil borings which extended to 10 feet below existing grades to support the design of new concrete pavement. Geotechnical recommendations for the proposed pavement section are provided in the geotechnical reports.

The Oakwood and Leib CSO facilities, both have established stormwater management systems in place. Both facilities are proposed to undergo paving projects that will require new stormwater management systems to handle the additional runoff generated.

Figures 2-1 and 2-2 show the existing storm sewer layout and storm catchment area delineations at the Oakwood facility.

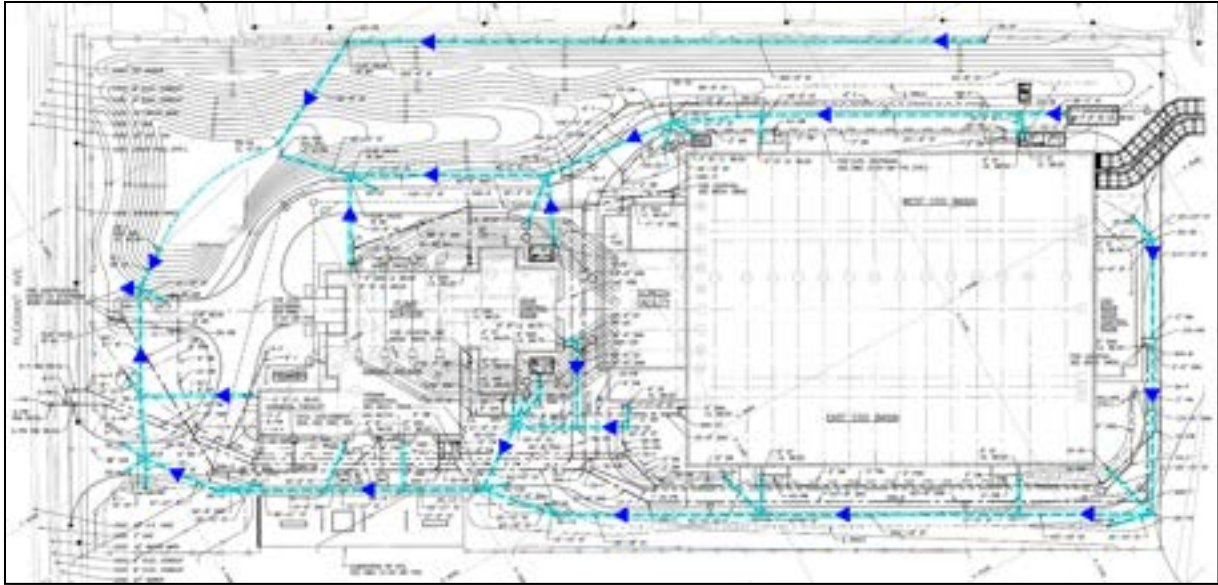


Figure 2-1
Oakwood CSO Facility Site Plan – Existing Storm Sewer Conveyance Map

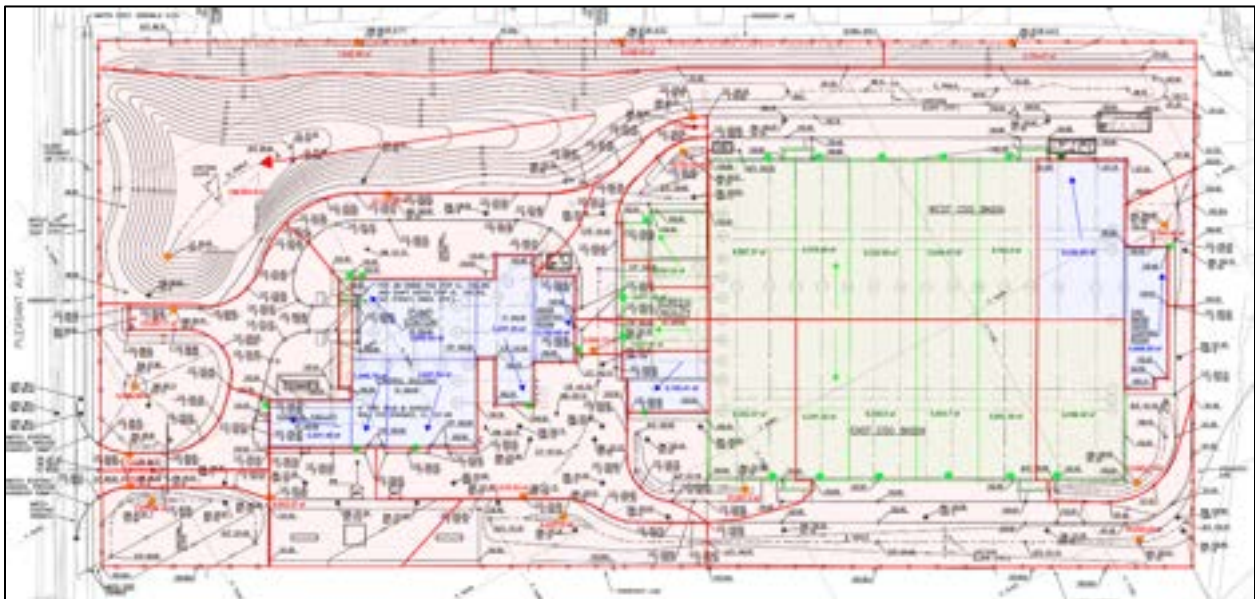


Figure 2-2
Oakwood CSO Facility Site Plan – Existing Stormwater System Catchment Area Delineation

Generally, the storm water collection system carries flows from the north end of the Oakwood facility to the south end. All on-site collected storm water is routed to the head of the facility where it is outletted into Junction Chamber 1. This storm water, as well as the combined wastewater from

the entirety of the Oakwood facility's service area, enters Junction Chamber 1 before it is pumped by either the sanitary or storm pumps at the facility.

The area around the CSO basins is the primary area of concern at the Oakwood facility, as this will be the site of the new paving. Presently, runoff from the roof of the CSO basin is evenly distributed to the east and west sides of the facility. Rain that falls on the CSO basin roof travels to the east or west edge and falls through scuppers that drop the flow on to concrete splash blocks on the ground at the base of the building. As overland flow, the runoff generally travels over the gravel road, to an earthen swale, and into the stormwater collection system. A swale exists on both the east and west sides of the building.

The overland flow from the basin roof across the gravel road has led to scouring of the road causing potholes and reduced accessibility around the CSO basin building. This issue has presented the need for the proposed paved road and updated stormwater management system.

Figures 2-3 and **2-4** show the existing storm sewer layout and storm catchment area delineations at the Leib facility.

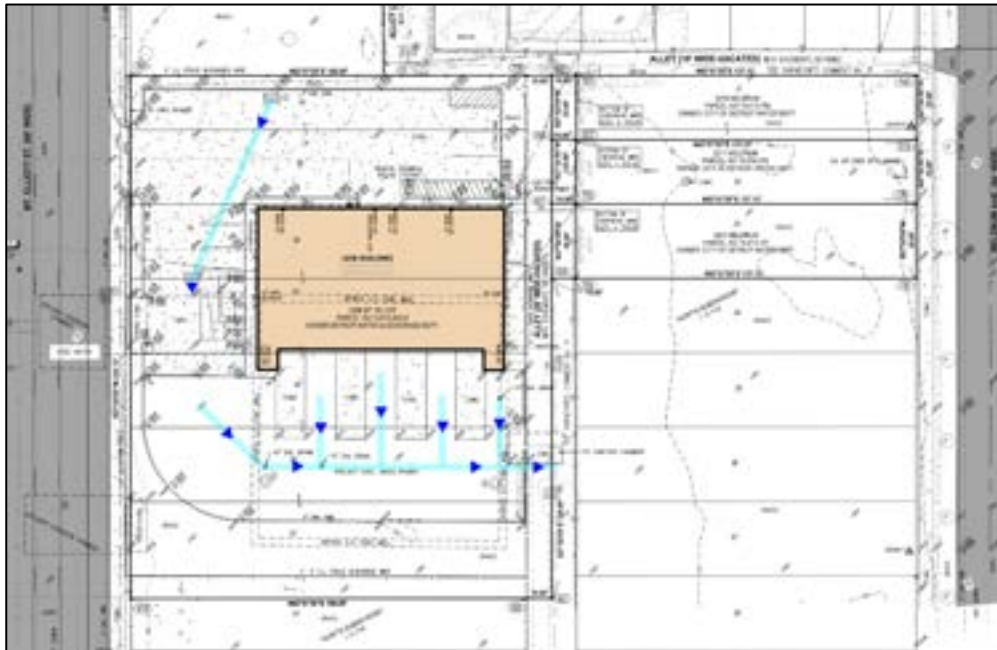


Figure 2-3
Leib CSO Facility Site Plan – Existing Storm Sewer Conveyance Map

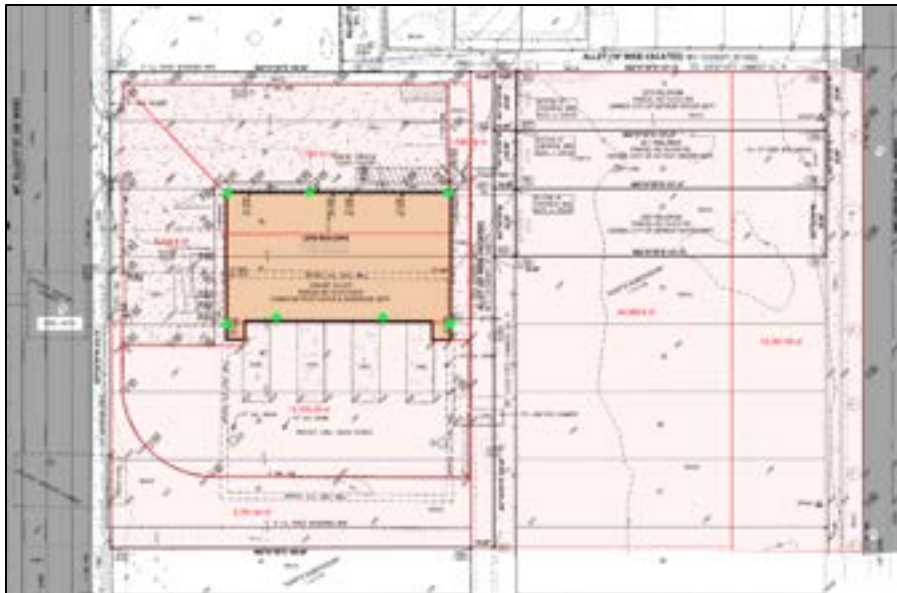


Figure 2-4
Leib CSO Facility Site Plan – Existing Stormwater System Catchment Area Delineation

There are two separate storm water management systems in place at the Leib facility. **Figure 2-3** shows one system in the Leib parking lot and one system in the grass pavers. All parking lot runoff and runoff from the north end of the facility roof flows into a storm sewer system that outlets via a drop manhole into the influent box at the head of the facility’s screening and disinfection operations. Runoff from the south side of the roof and on the grass pavers flows into a drainpipe system that outlets at the Toward Treatment Sewer junction chamber in the facility below. All other rainfall on the facility’s property is infiltrated into the ground or flows off of the site.

Runoff generated on the vacant lots adjacent to the Leib facility flows to either the alley between Leib and the vacant lots or to Meldrum Street. The direction of the runoff is determined by a highpoint that generally runs north-south. Flow to the alley is captured by catch basins that direct flow into a 10-inch combined wastewater sewer. Flow to Meldrum Street is captured by catch basins in the road at the Waterloo Street and Kercheval Avenue intersections.

Figure 2-5 shows the existing catch basin drainage structures in the alley. **Figure 2-6** shows a map of the existing DWSD combined sewer system near the Leib Facility site. Based on the latest survey by the Design Team, there are no direct sewer connections to either of the catch basin structures shown in the **Figure 2-5** images . It is assumed by the surveyor that the 6-inch PVC trap elbow ends in each catch basin structure lead to a blind tap into the 10-inch sewer line that runs through the alley, as shown in the **Figure 2-6**.



Figure 2-5
Drainage Structures in Alley Adjacent to Leib Facility. Catch basin north (top) and south (bottom) of TTS

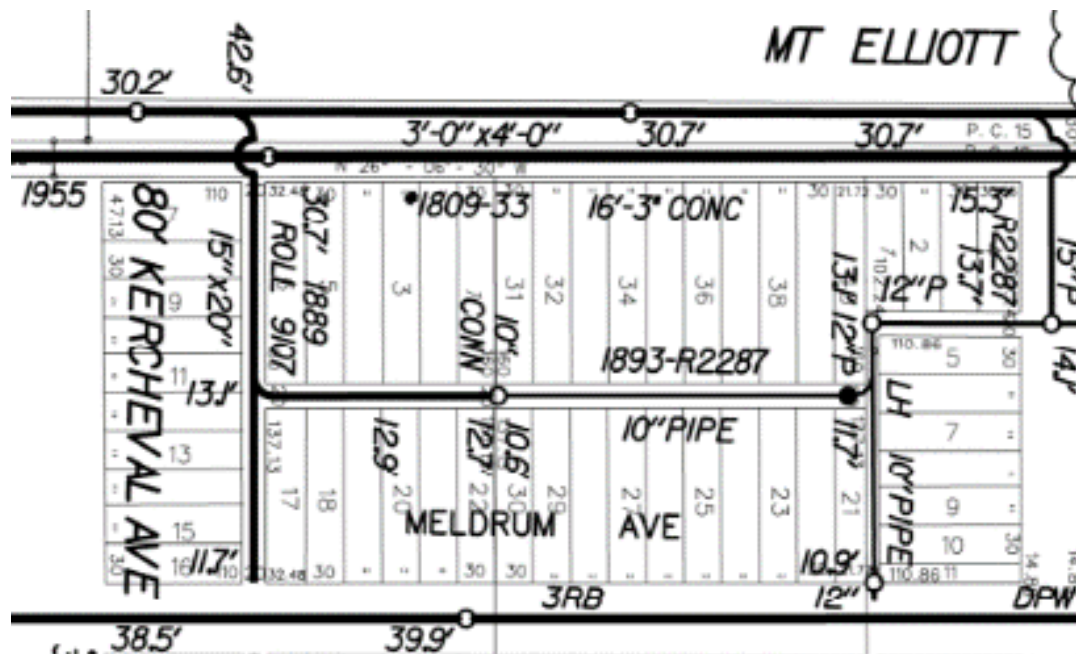


Figure 2-6
Combined Sewer System Near Site of Leib Facility

3.0 System Evaluation

The drainage, paving, and security system design requirements are discussed in the following sections.

3.1 Oakwood and Leib Site Paving & Access Requirements

The proposed pavement section at both the Leib and Oakwood CSO Sites call for 9-inch-thick reinforced concrete over a minimum 8-inch thick aggregate MDOT 21AA base with HS-20 loading. Based on the recommendations provided in the geotechnical report, the existing gravel and granular fill under the gravel road at the Oakwood CSO site will be removed prior to construction of the new concrete pavement and replaced with 8" thick MDOT 21AA base. Additional MDOT 21AA gravel needs to be imported if additional unsuitable existing material is found below the proposed profile of the new concrete pavement. The proposed pavement, loading, soils were evaluated in the geotechnical report for each site, and found to be adequate to support the proposed HS-20 Loading. The proposed access roadway at the Leib Site will need to be configured to provide for 5,000-gallon tanker truck deliveries of chemical to the CSO Basin. A WB-50 design vehicle was utilized for the analysis. A service drive width of 28 feet was found to be adequate to allow for the turning movements of this design vehicle. In addition, wider radius will be provided to allow wider turns for the trucks entering driveway. **Figure 3-1** shows this analysis. The proposed access roadway at the Oakwood Site will need to be configured to provide for a boom truck with crane to remove the scrubber units at the Odor Control Facility on the north side of the site. A Terex Boom Truck was utilized for the analysis, and a concrete drive width of 16 feet was found to be adequate to allow for

the turning movements of this design vehicle. Signs will be posted along the new paved road to prevent the semi-trailers or larger vehicles from entering the paved road around the north side of the Oakwood CSO facility. In addition, bollards will be provided to prevent existing electrical vault/panels and existing structures near the new paved road. **Figure 3-2** shows this analysis.

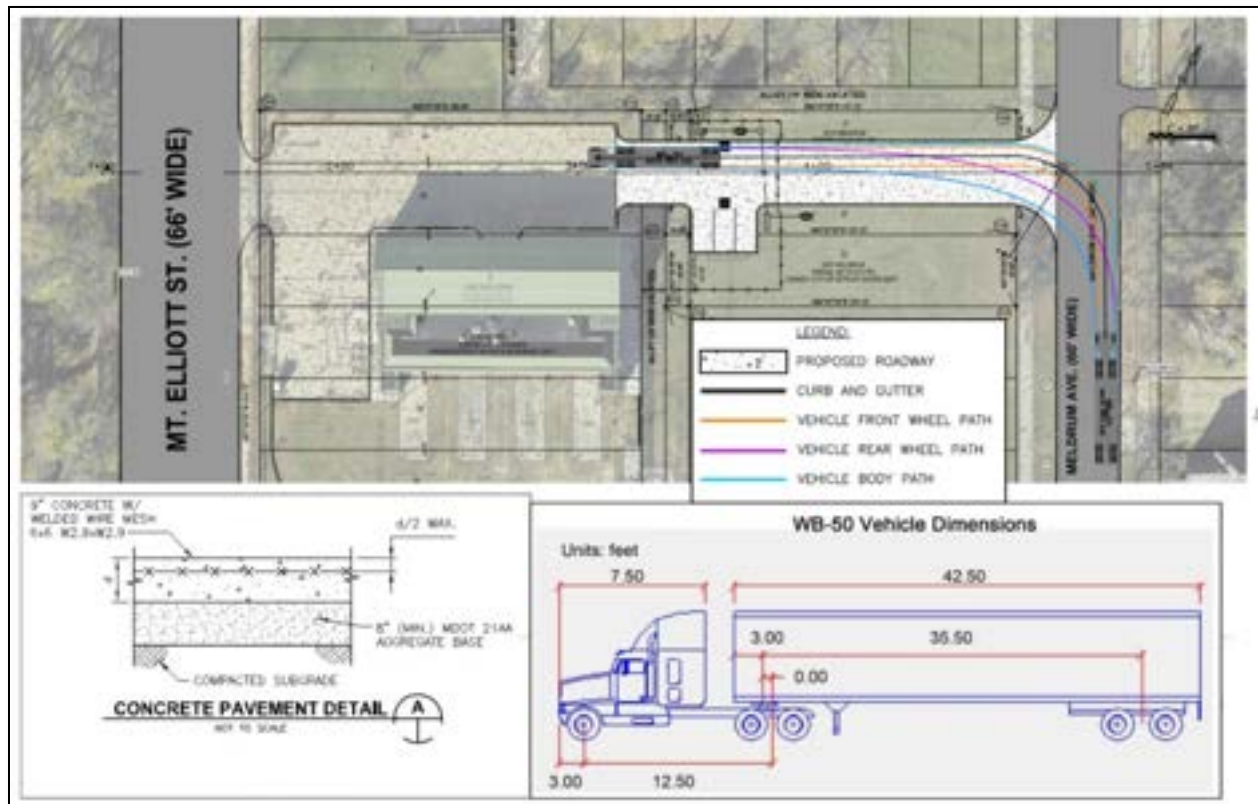


Figure 3-1
Leib CSO Facility Proposed Access Drive – WB-50 Design Vehicle Turning Movements

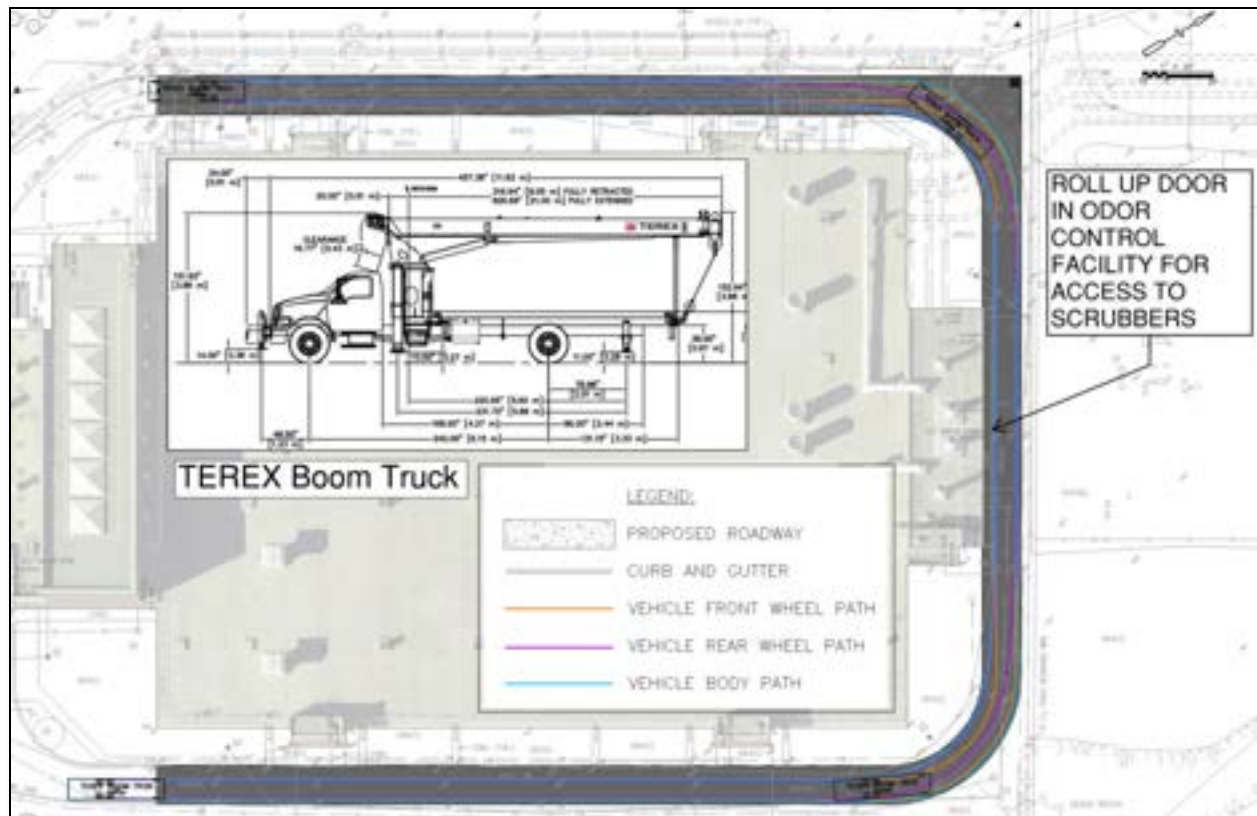


Figure 3-2
Oakwood CSO Facility – Boom Truck Turning Movements

3.2 Oakwood and Leib Site Drainage Requirements

As described above, both the Oakwood and Leib CSO facilities are proposed to undergo paving projects that will introduce new impervious area to the sites. At the Oakwood facility, a paved road will replace an existing gravel road that wraps around the Oakwood screen facility, CSO basin, and odor control building. The new paved road is proposed to have the same footprint as the existing gravel road. At the Leib facility, a new paved driveway is proposed that provides access to the facility from previously vacant lots. The vacant lots are presently grass covered. The paving at Leib includes an access driveway as well as an area for three parking spaces.

Per DWSD's Stormwater Management Design Manual (2019), any development site with regulated construction activity that involves the replacement or creation of one-half acre (21,780 square feet) or more of impervious surface is subject to the Post-Construction Stormwater Management Ordinance (PCSWMO). DWSD may require that any construction activity meeting certain conditions, as specified in Section 5-63-101 in Chapter 56 Article 4 of the Detroit Municipal Code, also comply with the PCSWMO.

The Detroit Municipal Code states that the PCSWMO applies to a site if any construction activity may create a condition that would result in runoff that would:

1. Exceed the safe capacity of the receiving public sewer or body of water as determined by the Department;
2. Cause undue channel erosion;
3. Increase water pollution by scouring or transport of particulate matter;
4. Endanger property; or
5. Endanger public safety.

Figure 3-3 provides a visual flowchart for understanding the applicability of the PCSWMO.

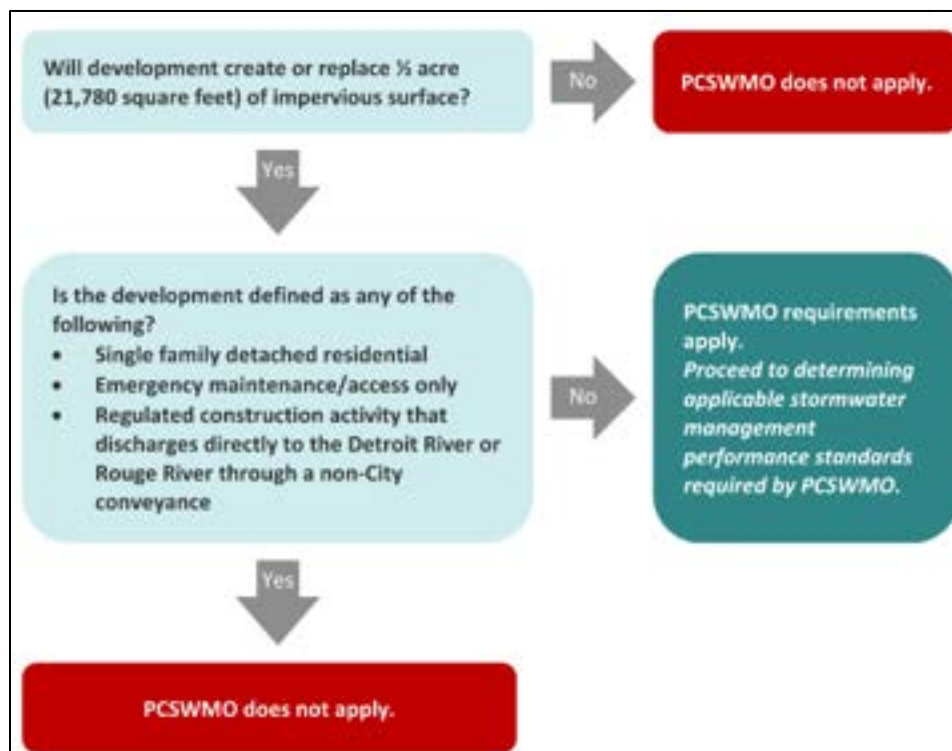


Figure 3-3
PCSWMO Applicability Flow Chart

The additional impervious area added by the Oakwood paving project is approximately 16,400 square feet. The additional impervious area added by the Leib paving project is approximately 5,630 square feet. Neither of these sites involve the creation of greater than one-half acre of impervious area or meet the additional criteria for PCSWMO applicability. Therefore, the Oakwood and Leib sites are not required to comply with the regulatory requirements of the PCSWMO.

Although not bound by the PCSWMO, the Design Team recommends implementing stormwater runoff infrastructure guided by the PCSWMO at both the Oakwood and Leib sites to ensure proper conveyance and drainage of stormwater runoff resulting from the paving projects.

3.3 Oakwood and Leib Electrical and Security Requirements

- Gate power requirements are expected to be minimal and can be powered from the existing CSO Facility
- Parking Areas must be secured with fencing, and card readers and security cameras provided.
- Alley Encroachment Easements will need to be obtained from impacted underground utilities.
- Existing AT&T utility will need to be raised to provide clearance, and existing underground DTE electric service will need to be installed per DTE standards beneath the proposed service drive pavement.

4.0 Description of Alternatives

4.1 Oakwood Facility Site Drainage Alternatives

The site drainage alternative to support the new paving around the CSO basin focuses on improving the swales on the east and west sides of the facility. The runoff generated from the roof of the CSO basin will still be routed down the east and west sides of the building via the existing scuppers. New splash blocks located under the scuppers will catch the flow and convey stormwater directly to the newly paved road. Existing splash blocks will be replaced to assure all the drainage reaches the stormwater system. The proposed pavement design does not implement a curb on the side of the road nearest to the facility, allowing for the drainage from the splash blocks to flow over the road. The outward facing edge of the new pavement will have a shoulder. The shoulder will be graded to drain the water off the road and towards the bioswales. This design is common to both the east and west sides of the facility.

The bioswales are examples of bioretention. Bioretention practices are landscaped, shallow depressions that capture and temporarily store stormwater runoff. Runoff intercepted by the practice is then filtered through the soil (often engineered soil filter media). Bioretention practices usually consist of a pretreatment system, surface ponding area, mulch layer, soil filter media, aggregate storage layer, vegetation, and subsurface drainage system.

A drainage pipe located in the bioswale will route the collected runoff to the stormwater collection system as the swale fills. From there, the stormwater will be routed through the existing stormwater collection system on site.

Based on the recommendations provided in the geotechnical report for the Oakwood CSO site, the existing granular fill at the proposed bioswale area will be removed (minimum 18" from finished

grade of the proposed swale) and replaced with a sandy-loam or loamy-sand bioretention soil with 6% organic content and pH of 6-7.

Figure 4-1 shows plan view sketch of the proposed runoff drainage system.

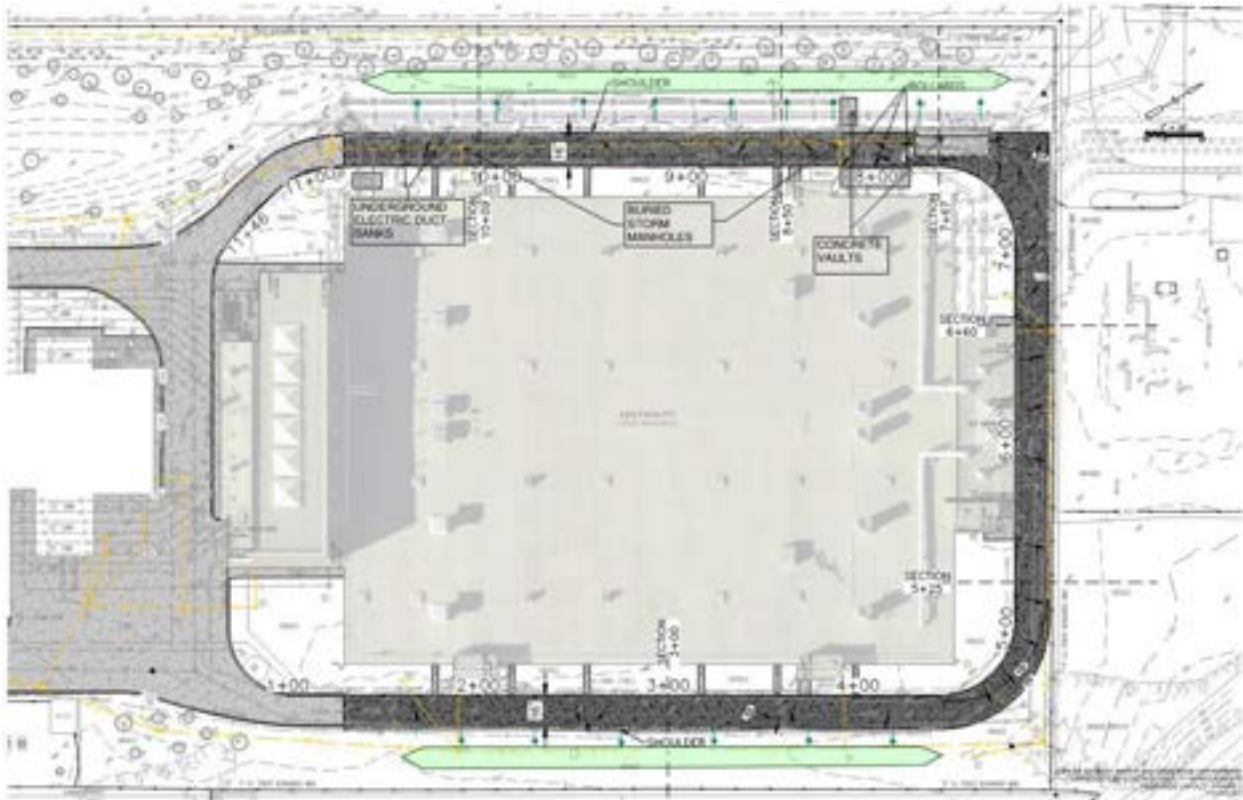


Figure 4-1
Oakwood CSO Facility – Plan View of Proposed Runoff Drainage System

In addition to routing runoff over the new pavement, this design will include work to raise the rims of multiple meter and electrical vaults on the west side of the CSO basin, as well as waterproofing of the manhole chimneys. This will be done to prevent runoff from spilling into manholes and flooding the vaults.

Figures 4-2 and **4-3** show the conceptual roadway profiles and cross sections along the proposed pavement. Due to large buried electrical duct banks on the west side of the facility, underground conduits conveying flow from the roof downspouts to the proposed bio-swale were not considered feasible.

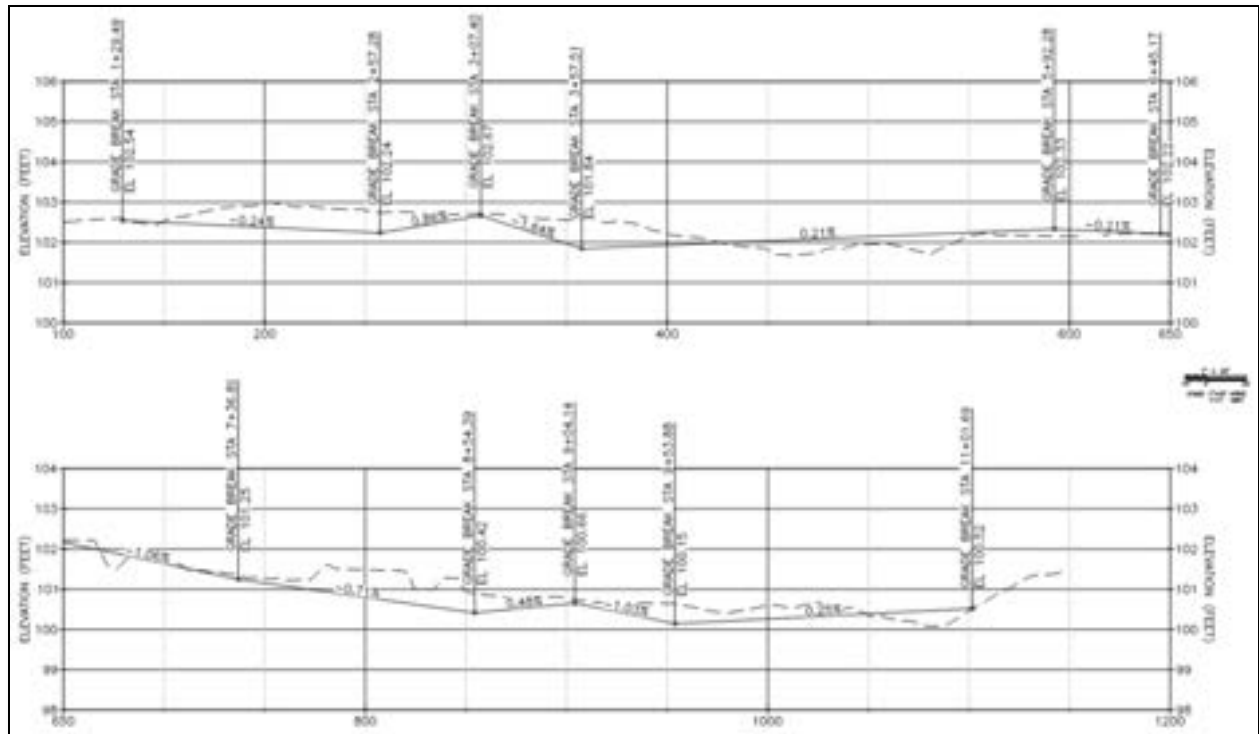


Figure 4-2
Oakwood CSO Facility – Conceptual Roadway Profile

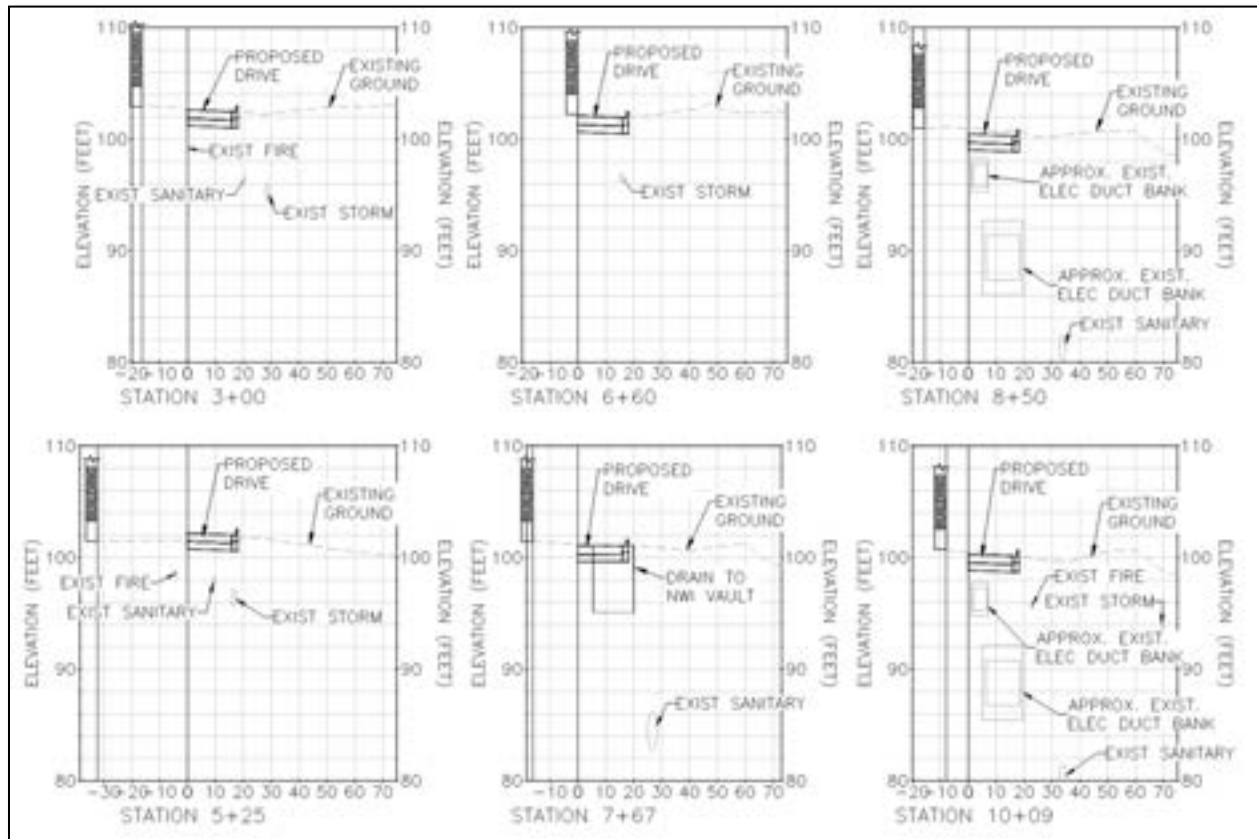


Figure 4-3
Oakwood CSO Facility – Conceptual Roadway Cross Sections

4.2 Leib Facility Site Paving and Security Fencing Alternatives

The new access drive to the Leib Site will eliminate three existing parking spaces from the existing parking lot. These parking spaces are proposed to be relocated adjacent to the new access driveway on the lots owned by DWSD. The CS-299 report indicated that additional storage space may be desired in the future outside the existing CSO Facility, so an area for this is included in the concept plans. Two conceptual fencing alternatives were developed to provide for security and access for the newly configured service drive entrance, parking, and potential storage area. Both developed alternatives will require an existing AT&T cable to be raised to provide adequate clearance for tanker trucks using the new access drive. The existing DTE underground service lead which runs through the vacated alley will need to be field located and modified to DTE standards so it can be maintained beneath the proposed concrete pavement in the vacated alley. Subsections 4.2.1 and 4.2.2 provide a description of the alternatives analyzed by the Design Team.

4.2.1 Alternative 1 No Fencing in the Vacated Alley

This alternative proposes to install a new 30-foot-wide motorized double swing gate along the existing fence line at the point where the new service drive enters the parking lot. An interior and exterior card reader would be located on either side of the swing gate. Ideally, power would be provided by a private underground electric service from the existing CSO Facility and would need to extend across the vacated alley. A new security camera would also be installed within the parking area to monitor the relocated parking spaces and potential future storage area. The parking and storage area would be fenced and accessed by a second 30-foot-wide motorized double swing gate. Alternative 1 is presented in **Figure 4-4**

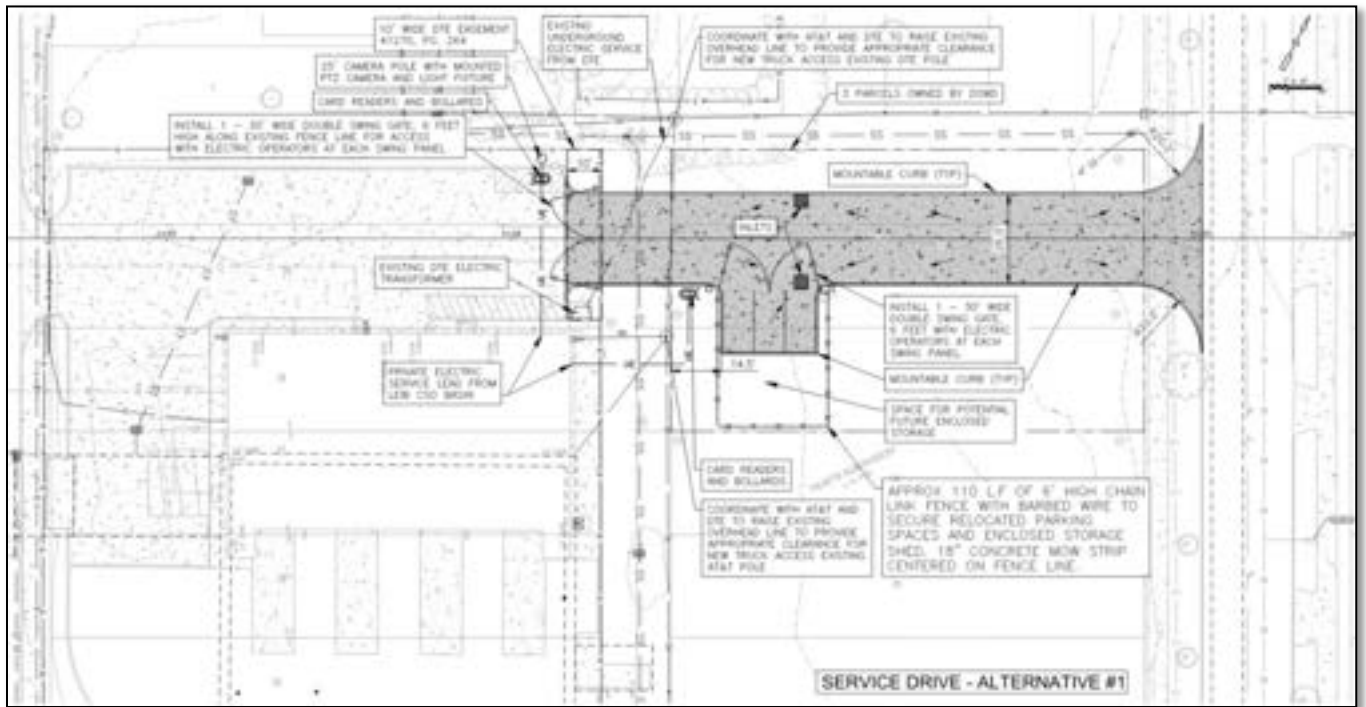


Figure 4-4
Leib CSO Facility Proposed Access Drive – Fencing & Security Alternative 1

4.2.2 Alternative 2 Fencing in the Vacated Alley

This alternative proposes to install a new 30-foot-wide motorized rolling gate approximately 50 ft to the north of the existing fence line at the point where the new service drive enters the parking lot. An interior and exterior card reader would be located on either side of the rolling gate. Ideally power would be provided by a private underground electric service from the existing CSO Facility and would need to extend across the vacated alley. A new security camera would also be installed inside the fence line to monitor the relocated parking spaces and potential future storage area. Two fenced areas of the vacated alley would have 20-foot-wide double swing gates which are normally

COORINATE WITH ART & DTE TO MAKE EXISTING OVERHEAD LINE TO PROVIDE APPROPRIATE CLEARANCE FOR NEW TRUCK ACCESS EXISTING DTE FENCE

20' WIDE DOUBLE DRWG GATES FOR SECURE, SHARED ACCESS BY ART & DTE, NORMALLY CLOSED AND LOCKED

20' WIDE DTE EXISTING 41270 PG. 254

EXISTING UNDERGROUND ELECTRIC FROM DTE

EXISTING DTE EXISTING TRANSFORMER

PRIVATE ELECTRIC SERVICE LINE FROM LER COO 8600

CARD READER AND BOLLARDS

20' CAMERA FUSE WITH MOUNTED CCTV CAMERA AND LIGHT FIXTURE PARALLEL 5' GATE (DRWG TYPE)

20' AUTOMATIC ROLLING GATE - CHAIN LINK

MOUNTABLE CURB (TOP)

MULTI

14.5'

MOUNTABLE CURB (TOP)

CARD READER AND BOLLARDS

GATE OPERATOR

GATE 5'-WIDE

MOUNTABLE CURB (TOP)

FENCE FOR FUTURE, FUTURE ENCLOSED STORAGE

2 PARCELS OWNED BY DTE

APPROX 545 LF OF 6" HIGH CHAIN LINK FENCE WITH BARBED WIRE TO SECURE RELOCATED PARKING SPACES AND ENCLOSED STORAGE SHED. 18" CONCRETE MOW STRIP CENTERED ON FENCE LINE.

COORINATE WITH ART & DTE TO MAKE EXISTING OVERHEAD LINE TO PROVIDE APPROPRIATE CLEARANCE FOR NEW TRUCK ACCESS EXISTING 41270 FUSE

20' WIDE DOUBLE DRWG GATES FOR SECURE, SHARED ACCESS BY ART & DTE NORMALLY CLOSED AND LOCKED

SERVICE DRIVE - ALTERNATIVE #2

Figure 4-5
Leib CSO Facility Proposed Access Drive – Fencing & Security Alternative 2

The Design Team developed four alternatives to facilitate drainage of runoff generated by the addition of a new driveway to the Leib CSO facility. Subsections 4.3.1 through 4.3.4 provide a description of the alternatives analyzed by the Design Team.

- Connection to DWSD Owned Sewer, Alternative 1 (Section 4.3.1)
- Connection to Toward Treatment Sewer (TTS) via Alley, Alternative 2 (Section 4.3.2)
- Connection to Onsite Stormwater System in Facility Parking Lot, Alternative 3 (Section 4.3.3)
- Surface Drainage and Bioswale, Alternative 4 (Section 4.3.4)

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Additionally, a low point will be established between the new driveway high point and the eastern edge of the alley adjacent to the Leib facility. There will be a catch basin on both the north and south edges of the new driveway at this low point. Runoff from the driveway east of the existing parking lot and west of the driveway high point will flow to this low point and be captured in the new catch basins. From here, the flow will be directed according to one of the three alternatives described in Sections 4.3.1 through 4.3.4.

This configuration of the driveway will have a slope at or near 1%. This will allow for sufficient drainage of the runoff off the driveway and will be ideal for routing the flow towards the proposed drainage structures. **Figure 4-6** shows the conceptual profile of the access drive.

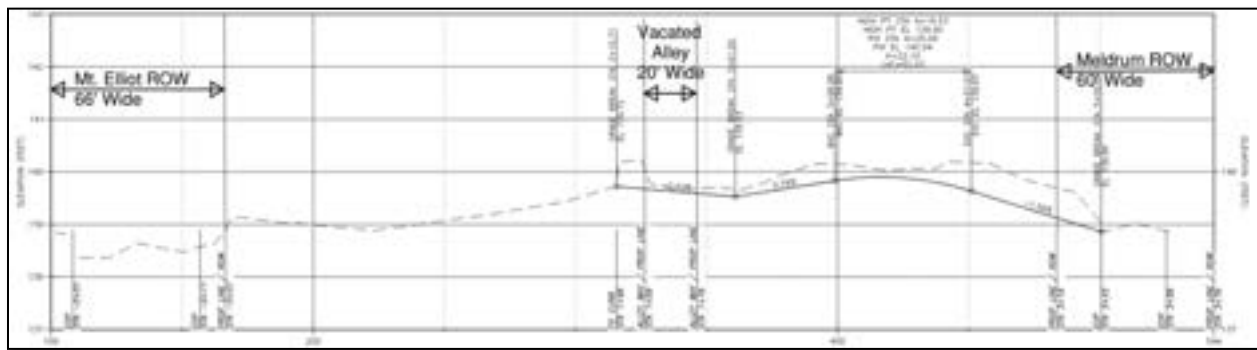


Figure 4-6
Leib CSO Facility Proposed Access Drive – Conceptual Profile

4.3.1 Alternative 1 - Connection to DWSD Owned Sewer

One alternative proposed by the Design Team is to route the captured runoff from the new driveway towards an existing DWSD combined sewer in the alley located north of the facility and driveway. This would involve the installation of a new storm sewer between the catch basins in the driveway and the manhole in the northern alley. From here, the flow would join the combined wastewater effluent in DWSD's combined sewer system. **Figure 4-7** illustrates this alternative.

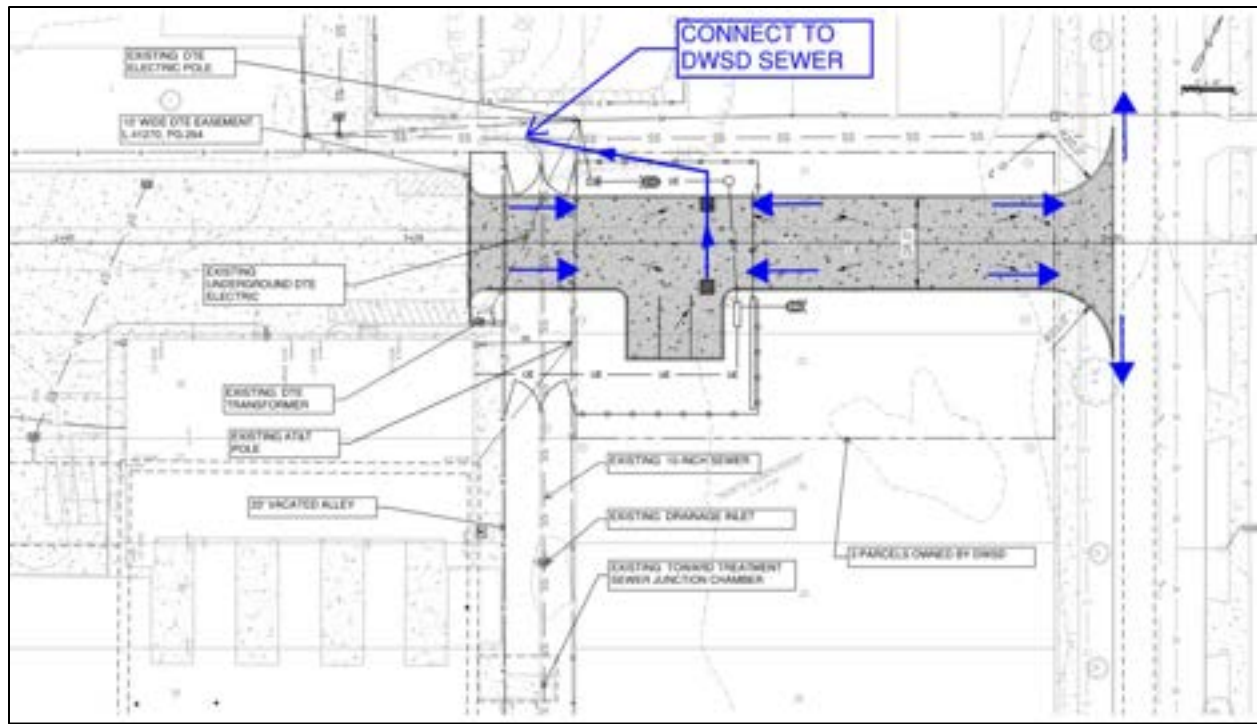


Figure 4-7
Plan View Sketch of the Proposed Alternative 1 Utilizing a Nearby DWSD Owned Sewer for Drainage

4.3.2 Alternative 2 - Connection to Toward Treatment Sewer via Alley

Another alternative proposed by the Design Team is to route the captured runoff from the new driveway towards the control gate chamber in the Leib facility. This would involve the installation of a new storm sewer between the catch basins in the driveway and the control gate chamber located in the alley adjacent to the Leib site. This connection would drop the flow in to the control gate chamber within the Leib Facility. From the control gate chamber, the stormwater would flow into the Toward Treatment Sewer. **Figure 4-8** illustrates this alternative.

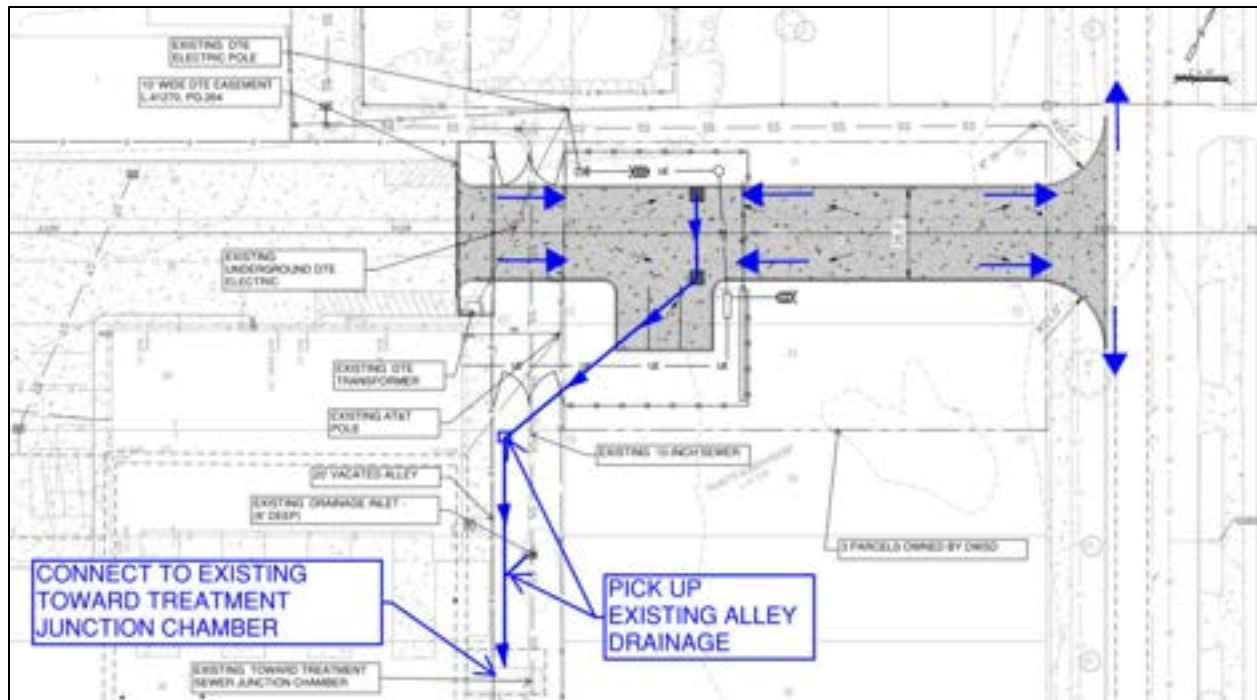


Figure 4-8
Plan View Sketch of the Proposed Alternative 2 - Utilizing the Toward Treatment Sewer for Drainage

4.3.3 Alternative 3 - Connection to the Onsite Stormwater System in Facility Parking Lot

Another alternative proposed by the Design Team is to route the captured runoff from the new driveway towards the existing onsite stormwater system in the Leib facility parking lot. This would require installing a new section of sewer between the catch basins in the driveway and the catch basin on the north end of the facility parking lot. From here, the runoff would be integrated into the existing stormwater system and outlet via a drop manhole into the influent box at the head of the facility's S&D operations. **Figure 4-9** illustrates this alternative.

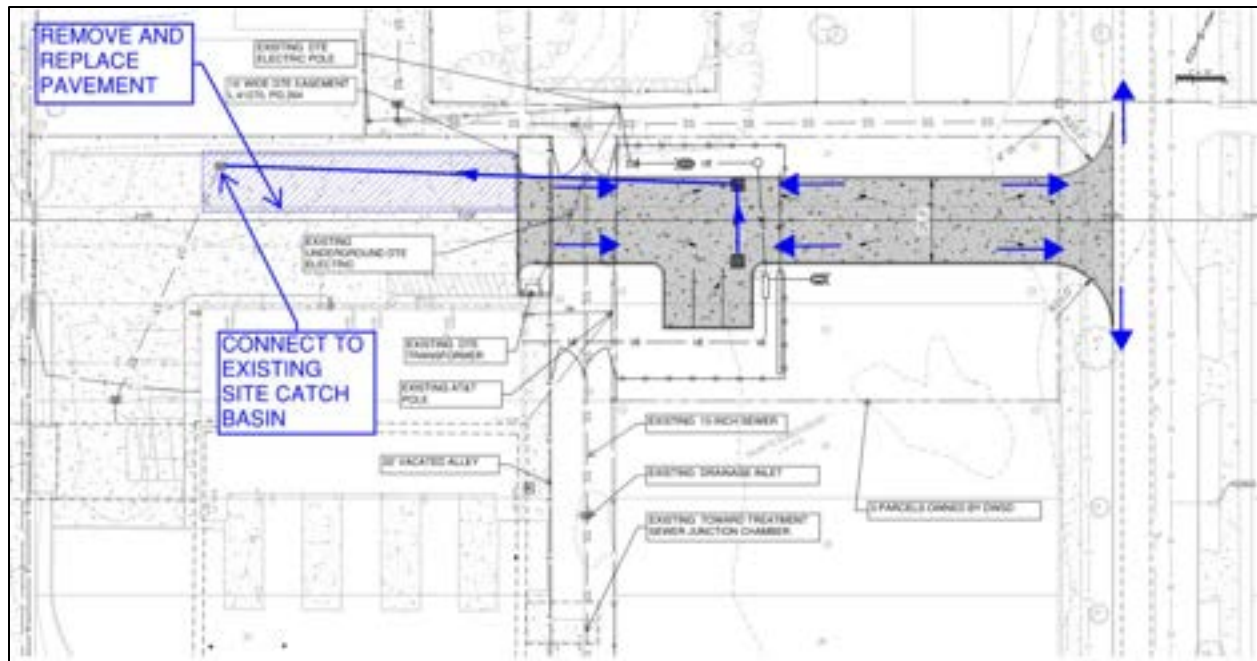


Figure 4-9
Plan View Sketch of the Proposed Alternative 3 - Utilizing the Onsite Stormwater System for Drainage

4.3.4 Alternative 4 - Surface Drainage and Bioswales

A final alternative considered the possibility of utilizing surface runoff from the newly paved road and surface draining the stormwater through bioswales adjacent to the road. This alternative was designed with minimal impact in mind. The design would allow runoff to flow off the road and into the grass lots with the bioswale improvements, increasing the infiltration capacity already present on site. Flow would be diverted off the road by paving a pronounced crown along the entire span of the access road to route sheet flow to either side. No new structures would be constructed to capture or route stormwater runoff.

This design would also allow for greater flexibility in grading the access road. Implementing curb for the road would not be an option under this alternative. **Figure 4-10** illustrates this alternative.

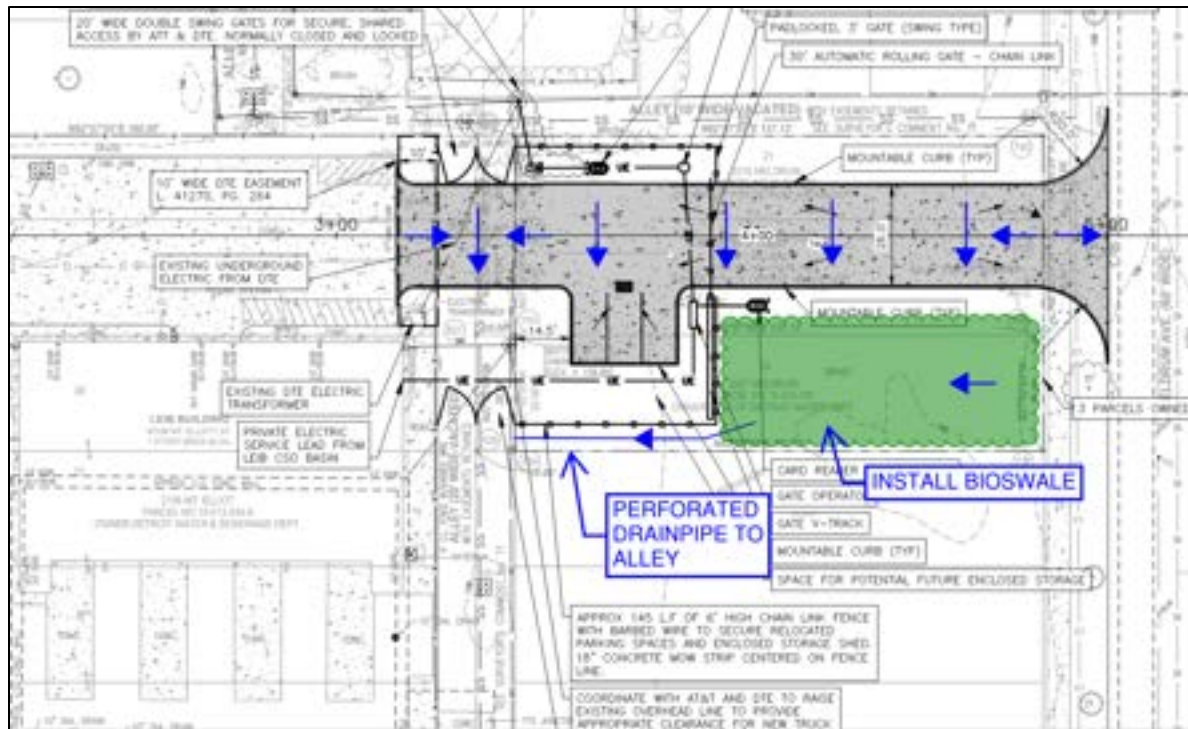


Figure 4-10
Plan View Sketch of the Proposed Alternative 4 – Surface Drainage and Bioswale

4.3 Alternatives Evaluation Criteria

Per Petition No. 1584 (Nov. 4, 2021) the City of Detroit reserves utility easement for the full extent of the vacated right-of-way. This easement requires ingress and egress at any time. Additionally, the standard permitting process for improvements within the limits of a vacated alley requires City Engineering permitting review and approval.

For the three parking spaces across the alley, parking lots are an allowable land use in an M3 (General Industrial) district.

The City of Detroit Engineering Division (CED) will need to approve the new driveway curb cut. The parcels 2207-2219 Meldrum St. will need to be combined and submitted for a separate Buildings, Safety, Engineering, and Environmental Department (BSEED) permit.

Outdoor storage sheds within manufacturing districts have been subject to a moratorium and most likely will require enclosure whether located on the present project site or adjacent lot. Further information about the present status of the moratorium should be confirmed with BSEED.

The design of the stormwater management systems at both the Oakwood and Leib facilities are guided by the DWSD's Stormwater Management Design Manual. Calculations of runoff flows and bioswale storage volume are developed based upon the 10-year, 24-hour storm event.

Peak runoff flow rates are calculated using the rational method. The formula for this method is seen in **Figure 4-11**. Runoff coefficients and rainfall intensity are derived from standard tables in the Stormwater Management Design Manual.

$$Q_p = CiA$$

where Q_p = Peak Flow, ft³/s
 C = Dimensionless runoff coefficient (Table 4-9)
 i = Rainfall intensity, in/hr.
 A = Drainage area, acre

Figure 4-11
Rational Method for Peak Runoff Flow Rate

Storage volume calculations for the proposed bioswales at Oakwood are also based on methodology described in the Stormwater Management Design Manual.

Sewer connections to existing DWSD owned sewers will require coordination and permitting from DWSD.

5.0 Alternatives Analysis

5.1 Oakwood Facility Roadway Geometrics and Cross-Section

The proposed Roadway cross section and width are adequate to provide for access to the Odor Control Facility. A shallow mountable curb may need to be utilized at the northwest corner of the facility where there is an existing rolling gate opening in the existing fence line.

5.2 Oakwood Facility Site Drainage

The drainage alternative at the Oakwood site will be designed with the assumption that roughly 16,400 square feet of impervious area will be added to the area surrounding the CSO Bains due to the newly paved service road. 0.1 cfs of additional runoff generated from the new paving over the existing gravel road will be considered when designing the stormwater management system.

To meet PCSWMO standards, the bioswales on either side of the CSO basin will be sized to manage the 10-year, 24-hour storm event. The bioswales on both sides of the basin will be sized to store the computed stormwater runoff for the associated drainage area.

Routing the CSO basin roof drainage over the road and shoulder has the benefit of requiring no additional structures to route the flow across the road.

The disadvantage of this alternative is that the road must be designed to accommodate runoff passing across it and must prevent water from becoming stagnant on the road. This alternative presents more limitations on the design and grading of the new paved road.

5.3 Leib Facility Fencing and Access

5.3.1 Alternative 1 - No Fencing in the Vacated Alley

The benefit of this alternative is that it allows free access to other utilities which presently occupy the vacated alley including AT&T communications lines, the buried DTE Electric Service, and the buried DWSD sanitary sewer. The disadvantage of this alternative is that swing gates need to be utilized at the existing fence line due to the limited clearance around the existing DTE transformer to allow for a roll gate which is what is preferred by GLWA. Another disadvantage is that a second set of swing gates would need to be maintained and used to access the relocated parking spaced on the DWSD owned lots. If additional parking spaces are required, a roll gate fencing configuration would need to be implemented on the lots owned by DWSD.

5.3.2 Alternative 2 - Fencing the Vacated Alley

The benefit of this alternative is that only one gate is needed to provide security and access to the new concrete access drive and relocated parking spaces. A roll gate across the access drive entrance can be provided in this arrangement because there are no clearance restrictions as it is located away from the existing fence line and existing DTE transformer. The disadvantage of this alternative is the normally locked swing gates providing shared access to other utilities restrict their access more than Alternative 1. Additionally, a fence across the vacated alley may present another issue with regard to permit approval from the City of Detroit.

5.4 Leib Facility Site Drainage

All alternatives will be analyzed with the assumption that roughly 5,630 square feet of impervious area will be added to the Leib facility site because of the implementation of the new driveway and three parking spaces. For Alternatives 1-3 discussed in Sections 4.3.1 through 4.3.3, the runoff generated will be considered when designing the new sewer system.

5.4.1 Alternative 1 - Connection to DWSD Owned Sewer

The connection to the existing DWSD combined sewer has the benefit of using an existing outlet near the site. It also has the benefit of requiring the shortest length of additional sewer compared to the next three alternatives.

This alternative has the disadvantage of requiring permitting from DWSD to tie into their sewer. Additionally, the DWSD sewer services homes in the area. Adding storm flow to the combined sewer raises the concern of increasing the peak hydraulic grade lines in this sewer during large storm events. DWSD stormwater permitting staff provided indications that they had no concerns with tapping the rear yard sewer at this location. Staff indicated a connection directly to an existing manhole structure or a blind tap to the existing sewer is permissible. Another disadvantage to this alternative is that this route would cross an existing electrical duct bank owned by DTE.

5.4.2 Alternative 2 - Connection to Toward Treatment Sewer via Alley

The connection to the TTS also has the benefit of using an existing outlet near the site. The TTS is already used as an outlet for the runoff generated over the grass paver and roof on the south side of

the facility and adding additional flow to this sewer should pose no issues. This alternative would also feature an additional one or two catch basins in the alley between the facility and the vacant lots. This would provide the added benefit of improving drainage in the alley.

This alternative has the disadvantage of requiring the construction of more structures compared to the other alternatives.

5.4.3 Alternative 3 - Connection to the Onsite Stormwater System in Facility Parking Lot

The connection to the onsite stormwater sewer system has the benefit of integrating into the already existing stormwater management system on site. The additional runoff added to the outlet at the head of the facility should pose no conveyance issues.

This alternative has the disadvantage of requiring a large section of the existing parking lot to be demolished and repaved to lay out the new sewer line and connect to the existing sewer system. This sewer alternative would also route through a DTE easement, which would require going through a DTE release of ROW process.

5.4.4 Alternative 4 – Surface Drainage and Bioswales

Allowing runoff from the new access road to freely flow onto the grassy lots and into bioswales has the benefit of not requiring the construction of new structures to capture and convey stormwater flow. Additionally, the expected runoff generated by the new driveway is expected to be minimal. This alternative does not provide the direct drainage that the prior three alternatives provide. However, this alternative does promote positive drainage from the vacant lot areas surrounding the new driveway. Overall, the installation of bioswales is expected to capture the runoff from the new driveway and improve the drainage in the vacant lots.

6.0 Life Cycle Cost Analysis

Not used.

7.0 Summary, Recommendations, and Key Decisions

Leib Site

The Jacobs CS-299 report estimated the construction cost for a new access drive and cantilever gate at the Leib Site of \$138,000. This cost did not include relocated parking spaces, underground drainage, or security fencing for the new access drive. The recommended alternatives will increase the estimated construction costs at this site.

Fencing Alternative 2 is recommended. This alternative provides secure access to the Owners' facilities with one rolling gate, and two normally locked swing gates for shared access where proposed fencing crosses the vacated alley. The rolling gate would be similar to the one which is presently in use at the site and meets the Owners (GLWA) security standards. The design team will coordinate with GLWA security staff to ensure the proposed improvements meet GLWA security standards. This alternative would be easier for the Owner to operate and maintain and provides

space for additional parking spaces to be added should this be required in the future. Shared access to utilities in the vacated alley is also provided for.

The preferred drainage alternative at the Leib site is Alternative 4 which allows runoff to flow across the driveway and into bioswales adjacent to the new driveway. This alternative does not require the construction of any additional structures on the site.

This alternative has the benefit of utilizing green infrastructure to infiltrate the runoff generated by the new driveway. There is little concern of the bioswales being able to capture the entirety of the runoff due to the small volume of runoff generation expected from the implementation of the new driveway. This alternative also has the benefit of avoiding crossing or connecting to other existing utilities on the site. Drainage Alternative 4 is also likely to be the least expensive alternative.

Oakwood Site

The CS-299 Report estimated the construction cost for a new concrete access drive and drainage at the Oakwood Site at \$497,000. The recommended alternative at this site includes the items considered in the CS-299 cost estimate.

The preferred drainage alternative at the Oakwood site is to route CSO basin roof drainage over the newly paved road. This alternative has the benefits of requiring no additional structures to route the flow across the road and being easier to maintain than an underground system. This alternative also avoids conflicts with existing utilities on the west side of the CSO basin.

The installation of improved bioswales on both the east and west sides of the CSO basin would complement this design for either routing alternative chosen. The bioswales will be sized to provide retention of the runoff generated at and around the CSO basin.

7.1 Key Decisions

Key decisions made during the course of review and presentation of this Technical Memorandum are as follows:

7.1.1 Leib Site

- For Leib site drainage, GLWA is against the implementation of drainage infrastructure. Instead, GLWA prefers that the Design Team utilizes drainage swales and the existing drainage system for the recommended alternative.
- For Leib site, GLWA prefers the Alternative 2 Fencing in the Vacated Alley. This alternative proposed 30 ft wide motorized rolling gate, an interior and exterior card reader, a new security camera, and 2-20 ft wide swung gates with lock for utility access, bollard for protection of transformer.

7.1.2 Oakwood Site

- For Oakwood CSO Facility, GLWA prefers the improvements including a paved road with shoulder on one side, bollard to protect electrical vault and other structure along the paved road, signs for semi-trailers, and waterproof covers/rims for existing manholes.

8.0 Next Step

This section provides a list of additional investigations to be performed to support the final recommendations for each alternative that will proceed into detailed design, or additional information and coordination needs for early in detailed design for advancement of this task.

- The design team will have to coordinate with Jonathan Farrugia to replace damaged concrete drive and sidewalk at the Oakwood CSO facility.
- The design team will discuss the quantities and unit prices of the base material with GLWA during design phase.
- During detailed design, truck turning analysis will be performed with a wider turning radius at the proposed driveway at the Leib CSO facility to provide sufficient clearance for the trucks and ensure no damage to the proposed improvements and ground.
- The grades and cross-section details of the proposed bioswale at the Oakwood CSO facility will be provided during design phase.
- During design phase, team will coordinate with GLWA security to ensure the proposed improvements meet GLWA standards.

2.2 Architectural, Plumbing, and HVAC, TM-8 and TM-9

Leib SDF

- Removal and reinstallation of chemical facility wall to accommodate hypo storage tank replacement
- Wall modification, door removal and new double door for SF-1 access
- East and West vestibule modifications for NFPA 820 area isolation
- Potential modifications to the chemical storage/feed room (TBD)
- New thermostat in office
- Floor drain modification in garage



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Dan Martel, METCO
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Date: June 1, 2023

*Subject: TM-8 Leib HVAC Improvements
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

This technical memorandum (TM) has been developed to address two of the HVAC related issues at the Leib CSO Screening and Disinfection Facility (SDF) identified as part of the Leib HVAC-1 task and identified in the CS-299 Report. The memo reviews the existing built conditions related the maintenance accessibility for the supply fan SF-1 and the temperature controls for the Office (Control Room). Based on the Design Team's evaluations discussed in this TM, the Design Team is recommending the following for the two HVAC related issues.

- To provide more adequate maintenance access to the supply fan (SF-1), the Supply Fan Room shall be enlarged by creating an opening in the east wall of the room, and adding a room extension with a ceiling, and adding a set of double exterior doors to allow for future replacement of SF-1.
- For the Office HVAC system temperature controls issue noted in the scope of work, it was determined through review of the CIP No. 260611, Great Lakes Water Authority (GLWA) Contract No. 1803718, Leib Combined Sewer Overflow (CSO) SDF HVAC Improvements, completed in 2021, that the temperature controls have already been separated from the Toilet and Jan Room, and the Sampler Room. However, according to discussions with the Operator, the Design Team recommends to replace the existing wall mounted thermostat that does not have a temperature readout screen, with a similar model that includes the LCD for displaying the temperature.

1.0 Introduction and Purpose

GLWA CSO Facilities Improvements Project – Contract No. 2101475 - Leib HVAC-1 Task requires the Design Team to review the issues related to the Leib facility's existing HVAC system as identified in the CS-299 Report. Two issues from the report were identified for review, analysis, and evaluation for implementation in to the GLWA CSO improvements Project.

1. The lack of maintenance access to the Supply Fan SF-1, located in the Supply Fan Room that supplies ventilated fresh air to the Screening and Disinfection area below grade. The size of the SF-1 unit and its physical position in the Supply Fan Room only allows for less than 12 in. of maintenance clearance on the east side of the room to maintain the supply fan's belt, sheeves, motor, and grease fittings.
2. The HVAC system temperature controls for room Office. The referenced CS-299 Report identified improvements that have been made to improve operator comfort, however, the Office HVAC system is still shared with Toilet and Jan Room, and Sampler Room. The report indicated that separate temperature controls are desired for the Office.

2.0 Existing System(s) Description (and/or Conditions)

Descriptions of the existing systems and conditions related to the two issues, lack of maintenance access to the Supply Fan SF-1, and HVAC system temperature controls for the Office are noted in Section 2.1.

2.1 Supply Fan SF-1 Lack of Maintenance Clearance in Supply Fan Room

Supply fan SF-1 for the Leib CSO SDF is located in the Supply Fan Room and supplied fresh air to the Screening and Disinfection area below grade through a below grade concrete duct/pipe connected to the metal supply ductwork in the Screening and Disinfection space. The supply fan pulls air from the air intake R13 – Plenum room to the west of the Supply Fan Room. The Supply Fan Room is considered by NFPA 820 as a Class 1, Division 1 hazardous classification space due to the room's connectivity to the Screening and Disinfection space below that also has the Class 1, Division 1 hazardous classification. The room has an open ceiling to the trussed roof system above, but is physically separated from all other spaces on the main level with continuous walls that separates the attic space, and precast concrete ceiling over spaces within the connected attic space. See **Figure 2-1**.

The current position of the supply fan SF-1 only allows for limited access to the maintain the supply fan's belt, sheeves, motor, and grease fittings. The position of the supply fan is dictated by the location of the concrete duct that it connects to, which appears to be shifted too far east to allow for suitable maintenance access on the east side of the room. **Figure 2-2** shows the limited access space.

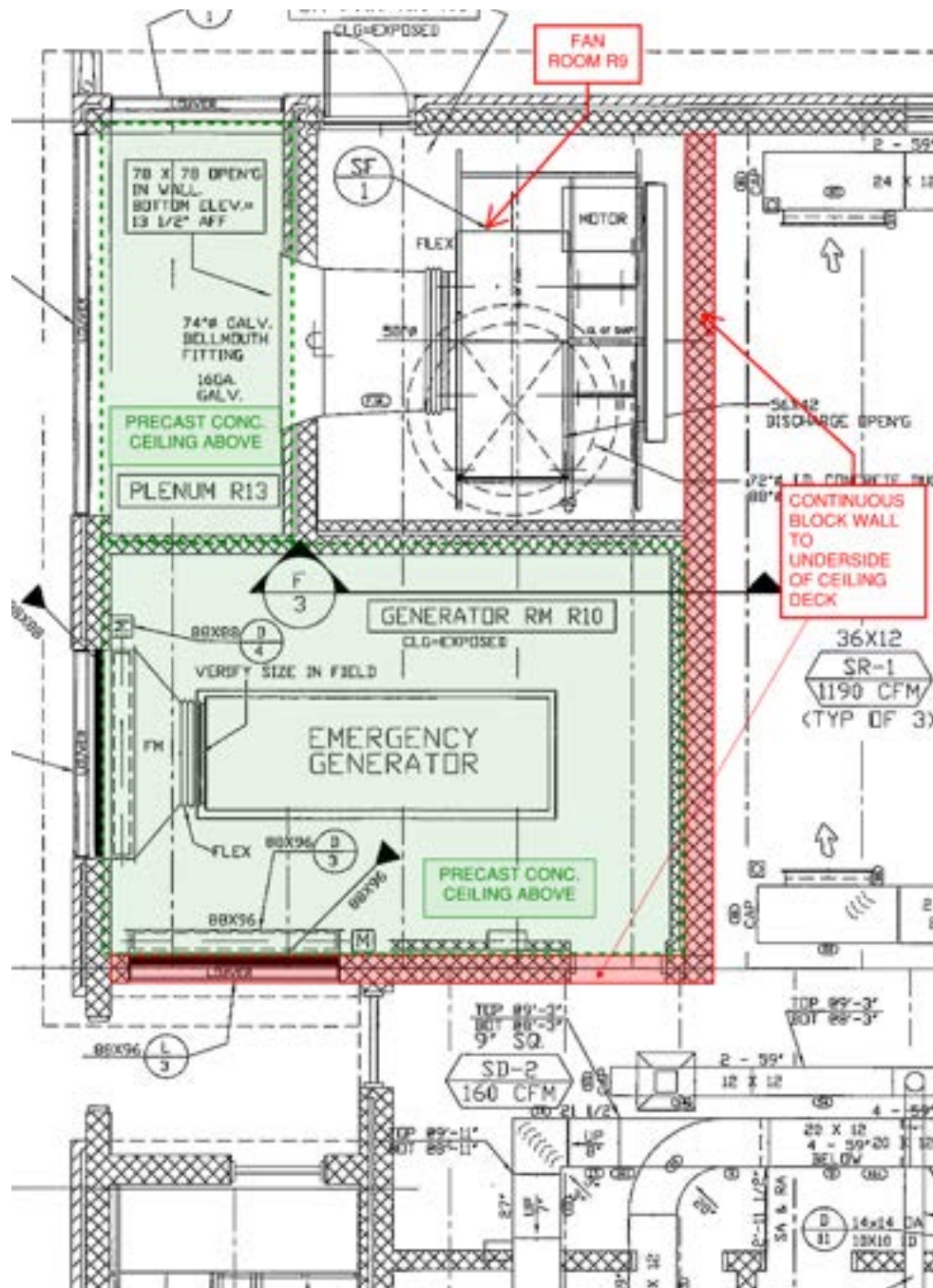


Figure 2-1
Supply Fan Room Plan Showing Adjacent Rooms and Physical Separation Method.



Figure 2-2
Northeast Corner of Supply Fan Room Showing Minimal Maintenance Access for SF-1.

2.2 Office HVAC System Temperature Controls

The Office HVAC system was originally installed under Detroit Water and Sewerage Department (DWSD) Contract PC-732 – Leib CSO SDF, and completed in 2004. The HVAC system for the Office consists of unitary split AC unit (Trane 4TXCB003DS3HCAA indoor unit and 2 Ton nominal capacity TTB024C100A outdoor condensing unit) and a natural gas fired furnace unit (Trane TUD1B080A9361BB) which has 80MBH input and 64 MBH output heating capacity. This single stage heating and cooling up-flow air handling unit has 766 CFM airflow. Supply and return ducts run directly to the Office with supply diffuser and return grille in the acoustical drop ceiling.

The Office HVAC system controls were recently upgraded under the CIP No. 260611, GLWA Contract No. 1803718, Leib CSO Facility HVAC Improvements, completed in 2021. The controls were updated to connect to a new HVAC control panel with BACnet MSTP control panel that adjusts the room temperature set points based on the user's definable schedule to determined Occupied Mode or Unoccupied Mode.

- Occupied Mode: The unit shall maintain 75 deg. F. (adjustable) cooling setpoint and a 68 deg. F. (adjustable) heating setpoint. The occupant shall be able to adjust the zone temperature heating and cooling set points at the zone sensor.
- Unoccupied Mode: The unit shall maintain 85 deg. F. (adjustable) cooling setpoint and a 55 deg. F. (adjustable) heating setpoint to achieve night setback temperature.

While the CS-299 Report indicates that Office's HVAC system also services the Toilet and Jan Room and Sampler Room, the current HVAC-1 unit only provides conditioned air to the Office. (**Figure 2-3**) The controls for the Office are already separated from other spaces, allowing the operator to adjust the temperature to their desired setting while the room is occupied.

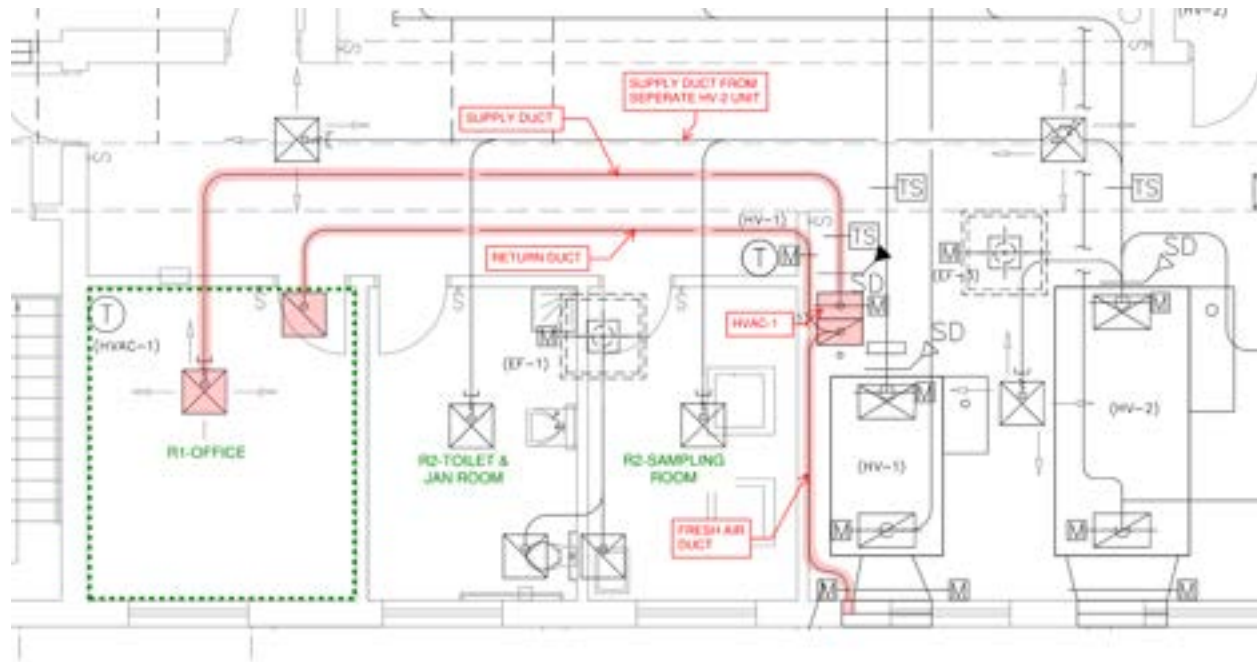


Figure 2-3
HVAC Plan M-100 from GLWA Contract No. 1803718, Leib CSO Facility HVAC Improvements showing dedicated HVAC unit for Office.

3.0 Evaluation

Evaluation of the existing systems and conditions related to the two issues, lack of maintenance access to the supply fan SF-1, and HVAC system temperature controls for Office are noted in Section 3.1.

3.1 Supply Fan SF-1 Lack of Maintenance Clearance in R9 – Fan Room

Evaluation of the supply fan SF-1 maintenance requirements listed in the Leib CSO SDF Operation and Maintenance Manual calls for maintaining the grease bearings, inspection of all bolts and screws, inspection of the belt, and a recommended dismantling and checking of the motor. The maintenance schedule taken from the manual is shown in **Table 3-1**.

Table 3-1 Supply Fan SF-1 Maintenance Schedule

Frequency	Item	Maintenance and Operation Task
Bi-monthly	Fan	1. Grease bearings
Semi- annually	Fan and Motor	1. Inspect bolts and screws. 2. Inspect belt. 3. Inspect for cleanliness.
Every 3 years	Motor	1. Recommended to pull apart. 2. Check and re-grease bearings

Note: Taken from Table 12-1 Maintenance and Operations Schedule

Additional maintenance recommended for centrifugal fans include:

- When inspecting bolts and screws, tighten if necessary.
- When inspecting the belt, check the tension of belt to meet manufacturer's requirements.
- Inspect bearings for excessive vibration, wear, and overheating.
- Check impeller and housing for build-up of foreign parts and/or overheating.
- Check sheaves for worn grooves or other damage, and for cleanliness. Replace as needed.

Typical required maintenance clearances needed for inspection and maintenance of the fan unit is 30 to 36 in. The current maintenance clearance provided between the motor housing and the north wall is about 24 in., while the maintenance clearance between the fan belt guard and the east wall is only about 6 in. While the 24 in.-clearance between the north wall and the motor housing is less than desired, the clearance is enough to allow for maintaining the motor under less-than-ideal clearance conditions. The 6 in.-clearance between the belt guard and the east wall is not suitable for maintaining the belt and proper inspection of the fan unit, belt, and sheaves.

3.2 Office HVAC System Temperature Controls

The current controls for the HVAC-1 unit servicing the Office provide the dedicated temperature control noted to be evaluated and modified as part of Leib HVAC-1 Task. Heating and cooling setpoints are adjustable, but are set up for efficiency to reduce the heating and cooling requirements during the evening when the facility is typically unoccupied.

During a site visit, the Design Team interviewed the Operator regarding the environmental conditions of the Office. The Operator indicated that the temperature level was fine, and felt that no adjustments were needed. The Operator showed the Design Team that they could press up or down on the button on the wall-mounted thermostat to raise or lower the temperature. **Figure 3-2** shows an image of the wall mounted thermostat.



Figure 3-2
Adjustable Wall Mounted Thermostat.

Further discussions with the Operator indicated that they were not able to see the temperature of the room in the Ovation SCADA system. This is confirmed by the GLWA Contract No. 1803718, Leib CSO Facility HVAC Improvements As Built Drawings, dated March 15, 2021. Sht. M-502 shows the requirement for temperature and temperature alarm monitoring through the existing Ovation SCADA system has been crossed out. The HVAC-1 unit is connected to a BACnet MSTP control panel and Jace controller that connects to a PC running the BACnet software to monitor and control the unit's settings, varying temperature points, and alarms.

4.0 Description of Alternatives

Alternatives that address the two issues, lack of maintenance access to the supply fan SF-1, and HVAC system temperature controls for the Office are discussed in this section.

4.1 Supply Fan SF-1 Maintenance Access

As part of the scope of the Leib HVAC-1 Task, The Design Team is tasked to resolve the maintenance access issues with supply fan SF-1. The CS-299 Report provided an evaluation of an approach that relocated the east wall of the Supply Fan Room that is shared with the Garage. Additional alternatives for providing maintenance access are also discussed in this section.

4.1.1 SF-1 Maintenance Access Alternative 1 - Enlarge Room by Moving the East Wall of Supply Fan Room:

To provide the maintenance access to the supply fan SF-1, a possible solution previously explored as part of the CS-299 Report was to enlarge the room by demolishing the east wall of the room and

constructing a new wall within the footprint of the Garage to provide the needed maintenance clearance. With the north side the fan's motor support skid less than 16 inches (motor housing about 24 inches) from the north wall, access to the enlarged maintenance area would require and an added man-door access to the exterior north wall. **Figure 4-1** shows a plan for the relocation of the Supply Fan Room east wall. Additional considerations include the current use of the space in the Odor Control Room (Garage) as an area for storage. **Figure 4-2** shows an image of the Garage space where the proposed wall would be relocated.

Alternative 1 modifications include the following:

- Shutdown of SF-1 temporarily for work for an extended period requiring temporary ventilation.
- Protect SF-1 during demolition work.
- Demo and remove 12-in. CMU wall that extends to the bottom of the sloped roof deck. This will require review from a Structural Engineer to confirm that the wall is not supporting any loads. The clear span roof truss appears to be supporting the roof deck.
- Items to be rerouted/relocated on north and west walls of the Garage
 - Sanitary vent pipe that runs through the roof.
 - Cold water piping.
 - Fire sprinkler riser and backflow preventer and associated piping.
 - Fire alarm system strobe device, associated conduit and wiring.
 - Conduit and wire with an unidentified pullbox.
 - Wall receptacles with associated conduit and wiring.
 - Disconnect switch for the air compressor located nearby.
 - Wall switch for lights above.
 - Partial of ductwork in the northwest corner, and relocation of supply grille.
 - Relocate hung lights in the Garage, and add additional lighting inside the Supply Fan Room extension and at the exterior door.
 - The floor drain in NW corner of the Garage will be relocated. Cannot be connected to the floor drain system in the Garage that remains, as this would violate NFPA-820 physical separation requirements.
- Sawcut and remove existing floor slab in the Garage to place new reinforced concrete foundation grade beam. Grade beam would be two ft 6-inch-wide and constructed to a depth of 5 ft, 9 in. below top of floor slab to match existing conditions under the existing wall being removed. Replace slab that was removed.

- Construct new 12 in. CMU wall to the underside of the roof deck located 4 ft from the existing location to allow for a new 36 in wide door into expanded room Supply Fan Room for maintenance access to the east side of SF-1.
- Clean entire Supply Fan Room space.
- Paint walls and ceiling. Touch-up paint all ferrous metals.
- Add additional storage racks as needed.
- Perform needed maintenance and inspections.

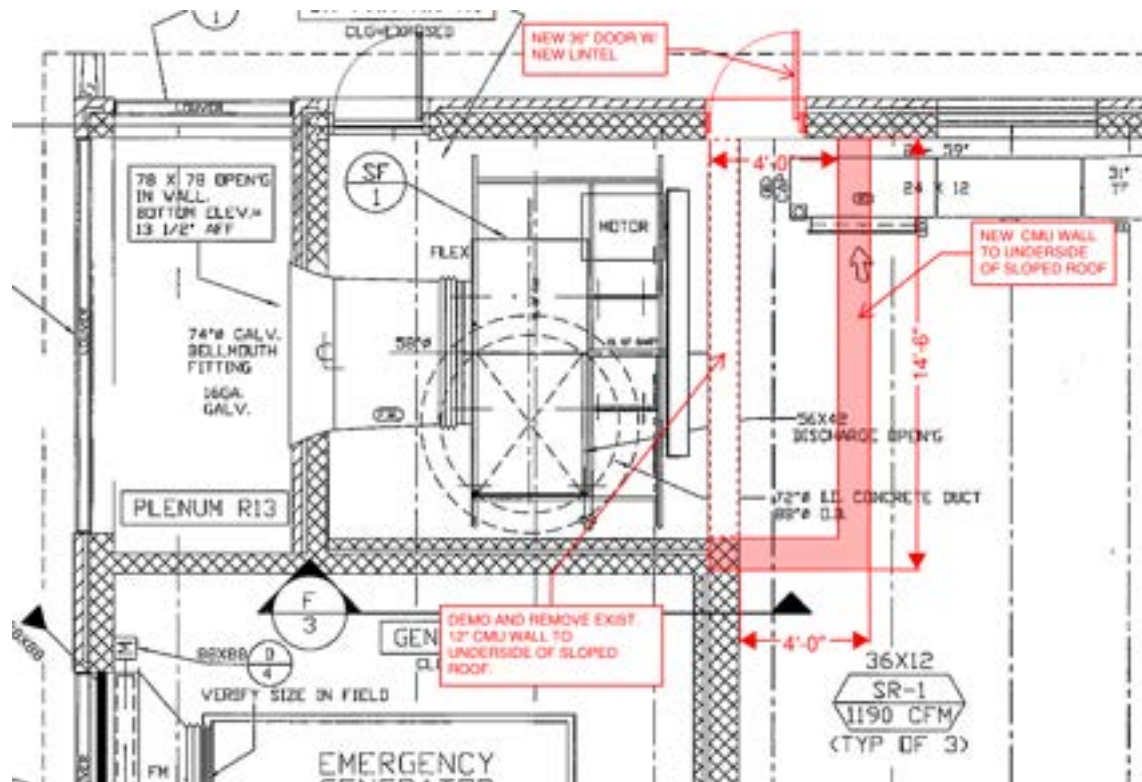


Figure 4-1
Leib CS SDF Removal of Supply Fan Room east wall and construct new east wall – Alternative 1.



Figure 4-2
Leib CSO SDF – north-west corner of Garage area

4.1.2 SF-1 Maintenance Access Alternative 2 - Enlarge Room by Creating an Opening in the East Wall of Supply Fan Room, and Adding Room Extension with Ceiling:

To provide the maintenance access to the Supply Fan SF-1, a possible solution would be to enlarge the room by opening the east wall of the room and constructing a new shorter wall with a ceiling deck within the footprint of the Garage to provide the needed maintenance clearance. The room extension would be enlarged only enough to provide the needed clearance, and avoid relocation of critical fire protection and domestic water systems. The newly constructed room extension could be constructed of 8-inch-thick CMU, with a new ceiling deck at about 10 ft above the finished floor.

Figure 4-3 shows the room extension of the Supply Fan Room through the east wall.

While similar in footprint to Alternative 1, this alternative would avoid the need for deep large foundations, where a thickened slab could be used, and avoids the difficult masonry work of coping around roof truss members and bridging. This alternative does require a new structural beam be installed in the mating wall for the Supply Fan Room and the Garage, which will require structural design and evaluation. To allow for replacement of SF-1 in the future without temporary shoring and removal of walls, a set of double doors sized to allow for the removal of SF-1 is included in the design. Additional considerations include the current use of the space in the Garage as an area for

storage. **Figure 4-3** show an image of the Garage space where the proposed wall would be relocated.

Alternative 2 modifications include the following:

- Shutdown of SF-1 temporarily for work.
- Protect SF-1 during demolition work.
- Temporarily shore 12" CMU wall to allow for new beam to be installed to create new opening in the wall.
- Demo and remove portion of 12 in. CMU wall below the new beam.
- Temporarily shore exterior bearing wall to allow for new lintel to be installed over new opening in the wall for a set of double doors.
- Items to be rerouted/relocated on north and west walls of the Garage.
 - Sanitary vent pipe that runs through the roof.
 - Fire alarm system strobe device, associated conduit and wiring.
 - Conduit and wire with an unidentified pullbox.
 - Wall receptacles with associated conduit and wiring.
 - Disconnect switch for the air compressor located nearby.
 - Wall switch for lights above.
- Relocate hung lights in the Garage, and add additional lighting inside the Supply Fan Room extension and at the exterior door.
 - The floor drain in NW corner of the Garage will be relocated. Cannot be connected to the floor drain system in the Garage that remains, as this would violate NFPA-820 physical separation requirements.
- Sawcut and remove existing floor slab in the Garage to place new thickened concrete slab to support shorter wall and tributary width of ceiling deck. Thickened slab would be 2- ft-wide at the bottom and angle up to the underside of existing 10-inch slab thickness, and be an extra 9 in. thicker than the slab to match the existing thickened slab details for similar configurations at the station.
- Construct new 8 ft CMU wall to a height of 8 ft, 8 in., with a new light gauge joists framed ceiling deck with $\frac{3}{4}$ rated plywood decking, and gypsum boards ceiling covering in the Supply Fan Room. This will allow for an open deck that can be used for storage in the Garage.
- Install new doors.
- Clean entire Supply Fan Room space.

- Paint walls and ceiling, existing roof structure if needed. Touch-up paint all ferrous metals.
- Add additional storage racks as needed.
- Perform needed maintenance and inspections.

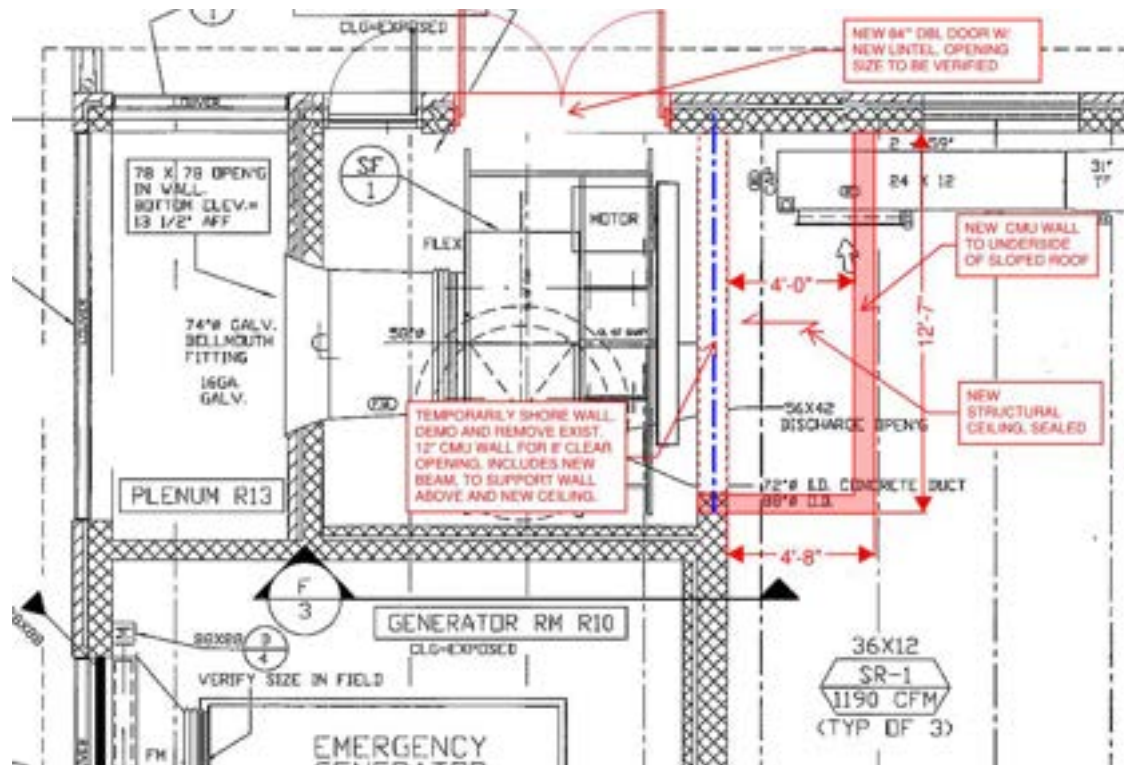


Figure 4-3
Leib CSO SDF – Removal of Supply Fan Room east wall and construct new east wall – Alternative 2.

4.1.3 SF-1 Maintenance Access Alternative 3 - Reposition the Existing SF-1 to Allow for Additional Maintenance Access:

To provide the maintenance access to the supply fan SF-1 and limit the encroachment on the Garage and the rerouting of piping and ductwork associated with the previously discussed Alternatives 1 and 2, repositioning the SF-1 supply fan was explored. The position of the supply duct pipe that penetrates the floor has dictated the position of SF-1 fan unit, with the supply discharge of the fan directly over the top of the pipe penetration. There is room however to lift up the supply fan unit and skid and shift to the west wall to provide the needed clearance on the east side of the fan unit at the belt, motor, and sheeves.

To accomplish this, the fan unit would need to be lifted and shifted approximately 30 in. The supply air intake opening into the Plenum Room is an 80" square opening that can be lifted 24 in. with 16

in, left for a new lintel to support the precast concrete ceiling deck of the plenum room. The fan unit skid would need to be supported on vibration isolators bearing on a new structural steel frame and posts to support the skid. To allow for clearance in front of the existing door, the fan's skid would need to be cut short, and with the structural support also designed to allow for the needed clearance in front of the door. The supply discharge of the fan unit would then connect to an angled duct section with a flexible connector. The angled duct section would then connect to the existing transitional duct section stubbing out of the duct pipe. Additionally, to provide better access to the east side of the fan unit, a new exterior door wall be added on the north wall at the east end of the wall, providing the needed access. **Figure 4.4** shows a plan showing the proposed modifications. **Figure 4.5** shows a sectional sketch showing the existing position and **Figure 4.6** shows a sectional sketch showing the proposed repositioning.

Alternative 3 modifications include the following:

- Shutdown of SF-1 temporarily for work.
- Disconnect SF-1 from supply and discharge ductwork.
- Temporarily shore R8-Plenum room precast concrete ceiling to allow demo of CMU wall at opening.
- Add new lintel and reposition opening.
- Modify existing skid to allow for clearance in front of the door.
- Temporarily lift SF-1 to assemble and install new structural steel support frame.
- Place SF-1 on the support frame, replace vibration isolators.
- Relocate controls and explosion proof enclosures as needed.
- Add new door and door opening in the exterior wall.
- Install new duct sections for connection to Plenum Room and the supply discharge ducts with new flexible duct connectors.
- Perform needed maintenance and inspections.

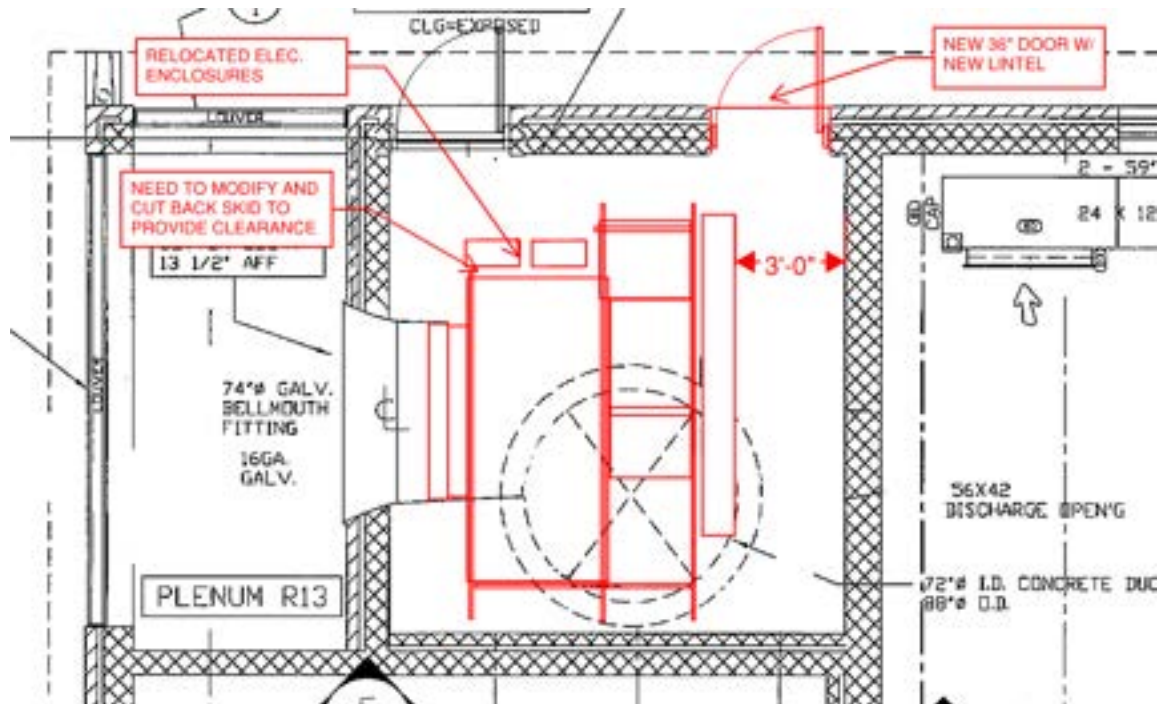


Figure 4-4
Leib CSO SDF – Repositioning of supply fan SF-1– Alternative 3.

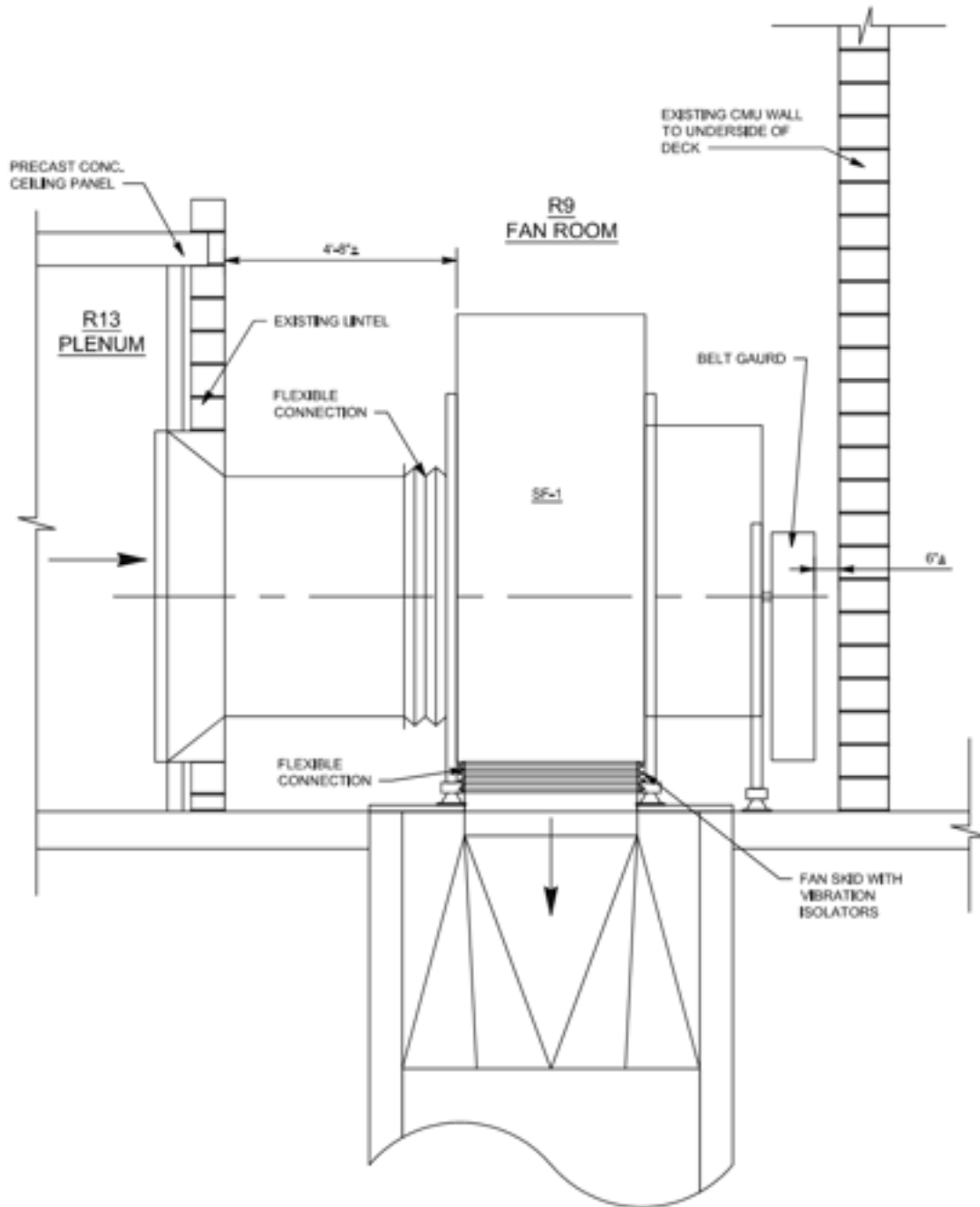


Figure 4-5
Leib CSO SDF – Sectional View of SF-1 – Existing Position.

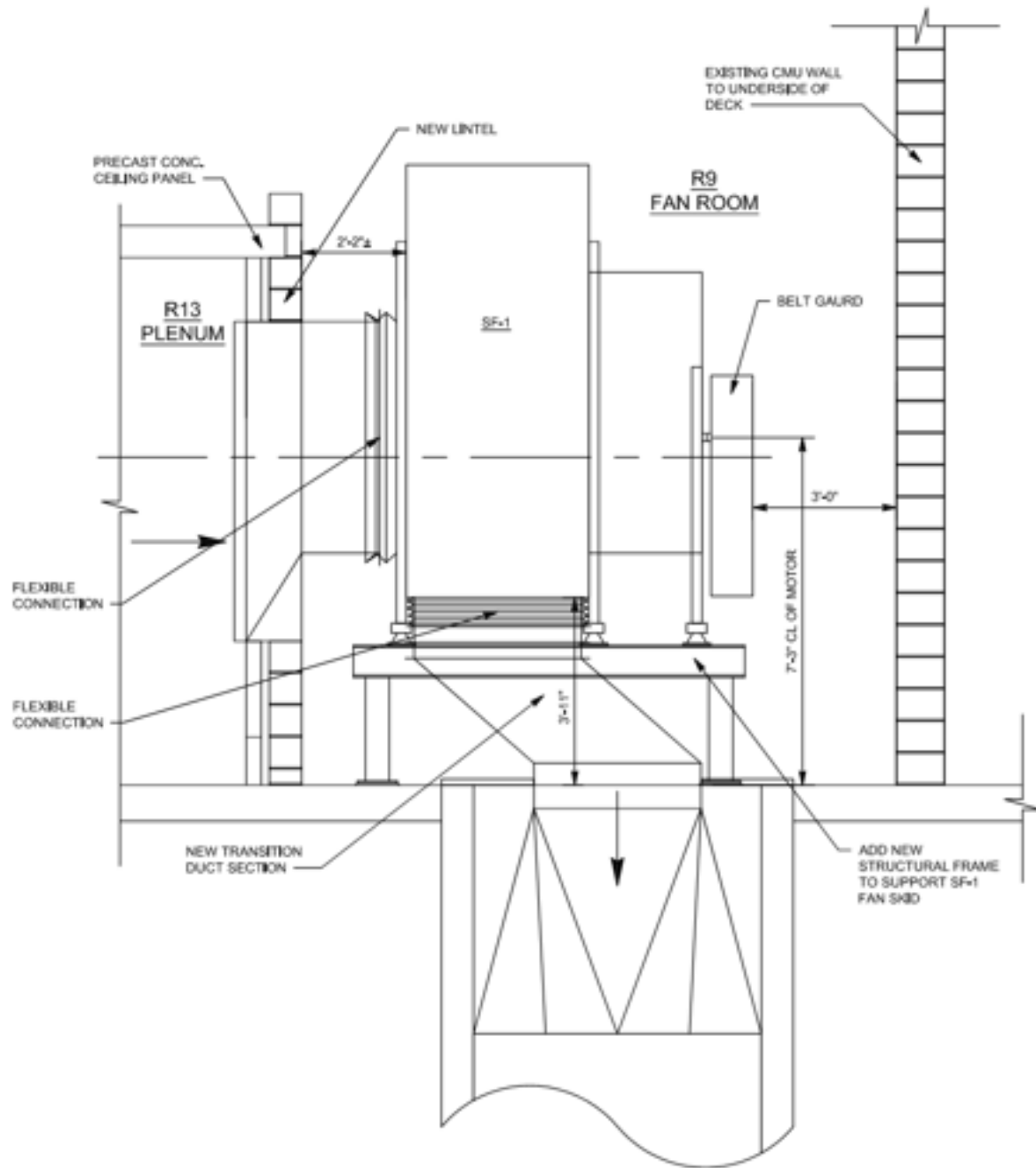


Figure 4-6
Leib CSO SFD – Sectional View of SF-1 – Repositioned

4.2 R1 – Office HVAC System Temperature Controls

As part of the scope of the Leib HVAC-1 Task, The Design Team is to improve the Operator's comfort level and provide separate temperature controls for the Office. As noted above in the Section 2.2 – Office HVAC System Temperature Controls, the Office currently has controls separate from the Toilet and Jan Room. and the Sampler Room. The recent upgrade to the HVAC controls completed in 2021 under the CIP No. 260611, GLWA Contract No. 1803718, Leib CSO SDF HVAC Improvements, has provided the dedicated controls and control of the Office temperature by using the wall mounted adjustable thermostat. Alternatives discussed in this section include leaving the system as is with the dedicated controls, or replacing the wall mounted adjustable thermostat with a wall mounted adjustable thermostat that includes a digital temperature readout.

4.2.1 Office HVAC System Temperature Controls Alternative 1 – Leave As Is:

With the temperature controls for the Office already dedicated to that room only, no further work related to these HVAC Controls is required under the scope of the Project. The Design Team would recommend that the HVAC Control setpoints, monitoring points, and occupied/unoccupied schedule are reviewed with the Operator, and adjustments be made accordingly using the BACnet connected system.

4.2.2 Office HVAC System Temperature Controls Alternative 2 – Replace Wall Mounted Thermostat:

As noted above, with the temperature controls for the Office already dedicated to that room only, no further work related to these HVAC Controls is required under the scope of the Project. However, per the noted interview with the Operator, the desire to know the temperature of the room and make adjustments as needed exists. To allow this added monitoring, the wall mounted thermostat can be replaced with same NS Series type sensor, but with a model that offers a LED display that allows the user to view zone temperature, relative humidity, and CO2 monitoring, with functionality of adjusting setpoints if needed. This replacement will not alter the current monitoring and control thru the BACnet MSTP control panel and Jace controller connected to a PC running the BACnet software.

4.3 Evaluation Criteria and GLWA Input when discussing alternatives.

4.3.1 Evaluation Criteria:

The above noted SF-1 related alternatives will be analyzed in the subsequent section using the following criteria.

- Improved Operation and Maintenance
- Costs

The above noted Office Temperature Controls related alternatives will be analyzed in the subsequent section using the following criteria.

- Improved Comfort Level
- Costs

4.3.1 GLWA Input:

During the Design Team's site visit to the Leib facility, The Design Team discussed Alternatives 1 and 2 with the facility's Operator who had concerns mostly about loss of space for storage in the Garage.

The operator also discussed a functionality issue with the operation of the supply fan SF-1. Prior to a recent upgrade, if there was a scheduled visit that required entry into the Screening and Disinfection area, which SF-1 supplies fresh air to, then the Operator would be able to press a "START" button located in the West Vestibule. The recent upgrade has reconfigured the controls so that SF-1 will start only after an occupancy sensor that turns the lights on to stairwells senses movement. The Operator would like the ability to start the SF-1 with a push button, rather than relying on the stairwell occupancy sensor.

5.0 Alternatives Analysis and Evaluation

To analyze the alternatives noted above for the two Leib HVAC-1 task issues, each alternative is analyzed for advantages and disadvantages listed, and evaluated based on the evaluation criteria for each issue.

5.1 Supply Fan SF-1 Maintenance Access Alternatives

The three alternatives to be analyzed and evaluated for supply fan SF-1 maintenance access are discussed in this section.

5.1.1 SF-1 Maintenance Access Alternative 1 - Enlarge Room by Moving the East Wall of Supply Fan Room – Advantages and Disadvantages:

Advantages:

- Provides the needed maintenance access for SF-1.

Disadvantages:

- Many items identified to be relocated, including fire main and possibly water BFP lineup.
- 12 in. CMU wall will require larger foundations to be constructed vs. Alternative 2
- 12 in. CMU wall difficulties coping around roof truss members and bridging.
- Loss of valuable floor space in garage currently being used for Storage.

5.1.2 SF-1 Maintenance Access Alternative 2 - Enlarge Room by Creating an Opening in the East Wall of Supply Fan Room, and Adding Room Extension with Ceiling – Advantages and Disadvantages:

Advantages:

- Provides the needed maintenance access for SF-1.
- Limits added foundations to thickened slab only.

- Limits difficult overhead masonry work to cope around roof truss members.
- Allows existing ductwork in Odor Garage to remain in place without modification.
- Allows fire main and BFP lineup in Garage to remain in place without modification untouched.

Disadvantages:

- Many items identified to be relocated (less HVAC duct, fire main, BFP lineup, compared to alternative 1)
- Need to add beam for opening in the 12 in. CMU east wall
- Loss of valuable floor space in garage currently being used for Storage, takes up 8-inch- wider space.

5.1.3 SF-1 Maintenance Access Alternative 3 - Reconfigure the Existing SF-1 to Allow for Additional Maintenance Access – Advantages and Disadvantages:

Advantages:

- Provides the needed maintenance access for SF-1.
- Leaves the existing storage area in the Garage alone.
- Relocation of several pipes and conduits along the shared wall with the Garage is not needed.
- Limits demo work of CMU walls to only repositioning opening through wall shared with Plenum Room.
- Limits difficult overhead masonry work to cope around roof truss members.
- Allows existing ductwork in Garage to be untouched.

Disadvantages:

- Limited space in Supply Fan Room to work and lift the fan unit.
- While maintenance access is improved. Some maintenance locations will be elevated, possibly requiring a step stool.
- Relocation of electrical enclosures needs to be reviewed further to ensure NEC required clearances are met.

5.1.4 SF-1 Maintenance Access Alternative Evaluation:

Table 5-1 Supply Fan SF-1 Maintenance Access Alternative Evaluation:

Alternative	Improved Operation and Maintenance Access: 1-5	Costs: 1-5	Total Score: 1-10
Alternative 1 - Enlarge Room by Moving the East Wall of Supply Fan Room	5	2	7
Alternative 2 - Enlarge Room by Creating an Opening in the East Wall of Supply Fan Room, and Adding Room Extension with Ceiling	5	4	9
Alternative 3 - Reconfigure the Existing SF-1 to Allow for Additional Maintenance Access	4	4	8

Based upon the alternative evaluation, Alternative 1 should be eliminated from consideration based on the costs being excessive related to the other two alternatives, which provide similar or equal improvement to operation and maintenance access.

5.2 Office HVAC System Temperature Controls

The two alternatives to be analyzed and evaluated for the Office HVAC System Temperature Controls discussed in this section.

5.2.1 Office HVAC System Temperature Controls Alternative 1 – Leave As Is – Advantages and Disadvantages:

Advantages:

- No further Costs
- Dedicated controls remain for the Office HVAC System

Disadvantages:

- Operator unable to confirm actual temperature in Office.

5.2.2 Office HVAC System Temperature Controls Alternative 2 – Replace Wall Mounted Thermostat – Advantages and Disadvantages:

Advantages:

- Operator able to confirm actual temperature in Office.
- Operator able to make adjustments to setpoints if allowed on thermostat.
- Dedicated controls remain for the Office HVAC System

Disadvantages:

- Additional Costs
- Setpoint adjustments by the Operator may not be desired by GLWA.

5.2.3 Office HVAC System Temperature Controls Alternative Evaluation:

Table 5-2 Office HVAC System Temperature Controls Alternative Evaluation:

Alternative	HVAC Controls Accessibility: 1-5	Costs: 1-5	Total Score: 1-10
Alternative 1 – Leave As Is	1	5	6
Alternative 2 – Replace Wall Mounted Thermostat	2	4	6

Based upon the above alternative evaluation, both alternatives should be reviewed with GLWA to confirm whether replacement of the existing wall mounted thermostat would be a benefit to the operations of the facility, and comfort level of the Operator.

6.0 Summary and Recommendations

Section 7.0 provides a summary and recommendations for the two HVAC issues, lack of maintenance access to the Supply Fan SF-1, and HVAC system temperature controls for Office discussed in this TM-8.

6.1 Supply Fan SF-1 Maintenance Access

For the supply fan SF-1 maintenance access issue noted in the scope of work as part the Leib HVAC-1 Task, three alternatives were described, evaluated, and analyzed above. As noted in the Leib HVAC-1 Task requirements one of the alternatives was taken from the CS-299 Report. As determined in the CS-299 Report, the cost associated with relocating the entire CMU wall, which extends to the bottom of the sloped roof deck, the additional requirements for relocating critical fire protection and domestic water services, and the requirement for a deeper foundations would outweigh the benefit gained versus the other two alternatives. Costs noted to relocate the wall in the CS-299 Report from 2021 were estimated at \$126,000.

Alternative 2 enlarges the Supply Fan Room to provide access similar to Alternative 1, but limits demolition of the wall, eliminates relocation of the fire main and BFP lineup, and limits the volume displaced in the Garage. Alternative 3 repositions the supply fan SF-1 inside the Supply Fan Room to allow for needed access. Both of the Alternatives 2 and 3 are feasible, however Alternative 2 allows for the needed access without raising the maintenance location points to require a step stool. Alternative 3 would also require modification of the existing equipment skid, which would likely result in an atypical fan unit installation. This would lead to additional modification of the skid when the fan unit is eventually replaced. In addition, the electrical enclosure required NEC clearance would need to be resolved. Alternative 2's main disadvantage is the loss of space used for

storage in the Garage. The Design Team would recommend that the stored materials and equipment be reviewed and evaluated for continued storage at the facility, and a layout of the space that better organizes the stored materials can be developed to assist in this review and evaluation, for adding additional storage racks as needed.

The Design Team's recommendation is to proceed with preliminary design with the modifications described in SF-1 Maintenance Access Alternative 2 to enlarge the room by creating an opening in the east wall of supply fan room, adding a room extension with a ceiling that can be designed to offer space for elevated storage in the Garage as well , and adding a set of double exterior doors to allow for future replacement of SF-1.

6.2 Office HVAC System Temperature Controls

For the Office HVAC system temperature controls issue noted in the scope of work, it was determined through review of the CIP No. 260611, GLWA Contract No. 1803718, Leib CSO Facility HVAC Improvements, completed in 2021, that the temperature controls have already been separated from the Toilet and Jan Room, and the Sampler Room. The Design Team's site visit and interview determined that the Operator would like the ability to see the temperature in the Office. The Design Team recommends to replace the existing wall mounted thermostat that does not have a temperature readout screen, with a similar model that includes an LCD for displaying the temperature.

6.3 Key Decisions

Key decisions made during the course of review and presentation of this Technical Memorandum are as follows:

6.3.1 SF-1 Maintenance Access:

- Add a set of double doors to the exterior wall of the Supply Fan Room to allow for the removal of SF-1 in the future, as discussed in the TM Workshop.
- Alternate 2 - Enlarge Room by Creating an Opening in the East Wall of Supply Fan Room, and Adding Room Extension with Ceiling was selected during the TM Workshop as the best alternate. This alternate has been revised to include the double doors requested during the Workshop.
- The existing floor drain in the Garage located in the footprint of the Supply Fan Room extension shall be relocated and not abandoned per direction from GLWA provided in the review of the Draft TM-08.

6.3.2 Office HVAC System Temperature Controls:

- Alternate 2 - Replace Wall Mounted Thermostat was selected during the TM Workshop as the best alternate.

7.0 Next Steps

This section provides a list of items which require advancement/further development as the design process advances for the two recommended paths previously discussed for providing additional maintenance access to the Supply Fan SF-1, and modifying HVAC system temperature controls for Office.

7.1 Supply Fan SF-1 Maintenance Access Room Extension with Ceiling

- Further detailed review of items listed to be relocated. Adjustments to the width and height of the opening can be made to further limit needed relocations.
- Recommended survey of existing stored materials, and planned organized layout for storing materials in the Garage.
- Structural analysis and design for adding new opening in the wall for the room extension, added foundation, and new door lintel.
- Coatings for the floor, walls and new ceiling will be determined during the design process.

7.2 Replacement of Office Wall Mounted Thermostat.

- Further discussions with GLWA is needed to determine if a new wall mounted thermostat with the temperature display shall have limits on controls of setpoint adjustments and scheduling adjustments.



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Dan Martel, METCO
Pulanith Egodaheewa, METCO*

Date: June 1, 2023

*Subject: TM-9 Leib NFPA 820 Analysis
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

This technical memorandum (TM) has been developed to analyze the Leib CSO Screening and Disinfection Facility (SDF) and how the current layout meets the National Fire Protection Association (NFPA) 820 requirements for classifying areas. Based on the Design Team's evaluations discussed in this TM, the Design Team is recommending the following for the two NFPA 820 connectivity issues.

- For the East and West Vestibules, the most cost-effective solution that meets the requirements of the issue is to remove the exterior vestibule walls and egress door for each vestibule, and replace with a new security gate with and exterior overhead canopy.
- For the Odor Control Duct, the preferred solution is to abandon the odor control duct between the Screening and Disinfection area and the Odor Control Room, (Garage) and fill, seal, and cut below the Garage's floor slab, with a new slab placed.

1.0 Introduction and Purpose

The Great Lakes Water Authority (GLWA) Combined Sewer Overflow (CSO) Facilities Improvements Project – Contract No. 2101475 requires the Design Team as part of the design process, to review NFPA 820 Hazardous classification for the Leib CSO SDF and analyze whether there are any issues with the facilities classifications for specific spaces.

Additionally, the Design Team's scope includes analyzing a hazardous classification connectivity issue with both of the east and west entrance vestibules, as part of the Leib HVAC-1 Task, and also reported in the reference CS-299 Report. This technical memorandum will also analyze the connectivity issues, propose alternate solutions, and evaluate the alternatives for inclusion in the project's design modifications.

2.0 Leib Screening and Disinfection Facility NFPA 820 Classifications

Table 2.1 lists of all areas in the Leib CSO SDF and the classification of each area as designed under the original PC-732 Contract that constructed the facility. These classifications will be analyzed under Section 3.0 of this memorandum. Refer to **Figure 2-1** for a floorplan of the main level of the facility showing the hazardous classifications as designed under PC-732. The below grade areas (plan not shown) are all considered Class I, Division I, Group D classification.

Table 2-1 Leib Screening and Disinfection Facility – NFPA 820 Classification Table

Area	NFPA 820 Classification as designed under PC-732
Main Level Areas	
Chemical Room	Unclassified
Maintenance Area	Unclassified
Generator Room	Unclassified
Supply Fan Room	Class 1, Division 2, Group D
Plenum	Class 1, Division 2, Group D
Electrical Equipment Room	Unclassified
Office	Unclassified
Toilet and Jan Room	Unclassified
Sampler Room	Unclassified
Odor Control Room (Garage)	Unclassified
HVAC Equipment Room	Unclassified
Corridor	Unclassified
West Vestibule	Unclassified
Stair 1	Class 1, Division 1, Group D
East Vestibule	Unclassified
Stair 2	Class 1, Division 1, Group D
Exhaust Shaft 1	Class 1, Division 1, Group D
Exhaust Shaft 2	Class 1, Division 1, Group D
Below Grade Areas	
Influent Diversion Chamber	Class 1, Division 1, Group D
Influent Channel	Class 1, Division 1, Group D
Screening Area (upper level)	Class 1, Division 1, Group D
Screening Chamber (lower level)	Class 1, Division 1, Group D
Mixing Chamber	Class 1, Division 1, Group D
Disinfection Chamber	Class 1, Division 1, Group D
Effluent Channel	Class 1, Division 1, Group D
Effluent Diversion Chamber	Class 1, Division 1, Group D
Control Gate Chamber	Class 1, Division 1, Group D

Note: Classifications assumed based on designed layout and elements as shown on the PC-732 As-built documents.



Figure 2-1
Leib CSO SDF – NFPA Hazardous Classifications Main Level Plan – as Designed Under PC-732

3.0 Analysis of Leib Screening and Disinfection Facility NFPA 820 Classifications

The Leib CSO SDF areas can be separated into two categories. Areas that fall under the NFPA 820 classification for sanitary and storm sewer liquid collection systems and treatment processes and the areas connected to them are classified as having explosion hazards, and are required to adhere to design standards that meet NFPA 820 Class 1, Division 1 or 2 (see **Table 2-1**), Group D.

3.1 Description of PC-732 Designed NFPA-820 Area Classifications

For the Leib facility, all areas below grade which serve the sewer collection and treatment systems are classified NFPA 820 Class 1, Division 1, Group D. This classification also applies to connect areas that include the stairwells that lead to and the exhaust shafts that serve the below grade areas. The Supply Fan Room and Plenum that supply fresh air to the below grade classified areas are classified by NFPA 820 as Class 1, Division 2, Group D. Design standards for this classification included explosion proof and rated electrical fixtures, equipment, and installation methods, as well certain ventilation and physical separation requirements.

Areas in the facility that are located on the main level and considered interior spaces that are not connected to the below grade areas that have the hazardous classification are considered Unclassified by NFPA 820.

3.2 Identified Connectivity Issues

Through the Design Team's analysis of the Leib CSO SDF, as constructed, the Design Team has identified two connectivity issues that require further evaluation and modifications to adhere to the NFPA requirements and provide a safe working environment. One connectivity issue, identified in the CS-299 Report and noted under the Leib HVAC-1 Task is typical for both the West and East Vestibules that are connected to the stairwells leading to the below grade sewer collection and treatment areas. The other connectivity issue identified during the analysis was the existing odor control duct installed for future use that is connected to the Garage. Both of these connectivity issues are described in further detail in the following sections.

3.2.1 East and West Vestibule Connectivity Issue

The GLWA CSO Facilities Improvements Project – Contract No. 2101475 - Leib HVAC-1 Task requires the Design Team to review the issues related to the Leib facility's existing HVAC system as identified in the CS-299 Report. One of the issues identified was the as-built configuration of the two vestibules on either side (east and west) of the building. The original design of the building as depicted in the Record Drawings show the small exterior courtyards without a roof. The current as-built condition has each courtyard with its own sloped roof de-attached from the building's main roofing system, and the opening above the courtyard wall and roof is covered with an insect screen. This current configuration of the courtyards with less than 50% free area results in these spaces being defined as interior spaces. The courtyards, now defined as interior spaces, are referred to in this memorandum as the East and West Vestibules. With each of the stairwells connected to the vestibules without physical separation to the Screening and Disinfection process area (Influent Channel, Screening, and Disinfecting Area,) the stairwells and interior spaces they are connected to share the same NFPA 820 Classification. (See **Figure 3-1** Leib CSO SDF West Vestibule and East Vestibule Enlarged Plans – Existing Conditions below).

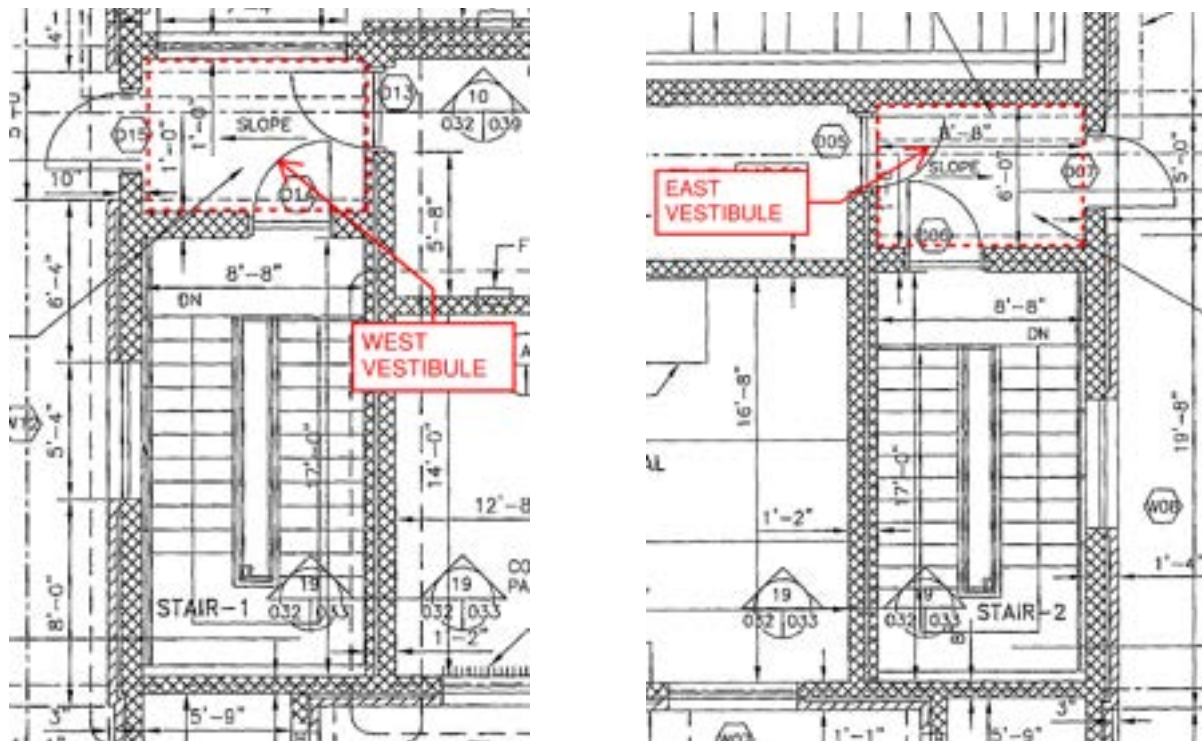


Figure 3-1
Leib CSO SDF – West and East Vestibules Enlarged Floorplans – Existing Conditions

The HVAC system for the Screening and Disinfection area is not run continuously (24/7) based on discussions with GLWA staff (on when staff is present, off when not staffed). Per NFPA 820-2020, Table 5.2.2, Row 2.a, the screening portion of the room is Class 1I, Division I with no ventilation or less than 12 air changes per hour (ACH). The influent channel is classified as Class 1, Division 1 also per NFPA 820, Table 4.2.2, Row 14.a with no ventilation or less than 12 ACH. When 12 ACH are introduced into the space, the area is classified as Class I, Division II per NFPA 820 Table 5.2.2, Row 2.b and Table 4.2.2, Row 14.b. Since the ventilation does not run continuously, the worst-case classification applies which is Class 1, Division 1 in the Screening and Disinfection area which will also classify other areas of the building depending on the connectivity of the Screening and Disinfection area to the other areas. It should be noted that current 10 State Recommended Standards for Wastewater Facilities – 2014 recommends 12 ACH for ventilating wet wells when continuous ventilation is used, and 30 ACH for intermittent ventilation,

The vestibules are connected to the main interior space of the facility, thus also making this space the same hazardous classification. Additionally, the West Vestibule is connected to the Generator Room with an intake louver, also making the Generator Room a classified space. As currently configured/connected, the building has areas that are classified with equipment that is not designed for those classifications. See **Figure 3-2** showing the floorplan of the main level of the facility with hazardous classifications shown that represents the Design Team's analysis and

interpretation of the as-built condition and the Classifications of these spaces. The below grade areas (plan not shown) are all considered Class I, Division I, Group D classification.



Figure 3-2
Leib CSO SDF – NFPA Hazardous Classifications Main Level Plan – as interpreted by the Design Team

3.2.2 Odor Control Duct for Future Use

During the Design Team’s facility walkthroughs of Leib the Design Team discovered that an existing 48-inch diameter concrete pipe was installed between the Garage and the Screening and Disinfection area as an odor control exhaust duct to be used for a future odor control system.

The duct creates a connection point between the Screening and Disinfection area, which is classified Class I Division I per NFPA 820, Tables 5.2.2, Row 2.a and Table 4.2.2, Row 14.a with no ventilation or less than 12 air changes per hour (ACH), as described in Section 3.1.1, and the Garage which was designed to be Unclassified. However, the end of the duct is only covered with a removable metal plate (see portion of **Figure 3-3** PC-732 D-98-10-125 HVAC Diagram and **Figure 3-4**).

NFPA 820 requires that for an area to remain unclassified when adjacent to a classified hazardous area, the areas shall be physically separated. NFPA 820 defines physical separated as “A gastight partition between two adjacent spaces, or two nonadjacent spaces, with no means of gas communication between the spaces and where personnel entry into the spaces is by individual, exterior access ports with no physical connection, or an airlock.” In the Design Team’s engineered opinion the metal cap, strapped down, does not provide the gastight separation needed to de-rate

the Garage and all connected spaces in the Leib CSO SDF, particularly due to the maintenance requirements for the duct. GLWA Staff has informed the Design Team that maintenance on the unused odor control duct includes removal of the sealed metal cap on the duct or pump out infiltration water in the below grade pipe, and intermittent manned inspection of the duct. When the physical separation (metal cap) is removed, the Garage and the entire main level that is connected to the space, even if there is a man door separation, will match the same classification as the Class 1, Division 1, Group D, hazardous classification areas below grade, as defined by NFPA - 820.

Additionally, If an odor control unit were to be installed on top of this concrete duct, the NFPA classification would need to be considered. With no ventilation or less than 6 ACH, the entire room the odor control equipment is in would be classified as Class 1, Division 2 as per NFPA 820, Table 4.2.2, Row 18.a. This would classify the whole first floor as Class 1, Division 2. Nothing on the first floor is rated for this area classification at this time. Per NFPA 820, Table 4.2.2, Row 18.b and c, 6 ACH would need to be constantly running to make the area within 3 ft of leakage sources such as fans, dampers, flexible connections, flanges, pressurized unwelded ductwork, and odor-control vessels Class 1, Division 2 and the areas beyond the 3 ft unclassified. There would still be a possibility of hazardous gases getting to the other portions of the building. However, this does meet the NFPA 820 requirements.

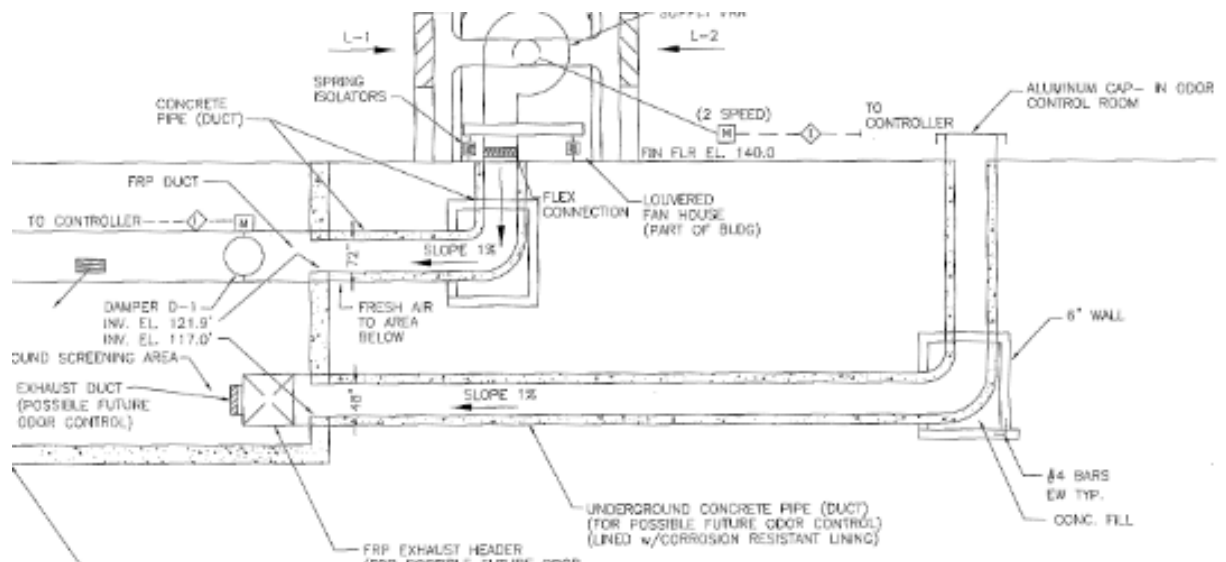


Figure 3-3

Leib CSO SDF – Existing Odor Control Duct (Not Used, for Future Use)



Figure 3-4
Leib CSO SDF – Existing Odor Control Duct penetrating the Odor Control Room (Garage) floor (not used)

4.0 Description of Alternatives

Alternatives that address the two connectivity issues at the two vestibules and the odor control duct connection are noted in this section.

4.1 East and West Vestibule Connectivity Issue Alternatives

As part of the scope of the Leib HVAC-1 Task, the Design Team is to resolve the connectivity issues identified in the CS-299 Report by designing modifications to the building such that an Operator is still protected from the weather when traveling from the unclassified portions of the building to the classified portions of the building, while meeting current NFPA 820 code requirements. As the CS-299 Report has noted, the original design for the vestibules was to provide an open to above courtyards, enclosed only by the surrounding walls. However, the constructed facility includes canopy shed roofs over the courtyards, with any openings between the walls and roof structure covered with insect screens. This technically results in the courtyards becoming interior spaces, now defined as vestibules, and creating the connectivity issue described above. The Design Team has developed two alternatives described in this section that include modifications that provide protection from weather, and eliminate the connectivity issue. The two alternatives are typical for both the East and West Vestibules. The West Vestibule was used in both alternatives to define the proposed modifications, due to the additional restriction of an air intake louver for the Generator Room being located in the vestibule.

4.1.1 Vestibule Connectivity Issue Alternative 1 - Relocate Stairwell Entrances, Add Partially Enclosed Exterior Connecting Vestibule:

Relocate the stairwell/vestibule shared wall to allow for the relocation of the door entrance to the stairwells from the vestibule to the exterior of the building to provide NFPA 820 required physical separation, relocate the vestibule exterior door to allow for the wall to be relocated. With the stairwell entrance moved out of the enclosed (as defined by the international Building Code (IBC)) vestibule, to protect GLWA staff from weather and provide a desired level of security, an exterior partially unenclosed (openings exceed 50% of wall area as defined by the IBC) vestibule with fence panels over the openings, and an egress gate/door constructed of the fence panel material will allow staff to access the stairwells safely, securely, and protected from weather elements, while eliminating the NFPA 820 connectivity issue for the vestibules. See **Figure 4-1** for a sketched plan, and **Figures 4-2** and **4-3** for sketched elevations showing the modifications and added vestibule. Note that the new added vestibule egress at the sidewalk at the top of the ADA ramp (West Vestibule only). This alternative, applies to both the East and West Vestibules.

Alternative 1 requires the following alterations:

- Temporary shoring of the existing stairwell roof/ceiling
- Demo of existing stairwell north wall with door, frame, electrical and controls.
- Placing new concrete footing for new wall location.
- Shifting the north wall of the stair well to allow for enough clearance on the stairs top landing for a door exit directly to the exterior.
- Adding a new stairwell exit door and frame.
- Modifying the masonry entrance wall at the existing Vestibule entrance to relocate the door opening, and add a new Vestibule door and frame.
- Extending the roof over the relocated wall.
- New Exterior Unenclosed Vestibule:
 - Sawcut and removal of sidewalk as required.
 - Placing new foundation for new masonry west wall.
 - Adding new shed roof structure with standing seam metal roof to match existing, with new gutter and downspout.
 - Adding new fence panels.
 - Adding a new egress gate/door made with fence fabric.

- Adding new lighting inside new exterior unenclosed vestibule.
- Adding new lighting at exterior of egress door/gate.
- Adding card reader at exterior of egress door /gate.
- Adding bollards in the parking lot to protect new vestibule.

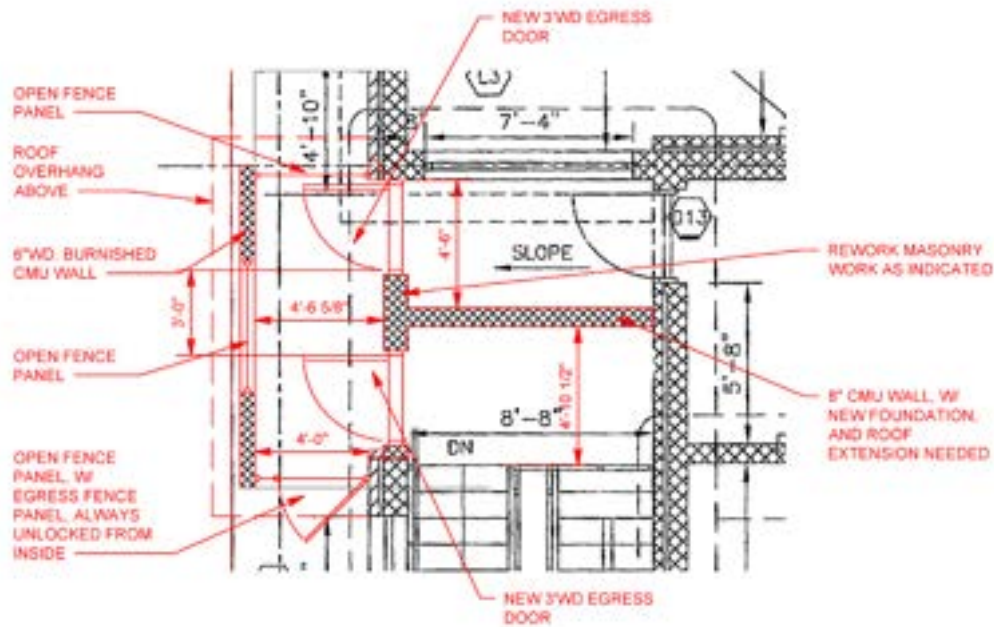


Figure 4-1

Leib – West Vestibule courtyard proposed modifications – Alternative 1: shifting stairwell wall, and adding new stairwell exterior door, adding new exterior unenclosed vestibule.

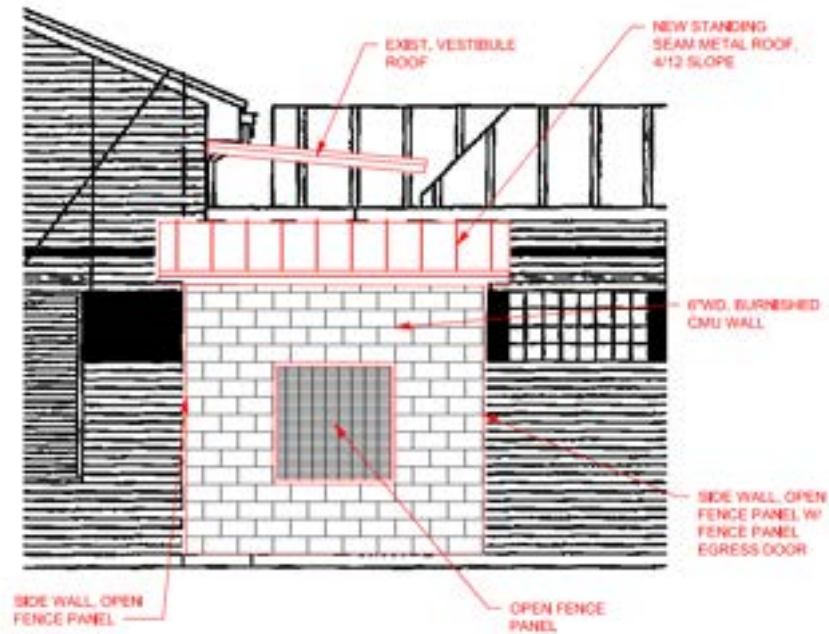


Figure 4-2
Leib – West Vestibule courtyard proposed modifications – Alternative 1: West Elevation

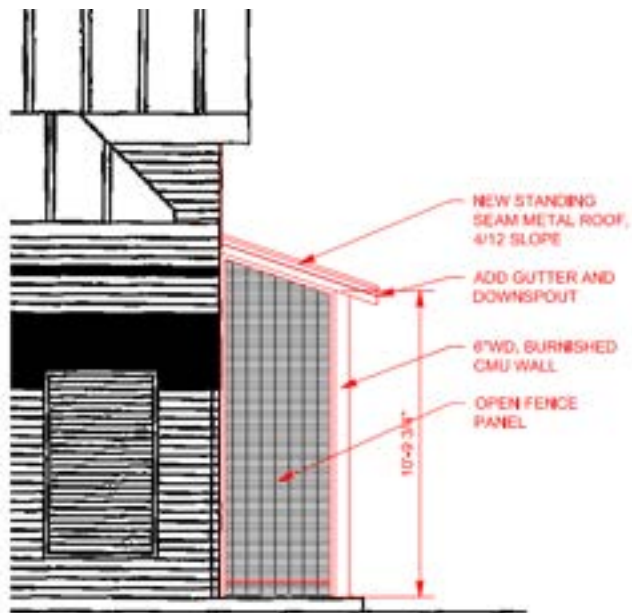


Figure 4-3
Leib – West Vestibule courtyard proposed modifications – Alternative 1: North Elevation

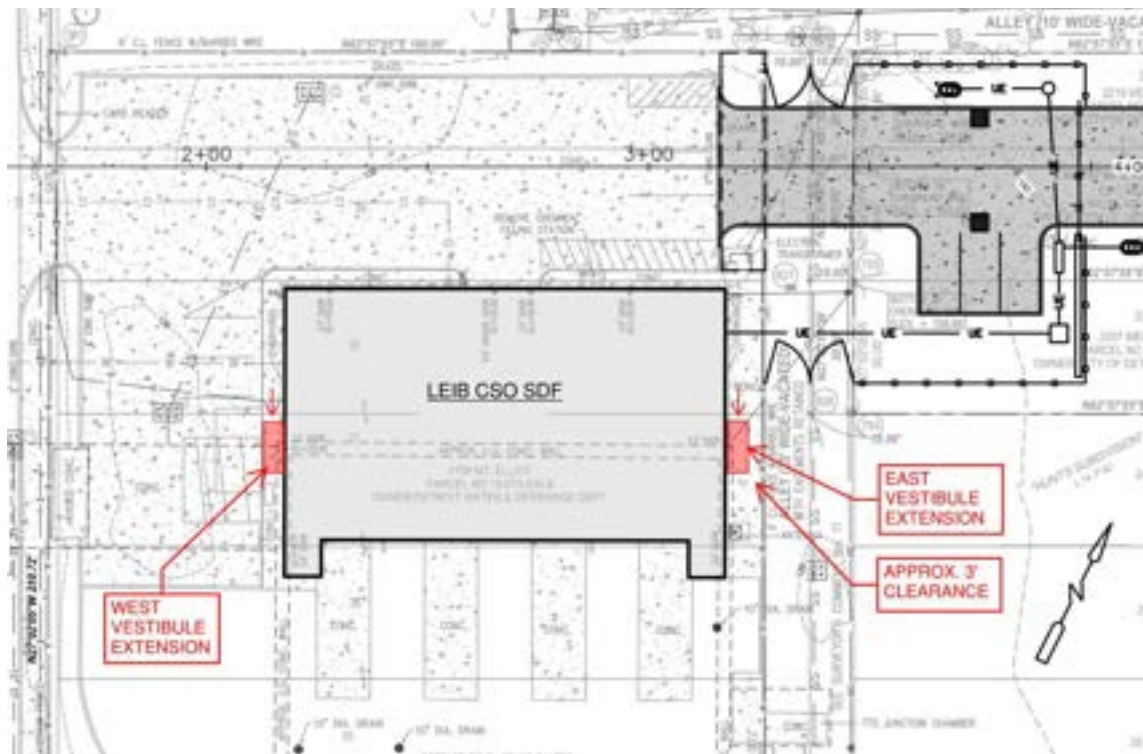


Figure 4-4
Leib – Conceptual Site Plan with Vestibule Extensions shown

4.1.2 Vestibule Connectivity Issue Alternative 2 - Remove Courtyard Wall and Entrance Door Entrances:

Remove the vestibule exterior wall and entrance door and provide a security gate in its place to provide enough free area of opening for the vestibule to be considered an exterior space. Per NFPA 820, Annex A, Figure a.4.2(b) (See **Figure 4-5**), a three-ft envelope around a door to a wet well or basin serving separate or combined sanitary sewer shall be considered Class 1, Division 2, when the Screening and Disinfection area has ventilation under 12 ACH. Per the Design Team’s discussions with the facility staff, when staff is present at the building the ventilation in the Screening and Disinfection area is on, and when the site is unstaffed, the ventilation to the Screening and Disinfection area is turned off, creating the Class 1, Division 2 envelope at the door. The envelope, however, does not encroach on the building’s door area or the Generator Room’s intake louver.

During the February 10, 2023 workshop, the discussion of needing a panic bar to the security gate was discussed. After further review and evaluation, the new security gate that will provide egress from the building will not require a panic bar. The security gate will be required to have a “passage” type lock that is always unlocked from the inside, and will only lock from the outside, similar to the existing lockset on the existing egress doors at the facility (see **Figure 4.6** for an image of the typical egress door and hardware at the existing vestibules). The passage lock will be electrified and connected to the security system’s credential reader, to allow secured access. A panic bar is only

required when the Michigan Building Code (MBC) or the NFPA Life Safety Code has determined that the space a person is egressing from is a Use Group H - High-Hazard, or Use Group A-Assembly and Use Group E - Educational when the occupant load exceeds 50 people. For the Leib CSO SDF, the MBC Use Group is F-2: Factory Low-Hazard, where there is a low risk of a fire hazard.

This alternative can apply to both the East and West Vestibules.

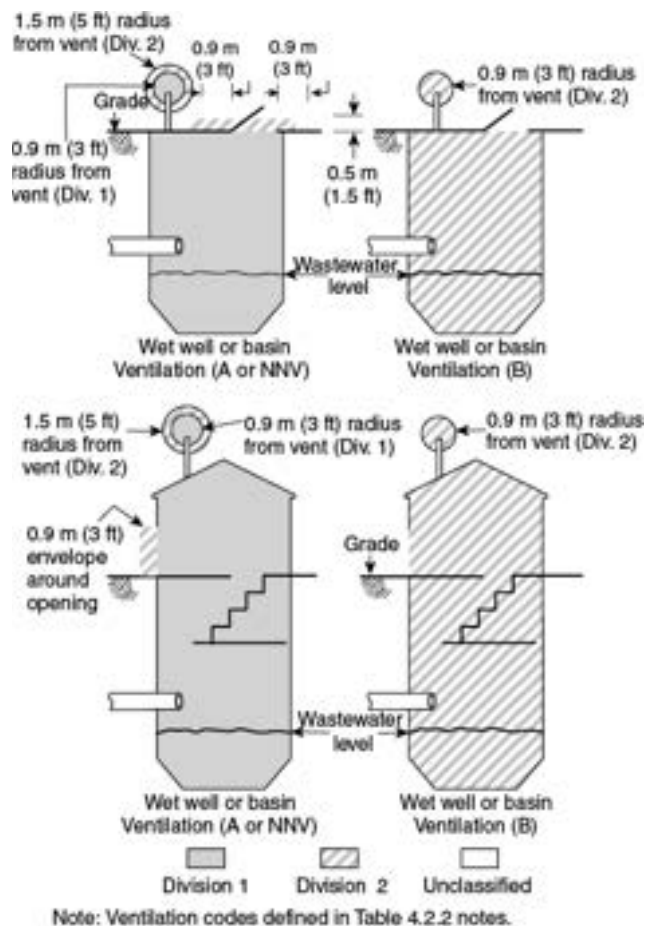


Figure 4-5
Wet Well or Basin Serving Separate or Combined Sanitary Sewer from NFPA-820; Illustration of Table 4.2.2
Rows 14 and 32

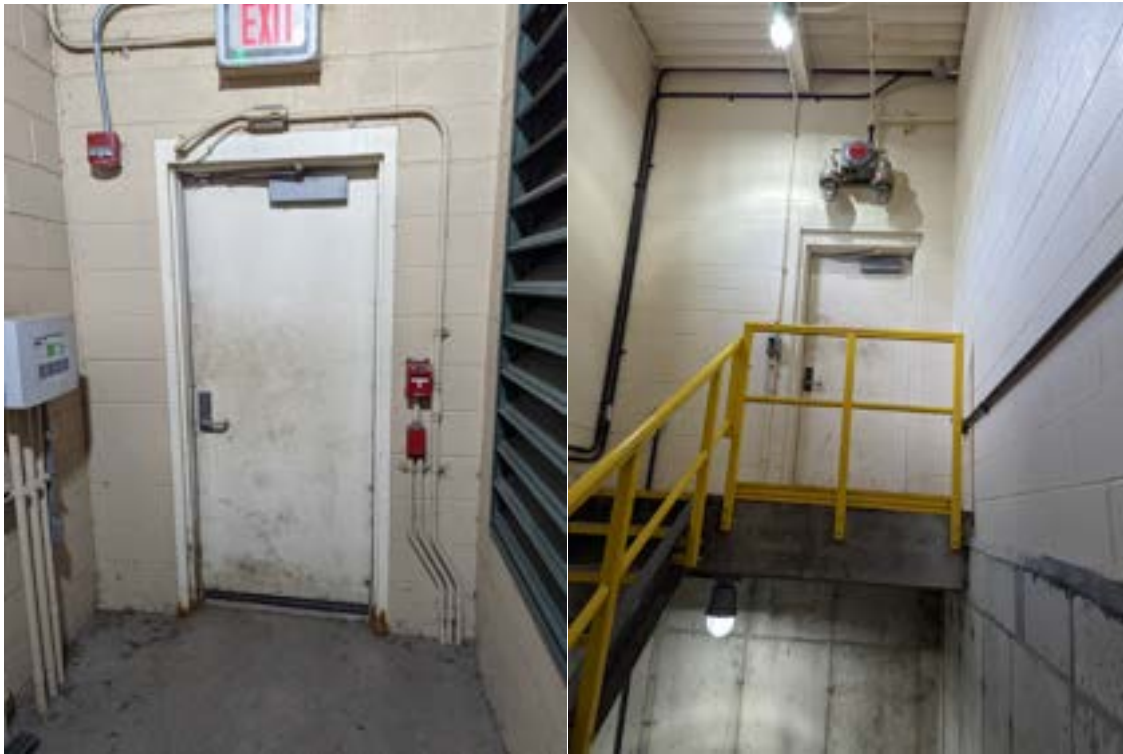


Figure 4-6
Existing egress doors at the West Vestibule and West Stairwell with Passage type lockset (typical for the East Vestibule and Stairwell).

Alternative 2 requires the following alterations:

- Removal of the exterior wall at the entrance courtyards and entrance doors.
- Removal of exterior light fixture at the entrance door, add additional new lighting.
- Removal of insect screening above wall to be removed, and replace with a bird screen or screen that allows the free open area of the combined gate and screen to exceed 50% of the area. An insect screen may not allow for this required percentage.
- Rework wall coping.
- Adding security gate with egress hardware.
- Adding exterior Canopy for additional weather protection at the gate.
- Adding credential reader at new location.

See **Figure 4-7** marked drawing with proposed reconfiguration. **Figure 4-8** shows the current open area provided above the exterior partial wall with the entrance door below, currently covered with a bug screen. This open area above will contribute to the required 50% open area needed at the exterior wall. Both the West and the East Vestibules share this condition.

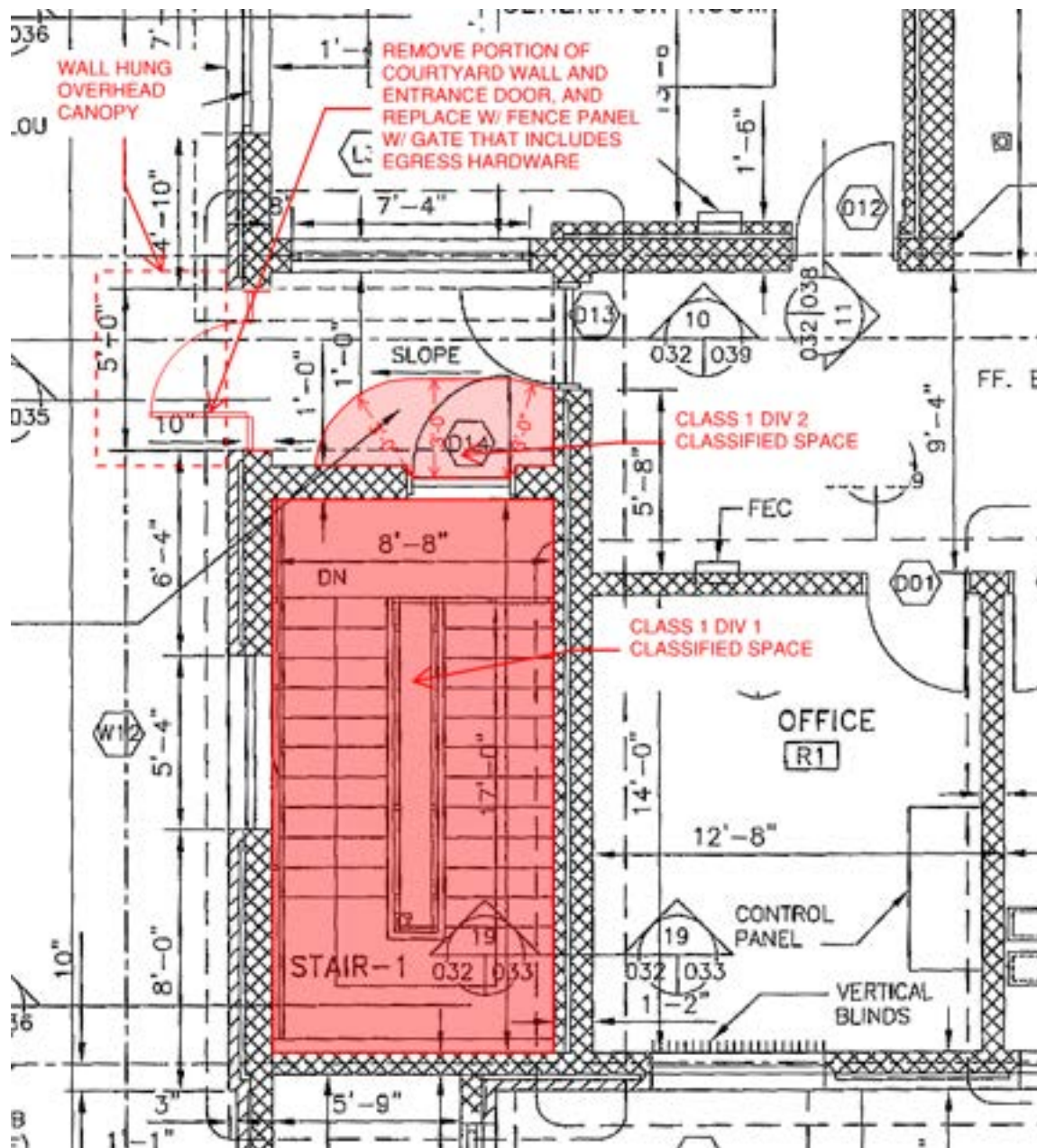


Figure 4-7
Leib CSO SDF – West Vestibule courtyard proposed modifications – Alternative 2: Removal of Vestibule Exterior Wall and Door, and Install a Security Gate with Egress Hardware.



Figure 4-8
Leib CSO SDF – Showing Open Area above West Vestibule partial wall, currently with a bug screen. Similar to the condition at the East Vestibule.

4.2 Odor Control Duct for Future Use Connectivity Issue Alternatives

As described in Section 3.1.2, during the Design Team's facility walkthroughs of Leib and NFPA 820 analysis the Design Team discovered that the existing 48-inch diameter concrete pipe installed between the Garage and the Screening and Disinfection area as an odor control exhaust duct to be used for a future odor control system creates a connectivity issues point between the hazardous classified spaces below grade and the intended to be Unclassified spaces on the main level. The Design Team has developed two alternatives to address the connectivity issue.

4.2.1 Odor Control Duct for Future Use Connectivity Alternative 1 - Abandon Duct, Fill, Seal:

The provisions constructed for a future odor control system at the Leib CSO SDF have never been utilized. The Design Team has confirmed with GLWA that the odor control duct can be abandoned, provided that the concrete pipe/duct is filled with a material that could be removed in the future, if

GLWA or permitting agencies require use of it. Discussions with the facility staff indicate that the concrete pipe duct experiences ground water infiltration and occasionally needs to be dewatered and inspected. The location of the duct penetration through the floor of the Garage limits the flexibility for uses for this room, which includes an overhead door for deliveries, and is used as a storage space. The concrete pipe duct can be abandoned, cut below the existing slab, filled, and the floor opening replaced with a new slab to open the area in the room for other uses. Per the Design Team's discussion during the February 10, 2023 workshop with GLWA, prior to abandoning the duct, the associated ductwork in the Screening and Disinfection area shall be disconnected and can be partially left in place for future use or removed. The wall opening in the Screening and Disinfection area where the odor control pipe/duct penetrates shall be filled with concrete that is doweled into existing wall with two rows of water stop to prevent future leakage. Also, prior to abandoning the pipe/duct, it shall be inspected for observed infiltration, repaired accordingly, leak tested for at least 90 days, then filled with a material that can be removed in the future should GLWA or a permitting agency require that the duct/pipe be needed for an odor control system. The pipe shall then be capped in the Garage with a concrete slab, rated for vehicle loads, doweled into the existing slab and sealed at the perimeter,

Alternative 1 requires the following alterations:

- Removal of odor control ductwork, or a portion of, in the Screening and Disinfection area.
- Inspection, repair and testing for infiltration.
- Cutting the pipe duct below the existing slab.
- Filling the Screening and Disinfection wall opening and seal.
- Filling the concrete pipe with a fill material that can be removed in the future (possibly sand or polyurethane foam).
- Placing subgrade and vapor barrier.
- Placing concrete slab, tied into existing slab.
- Repair floor coating.
- Renaming the Garage as Delivery/Storage.

4.2.2 Odor Control Duct for Future Use Connectivity Alternative 2 – Duct Remains, Seal Duct Openings in Screening and Disinfection Area:

Should GLWA elect to keep the existing concrete pipe duct for a future odor control system, the odor control duct in the Screening and Disinfection area has grilles that expose the ductwork to the classified environment. The grilles can be removed and replaced with duct opening caps with

gasketed seals and the ductwork can be inspected, sealed and pressure tested to verify a gastight physical separation to meet the requirements of a NFPA 820. Sealing the ductwork in the classified area will allow the sealed cap to be removed for maintaining the duct making the Garage and all other spaces connected to it a NFPA 820 Class I, Division I, Group D classified space.

Alternative 2 requires the following alterations:

- Remove the existing grilles on the odor control duct located in the Screening and Disinfection area.
- Replace grilles with blanks that are sealed to prevent gasses from entering the duct.
- Confirm any other penetrations in the ductwork or at the thru-wall duct penetration in the Screening and Disinfection area is sufficiently sealed.
- Perform a pressure test on the ductwork to confirm the gastight physical separation.

4.3 Evaluation Criteria and GLWA Input when discussing alternatives.

4.3.1 Evaluation Criteria:

Alternatives for the vestibule connectivity issue discussed in Section 4.1 will be analyzed in the subsequent section using the following criteria.

- Protection from Weather
- Security
- Costs

Alternatives for the odor control duct for future use connectivity issue discussed in Section 4.2 will be analyzed in the subsequent section using the following criteria.

- GLWA future considerations
- Costs

5.0 Alternatives Analysis and Evaluation

To analyze the alternatives noted above for the two NFPA 820 connectivity issues, each alternative is analyzed for advantages and disadvantages listed, and evaluated with based on the listed evaluation criteria for each issue.

5.1 East and West Vestibule Connectivity Issue Alternatives

This section discusses the two alternatives to be analyzed and evaluated for the East and West Vestibule connectivity issues.

5.1.1 Vestibule Connectivity Issue Alternative 1 - Relocate Stairwell Entrances, Add Partially Enclosed Exterior Connecting Vestibule: – Advantages and Disadvantages:

Advantages:

- Eliminates connection from the Screening and Disinfection area and Stairway to the remainder of the building, allowing the building main level hazardous classification to be Unclassified.
- Provides covered and partially enclosed connectivity between the Main Level and the Stairwells leading to the Screening and Disinfection level.
- Compared to Alternative 2, allows the entrance courtyards to remain covered with a bug screen, providing protection Employees.
- Maintains or improves the level of security.

Disadvantages:

- Relocating bearing walls and adding new support beam
- Relocating exterior courtyard door which will require adjustments to multi-wythe wall.
- Will need to extend roof above the stairwell.
- Encroachment on existing sidewalk.

5.1.2 Vestibule Connectivity Issue Alternative 2 - Remove Courtyard Wall and Entrance Door Entrances: – Advantages and Disadvantages:

Advantages:

- Reclassifies the courtyard as an exterior space, thus eliminating the classified connection between the Screening and Disinfection Area Stairwell and the main level of the building.
- Less modifications to the building as compared to Alternative 1.

Disadvantages:

- The Entrance Courtyard is unprotected from bugs and wind or driving rain. A roof overhead still exists.

5.1.2 Vestibule Connectivity Issue Alternative Evaluation:

Table 5-1 Vestibule Connectivity Issue Alternative Evaluation:

Alternative	Protection from Weather 1-5	Security: 1-5	Costs: 1-5	Total Score: 1- 15
Alternative 1 - Relocate Stairwell Entrance, Add Exterior Canopy.	3	4	1	8
Alternative 2 – Replace Courtyard Wall and Entrance Door Entrances with a Security Gate, Add Exterior Canopy.	3	4	5	12

The numbers shown in **Table 5-1** are based on the Design Team’s evaluation of the criteria identified in Section 5.1.2, 1 being the lowest score and 5 being the highest based on comparison of both alternatives. The total score is an accumulation of the scores shown.

Based upon the above alternative evaluation, and previous discussions with GLWA during the February 10, 2023 workshop, Alternative 2 that includes removal of the exterior vestibule wall and egress door, and replacing with a new security gate with an exterior overhead canopy is the preferred alternative.

5.2 Odor Control Duct for Future Use Connectivity Issue Alternatives

This section discusses the two alternatives to be analyzed and evaluated for the odor control duct for future use connectivity issue.

5.2.1 Odor Control Duct for Future Use Connectivity Alternative 1 - Abandon Duct, Fill, Seal Advantages and Disadvantages:

Advantages:

- Creates a NFPA 820 required gastight physical separation between the Screening and Disinfection area and Garage.
- Eliminates the water infiltration inside the pipe duct issue and associated maintenance and inspection.
- Provides more usable space in the Garage.

Disadvantages:

- Analysis is needed to confirm subgrade can support additional weight of filled duct.

5.2.2 Odor Control Duct for Future Use Connectivity Alternative 2 – Duct Remains, Seal Duct Openings in the Screening and Disinfection Area – Advantages and Disadvantages:

Advantages:

- Creates a NFPA 820 required gastight physical separation between the Screening and Disinfection area and Garage.
- Allows for the future installation of an odor control system with the ventilation requirement summarized above to avoid hazardous classification for the entire floor.
- Lower cost than Alternative 1

Disadvantages:

- Requires maintenance to inspect and dewater the concrete pipe duct.
- Pipe remains an obstacle in the middle of the room.
- A future odor control system will require additional modifications to the existing building's HVAC system and odor control ductwork to come in compliance with NFPA 820.
- Existing ductwork work needs to be inspected, sealed and pressure tested.

5.2.3 Odor Control Duct for Future Use Connectivity Issue Alternative Evaluation:

Table 5-2 Odor Control Duct for Future Use Connectivity Issue Alternative Evaluation:

Alternative	GLWA Future Considerations 1-5	Costs: 1-5	Future Storage/Maintenance: 1-5	Total Score: 1-15
Alternative 1 - Abandon Duct, Fill, Seal	1	2	5	8
Alternative 2 – Duct Remains, Seal Duct Openings in Screening and Disinfection Area	3	3	1	7

The numbers shown above are based on the Design Team's evaluation of the criteria identified in Section 5.1.2, 1 being the lowest score and 5 being the highest/best based on comparison of both alternatives. The total score is an accumulation of the scores shown.

Based upon the alternative evaluation, Alternative 1 has the higher score. Considering the above alternative evaluation and previous discussions with GLWA during the February 10, 2023 workshop, GLWA would like the Design Team to pursue Alternative 1 that provides more flexibility in the area used for storage and eliminates the maintenance component for the duct work.

6.0 Summary and Recommendations

Section 7.0 provides a summary and recommendations for the two NFPA 820 connectivity issues identified and discussed in the description, evaluation, analysis above.

6.1 East and West Vestibule Connectivity Issue Alternatives

After discussions with GLWA, the primary criteria when evaluating the alternatives include resolving the NFPA 820 connectivity issue, and providing connectivity from the main level to the Screening and Disinfection level below that is protected from weather and is secured. While both alternatives technically resolved the NFPA-820 connectivity issue, Alternative 2 provides the weather protection and security desired by GLWA. The Design Team recommends that for both the East and West Vestibule, that the least costly solution that meets GLWA's requirements for security and weather protection is removal of the exterior vestibule wall and egress door, and replacing with a new security gate with an exterior overhead canopy.

6.2 Odor Control Duct for Future Use Connectivity Issue

With the Leib CSO SDF operating over 20 years without any significant odor issues requiring an odor control system be installed, the GLWA and the facility will benefit by abandoning, filling, and sealing the existing unused below grade odor control duct. As described in Sections 4.2 and 5.2, the current physical separation method does not meet the NFPA 820 requirements. The Design Team recommends that GLWA take immediate steps to temporarily seal the duct in a manner that provides a gastight separation between the duct and the Garage, with no means of gas communication between them. This will bring the current connection through the odor control duct into compliance with NFPA 820.

As part of the GLWA CSO Facilities Improvements Project – Contract No. 2101475 work, The Design Team is recommending the abandonment of the odor control duct between the Screening and Disinfection area and the Garage. The duct would be filled, sealed, and cut below the Garage's floor slab, with a new slab placed. This allows for more flexibility in the space, currently being used for storage and deliveries. The additional benefit to GLWA is the maintenance and difficult inspection of the duct is eliminated from the facilities maintenance requirements.

6.3 Key Decisions

Key decisions made during the course of review and presentation of this Technical Memorandum are as follows:

6.3.1 East and West Vestibule Connectivity Issue:

- Per the discussions that took place at the TM Workshop and with the CSO Manager, Alternative 2 was selected as the best solution, that provides adequate security and the desired weather protection.
- A bird screen is acceptable for the desired protection. A bug screen is not needed per discussions with the CSO Manager.

6.3.2 Odor Control Duct for Future Use Connectivity Issue:

- Per the discussions that took place at the TM and Preliminary Review Workshops, the Odor Control Duct shall be abandoned as noted above in this Technical Memorandum.

7.0 Next Steps

The following list of items will require advancement/further development as the design process advances for the two recommended paths summarized in Section 7.0 for resolving the NFPA 820 connectivity issues for the East and West Vestibules and the odor control duct for future use noted above.

7.1 East and West Vestibule Connectivity

- Further detailed review and design to evaluate different types of screens to be used with the security gate so that the complete gate and screen assembly allows for the required 50% free area.
- Coatings for the floor, walls and new ceiling will be determined during the design process.

7.2 Odor Control Duct for Future Use Connectivity

- Structural analysis needed to confirm subgrade can support additional weight of filled duct.
- Review material options for filling the duct that allows for removal in the future and can support the transferred loads from the new slab added above.

2.3 Structural, TM-3 and Embedded in Various TM's

Oakwood RTB, TM-3 and embedded in various TM's

- Screen Facility, core drills of floor slab for conveyor drains
- Storm PS, removal of cast in place concrete covers over sanitary flow trench
- Sanitary PS influent channel, removal of top of stairs and replace with concrete sloped slab
- Concrete equipment pads for new chemical recirculation pumps
- Openings and hatches for sample pumps in CSO basins

Leib SDF, and embedded in various TM's

- Modifications to concrete
 - Stepped bottom slab in screen inlet channels to be sloped
 - Screen channel walls at each existing Romag screen to be lowered 1-ft
 - Screen channel walls at COPA screen channels modified to accommodate new Romag screens
 - Remove conc duct above garage floor
- Modifications associated with Architectural improvements at entrances and supply fan
- Fill below grade duct with sand
- Provide water proofing on the inside of the concrete duct
- Provide reinforced concrete wall or slab at each end of duct to isolate from room
- Removal and reinstallation of chemical facility wall to accommodate tank replacement
- Concrete equipment pedestals for new chemical recirculation pumps
- Exterior wall modifications to accommodate SF-1 improved access



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

From: Steve Fehniger, CDM Smith

Date: June 1, 2023

*Subject: TM-3 Sanitary PS Concrete Stair Modification Evaluation (OKW-PUMP-2)
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

This technical memorandum (TM) summarizes the evaluation conducted to address the condition in which the wastewater is aerated as it flows down the concrete stairs entering the sanitary pump station wet well (east and west) to minimize or eliminate air entrainment/odor release.

Recommendation: the recommended modification to minimize the aeration of the wastewater and minimize associated maintenance is to replace the stair with a sloped concrete fillet.

Two alternatives were included in the evaluation:

- The first removes the concrete stair immediately upstream of the bar screen and replaces it with a sloped fillet (sloping from the storm wet well bottom slab [approximately 50.3'] to the influent channel at the base of the stair [41.0']) to minimize cascade affect and aeration if the sanitary flow trench is blocked and flow is conveyed over the stair as approach the sanitary influent channel.
- The second uses an inlet chute connected to a discharge pipe to funnel flow conveyed toward the stair into a closed conduit discharging at the base of the stair. The configuration of the inlet chute and pipe would be developed to contain the majority of the flow conveyed over the stair.

Alternatives evaluation criteria were grounded in the guiding principles for the project with an emphasis on ability to meet the goal to minimize or eliminate air entrainment/odor release coupled with enhanced reliability, maintenance reduction and simplicity.

1.0 Introduction and Purpose

TM-3 is focused on evaluation of the sanitary pump station (east and west) concrete stairs to minimize or eliminate the condition in which the wastewater is aerated as it flows down the concrete stairs entering the wet well.

This TM will not answer questions related to the obstruction of flow through the sanitary flow trench located beside the top of concrete stair.

2.0 Existing System(s) Description (and/or Conditions)

The sanitary wet wells are each configured with three flights of stairs cast into the concrete floor slab or fillets (45-degree sloped concrete in corners and between pumps) as shown in **Figure 2-1**.

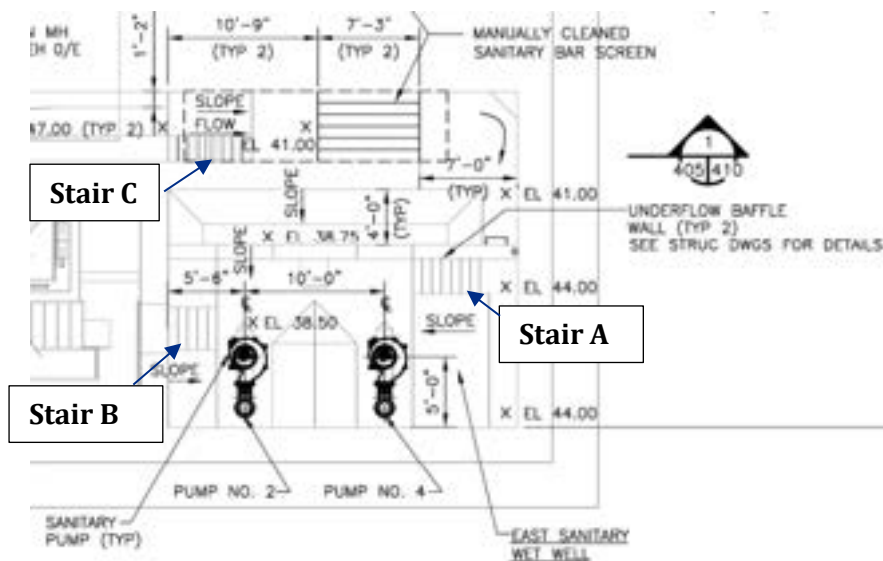


Figure 2-1
East Sanitary Wet Well Plan with Concrete Stairs Identified (west wet well similar)

The stairs can be identified by location:

- Stair A: downstream of underflow baffle wall
- Stair B: beside watertight door
- Stair C: sanitary influent channel upstream of screen

As clarified at TM workshop No. 1 held on April 5, 2023, the aeration of the wastewater has occurred only at stair C. It appears that this has been caused by debris accumulation in the sanitary flow trench to the extent that flow through the trench was fully or partially obstructed resulting in flow being conveyed over the storm wet well floor to the top of Stair C rather than discharged to the sloped concrete surface at termination of the trench adjoining the stair. This has resulted in aerating the wastewater at times. The same condition can exist in the approach to both wet wells.

For reference, the intended approach flow for this wet well type is represented in **Figures 2-2 and 2-3**.

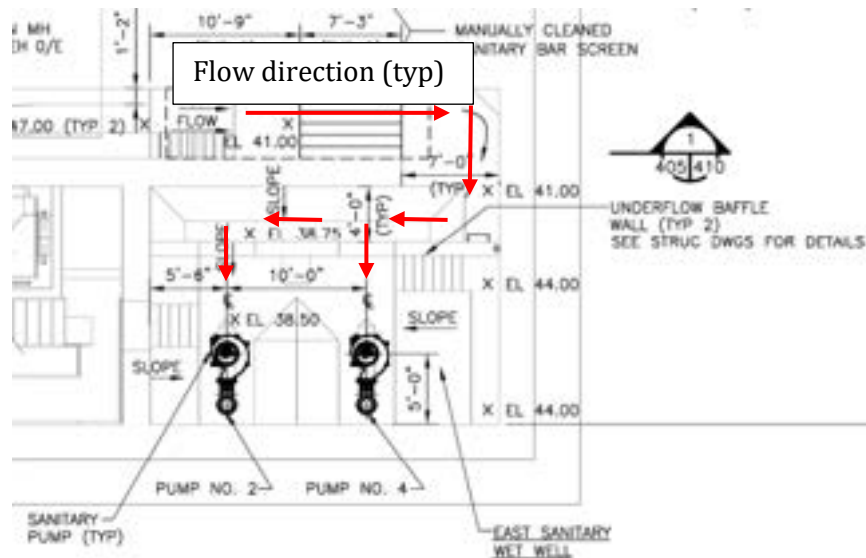


Figure 2-2
East Sanitary Wet Well – Intended Flow Path to Provide Optimal Approach Flow Conditions

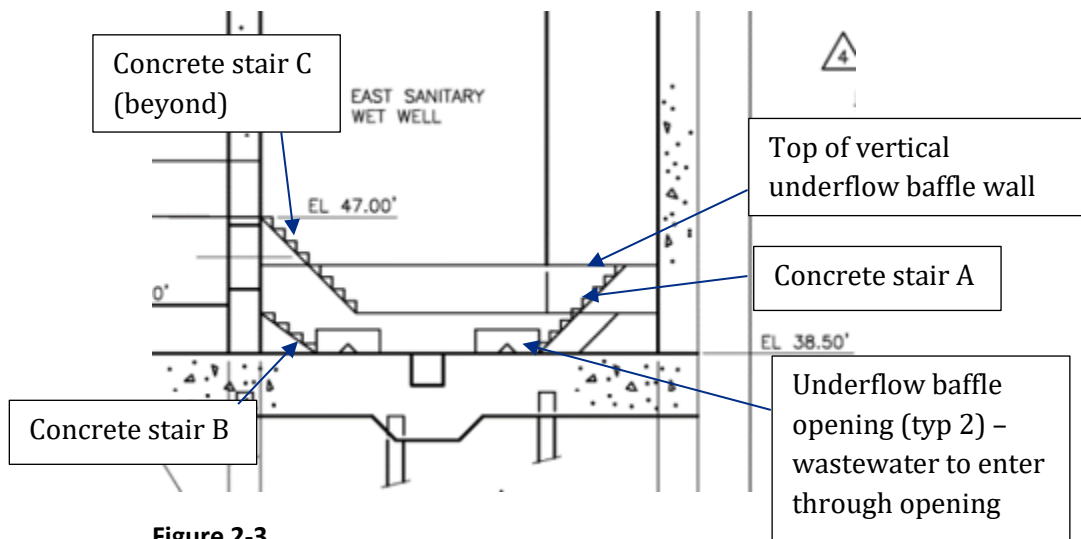


Figure 2-3
East Sanitary Wet Well Section – Intended Flow Path to Provide Optimal Approach Flow Conditions

From discussion with the Great Lakes Water Authority (GLWA) the Design Team also understands that the stairs have not been utilized historically when staff have been working in the wet well since the stairs remain slippery even after cleaning.

3.0 System Evaluation

The evaluation of the concrete stair has focused initially on determination of which stair (A, B or C) has wastewater flowing down it leading to aeration. This evaluation has determined that only stair C has been of concern for this operating condition as described in Section 2.

The second portion of the evaluation was focused on how to prevent the aeration from occurring in the future. The path forward for evaluation was based on addressing the flow down the stair and two alternatives are discussed in Section 4.

The evaluation also considered if there would be value to remove stair A or B as part of the proposed modifications.

Stair A provides a means of transitioning from the significant elevation change from the channel upstream of the vertical underflow baffle and the bottom of the sanitary wet well. This stair is not causing aeration of the wastewater. Therefore, the stair is not recommended for modification as part of this project.

Stair B is not typically utilized by operations or maintenance staff for wet well entry due the slippery condition of the stairs, even after cleaning. However, if the watertight door is utilized this stair would be an improvement over traversing a 45-degree fillet which would replace this stair to match the sidewall fillet slope. Therefore, since stair B is not causing aeration of the wastewater and provides a more accessible means to the watertight door than a 45 degree slope the stair is not recommended for modification as part of this project.

4.0 Description of Alternatives

There were two alternatives considered to address the aeration of wastewater as cascades down stair C which are described in this section.

4.1 Remove concrete stair C and replace with concrete fillet

This alternative (Alternate 1) removes the concrete stair immediately upstream of the bar screen and replaces it with a sloped fillet. The fillet would slope from the storm wet well bottom slab (approximately 50.3') to the influent channel at the base of the stair (41.0') to minimize cascade affect and aeration if the sanitary flow trench is blocked and flow is conveyed over the stair as approach the sanitary influent channel.

4.2 Add piping to bypass the concrete stair C

This alternative (Alternate 2) uses an inlet chute and pipe to funnel flow conveyed toward the stairs into a closed conduit discharging at the base of the stair. It is assumed that the configuration of the inlet chute and pipe would contain a portion of the flow conveyed toward the top of stair. It would be a challenge to capture all the flow.

The alternative includes an initial concern for the potential to passively bypassing the pipe (if spill over inlet chute) resulting in continued aeration. In addition, the design team is concerned that

debris may catch on the chute inlet or within the pipe leading to an additional maintenance requirement at a difficult to access location.

4.3 Alternatives Evaluation Criteria

The alternatives evaluation criteria are grounded in the guiding principles for the project with an emphasis on ability to meet the goal to minimize or eliminate air entrainment/odor release coupled with enhanced reliability, maintenance reduction and simplicity.

5.0 Alternatives Analysis

Alternate 1, which replaces the stair with concrete fillet, is superior on a technical basis to the chute/pipe alternative for all evaluation criteria. Therefore, recommend the concrete fillet based on evaluation of non-cost factors given the importance to align with guiding principles (minimize maintenance, enhanced reliability, simple) with an alternative which will address the concern to the maximum extent feasible.

5.1 Conceptual Structural Modifications to Accommodate Alternate 1

From structural perspective, the existing stairs can be modified by jackhammer or saw cutting to remove the steps including the embedded rebars down to the surface to accommodate the new sloped concrete surface described above. The contractor will then remove and scarify to two inches below the exposed sloping surface. Once the contractor has prepped the surface new concrete repair mortar will be applied in approximately a two-inch thick layer. At the bottom of the existing stair a groove will be chipped out to avoid a feather edge at the low point of the fillet. The repair mortar will be troweled smooth to match the adjacent surface. **Figure 5-1** generally illustrates this approach.

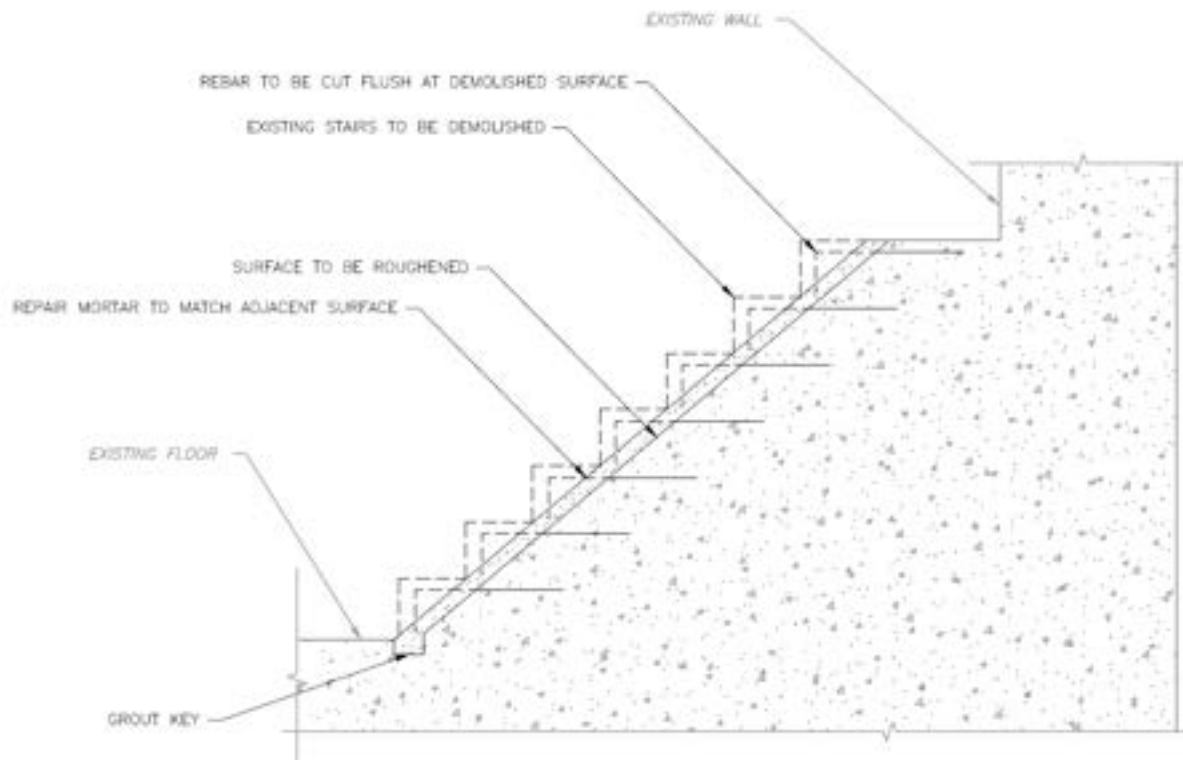


Figure 5-1
Conceptual Structural Modifications to Stair C

6.0 Summary, Recommendations and Key Decisions

The evaluation concluded that the only concrete stair which requires modification as part of this project is Stair C as shown in **Figure 6-1**. The recommended modification to minimize the aeration of the wastewater and minimize maintenance is to replace the stair with a concrete fillet with a slope to transition from storm wet well bottom slab to the sanitary influent channel bottom slab.

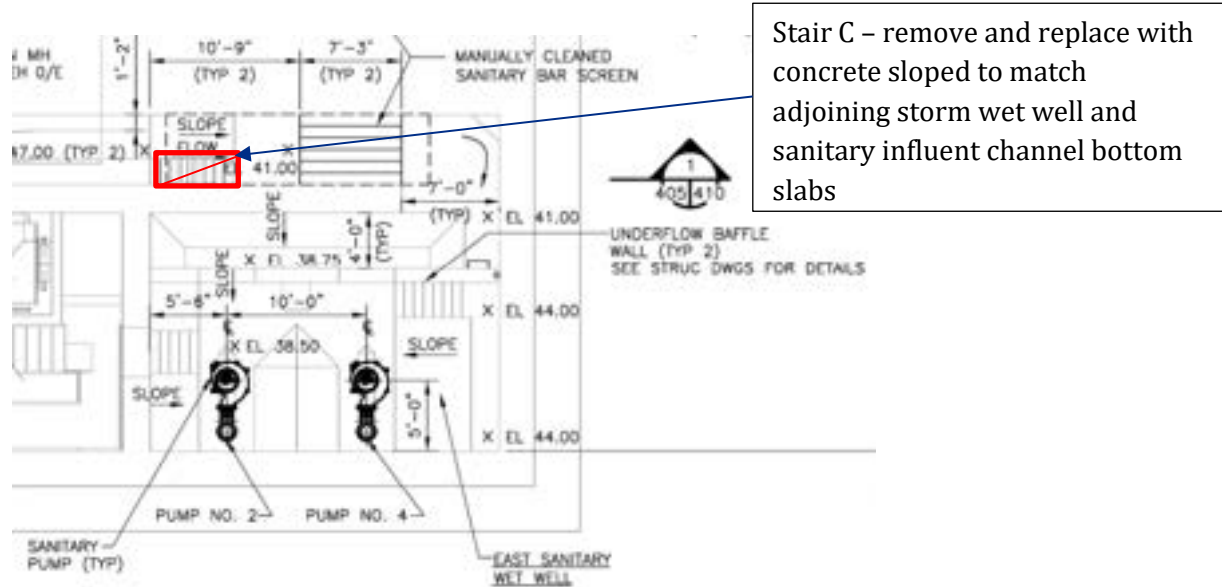


Figure 6-1
East Sanitary Wet Well – Recommended Concrete Stair Modification (west wet well similar)

6.1 Key Decisions

Key decisions made during the course of review and presentation of this Technical Memorandum are as follows:

- Stair C modification to remove concrete steps and replace with sloped concrete fillet/ramp as conceptually shown in Section 5.
- No modifications required to Stair A or Stair B.

7.0 Next Steps

Not Used.

2.4 Security, TM-24

Leib SDF

- Add camera for new entrance to site
- Key card/intercom panel for badge access at new entrance
- New fencing security provisions

TM-24 can be found in Section 2.1.

2.5 Process Mechanical, TM-2, TM-4, TM-5, TM-15, and TM-22

Oakwood RTB, TM-2, TM-4, TM-15, and TM-22

- Rehabilitation/modification of Storm Pumps
 - Modify (water lube bearings changed to grease lube) for each storm pump
 - *Modify support grating over opening at storm pump motor room to support grease lube system skid (one corner of opening)*
 - Small & Large Pumps, 66x54 WCA and 88x72 WCA included (total of eight)
 - Disassembly, Removal and shipping to factory
 - Factory witness test (TBD)
 - Installation, startup, training and return shipping
 - Modify existing seal/lube/cooling water system (1 dedicated per storm pump) to serve the only remaining load: motor thrust bearing cooling
- Clean both storm wet wells, both sanitary wet wells and influent tunnels - vactor or submersible slurry pump removal, fillets and splitters
- Changes to Ovation programming controlling and monitoring storm & sanitary pump systems
- Modify screenings conveyor to include three drain sections (drain boxes)
- Relocate flushing valves in CSO Basin
- Add conditioning pump and flushing water nozzle system in each CSO basin drainage sump
- Modify storm wet well flushing system in each wet well

Leib SDF, TM-5 and TM-22

- Rehabilitate existing Romag screens
- Replace all COPA screens in the two screen channels with Romag screens
- Replace the two SS hydraulic lines to each Romag screen (TBD)
- Replace screen control panels
- Add flushing water system to screen inlet channels and screenings channel



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

From: Steve Fehniger, CDM Smith

Date: June 1, 2023

*Subject: TM-2 Storm Pump Rehab and Wet Well Cleaning (GLWA OKW-PUMP-1B)
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

The problem statements incorporated and addressed in this technical memorandum (TM) include how to approach wet well cleaning (short and long term), several elements of rehabilitation of the storm pumps and evaluation of a separate contract for the storm pump specific work items.

Recommendations

Cleaning: Near-term cleaning evaluation was conducted to determine the major elements of a wet well cleaning specification which will be developed in final design phase to define the requirements for cleaning the two storm and two sanitary wet wells as part of this project. For long-term cleaning, the evaluation defined the path forward to develop Standard Operating Procedures (SOP) which will incorporate the storm wet well flushing system/sanitary pump operation cleaning after each wet weather event as well as recommended intermittent cleaning procedures.

Storm pump rehabilitation:

Storm pump rehabilitation recommendations included the following:

- Pump manufacturers to list in the storm pump rehabilitation specification: Johnston/Sulzer, Xylem Flygt AC-Custom Pump and Fairbanks Nijhuis.
- Scope of rehabilitation includes replacement of the shaft sleeves, line shaft bearings and bowl bearings.
- Proceed with grease lubrication system which was determined to be technically feasible for the application.
- Grease lubrication system configuration, redundancy, location and other recommendations listed in Section 7.

- Reconfigure cooling water system for motor thrust bearing to be connected to the intermediate level process drain system and replace the sump pump to meet new conditions of service.

Storm pump as separate contract: Proceed with a separate contract for the storm pump rehabilitation/modification due to the construction phase duration being insufficient to incorporate the time required to perform the work.

The evaluations performed to determine the above recommendations were divided into the three focus areas as follows:

The evaluation for wet well cleaning focused on development of core requirements and constraints to include in the cleaning specification coupled with how much the sanitary pumps could be utilized as part of this activity. The long-term cleaning evaluation included qualitative benefit assessment to modify wet well access capabilities relative to clearances available for cleaning equipment. In addition, a list of items to include in SOP which summarizes the future cleaning activities utilizing the storm wet well flushing system and intermittent wet well entry.

The storm pump rehabilitation evaluations were subdivided to determine which pump manufacturers could perform the required work, summarize the anticipated pump rehabilitation requirements based on findings from ST-5 2022 rehabilitation, assess feasibility to field modify ST-5 to add grease lubrication in the field, and technical feasibility of pumps to be modified to convert water lubed bearings to grease lubrication. The evaluation included a related determination of the modifications of the seal/cooling/lube water system to be coordinated with the grease lubrication system including associated disposal method for spent motor cooling water.

The evaluation of separation of the storm pump work from the remainder of the project as a stand-alone set of contract documents, to be bid before the remainder of the project, focused on feasibility to separate this work from the remainder of the project, potential cost, and schedule efficiencies.

1.0 Introduction and Purpose

TM-2 is focused on evaluation/investigation of two distinct pump system elements: storm pump rehabilitation/modification (rehab) and cleaning of the storm and sanitary wet wells contained within the Oakwood Pump Station.

The TM is structured to first cover the wet well cleaning and then storm pump rehab within each section.

The cleaning evaluation considers both the near-term (work to be performed as part of this project) and long-term (operations/procedures to be performed after this project). The storm pump rehabilitation evaluation focus is on required improvements to restore the pumps to full functionality, assess technical feasibility of line shaft and bowl bearing conversion to grease lubrication, maximize reliability while reducing maintenance to the extent feasible.

This TM will not answer all storm pumping system related questions. Refer to technical memoranda/reports developed on the topics of storm pump control philosophy revisions (TM-15), storm wet well physical model study, and storm wet well flushing system improvements (TM-22) for coverage of those topics.

2.0 Existing System(s) Description (and/or Conditions)

The existing Oakwood storm pump station is configured with a split modified trench wet well as the intake for the storm pumps. Downstream of each trench is a solids handling type wet well equipped with a total of four submersible sanitary pumps as shown in **Figure 2-1**. The wet wells are connected only at the upstream junction chamber which is located near the southern limit of the facility site.

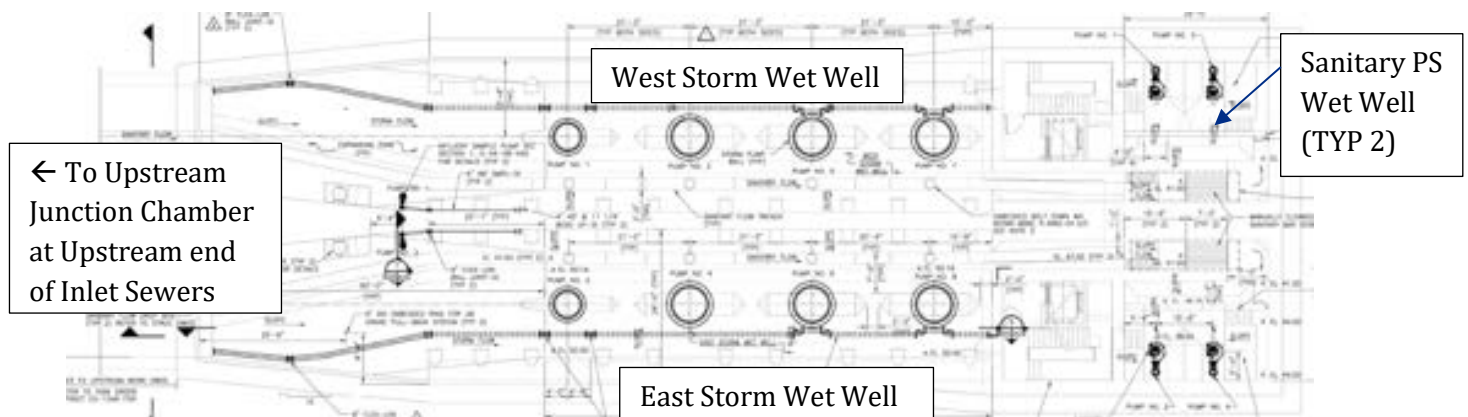


Figure 2-1
Oakwood Storm and Sanitary Wet Well Configuration (PC-755 Record Drawing D-04-08-405)

2.1 Wet Well Debris Accumulation/Cleaning

Debris accumulation in the storm and sanitary wet wells occurs regularly. This requires periodic manual cleaning. The deposited debris is primarily composed of a heavy sediment/sand/sludge mixture. The rate of deposition varies as a function of the number of wet weather events, operation of the storm and sanitary pump stations, and the frequency of sanitary pump station screen manual cleaning. The 3-inch clear coarse bar racks tend to accumulate rags which lead to blinding over time and a resultant significant (presently 10-ft where full screen field height is installed) differential head across the screen. This condition likely limits debris transport to the sanitary pumps.

At the time of this writing, as part of a separate project, a contractor was preparing for a second attempt to clean the wet wells. In addition, at the time of the cleaning the Great Lakes Water Authority (GLWA) may decide to remove the lowest portion of the complete sanitary pump station screen to avoid the blinding and associated backup of debris accumulation in the storm wet well and sanitary flow trench based on performance with the modification of the other sanitary pump station screen completed more than a year ago.

The quantity of debris accumulation is substantial over time with a present cleaning frequency of approximately every third year as noted by operations staff. Based on observations from the storm wet well expansion zone in Fall 2022 (during first recent attempt to clean wet well), there is significant debris accumulation in the wet well. Discussions with operations staff identified that one of the single most valuable improvements to the facility would be to increase the cleaning frequency to annual.

There is an existing flushing system in each storm wet well and at the beginning of the sanitary flow trench which is utilized infrequently at best and has not demonstrated effective cleaning performance over the service life of the facility. This system is described and evaluated in TM-22 titled Flushing Systems.

2.1 Storm Pumping System

The Oakwood storm pump system is comprised of eight vertical mixed flow storm pumps positioned within the two wet wells with “small” variable speed-controlled pumps at the upstream end of each wet well followed by “large” vertical-mixed flow pumps. The pumping units were all furnished and installed as part of the original construction. The pumps were manufactured by ITT Flygt (now Xylem Flygt AC-Custom Pump) and the motors were manufactured by Hyundai Ideal (now Ideal Electric). The pump station has a firm pumping capacity of 1675 cfs (1.1 BGD) at the design total head with one of the large pumps off-line.

No major modifications have been made to the pumping units since placed into service in 2012. One pump (ST-5) was rehabilitated by Kennedy Industries in 2022. Major component replacement included line shaft and bowl bearings and shaft sleeves as described in Section 3.

Pump details are included in **Table 2-1**.

Table 2-1 Storm Pumping Units Summary

Pump Nos.	Pump Description	Design Point Total Head, ft	Design Point Flow Rate, cfs (mgd)	Motor Full Speed, rpm	Motor HP	VFD speed controlled, Y/N	Present Speed Range, % speed	Discharge Size, in.
ST-1 and 2	Small Pump	48	150 (97)	594	1500	Y	75 - 100	54
ST-3, 4, 7 and 8	Large Pump	48	275 (178)	446	2000	N	NA	72
ST-5 and 6	Large Pump	48	275 (178)	446	2000	Y	75 - 100	72

2.1.1 Present Storm Pump Station Operations

The storm pump station is normally operated manually from the Ovation workstation in the pump station control room. The station is commonly left in auto mode when facility is not staffed to facilitate system operation during wet weather event as triggered by wet well level setpoints. On average the station operates about 25 times per year. Each station operation involves at least one

storm pump running.. This operational frequency was based on review of downstream equipment systems which are required to be running before any storm pump will start (screenings conveyor data utilized) as determined through review of operational data from September 2019 – November 2022, excluding conveyor starts for post-event cleaning.

Present wet well level-based pump setpoints (Detroit datum):

- Lead pump start: 73 ft
- Lag pump start: 76 ft
- Maximum level: 78 ft
- Last pump in operation stop: 65 ft

Based on observations and discussions with operations staff as part of ride-along site visits, the selection of the first pump to start is an operator preference and can be a small pump or large pump (constant or variable frequency drive [VFD]). This decision is guided in part by desire to distribute the runtime between the storm pumps. In addition, some operators favor starting an event with a large pump as they feel the ability to dose a high concentration of sodium hypochlorite at beginning is greater with the corresponding larger metering pump than the small pumps. Most events require only one storm pump to operate at a time with fill/draw approach with a resultant varied number of pump operation cycles per event.

The speed of the VFD speed-controlled pumps is automatically controlled “behind the scenes” via Ovation programming as the operations staff do not modify the VFD speed. Operators indicated the speed ramps up when the wet well level increases. For the events observed these pumps remained at minimum speed as the flow rate did not continue to rise after the pump was turned on. This results in operation outside the Allowable Operating Region (AOR) with associated reduced service life and lower pump efficiency. However, for the ride along witnessed events the pumps were able to convey the combined sewage required to meet the needs of the application in this operating condition.

The subsequent pumps turned on is an operator decision with consideration of not starting a pump which has recently been shut down to allow the motor to cool down.

2.1.2 Present Pump Line Shaft and Bowl Bearing Lubrication System Operation

The pump line shaft and bowl bearing water lubrication system operation has been a reliability challenge due largely to debris in the combined or sanitary sewage entering the enclosing tube and plugging the bearing lubrication grooves when the level in wet well is above the impeller if the cooling/seal/lube water is not providing a clean water purge of the enclosing tube during this operating condition. The plugging has resulted in the inability to convey water out the enclosing tube. If this occurs storm pump operation is suspended until the flow path is reestablished to allow water to serve all intended functions. This plugging has also led to seizing of the pump in some

cases. Both of these conditions (plugging and seizing) have resulted in pump downtime and substantial maintenance efforts to return pumps to operational condition.

As a result, the present operation of the cooling/seal/lubrication water system is to run continuously (every day) independent of whether a storm pump is in operation or if the wet well level is above the pump bell. This operating practice has resulted in reliable operation of the storm pumps. However, the continuous use of water also creates a high associated operating cost for the secondary water supplied to these systems (potable water downstream of a backflow preventer). At present water rate, approximate water cost of \$846,000 per year at Oakwood facility which as far as the Design Team is aware is predominately utilized for this system demand as detailed in Section 3.2.10.3.

3.0 System Evaluation

The evaluation of the cleaning system/approach for the storm and sanitary wet wells summarized in the following section has been divided into two, time horizons (near-term and long-term). The evaluation of storm pump rehab is first focused on ST-5 rehab findings as relate to rehab needs of all pumps followed by feasibility evaluation for conversion of the bearing lubrication system from water to grease.

3.1 Cleaning System/Approach Evaluation

3.1.1 Cleaning System/Approach Evaluation - Near-term cleaning activities

As described in Section 2, the storm and sanitary wet wells tend to accumulate debris over time. From discussions with operations staff the Design Team learned that the flushing system for the storm wet well is infrequently utilized in part due to one of the system motorized isolation valve requiring service. However, given the depth of debris in the wet well observed in the fall it is unlikely that the flushing system would be able to clear the present quantity of debris.

Evaluation and effectiveness of the flushing system is discussed in TM-22 thus not a focus herein. In addition, the Design Team does not plan to use the flushing system in the cleaning activity performed by the contractor as part of this project.

The near-term cleaning activities are independent of the cleaning contract as part of a separate project at the time of this writing.

The focus of the near-term cleaning is to develop a cleaning specification to require the contractor to clean all sludge and debris from the two storm and two sanitary wet wells as part of construction phase activities.

The wet well cleaning specification will define the requirements including the following:

- Scope of cleaning as shown in **Figure 3-1**.
 - Both storm and both sanitary wet wells

- Installed portion of both sanitary influent channel screens
- 18-foot diameter approach tunnels and sanitary trenches up to the junction chamber (up to stop plate)

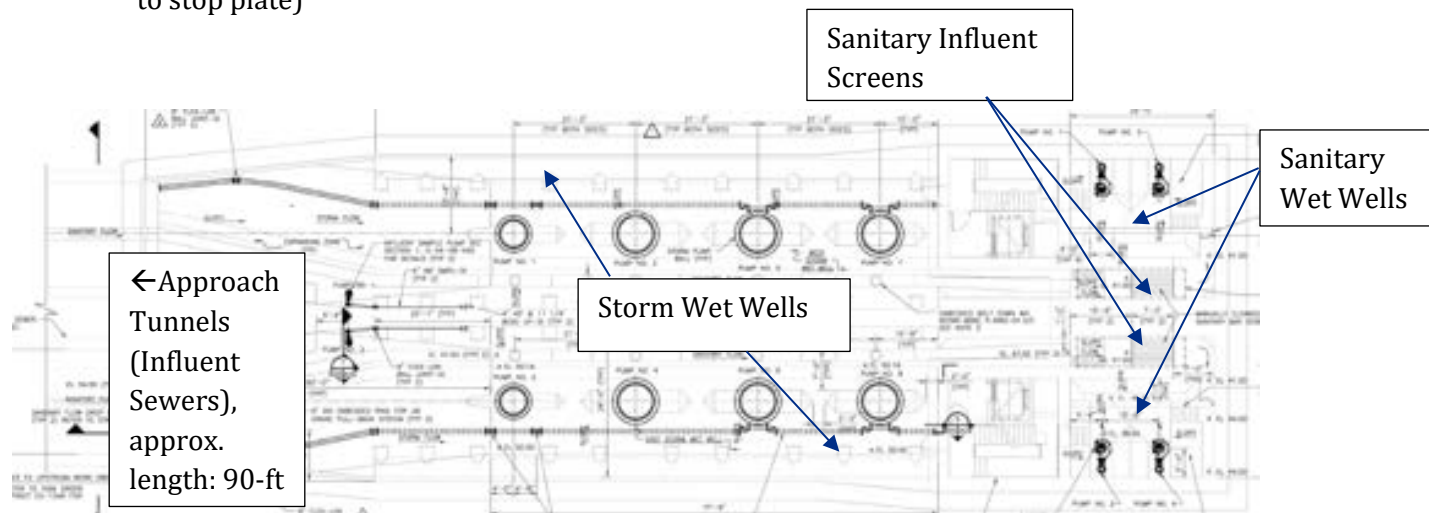


Figure 3-1
Oakwood Storm and Sanitary Wet Well Areas to be Cleaned (PC-755 Record Drawing D-04-08-405)

- Constraints
 - Access through intermediate level, if storm pump is removed, will not be allowed due to separation requirements to not interconnect hazardous and unclassified areas.
 - Limitations on use of the sanitary pumps to convey water above the debris and, if GLWA approved, fluidized debris.
 - Limited clearance around pumps, fillets, splitters and sanitary flow trench
 - No heavy machinery (weight to be defined) will be operated or moved across the sanitary trench covers (6-inch" thick reinforced concrete) provided near each pump bell.
- Allowable points of access as shown in **Figure 3-2**.
 - Hatch at top of each expansion zone (6 ft x10 ft)
 - Sanitary wet well openings above influent channel and floor hatches (19 ft x 5 ft with screen below)
 - Potentially the water-tight doors into the storm and sanitary wet wells which requires further coordination with GLWA due to recent leakage issues with these doors.

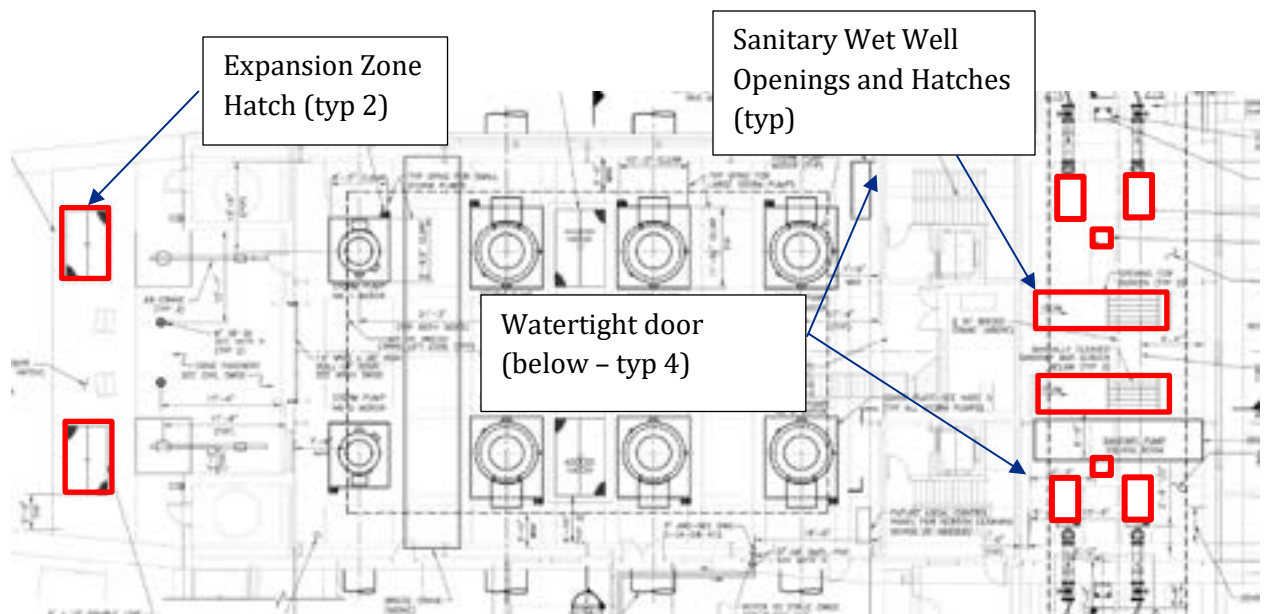


Figure 3-2
Oakwood Storm and Sanitary Wet Well Access Points (PC-755 Record Drawing D-04-08-407)

- Permanent ventilation system capacity and capability
 - Supply fan dedicated to the wet wells (one fan for east and one for west)
- Allowable water source and location of connection, assuming contractor will be permitted to use secondary water for use in the cleaning process.

In addition, acceptance criteria in form of qualitative description of how clean the wet wells must be to comply with the specification.

3.1.1.1 Cleaning System/Approach Evaluation – Extent of Allowable Use of Sanitary Pumps

The four sanitary pumps are equipped with hard metal components to maximize service life when pumping high solids pumpage. However, the nearly continuous duty of these pumps for this critical application likely is not aligned with a contractor using the pumps to convey solids downstream (into collection system and ultimately to the water resource recovery facility [WRRF]). Based on discussion at the GLWA TM workshop No. 2 held on April 19, 2023, GLWA agreed with the cleaning contractor will not be allowed to use the sanitary pumps but will be able to discharge decant water to manhole along the sanitary system.

A consideration will also be the potential to overload or starve the pumps due to an excessively high-debris concentration with the potential to clog the pumping units with potential for associated overloads.

As coordinated with GLWA in TM workshop No. 2, the cleaning contractor will be required to remove the accumulated debris, likely with vactor truck, dewatered/decanted and solids disposed off-site. The removal methods and/or associated constraints will be further defined based on the Pullman meeting noted in the Next Steps section.

3.1.1.2 Cleaning System/Approach Evaluation – Potential to enhance access/wet well limited clearance impact

The existing access methods to enter the wet wells with personnel and equipment are described above. The ability to increase the accessway size is limited by the configuration of the pump station as described in this section.

An important consideration is the limited value that greater accessway size may offer due to the constraints within the wet wells due to pumps, splitters, fillets, etc. as described below.

Wet well limited clearance constraints:

- Storm wet well as shown in **Figure 3-3**
 - 8-inch flushing water header at ~11 ft above wet well floor on outside wall. The distance from the flushing water header to the pump intake (bell) is about 6 ft. However, from toe of sidewall fillet to pump bell is about 5 ft on the side by the flushing water pipe.
 - There are splitters under each pump bell. Distance between splitters (parallel to line of pumps) is about 2 ft.
 - Distance between pump bell and sanitary trench is about 3 ft.
 - Between the sanitary trench and the East/West dividing wall is a 45-degree fillet.
- The sanitary wet well is also filled with 45-degree fillets at the perimeter walls, splitters below the pumps and a vertical baffle wall to direct flow to pump which greatly limit equipment from maneuvering in the limited clear area with the potential to hit a pump.

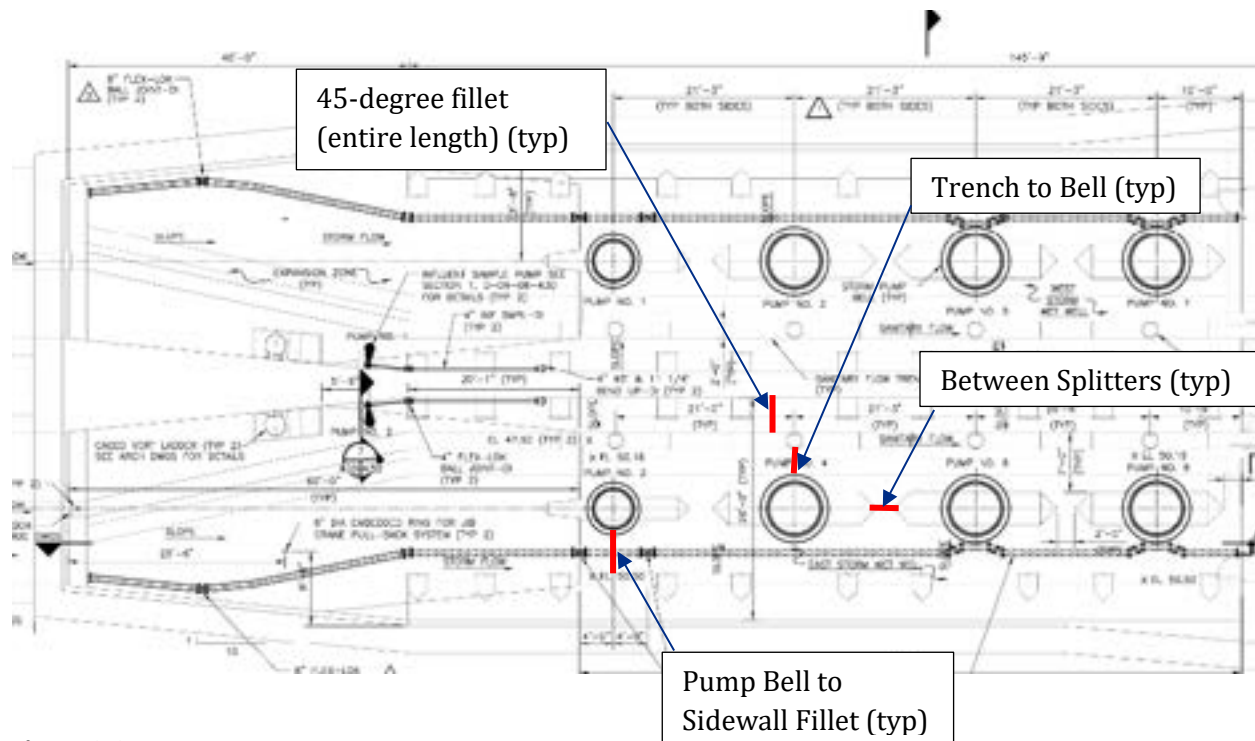


Figure 3-3
Oakwood Storm Wet Well Clearance Constraints (PC-755 Record Drawing D-04-08-405)

Considering these clearance constraints it appears that the clear distances available for equipment in the storm wet wells are within the limits of the hatch size provided above the expansion zone. In addition, it is clear that the maneuverability of cleaning equipment will be constrained by the wet well clearance constraints in both sanitary and storm wet wells.

Ability to increase size of wet well openings:

The storm wet well access enhancement evaluation focused on the existing 6 ft x 10 ft hatch of each expansion zone. The vertical shaft for this accessway is limited to the south by the surge relief box culvert (Oakwood record drawing D-04-08-306) and to the north by the jib crane foundations (D-04-08-307). Therefore, evaluation concluded that the wet well openings are maximized to extent feasible and aligned with the working clearances in the wet well.

For the sanitary wet well the value of opportunities to enhance access are constrained by available working clearances for equipment below which led to the finding that there is not a significant benefit to increasing the size of openings.

3.1.2 Cleaning System/Approach Evaluation - Long-term activities

The long-term cleaning system/approach evaluation is focused on two key elements, first development of an SOP to delineate the recommended steps and processes to follow for

intermittent cleaning requiring supplemental equipment and entry as well as flushing system sourced cleaning after each wet weather event. Second, utilize the improved storm wet well flushing system and associated sanitary pump operation to minimize the frequency of required cleaning that will be integrated into the SOP.

The SOP will be developed in the final design phase and will likely be focused on an intermittent cleaning method utilizing slurry pumps to facilitate removal of the debris from the wet well given the limited working clearances for equipment within the wet wells.

The improvements to the storm wet well flushing system, based upon the evaluation performed as part of this project, will be incorporated into the SOP to facilitate cleaning of the storm wet well after each storm event using the flushing water without entry into the wet well. The intent of the flushing system will be to reduce the frequency of manpower intensive cleaning within the wet well. The evaluation of the flushing system as part of the physical model study will provide insights on operation that will be captured in the SOP.

3.2 Storm Pump Rehab Evaluation

The storm pump rehab evaluation consisted of several sub-evaluations which sum to the overall evaluation of the required components to be rehabilitated, the determination if grease lubrication is technically feasible coupled with conceptual consideration of how to accommodate systems in the pump station and assessment of if a path forward focused on the storm pump work items bid as a stand-alone contract is justified from cost and/or schedule perspective.

3.2.1 Evaluation of Pump Manufacturers to Execute Storm Pump Rehab

This storm pump manufacturer evaluation extended beyond the original manufacturer to enhance competition given hydraulic design will not be changed and GLWA's concurrence to consider others.

The pump manufacturers/pump shops which may be capable to perform the storm pump rehabilitation work (including the modification to bearing grease lube system) were assessed based on three key criteria: large vertical suspended pump rehabilitation experience, custom grease lubrication system engineering/fabrication experience, and ability to factory test the rehabilitated pumps.

The following manufacturers/shops were contacted:

- Flowserve
- Johnston/Sulzer
- Xylem Flygt AC-Custom Pump (OEM)
- Kennedy Industries
- Fairbanks Nijhuis (Pentair)

A summary of the evaluation findings is provided in **Table 3-1**. It is clear from this evaluation that the number of qualified entities to perform the work is limited. In addition, the OEM manufacturer, Xylem, will have an advantage over the other listed manufacturers due to their familiarity with the pump design and fabrication details of the installed pumps.

Table 3-1 Pump Manufacturer/Shop Evaluation Summary

Pump Manufacturer/Shop	Large VS Pump Rehab Experience?	Grease Lube System Design/Fab. Experience?	Factory Test Capability?	Notes
Flowserve	Yes	No	Not determined	
Johnston/Sulzer	Yes	Yes	Yes	
Xylem Flygt AC (OEM)	Yes	Yes	Yes	
Kennedy Industries	Yes	No design experience	No	Plans to team with Xylem Flygt who they represent locally
Fairbanks Nijhuis	Yes	Yes	Required third party test location if performance test	At this time, uncertain if third party test facility can test pumps of this size

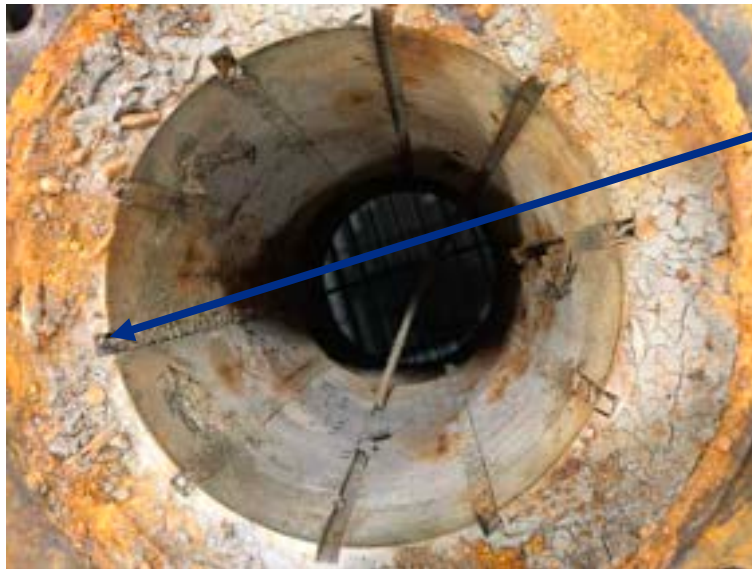
Based on the results of the evaluation the following pump manufacturers are recommended to be listed in the storm pump rehabilitation specification: Johnston/Sulzer, Xylem Flygt AC-Custom Pump and Fairbanks Nijhuis. At the time of this writing evaluation of the type and extent of factory test to be conducted was under evaluation. If determined a performance test is required this may result in Fairbanks Nijhuis not being able to meet this requirement.

3.2.2 ST-5 Rehabilitation Findings, Lessons Learned and Conclusions

ST-5 (large pump) was removed from the pump station in pieces (due to vertical clearance constraints) and transported to Kennedy Industries (KI) for inspection, cleaning, dimensional clearance tolerance check and rehabilitation in Spring 2022. This pump is assumed to be representative of all the storm pumps and thus will be the basis to determine rehabilitation scope.

KI's work included all pump components up to the stuffing/packing box excluding the discharge head. Conversion to grease lubrication of the bearings was not part of the work. A report summarizing the inspection findings and components in need of repair is included in Appendix A for reference.

Supplemental photos to their report were provided by KI showing the quantity of debris accumulated in the bearing lubrication grooves which confirms the plugging maintenance challenges with the water lubrication system discussed in Section 2 coupled with system operation as shown in **Figure 3-4**.



Bearing groove filled
with debris (typ)

Figure 3-4
ST-5 representative bearing grooves filled with debris (photo courtesy of KI)

ST-5 was installed but unable to operate for about 1 year based on discussions with GLWA maintenance staff. In that time mud accumulated (caked on) the upper side of the impeller vanes. This is of concern from a rotor balance perspective. This highlights the need to regularly operate the pumps to avoid sediment depositing on and bonding to the top-side of impeller vanes. The mud accumulation is shown in the **Figure 3-5** which also includes some debris from other components loosened by the disassembly process.



Figure 3-5
ST-5 Impeller with mud deposited on top side of vanes (photo courtesy of KI)

From the Design Team discussions with GLWA maintenance staff the Design Team learned that KI was directed to replace all the Thordon SKL line shaft and bowl bearings with bronze-backed cutlass (cutless) rubber bearings given GLWA's good success with this bearing type on other wastewater applications.

The following conclusions can be drawn from the KI's work:

- The following components will require replacement in the rehabilitation of each storm pump: all bowl and line shaft bearings and potentially shaft sleeves (if determine alternate material to existing ASTM A276 Type 410 stainless steel shaft sleeves optimized for grease lubrication would enhance reliability and reduce maintenance).
- The bearing replacement material of construction recommendation is focused on providing a bearing of similar stiffness to the Thordon SKL (to minimize impact to pumping unit natural frequency to potential excitation source separation margins). The replacement will also be well suited for grease lubrication and durable. This will be a bronze bearing with the alloy to be determined in the basis of design (BOD) phase.

These rehabilitation items will be included in the storm pump rehabilitation specification as part of the contract documents.

3.2.3 Evaluation of ST-5 field modification feasibility for grease lube system components

The evaluation of feasibility to modify recently rehabilitated ST-5 in the field (in pump station motor room) to accommodate grease lubrication modifications included consideration of the following:

- Pump will require nearly complete disassembly for the modifications
- Machining of components, precision drilled and tapped holes, hydraulic press removed/installed parts and other machining is anticipated to facilitate accommodation of grease lubrication system components
- Tight tolerance fits required to meet reliability, functionality and efficiency guiding principles
- Line shaft and pump bearings will require replacement to bronze bearings
- Ample space will be required for laydown and work areas
- Pump Station operation must be maintained throughout construction

Based on this evaluation the Design Team concluded that field modification of ST-5 will not be feasible due to the following: observation of staff activities and storage functions in the storm pump motor room during the Design Team ride-along site visits; machining equipment required to be brought to the site (supplied power and anchored to floor) and limited working space (which must

be in hook reach of the bridge crane). Therefore, the pump must be sent off-site to be modified to accommodate the grease lube system components.

3.2.4 Grease lubrication system technical feasibility evaluation

To address the cooling/seal/lube water system plugging and storm pump seizing due to debris accumulation in the enclosing tube with resultant pump down time and reduced reliability described in Section 2, the technical feasibility to convert the existing water lubricated line shaft and bowl bearings to grease lubrication was evaluated and investigated with a focus on the following:

- Discussion with grease lube experienced pump manufacturers
- Past use of this lubrication system in vertically suspended (VS) pumps
- Investigation of similar applications in southeastern Michigan equipped with grease lubrication with several discharging to receiving streams
- Adequate space in the pump station for the grease lubrication systems with sufficient room for maintenance access while minimizing impact to pump/motor maintenance access

A summary of the findings from each of the evaluation elements follows:

- Experienced pump manufacturer input: Universally agree that this conversion is feasible even though unusual.
 - Manufacturers added that it is typical grease lube to be applied for intermittent (on demand) use systems such as the storm pumps
- VS pump grease lube experience in the pump industry: Confirmed
- Similar VS grease lube equipped applications in SE Michigan were identified including the following:
 - Several MDOT stations conveying flow to Detroit and Rouge Rivers
 - Wayne County CSO PSs discharge to interceptor then pumped to Rouge River tributaries
 - Wayne County airport pump to ponds which are released to surface water system in warmer months

In conclusion, the modification of the storm pumps to equip with grease lubricated bearings has been determined to be technically feasible. Redundancy, configuration, location and other associated evaluations for this system are covered in the following sections.

3.2.5 Storm Pump Grease Lubrication System Redundancy Evaluation

The number of grease lubrication systems relative to the number of storm pumps was evaluated with vision provided by the project guiding principles. As part of this evaluation, in the February 20, 2023 meeting with GLWA pump maintenance staff the Design Team learned that past experience with a grease lubrication system that served multiple process pumps led to problems with resultant loss of all process pumps greased by the shared lube system. Ultimately the process pumps were modified to no longer be served by a shared lubrication system.

In the evaluation the Design Team determined that commercially available lubrications systems, such as those manufactured by Farval, are limited on the number of process pumps which can be served by a single lubrication system. For example, the CS2000 system, under consideration for this application, would be able to serve two storm pumps. However, both units would be lubricated at the same quantity and time which may not be required if storm pump runtimes vary.

A comparison of advantages and disadvantages of dedicated lubrication systems versus shared lubrication systems is provided in **Table 3-2**.

Table 3-2 Advantages and Disadvantages of Dedicated vs. Shared Grease Lubrication Systems

Grease Lube System Redundancy	Advantages	Disadvantages
Dedicated grease lubrication system to each storm pump	- Grease lube system redundancy equivalent to storm pumps - Improved operational flexibility - Simplified control and operation of this support system - Grease supply quantity would be pump specific, no excess usage - Access impacts to storm pumps/motors maximized by avoiding grease pipe obstacles between storm pumps - Minimize length of grease piping - Minimizes single points of failure	- Increased capital cost - Additional units to maintain
Shared grease lubrication system to multiple storm pumps (2 storm pumps)	- Reduced capital cost - Lower quantity of units to maintain	- Storm pump redundancy limited by grease lube system - Increased control complexity - Grease piping likely access obstacle

Despite the capital cost increase with storm pump dedicated grease lubrication systems, the non-cost advantages vs. disadvantages listed coupled with past GLWA pump maintenance experience have led to the recommendation to provide a dedicated grease lube system to each storm pump. Through discussions with GLWA staff responsible for pump maintenance and as discussed further at TM workshop No. 2 held on April 19, 2023, the use of a dedicated grease lube system for each storm pump was agreed upon.

3.2.6 Evaluation of Storm Pump Grease Lubrication System Location

There are two locations in the storm pump station (PS) available for new grease lube system equipment: first, the intermediate level in vicinity of each pump with the specific location to be selected in coordination with GLWA in preliminary design phase; second, the storm pump motor room which was initially eliminated due to probable conflicts with storage functions, staff use of the room (electrical techs “home base”) and the inability to place equipment inboard of the pump motors due to potential for access limitations for vehicles stored or utilized in the room. However, GLWA operations staff noted in the February 13, 2023 workshop that the staff use of the area is temporary and stored items can be relocated. The areas utilized for storage and by staff were primarily located between the storm pump motors as well as at the north end of the truck access way in center of PS. Therefore, the motor room is a viable option which is further evaluated in this section.

Based on general review of the two PS floors the Design Team assessed, at a conceptual level, that sufficient room would be available on each floor near each pump while minimizing the impact to existing equipment maintenance access. This will be evaluated in further detail after specific model and configuration are known with application specific dimensions and number of units selected.

A comparison of advantages and disadvantages of the two locations available to house the grease lubrication systems is provided in **Table 3-3**.

Table 3-3 Advantages and Disadvantages of Grease Lube System Location: Conceptual Evaluation - Storm Pump Motor Room versus Intermediate Level

Location	Advantages	Disadvantages
Storm pump motor room	▪ Readily accessible with bridge crane and grease re-supply cart (with manual grease pump and grease) ▪ Somewhat closer to the power source ▪ Typical to locate lube systems at the “at grade” level. ▪ Closer to control room for intermittent inspection	▪ Reduces the available space for other functions in the room (storage, etc.) ▪ Further from the bearings resulting in longer grease lines.
Intermediate level	▪ Lower “traffic” area in terms of staff, storage functions and no vehicle access ▪ Closer to the bearings, shorter grease lines	▪ Requires use of existing hatch and bridge crane to lower grease re-supply cart (or grease to the cart) to intermediate level to resupply grease (additional maintenance effort) ▪ Could restrict access to stuffing box which will not be required as present conditions with limited adjustments required ▪ Further from power source: anticipate small increase in conduit and wire length at greater cost ▪ If a monumentally high wet well water surface elevation, remote potential to partially flood this level which would damage these systems

Based on the evaluation summary in **Table 3-3** and no distinctly higher cost for one location, the Design Team recommends the storm pump motor level as the preferred level for further evaluation in the next phase based on the number of units selected and the application specific footprint to be developed in further collaboration with GLWA. As discussed and agreed upon at TM workshop No. 2, the design team will proceed with the storm pump motor room as selected location for the grease lubrication systems.

3.2.7 Conceptual Evaluation of Storm Pump Enclosing Tube Bottom Seal

In addition, given the application specific challenge of debris migrating into the enclosing tube the Design Team began investigation of the probable sealing method for the bottom of the tube to minimize the potential for this to occur in the future. The concept, at the time of this writing, includes specifying a custom engineered sealing solution manufactured by a seal specialty company, such as Chesterton, to obtain a configuration for optimized longevity and functionality. This would likely include two lip seals (one to minimize wastewater/debris entry into the tube and other oriented to minimize grease release out of the tube) along with a throttle bushing to discourage debris from contacting the seal face to maintain seal integrity. Further evaluation will be performed as the design progresses.

3.2.8 Evaluation of Storm Pump Existing Grease Lubricated Bearing Connection to Lubrication System

Each storm pump is equipped with one line shaft bearing which is not water lubricated, rather it is grease lubricated. This bearing is located on each storm pump between the top of discharge head and bottom of motor approximately at the elevation of the storm pump motor room floor.

The bearing is presently manually greased via a grease gun connected to a zerk fitting on the motor stand to allow grease to be applied without entering the motor stand window.

The incremental capital cost increase in cost to connect this bearing to the grease lube system would be negligible (estimated by bearing lubrication manufacturer to be \$200/system) if determined early in the design.

A comparison of advantages and disadvantages of connection of the grease lubrication system to the existing grease lubricated bearing is provided in **Table 3-4**.

Table 3-4 Advantages and Disadvantages of Connecting Grease Lubrication System to Existing Grease Lubricated Bearing

Existing Grease Lube Bearing Lubricant Source	Advantages	Disadvantages
Connect grease lubrication system to existing grease lubricated bearing	- One system utilized to lube all pump bearings - One type of grease applied to all pump bearings - Reduce the bearing maintenance by focusing only on the grease lube system - May be an opportunity to enhance the seal arrangement at the shaft to reduce grease leakage	- Change from present maintenance procedures - Nominal capital cost increase to add grease lubrication point in the grease lube system
Do not connect grease lubrication system to existing grease lubricated bearing	- Maintain present procedure which is part of the normal PM activities - Confirmed technically feasible with Xylem Flygt.	Potential for multiple grease lubricants to lube pump bearings

Based on the evaluation summary in **Table 3-4**, the Design Team recommends the storm pump bearing located between the discharge head and the motor be connected to the lubrication system for system simplicity, higher reliability and centralized maintenance and a common lubricant for all pump bearings. As confirmed in TM workshop No. 2, GLWA agreed to adding this bearing to the central grease lube system lubricated bearings.

3.2.9 Evaluation of the Seal/Cooling/Lube Water System Modifications

The modification of the storm pumps to be equipped with grease lubricated line shaft and bowl bearings will eliminate two of the three functions of the water system (seal and lube). This is due to the lubrication conversion from water to grease coupled with the stuffing box seal water no longer

being required since the enclosing tube will no longer contain water and the elevation of the stuffing box is above the maximum water surface elevation and packing will no longer be needed.

The existing seal/lube/cooling water configuration the water pressure remaining at the connection to the storm pump stuffing box/pump column and bowl bearings was expected to be too low under maximum operating conditions. As a result a small booster pump was used to increase the water pressure to the minimum required. Booster pumps were each selected for a rating of 10 gpm at 85 feet total head boost.

From the preliminary investigation, it appears that the existing booster pump may not be required when the storm pumps are modified to grease lubrication, but this will be verified during preliminary design.

The remaining function of the system will be cooling water for the motor thrust bearing. This function requires 8 to 9 gpm at water temperature less than 85 °F at pressure no greater than 100 psi according to the shop drawings. This cooling water requirement was discussed with Ideal Electric (motor OEM) who indicated that a pressure of 30 psi at the cooler inlet (near top of motor) is suitable for the application. Ideal acknowledged pressure could likely be even lower and not impact cooling function as long as flow rate is maintained.

Alternatives for the motor thrust bearing cooling water disposal are summarized and evaluated in Sections 4 and 5, respectively.

3.2.10 Evaluation of Storm Pump Rehab Contract Separate from Remainder of Project Work

The evaluation of separating the storm pump work from the reminder of the project as a stand-alone set of contract documents, to be bid before the reminder of the project, focused on the following:

- Feasibility to separate this work from the remainder of the project
- Potential cost efficiencies
- Potential schedule efficiencies

3.2.10.1 Scope of systems/sub-systems included in the storm pump work

The storm pump systems/sub-systems envisioned to be included in dedicated storm pump contract include the following:

- Storm pump removal, rehabilitation/modification and re-installation, including associated factory testing
- Modification of the storm pump motor thrust bearing cooling water system which will replace a portion of the cooling/seal/lube water system dedicated to each storm pump

- Revisions to the Ovation programming to accommodate new monitoring and control features for the grease lubrication system.
- Revision to Ovation programming to reflect the GLWA selected control strategy revisions to constrain rehabilitated pump operation to within AOR (outside the unstable portion of the curve). This includes revision to wet well operating range and acceptable speed range for both pump sizes.
- Electrical system revisions to provide power, and instrumentation and control (I&C) conduit and cables for the new grease lubrication system equipment and instruments for each pump.

3.2.10.2 Contract Options

The two design-bid-build delivery contract options are as follows: first, general contractor sourced contract with the pump manufacturer and other specialty contractors as subs to the general. Second, a contract direct to the pump manufacturer which would be responsible for the full scope of work. This would include several work items that are not normally furnished by the pump manufacturer resulting in several subcontractors all contracted to the pump manufacturer.

A summary of the comparison of the two contract options evaluated on qualitative basis follows:

- Pump manufacturer discussions: Pump manufacturers have indicated that they are not comfortable with the direct to GLWA contract due to being responsible for several work elements which are not their specialty. Uncertain if pump manufacturers would be willing to take on the added risk and responsibility to connect and integrate the pumps into the support systems.
- Pump manufacturer direct contract with GLWA: Based on evaluation of pumping equipment pre-purchase for a GLWA water treatment plant improvements project, focused only on the equipment, there is significant concern that the probability of not reaching consensus on terms and conditions is high which could lead to a no-bid condition for qualified manufacturers.
- Project is well suited for a general contractor to perform with multiple subcontractors and the pump manufacturer's work being the majority of the project.

Based on this evaluation summary the contract configuration which is most likely to be successful is the general contractor contract. The analysis which follows has assumed that this would be the contract arrangement.

3.2.10.3 Conceptual Cost Differential – In Overall Contract or Separate Contract

The conceptual cost differential for the work to be in the overall construction contract versus in a separate stand-alone general contractor executed contract is linked the several key factors:

- When the work would be completed (potential to save on escalation)

- Potential major savings associated present continuous operational cost: potable water, downstream of a backflow preventer, 24/7 to the cooling/seal/lube system (based on estimated average flow rate of about 15 gpm/pump observed at rotameters on ride alongs and 2023 water rate of \$13.41/1000 gallons (combined water and sewer charges) this service uses roughly 63 million gallons per year at approximate annual cost of \$846,000.)
- Assumed indirect costs for separate contract for storm pump work would be comparable to those if performed as part of the overall cost.
- Maintenance cost differential not considered given the continuous cooling/seal/lube water supply operating mode appears to have greatly limited if not stopped the maintenance demands for this water system since no longer seizing the pumps or require extensive manual intervention to return to full functionality if system were to plug or seize.
- Determined that the other LCCA factors are essentially equal between the two contract options.

On a conceptual level the cost differential would be a savings compared to incorporation in the overall contract on a qualitative basis, without consideration of the cost of preparing a separate design package or overseeing the work (resident project representative (RPR) and general services). This is based on reduced duration of operating cost for water continuously supplied to the pumps and reduced escalation.

However, the cost differential differences, which qualitatively support a separate contract, were secondary to the identified need described in Section 3.2.10.4 to begin this element of the work as soon as possible due to the overall duration required to perform the pump rehab relative to planned overall project construction schedule.

3.2.10.4 Conceptual Schedule Differential – In Overall Contract or Separate Contract

The schedule comparison of the two contract options is based upon the timing of the overall project construction phase to the estimated duration of major work tasks for the storm pump separate contract.

Several assumptions are required to compare the two schedules:

- Only one storm pump can be out of service at a time to maintain seven units available for combined sewage conveyance, if needed. As a secondary assumption, two pumps out of service at a time after the first pump was investigated. The maximum number of pumps operating in the larger wet weather events was evaluated and is summarized in TM-15.
- The overall project construction phase timing will remain as scheduled, at the time of this writing, (Notice to proceed (NTP) July 31, 2025 to completion January 31, 2029). This schedule assumption will be further reviewed as the design progresses. However, it was used as a basis for comparison to a separate contract herein.

- Several tasks required prior to starting the rehab work as a separate contract, each of which require time as follows: (design phase (assumed 9 months), bid phase (assumed 3 months), contract approval (assumed 300 days as indicated in contract))
- The major steps of the storm pump rehab/modifications for each pump will include the following (with Xylem estimated durations) with several assumptions:
 - Pump manufacturer engineering: 8 weeks
 - Submittal review phase: 10 weeks
 - Pump removal and transport: 2 weeks (1 week each)
 - Pump rehabilitation/modification (includes clean, disassemble & inspect): 26 weeks for first pump and 20 weeks for subsequent pumps (based on Xylem furnished estimates)
 - Pump factory testing: 3 weeks
 - Allowance for witness of factory testing (assume factory testing witnessed): 3 weeks
 - Pump transport and installation: 3 weeks (includes 1 week for transport)
 - Connection and testing of support systems (cooling water, electrical, I&C) assuming all work that can be done with pump removed is performed during pump rehab time: 3 weeks
 - Field commissioning (assume not wait for wet weather event to complete commissioning): 2 weeks
- Estimated total time for first pump rehabilitation/modification return to operation from Design Team NTP: 151 weeks.
- The duration for each subsequent pumps would exclude the engineering and submittal review phases resulting in estimated duration per pump of 36 weeks.
- Total estimated time for all pumps including the design, bid, contract approval and work on each pump summarized above: 403 weeks (if one pump rehabilitated/modified at a time). This duration could be reduced substantially if two pumps could be rehabilitated simultaneously. In addition, may be opportunities for factory test duration dependent on required tests and extent of witness requirements.
- The support system modifications would occur within the storm pump rehab task durations stated above to extent feasible unless indicated otherwise. Three weeks estimated for connection of support systems after pump and motor reinstalled.

- The above schedule approximation does not account for Michigan frost law transport constraints which could extend the schedule delineated above.
- The duration required if rehabilitate/modify one storm pumping unit at a time and start at end of the BOD phase (Task C) would extend beyond the scheduled construction completion date.

The above analysis demonstrates that the ability to facilitate storm pump rehabilitation/modification work item completion prior to the overall construction project would not be feasible if the work on one pump is completed prior to starting on the next without substantial extension of the planned construction schedule.

The separate contract schedule starting final design immediately after Task C completed, if two pumps are rehabilitated/modified after the first pump, was compared to the current construction schedule in TM workshop No. 2 demonstrating a time savings of approximately three months inclusive of associated assumptions. Based on the limited time savings provided coupled with the added cost of a separate contract, at TM workshop No. 2, GLWA decided not to pursue a separate contract for the storm pump work. However, identified that discussions with EGLE and other GLWA stakeholders are needed to determine if two pumps can be removed at a time as part of the BOD phase.

4.0 Description of Alternatives

Alternatives analyses were focused only on the cooling water disposal element of the storm pump rehabilitation/modification improvement item.

4.1 Storm and Sanitary Wet Well Cleaning

Not used.

4.2 Storm Pump Rehabilitation/Modification

Several alternatives were evaluated to determine the recommended method to dispose of the cooling water required to address the process needs of the motor thrust bearings. This evaluation was required due to the change from water lubricated to grease lubricated bearings which will result in the water flow path also being modified. The disposal/use of the cooling water in the existing configuration will no longer be feasible since thrust bearing cooling water will no longer be discharged to the stuffing box or enclosing tube since now filled with grease as described above.

4.2.1 Motor Thrust Bearing Cooling Water Disposal Alternatives Description and Evaluation

The following alternatives were evaluated on a technical and permitting basis to determine which would be viable and most closely aligned with the project guiding principles.

Alternative A

The possibility of discharging the spent cooling water from the motor heat exchanger to an existing pipe in the yard that conveys flow to the storm water pond in front of the pump station. It was thought that this was a reasonable solution because this water source was close to potable water with only a slight increase in temperature. However, it was assumed that this likely would be a permitting challenge to convey process utilized water to environment and thus was not developed into a full alternative.

Alternative B

For this alternative, the cooling water piping will be redirected to discharge to the process drain system on the intermediate level. The process drains are located between the storm pumps. The drains direct the collected flow to a sump pit equipped with a pump located on the intermediate level which discharges to a 6-inch sanitary pipe at elevation 98 ft.

GLWA raised concerns with the potential for the intermediate level to flood if the sump pump stops working and asked that a backup pump be provided. The accommodation of the second pump was discussed at TM workshop No. 2 on April 19, 2023 and then further with operations at follow-up meeting to the workshop on May 3, 2023. It was agreed that a spare pump would be provided above the sump pit, connected to the sump pump discharge piping to operate only if triggered by a flood condition. This improvement would also include a level sensor to alert if the level is above the sump pit meaning the duty pump is not functioning properly.

The existing sump pump (P-3) is rated at 40 gpm and is listed as ½ horsepower according to record drawings. The sump is 5-ft diameter and serves the process drain system for all eight storm pumps. The existing sump pump will require replacement with a new unit rated preliminarily at 63 gpm at 18 ft total head. It is expected that a submersible pump is commercially available for that rating with no more than 1 horsepower motor. It appears that a Hydromatic SPX50 is a viable selection for these conditions.

Alternative C

This alternative is similar to alternative B except that the 1-inch pipe would be directed to the floor drain system in the motor room level. The advantage to Alternative B is that the water is discharged by gravity at the motor room level and no modifications would be required to the sump pump system. The concern with this option is that there are only four process drains (PDs) on the motor room floor, and they are in areas that are presently being used by GLWA for other tasks including storage with the drain piping interfering with those functions. In addition, the configuration of the PDs in this floor are not adapted to continuous process drainage and spillage out of the drain inlet is anticipated. Using the existing PDs near each pump on the intermediate level makes more sense since the intermediate level is not a multi-functional space.

Alternative D

Alternative D evaluated in concept if possible to use the existing motor thrust bearing heat exchanger and existing cooling water booster pump with eight motor-dedicated new appropriately sized radiators with electric motor driven fan to dissipate the heat from each storm pump motor thrust bearing. In this option the secondary water supply would be replaced with a water and corrosion inhibitor or ethylene glycol mixture that would be recirculated in much the way automobile engines are cooled. This alternative was not fully developed due to concerns with conflicts with project guiding principles including reducing maintenance, simplifying operation, and enhancing reliability for a pumping system with limited run time. Additionally, this concept appeared to be significantly more complex than the other alternatives, thus not desirable. Further, the waste heat would have been blown into the motor room which could be detrimental at certain times of the year.

5.0 Alternatives Analysis

5.1 Storm and Sanitary Wet Well Cleaning

Not used.

5.2 Storm Pump Rehabilitation/Modification

5.2.1 Motor Thrust Bearing Cooling Water Disposal Alternatives Evaluation

The evaluation of motor thrust bearing cooling water disposal was covered in part in the description of the alternatives in Section 4.0. Based on the evaluation summary, the recommended alternative storm pump dedicated cooling water system modification is Alternative B (water discharge to intermediate level sump pit and pumped to sanitary pipeline for disposal at WRRF) given its alignment with guiding principles with focus on reliability, simplicity and maintenance minimization.

If the cooling water booster pumps are determined to no longer be required, the cooling water system will be redesigned and significantly simplified. Confirmation of minimum potable water system pressure is required to determine if booster pumps will no longer be needed. This will be determined in preliminary design phase.

6.0 Life Cycle Cost Analysis

Not used.

7.0 Recommendations and Key Decisions

The major recommendations for the wet well cleaning and storm pump rehab are summarized in this section. Greater detail is provided in the preceding sections.

7.1 Storm and Sanitary Wet Well Cleaning

Near-term: In the final design phase a wet well cleaning specification will be developed to define the requirements for cleaning the two storm and two sanitary wet wells as part of this project.

Long-term: Also in the final design phase a SOP will be developed to incorporate the storm wet well flushing system/sanitary pump operation cleaning after each wet weather event as well as the intermittent cleaning procedures which will require staff entry and the use of supplemental portable equipment to conduct the cleaning.

7.2 Storm Pump Rehabilitation/Modification

The following pump manufacturers are recommended to be listed in the storm pump rehabilitation specification: Johnston/Sulzer, Xylem Flygt AC-Custom Pump and Fairbanks Nijhuis.

Recommended scope of rehabilitation includes replacement of the shaft sleeves, line shaft bearings and bowl bearings.

Recommend proceeding with grease lubrication system which is technically feasible for the application.

Recommended scope of grease lubrication system to consist of:

- Dedicated lubrication system for each storm pump
- Grease line to each line shaft and bowl bearing
- Food grade grease
- Inclusion of the existing grease lubricated bearing between the stuffing box and the motor
- Recommend reconfigure cooling water system for motor thrust bearing to be connected to the intermediate level PD system and replace the sump pump to meet new conditions of service.

Recommended to provide a dedicated grease lube system to each storm pump based on evaluation above and GLWA experience.

Recommended the storm pump motor level as the preferred location for further evaluation in the next phase based on the number of units selected and the application specific footprint to be developed in further collaboration with GLWA.

Recommended the storm pump bearing located between the discharge head and the motor be connected to the lubrication system for system simplicity, higher reliability and centralized maintenance and a common lubricant for all pump bearings.

Recommend proceeding with a separate contract for the storm pump rehab due to the construction phase duration being insufficient to incorporate the time required to perform the work.

7.3 Key Decisions

Key decisions made during the course of review and presentation of this Technical Memorandum are as follows:

- Sanitary pumps will not be utilized during the cleaning process performed by outside contractor as part of the construction contract.
- Storm pump improvements: One grease lube system per storm pump; grease lube systems located on motor room level; connect the one existing grease lube bearing to the new grease lube system; and cooling water disposal alternative acceptable but will require sump pump backup included in Next Steps section.
- Storm pump rehabilitation/modification to be performed in one construction contract. Need to include time limits and statements to provide submittals in a limited time from notice to proceed and remove first storm pump as soon as possible and rehab two pumps at a time (two pumps at a time requires other stakeholder buy-in as included in the Next Steps section).
- GLWA noted agree with CDM Smith recommendations for pump manufacturers to list for pump rehab/modification.

8.0 Next Steps

The items which require advancement/further development as the design process advances include the following:

8.1 Storm and Sanitary Wet Well Cleaning

- Determine if watertight door access will be permissible for the contractor's cleaning activities based on input from GLWA.
- During the BOD phase, discuss the recently completed storm and sanitary wet well cleaning performed by Pullman and WSI to understand methods and constraints based on their experiences.
- Consider how include cleanup of the upstream pinch valve area to minimize the need for additional cleaning required for the work in this area in the overall cleaning specification.

8.2 Storm Pump Rehabilitation/Modification

- Obtain grease lubrication system application specific sketches from Farval. Incorporate opening up (particularly electrical/control panels) configuration somewhat to enhance access over a standard baseplate mounted system.
- Provide a list of the common maintenance requirements to GLWA operations to allow understanding as requested during workshop held on February 13, 2023.

- Further discussion of the degree of automatic operation of the grease lubrication system either as a primary lubrication step or as a back-up to manually initiated lubrication cycle conducted on a regular time interval.
- Determine if a hold point will be required at the factory to allow inspection of the new components prior to installation due to inability to inspect after assembled as noted by GLWA staff in the February 20, 2023 meeting.
- Further evaluate required maintenance access to the storm pump discharge head and motor in collaboration with GLWA to determine the locations where the new grease lube system could be located.
- Further develop the design concept for seal at bottom of enclosing tube including discussions with specialty seal manufacturers.
- Investigate risk of storm pump seals drying out in the enclosing tube if pumps are off for several months coupled with materials selection to minimize the potential for the resultant seal damage to occur.
- Determine recommended line shaft bearing, bowl bearing and shaft sleeve materials of construction.
- Determine the focus areas of required storm pump factory testing. In particular is a performance test warranted when no change to the hydraulic design.
- Determine if two storm pumps can be removed simultaneously for rehabilitation/modification based on coordination to be completed with EGLE and GLWA.
- Further evaluate how to expedite the storm pump rehabilitation/modification work. As part of this evaluation gather information regarding number of pumps simultaneous operating for the larger events.
- Obtain product data for furnished sump pump in intermediate level sump pit.
- On the intermediate level of the storm pump station, incorporate a second sump pump located above the sump to serve as an emergency backup to the new pump which will replace the existing sump pump.
- Investigate minimum potable water pressure for this portion of the distribution system to determine if existing cooling water booster pump could be removed. This includes the ongoing coordination for the concept and device recommended by design team and GLWA acquiring and installing the pressure monitoring/recording equipment.

- All new and/or modified process mechanical loads will be coordinated with electrical to verify available power system capacity, available voltages, and location of starter/VFD/breaker needed for each piece of equipment.

Appendices

Appendix A – ST-5 Pump Component Condition Report Prepared by Kennedy Industries for GLWA dated May 9, 2022

Appendix A

ST-5 Pump Component Condition Report

Prepared by Kennedy Industries for GLWA dated
May 9, 2022



May 9, 2022

Mr. Tom Hall
LGC Global
Oakwood CSO basin
12082 Pleasant Street
Detroit, MI 48217

RE: Allis Chalmers 88X72 WCA Oakwood CSO Position 5 Sanitary Pump
Serial Number: 1-0842-70285-04
Customer Reference Order #:
Kennedy Industries #: 114796

Mr. Hall:

Attached are photos with descriptions of the parts in need of repair or replacement. If you have any questions, please do not hesitate to contact us.

Sincerely,

Mike Horn

Repair Center Manager
KENNEDY INDUSTRIES, INC.

PUMP



- Pump at Kennedy facilities.

IMPELLER



- Impeller is in good condition and will be reused.

SHAFTS



- Intermediate shaft T.I.R. is 0.002" and within specification.
- Head shaft T.I.R. is 0.003" and within specification.
- Both shafts are in good condition and will be reused.

DIFFUSER



- Register to diffuser bowl ID clearance is 0.010" and within specification.
- Diffuser is in good condition and will be reused.

UPPER BEARING



- Inside of upper bearing is plugged with hard product.
- Bearings will be replaced with upgraded bronze-backed, cutless bearings to restore proper operating clearance.

LOWER BEARING



- Lower bearing will be replaced with upgraded bronze-backed cutless bearing to restore proper operating clearance.

ENCLOSING TUBE



- Tube was cut at removal.
- Weld and blend to restore surface conditions.

STUFFING BOX



- Stuffing box is worn.
- New stuffing box bearing will be manufactured and installed to restore proper operating clearance.

STUFFING BOX BEARING SLEEVE / PACKING SLEEVE



- Sleeves are worn and pitted.
- Sleeves will be machined to restore concentricity and proper surface finish.

SPYDER BEARING SLEEVE



- Spyder bearing sleeve is worn and pitted.
- Sleeve will be machined to restore concentricity and proper surface finish.

LOWER BOWL SLEEVE



- Lower bowl sleeve shows minimal wear.
- Sleeve will be machined to restore proper concentricity.



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Julie Aichler, CDM Smith
Steve Fehniger, CDM Smith*

Date: June 1, 2023

*Subject: TM-4 Oakwood Screw Conveyor & Grinder System Modifications (OKW-SCR-2)
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

The screen facility at the Oakwood Combined Sewer Overflow (CSO) Retention Treatment Basin (RTB), is equipped with a screenings grinder/washer/compactor (referred to as the grinder), located in the screenings collection room. The grinder receives the screenings and a large quantity of washwater which is conveyed from the perforated plate screens to the grinder via the shaftless screw conveyor.

The following are recommended improvements or alternatives to address the issues the Oakwood screenings system:

- Maintain washwater pressure at approximately 110 psi at the screens. Modify conveyor to add three drain sections (drain boxes)
- Continue to utilize existing grinder with modified discharge tube (as presently configured)

The system evaluation and alternatives analysis performed to arrive at these recommendations was focused on evaluating the existing screenings handling system components to identify feasible alternatives which address the goals of the task:

- Goal 1: Reduce amount of water flowing into grinder or dumpster when screenings grinder is off-line
- Goal 2: Address problems with grinder/washer/compactor (grinder) discharge tube clogging between events to improve reliability and reduce the time that the grinder is off-line during events

The evaluation was focused on meeting these two goals while being directed by the project guiding principles. In particular the following: reducing operation and/or maintenance required, providing

equipment which is accessible and easy to maintain, equipment selection to accommodate intermittent use, and maintain operation of Oakwood throughout the construction phase.

1.0 Introduction and Purpose

The screen facility at the Oakwood RTB is equipped with a screenings grinder/washer/compactor (referred to as the grinder), located in the screenings collection room. The screenings grinder receives the screenings and a large quantity of washwater which is conveyed from the perforated plate screens to the grinder via the shaftless screw conveyor. The screenings grinder had an inclined discharge tube to provide retention time and dewatering of the ground, washed screenings, as originally configured. The discharge tube was prone to clogging when the solids would dry and harden between storm events, preventing the equipment from working properly in subsequent storm events.

The screenings grinder can be manually repositioned away from the conveyor discharge chute by sliding it on the trolley and rail system, when not in use. When the grinder is moved to its off-line position, the screenings and washwater discharge freely to the dumpster below via a portable vertical chute section. The shaftless screw conveyor is designed with a tight seal between the conveyor spiral and liner, and no means of draining the water other than at the low point which does not receive much drainage. Therefore, the water is conveyed to the outlet and causes a significant amount of water to fall into the dumpster and floor on the lower level of the screenings collection room if grinder in off-line position.

The goals of this task are focused on addressing the two main operational challenges described above:

- Goal 1: Reduce amount of water flowing into grinder or dumpster when screenings grinder is off-line
- Goal 2: Address problems with grinder/washer/compactor (grinder) discharge tube clogging between events to improve reliability and reduce the time that the grinder is off-line during events

The following evaluations and investigations were performed during the study phase in an effort to address the goals above (in order of process flow):

- Evaluate potential to reduce the amount of washwater used at each screen (linked to Goal 1)
- Evaluate modifications to screw conveyor to reduce the amount of water conveyed to grinder (Goal 1)
- Evaluate existing grinder operation w/ modified, horizontal discharge tube (Goal 2)
- Investigate potential alternative washer/compactor equipment (Goal 2)

- Washer/compactor performance goals – no free water; more reliable; less maintenance

The remainder of this tech memo is organized as follows:

- Section 2 describes the Oakwood screenings handling system in greater detail.
- Section 3 provides information on evaluations performed to understand present operations and address the goals above.
- Sections 4 and 5 present the alternatives developed and evaluation of those alternatives to meet the goals of this task.
- The life cycle cost analysis (LCCA) is presented in Section 6 for alternatives that are deemed technically feasible and anticipated to address the goals and where there is some anticipated cost difference that can be quantified given specific assumptions about future operations.
- Finally, the recommendations for which alternative(s) should move forward into detailed design are summarized in Section 7.

2.0 Existing Oakwood Screenings Handling System Description

The screening removal and handling system at Oakwood CSO RTB, consists of six, 6-mm perforated plate screens, the shaftless screw conveyor, the grinder, and screenings dumpster. The general system description as summarized in the Oakwood Operations & Maintenance (O & M) Overview Manual follows. During storm pump operations, all six of the perforated plate screens are running and rotating at their maximum speed. Stormwater flows pass through the screening plates, into the Screen Outlet Chamber. Screened material collected by the screens is washed off using a combination of high-pressure spray water and a beater brush. The screenings and washwater discharge from the screen into a shaftless screw conveyor. The screw conveyor carries the screenings to the grinder which grinds the screenings to a smaller size and then washes and dewateres the screenings prior to discharging through a chute into a dumpster. In certain circumstance, such as when the grinder is out of service, the screenings can be discharged directly from the screw conveyor into a portable vertical chute and into the awaiting dumpster. These process elements are shown in **Figures 2-1** and **2-2**, provided for reference regarding the screen facility layout and general configuration.

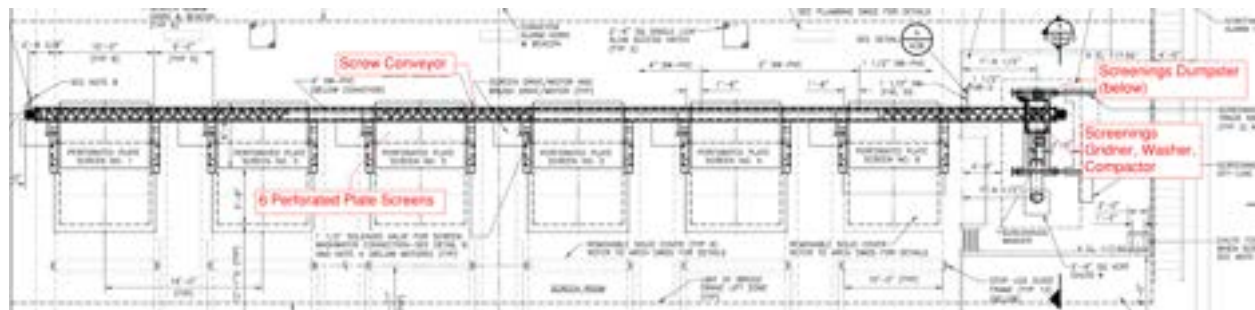


Figure 2-1

Excerpt of Screen Facility Record Drawing - Plan

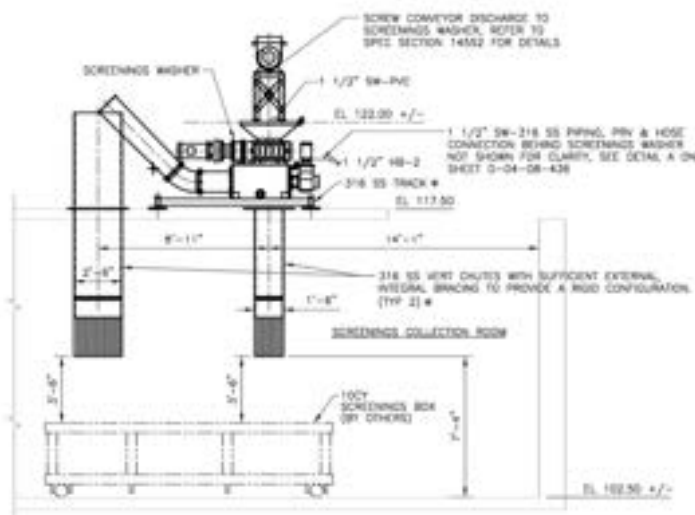


Figure 2-2

Excerpt of Screenings Collection Room Record Drawing - Section

2.1 Screen Washwater

The screens are cleaned as they rotate during operation by a motorized polypropylene bristle brush. After passing the brush, the screen plates are cleaned by a bi-directional spray wash constructed of stainless steel with brass nozzles. There are two spray bars with a total of 34 nozzles which clean the perforated plates of each screen. The design washwater pressure of 100 psi at the screen, is supplied by the secondary water high-pressure piping and duplex booster pump system located in the screen facility mechanical room. The maximum secondary water flow rate to each screen washwater system is designed to be 22 gpm. There is a 4-inch secondary water pipe that is routed below the conveyor and provides water to the washwater supply piping at each screen. Photographs of the booster pump system and the typical washwater supply piping are provided in **Figures 2-3** and **2-4**.

The pressure of the booster pump discharge to the high-pressure water system is controlled by a Pressure Reducing Valve (PRV) with a pressure setting range of 30 to 300 psi, which is set by positioning the pressure adjusting screw. The inlet pressure to each perforated plate screen spray bar can be fine-tuned by adjusting a “circuit setter” valve, also referred to by GLWA operators as a “dial” valve at the base of the washwater supply piping to each screen. There is a pressure gauge located on the washwater piping immediately upstream of the spray bars which indicates the water pressure provided to spray nozzles for cleaning each screen.



Figure 2-3
Oakwood Screen Facility Booster Pump System



Figure 2-4
Typical Screen Washwater Piping

2.2 Screw Conveyor

Two shaftless double spiral type screw conveyors work in unison (one pull and one push end to end in a common trough) to collect screenings falling off the perforated screens when in operation. The conveyor is located on the north side of the screens under the screen discharge chutes. The conveyor move the discharged screenings from the screens into the grinder or into the alternate chute bypassing the grinder.

The conveyor was specified to convey 250 cubic feet/hour of screenings material and washwater with 30% of the trough full, but according to the shop drawing can convey up to 312 cubic feet/hour with the trough 30% full. The troughs are U-troughs with integral flanges made of 316L stainless steel. There is a separate 6-inch flanged drainage outlet at the low end connected to a

drainpipe. See **Figure 2-5** for an overview photo of the conveyor. Screenings and washwater are discharged from the conveyor directly into the screenings washer hopper as described above.

The wear liner for the shaftless screw conveyor is made from ultra-high molecular weight polyethylene (UHMW-PE) and is replaceable. The liner is 12 mm thick, formed of two bonded layers, each of a different color (red and yellow), to provide a visible indication of when the liner is nearing the end of its useful life (replace when yellow inner liner is showing). The liner extends the full length of the trough, covering the entire semicircular bottom portion of the trough. The wear liner is inserted into the trough in 4-foot sections to provide ease of replacement. The liner is fastened to the trough using Type 316L stainless steel retaining clips welded to the trough.



Figure 2-5
Screw Conveyor

2.3 Screenings Grinder

The grinder is a self-contained, hopper fed system used to grind, wash, compact and dewater screenings that have been captured by the six Perforated Plate Screens during operation. The existing equipment is the JWC Washer Monster, Model SWM4018.

Once fed into the hopper the screenings are pulled into and through a grinder to reduce the size of the screenings. The ground solids are then passed through the auger, where water spray nozzles wash and separate the soft organics from the undesirable solids. The solids are compacted, dewatered and finally discharged as a cake from the discharge tube into dumpster below. The screenings grinder is designed to process up to 150 cubic feet/hour of wet screenings.

The grinder is made up of the inlet hopper, grinders, tank, trough, auger, and transport segment casing (discharge tube). The electric motors for the grinder and auger are explosion proof (Class I, Division 2, Group D) design, operating on 460 Volt, 3 Phase, 60 Hz power, requiring 10 HP for the grinder and 3 HP for the auger.

The inlet hopper is constructed from Type 316L Stainless Steel. The hopper has built in supports for the spray wash system. The inlet hopper is positioned under the screw conveyor to allow screenings to fall into the inlet hopper and a neoprene skirt is provided on the discharge of the conveyor to help prevent spilling out onto the floor.

A spray wash system provides wash water to clean the walls of the hopper. Explosion proof solenoid valves are used to control the spray wash water supply. A manual isolation ball valve is located on the wash water supply line to shut off or regulate the flow of wash water to the spray wash system. A bypass pipe is routed around the solenoid valve, with a manual ball valve to allow manual water flow to the spray wash system if the solenoid fails to open. Presently the manual isolation ball valve on the washwater supply line is closed. The water that is conveyed to the grinder from the screens is sufficient to keep screenings moving through the hopper and passively washing the screenings as it passes through the auger section to the drain.

The tank (auger/washer enclosure) has a 4-inch NPT drain with a 4-inch flush port. The tank is designed to allow it to be lifted from the system by the bridge crane and/or by forklift or similar devices. The tank has an inspection cover for access to the auger. The trough is a replaceable, Type 316L stainless steel assembly. The perforations in the trough are 0.25-in (6 mm). These perforations allow the screenings to dewater and separate liquids and soft organics from the solids as the screenings are washed and conveyed.

The auger spiral is made of a high wear-resistant, alloy steel. The outer edge of the upper portion of the spiral has a replaceable brush/wiper that cleans the perforations and protects the screen trough from excessive wear.

As of the spring of 2022 the grinder discharge tube was reconfigured to eliminate the 45-degree elbow/bend at the auger outlet and is oriented horizontally, as shown in **Figure 2-6**. This modification was fabricated to eliminate or reduce clogging of the discharge tube between events. Prior to 2022, the grinder was in the off-line position for an unknown duration but is assumed to be several years as operators could not recall how many years ago it was taken offline. The grinder is also assumed to have very few operating hours, relative to the age of Oakwood. The evaluation of grinder operation in this configuration is discussed in Section 3 and Section 5.



Figure 2-6
Grinder Configuration as of 11/27/22

3.0 System Evaluation

The Design Team performed five separate ride-along site visits during storm pumping events between late October 2022 and January 2023. Observations and data were collected during these visits to improve understanding of the screenings handling system operation and gain information from the operations staff at the facility, as summarized in this section for each of component of the screenings collection system. These site visits were also valuable to gain insights for the evaluation of alternatives as described in Section 5.

3.1 System Operation - Runtime

Three years of operating data was also acquired from the Ovation system, covering a period from September 2019 through October 2022. The screw conveyor running/not running data was used as an indication for when the storm pumps and screen facility were in operation. Analysis of this data showed that there were 112 operating events for the Oakwood Screen Facility or about 35 events per year on average. Event durations vary based on duration and intensity of the rainfall/snow melt that triggers the event, but often consist of periods during the storm event when operation cycles (starts/stops) as the storm wet well is drawn down and then fills. Since this analysis was focused on the screen facility operation, the storm events were not distinguished between those that resulted in discharge to the river and those that were storage only. The end of one event and start of another was characterized by at least 24 hours between shutdown and the next startup of the screw conveyor. Based on the total conveyor runtime of 1365 hours (about 57 days total) during the period of 3.2 years analyzed and the number of events identified, the overall average operating

time per event was approximately 12 hours. Utilizing the run time of the conveyor in this analysis was an overestimation of the storm pump and perforated plate screen operating time because it includes approximately 10 times (approximately 48 hours runtime) per year that the conveyor is running while the chutes from the screens and conveyor are being cleaned between storm events. However, it is a good approximation of the conveyor operating time and grinder operating time. This information will be utilized in the Alternatives Analysis and Life Cycle Cost Analysis provided in Sections 5 and 6.

3.2 Screen Washwater Pressure and Estimated Volume

The Design Team observed the screen washwater pressure as indicated by the pressure gauge located at each screen during several ride along events. The operating pressure at the screen is typically maintained close to 110 psi by the operators. They make adjustments to the pressure at each screen periodically by adjusting the dial valve at the bottom of the washwater feed piping at each screen. Screen #4 is operating at a slightly lower pressure due to the conditions of service for the replacement solenoid valve located at that screen. The operators indicated that they keep the pressure at screen #4 to 100 psi or less. The pressure observed on that screen was about 80 psi for three events (10/31/22, 11/27/22, 12/15/22), and about 100 psi for two events (12/30/22 and 1/19/23). The observed pressure at the other screens during all events ranged from 108-112 psi, except for Screen #1 which is at 120 psi. Screen #1 is likely experiencing a higher pressure because it is the first screen downstream of the booster pumps.

The perforated plate screen manufacturer, Andritz, provided information regarding the washwater flow rates predicted for each nozzle on the spray bars based on the nozzle geometry (orifice diameter and spray angle) and washwater pressure. As indicated in Section 2, there are 34 nozzles per perforated plate screen. **Table 3-1** provides a summary of the estimated washwater volume per screen with the existing nozzles, which are 0.05-in orifice diameter with 50-degree spray angle, at various pressures from 70 psi to 110 psi.

Table 3-1 Screen Washwater – Estimated Flow Rate per Screen at various Washwater Pressures

Washwater Pressure	70 psi	80 psi (Screen #4)	100 psi (design pressure)	110 psi (present operation)
Existing Nozzles (0.05 in)	18 gpm	19.4 gpm	21.4 gpm	22.3 gpm

3.2 Screen Field Observations

During several of the ride-along site visits observations were made during and after storm pumping and perforated plate screen operation. The purpose of these observations were to:

- Characterize the type and amount of screenings collected by the screens during operation
- Investigate the effectiveness of the screen cleaning mechanisms and washwater at cleaning the screen field during and at the end of storm pumping/screen operation

Observations of screenings on the front of screens indicates a fair amount of leaves and debris consisting mostly of small food wrappers, a few tissues/rags, a few identifiable sanitary trash items which are removed from the storm flow and carried up by the perforated plate screens. No large objects and not an overwhelming amount of leaves, were observed. Grit and fine particles were also carried up by the screens in between perforations. **Figure 3-1** provides a photograph as an example of the screenings collection observed during the ride-alongs.

During all the storm events during the study phase only one storm pump was operating at a time. Operators were also asked for their recollection and description of the typical screenings collected and they also indicated some small grit and dirt, small debris and leaves. They noted no large objects, but do see a lot of leaves, at times, presumably during a large rain event in fall.



Figure 3-1

Screen #2 while Storm pump #8 (ST-8) running (largest amount of screenings observed)

The Design Team attempted to assess the effectiveness of the screen washwater and brush at cleaning the screens through observations made while the screens were in operation and based on how clean the screens were after storm pumping stopped and the screens were shutdown. For the events where observations were made on all the screens and Screen #4 had washwater pressure at 80 psi, there were no differences noted between the cleaning of the other screens and Screen #4, when observing the front of the screen after the final cleaning cycle. Based on the limited debris on the screens during operation it could be assumed that the screens are being relatively well cleaned during each rotation, however, this may not account for passive cleaning taking place when the screen field is lowered down into the process flow on the downstream side of the screen. Therefore,

further evaluation is required to assess if the lower washwater pressure is cleaning the screen as effectively as the higher pressure washwater before reintroduced into the process flow. This assessment was performed during additional ride along events in February-March 2023 and is summarized in Section 5.1.

After the storm pumps stop running, the screens will run for an additional 5 minutes if they are in remote/automatic mode. If they are running in remote/manual then the operator will stop each screen manually from the control room but should still be allowing for some run-time after the pumps stop for the screens to see at least one full rotation or more for cleaning. While Screen #4 was observed during operation with 80 psi washwater pressure during three events, there was only one event (12/15/22) where it was observed after operation stopped. During this event, the screen field was sufficiently cleaned similar to other screens after operation stopped and is shown in **Figure 3-2**. The cleaning was also observed on 12/30/22 and 1/19/23, but the washwater pressure on Screen #4 was adjusted to approximately 100 psi during these events. Screen field cleaning was confirmed to be effective at that pressure as observed, however the uncertainty regarding passive cleaning by the process flow on the downstream side of the screen requires further evaluation.



Figure 3-2
Clean Screen #4 after Operation Stopped on 12/15/22

3.3 Conveyor Operation

Observations of the screw conveyor operation during field visits included opening the hinged covers, after Great Lakes Water Authority (GLWA) operators removed the bolts from the cover plates, over the drain section at the low end of the conveyor and over the section near the discharge end, between Screens #4 and #6.

The observations of the drain section included:

- Accumulated debris – likely due to brush wear and minimal brush contact due to flights being higher close to drive (alignment not allowing brush contact with perforated plate)
- During operation little/no water flowing back to low point drain section (**Figure 3-3**)



Figure 3-3
Inside conveyor at drain section during operation

Observation of the conveyor section between Screens #4 and #6 showed the following:

- Confirmed significant amount of water conveyed to discharge end of conveyor
- Water and screenings moved forward well and not wrapping or accumulating on the spiral (**Figure 3-4**)
- At this location of the conveyor, it is full to nearly the top of the liner during operation
- Spiral and liner are in good condition. Liner shows some wear from the spiral but is not showing indication of wearing through the top layer.



Figure 3-4
Inside operating conveyor between Screens #4 and #6 during wet weather event

3.4 Screenings Grinder Operation

The grinder was offline for many years due to screenings hardening in the discharge tube between storm pumping events resulting in the grinder being unable to push the plug of hardened, compacted, dried screenings out during the next event. Under the CS-299 CSO Facilities Needs Assessment project, technical representatives from JWC, the equipment manufacturer, assessed the conditions of the grinder/washer/compactor in October 2020. They found that the unit was operational, and was in very good condition since it had low runtime. To reduce the possibility of clogging they suggested changing the discharge tube elbow to 11 degrees to create a reduced inclination angle. In the CS-299 report a modification of the discharge tube to horizontal was recommended. The JWC field report also indicated that the water supplied to the hopper above the grinder could be turned off. With the amount of water that is coming in from the conveyor, the additional water to prevent screenings from accumulating on the sides of the hopper was deemed unnecessary.

In the spring of 2022, GLWA modified the discharge tube to a horizontal configuration as described in Section 2. GLWA also turned off the water feed to both the hopper and the washer/auger section of the grinder so that just the water from the conveyor was passing through the grinder to the drain.

Based on operator interviews at the start of this project, the grinder was identified to be working well and the horizontal discharge tube configuration is providing sufficient dewatering and is not clogging between events. Sufficient dewatering in this situation is defined by absence of any free water flowing or dripping from the end of the discharge tube. When the modification was made to the horizontal discharge tube, the initial configuration had the outlet end/opening facing the side. This did cause a problem where dewatered screenings that dried and hardened at the end of the tube between events would push out of the tube and against the side of the discharge chute with enough force to move the grinder out of alignment with the conveyor discharge. The Design Team observed the grinder in operation during an event where this occurred (11/27/22). The end of the discharge tube was adjusted to open generally downward shortly after this event. See **Figure 3-5** for present grinder configuration.

Observations made after the discharge tube end was modified to generally downward show that:

- No free water is present (no water going into the dumpster below) when the water supply to the grinder is off (only processing the screening washwater from the conveyor)
- Screenings falling away in smaller clumps and there is no longer a problem with the grinder being pushed out of alignment

There has been limited time between events in the present configuration, however it appears that the grinder is working well and has been reliable in this configuration. Additional observations should be made in coming months if there is an opportunity with a longer idle time, greater than the 2 to 3 weeks between events observed after the modification.



Figure 3-5
Grinder Discharge Tube with Outlet Facing Down (present configuration)

3.5 Future Screenings Production Estimate

The Design Team calculated an estimate of the screenings produced from the existing 6 mm perforated plate screens based on design storm total treated volumes under current collection system conditions and future collection system conditions, after the proposed Oakwood District Intercommunity Relief Sewer (ODIRS) is completed. The screenings volume estimations in **Table 3-2** are based on the estimated screenings removal rate for 6 mm perforated plate screens of 1-3 ft³/MG as described in the GLWA Wastewater Master Plan Report TM-5a.

- The estimated screenings production under existing conditions are well within the storage capacity of the existing 10 cubic yard (CY) dumpster.
- The estimated screenings removed from the treated design storm volume at Oakwood for future collection system configuration would be up to 5.5 times greater than the current volume.
- The estimated screenings volume after compaction for the future 10-year, 24-hour storm event is about 5-17 CY.
- Depending on the storm event characteristics, the future screenings volume may fill one 10 CY dumpster. It is recommended that GLWA consider the staff needed as well as additional dumpster and dumpster moving equipment that may need to be on-site and available to reposition the dumpster(s) under the discharge chute during storm events. Alternatively, equip the facility with 20 CY dumpster and provide equipment on site to shift the dumpster position as needed during event to fill the dumpster across a greater percentage of the surface area and minimize screenings falling out of the dumpster.

Table 3-2 Estimated Screenings Production at OKW Before and After ODIRS Constructed Based on 1-3 cf/MG (for Raw-Wet Screenings)

Design Storm	Raw Wet Screenings Estimate			Compacted Screenings Estimate ²
	Total Treated Volume, MG ¹	Lower Limit, ft ³ (CY)	Upper Limit, ft ³ (CY)	Lower – Upper Limit, CY
10-year, 24-hour (design peak wet weather event)				
Current Collection System Configuration	80.5	80.5 (3)	242 (9)	1.2-3.6
Future Collection System Configuration	368	368 (14)	1,105 (41)	5.5-16.4
6-month, 24-hour (design average wet weather event)				
Current Collection System Configuration	16.5	16.5 (1)	49.5 (2)	0.4-0.8
Future Collection System Configuration	92	92 (3)	277 (10)	1.2-4

¹Volume per CSO Improvements Project TM-20 Table 3-3: Increase in Storm Volumes for Future Collection System Conditions for Oakwood and Leib

²Based on WWMP estimated screenings volume reduction of 60% through a washer/compactor.

4.0 Description of Alternatives

Alternatives were developed for each of the screenings handling system components to address the task goals of reducing the amount of water conveyed to the grinder and improving the reliability of the grinder operation by reducing or eliminating issues with screenings clogging the discharge tube between events. Discussion of advantages and disadvantages for the feasible alternatives is provided in Section 5.

The alternatives for reducing the amount of water conveyed to the screenings grinder are limited to modifications that could be made to the existing screens and conveyor. This equipment is overall in good working condition and not planned for replacement.

4.1 Screen Washwater Reduction

The perforated plate screens use high-pressure washwater applied through a series of spray nozzles, along with a rotating brush, to clean the screen field as it rotates during operation and for a given duration after storm pumping stops. As shown in **Table 3-1**, the present configuration and operation of the perforated plate screens utilizes approximately 22.3 gpm per screen.

The Design Team contacted the screen manufacturer, Andritz, to inquire whether there were any advancements in the design of the screens or cleaning mechanisms, since the time the Oakwood screens were manufactured, that would allow for a reduction in the amount of washwater required for cleaning. They indicated that the design has not changed. The options that they provided for reducing the amount of water applied to the screens were to:

- Reduce the pressure of the water feed to the spray nozzles, which would reduce the volume of water that can pass through the fixed nozzle orifice
- Replace the nozzles with ones with a smaller orifice size, which would also reduce the volume of water that can pass through the nozzle orifice, but at the original water pressure.

With either option Andritz recommended a trial period for evaluating if the screens are being sufficiently cleaned after modification.

For example, this would mean replacing the nozzles on one screen first to evaluate how well it cleaned and then completing the replacement on the other screens. The pressure reduction could be evaluated by adjusting the valve at one screen or several screens for evaluation before making the lower pressure the standard operation for the facility.

Andritz provided a data sheet for the spray nozzles used in the perforated plate screens which showed the expected flow rate per nozzle based on size and pressure. Some interpolation was required to estimate the flow rates at the desired pressures, so the flow rates are approximate. Estimated flow rates for the total flow at each screen using the existing nozzles are shown in **Table 3-1**. If the pressure is reduced to 80 psi the washwater utilized at one screen would be reduced from 22.3 gpm (at 110 psi) to 19.4 gpm, saving about 3 gpm per screen or 15% reduction in

washwater. If the nozzles were replaced with nozzles of the next smaller orifice size, and the feed pressure was reduced to the original design pressure of 100 psi, the water use per screen would be about 16 gpm.

Evaluation of the effect of potential changes in washwater flow rate on the booster pump system is provided in Section 5.

4.2 Screw Conveyor Modification

Alternatives for reducing the amount of water conveyed to the grinder by modifying the screw conveyor were investigated by the Design Team. Based on discussion with the screw conveyor manufacturer, Spirac, and Design Team technical staff concerning other recent perforated plate screen and screw conveyor installations, the only alternative identified was to install additional drainage sections along the length of the conveyor. As noted in Section 3, there is little to no water draining back past the spiral to the existing drain section at the low end (upstream of all the screens) of the conveyor. It is now more common for the conveyor to be configured with a drain box, similar to the existing one, at a location beyond the screens where more water is present in the conveyed material.

Spirac has recommended adding three drain boxes to the existing conveyor as shown in **Figure 4-1**. Spirac would provide the parts for the drain boxes including the 316 SS perforated plate with 5mm holes for the trough, drainage collection box and 6-inch flanged drain outlet, and brushes to attach to the spiral at each drain section to clean the perforations as the screw rotates. New 6-inch PVC drainpipes would be routed to new openings to the screen outlet channel below the floor to discharge the drained water. These are shown conceptually from the drain boxes screen channels in **Figure 4-1**.

The installation would be performed by a local contractor with certification to weld and passivate 316 stainless steel. A manufacturer's representative could also be present in the field to provide guidance and instruction at the start of the retrofit process or for the entire duration. The drain box installation could be performed during dry weather and completed within approximately three days for all three drain boxes.

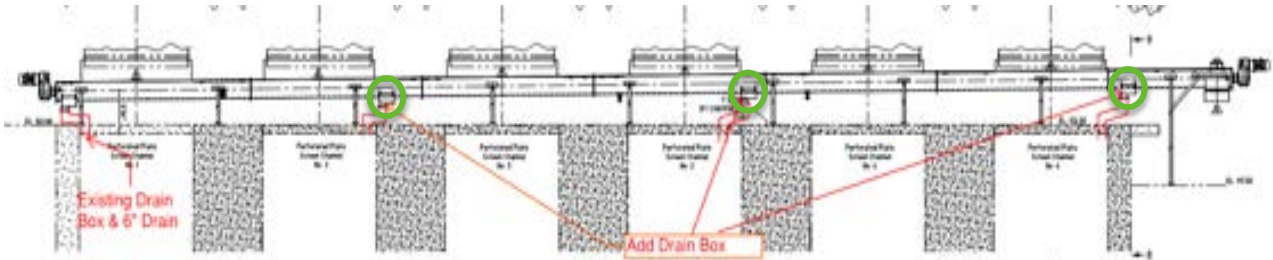


Figure 4-1
Conveyor Additional Drain Sections – Conceptual Layout (Drawing background: Spirac Shop Drawing)

The description of the drain box installation process from Spirac is:

- Empty the conveyor of all screenings
- Disconnect power supply to the conveyor
- Lift the spiral
- Cut the section of the conveyor and liner out for installation of the drain box—same dimension as the drain box
- Weld the brush clips on the existing spiral and attach the brush where the drain box is to be installed
- Using a continuous weld, weld the drain box into the existing conveyor
- Drain box will come complete with perforated plate drain section
- Attach the drainpipes to the drain boxes

4.3 Screenings Grinder Alternatives

The grinder alternatives were developed to address the goal of improving the screenings grinder/washer/compactor reliability by reducing the likelihood of the discharge tube to clog and provide sufficient dewatering such that no free water is flowing into the dumpster. The two alternatives identified are:

- Continue using the existing grinder with the modified, horizontal discharge tube
- Replace the grinder with a new screenings washer compactor

Based on observation of five events and historical information from discussion with operators, as described in Section 3, there is no large debris or items that would jam the auger being removed. Therefore, the observations suggest that the grinding function is not needed. This provides the opportunity to reduce maintenance of both a grinder and auger motor and the grinder equipment

by removing that function from the alternative equipment being considered. The alternative equipment performs washing and compaction of screenings only based on this “no large debris” finding.

Two manufacturers of screenings washer/compactors were identified who could offer equipment with the capacity to process a screenings volume equal or greater than the 312 cubic feet/hour capacity of the conveyor. These were Kusters-Zima and Huber. This equipment was considered as an alternative to the existing grinder to provide reliable operation based on increased capacity to accommodate additional screenings load (matching the conveyor capacity), increased auger power to push screenings through discharge tube, experience of screenings-handling-focused engineers of the Design Team with these manufacturers coupled with their reliability compared to JWC, and the removal of the grinder function to simplify the dewatering equipment operation and maintenance.

The existing grinder capacity is only 150 cubic feet/hour. Due to the larger capacity both manufacturers have a larger tank and auger section and a higher power motor on the auger than the existing equipment. Overview schematics and highlighted features of the alternative washer/compactors are shown in **Figure 4-2**. The equipment configuration description of the existing grinder compared to the alternative washer/compactors is provided in **Table 4-1**.

The evaluation of the alternative washer/compactors is described in the next section and included consideration of fit within the existing structure and ability to meet the task goals and guiding principles. The discharge tube configuration would be customized by coordinating with each candidate manufacturer to minimize the angle of the discharge bend and the tube length. Preliminary coordination was done to evaluate the capability and suitability of the equipment for this project as discussed further in Section 5.

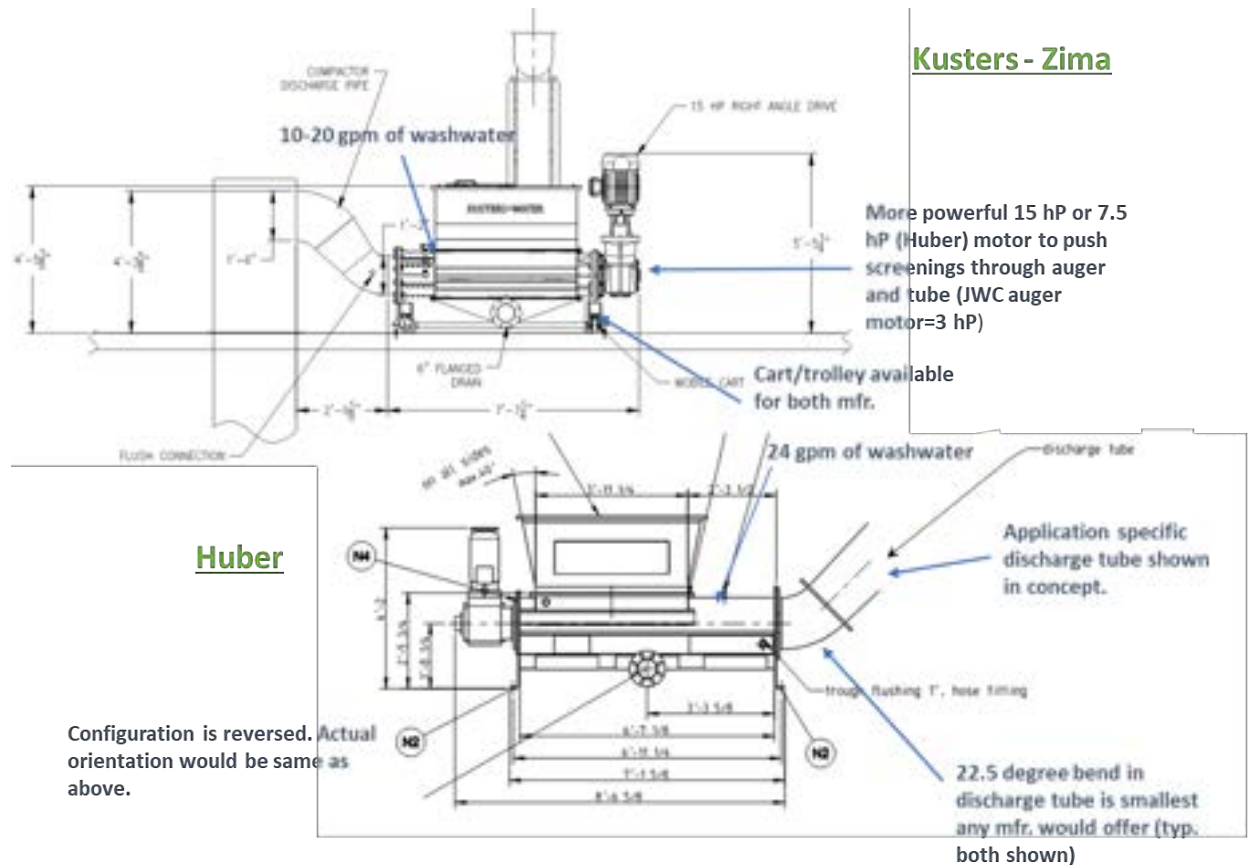


Figure 4-2
Alternate Washer/Compactor Equipment Conceptual Overview – Kusters-Zima and Huber

Table 4-1 Description of Equipment Configuration for Screenings Washer Alternatives

Feature	Existing Grinder	Alternate Washer/Compactors
Number of Units	1	1
Type	Wash press w/ integral grinder	Wash press
Capacity	150 cu ft/hr	312 cu ft/hr (approx.)
Maximum Motor Size	Grinder: 10 HP Wash Press (auger): 3 HP	Wash press (auger): maximum 15 HP
Discharge Tube configuration	Horizontal w/ length of 5 ft	22.5-degree upward bend w/ maximum length of 3 ft

4.4 Alternatives Evaluation Criteria

Several criteria are used to evaluate the alternatives described above. These criteria and the associated project guiding principles include:

- Fit within the existing structure

- Meet the needs of the facility and goals of the improvements required, without adverse impact to adjacent equipment or systems
- Reduce operation and/or maintenance required
- Provide equipment which is accessible and easy to maintain
- Equipment selection to accommodate intermittent use
- Maintain operation of OKW throughout construction phase
- Cost

Any alternatives that do not meet certain criteria may be eliminated from further consideration. For example, an alternative may be eliminated if deemed not technically feasible based on fit within the existing structure or causes a potential detrimental effect on adjacent equipment or systems. Alternatives that pass the technical feasibility test are evaluated based on the remaining criteria which may be more value-based criteria and considered by examining the pros and cons of each alternative.

5.0 Alternatives Analysis

This section provides evaluation of the alternatives relative to the criteria listed above. The technical feasibility of alternatives to fit within the existing structure and potential effect on adjacent systems are discussed. These evaluations can lead to removal of alternatives from further evaluation. The alternatives that are deemed technically feasible are further evaluated for their advantages and disadvantages relative to the other criteria such as maintenance and operational reliability. The life cycle costs analysis (LCCA) in Section 6 is only prepared for the final, remaining or leading alternatives where cost differences are beneficial in supporting a recommended alternative in Section 7.

5.1 Screen Washwater Reduction

As described in Section 2, the high-pressure water is supplied for cleaning the perforated plate screens using a booster pump system located in the Screen Facility Mechanical Room. The Design Team reviewed the pump curves, as provided by the pump manufacturer, to evaluate the affect that reducing the flow rate of water to the perforated plate screens could have on the booster pump operation. It was assumed that all six screens are available and operating with the given amount of washwater supplied for this evaluation. The pump curve is shown in **Figure 5-1**, with the approximate operating point for the total washwater feed rates under different operation conditions are indicated. **Table 5-1** summarizes these alternative operating conditions, total flow rates, and the Design Team's conclusions regarding whether these conditions may have an adverse effect on the booster pumps. Each set of conditions is shown with and without approximately 20 gpm of washwater, total for both the hopper and auger, being used at the grinder. The washwater

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to the grinder is presently turned off and it is unknown if that condition will persist into the future or if future conditions will include use of washwater for the grinder hopper or screenings washing.

Table 5-1: High-Pressure Washwater Feed Rate Conditions

Conditions	Total Estimated Flow (gpm)	Booster Pump Operating Range Acceptable
Present– 5 screens at 110 psi and one screen at 100 psi, zero flow to grinder	131	Yes
Alt 1 – 6 screens at 80 psi & 20 gpm to grinder	134	Yes
Alt 1b – 6 screens at 80 psi & zero flow to grinder	114	Yes, but this is in the flatter part of the curve and approaching the Allowable Operating Region (AOR) or min stable flow in Figure 5-1, and pump operation should be monitored [based on all 6 screens in operation]
Alt 2 – 6 screens at 100 psi, with smaller orifice nozzles installed, & 20 gpm to grinder	116	Yes, but this is in the flatter part of the curve and approaching the Allowable Operating Region (AOR) or min stable flow in Figure 5-1, and pump operation should be monitored [based on all 6 screens in operation]
Alt 2b – 6 screens at 100 psi, with smaller orifice nozzles installed, & zero flow to grinder	96	No, this is too close to the AOR left limit and well into the flat part of the curve
Alt 3 – 6 screens at 70 psi (existing nozzles), & 20 gpm to grinder (unknown screen cleaning performance, typical)	128	Yes
Alt 3b – 6 screens at 70 psi (existing nozzles), & zero flow to grinder	108	No, this is too close to the AOR left limit and well into the flat part of the curve

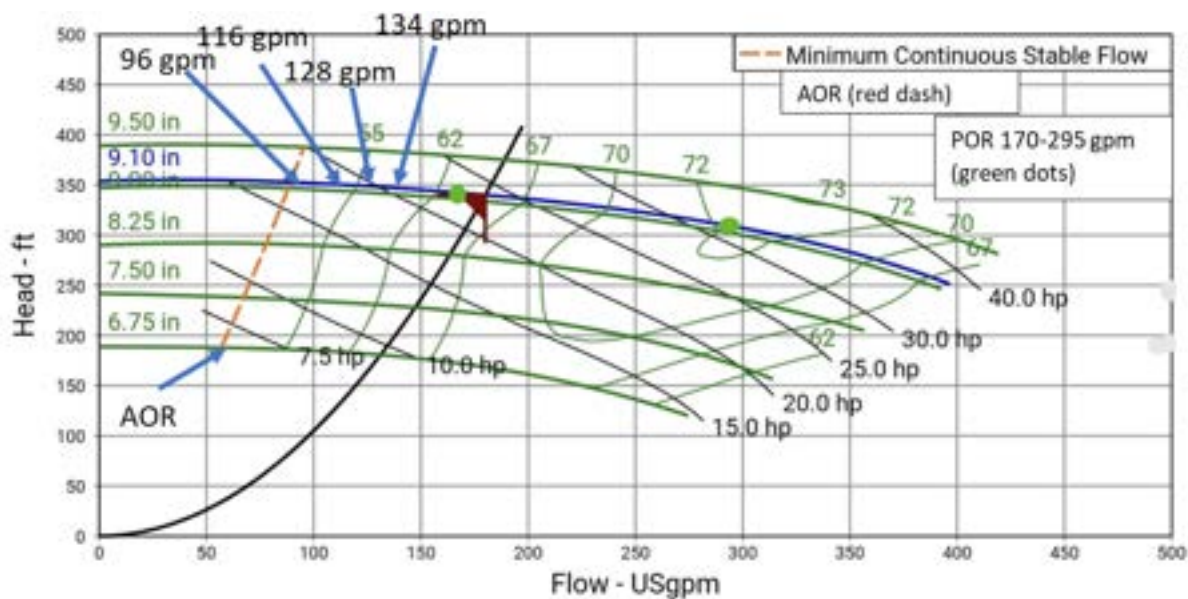


Figure 5-1
Tyco Furnished Model KS2009 Booster Pump Curve & Approximate Operating Points for Estimated High-Pressure Water Feed Rates

Based on review of the booster pump performance curve and potential flow rates with each of the perforated plate screen washwater alternatives, the Design Team removed Alternatives 2 and 3 from further consideration. If the washwater to the grinder is not utilized and the screen washwater feed rates are reduced as in these two alternatives, then there is a risk that the booster pumps will be operating in a flow range that would cause the pump to operate outside or very close to the AOR left limit resulting in reduced service life, increased maintenance and lower efficiency.

The reduction in screen washwater by reducing the pressure at the screens to 80 psi (Alternative 1) was deemed technically feasible to move forward for further consideration and evaluation. Evaluation of the screen cleaning performance at the reduced pressure was completed during three additional ride along visits on 2/22/23, 2/27/23, and 3/4/23. There is also the option to reduce the operating pressure to the design pressure of 100 psi and not operate at 110 psi at the screens. This is not discussed in detail but would reduce the water usage by about 1 gpm per screen (~5% reduction).

The pros and cons of the alternative to reduce the washwater pressure to 80 psi compared to leaving the washwater pressure as-is (or reducing to 100 psi) are presented in **Table 5-2**.

Table 5-2 Advantages and Disadvantages of Reducing the Water to Each Screen

Alternatives	Advantages	Disadvantages
Reduce washwater pressure to 80 psi at the screens [based on all six screens in operation]	▪ Slight reduction in water applied per screen ▪ Cost savings for reduced water usage ▪ Approximately 15% less water flowing into dumpster if grinder offline (without conveyor modifications)	▪ Decrease in screen cleaning performance (based on observation of screen field between spray nozzles prior to screen field return into channel)
No change to screen washwater settings (maintain same flow and pressure)	▪ Screens continue to be cleaned as well as present conditions ▪ Water appears to be accommodated by the modified grinder (without conveyor modifications)	▪ Paying for water that may not be needed

The Design Team met with GLWA on 2/13/2023 to discuss these alternatives. GLWA operators were receptive to this concept and offered to adjust the washwater pressure down to 80 psi at each of the screens for evaluation. The Design Team suggested that the pressure reduction be on one screen only and could be compared to other screens. This evaluation was completed with GLWA operators reducing the washwater pressure to 80 psi on one screen, close to the discharge pipe of the operating storm pump, and maintaining the pressure at 110 psi on the next closest screen. GLWA opened the access door located below the cleaning brush and spray nozzles on both screens to allow observation of screenings that were not washed off before the screen pass into the screenings channel. The Design Team observed the screen cleaning in-person and captured photos and video clips for comparison between the screen cleaning with 80 psi and the screen cleaning

with 110 psi washwater. The following observations were made regarding the cleaning of the perforated plate screen field:

- Observations are challenging when the screens are in operation due to the spray and mist from the washwater nozzles and limited range of about two sections of the screen field visible at a time as it rotates through the access door area, however the screen field could be seen well enough to observe differences in cleaning performance.
- Both screens appeared to be fairly clean overall and did not have any significant sized or amounts of screenings carrying over and going past the brush and washwater.
- Detailed review of the video and photos taken during the evaluation did show that the screen with reduced washwater pressure would at times (every few screen segments) have several small bits of debris, about the size of a nickel or dime or smaller and natural in appearance (no trash items), that stuck to the screen and were not washed off. See **Figure 5-2** for an example or what was observed every approximately five screen segments.
- The screen with typical washwater pressure, 110 psi, also had some small bits of debris that stuck to the screen but these were smaller and less frequent/numerous. See **Figure 5-3** for an example of what was observed every approximately 5-10 screen segments.



Figure 5-2 – Example of Screen Cleaning with 80 psi Washwater Pressure



Figure 5-3 – Example of Screen Cleaning with 110 psi Washwater Pressure

Based on these observations, the Design Team concluded that there was a sufficient increase (double to triple the quantity) in the limited amount of screenings carryover with reduced washwater pressure to 80 psi that this change should not be recommended given the permit compliance considerations with screenings carryover.

While the evaluation was being performed, the potential cost savings of reducing the pressure and reducing the volume of water applied to each screen was calculated. The potential cost savings of applying less water to each screen is about \$6,000/year, assuming change from 110 psi to 80 psi washwater pressure, with associated reduction of 17 gpm total for six operating screens. This is based on the estimated annual operating hours as described in Section 3, which included 36 events with an average runtime of 12 hours per event (or the equivalent of 18 full days per year) and a water rate of \$44.92/1000 cf (Mcf), \$6.01 per 1,000 gallons of water (kgal) plus sewer rate of \$55.40/Mcf, \$7.41/kgal, from the Detroit Water and Sewerage Department (DWSD) 2023 rates document provided by GLWA. The sum of these rates, \$13.41 is applied to the estimated volume of water saved to get the cost savings value. The estimated cost savings for reducing the water pressure is small compared to other operating costs at the facility coupled with concerns with additional screenings carryover supports the recommendation to maintain the present washwater pressure.

5.2 Screw Conveyor Modification

The only feasible alternative for reducing the amount of water reaching the end of the shaftless screw conveyor was to add drain boxes supplied by the conveyor manufacturer. These drain boxes

would consist of a 316L stainless steel perforated plate and box with 6-inch drain outlet to replace a section of the conveyor trough in three places. A brush is added to the spiral flights in contact with the drain section to keep the perforations clear of debris.

The drain boxes are about 1-foot long and will fit under the conveyor trough as shown in **Figure 4-1**. Routing of the drainpipe to the screen outlet channel would need to be determined to avoid the conveyor support structure and existing secondary high-pressure water piping, but conceptually this is feasible in the area near the proposed drain boxes.

The pros and cons of this alternative, compared to not installing the drain boxes are discussed in **Table 5-3**

Table 5-3 Advantages and Disadvantages of Adding Drainage Sections to the Conveyor

Alternatives	Advantages	Disadvantages
Modify conveyor to add 3 drain sections (drain boxes)	- Should have significant reduction in water conveyed to grinder/washer/compactor - Less water flowing into dumpster/screenings collection area when grinder/washer/compactor offline.	- Potential for clogging and cleaning needed for drain sections (potential maintenance needed between events) - No excess water for screenings washer thus need to use more secondary water, but has advantage at washing system pressure distributed via the header - Replace brushes on spiral as wear occurs (estimated every 5+ years)
No change to conveyor	- No additional cost or maintenance required. - Existing grinder continues to utilize the excess water as washwater	- Large amount of water conveyed to grinder and to dumpster/collection level if grinder off-line - Does not address the goal to reduce the water to the grinder - Passive flow of water through auger section not cleaning screenings as well as pressurized water through nozzles would

During the meeting on 2/13/23 with GLWA, they expressed interest to know what other customers with drain sections along the length of the shaftless screw conveyor experience regarding ability of the spiral brush to keep the drain section clear and how well the water drains through the drain boxes. The Design Team is working with the manufacturer, Spirac, to obtain references and follow-up on this aspect of the evaluation.

This alternative is not evaluated in the LCCA, because there is only one alternative, adding the drain boxes, which will address the task goal to significantly reduce the amount of water conveyed to the grinder. There may be additional maintenance required to periodically clean the drain sections and replace the brushes on the spiral, but no other alternatives were identified.

5.3 Screenings Grinder Alternatives

The two alternatives identified to improve the grinder reliability and address concerns with intermittent operation are to continue using the existing grinder with the modified discharge tube or purchase a new washer/grinder. As discussed in Section 4, it was determined that if the grinder is replaced, the grinder function would not be necessary based on the screenings composition observed during several events and based on historical information from operations staff.

To meet the criteria of fit within the facility and access for maintenance, the Design Team evaluated the equipment data sheets and dimensional drawings provided by the two equipment manufacturers contacted. Excerpts of these drawings are shown in **Figure 4-2**. Due to the larger capacity and larger motor than the existing equipment, the overall length is greater than the existing grinder. This results in insufficient clearance on the right side of the machine between the motor and guardrail to access the back of the machine or maintain the motor with the manufacturer's standard arrangement. The Design Team worked with the manufacturers' sales engineers to adjust the alignment for the washer/compactor below the conveyor and shorten the discharge tube, so the washer/compactor could move to the left and provide about 3 feet of clearance between the motor and the guardrail. The discharge tube was shortened so the end of the discharge tube can align with the opening in the screenings washer platform for discharge of the compacted screenings to the dumpster below. With these modifications the alternative washer/compactors can meet the evaluation criteria of fitting within the existing structure.

Screenings Washer Platform and Conveyor Drain Piping Structural Considerations

If another manufacturer is identified or if this alternative moves into detailed design and one of the manufacturers is unable to provide a short enough discharge tube to align with the existing opening, the Design Team also performed a structural evaluation of the feasibility to modify the screenings washer platform to expand the opening to the screenings collection area below and extend the footprint of the platform if needed as well.

The existing platform is a reinforced concrete structure supported on concrete beams. The existing platform could be expanded if needed with a maximum expansion of 8 feet. However, this expansion would limit access of the bridge crane to the lower level of the structure and is not preferred unless absolutely required.

The new screenings washer may require an increase in the chute opening. This chute opening poses no structural concerns if it avoids the existing structural beams below the slab.

For the conveyor drain piping, several 8-inch cores will need to be added. The contractor will be required to scan the existing slab with ground penetrating radar to locate rebar and where possible cores will be located to avoid rebar or where rebar cannot be avoided cores will be located to minimize cut rebar.

Alternate Washer/Compactor Accommodation of Intermittent Use

Coordination with the washer/compactor manufacturers also focused on modification and evaluation of the equipment to balance the needs of dewatering/compacting the screenings and reducing the potential for the discharge tube to clog between events. Both manufacturers are offering a minimum of 22.5-degree bend in the discharge tube and neither was willing to provide a lower angle or horizontal discharge tube. They want the bend so that there is some back pressure on the auger to provide dewatering and some compaction of the screenings. This is a lower degree bend than their standard 45-degree bend. The discharge tube beyond the bend widens in diameter from the bend to the outlet. The length and incline of this section provides further dewatering but the widening reduces screenings contact and sticking to the walls of the tube. The shorter length of the tube will also help reduce the screenings resistance to moving through the tube.

Despite the shorter, wider tube, relatively low angle bend, and the higher horsepower auger motor to help push screenings through the discharge tube and minimize potential for clogging between events, both manufacturers recommend a preventative maintenance activity at the end of event to loosen remaining screenings in discharge tube. The suggestions included possibly adding ice chips or water via a flushing port to move more screenings out of the discharge tube; or rake out debris from the reachable portion of tube. If the alternate screenings washer is selected, the design would include reconfiguring/replacing the vertical chute so that the outlet of the washer/compactor chute is accessible. The significantly shorter discharge tube would improve the feasibility to reach and loosen the screenings. However, this required action and the remaining potential for clogging between events does not meet the criteria of reducing maintenance required and accommodating intermittent use.

The pros and cons of the alternative for a new washer/compactor, compared to continuing to use the existing grinder in its modified configuration are discussed in **Table 5-4**.

Table 5-4 Advantages and Disadvantages of Washer/Compactor and Grinder Alternatives

Alternatives	Advantages	Disadvantages
Replace with new Washer/Compactor	- Only one motor (auger) to maintain and power. - Larger motor with more power to push screenings through auger and discharge tube - Shorter discharge tube (to accommodate longer compactor unit and meet existing floor opening) - Larger capacity (312 cu ft/h v. 150 cu ft/hr) to accommodate future conditions	- Larger size of equipment, may reduce clearance on motor side of unit - Both manufacturers have minimum elbow of 22.5 deg (will not do horizontal discharge) - Both mfrs recommend break up plug with rake or stick at end of event to reduce hardening and clogging for next event; or flushing, ice chips or wetting screenings in elbow - Replaces equipment that has limited operating hours
Continue to utilize existing JWC grinder compactor with modified discharge tube	- Lowest cost, near term—continues to utilize existing equipment with very low runtime hours - Familiar with the equipment - Small/compact unit, fits in existing space - Provides dewatering and discharge tube modification appears to have eliminated clogging issue - No free water discharged (with present operation—washwater turned off)	- Grinder section is additional point of future failure potential - Additional maintenance for grinder motor, gear box and cutters. - Conveyor outlet requires modification to prevent drips between neoprene and inlet hopper

GLWA expressed a preference to continue using the existing grinder with horizontal discharge tube over replacing the unit, during the meeting on 2/13/23. This preference is based on their present satisfaction with how the existing grinder is operating since the discharge tube horizontal configuration has been in place with a downward facing outlet. They also have concerns about the proposed bend in the alternative washer/compactors causing clogging and not allowing for intermittent operation without an increase in maintenance.

The LCCA presented for this alternative in the next section compares the costs to purchase, install, operate, and maintain a new washer/compactor compared to the existing grinder.

6.0 Life Cycle Cost Analysis

The Life Cycle Cost Analysis (LCCA) was prepared for the new washer/compactor equipment and compared to continuing to use the existing grinder for a 20-year period starting from the estimated end of project construction.

6.1 Approach

The LCCA provides comparative cost estimates intended to represent order-of-magnitude estimates for equipment capital and O & M costs. It is intended for planning purposes and comparing

alternatives, and does not serve as an opinion of probable construction cost (OPCC). The costs developed for this project phase are based on general requirements of each alternative. The alternatives that were not eliminated from further consideration based on technical feasibility to meet project goals and where there are two remaining viable alternatives, are included in the LCCA. As described above, for the screenings conveyor and grinder system modifications, this includes the comparison between replacing the grinder with a larger capacity screenings washer/compactor compared to keeping and maintaining the existing grinder. Escalation rates are applied to move present costs into the future to the time when the purchase, energy use, or maintenance will occur. Then a discount rate is applied to move those future costs back to the present and provide the net present value of each alternative. The individual escalation rates are discussed in the following sections. The discount rate applied is 4%.

6.2 Initial Purchase and Installation (include commissioning and startup)

Initial purchase costs are based on budgetary costs estimates for the washer/compactor. The costs include the washer/compactor, with quick connect power cables, and a trolley/cart for moving the unit from on-line to off-line position. The highest of the two budgetary cost estimates received were used in the analysis. To accommodate the larger equipment and provide access to the discharge tube, a modified vertical discharge chute was included in the initial purchase cost. This would be a section of the chute from below the screenings washer/compactor discharge tube to the opening in the floor.

Supporting component purchase costs were estimated as by approximate percentage of primary equipment cost. For the screenings washer/compactor these estimates included 10% for miscellaneous electrical and 10% for instrumentation and control.

Installation and commissioning were estimated as 30% of the equipment purchase, plus an estimated cost for the equipment manufacturer's field representative to oversee and confirm proper installation and startup. Two, 1-day trips were assumed for the LCCA.

Contractor costs, including general conditions, permits, insurance, bonds, overhead and profit, and 30% contingency were added to the purchase, installation, and commissioning costs as an overall percentage of 75%.

The total installation and commissioning costs were escalated from February 2023 to the approximate mid-point of construction, estimated to be May 2027, based on the project schedule at the time of the analysis. The escalation rate utilized is 6% annually.

6.3 Operation, Energy, and Maintenance

These costs applied to both the new screenings washer/compactor and the existing grinder. Operation costs were based on the usage of washwater in the inlet hopper and to wash the screenings as they move through the tank and auger section. The average water usage is 20 gpm. The operating duration for each year was estimated based on the screw conveyor operating hours as described in Section 3 and amounts to 36 events with an average runtime of 12 hours per event

(or the equivalent of 18 full days per year). The annual water use cost was calculated using a water rate of \$44.92/1000 cf (Mcf), \$6.01 per 1,000 gallons of water (kgal) plus sewer rate of \$55.40/Mcf, \$7.41/kgal, from the DWSD 2023 rates document provided by GLWA. The sum of these rates, \$13.41 is applied to the estimated volume of water. It was assumed that the existing grinder will also use 20 gpm in the future to move screenings through the inlet hopper and grinder and wash screenings in the tank and auger section, assuming the amount of water conveyed by the screw conveyor is significantly reduced. An annual escalation rate of 3.5% was applied to the water cost rate. Energy usage costs for both alternatives were based on the operating hours per year as described above and the nominal nameplate horsepower (HP) of each motor converted to kilowatts (kW). The washer/compactor only has one motor for operating the auger but one of the two manufacturers investigated has a 15 HP motor, and the other manufacturer uses a 7.5 HP motor for this function. This is higher than the 3 HP motor on the existing grinder auger. However, the existing grinder has a 10 HP motor on the grinder element, so the total HP used is 13. The energy escalation rate applied is 2.7% per year.

The amount of maintenance required for each alternative was estimated based on potential maintenance activities after each event, annual preventative maintenance, and estimated spare parts replacement at times during the life of the equipment.

The following maintenance cost assumptions were applied to the alternative with the new washer/compactor:

- Estimated 30 minutes would be required at the end of each event to clear the discharge tube or break up the plug so that it further reduces the potential for clogging at the next event.
- Annual preventative maintenance for inspection and lubrication was estimated as a total of 16 hours, based on two staff, 8 hours once per year performing inspection and lubrication of parts that do not require any disassembly of the unit.
- Estimated repairs and/or spare parts replacement, was applied at year ten of the equipment life and assumed to be 10% of the original purchase cost.

The following maintenance cost assumptions were applied to the alternative continuing to use the existing grinder:

- Estimated 15 minutes of maintenance to check the unit after each event and/or minor, periodic housekeeping around the unit.
- Annual preventative maintenance for inspection and lubrication was estimated as a total of 32 hours, based on two staff, 16 hours once per year performing inspection and lubrication of parts that do not require any disassembly of the unit.
- Based on the very low runtime hours on the existing grinder, it was assumed the existing equipment would not require a full replacement within the 20-year time period and

maintenance repairs/replacement would be similar to the alternative for a new washer/compactor.

- Estimated repairs and/or spare parts replacement, was applied at year ten of the equipment life and assumed to be 10% of the original purchase cost. An updated purchase cost was obtained from JWC to use in this estimate.

The following assumptions apply to both alternatives:

- An average labor rate of \$140/hour (including benefits) was utilized.
- Maintenance costs were escalated 3.5% from present (2023) to the year when performed

6.4 Decommissioning/Salvage

The salvage value was estimated as 10% of the original equipment purchase cost (before sales tax), and then escalated to the end of the 20-year analysis period using a 3.5 annual escalation rate (consistent with the maintenance escalation rate). Salvage value is shown as a negative value in the LCCA because it is an income as compared to the other values included in the analysis, which are costs.

The salvage value assumed for the existing grinder was based on a present (2023) budgetary cost estimate obtained from JWC for the same model as the existing grinder.

6.5 LCCA Results

Table 6-1 provides a summary of the LCCA for the screenings conveyor and grinder system improvements focused on comparison of the two alternatives for either replacing the grinder with a new washer/compactor (eliminating the grinding function) or continuing to use the existing grinder. All values in the table are rounded to the nearest \$5,000.

This analysis shows a significant difference in cost due to the purchase of new equipment for Alternative 1. The O&M costs for both alternatives are within the \$5,000 rounding for electricity and water use; and have a difference of \$35,000 based on additional maintenance needed for the existing grinder to maintain the grinder, gear box and motor, in addition to a slightly higher replacement parts cost estimate.

Table 6-1 LCCA Summary for Grinder Alternatives

Alternative	Capital Costs (Year 2027)			20-Year NPV of Capital Costs	O & M Cost Breakdown (20-Year Present Values)			20-Year NPV of O & M Costs	Salvage Value (NPV)	20-Year NPV
	Initial Capital Cost	Installation, Commissioning & Startup	Total Construction Cost		Electricity	Maintenance	Washwater			
Alternative 1 - Replace with new Washer/Compactor	\$225,000	\$415,000	\$640,000	\$545,000	\$10,000	\$80,000	\$130,000	\$220,000	(\$15,000)	\$755,000
Alternative 2 - Continue to utilize existing JWC Grinder	\$0	\$0	\$0	\$0	\$10,000	\$115,000	\$130,000	\$250,000	(\$15,000)	\$235,000

7.0 Summary, Recommendations, and Key Decisions

The goals task OKW-SCR-2 were defined as:

- Goal 1: Reduce amount of water flowing into grinder or dumpster when grinder is off-line
- Goal 2: Address problems with grinder/washer/compactor (grinder) discharge tube clogging between events

Based on evaluation of the existing screenings handling system and investigation into feasible equipment modifications, improvements, or replacement options, the following alternatives were developed:

- Reduce washwater pressure to 80 psi at the screens (Goal 1)
- Modify conveyor to add three drain sections (drain boxes) (Goal 1)
- Replace grinder with new Washer/Compactor (Goal 2)
- Continue to utilize existing grinder with modified discharge tube (Goal 2)

These are not separate, independent alternatives but a series of alternatives that could be applied in combination to achieve the improvement goals of the screens handling for the wet weather flows. With each alternative stated above to address the goal of reducing the amount of water being conveyed there is also the option the maintain the operation and equipment as-is and understand the trade-offs between reducing the washwater volume conveyed and not reducing the volume conveyed.

The Design Team recommends the following alternatives be implemented based on the analysis summarized herein, along with a brief description of the reasoning and/or remaining concerns associated with the selected alternatives:

- Maintain present screen washwater operating pressure of approximately 110 psi.
- Modify conveyor to add three drain sections (drain boxes)
 - The drain boxes are relatively low cost and short construction duration to install
 - Should address the large volume of water discharged to the screenings collection room when the screenings grinder is off-line
 - There is remaining uncertainty in the potential of the drain sections to clog with debris, effectiveness of the brush to keep the sections clear, and potential cleaning/maintenance required between events. (See next steps section for on-going effort to address this uncertainty)

- Continue to utilize existing grinder with modified discharge tube
 - This is the lower cost alternative, based on assumption that existing grinder does not need to be replaced within the project life cycle.
 - The equipment has been functioning well and meets the task goal to improve intermittent operation and prevent clogging of the discharge tube.

With the additional design storm total flow volumes of 4.5 to 5.5 times the current collection system configuration peak design storm volumes after the ODIRS is completed, the Design Team also recommends that GLWA monitor the volume of screenings collected during each storm event. Additionally, consider whether a larger dumpster and/or additional, dumpster change-out trained staff and equipment will be needed at the facility to reposition or change the dumpster during storm events.

7.1 Key Decisions

Below are the key decisions made by GLWA related to the Oakwood screenings conveyor and grinder system improvements:

- Addition of drain boxes to the conveyor trough to move forward into BOD phase
- GLWA will continue to use the existing grinder as modified with horizontal discharge tube
- No change to screen cleaning washwater pressure
- There is no further modification required to the existing modified screenings vertical chute



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Mohsen Sadatiyan, CDM Smith
Steve Fehniger, CDM Smith*

Date: June 1, 2023, Revised June 7, 2023

*Subject: TM-5 LEIB-SCR-1 Screening improvements and Pilot Screen
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

This technical memorandum (TM) focuses on the study/evaluation of the screening system at the Leib Combined Sewer Overflow (CSO) Screening and Disinfection Facility (SDF) to improve screen reliability and functionality, including screenings conveyance. The evaluation included analysis of the existing screen operations (field investigations during wet weather, analysis/evaluation of available Ovation, operations and maintenance (O&M), or other historical data) in accordance with the original system design. The results of these analyses were used to determine recommendations that can improve screenings removal, improve screen functionality, and reduce the number of times the screens are overtopped. Based on the scope of this task (LEIB-SCR-1), the improvements include the following:

- Rehabilitation of the screen equipment in three of four screen channels
- Replacement of the screen equipment in one of the channels equipped with COPA® screens as a new pilot screen.

Table ES-1 summarizes the original design criteria from more than two decades ago and the design criteria based on the present system SWMM modeling and updated requirements.

Table ES-1 Design Parameters

Parameter	Original Design (1998)	New Design (Predicted 5-minute Peak Flow Rate)	
		present Condition	Future Condition (after Meldrum connection)
Hydraulic Capacity (cfs)	2,000	2,000	2,000
Screening Peak Flow (cfs)	1,550	520	950
Average Flow (cfs)	N/A	118	380
Peak Design Event	10-year, 1-hour event	10-year, 24-hour event	
Average Design Event	N/A	6-month, 24-hour event	
COPA® Blinding Factor	30%	50%	
ROMAG Blinding Factor	20%	25%	
Multi-rake Blinding Factor	-	30%	
Redundancy	None (all 4 channels in operation for screening peak design flow operating condition)	3+1 (one channel out of service for screening peak design flow operating condition)	

This TM presents the results of the evaluation of the existing screening system at Leib. The assessment consisted of a multi-faceted approach, including reviewing existing records of original design and construction, subsequent modifications, operating data and process video recordings, site visits, interviews and meetings with operations staff, and screening sampling efforts.

Based on evaluation of the existing system and communications with the screen manufacturers, the following recommendations are provided to improve the performance of the existing screen system.

- ROMAG control technology and instruments for actuating the hydraulic cylinders driving the cleaning combs were improved in recent designs. Based on the manufacturer's input, updating this component of the system can reduce the frequency of screen overloading faults. Also, replacing the hydraulic power packs can improve the reliability of these screens. In addition, lowering the bottom elevation of ROMAG screens by approximately 1-foot while maintaining discharge weir elevation at the current elevation allows the screen assembly to meet the manufacturer's recently recommended maximum through-bar (slot) velocity of 5 ft/s and could reduce cleaning mechanism faults.
- The technology of COPA® screens has not changed considerably in the last few decades. Accordingly, no other improvement options exist except for replacing the screens or their components with the same assembly, which is not recommended.
- In addition to the rehabilitation of ROMAG and COPA® screens, the system evaluation identified potential operation and control changes that could improve existing equipment

performance and reduce the frequency of overtopping. The primary recommendation is to run the equipment as much as possible on auto and allow 10% of the influent (aka side flow) to be conveyed to Toward Treatment Sewer (TTS) to reduce the accumulation of screenings upstream of these diversion-type screens.

- Calibration of the Influent flow meter, Toward Treatment flow meter, and Screening level sensor (which are critical instruments in screen and gate operation control) is recommended for reliable automatic operation.

Various alternatives were evaluated for a new screening technology from a technical feasibility perspective in alignment with project guiding principles. The evaluated alternatives are listed below:

- Alternative A: One multi-rake bar screen
- Alternative B: Two multi-rake bar screens installed perpendicular to the flow direction
- Alternative C: One center flow multi-rake bar screen
- Alternative D: Two overflow screens with screws
- Alternative E: Multi-rake bar screen and overflow screen
- Alternative F: Continuous element screens
- Alternative G: Replacing COPA® screens with ROMAG screens
- Alternative H: Facility expansion and major structural modifications

Based on the alternatives evaluation, Alternatives A and G, appear to be viable alternatives for the pilot screen and were selected for further economic comparison via life cycle cost analysis.

An extension of Alternative A and G for future consideration is summarized in this TM. Alternative G extension includes replacement of all COPA® screens in both channels with ROMAG screens that can provide screening capacity for 950 cfs peak design flow with one channel out of service. The extension of Alternative A will allow replacement of all remaining ROMAG and COPA® screens with similar multi-rake bar screens to meet the peak screening design flow of 950 cfs while one of the screening channels is out of service. This expansion will modify some flow paths through the Screening Inlet and Outlet Channels to convert the three existing middle Screening Outlet Channels to future Inlet Channels and two existing middle Screening Inlet Channels to future Outlet Channels.

Life cycle cost analysis conducted for Alternatives A and G for future scenario (all COPA® screens are replaced with new screens). It is assumed that Alternative A will be constructed in two phases. In Phase 1, the COPA® screens of the easternmost channel will be replaced with one multi-rake screen while the remaining screens will be rehabilitated. After 10 years, in Phase 2, all remaining

ROMAG and COPA® screens will be replaced with similar multi-rake screens. Alternative G is assumed to be constructed also in two phases. In Phase 1, the COPA® screens of the easternmost channel will be replaced with two ROMAG screens similar to existing at this facility, while the remaining screens will be rehabilitated. After 10 years, in Phase 2, the remaining COPA® screens will be replaced with two new ROMAG screens. The LCCA showed considerable (about \$3.96 million at the end of both phases) economic advantage of Alternative G over A on life cycle cost basis.

Advantages to Alternative G include limited structural modification, ROMAG screen's hydraulic capacity, and consistency of the equipment with what is already installed in this facility. The consistency of the screen technology not only has the advantage of operational familiarity, but also commonality of spare parts and understanding of maintenance needs. The life cycle cost analysis showed considerable economic advantage of Alternative G over A. The main driver for this considerable cost difference was limited structural modifications and capability of maintaining the existing ROMAG screen in service after some rehabilitation, including replacement of hydraulic power units and control and instruments for screen cleaning mechanisms, in Alternative G. Another advantage of Alternative G over A includes screenings capture capability with the smaller opening size of ROMAG screens (4-mm) in comparison to opening size with multi-rake bar screens (6-mm).

With the manufacturer recommended updates to the power pack, control panel, and new control logic, as well as operation of the facility in accordance with manufacturer recommendations for screen operation and providing the required side flow minimum of 10% through proper gate operation, Alternate G is technically feasible. Hydraulic analysis was completed to confirm that it is technically feasible for the system to produce the minimum 10% side flow within an acceptable headloss. Therefore, based on several advantages and lower cost, Alternative G, all ROMAG screens, is the recommended alternative to meet GLWA's goals and associated guiding principles for this project improvement item.

1.0 Introduction and Purpose

Completed in 2003, the Leib CSO SDF was constructed as a pilot to evaluate its effectiveness in screening and disinfection of overflows to the Detroit River. After nearly two decades of use and a long track of operation data, the facility screening processes require evaluation to determine the improvements within the constraints defined by the contract.

This TM focuses on the study of the screening system at the Leib Facility to improve screen reliability and functionality including screenings conveyance. This includes the analysis of the existing screen operations (field investigations during wet weather, analysis/evaluation of available Ovation, O&M, or other historical data) in accordance with the original system design. The results of these analyses will be used to determine recommendations that can improve screenings removal, improve screen functionality, and reduce the number of times the screens are overtopped.

Based on the scope of this task (LEIB-SCR-1) the improvements include rehabilitation of the screen equipment in three of four screen channels and replacement of the screen equipment in one of the channels equipped with COPA® screens.

The screen rehabilitation requires control panel upgrades and screen rebuilds (hydraulics, instrumentation, and hardware) for the remainder of the existing screens that will remain in place, as well as potential improvements to convey debris more effectively to the screenings collection channel. This includes rehabilitation of the screening mechanisms (screen, rakes, hydraulic rams, etc.), the hydraulic pumps, hydraulic tubing, and instrumentation associated with these screens. The improvements include updating the existing screens with the latest available technology to enhance system operation to be more resilient from becoming plugged and allowing flow to overtop the screen. The conveyance of screenings was also investigated for remaining existing deflection type screening systems.

The new pilot screen technology is to be installed in one of the existing COPA® screen channels. The designed improvements include necessary modifications to the screen channel and conveyance to allow the new screen to be installed. The designed and installed improvement will be evaluated to demonstrate that the selected pilot technology will effectively meet the Criteria for Success in CSO Treatment (1998).

Alternatives were evaluated for a new screening technology from a technical feasibility perspective in alignment with project guiding principles to identify a more reliable means of removing the screenings from the combined sewage and conveying the screenings into the screenings collection channel for transport to the Water Resource Recovery Facility (WRRF) through the Towards Treatment Sewer (TTS) which discharges to the Detroit River Interceptor (DRI).

The evaluation and study efforts include weather-dependent operations ride-a-longs to understand how the facility is operated, understand operational issues, and make recommendations for improvements. At the time of this writing no wet weather events had resulted in screen operation during the study phase.

The following sections will provide a description of the existing system description, a summary of the system evaluation and potential improvements for the remaining existing screens, alternatives analysis for the pilot screen, and the Design Team's recommendations for system and facility improvements.

2.0 Existing System(s) Description (and/or Conditions)

2.1 Background

The Leib CSO SDF was constructed as a demonstration CSO treatment facility as part of the City of Detroit's National Pollutant Discharge Elimination System (NPDES) Permit and its long-term CSO control plan. The facility is located east of Mt. Elliott between Waterloo St. and Kercheval St. It was designed to treat a total CSO flow of 1,550 cubic feet per second (cfs) with hydraulic capacity for flows of up to 2,000 cfs (to be conveyed through the facility with partial screening and disinfection

with less contact time). Flow conveyed to the facility is via the 16-ft diameter Mt. Elliott Sewer. The facility is a flow-through type receiving both dry and wet weather flows. **Figure 2-1** and **Figure 2-2** show the schematic of the facility and some upstream and downstream CSO system components.



Figure 2-1
Leib Facility Location Plan (DWSD, CS-1281, 2008)

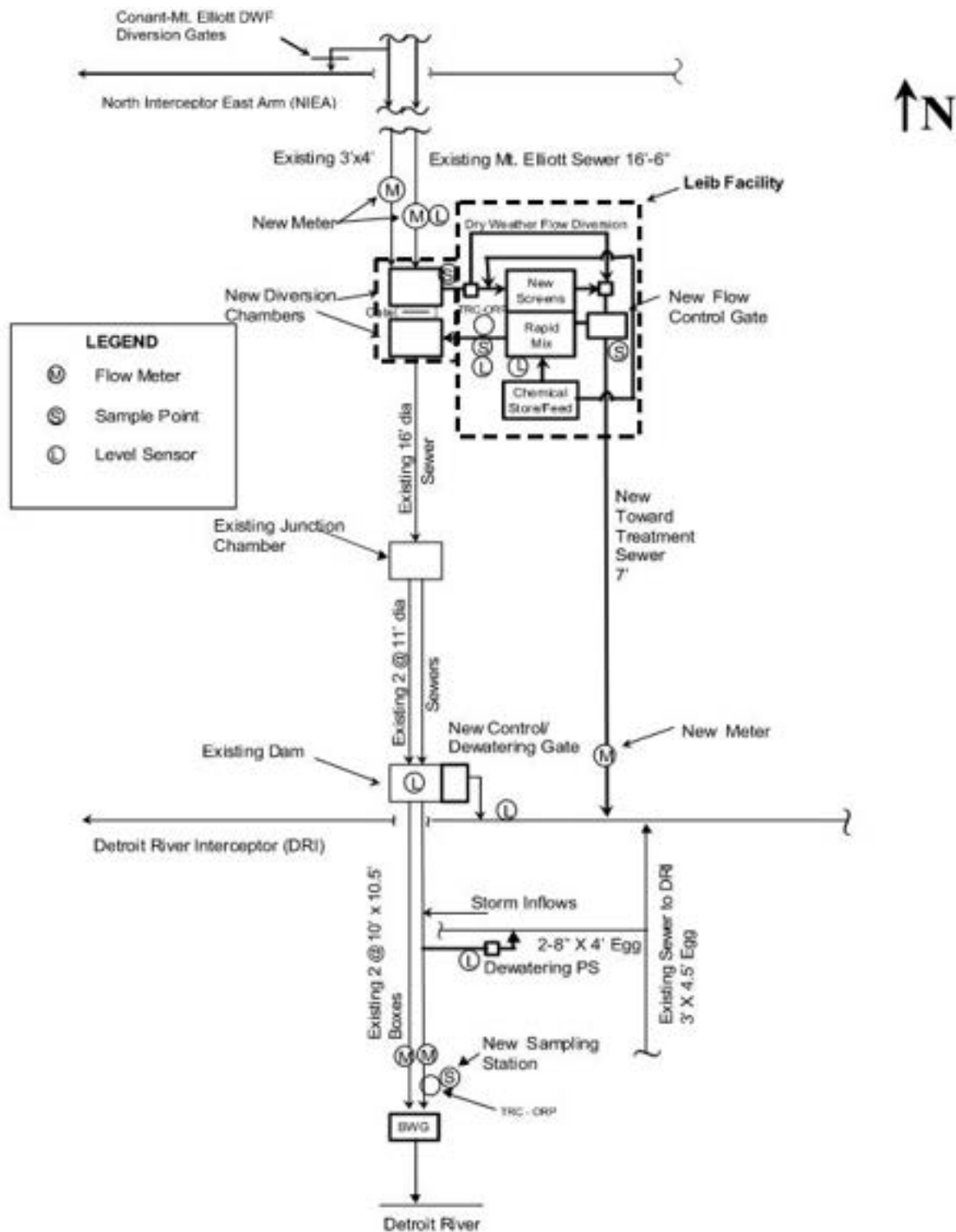


Figure 2-2
Schematic of Leib Facility (DWSD, CS-1281, 2008)

2.2 Present Leib Wet Weather Operations

Under wet weather conditions, when the flow entering the facility from the Mt. Elliott sewer exceed the capacity of the 3-ft diameter outlet of the dry weather channel, the sewage begins to back up in the influent channel. At this stage, water flows into the facility and begins to rise in the Screening Chamber. When water levels rise above elevation 109' (about 12 ft deep), the dry weather gate closes, which leads to further flow accumulation and level rise in Screening Influent Channels.

If the level in the Screening Chamber exceeds elevation 110' (~13.0 ft deep), flow through ROMAG screens begins. At the same time, the screens will turn ON, the screenings channel gates open and the normally open SCUBA-actuated gates at the Leib Regulator Chamber will close. The combined sewage conveyed through the screens (screened flow) drops into the screened flow outlet channels associated with each screen and into the Disinfection Chambers. **Figure 2-3** shows the flow path of wet and dry weather flows through the facility. Under normal conditions, all screens are used to screen flows. Screenings captured by the screens continue to flow up the inclined screen channel and enter the screenings collection channel. This channel conveys the screenings flow to the TTS. As indicated in the project CS-1280 report, due to the elevation difference between Leib and the DRI, there will always be positive flow through the TTS to the DRI, even when there are high flows in the DRI. In anticipation that there may be high flows in the DRI caused by upstream wet weather, while there is no wet weather in the Leib tributary area, a gate is located on the TTS at the Toward Treatment sump. This gate will be closed if sensors indicate that flow from the DRI may back up into Leib.

The control system automatically turns the screens and mixers off as wet weather flows subside and when the level in the Screening Chamber drops below elevation 109.8' (~12.8 ft deep). Water remaining in the facility flows out through the TTS to the DRI. When sensors confirm that capacity exists in the DRI, a gate at the regulator on the Leib sewer at Jefferson Avenue opens, allowing water remaining in the Leib outfall sewer to flow into the DRI. When the Leib outfall above the DRI has completely drained into the DRI, system operators activate the dewatering pumps at Harbor Town, and water remaining in the Leib outfall sewer at a level below the DRI is pumped back into the DRI. Also, at this time, the Great Lakes Water Authority (GLWA) personnel may enter the screening and disinfection chambers to wash down remaining solids to the TTS.

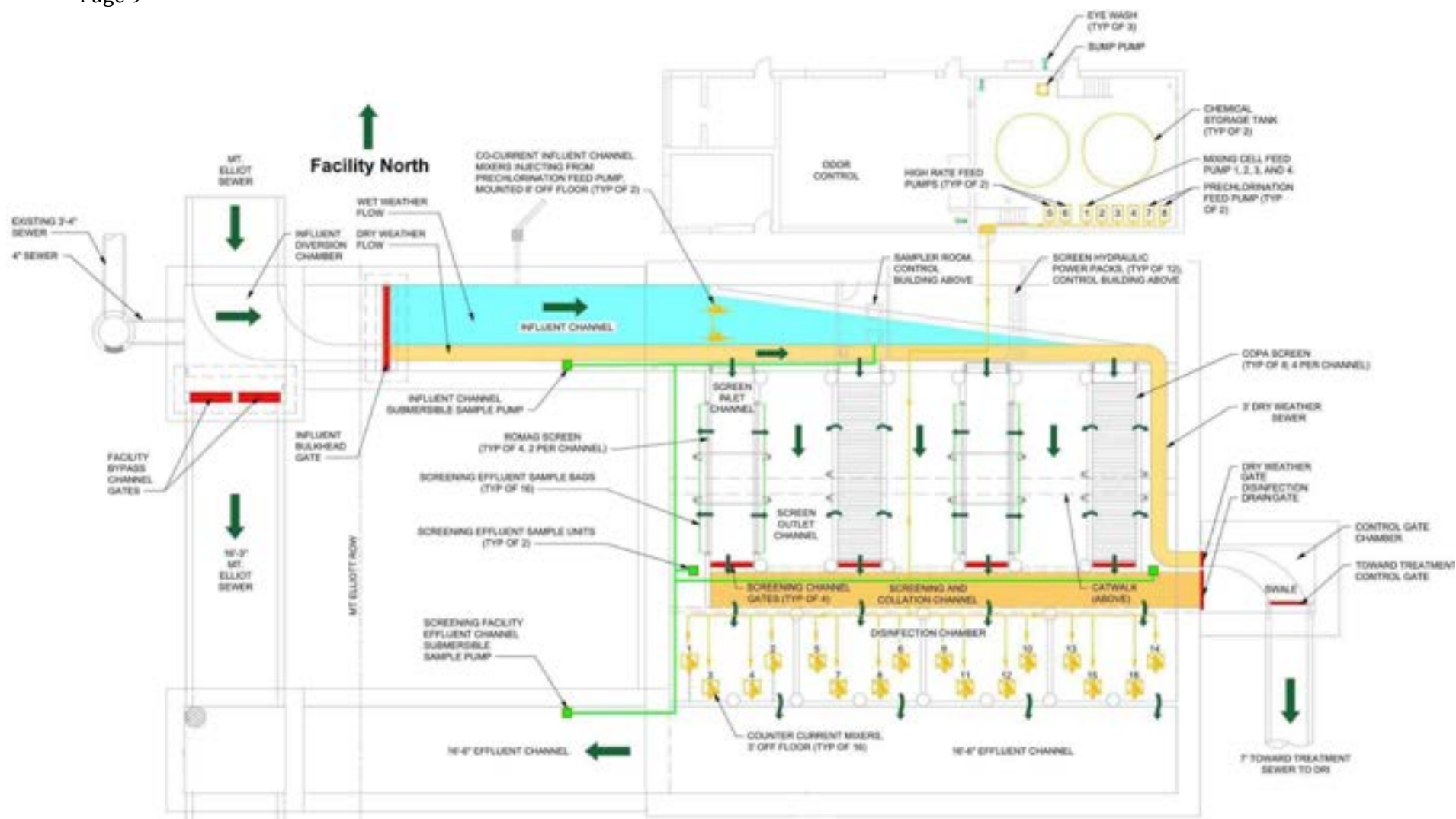


Figure 2-3
 Leib Facility Process Nomenclature, Layout and Flow Path (GLWA, CS-299,2021)

2.3 Screens

The Leib facility has two types of deflection-style bar rack screens, each with 4-mm thick stainless-steel bars with 4-mm spacing. A total of 12 screens are installed in the four Screening Inlet Channels. Two channels are equipped with ROMAG screens (two screens per channel), and the other two are equipped with COPA® screens (four screens per channel). Both types of screens share the same purpose of mechanically screening flow passing through bar openings and discharge the screenings removed from screen field back into the Screening Inlet Channels which are connected to the Screening Collection Channel for transport to the WRRF through the TTS and DRI.. The ROMAG screens have a vertical arrangement, with flow moving horizontally through the bars and falling to Screening Outlet Channel (**Figure 2-4**).



Figure 2-4
Horizontal COPA® (left) and Vertical ROMAG (right) Screens

The COPA® screens have a horizontal arrangement with flow conveyed up vertically through the bars and overflowing to the Screening Outlet Channels. Each screen consists of bar screen assemblies, cleaning carriage (comb for ROMAG and rake for COPA®), overflow weir, hydraulic power pack, and controls. ROMAG screens are also equipped with inclined flow control weir plates on the downstream side to prevent flow through the screen unless the water level reaches almost its mid-height.

2.4 Screen Hydraulic Power Packs

A separate hydraulic power pack drives each screen's hydraulic cylinder. The power packs are in the Mechanical Equipment Room, above and on the north side of the Screening Inlet Channels

(Figure 2-5). The control panels for the power packs are located directly on the other side of the wall in the Electrical Equipment Room. Each hydraulic power pack includes a hydraulic gear pump with a suction filter powered by an electric motor. Each hydraulic power pack has 10-gallon capacity oil reservoir filled with vegetable-type hydraulic oil. In addition, each unit is equipped with a 0-3,000 psi pressure gauge, pressure limiting/relief valve, replaceable oil filter, filler/ breather cap with strainer, and combination level and temperature switch. All connection fittings between hydraulic hoses and other system components are stainless steel. In addition, the ROMAG hydraulic power packs are equipped with an emergency shutdown pressure switch should the pressure in the hydraulic lines exceed a specific manufacturer set point.

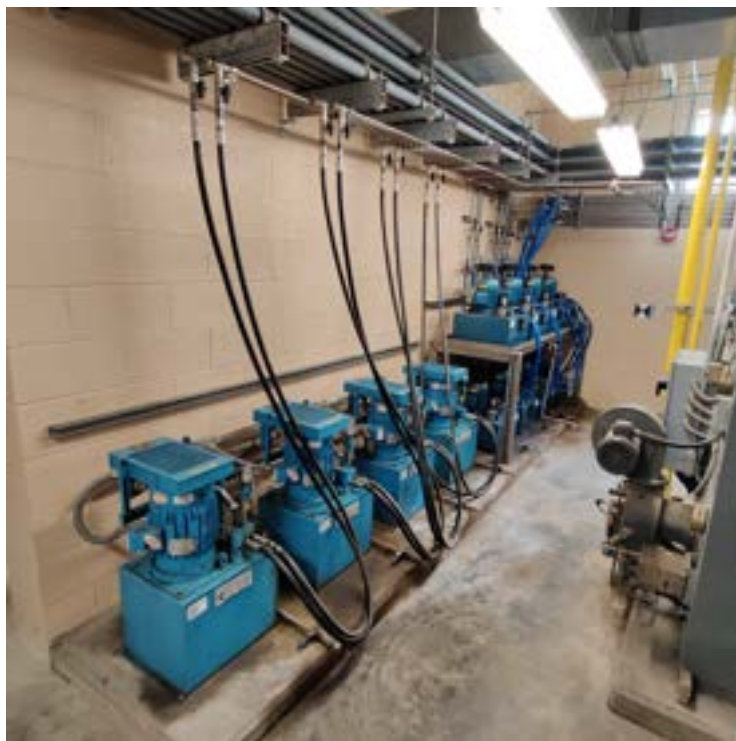


Figure 2-5
Hydraulic Packs for ROMAG (4 on the left) and COPA®(8 on the right, two rows one below and one above)

2.5 Screen Channel Gates

At the end of each screen inflow channel, the outlet gate allows a portion of the influent flow to be conveyed to TTS. **Figure 2-6** shows these gates at the south end of ROMAG and COPA® Screening Inlet Channels. These stainless steel upward-opening electrically actuated slide gates can be opened automatically or manually (whether remote from Ovation or locally from the actuator local control at each gate). Based on the conducted field test and a review of operation video recordings, gate travel time is approximately 4 minutes to open these gates from 0 to 100%.



Figure 2-6
Screening Channel Gates for ROMAG (left) and COPA® (right)

2.6 Initial Design Goal and CS-1281 Evaluation of the Facility Performance

Based on this facility's original design and subsequent evaluation records, Criteria for Success in CSO Treatment was issued in 1998. The Criteria for Success document was developed initially for use in conjunction with evaluations of the Rouge River CSO Demonstration Basins. The document specifies procedures for evaluating Phase II CSO Control goals outlined by the NPDES permit for CSOs within the Rouge River watershed. These criteria were used as a guideline for assessing the Leib CSO SDF ability to meet Phase II requirements during discharges to the Detroit River from 2003 to 2005 as part of the CS-1281 project.

The Criteria for Success document specifies that a CSO control facility would be considered to eliminate raw sewage discharges if the treated effluent did not appear as raw sewage. In accordance with this criterion, the sampling plan for the screening and disinfection facilities included the use of 4-mm mesh sample bags (Copasacs) to measure the ability of the fine screens to achieve "operationally complete" removal of sanitary trash from the effluent. Two screening events (each 3 hours or less) from 6/2003 to 6/2005 took place that each resulted in under 400 cfs peak flow.

The evaluation report indicates that only flow that passes through the screens is considered influent to the facility because flow up to approximately 200 cfs passes to the DRI via the TTS upstream of the screens. This toward treatment flow is roughly equivalent to the flow entering the DRI before facility construction through the Leib regulator gates, which are now closed during events. It was observed that approximately 50-100 cfs of influent flow is necessary to convey

screenings away from the facility effectively. It also indicated that two of the eight COPA® screens stopped functioning near the end of one of these two events. However, these failures did not cause flows to pass unscreened, overtop the screens, or otherwise receive insufficient screening. No identifiable difference was observed between the performance of the COPA® and ROMAG screens operating in parallel at Leib.

3.0 System Evaluation

To evaluate the condition of the Leib Screening system, a multi-faceted approach was taken that included:

1. Three site visits, which included checking the equipment condition and discussing the facility's operation and maintenance with GLWA team members.
2. Preparing existing screenings sampling devices to obtain an improved quantitative and qualitative understanding of the screens performance and capture rate during wet weather events.
3. Collecting and analyzing the facility's last 3 years of operating data (from January 2020) to better understand how equipment reacted to the wet weather events.
4. Collecting and reviewing the video recordings of the last five wet weather events (during 2021 and 2022) to observe the typical equipment operation during the event and identify anomalies.
5. Conducting meetings with operations staff to focus on standard operating procedure (SOP) and O&M procedures in practice and discuss the findings from the review of operating data and video recordings.

These evaluation activities and their outcomes are described briefly in the following sections.

3.1 Site Visits

During the site visits on 11/10/22, 11/1/22, 10/20/22, and 2/27/23, the screening system component's condition was visually inspected, and operation and maintenance items were discussed with day and night shift staff.

In general, the condition of various system components, including ROMAG and COPA® screens structure, cleaning mechanism, combs, rakes, weirs, hydraulic power packs, lines, gates, and actuators, and associated instruments, visually appear to be in good condition. No significant wear, corrosion, or erosion were observed. A few signs of hydraulic oil leaks were observed on a couple of screen support walls related to past incidents of tube leaks. It appears that limited facility activations in combination with commendable housekeeping, resulted in the relatively untarnished condition of the system components. With the exception of some signs of corrosion on the structural truss supporting the catwalk above the screens, there were no significant signs of corrosion or harsh atmospheric environment in the basement or upstream area of the facility.

Based on discussions with operators, there is not a single fault on any piece of equipment that can be indicated as the leading cause of the system operation interruption during wet weather events. However, further discussion of the historical trend of issues indicated that, in general, overloading of the screening cleaning mechanism and issues with leaks or faults of the hydraulic power units may be the leading cause of screen operation interruption during wet weather events.

Operators indicated that the largest object observed in the influent in the last few years of operation was a small traffic cone. Typically the influent does not contain large objects.

There was one event that resulted in screen activation since June 7, 2022, which occurred on February 27-28, 2023. The analysis of the screenings sampling, gate positions, and toward treatment flow from this event is summarized in the next section

3.2 Screenings Sampling

The existing screening sampling devices downstream of each screen and also downstream of the screening chamber are used to take screenings samples during a wet weather event. Proper-size sampling nets were obtained, and the existing sampling devices were cleaned and equipped with nets to capture material that may escape screens during an event. In general, the sampling and analysis methodology of CS-1281 (2004 to 2008) project were used for this effort. **Figure 3-1** shows sampling nets installed downstream of a COPA® screen and in screening chamber.

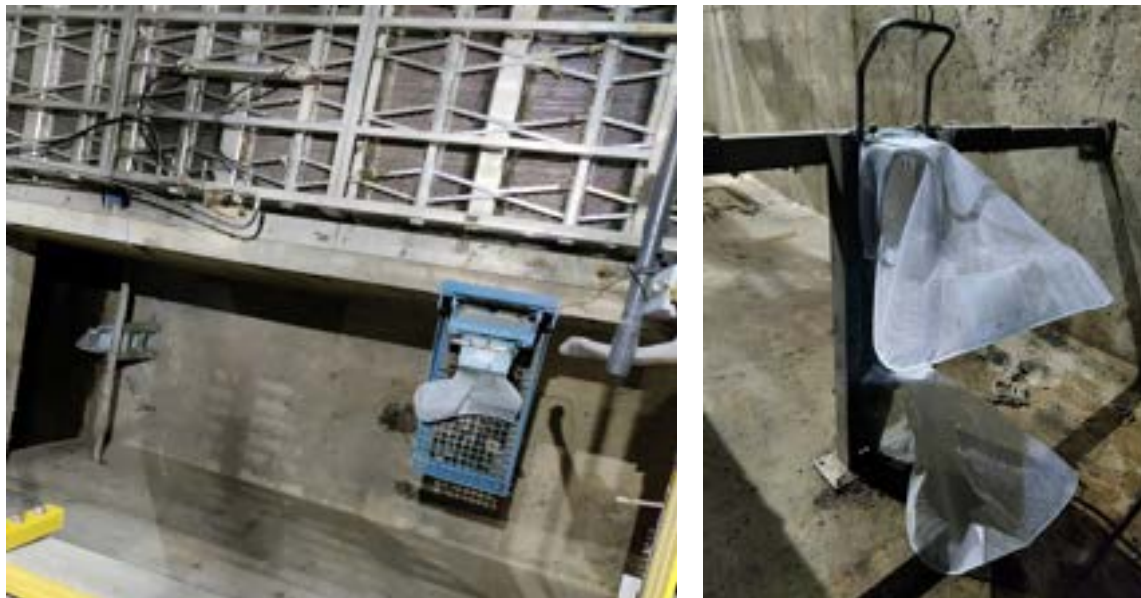


Figure 3-1
Sampling Nets Installed Downstream of COPA® screen (left) and in Screen Outlet Chamber (right)

However, due to the low frequency of this facility activation, from June 2022 to March 2023, there was only one wet weather event that resulted in the activation of screens. The event started on the evening of 2/27/2023 and finished on the morning of 2/28/2023. The event resulted from 0.75

inches of rainfall over about 9 hours. During the operation ride-along of this event (from the 1st to 4th hour), inflow as high as 394 cfs was observed. All 12 screens of 4 channels were in operation without overflow. All four screening channel gates were 100% open, and the Toward Treatment gate was 12.5% open. The dry weather gate was also open, and the total flow conveyed to TTS fluctuated between 57 to 98 cfs. During the operation ride-along, it was observed that the screen cleaning mechanisms were working. The screen field looked clean with limited screenings accumulation, and with the screening channel gates 100% open, the screenings were moving to TTS. The flow to the TTS visibly has more screenings (wipes, floatable, etc.) than the flow conveyed to the Disinfection Chamber. However, based on net samples, it seems some material was getting through the screens, especially if the item was one or two dimensions was smaller than 4 mm screen openings. **Figure 3-2** shows the location of 12 nets installed downstream of screens. The net assemblies have 1 foot by 1 foot flow path openings and about 3.5 mm by 3.5 mm net holes. The weight of captured material in these nets during the whole event varied from 0.4 to 1.2 pounds. In general, it seems the amount of materials passing through screens is increasing from the west channel to the east channel. The captured material in nets includes decomposed wipes and toilet paper, leaves, wood chips, twigs, fabric, plastic, cement pieces, paint pieces, plastic wraps, and seeds, with one folded N95 mask found in the S6 net. The smallest dimension of each captured item was not larger than 3 mm however the larger dimension of some items like twigs could be as much as 60 mm (mostly in one dimension). **Figure 3-3** shows a view of 12 sampling nets after the event and a sample content of captured materials.

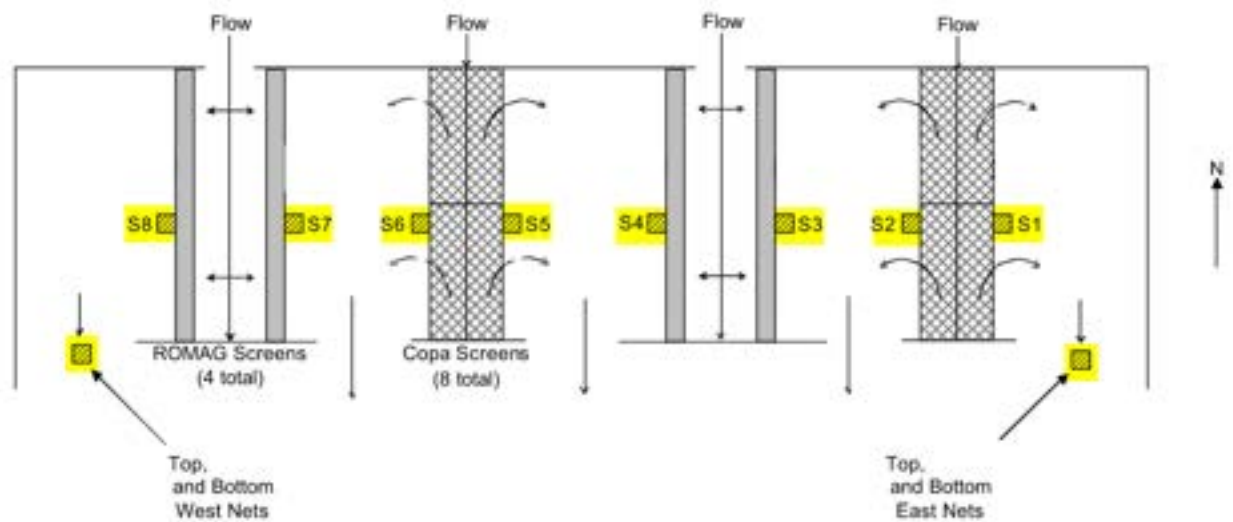


Figure 3-2
Installation locations of screenings sampling nets



Figure 3-3
Top face of all sampling nets (top) and content of S1 net (bottom)

3.3 Operation Data Analysis

Collecting and analyzing system components' operating data during the last 3 years, from January 2020 to January 2023, provided a better understanding of the system operation. The analyzed data included the following:

- Three flow sensors: Influent, Toward Treatment, Outfall Sewer
- Six level sensors: Influent, Screening, Mixing Chamber, Outfall Lower Sewer, Outfall Upper Sewer, Upper DRI
- Seven gates position: Screening Outlet Gates 2, 4, 6, and 8, Dry Weather Gate, Disinfection Chamber Drain Gate, Toward Treatment Gate
- Twelve screens: Auto, Overflow Fault, Run

A data review showed many instances that one or multiple sensors' data was unavailable through the data archive or the reported values were unreliable or erroneous. However, analysis of data from various sensors at the same time showed that with high certainty, there were ten wet weather events in the last 3 years, which resulted in screen activation. The data analysis showed various irregularities in the operation of screens and gates, which did not match the expected operation per facility SOP and O&M documents. Based on the SOP and O&M, it was expected that all screens turn on when the water level in Screening Chamber reaches about elevation 110' (~13 ft deep). At this time, all four Screening Outlet Gates open, the Dry Weather Gate closes, and the Toward Treatment Gate changes position from 100% to 12% open. Also, it was expected that the opposite of all these actions would happen when the water level in Screening Chamber drops below elevation 109.8' (12.8 ft deep). However, analyzing data from a few recent events during the last three years showed the screens did not start at the expected level, and if started, shut down soon, after a few minutes in some cases. Also, the TTS gate was closed for a long duration of the event. Ovation data points that were used in this analysis include influent, outfall and TTS flow, influent, screening, mixing chamber and TTS levels, screen outlet gates, 2, 4, 6, 8, dry weather gate and TTS gate positions, screens 1 to 12 fault and run status. For instance, **Figure 3-4** shows the status of screens, TTS gate, and influent level & flow in addition to the TTS level and flow for a screening event from 6/7/22 to 6/8/22. During this event, no screen fault is recorded on Ovation. The TTS gate is closed, and flow to TTS is almost zero from around 5 AM to 11 PM of 6/7/22, while the influent flow, level, and screening level are high. All screens turned on early in the event and then turned off, and some of them came back on and off during the event for short periods of time.

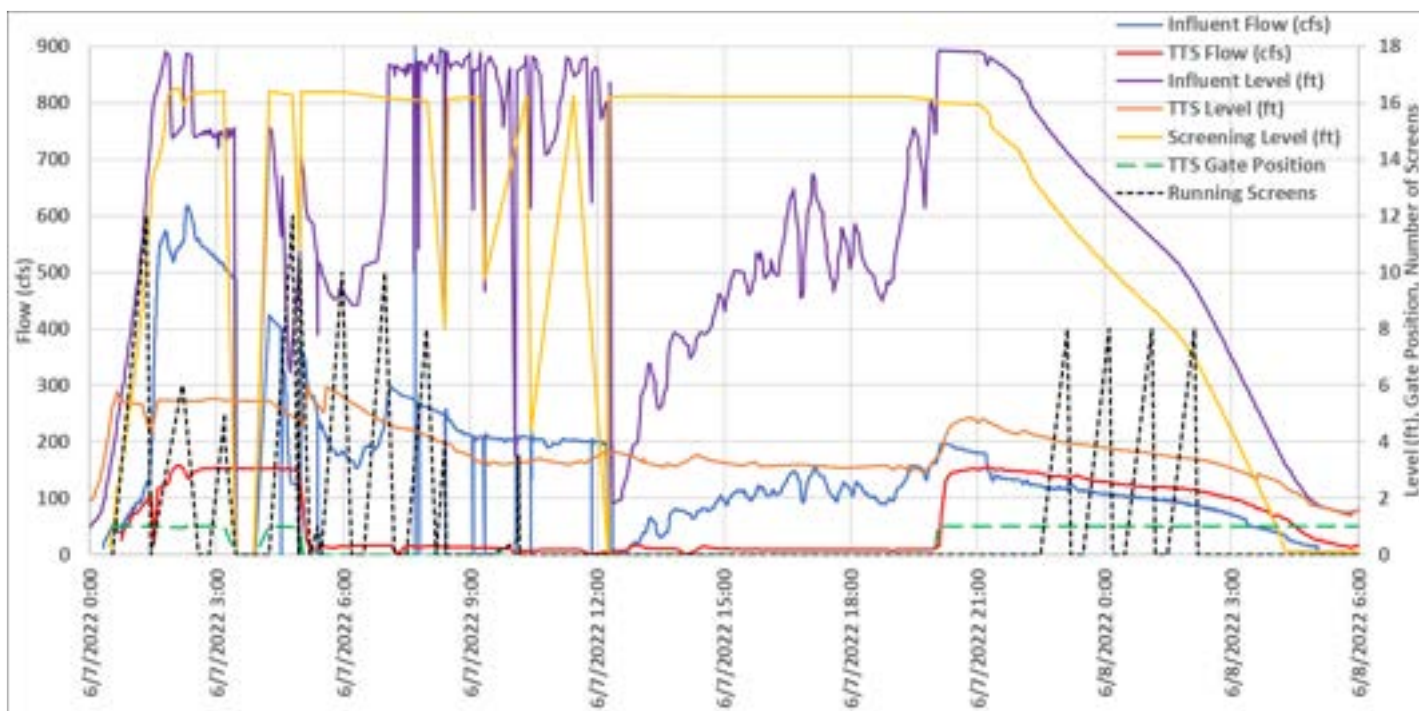


Figure 3-4
Ovation historian data for Leib screening event on 6/7/22 to 6/8/22

Table 3-1 lists the summary of data related to each screening event in the last 3 years. Many irregularities can be seen where system responses do not match the expected system component status based on SOP and O&M.

3.4 Video Recording Review

The video recordings of five out of the ten screening events from January 2020 to January 2023 were provided by GLWA. A review of the video recordings also showed some equipment operation irregularities, system responses that were not matching the expected system operation per SOP and O&M. Based on SOP, it was anticipated that lights turn on and video recording would start as soon as screens turn on, and the light turns off, and video recording stops when screens turn off. The summary of the video recording review and observed anomalies are shown in **Table 3-1**.

Table 3- 1 Summary of Leib Screening Event Information from January 2020 to January 2023

Event Date	6/7/2022	10/25/2021	9/22/2021	8/12/2021	7/24/2021	7/16/2021	6/26/2021
24 hours Rain	1.97"	1.04"	0"	1.73"	1.33"	2.72"	4.73"
Video Recording Available?	Yes (4 hrs.)	Yes (2.5 hrs.)	Yes (2 hrs.)	No	No	Yes (4 hrs.)	Yes (1 hr.)
Max Influent Flow During Event, cfs (based on Ovation)	910.93	n/a	n/a	649.99	404.27	1087.86	551.81
Max Influent level During Event, ft (based on Ovation)	17.92	18.45	18.40	16.87	16.84	18.45	16.50
Screening Event Duration hr: min	7:05	7:24	12:17	11:30	6:39	8:16	10:30
Avg TT Gate Position During Event, % open (based on Ovation)	49.95	26.06	0.00	24.75	96.83	11.45	29.04
Screening Channel Gates	Gate 2 closed, other three open for 1 min	all open for 1 min at the beginning of the event, then closed for the remainder	all closed	all closed	all closed	Gates 2, 4 & 6 were open 3 hours after the start of the event until its end; the other one stayed closed	open 15 min after the screen start and stays open for the whole event
ROMAG	All ran periodically for short intervals during the event	1 & 2 never ran, 7 & 8 ran except the last 1-2 hours	All ran only during the 1st hour of the event	Only seven ran during the event, except for the 1st hour	All never ran	1 & 2 never ran, 7 & 8 potentially overloaded after ~1 hr	All except 1 ran during the whole event
COPA®	All ran periodically for short intervals during the 1st 3.5 hrs. of the event, then ran continuously for the 2nd 3.5 hrs. of the event.	Three only ran during the 1st half an hour of the event. The rest ran the whole event.	All ran during the entire event	All ran during the event except the 1st hour	All ran during the whole event	All ran during the entire event	All ran during the whole event
Known operation issue based on operator notes	Hydraulic line leak, power loss	Power packs has issue and filter cup was leaking	No issues	Overload fault for screens 1 & 2, Hydraulic issue for screen 8	Remaining issues from 7/16	2, 7, 8 had issues and couldn't ran even on manual	Many issues resulting in screen and hydraulic unit repair and replacement of hoses, ROMAG combs and COPA® rakes

These observed operation anomalies could potentially contribute to the screen overflowing that was observed in all five events.

3.5 Operator Meeting

After a desktop study of SOP, O&M, project records, site visit records, and analysis of archive operating data and video recordings, a meeting was arranged to discuss the results of the analysis with the operation team. Comparing notes with staff who have been leading the operation of this facility over the last ten years confirmed the ten-identified screening events in the previous 3 years. Also, various causes were identified that could explain several of the irregularities observed in archived operating data and video recordings. The main contributors to these irregularities were Ovation communication loss or faulty signal from instruments, oil leak and hydraulic unit fault, screen overload, and power loss. Also, during a meeting on 1/26/23, it was indicated that typically operators leave the Toward Treatment Gate or Screen Channel Gates completely closed during the wet weather event to prevent adding flow to DRI. Considering that all existing ROMAG and COPA® screens are deflection-type screens that need active side flow to TTS to prevent screenings accumulation on the face of the screen, preventing flow to the TTS results in screen clogging and overloading.

Further discussion with GLWA operations and engineering staff indicated that there is no fixed limit on the amount of water that can flow from the Leib facility to DRI during the wet weather. However, the currently established protocol is to position the Toward Treatment Gate about 20% open to limit the excessive water flow to DRI in wet weather conditions.

Table 3-1 lists a summary of critical information collected during the meeting with operators. Discussion of the significant improvements and maintenance conducted on the screens revealed the recent replacement of hydraulic hoses of all screens from the power pack to the solid pipes. In addition, staff indicated that the cleaning combs of ROMAG and rakes of COPA® screens were replaced recently. This rehabilitation activity was conducted in mid-2021 after major screening issues were observed during the wet weather events on 6/26/2021.

4.0 Improvements of Existing Screening System

Based on existing system evaluation and communications with the screen manufacturers, recommendations are provided below to improve the performance of the existing screen system. The goal is to make the system more reliable and enhance debris removal to allow the screens to maintain function throughout events to reduce the frequency of screen overtopping.

4.1 ROMAG Screen Improvements

ROMAG is one of the dominant screening products in the market for deflection-type screens. They have a track record of installation in North America and are still active in this market under SAVECO representation. Their present local representative in Michigan is Peterson & Matz Inc., which is familiar with the equipment in this facility. Their control technology and instruments for actuating the hydraulic cylinders driving the cleaning comb were improved in recent designs. Based on the manufacturer's input, this modification can reduce the frequency of screen overloading faults by decreasing the chance of shortening the cleaning mechanism strokes. The updated control features includes:

- Short Stroke detection / alarm
- Blocked clean rake/carriage detection / alarm
- Rakes parked at home to allow for maximum cleaning force upon initial startup
- Pressure monitoring and individual set points for controlling rake/carriage in each direction
- Repeat cycle timer
- Allows for control of upstream level sensor setpoints to control screen cycle
- Running the screen cleaning mechanism faster

Also, replacing the hydraulic power pack and possibly its piping could improve power delivery from the unit to the screen cleaning mechanism with reduced pressure loss. This, in combination with providing the required power to clean screenings from screen field and the proper speed of the combs, can reduce the potential for over-pressurizing fault and tripping the unit.

The operation of the ROMAG screens will also be improved by providing the required minimum 10% side flow to convey screenings to the toward treatment sewer and out of the screenings collection channel. Hydraulic analysis performed by the design team, concluded that it is technically feasible to provide the minimum 10% side flow with the screenings channel gates and the toward treatment gate positions set properly, as described further in Section 4.4. As described in Section 3.2, the desired minimum side flow was also exceeded during the 2/27-2/28/23 wet weather event which activated screen operation. The hydraulic evaluation also showed that the headloss through the facility was acceptable while achieving the 10% minimum side flow.

According to the manufacturer's recently identified requirement, exceeding a through-bar (slot) velocity of 5 ft/s can negatively impact the screen's cleaning mechanism, potentially causing the accumulation of screenings and lead to faults. To facilitate slot velocity remains below 5 ft/s during the peak screening design operating condition, the manufacturer suggested lowering the bottom of the screen by approximately 1-foot while maintaining the existing elevation of the top of the discharge weir. Implementing this change requires limited structural modifications, including the removal of 1-foot of concrete wall beneath the screens that will allow reinstalling screens at the lowered elevation. Additionally, the discharge weir plate on the downstream face of the screen requires replacement. These modifications will result in a larger portion of the screen face being submerged during peak flow conditions, effectively reducing the slot velocity. This alteration will not have an impact on the upstream water surface elevation since the elevation of the top of the discharge weir remains unchanged in this configuration.

The possibility of replacing the existing rakes with 4-mm screen openings with new rakes with 6-mm screen openings was discussed with the manufacturer. Although ROMAG is not recommending the 6-mm openings, and they typically use the 4-mm openings for CSO applications, they can provide 6-mm openings. The 6-mm opening is the typical opening size of CSO facilities using other screen technologies and is commonly one of the smallest sizes of screen openings considered for CSO facilities. Changing the opening size from 4-mm to 6-mm has advantages and disadvantages. Having a narrower opening can increase the capture rate. Also, the close distance of two bars provides a support mechanism for the wider flat shape debris (e.g., leaves, wipes, paper, etc.) that increase the potential capture. A wider gap between the bars may result in flat or stringy-type debris wrapping around the rake that might be harder to clean from the screen surface by the cleaning mechanism. This wrapping condition was of concern to ROMAG representatives. However, 6-mm openings reduce the potential of screen clogging and can improve the hydraulic throughput of the unit and reduce the slot velocity. In this case, although finer material might pass the wider openings, in general, due to reducing the potential for screen clogging, high slot velocity, and reduced probability of overtopping, the screenings capture performance during the entire event may increase. Based on the above considerations, the design team recommends maintaining 4-mm openings.

The Design Team's review of recent installations of similar ROMAG equipment in other parts of the country showed that although the new equipment is not working flawlessly, the number of faults and overtopping are limited.

4.2 COPA® Screen Improvements

The official supply of COPA® screens to North America has been interrupted in the last decade. The company does not have an official representative or installation list for new equipment installations in the United States (U.S.). Furthermore, based on the discussion with the company United Kingdom (U.K.) headquarter staff, the technology of these screens has not improved considerably in the last few decades. Accordingly, no other improvement options exist except for replacing the screens or their components with the same assembly.

The engineer's inquiry of other COPA screen installations in the U.S. after the original construction of this facility did not find a successful example of COPA screen implementation for CSO applications.

Considering the relatively untarnished condition of the existing COPA screen and the plan to replace half with a different type of screen as part of this project pilot screen evaluation, it is not recommended to replace the remaining COPA® screens in kind. However, due to the safety risk associated with cleaning the COPA® screens after the event from the top of the screen, it is recommended that permanent fall arrest/protection tie point be provided on top of the remaining COPA® screen equipped channel. This could help operators and maintenance staff to have an additional and accessible safety protection device in case they need to climb on top of the Copa® Screening Channel via the lower Screening Outlet Channel.

4.3 Screenings Channel Gate Improvements

As discussed in the previous section, visual inspection and dry run of the Screenings Channel Gates demonstrated operational equipment in good condition. Gates appear to be well maintained. Based on the present condition and travel time the gate system equipped with electric actuators a change to the equipment or the actuation system was not identified as beneficial to enhancing performance.

Replacing the upward opening gates with rectangular butterfly gates, in theory, can give more control to take the flow to the TTS from an area closer to the surface of ROMAG screens instead of from the middle of the channel. This, in theory, can help increase the efficiency of washing away the screenings accumulation from the face of ROMAG screens.

Discussions with the manufacturer showed no positive experience with the concept of using rectangular butterfly gates. The lack of practical evidence for benefit and the need to change the gates for two channels while the gate for the COPA® channel needs to stay the same (due to the screen arrangement) led to disregarding this option. In addition, implementing this option could increase the complexity of the operation and maintenance of the system and might lead to some operation and maintenance challenges due to wrapping screenings around the gate, and may not have a sensible positive outcome.

4.4 Control and Operation Improvements

In addition to the rehabilitation of ROMAG and COPA® screens the review of operating data, operations discussions, and Design Team observations indicated potential operation and control changes that could improve existing equipment performance and reduce the frequency of overtopping.

The main operational change focuses on providing a flow path for about 10% of the influent flow to wash down the captured screenings from the screen field to the TTS. The existing deflection-type screens require this flow to prevent the accumulation of screenings upstream of screens that eventually result in screen clogging, cleaning mechanism overload, and screen overtopping. ROMAG

representatives recommended a minimum of 10% influent flow. This number is recommended for this application to meet the minimum requirement of the deflection type screen while minimizing conveyance of an excessive amount of flow to DRI during a wet weather event. In addition, the automatic controls of screens should be set to activate the ROMAG and COPA® screens as soon as flow reaches the discharge weir of the ROMAG screens; at the same time, Screenings Channel Gates need to be opened fully while the Dry Weather Gate is closed, and the position of the Toward Treatment Gate should be partially closed so 10% of the influent flow is conveyed to the TTS. Based on discussions with the GLWA CSO operations and engineering teams, a 20% open Toward Treatment Gate is not expected to have an adverse effect on the downstream DRI during a wet weather event. Considering the peak design flow of 950 cfs (after Meldrum St. connection), about 95 cfs needs to be conveyed to TTS for proper transfer of screenings away from the screen field. The Toward Treatment Gate open position should be adjusted based on the influent flow to the facility and TTS flow to keep the TTS flow about 10% of the influent flow if feasible within the maximum gate open during wet weather event constraint.

It is important to note that the screenings channel gates provide a flow path to the screenings collection channel. However, the opportunity to control flow rate from each screen channel to the screenings collection channel is limited if system complexity is not increased as part of the improvements. Presently instrumentation is not in place to allow determination if the appropriate flow is being conveyed given the deflection screen flow split varies between the technologies resulting in the side flow rate varying accordingly to meet the 10% minimum. This is a limitation of the system resulting in inability to provide inputs to determine gate position to throttle flow to achieve 10% discharge to TTS from each channel relative to the influent flow through each screen. In addition, the throttled gate may cause screenings to back up if the majority tend to float in the upper portion of channel.

It is recommended that operators be discouraged from running screens and gates manually (whether local manual or remote manual) unless the Ovation communication or instrument issues prevent the automatic operation from functioning as expected. Also, to provide a greater flow path area through the screens and reduce the potential for clogging, it should be considered to run all screen cleaning mechanisms at the manufacturer recommended speed during the automatic operation. The cleaning mechanism of existing ROMAG and COPA screens has only a one-speed option. However, other technologies (e.g., multi-rake screens) can provide an option for running the cleaning mechanism at low or high speeds.

At the end of the wet weather event, with a few minutes delay after the water level in the screening influent channel drops below the elevation of the discharge weir screens, all screens should be turned off, and the Screenings Channel Gate closed at the same time.

The Disinfection Drain Gate remains closed during events as it is only used for Leib dewatering.

4.5 Field Instrument Calibration and Backup Monitoring Options

Calibrating the Influent flow meter, Toward Treatment flow meter, and the Screening level sensor (which are critical instruments in screen and gate operation control) is very important for successful automatic operation. To protect screens from running dry (which is harmful to, the screens, particularly the ROMAG screens), when the screening level sensor reads faulty unrealistic high-water level, the backup level switches for high and low levels can be used. Alternatively, a combination of signals from other sensors (e.g., Influent or Outfall Sewer flow, Mixing Chamber level, etc.) could be used as a verification or as a backup of the Screening level sensor readings.

5.0 Description of Pilot Screen Alternatives

Various alternatives were evaluated to replace the existing COPA® screen in one of the Screening Inlet Channels with a new technology or installation. These alternatives are described in the following subsections.

5.1 Design Criteria

Table 5-1 summarizes the original design criteria from more than two decades ago and the design criteria based on the present analysis and updated requirements.

Table 5-1 Design Parameters

Parameter	Original Design (1998)	New Design (Predicted 5-minute Peak Flow Rate)	
		Present Collection System Configuration	Future Configuration (after Meldrum connection)
Hydraulic Capacity (cfs)	2,000	2,000	2,000
Peak Flow (cfs)	1,550	520	950
Average Flow (cfs)	N/A	118	380
Peak Design Event	10-year, 1-hour event	10-year, 24-hour event	
Average Design Event	N/A	6-month, 24-hour event	
COPA® Blinding Factor	30%	50%	
ROMAG Blinding Factor	20%	25%	
Multi-rake Blinding Factor	-	30%	
Redundancy	None (all 4 channels in operation for peak design flow operating condition)	3+1 (one channel out of service for peak design flow operating condition)	

The original peak design flow capacity of 1,550 cfs for screening was considered to go through all four Screening Inlet Channels with all 12 screens in service. However, based on the latest revision of the Recommended Standards for Wastewater Facilities (Ten States Standards, 2014), this facility is to be designed with the capability to screen peak design flow with one unit (channel) out of service.

The original design basis utilized 30% and 20% blinding factors for COPA® and ROMAG screens, respectively. Peak design flow of 1,550 cfs total with, flow split through each COPA® (410 cfs) and ROMAG (365 cfs) screens Inlet Channel.

The communication with COPA® and ROMAG manufacturers and using their most up-to-date blinding factors and formulas indicated that a 50% blinding factor for COPA® and a 30% blinding factor for ROMAG screens are more representative values for the real operating condition of these types of equipment.

The updated SWMM model of the upstream watershed and historical wet weather records of the last two decades were studied as part of this project, and the 5-minute peak design flow of 950 cfs based on 10-year, 24-hour design event is considered for this improvement design (includes future Meldrum St. connection). The average flow is determined to be 380 cfs (includes future Meldrum St. connection). To meet the Ten States Standards requirements, the peak flow needs to be screened with one Screening Inlet Channel out of service.

5.2 Multi-rake Bar Screens

This technology incorporates a fixed screen field with bars installed between 45-degree to nearly vertical angle. Multiple rakes clean the screen field with teeth that engage into the space between the bars and travel over the screen field frequently (every 5 to 10 seconds for some screens). The rakes are attached to a chain that rotates in front of the screen. The screenings are lifted by the rakes and discharged off the back of the screen. Manufacturers of multi-rake bar screens on the U.S. market include the MS screen by Headworks® (see **Figure 5-1**),; the FlexRake® by Duperon®; and the RakeMax® by Huber. Despite Duperon's advantages of having a headquarter in Michigan and lack of a submerged lower sprocket, based on challenges at other applications at 6-mm and limited cleaning speed when plan to run at max speed continuously, the FlexRake® receives a lower ranking in comparison to Huber and Headworks product for this application. The following subsections describe three alternatives for various installations or types of multi-rake bar screens which are applicable to this site.



Figure 5-1
Multi-Rake Bar Screen (Headworks® MS-1)

Multi-rake bar screens have a lower screenings capture ratio than other perforated or mesh screens due to removal in one dimension only. However, the screens are more rugged and appropriate for wastewater or combined sewage applications. In addition, this technology has lower head loss compared to other screening technologies. Finally, this type of screen has a long track of successful installation in various capacities. These are some advantages and disadvantages of multi-rake bar screens:

- Advantages
 - Multiple rakes are attached to the chain to permit quick cleaning of the bars and reduce screen blinding
 - Very low headroom requirements with only the motor, frame, and doctor blade mechanism located above the screen discharge point
 - Medium footprint due to recommended inclination angle (as low as 45 degrees up to 90 degrees, typically 75 degrees)
 - Lower head loss compared to other screens

- Deep installations are possible and have been done previously. Also, installation in segments is possible in case of limited available space for installation and rigging
- A VFD can control the motor drive to moderate the rate at which the rakes clean the screen field
- Availability of clear bar spacing as low as ¼-in (6-mm) for combined sewage
- Some manufacturers do not include a lower submerged sprocket (Duperon Flexrake®) which is more convenient for maintenance and limits maximum operating speed
- High screenings loading rate and flow capacity
- Holds up well to high-grit applications
- Disadvantages
 - Submerged lower sprocket and bearing (typical installation for most manufacturers except Duperon Flexrake®) can be hard to access for maintenance. However, technological innovations have significantly increased the durability of submerged components. For example, the lower sprocket and bearing are a self-lubricating design, and grease lines are not required. For instance, based on information from Headworks®, the lower sprocket assembly utilizes an exclusive self-lubricating ceramic bearing. The assembly is maintenance-free, highly wear-resistant, and covered by a 5-year warranty. Units have been in operation for ten years without any parts replaced. The screen can be operated in dry conditions without damage to the sprocket and bearings. However, long periods of dry operation are not recommended as the hard ceramic bearing could cause wear on the stainless-steel shaft. For this application, which is dewatered between events, access to the lower components is more readily feasible than in continuous duty applications.
 - Screen remains in one position for long periods without flat spotting the bearing or shaft in this arrangement. However, exercising the screens on a regular interval, which the control system can automatically perform, is recommended to create a movement of other parts (i.e., the chain and motor) and verify the screen operates.
 - A large amount of stringy material could wrap around the lower sprocket and cause it to stop turning, thereby causing a torque overload shut-down.
 - Annual to semi-annual inspection recommended.
 - Ultra-High Molecular Weight polyethylene (UHMW) turnaround shoe is available as an alternative to the sprocket assembly; however, the shoe is much more susceptible to wear

from grit and would end up being replaced three to four times before a sprocket would need to be maintained.

5.2.1 Alternative A: One Regular Type Multi-Rake Bar Screen

This alternative includes installing a multi-rake bar screen toward the south end of the easternmost screening channel to replace the four existing COPA® screens (No. 8 to 12). **Figure 5-2** shows the arrangement of the new screen and its screening discharge chute in plan and section views. Huber RakeMax®, and Headworks® MS series all can provide multi-rake bar screens for this application, including the extended chute.

In addition to removing the COPA® screens, installation of a new screen for this alternative would require structural changes as follows:

1. Removal of the stepped concrete fill in the Screening Inlet Channel
2. Removal of the existing Screening Outlet Gate and close opening. To seal the existing concrete opening, adhesive dowels and a hydrophilic waterstop will be installed around the perimeter of the existing openings. The opening will then be filled with reinforced concrete.
3. Adjustment of the elevation of the top of the walls of both sides of the Screen Inlet Channel.
4. Modification of the platform and walkway around the screen and its discharge chute to resolve conflicts.
5. Creation of a new opening on the lower part of the channel wall for screened combined sewage to flow downstream of the screen to the Mixing Chamber. This opening can be created either on the south end wall of the Screening Inlet Channel for a flow path under the Screening Collection Channel or on both the east and west walls of the Screening Inlet Channel. If this alternative is selected the size and location of the wall openings will need to be refined and further coordinated with disinfection unit process in future design phases. The opening invert should be at the same level as the concrete floor of the channel to allow discharge and flushing of potential sediment. The chambers containing walls where new openings are required will be required to be fully drained during construction. Once drained, the new openings can be cut into the existing concrete wall. The existing rebar will need to be drilled back into the concrete wall and sealed to prevent corrosion. Depending on the final size and location of openings, additional structural strengthening or stiffening may be required.
6. Creation of a small opening on the north wall of the Screening Collection Channel for the screenings chute discharge point to this channel.

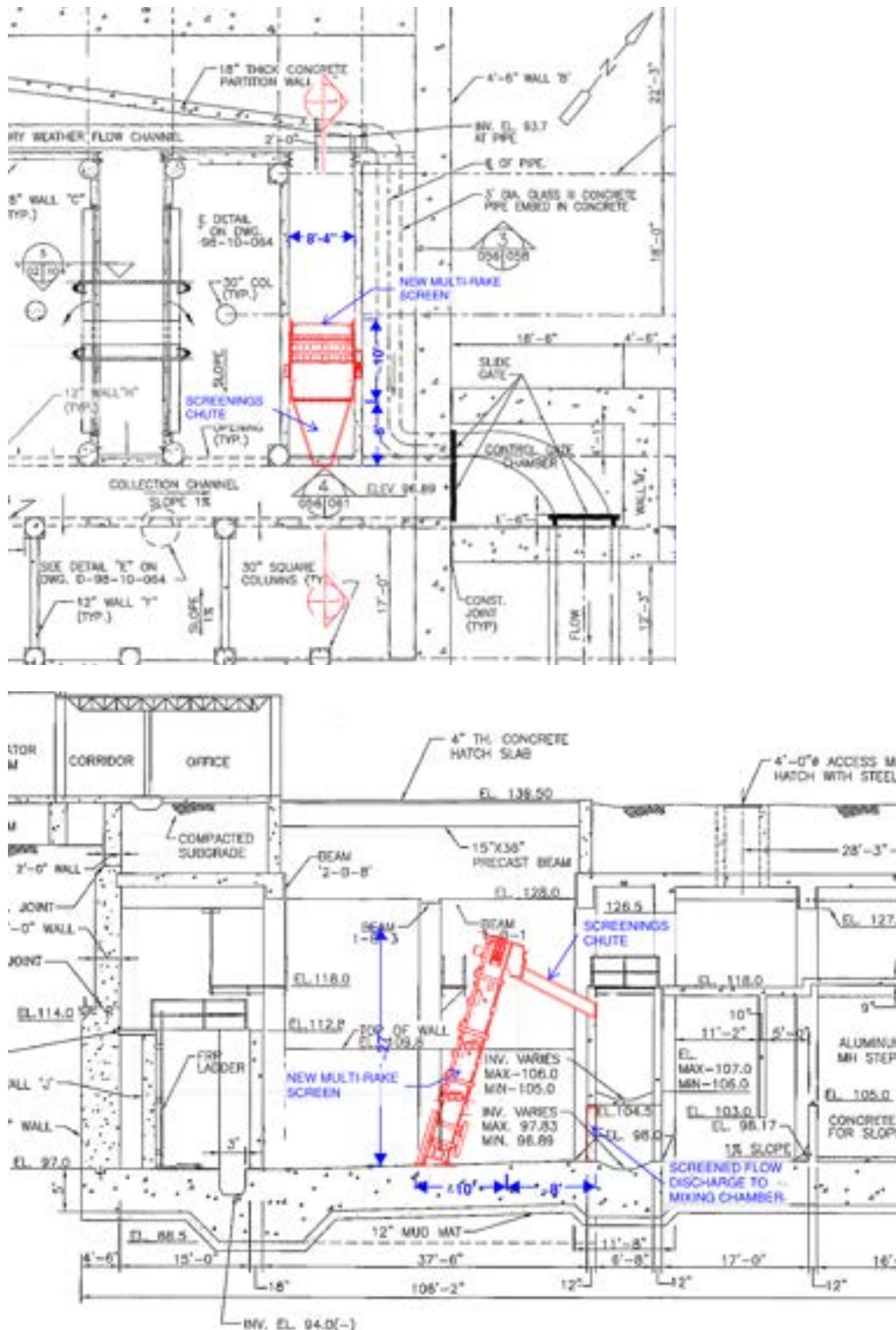


Figure 5-2
Alternative A Plan (Top) and Section (Bottom) Views (Duperon)

5.2.2 Alternative B: Two Multi-rake bar Screens Installed Perpendicular to the Flow Direction

This alternative includes installing two multi-rake bar screens perpendicular to the flow path of water. The two screens can be installed either face to face on both East and West sides of the Screening Inlet Channel or side by side, both on the south wall of the Screening Inlet Channel.

Figure 5-3 shows the former face-to-face arrangement of the new screens and its screening discharge sluice channel in plan and section. Headworks® indicated their MS-1 multi-rake bar screens can be installed in this arrangement, including the required sluice chutes.

The structural changes required for this alternative are similar to Alternative A. However, the extent of change items 5 and 6 is broader for this alternative. The wall opening for installing screens in this alternative affect the full height of both the east and west walls of the Screen Inlet Channel. Also, there would be two openings for the discharge point of the sluice chutes on the north wall of the Screening Collection Channel.

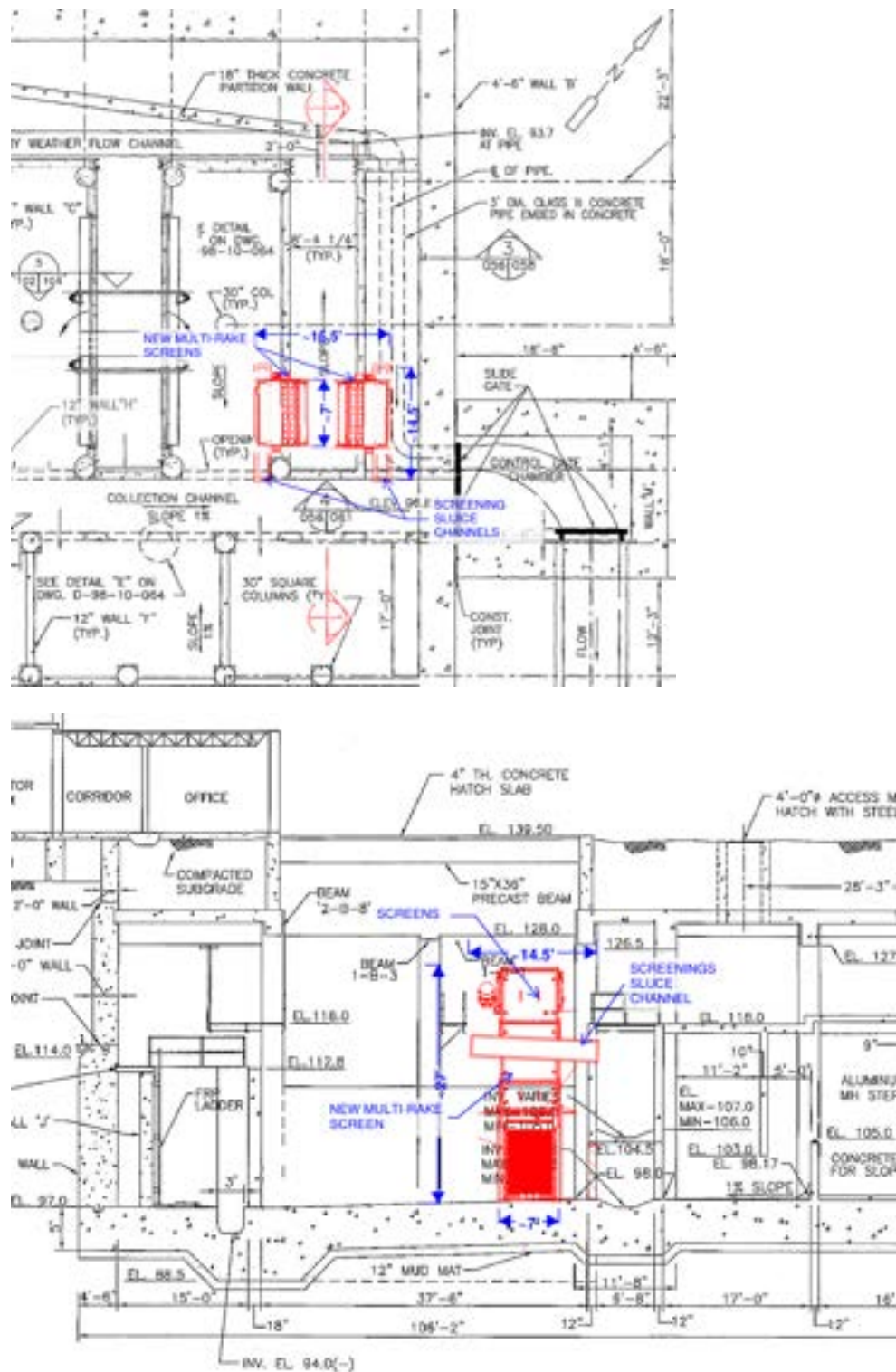


Figure 5-3
Alternative B Plan (Top) and Section (Bottom) Views for Headworks screens

5.2.3 Alternative C: One Center Flow Multi-Rake Bar Screen

This alternative includes installing one center flow multi-rake bar screen toward the south end of the Screening Inlet Channel. **Figure 5-4** shows the plan view of this alternative with a sketch of this specialized type of multi-rake bar screen. In this installation, incoming flow from the Screening Inlet Channel impacts a dead-end plate in the screen, causing the flow to turn 90 degrees and be conveyed through U-shaped bars of this multi-rake bar screen located at the center of the channel. Two side plates at the inlet point of the screen guide the flow toward the center of the U-shaped screen. The rake mechanism rotates around a closed chain loop to clean the screen from one side of the U-shaped bars to the other side and discharge the captured screenings on one side. Huber would supply this screen as a variant of their standard RakeMax® multi-rake bar screen.

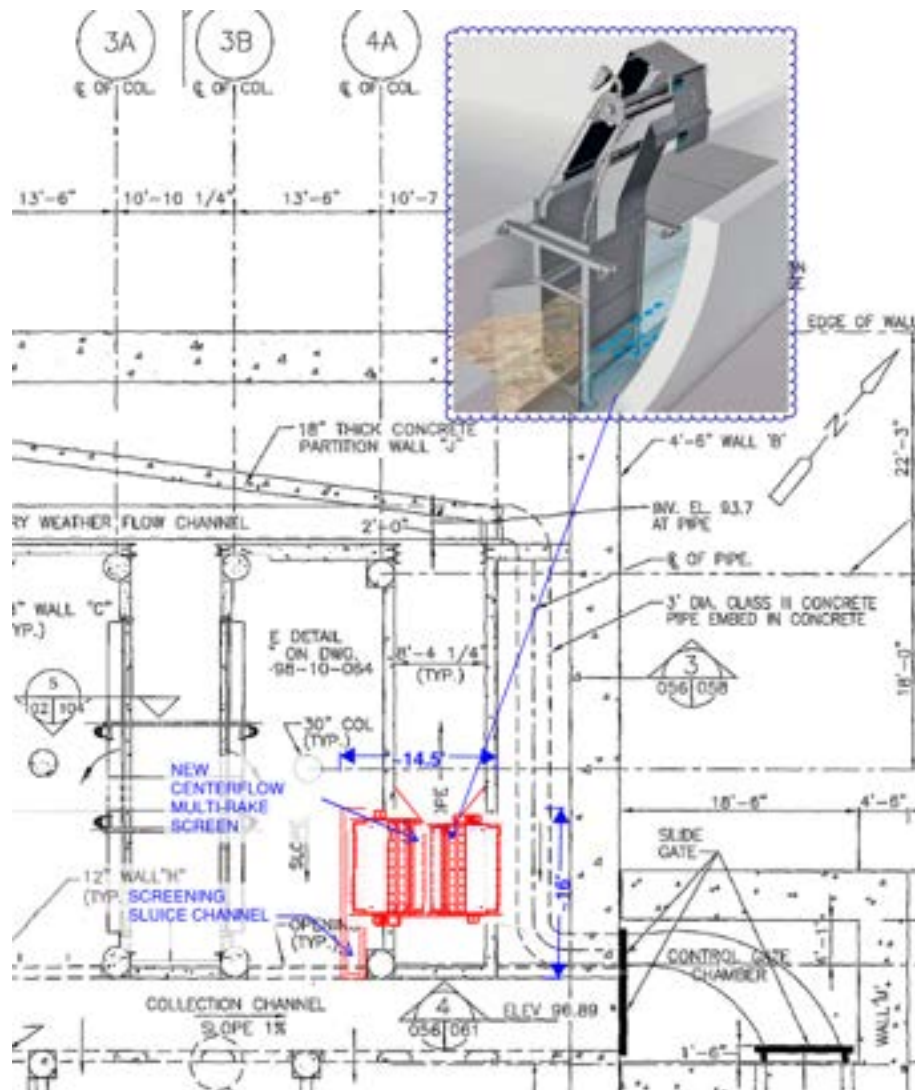


Figure 5-4
Alternative C Plan View (Huber RotaMax CF)

5.3 Alternative D: Two Overflow Screens with Screws

This alternative includes installing two overflow-type screens on both East and West walls of the easternmost screening channel. Similar to COPA® and ROMAG screens, overflow screens return the captured screenings to the influent channel, which needs to be carried over to the Screening Collection Channel by a portion of the influent flow. **Figure 5-5** shows the proposed arrangement of these new screens in plan view. The flow direction through the screen is typically from top to bottom. The semicylindrical perforated screen field is under the rotating screw equipped with soft brushes on the edge of the screw, which aid in screen field cleaning. Accordingly, these screens hang from the outer wall face at the top of the concrete walls. Both Huber ROTAMAT® RoK1 and SAVCO SAVI VSE700 can be made in 28-inch diameter and 28 feet long for this application. Huber ROTAMAT® RoK 2 is also a similar equipment with an opposite upward flow path due to the location of the semicylinder perforated plate screen on top of the screw. Accordingly, RoK 2 can be installed on the inner face of the concrete walls of the Screening Inlet Channel and stay entirely within the channel. Therefore, the structural modifications for this alternative are minimal.

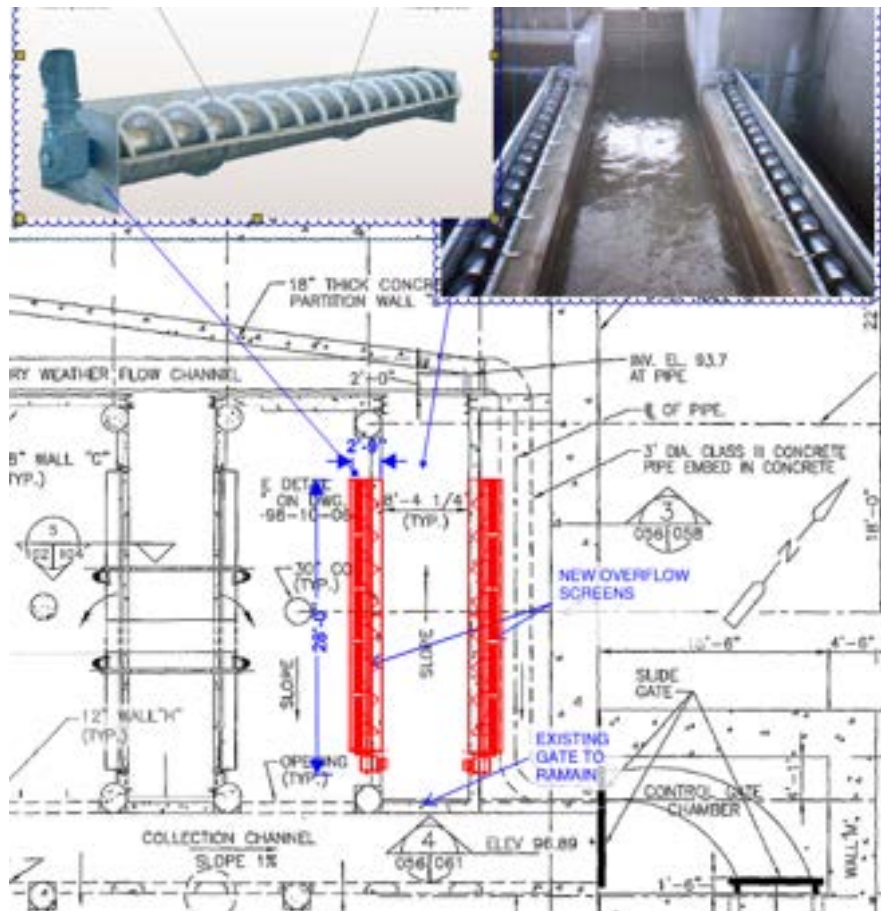


Figure 5-5
Alternative D Plan View SAVECO SAVI VSE (top left) and Huber ROTAMAT® RoK1 (top right)

5.4 Other Alternatives

In addition to the main alternatives described above, a few other alternatives were considered, listed below. These alternatives are presented in this subsection as a group as they are considered secondary alternatives that are less promising than the first group and face challenges to meet the guiding principles of the project and improvement goals.

5.4.1 Alternative E: Multi-rake Bar Screen and Overflow Screen

This alternative is a combination of Alternative A, and Alternative D. One multi-rake bar screen on the south end of the Screening Inlet Channel captures screenings similar to Alternative A. However, to achieve a higher hydraulic capacity for this screening channel and especially during significant events, an upstream overflow screen would be installed on the south wall of the channel. Captured material with the overflow screen will be discharged back to the channel and recaptured again by the multi-rake bar screen. **Figure 5-6** shows the plan view of this alternative. Huber can supply both types of these screens. The structural modifications needed for this alternative are similar to Alternative A.

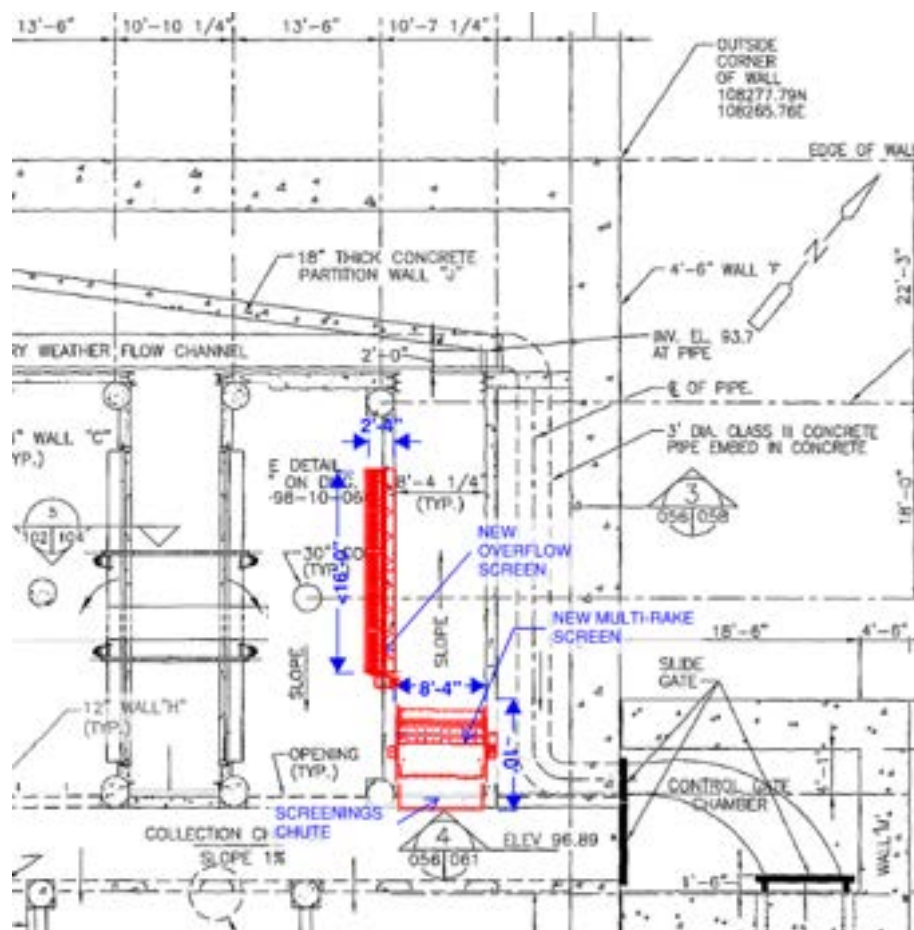


Figure 5-6
Alternative E Plan View (Huber)

5.4.2 Alternative F: Continuous Element Screens

This screening technology (sometimes referred to as belt, band, or escalator screens) consists of a continuous band of either perforated plate or bar screen media that rotates through the influent stream. The screen serves the dual purpose of removing debris from the waste stream and conveying it out of the channel to the operating floor for discharge. The debris is then usually removed from the screen by a water spray, sometimes in conjunction with a counter-rotating brush. There are two continuous element screen styles: perforated plate screens and bar screens. Five perforated plate panel constant element screens on the market in the U.S. are the Aqua Guard PF manufactured by Parkson, the Filterscreen manufactured by FSM (SAVECO), the Perforator® marketed by Headworks®, the Escamax manufactured by Huber, and the Aqua-Screen manufactured by Andritz. The most common continuous element bar or fine mesh screen on the U.S. market is the AquaGuard manufactured by Parkson.

Baby Creek SDF and Oakwood RTB have continuous element screens with 6-mm openings. Baby Creek screens are Escalator® from US Filter/Envirex (presently supplied by Veolia's John Meunier), and Oakwood screens are Andritz Aqua-Screen.

This type of screen can be installed in arrangements similar to multi-rake screens indicated in previous alternatives. The structural modifications needed for this alternative are similar to Alternative A. These are some advantages and disadvantages of continuous element screens:

- Advantages
 - With perforated plate or mesh elements, high screenings capture ratio can be achieved due to two-dimensional screening. Perforated plate varieties prevent thin objects from wedging into the screen or passing through a bar configuration.
 - Capability to lift large debris out of the flow
 - Medium-sized footprint due to recommended inclination angle (typically 60-75 degrees from horizontal, possibly more)
 - Typically no submerged bearings with manufacturers that use a guide rail at the channel bottom to support the submerged screen elements
 - Medium to low headroom required
- Disadvantages
 - Numerous moving components are subject to wear
 - High headloss because of the low percentage of open area and flow having to pass through the screen twice

- Wet screenings and a substantial amount of wash water are required
- Potential for perforated plate screen holes to plug with hair, stringy material, or grease
- The brush or spray water may not entirely remove the screened material. When this happens, the material removed on the upstream side of the unit is carried over and deposited in the downstream flow, partially reducing the capture of screenings
- Perforated plate screens are not recommended for directly screening combined sewage flow without protection from either a coarse bar screen or a pump station upstream of the screen

5.4.3 Alternative G: Replacing COPA® Screens with ROMAG Screens

In this alternative, COPA® screens of the most eastern channel will be replaced with ROMAG screens similar to the arrangement of existing screens in the westernmost channel. So, except for the improvements described for rehabilitating the existing ROMAG screens, it is expected that the replaced screens of the easternmost Channel will perform similarly to the other existing ROMAG screens. The structural modification for this alternative is limited to some height adjustment for the east and west walls of the Screen Inlet Channel and lowering the height of the ROMAG screens by 1-foot to meet the manufacturer's guidelines for maximum through bar, slot velocity of 5 ft/s as described in Section 4.1. After this improvement, considering a scenario when one of the channels equipped with ROMAG screens is out of service, three other remaining channels can screen the peak design flow of 950 cfs.

5.4.4 Alternative H: Facility Expansion and Major Structural Modifications

This final alternative is considered to provide the maximum flexibility to install a new screening technology that meets project requirements and follows the project's guiding principles without being bound by the existing structure and facility constraints. The available logical area for expanding the existing facility and providing the required space for a new screening channel is on the east side of the facility for a new parallel Screening Influent Channel. The north and south side of the facility do not have the proper room for expansion due to the existing in and out flow paths and also the location of the control building on the north side. The east side appears to have room for expansion contingent on the acquisition of the available vacant lots on that side and also the alleyway. **Figure 5-7** shows the plan view of the existing site, the vacant parcels acquired for a new driveway, and the potential land needed for expansion on the east side.

The construction of this alternative requires significant modifications to the existing structure and adds considerable area and structural component to the facility. The impacts to other systems, HVAC, lighting, and electrical improvements, are also significant. This alternative was not pursued further given the goal to accommodate the improvements for the present and future conditions within the limits of the existing footprint.



Figure 5-7
Alternative H Potential Land Acquisition Plan

5.4.5 Other Alternatives that Were Ruled Out

Other technologies like Single Rake Bar Screens, Stair Screens, Inclined Cylindrical Screens, Grinder/Auger Screens, and Center-flow Band Screens were also considered but ruled out due to their limitations of inapplicability to the existing project condition. The main criteria for ruling out each of these technologies are listed below:

- Single Rake Bar Screens: infrequent single raking mechanism cleaning cycle and the resulting screen blinding potential.
- Stair Screens: potential for damage from excessive amounts of grit. Grit material can become jammed between the lamella bars, causing excessive wear, jamming, and damage to the lamellas or motor
- Inclined Cylindrical Screens: placed in shallow channels with limited depth. Manual removal of large debris would be required and has a minimal flow rate per unit capacity.

- Grinder/Auger Screens: limitations similar to Inclined Cylindrical Screens
- Center-flow Band Screens: large solids may be retained in the drum and require manual removal; there are a limited number of installations of this technology in the U.S. It is not typically used for CSO applications or flows less than 150 cfs.

5.5 Pilot Screen Alternatives Evaluation Criteria

Multiple criteria were considered to evaluate the alternatives previously described in Section 5. These criteria include meeting key objectives of this task defined in the Contract, guiding principles provided by GLWA, and technical and construction feasibility.

The following criteria were considered for these evaluations:

- Meet the flow and head loss requirements: Consider if the alternative can convey the required flow to meet the total peak screening design capacity of the facility with one Screening Inlet Channel out of service without raising the water surface elevation beyond the existing emergency overflow of the ROMAG screens. Also consider if replicating the alternative for other screening channels (with equipment sized for the utilized channels) in future will meet the flow and head loss requirements.
- Effective capture of screenings: Meet the requirements of the NPDES permit considering that the receiving water shall contain no identifiable sanitary solids (floating or settleable) or deposits as a result of this discharge in unnatural quantities which are or may become injurious to any designated use.
- Comply with present version pertinent design standards:
 - Ten State Standards requirements, including screen redundancy, approach and slot velocities, etc.
 - Material and classification requirements, including corrosion resistance and NFPA 820 Class I Div. I area classification
- Effective conveyance of screenings to Toward Treatment Sewer: consider maintaining the present method of transferring screenings to Toward Treatment Sewer for deflection screens and not add a screenings handling operations task at the facility with the alternate screen technology. As part of this consider the flow constraints to TTS balanced with effective screenings conveyance
- Reduce the possibility of clogging and overtopping screens: operate in accordance with screen manufacturer's recommendations to minimize the number of times the screen is overtopped

- Reliable system components: Limiting the number of times that equipment is out of service or shuts down due to various system faults, communication loss, etc.
 - System ready on demand on an intermittent basis
 - Reduced number of single points of failure and having a reliable installation track record for similar existing applications
- Ease of construction: Consider the level of modifications to the existing system and structure including required access for installation. Also consider the required phasing of the project from pilot screen installation to whole facility rehabilitation and maintaining the screening capacity during these phases.
- Ease of operation and control: have simple control and operation to the extent possible with the capability to run in manual when needed. Reduced human capital needed for operation. Simple controls with reduced nuisance alarms and alarms that shut down the equipment. Minimized number of permissive to start equipment.
- Ease of access, cleaning, and maintenance: Have enough space for safe access, reduced human capital, and cost needed for maintenance. Fewer moving parts and more durable components that need maintenance.
- Redundancy: have sufficient redundant system components
- Manufacturer: combination factors including availability of multiple manufacturers, their U.S.-based and local services, their responsiveness, history, and reputation

6.0 Pilot Screen Alternatives Analysis

This section evaluates the alternatives using the criteria presented in Section 5.5. Two alternatives were not carried forward for further evaluation.

- Alternative F (continuous element screen), was not evaluated further due to its limitations meeting the required hydraulic capacity at the peak flow and its disadvantages in comparison with the multi-rake bar screen.
- Alternative H (facility expansion), was not considered further due to its costly, extensive, challenging structural modifications, and likely major system revisions to other systems including HVAC and electrical. In addition, this alternative would not be able to accommodate the improvement goals for the present and future conditions within the limits of the existing footprint with other alternatives.

The alternatives A, B, C, D, E, and G are included in **Table 6-1** and compared with respect to the major evaluation criteria listed in the Section 5.5. Based on the evaluation summarized in this table,

Alternative A, with one multi-rake bar screen on the south end of the Screen Inlet Channel, appears to be a viable alternative for the pilot screen.

The possibility of using this Alternative to meet the future Leib peak design flow (after the replacement of all screens) was also investigated. As shown in **Figure 6-1**, by implementing several structural modifications and repurposing the middle Screening Outlet Channels as Screening Inlet Channels, it will be possible to convey peak design flow with this alternative with one of the largest units out of service. Accordingly, this alternative is considered one of the viable options to be analyzed more from a life cycle cost perspective.

Table 6-1 Summary of Pilot Screen Alternative Analysis

Alternative	A	B	C	D	E	G
Description	One Regular Type Multi-Rake Bar Screen	Two Multi-rake bar Screens Perpendicular to the Flow Direction	One Center Flow Multi-Rake Bar Screen	Two Overflow Screen with Screw	a Multi-rake Bar Screen and an Overflow Screen	Replacing COPA® Screens with ROMAG Screens
Number of Screens	1	2	1	2	2	2
Additional Appurtenances	One Sluice Chute	Two Sluice Channels	One Sluice Channel	One Existing Gate	One Sluice Channel	One Existing Gate
Meeting the flow and head loss requirements	Can screen about 190 cfs in this installation and in combination with other existing screens, will meet the design peak flow. Can handle the whole facility's peak demand in future extensive modification.	Can screen about 380 cfs in this installation and in combination with other existing screens, will meet the design peak flow. Can handle the whole facility's peak demand in future moderate modification.	Can screen about 240 cfs in this installation and in combination with other existing screens, will meet the design peak flow. Can handle the whole facility's peak demand in future extensive modification.	Can screen about 250 cfs in this installation and in combination with other existing screens, will meet the design peak flow. Not capable of handling the whole facility's peak demand in future modification.	Can screen about 290 cfs in this installation and in combination with other existing screens, will meet the design peak flow. Not capable of handling the whole facility's peak demand in future modification.	Can screen about 390 cfs in this installation and in combination with other existing screens, will meet the design peak flow. Can handle the whole facility's peak demand in future, with limited modifications.
Effective capturing of screenings	One-dimensional 6-mm screen	One-dimensional 6-mm screen	One-dimensional 6-mm screen	Two-dimensional 6-mm screen	Combination of one and two-dimensional 6-mm screens	One-dimensional 4-mm screen
Effective transfer of screenings to Toward Treatment Sewer	Relatively short sluicing with limited wash water use	Moderate-length sluicing with moderate wash water use	Moderate-length sluicing with limited wash water use	Challenging deflection of screenings away from the screen field against the water flow. Considerable flow to TTS	Combination of deflection screening and sluicing. Relatively short sluicing with limited wash water	Relies on deflection of screenings away from the face of the screen against the water flow. Considerable side flow needs
Reducing the possibility of clogging and overtopping screens	Less prone to clogging or overloading	Less prone to clogging or overloading	Some potential for cleaning mechanism to push material around without effective cleaning	Moderate to the high potential of clogging or overloading screen	Combination of deflection screen and multi-rake bar screen Moderate to the high potential of clogging or overloading screen for deflection screen	Above average potential of clogging or overloading screen, if facility operated without required side flow.

Table 6-1 Summary of Pilot Screen Alternative Analysis (continued)

Alternative	A	B	C	D	E	G
Reliable system components	Reliable type of equipment with many examples of a similar installation	Reliable equipment installed in an uncommon arrangement	Newer version of reliable multi-rake bar screens with limited installation records	Limited installation, especially within the expected range of flow	Combination of a more and less reliable and common type of equipment	Some installation records but less common and reliable than other types (e.g., multi-rake bar screen)
Ease of construction	Limited structural modification with limited challenges for rigging and assembly	Challenging structural modification with some conflicts and difficult downstream level control during the pilot phase. Moderate challenges for rigging and assembly	Moderate structural modification with limited challenges for rigging and assembly	Very limited structural modification with minimal challenges for rigging and assembly	Combination of both types of screen modification needs and more complex rigging and assembly	Limited structural modification with minimal challenges for rigging and assembly
Ease of operation and control	Relatively easy to control and operation in auto and manual modes	Relatively easy to control and operation in auto and manual modes	Relatively easy to control and operation in auto and manual modes	Relatively easy to control and operation in auto and manual modes	More complicated control and operation in auto and manual modes due to a combination of two pieces of different equipment	Relatively easy to control and operation in auto and manual modes
Ease of access and cleaning	Moderately accessible equipment	Tighter installation arrangement and limited space, and the harder-to-access area between screens	Harder to access and clean areas downstream of the screen	Harder to clean and access perforated plates under screws, multiple pieces of equipment	Harder to clean and access perforated plates under screws. Multiple pieces of dissimilar equipment	Moderately accessible
Ease of maintenance	Limited maintenance needs of moving components on the lower elevations	Limited maintenance needs of moving components on the lower elevations. Multiple pieces of equipment	Lack of moving components at the bottom of the channel	Some challenges to access, and required maintenance of bearing, screen brushes, etc. Multiple pieces of equipment	Some challenges to access and require maintenance of bearings, screen brushes, etc. Multiple pieces of dissimilar equipment	Hydraulic power pack, cylinder, and line maintenance
Redundancy	One piece of equipment	two pieces of equipment with good hydraulic capacity	One piece of equipment	Two pieces of equipment with moderate hydraulic capacity	One piece of equipment effectively separates the screenings from the flow	Two pieces of equipment with good hydraulic capacity
Manufacturer	Three reputable manufacturers with good responsiveness and local representation	One reputable on-board manufacturer with uncommon installation arrangement with good responsiveness and local representation	One reputable manufacturer with moderate responsiveness and local representation	Only two manufacturers with moderate responsiveness and local representation	Only one manufacturer for both screens with moderate responsiveness and local representation	Only one manufacturer with moderate responsiveness and local representation

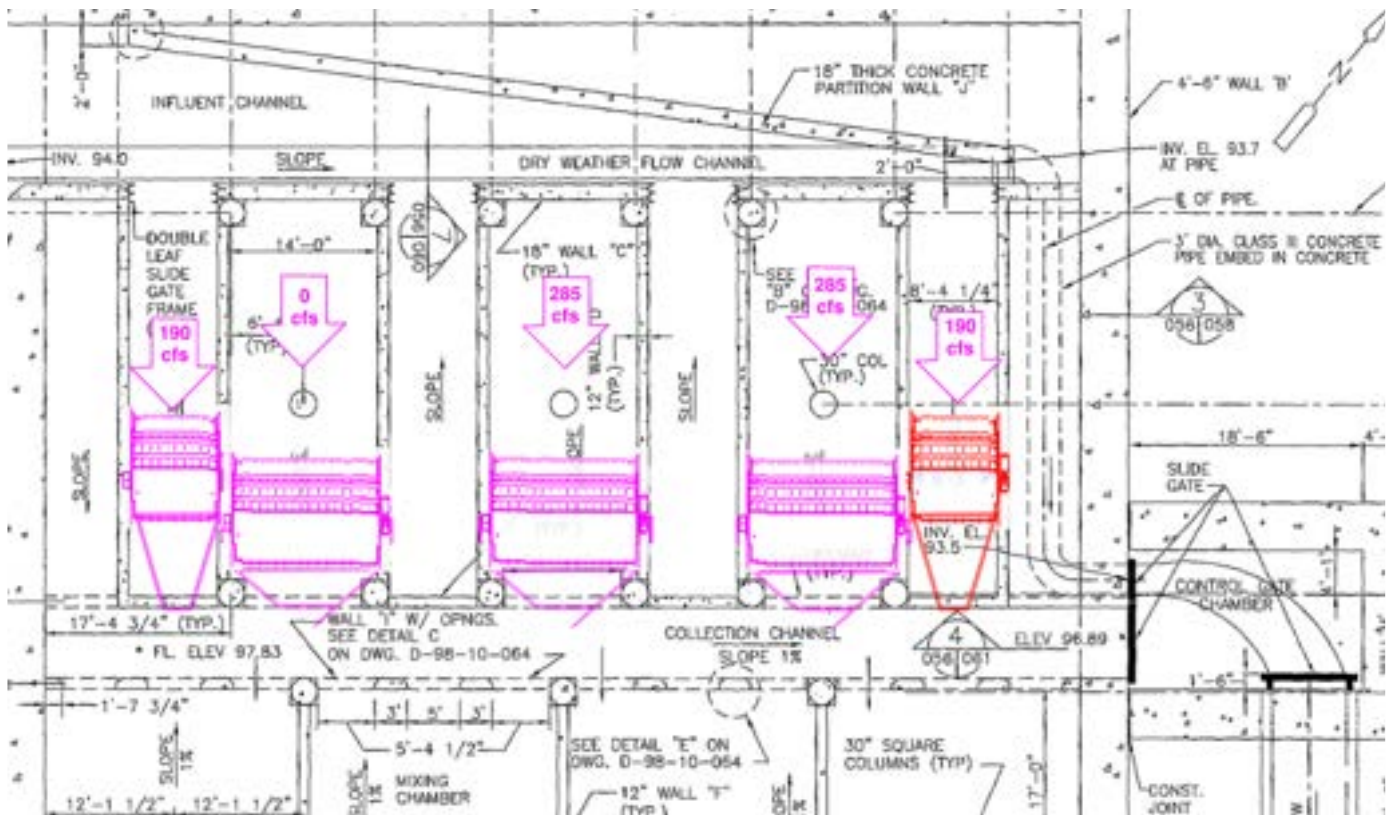


Figure 6-1
Alternative A Future Expansion Plan (Magenta bar screens) To Accommodate Future Peak Design Flow

One of the significant structural changes to accommodate the installation of future wider multi-rake bar screens is related to providing access openings through the roof of the screening chamber. To complete this, the entire existing soil fill above the slab at elevation 131.00 would be removed first. After soil is removed, a new concrete wall would be cast in line with the end of the existing channels. The new concrete wall will support the precast concrete beam to be installed, as described below. A new opening of approximately 16 feet x 10 feet would then be cut in the slab at elevation 131.00. Finally, a new precast concrete beam and removable slabs similar to the existing would be installed at elevation 139.00. Care would need to be taken during this installation to avoid damaging existing beams or columns that are to remain. **Figure 6-2** shows the general extent of these modifications at elevations 131ft on the left and 139 ft on the right.

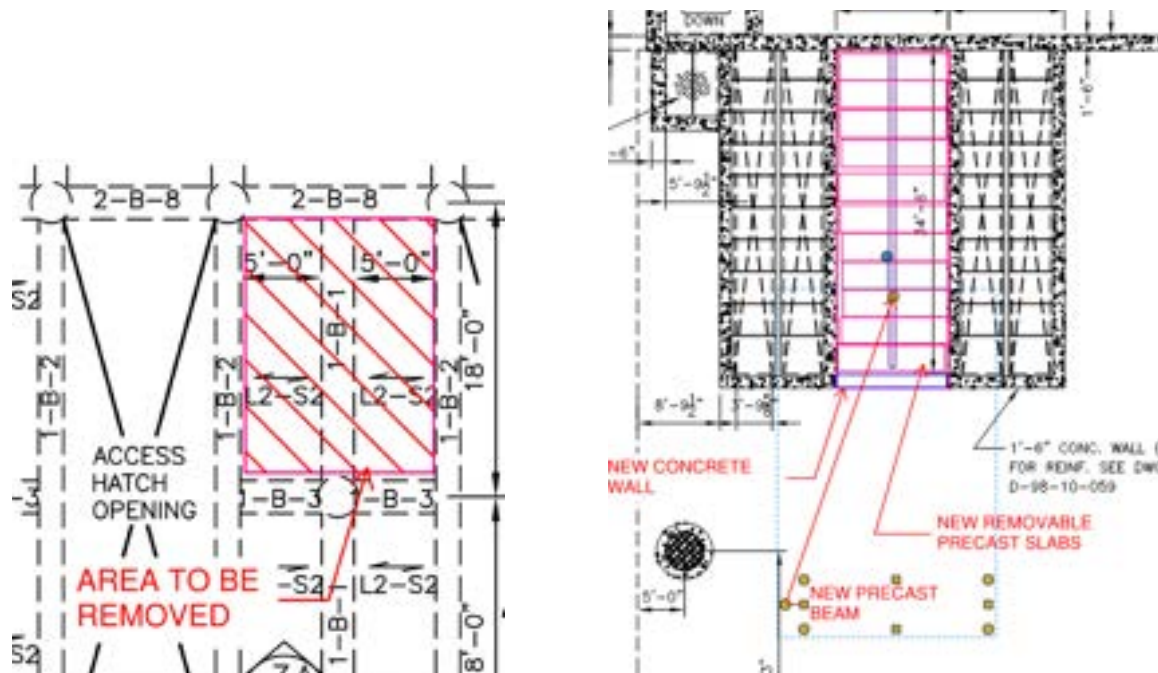


Figure 6-2
Major Structural Modification at Elevation 131 ft (left) and 139 ft (right) to Accommodate Access Hatched Needed to Install Wider Multi-rake Bar Screen in Future

Alternative B, with two multi-rake bar screens, installed perpendicular to the flow direction, had promising hydraulic capacity. However, it seems to be a less common installation, and there was only one major manufacturer who had experience with this type of installation. In addition, considering its challenging structural modifications to control the water depth downstream of the pilot screen and limited space around screens, the potential of structural conflict resulted in ruling out this alternative from a technical and feasibility perspective.

Alternative C with center flow multi-rake bar screen was only offered by one manufacturer. Its limited capacity to pass the facility's peak design flow in the future (after the replacement of all screens) was a major challenge. Also, the lack of a reliable installation track record in similar CSO projects resulted in ruling out this alternative on a technical basis.

Alternative D, with two overflow screens with screws, did not have a long track record of installation in the required flow capacity range required for Leib in the United States (U.S.). It appeared to be an unproven technology for this application and was not capable of handling the future Leib peak flow rate (after replacing all existing screens). Accordingly, this alternative also was not considered for further analysis on a technical basis.

Alternative E, as a combination of Alternative A and D, could improve the flow capacity during the pilot phase. However, it could not accommodate the future peak capacity (after replacing all existing screens). In addition, the complexity of the system with multiple pieces of different types of

screens and the other challenges of Alternative D was a negative. Accordingly, this alternative was not considered for further life cycle cost analysis on technical basis.

Alternative G, including replacing the COPA® screens with ROMAG screens in two channels, was requested to be investigated by GLWA. Considering its hydraulic capacity and consistency of the equipment with what is already installed in this facility, and that it has been in use for two decades, making it a viable alternative, if the facility is operated with at least the minimum required side flow. Also, limited structural modification and potential to improve its performance by using updated controls and improved operation procedures transformed it as an appealing alternative which is considered for further LCC analysis.

Similar to Alternative A, the possibility of using Alternative G to meet the future Leib peak design flow (after the replacement of all screens) was also investigated. By implementing limited structural modifications, it will be possible to screen flows higher than peak design flow with this alternative with one channel out of service. Accordingly, this alternative is considered another viable option to be analyzed more from a life cycle cost perspective.

Based on the result of this technical analysis and comparison, Alternatives A and G, were selected for further economic comparison via life cycle cost analysis as discussed in Section 7.

7.0 Life Cycle Cost Analysis

The approach and assumption used for Life Cycle Cost Analysis (LCCA) are listed in this section.

7.1 Approach

Comparative cost estimates intended to represent order-of-magnitude estimates for equipment capital and O&M costs. This LCCA intended for planning purposes and comparing alternatives and does not serve as an Opinion of Probable Construction Cost (OPCC). Accordingly, common improvement or modifications items between the alternative might not be included in the analysis. Following bullet points shows the list of general parameters that were used for this LCCA:

- Lifecycle period: 20 years
- Baseline year: 2023, Bringing future cost back to present year for present value comparison
- End of Construction and Start of 20-year Life Cycle: February 2029 (per present schedule)
- Midpoint of Construction: May 2027 (per present schedule). Approximately 51 months (4.25 years) from February 2023
- Discount rate of 4% is applied to the future costs of purchase, installation, and commissioning of equipment, energy costs, maintenance and replacement costs, and salvage value when calculating the total present value of each alternative in 2023
- Summary values are rounded to nearest \$5,000

7.2 Initial Purchase, Installation and Structural Modifications

Initial purchase cost was based on budgetary costs estimates for major equipment and components. Supporting component purchase costs is estimated, as needed to distinguish between alternatives. Supporting elements are estimated by approximate percentage of primary equipment cost. For both alternatives instrumentation and control are estimated as 5% of the component purchase cost. Electrical cost of Alternative A is estimate as 15% of the component purchase cost due to more extended electrical components inside the classified area. This estimate is changed to 10% of the component purchase cost for Alternative G, as its components in the classified area are hydraulically powered.

For both alternatives, installation and commissioning are estimated as 30% of the equipment purchase cost. Structural modifications are estimated based on calculated quantities and CDM Smith's OPCC for these items. Contractor costs, including general conditions, permits, insurance, bonds, overhead and profit, and 30% contingency is added to the purchase, installation, commissioning costs and structural modifications as an overall percentage of 75%.

Escalation rate of 6% is applied to the initial purchase costs for equipment to escalate it from present to the year of purchase/installation, which is assumed to be 2027. CDM Constructors Inc. (CCI) estimates are using 7% escalation for the next 2 years, the following 2 years are at 5% escalation, and then later years would have a lower escalation rate. Accordingly, it is recommended for the approximate 4 years of escalation needed from present to midpoint of construction apply an average escalation rate of 6%. The same rate is applied to the installation and commissioning costs to account for escalation of labor rates.

For Alternative A, these items were considered:

- Phase 1 (starting 2027):
 - Demolition of COPA® screens in the easternmost channel and its Screening Channel Gate
 - Installing one new narrower multi-rake bar screens in the easternmost screening inlet channel
 - Rehabilitation of existing ROMAG & COPA® screens in other remaining channels are not considered in this LCCA as these are common costs to both Alternatives A & G (Phase 1). Also, during Phase 1, only the O&M cost associated with the easternmost channel screens is included, as the O&M cost of other channels is a common cost to both Alternatives A & G.
 - Minor structural modifications for channel and flow path and for installing new screen
- Phase 2 (starting 2037):
 - Demolition of all remaining ROMAG and COPA® screens and Screening Channel Gates

- Installing two new narrower multi-rake bar screens in the westernmost and easternmost screening inlet channels
- Installing three wider multi-rake bar screens in three middle channels, including engineering cost
- Major structural modifications for channels and flow paths and for installing new screens

For Alternative G, these items were considered:

- Phase 1 (starting 2027):
 - Demolition of COPA® screens in the easternmost channel
 - Installing two new ROMAG screens instead of COPA® screens
 - Minor structural modifications for installing new screens
 - Rehabilitation of existing ROMAG & COPA® screens in other remaining channels are not considered in this LCCA as these are common costs to both Alternatives A & G (Phase 1). Also, during Phase 1, only the O&M cost associated with the easternmost channel screens is included, as the O&M cost of other channels is a common cost to both Alternatives A & G.
- Phase 2 (starting 2037):
 - Demolition the remaining COPA® screens
 - Installing two new ROMAG screens to replace COPA® screens
 - Minor structural modifications for installing new screens

Lowering the existing ROMAG screens about 1-foot and replacing screen discharge weir plates are common activities for Phase 1 of Alternative A & Alternative G are not included in LCCA.

7.3 Operation, Energy, and Maintenance

Alternatives analyses for systems/equipment with significant energy requirements or significant, quantifiable differences in energy requirements includes energy cost comparisons in the LCCA. However, in this case, the relative low energy usage of screens, in addition to the low frequency of screen activation in this facility resulted in an insignificant effect of energy cost on LCCA. Total power consumption of all screens of Alternative A is 21 horsepower. This number for Alternative G is 40 horsepower. This facility screens are being activated in average about three times per year with total duration of about 24 hours per year. Considering increasing the events two times higher in future after adding Meldrum St. connection, the lifecycle energy cost difference between two alternatives is less than a couple thousand dollars.

Elements of routine maintenance and mid-lifecycle replacement needs are focused on areas of difference between alternatives.

Escalation rate of 3.5% is applied to routine maintenance and mid-lifecycle replacement materials and labor. The escalation rate used for maintenance is based on the historical average escalation rate due to the number of years into the future that these costs are projected.

7.4 Decommissioning/Salvage

Decommissioning/Salvage value of 10% of the original equipment purchase cost (before sales tax) is assumed for major equipment, and then escalated to the end of the 20-year analysis period using a 3.5% annual escalation rate (consistent with maintenance escalation rate). Salvage value is used as a negative value in the LCCA because it is an income as compared to the other values included in the analysis, which are costs.

7.5 Life Cycle Cost Analysis Results

Table 7-1 shows the summary of LCCA analysis for both phases of Alternatives A and G. Accordingly, it is clear that Alternative G with fewer new screens installed and less structural modifications, is about \$3.96 million less expensive than Alternative A.

Table 7-1 Summary of Life Cycle Cost Analysis

Alternative	Capital Costs (Year 2027 for Phase 1 & Year 2037 for Phase 2)			20-Year Net Present Value of Capital Costs	O&M Cost Breakdown		20-Year Net Present Value of O&M Costs	Salvage Net Present Value	20-Year Net Present Value
	Initial Capital Cost	Installation, Commissioning & Startup	Total Construction Cost		Electricity	Maintenance			
A (Phase 1)	\$745,000	\$1,105,000	\$1,850,000	\$1,580,000	\$0	\$30,000	\$30,000	\$55,000	\$1,560,000
A (Phase 2)	\$6,355,000	\$10,215,000	\$17,475,000	\$10,090,000	\$0	\$580,000	\$580,000	\$315,000	\$10,360,000
A (both phases)				\$11,670,000			\$610,000	\$370,000	\$11,920,000
G (Phase 1)	\$1,600,000	\$4,665,000	\$4,020,000	\$3,435,000	\$0	\$30,000	\$30,000	\$0	\$3,470,000
G (Phase 2)	\$2,865,000	\$4,845,000	\$7,225,000	\$4,170,000	\$0	\$615,000	\$615,000	\$300,000	\$4,485,000
G (both phases)				\$7,605,000			\$645,000	\$300,000	\$7,955,000

8.0 Summary and Recommendations

The evaluation of the existing screening system consisted of a multi-faceted approach, including reviewing existing records or original design and construction, subsequent modifications, operating data and process video recordings, site visits, interviews and meetings with operations staff, and screening sampling efforts (sampling not yet performed at time of this writing).

After this evaluation, several improvements are recommended to enhance system reliability and improve debris removal to allow the screens to function optimally leading to reduction of the number of times the screen is overtopped. The improvements cover potential modifications to the remaining ROMAG & COPA® screens in conjunction with control and operational changes. In summary, it is suggested that ROMAG hydraulic power units and control and instruments for screen cleaning mechanisms be replaced with the more up-to-date design. No changes are recommended for the COPA® screen due to a lack of improvement in its design over the last three decades. However, due to the age of the equipment, replacement of its power pack and combs is recommended. To improve control and operation, the primary recommendation is to run the equipment as much as possible on auto and allow 10% of the influent to be conveyed to Toward Treatment Sewer to reduce the accumulation of screenings upstream of these diversion-type screens.

In addition to the proposed improvements to the existing equipment and their operation, several alternatives to replace the COPA® screen of one of the Screening Inlet Channels with another screen technology were presented and analyzed. Based on the analysis of Alternatives A to H and considering their technical pros and cons in conjunction with project guiding principles, Alternative A and Alternative G were recommended for further evaluation and life cycle cost analysis. Alternative A includes installation of a multi-rake bar screen in one Screening Inlet Channel and discharging the screenings to the Screening Collection Channel. An expansion of this alternative for future consideration is also summarized in this TM. This expansion will allow replacement of all remaining ROMAG and COPA screens with similar multi-rake bar screens to meet the peak screening design flow of 950 cfs while one of the screening channel is out of operation. This expansion will modify some flow paths through the Screening Inlet and Outlet Channels to convert the three existing middle Screening Outlet Channels to future Inlet Channels and two existing middle Screening Inlet Channels to future Outlet Channels.

In addition to Alternative A, Alternative G, including replacing the COPA® screens with ROMAG screens in one channel, was requested to be investigated by GLWA. Advantages to Alternative G include limited structural modification, ROMAG screen's hydraulic capacity, and consistency of the equipment with what is already installed in this facility. The consistency of the screen technology, not only has the advantage of operational familiarity, but also commonality of spare parts and understanding of maintenance needs. The life cycle cost analysis showed considerable economic advantage of Alternative G over A. The main driver for this considerable cost difference was limited structural modifications and capability of maintaining the existing ROMAG screens in service after some rehabilitation, including replacement of hydraulic power units and control and instruments

for screen cleaning mechanisms, in Alternative G. Another advantage of Alternative G over A include screenings capture capability with the smaller opening size of ROMAG screens (4-mm) in comparison to opening size with multi-rake bar screens (6-mm).

With the manufacturer recommended updates to the power pack, control panel, and new control logic, and operation of the facility in accordance with manufacturer recommendations for screen operation and providing the required side flow minimum of 10% through proper gate operation, Alternate G is technically feasible. Hydraulic analysis was completed to confirm that it is technically feasible for the system to produce the minimum 10% side flow within an acceptable headloss. Therefore, based on several advantages and lower cost, Alternative G, all ROMAG screens, is the recommended alternative to meet GLWA's goals and associated guiding principles for this project improvement item.

9.0 Next Steps

This section lists the items that require advancement/further development as the design process advances. After the final selection of one of the proposed alternatives by GLWA the following items will need to be addressed:

- Define the detailed structural modifications and evaluate the potential conflicts and modifications required to resolve them to coordinate the selected alternative with associated structural modifications.
- Determine extent of modifications to screen inlet channel concrete floor slope to be compatible with lowering of ROMAG screens to avoid conflict between sloped concrete and lowered screen equipment.
- Develop a detailed plan for the improvement implementation by considering how equipment would enter the process space and installation options available for large pieces of equipment coupled with associated constraints for maintenance of operation during construction.
- Refine the hydraulic grade line development for the selected alternative.
- Finalize the material and coating selection for various components of the selected alternative.
- Develop control strategies and required instruments for the selected alternative, including the local control station at the operation floor.
- All new and/or modified process mechanical loads will be coordinated with electrical to verify available power system capacity, available voltages, and the location of electrical gear required for each piece of equipment.
- Expand the design criteria table for the selected alternative to include approach velocities, channel levels, and speed of cleaning along with estimates of solid loading and mass removal rates.

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Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Steve Fehniger and Julie Aichler, CDM Smith
Paul Witt, PCI*

Date: June 1, 2023

*Subject: TM-15 Storm and Sanitary Pump Operational Strategies Improvement Evaluation
(OKW-PUMP-1A) Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

The problem statements incorporated and addressed in this technical memorandum (TM) include improvements to the operational strategies for the storm pumps, sanitary pumps and wet well level sensor selection. These improvements were guided by review of operating data, ride-along observations and discussions, determination of revised minimum storm wet well level for each storm pump size, Allowable Operating Region (AOR) and Preferred Operating Region (POR) provided by pump manufacturers, evaluation of how to maintain pump operation within their respective AOR, review of present Auto mode operational strategy programming and review of past studies.

Recommendations

Storm pump operational strategy: Improve operational strategy as described conceptually in Section 4.

Sanitary pump operational strategy: Improve operational strategy as described conceptually in Section 4.

Wet well level sensor selection operational strategy: Improve operational strategy as described conceptually in Section 3.

The evaluations performed to determine the above recommendations as follows:

- Review of operating data: for key parameters determined patterns which guided how to improve the operational strategies. Refer to Section 3.1.

- Ride-along observations and discussions: enhanced understanding of the present operational practices including where may consider changes to extend service life and optimize operation. Refer to Section 3.2.
- Determination of revised minimum storm wet well level for each storm pump size: Physical model study findings combined with net positive suction head (NPSH) margin evaluation and check of motor loading resulted in lower lead pump shut off levels, 62.5 ft for large pumps and 61 ft for small pumps. Refer to Section 3.3.
- AOR and POR provided by pump manufacturers: Xylem Flygt AC Custom pump and Xylem Flygt provided performance curves with application specific AOR and POR limits. Refer to Sections 2.1.1 and 2.2.1.
- Evaluation of how to maintain pump operation within their respective AOR limits: The manufacturer provided AOR limits were utilized in the overlay of system curve envelope with performance curve to determine where and over what speed range the pumps could be operated for these applications. Speed range restrictions which differ from present practice are required to maintain operation within the AOR over full range of operating conditions. Refer to Section 3.4.
- Review of present Auto mode operational strategy programming: The Design Team tabulated and reviewed the present Auto mode operational strategy programming to assess how it relates to the common manual operation of the storm pumps with behind-the-scenes control logic on some elements and combination of manual and automatic operation of the sanitary pumps relative to the findings from our evaluations. Refer to Sections 2.1.3 and 2.2.3.
 - An area of concern was identified related to sanitary pump auto shutoff level and the associated level sensor selection programming due to discrepancies between the radar and ultrasonic level readings. Refer to Section 2.2.3.4.1.
- Review of past studies: The past studies summarized in the CS-299 report (included as an appendix to the Conceptual Design Report) and the Brown & Caldwell TM findings and recommendations were reviewed to determine how/if our evaluations may need to be modified based on the earlier work. Overall, our path forward tended to differ by varying extents as compared to those recommendations. Refer to Section 3.6.

1.0 Introduction and Purpose

TM-15 is focused on evaluation of improvements to the existing storm pumping system and sanitary pumping system operational strategies. The goals of evaluation center around several project guiding principles with attention to maximizing performance efficiency (optimizing), reliability, and service life while minimizing downtime and maintenance requirements to the extent feasible.

The TM was configured to first cover the storm pumping system and then the sanitary pumping system when the topic covered is not common to both applications.

The evaluation included consideration of the following:

- Review of operating data
- Operational difficulties understood from operations ride-along visits.
- Reduction of storm pump minimum operating level from physical model study to maximize pump run time for each pump cycle while operating within AOR.
- Constraints on pump operation to maintain operation within the AOR while maximizing service life of storm and sanitary pumps.
- Maintain the storm pump historical maximum operating level (El 78.00) to match the freeboard present to minimize potential for basement backups in the Oakwood subdistrict.
- Consideration of CS-299 report and Brown & Caldwell TM findings focused on the storm and sanitary pump systems.

This TM answered key storm pumping system-related questions linked to the improvement of the storm and sanitary pump operational strategies. The questions answered included the following:

- How low can the storm wet well be operated for each pump size?
- What is the AOR and POR of each pump size/model?
- What speed range will be feasible to maintain operation within the AOR over the system curve envelope?
- What other constraints will impact the proposed revisions to the operational strategies

For additional storm pump system topics evaluated as part of the project, refer to the following technical memoranda/reports developed on the topics of storm wet well pump intake conditions (storm pump station physical hydraulic model study report included in Appendix A), and storm wet well flushing system improvements (TM-22) for coverage of those topics.

2.0 Existing System(s) Description (and/or Conditions)

The existing Oakwood storm pump station is configured with a split modified trench wet well as the intake for the storm pumps. Downstream of each trench is a solids handling type wet well equipped with submersible sanitary (SN) pumps as shown in **Figure 2-1**. The wet wells are connected only at the upstream junction chamber which is located near the southern limit of the facility site.

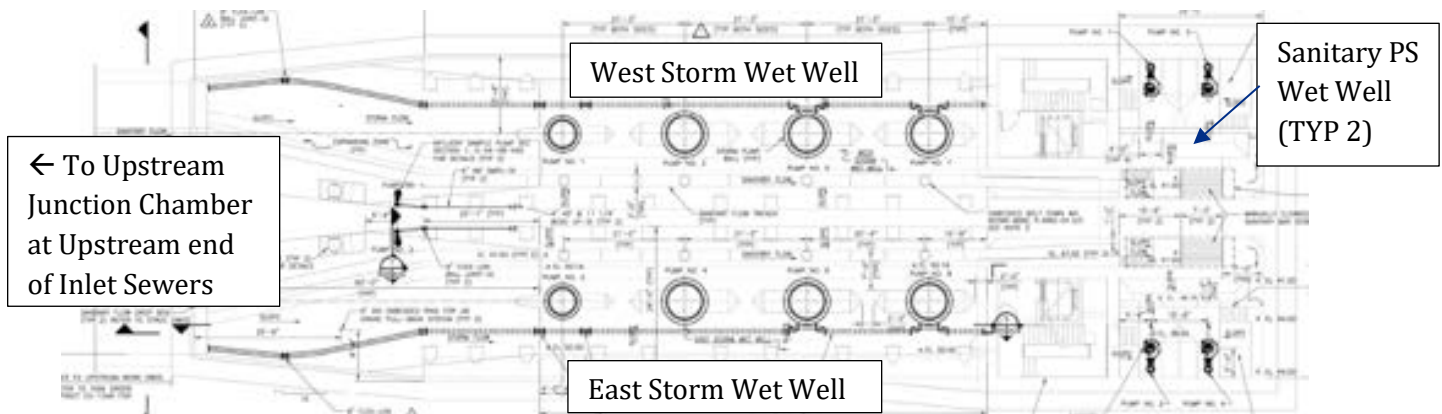


Figure 2-1
Oakwood Storm and Sanitary Wet Well Configuration (PC-755 Record Drawing D-04-08-405)

2.1 Storm Pumping System

The Oakwood storm pump system is comprised of eight vertical mixed flow storm pumps positioned within the two wet wells with “small” variable speed-controlled pumps at the upstream end of each wet well followed by “large” vertical mixed flow pumps. The pumping units were all furnished and installed as part of the original construction. The pumps were manufactured by ITT Flygt (now Xylem Flygt AC-Custom Pump) and the motors were manufactured by Hyundai Ideal (now Ideal Electric). The pump station has a firm pumping capacity of 1675 cfs (1,100 MGD) at the design total head with one of the large pumps off-line.

No major modifications have been made to the pumping units since placed into service in 2012. One pump (ST-5) was rehabilitated by Kennedy Industries in 2022.

Pump details are included in **Table 2-1**.

Table 2-1 Storm Pumping Units Summary

Pump Nos.	Pump Description	Design Point Total Head, ft	Design Point Flow Rate, cfs (MGD)	Motor Full Speed, rpm	Motor HP	VFD speed-controlled, Y/N	Present Speed Range, % speed	Discharge Size, in.
ST-1 and 2	Small Pump	48	150 (97)	594	1500	Y	75 - 100	54
ST-3, 4, 7 and 8	Large Pump	48	275 (178)	446	2000	N	NA	72
ST-5 and 6	Large Pump	48	275 (178)	446	2000	Y	75 - 100	72

2.1.1 Storm Pump Performance Curves

The small (WCA 66 x 54) and large (WCA 88 x 72) storm pump performance curves shown in **Figures 2-2** and **2-3** were furnished by Xylem Flygt AC Custom Pump. The POR range from 85 to 115 percent of BEP flow rate is aligned with the guidance in latest edition of ANSI/HI 9.6.3

Operating Regions guideline for the specific speed (7300). The AOR limits are determined by the pump manufacturer in accordance with ANSI/HI 9.6.3. As expected, the AOR left limit is set to avoid the unstable portion of the curve (flat portion).

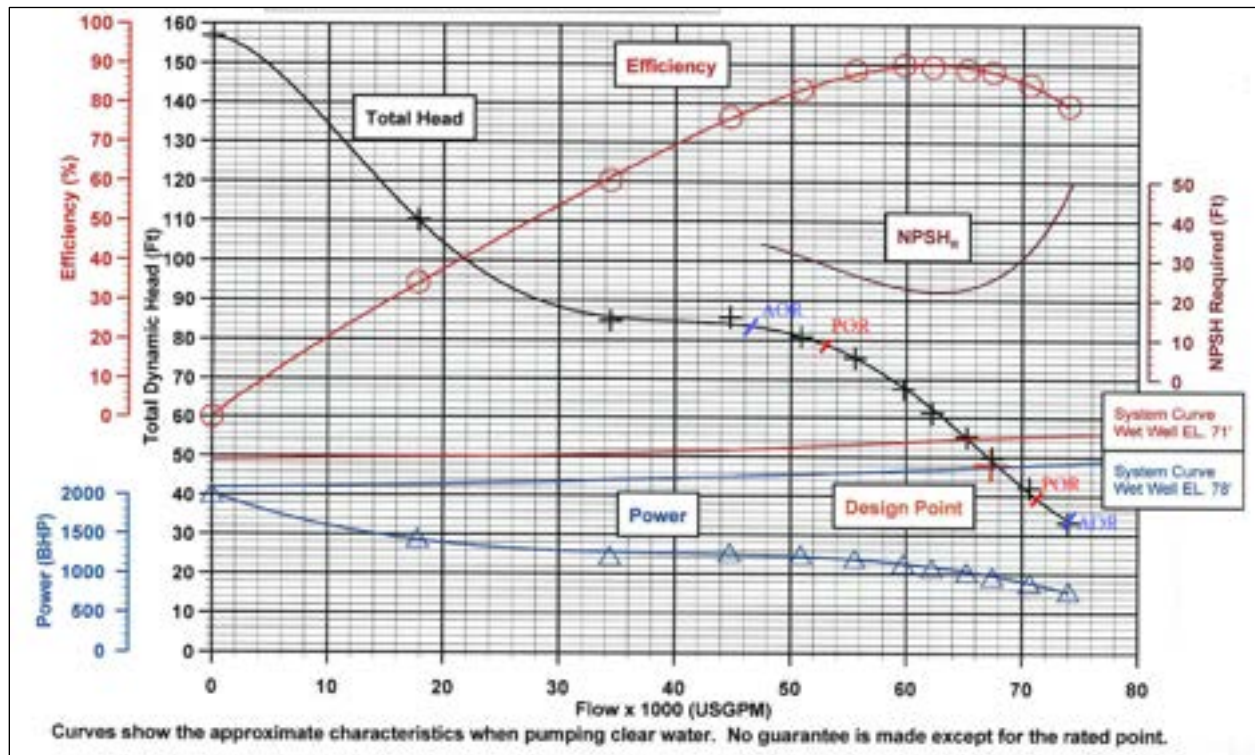


Figure 2-2
Small Storm Pump Factory Test Performance Curve, courtesy of Xylem Flygt AC Custom Pump

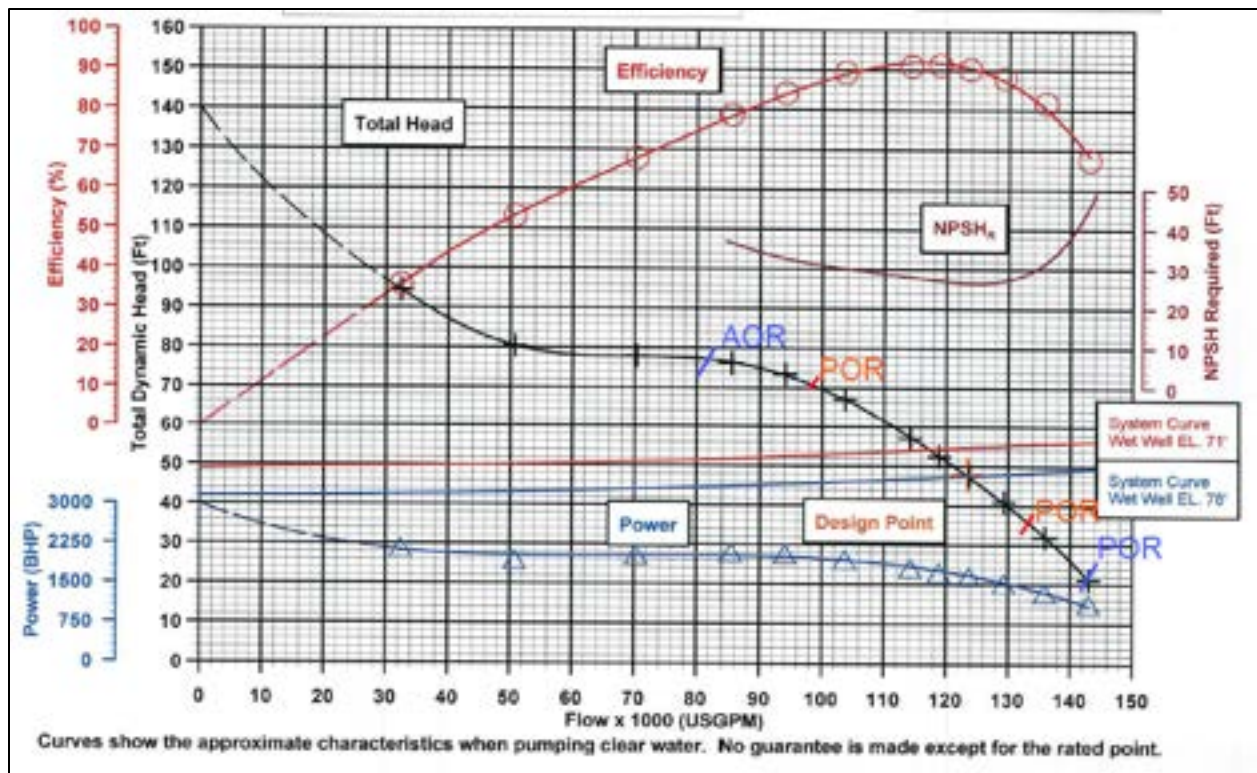


Figure 2-3
Large Storm Pump Factory Test Performance Curve, courtesy of Xylem Flygt AC Custom Pump

2.1.2 Present Storm Pump Station Operations

The storm pump station is normally operated manually from the Ovation workstation in the pump station control room. The station is commonly left in auto mode when the facility is not staffed to facilitate system operation during a wet weather event as triggered by wet well level setpoints. On average, the station operates about 25 times per year (significantly more than on average 11 activations of the retention treatment basin. This operational frequency was based on review of downstream equipment systems which are required to be running before any storm pump will start (screenings conveyor data utilized) as determined through review of operational data from September 2019 – November 2022, excluding conveyor starts for post-event cleaning.

Present wet well level-based pump setpoints (Detroit datum):

- Lead pump start: 73 ft
- Lag pump start: 76 ft
- Maximum level: 78 ft
- Last pump in operation stop: 65 ft

Based on observations and discussions with operations staff as part of operations ride-along site visits, the selection of the first pump to start is an operator preference and can be a small pump or large pump (constant or variable frequency drive [VFD]). This decision is guided in part by desire to distribute the runtime between the storm pumps. In addition, some operators favor starting an event with a large pump as they feel the ability to dose a high concentration of sodium hypochlorite (hypo) at beginning is greater with the corresponding larger metering pump than the small pumps. Most events require only one storm pump to operate at a time with fill/draw approach with a resultant varied number of pump operation cycles per event.

The speed of the VFD speed-controlled pumps is automatically controlled “behind the scenes” via Ovation programming as the operations staff do not modify the VFD speed. Operators indicated the speed ramps up when the wet well level increases. For the events observed, these pumps remained at minimum speed as the flow rate did not continue to rise after the pump was turned on.

The subsequent pumps turned on is an operator decision with consideration of not starting a pump which has recently been shut down to allow motor to cool down.

2.1.3 Present Storm Pump System Ovation Control Logic for Automatic Operation

The present Ovation control logic is provided to aid in understanding of how storm pumps would be controlled if in Auto mode. However, the station is typically manually controlled when staffed such that the following logic application is limited by operational practices.

The following is a summary of the storm pump automatic operation sequence based on review of the presently programmed Ovation Control Logic. This scenario assumes that all storm pumps are operational and that all storm pumps are in Auto mode.

Prior to a storm event, the operator selects the Storm Pump (ST) sequence. The sequence is shown on a selection screen in Ovation as shown in **Figure 2-4**. The following sequence is commonly applied: ST1, ST2, ST5, ST6, ST3, ST4, ST7, ST8 (VFD speed-controlled pumps operate before the constant speed pumps). The target level to maintain in the wet well is 76 ft. As noted previously, the decision regarding lead pump selection is guided in part by desire to distribute the runtime between the storm pumps.



maintain the target level of 76 ft.

than 60 seconds, Ovation will start the next storm pump in the sequence.

together to maintain the wet well target setpoint.

speed to maintain the wet well target setpoint.

well level is 1.5 ft above the target setpoint for more than 60 seconds, Ovation will start the next

storm pump in the sequence. The fourth pump will run at minimum speed for 75 seconds. Then the pump will ramp up and the four operating pumps will slow down to match speeds and modulate speed to maintain the wet well target setpoint.

If the wet well continues to rise and the four running pumps are at maximum speed and the wet well level is 1.5 feet above the target setpoint for more than 60 seconds, Ovation will start the next storm pump in the sequence.

Typically, the remaining pumps in the sequence are constant speed pumps. The constant speed storm pumps are programmed internally (not through Ovation) to ramp up over a range of 0-180 seconds, with an initial setting of 75 seconds to allow discharge piping to fill up as the pump speed is increasing to full speed. The VFD speed-controlled pumps will continue to modulate to maintain the wet well target setpoint while the constant speed pump runs at full speed.

If the wet well continues to rise and the five running pumps are at maximum speed and the wet well level is 1.5 ft above the target setpoint for more than 60 seconds, Ovation will start the next storm pump in the sequence. The VFD speed-controlled pumps will continue to modulate to maintain the wet well target setpoint while the constant speed pumps will run at full speed. This sequence will continue until seven pumps are operating or the wet well level begins to fall.

As the wet well level begins to fall, the pumps will shut down in reverse order. As stated before, the VFD speed-controlled pumps will continue to modulate to maintain the wet well target setpoint while the constant speed pumps will run at full speed. If the wet well continues to fall and the four VFD speed-controlled pumps are running at minimum speed and the wet well level is 1.5 ft below the target setpoint for more than 60 seconds, Ovation will stop the last storm pump that was started in the sequence. The VFD speed-controlled pumps will continue to modulate to maintain the wet well target setpoint while the remaining constant speed pumps will run at full speed. If the wet well continues to fall and the four VFD speed-controlled pumps are running at minimum speed and the wet well level is 1.5 ft below the target setpoint for more than 60 seconds, Ovation will stop the next storm pump that was started in the sequence. This sequence continues with each pump turning off in the reverse order that they turned on until the last VFD speed-controlled pump is operating.

If the wet well continues to fall, the final VFD speed-controlled pump will continue to run until the level falls below 65 ft for 60 seconds. It should be noted that the original level to shut down the last pump was 71 ft. This value has been changed since the initial programming.

2.1.4 Present Storm Pumping Unit Vibration and Temperature Monitoring

The Ovation system monitors each storm pumping unit's vibration and temperature sensors.

2.1.4.1 Vibration Monitoring

The vibration sensors cause an alarm for any of the pumping units if a sensor value exceeds 0.85 in/s (documentation does not indicate in/sec RMS or peak).

The Multilin motor protection device for a representative pump was reviewed as well to check if a vibration trip was configured and set to On. The investigation identified that vibration trip value was configured but was set to Off. The configuration setting to Off for the variable speed-controlled pumps may have been set due to high vibration sourced tripping of the pumps with the operation commonly including the unstable portion of the curve and/or operation far left of AOR left limit. Both operating conditions lead to elevated vibration amplitudes. However, the pump system requires pumps to maintain levels to meet the needs of the system which cannot occur if shutting down on high vibration.

2.1.4.2 Temperature Monitoring

The temperature sensor monitoring by Ovation includes set points for alarm and trip temperatures. **Table 2-2** provides the alarm and trip temperatures for the storm pumps. Note that the motor lower bearing set points were 10 degrees Celsius higher for small pumps than the large pumps, but all other settings were the same for all pumping units.

Table 2-2 Storm Pump Temperature Set Points

Sensor location	Alarm	Trip
Motor Stator	120 °C	NA
Motor Upper Bearing	80 °C	85 °C
Motor Lower Bearing (Large ST/Small ST)	80/90 °C	85/95 °C
Motor Thrust Bearing	80 °C	85 °C
Pump Upper Bearing	65 °C	71 °C

2.2 Sanitary Pumping System

The Oakwood sanitary pump system is comprised of four vertical, submersible, solids handling pumps (two in each wet well). Sanitary pumps SN-2 and SN-4 are located in the East Sanitary Pump wet well. Sanitary Pumps SN-1 and SN-3 are located in the West Sanitary Pump wet well. The pumping units were originally wet-pit submersible Vaughan chopper pumps which have been replaced with Flygt N-series submersible solids handling pumps (model NP3315.095 MT FM) with 407 mm diameter impeller. The pump station has a firm pumping capacity of approximately 22 cfs (14.2 MGD) based on the overlay plot-based evaluation covered in Section 3 with one pump off-line.

Each on-line sanitary pump operates off level control set points as described below in greater detail. The pumps convey sanitary wastewater through a 14-inch discharge pipe. The 14-inch discharge pipes from each of pump combine into one 20-inch Sanitary Force Main within the sanitary pump discharge pipe vault located in the Sanitary Pump Room. From the sanitary pump discharge pipe vault, the pumped wastewater flows into its associated meter vault. The meter vault contains a magmeter, which measures the sanitary pump flow rate and totalized volume. The flow signal is sent from the magmeter to the Sanitary Pump VFD Control Cabinet and to the Ovation Control Screen where the flow volume is displayed and the signal used to control the speed of the pump.

2.2.1 Sanitary Pump Performance Curve

The Flygt NP3315 sanitary pump performance curve shown in **Figure 2-5** was furnished by Xylem Flygt through their local representative, Kennedy Industries. A submittal curve for this model and impeller trim was provided since no factory performance testing was performed on the sanitary pumps. The POR range from 70 to 120 percent of the best efficiency point (BEP) flow rate is aligned with the guidance in ANSI/HI 9.6.3 Operating Regions guideline in the specific speed range of this unit. The AOR limits are determined by the pump manufacturer in accordance with ANSI/HI 9.6.3. The AOR right limit at 125% of BEP flow rate was questioned in discussion with Xylem Flygt technical specialists. Xylem Flygt identified the right limit as required for the application based on their experience and added not driven by a perceived NPSH margin limitation.

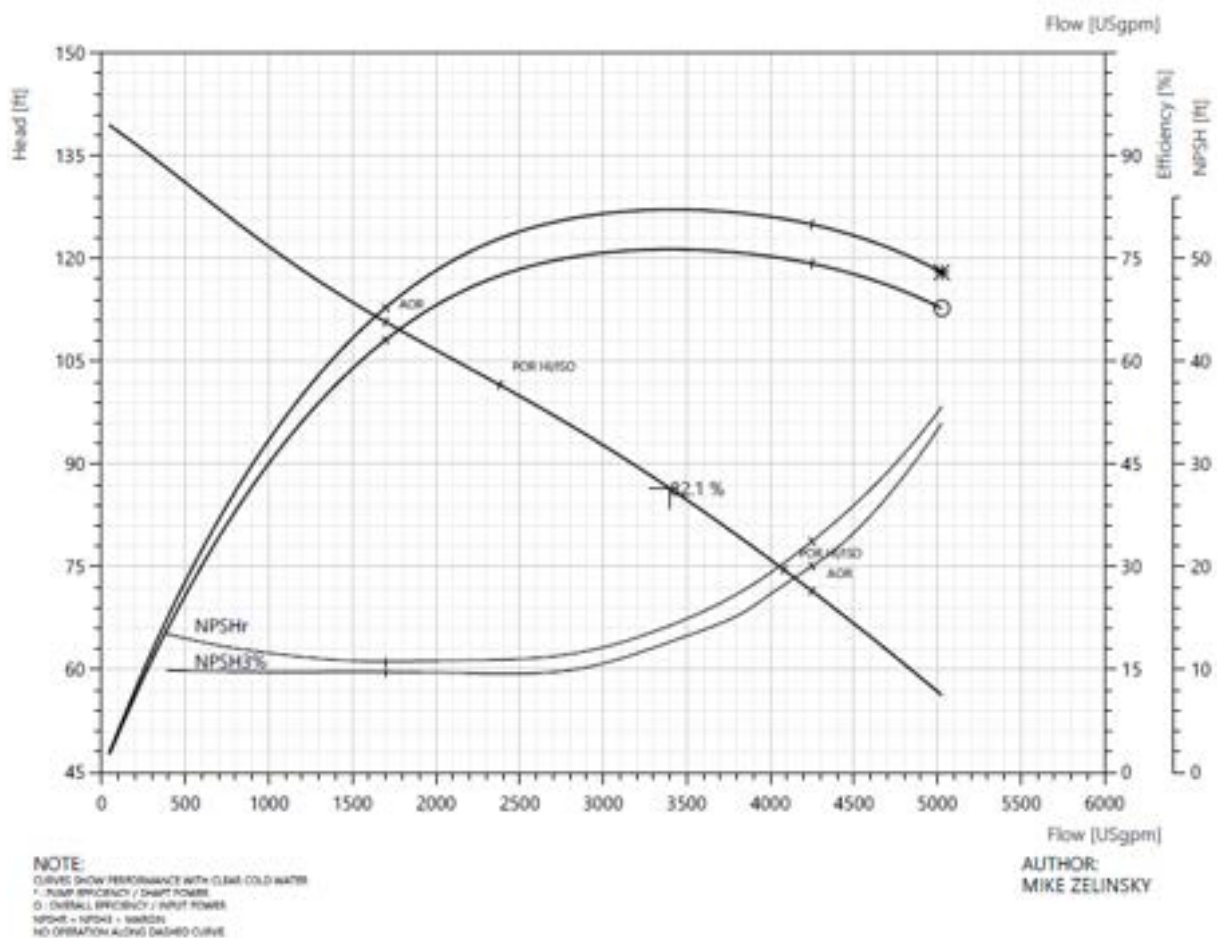


Figure 2-5
 Sanitary Pump Submittal Performance Curve, courtesy of Xylem Flygt

2.2.2 Present Sanitary Pump Station Operations

The sanitary pump station is normally operated in Auto mode by the Ovation programmed logic. At times, operators choose to control the pump station manually from the Ovation workstation in the pump station control room. The system is left in Auto mode when facility is not staffed to facilitate continuous system operation.

The sanitary pump system operates continuously to match the influent flow to within the hydraulic capacity of the pumps except when turned off during a wet weather event. The past practice to operate one pump, including pump cycling, during wet weather events to keep the pumps from being buried in grit has not been utilized since an earlier study recommended termination of this operating practice (approximately 2019). This has not resulted in burying sanitary pumps in grit based on operations staff input.

When operated in Auto mode a target wet well elevation (operator selectable) is the focus of the level-based control system. The manual operation of the facility is typically within similar wet well level operating range in dry weather conditions.

Present wet well level-based pump setpoints (Detroit datum):

- Lead pump start: 44.5 ft
- Target level: 45 to 46 ft (operator selectable; automatically increased by 1-ft if three pumps in operation)
- Lag pump start: 1.5 ft above Target level
- Third pump start: 47.5 ft
- Last pump in operation stop: 41 to 42 ft (operator selectable)
- Pumps turned off due to anticipated wet weather event: 62-67 ft.

Based on observations and discussions with operations staff as part of operations ride-along visits, the selection of which wet well to operate in dry weather is an operator preference. This decision is guided in part by desire to distribute the runtime between the pumps. In addition, the differential head across the sanitary bar screen may impact which wet well to operate along with which pumps are out of service. Operations staff noted that dry weather conditions typically only require one sanitary pump in operation.

The speed of the VFD is automatically controlled “behind the scenes” via Ovation programmed logic as the operations staff do not modify the VFD speed. The speed is varied as described in the next section with the range of speeds between 1775 and 881 rpm.

2.2.3 Present Sanitary Pump System Ovation Control Logic for Automatic Operation

The present Ovation control logic is provided to aid in understanding of how sanitary pumps are controlled when in Auto mode. However, this pumping system is typically manually controlled when approaching storm pump operation such that the following logic application is limited by operational practices.

2.2.3.1 Background

There are two sanitary isolation pinch valves (SG-9 and SG-10) which direct flow into their respective wet wells. SG-9 is connected to the West Wet Well. SG-10 is connected to the East Wet Well. In “normal operation,” the operator chooses which wet well will be the initial wet well for control. The operator can select East or West by clicking the selected button on a pop-up. Assuming the pinch valves are in Auto, selecting West will open SG-9 and close SG-10. Selecting East will close SG-9 and open SG-10.

Each of the two sanitary wet wells were originally provided with two sets of redundant bubbler level sensors to measure wet well level. However, over time, the bubbler sensors were replaced with one radar level sensor and one ultrasonic level sensor in each wet well. Per the original PC-755 design, the system is programmed to use the highest of the two sensors in each wet well and use those values for control.

Decisions on which pumps to select next are based on an operator selectable sanitary pump sequence. In this example (pictured in **Figure 2-6**) the pump sequence will be SN1, SN3 for West Wet Well and SN2, SN4 for East Wet Well.

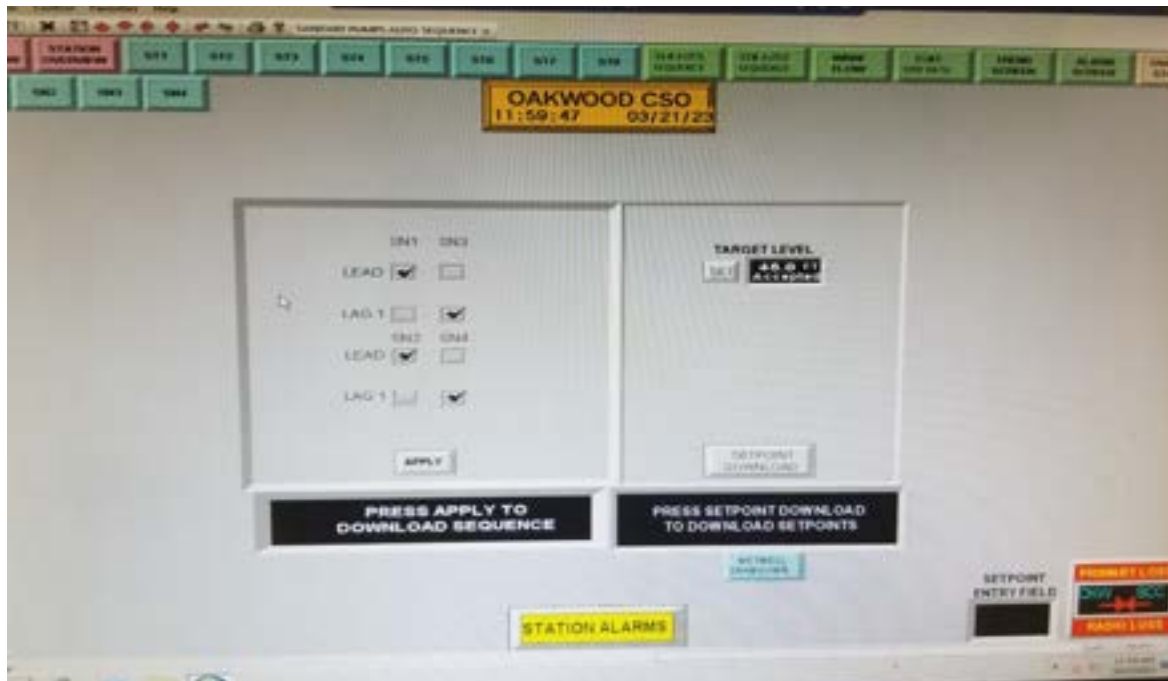


Figure 2-6
Oakwood Sanitary Pump Selection Ovation Screen

2.2.3.2 Sanitary Pump Auto Operation Scenario

The following is a summary of the sanitary pump automatic operation sequence based on review of the presently programmed Ovation Control Logic. This scenario assumes that all sanitary pumps are operational and that all sanitary pumps are in Auto mode.

In normal operation, the pumps will be in Auto mode and the pumps will be controlled by a target level. The target level is presently 45.0 ft (it was 45.5 ft in original design).

In this scenario, the East Wet Well was selected. Therefore, SG-9 is closed, and SG-10 is open.

If no pumps are presently running, the lead pump in the selected wet well will start if the level is greater than 44.5 ft for more than 30 seconds. Pump SN2 will start at 44.5 ft and run at minimum speed (881 rpm) until the target level of 45.0 ft is reached. The pump speed will then be varied from minimum speed to full speed to maintain the target level utilizing PID control.

If the lead pump is operating at full speed (1175 rpm) [it appears that the Flygt full speed (1185 rpm) was not modified in the programming, carried forward with 1175 rpm] and the selected wet well level is 1.5 ft above the target level for more than 30 seconds, the lag sanitary pump in the selected wet well (SN4 in this case) will be started. SN4 will run at minimum speed (881 rpm) for 30 seconds. SN4 will be ramped up slowly and SN2 will be ramped down so both pumps run at the same speed. Both pumps will then run in tandem (varying speed together) to maintain the target level.

If both pumps are running together maintaining the setpoint between -0.1 and 0.1 error with a flow rate of less than 9.8 cfs (6.3 MGD) for over an hour, the lag pump will shut off. This logic was added to prevent two pumps from running unnecessarily when only one pump is needed to handle the incoming flow. (This was not in the original design)]

If both pumps are running together to maintain the setpoint and both pumps are at full speed (1175 rpm) and the selected wet well (East Wet Well) level is increasing and greater than 47.5 ft for more than 60 seconds, the control system will open SG-9 to make both wet wells active. The lead pump in the other wet well (in this case SN1) will be started and operated at full speed (1175 rpm) to attempt to pump down its wet well.

It should be noted that when three sanitary pumps are running and both wet wells are active, the target level is automatically increased by 1 foot (in this case 46 ft).

Also, when three sanitary pumps are running and the selected wet well level is higher than 44 ft, the pump speed control for the two pumps that are running in tandem is based on the Sanitary capped flow, which is (23.2 cfs [15 MGD] – combined sewer overflow (CSO) Basin Drain to Northwest Interceptor [NWI] Flow). Therefore, the two pumps which are varying in speed may deviate from the target level to avoid exceeding the capacity of the pipeline.

If SN1 succeeds in pumping down its wet well to below 47.5 ft, and both wet wells are decreasing, SG-9 will close, and the pump will stop. Since only one wet well is active again, the target level is returned to its originally entered value of 45 ft. The remaining two pumps in the selected wet well will continue to run and vary their speeds in tandem to maintain the target level.

However, if the three sanitary pumps are running, and the wet wells are still increasing, eventually the lead storm pump will start. When this happens, the lag pump in the selected wet well will stop. The lead sanitary pump in each wet well will continue to run at minimum speed to minimize grit accumulation in the wet wells during the storm event. The lead sanitary pump in each wet well will alternate with its corresponding lag pump each hour.

If the Recirculation Gate is closed during this time, the speeds of the running sanitary pumps will be set to 80% (1057.5 rpm) and continue to run until all storm pumps have been turned off. If the Surge Relief Chamber is higher than 102.98 ft, the sanitary pumps will stop.

[From discussions with the Great Lakes Water Authority (GLWA) and observations during ride - long visits, common practice no longer includes running sanitary pumps during a storm event. Therefore, the logic described in the two paragraphs above should be removed/modified to stop the sanitary pumps when the storm pumps are running during a storm event.]

If the storm event described above did not occur and only the selected wet well is active again, both pumps will continue to run and vary their speeds in tandem to maintain the target level.

If both pumps are operating at minimum speed (881 rpm) and the selected wet well level is 1.5 ft below the target level for more than 30 seconds, the lag sanitary pump in the selected wet well (SN4 in this case) will be stopped.

If the lead pump is operating at minimum speed (881 rpm) and the selected wet well level is 1.5 ft below the target level for more than 30 seconds, the lead sanitary pump in the selected wet well (SN2 in this case) will be stopped.

Sanitary pumps are also programmed to stop if they are in Auto and the wet well level falls below 40 ft.

When all pumps are stopped, the control system will automatically alternate the pump sequence based on run times so near equal runtimes are maintained.

An automatic wet well drawdown was programmed for the sanitary pumps. The time the drawdown starts is configurable by the operator by entering the time in a pop-up window. Presently, the start time is 9:00 AM daily based on the controller clock. The drawdown process will start one pump in each wet well (if the wet well level is greater than 44 ft) and attempt to pump the wet wells down to 42 ft (this was 39.5 ft in original design). A 15-minute timer is programmed to abort the process if 42 ft is not reached during that time. The process will also be aborted if a CSO event is detected (storm pump is running). The pump that draws down its respective wet well will be alternated with its partner each day. [From our discussions with GLWA operations this feature is not utilized.]

It should be noted that in the distant past it was observed that SG-9 appeared to be “leaking”. The West Wet Well level would rise even though SG-9 was fully closed. To combat this problem, logic was added to start a dewatering process on only the West Wet Well whenever the level was greater than 50 ft, the East Wet Well was less than 50 ft, and SG-9 was closed. The dewatering process would last for one hour or stop if the West Wet Well level was below 42 ft.

[The West Wet Well leaking dewatering logic described in the paragraph above, was not part of the original design]

2.2.3.3 Present Sanitary Pumping Unit Moisture and Temperature Monitoring

The Ovation system monitors each sanitary pumping unit’s moisture and temperature sensors. Moisture detection is present to protect the submerged bearings and motor from exposure to the wet well contents. The temperature monitoring sensor protects the motor from an over-temperature condition. The system, as presently programmed, will shut down the pumping unit if either trigger (high moisture or high temperature) is detected by the sensors.

From ride-along insights it appears that the high moisture trigger, as configured, may only trip once if there is a leak which could persist but not necessarily trigger another alarm.

2.2.3.4 Sanitary Pump – Observations While Verifying the Present Programming

The following observations were made as the present programming was confirmed within Ovation. Summarized herein as related to the control narrative but the first may merit attention in the near term to protect the pumps.

2.2.3.4.1 Sanitary Pump – Pump Shutdown Based on Wet Well Minimum Level

The Design Team observed a sanitary pump logic change that was applied to all four sanitary pumps. This change could have been made because the sanitary pumps were being run in exclusively in Manual mode instead of Auto mode and operations were possibly not turning off the pumps at low level. At the time the Ovation programming information was obtained, the observed method of operation was the Manual mode. It appears that logic was added to attempt to stop the pump automatically if the level reached a specified value even though the pump was in Manual mode. The logic was not added correctly, and the level used to stop the pumps was 0 ft. This level will never be reached since the wet well levels are calibrated from 38 to 78 ft. This logic will not work in its present state and recommend removal.

As stated above, the original redundant bubbler level sensors have been replaced with one radar level sensor and one ultrasonic level sensor in each wet well. Per the original PC-755 design, the system is programmed to take the highest of the two sensors in each wet well and use those values for control. It doesn't appear that the sensors are calibrated the same. As the wet wells are being pumped down, L804016C (radar in West Wet well) it appears to get stuck at 43.6 ft frequently when compared to its ultrasonic partner (L804016A) over a period of time. The ultrasonic typically will reach 39 ft during these instances. An example is shown below in **Figure 2-7**.

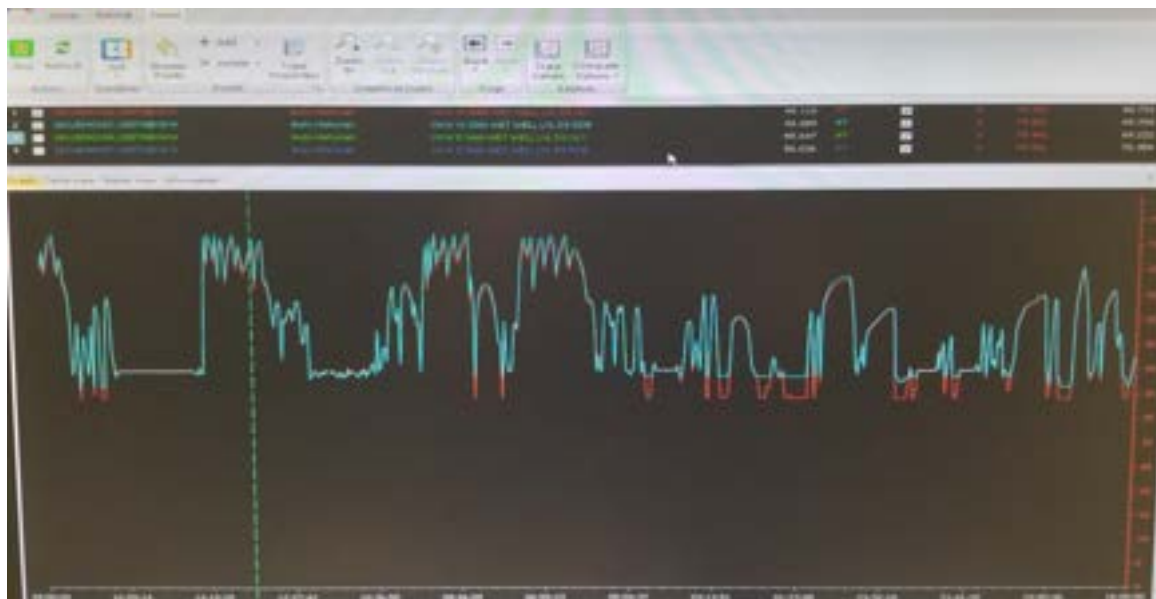


Figure 2-7
Oakwood Sanitary West Wet Well Level (Radar and Ultrasonic Instrument Output)

A similar phenomenon happens with the East Wet Well sensors. An example is shown below in **Figure 2-8**.

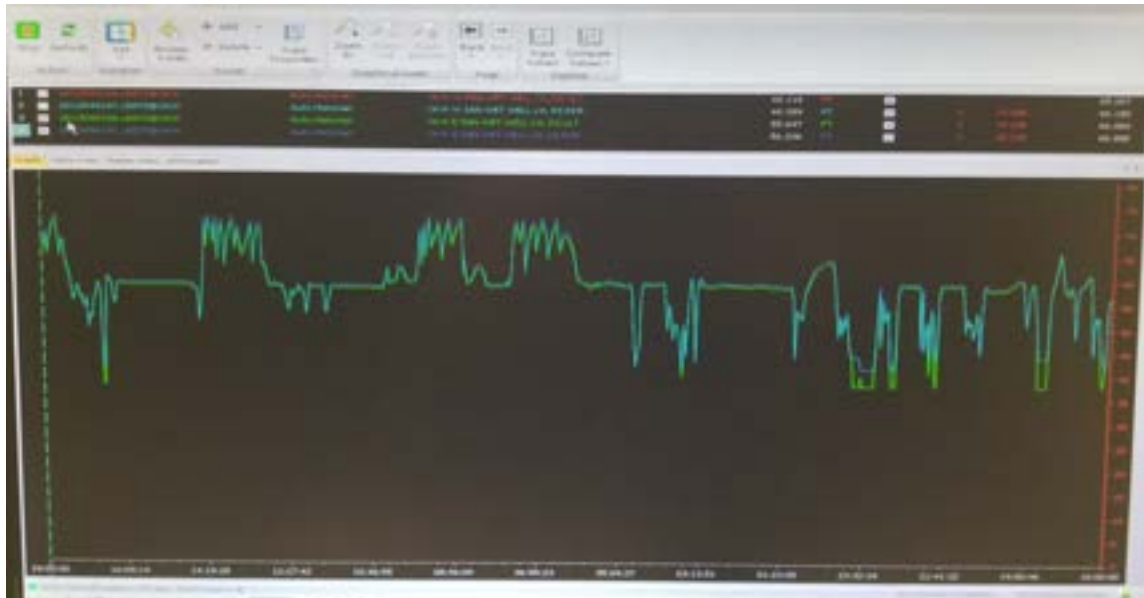


Figure 2-8
Oakwood Sanitary East Wet Well Level (Radar and Ultrasonic Instrument Output)

This behavior will impact any of the processes that use the wet well level to stop the pump. The Design Team recommends that this be addressed. If the level sensors are not calibrated correctly, this will cause problems when stopping the pumps in Auto mode.

2.2.3.4.2 Sanitary Pump – Upstream Isolation Valve Position

SG-9 and SG-10 are always open (Valves in Local Mode), likely due to the valves not closing leak tight. Therefore, what is considered “normal” operation of the sanitary pumps as described in the automatic operation scenario above is not entirely possible (somewhat compromised) with the valves not fully functional.

2.3 Storm and Sanitary Wet Well Sensor Selection Control Logic

The East and West Wet Wells were originally equipped with redundant level sensors on the upstream and downstream sides of the sanitary bar screen. The selection of which level to use for pump system control was performed by the control system through logic. The present control logic was configured to use the higher of the two levels, defaulting to the second sensor only if the primary were to fail. There are no operator actions to change how the level selection operates.

3.0 System Evaluation

The evaluation of improvements to the existing storm pumping system and sanitary pumping system operational strategies summarized in the following section have been separated into distinct categories in each subsection. Each category provides insights to aid in the improvements recommended to the operational strategies in addition to insights that will likely ripple to other elements of the design.

3.1 Operating Data Evaluation

Three years of operating data was acquired from the Ovation system, covering a period from September 2019 through mid-November 2022. The data collected and reviewed for the storm pumping system included pump runtime, speed, pump and motor bearing temperatures, pump and motor vibration, and wet well levels. Additional storm pump related parameters were collected but were not the focus of the evaluations described in this section.

The data collected for the sanitary pumping system included sanitary meter flow rates, pump running, pump speed, wet well levels, NWI level, and surge relief chamber level. Additional sanitary pump related parameters were collected but were not the focus of the evaluations described in this section.

3.1.1 Storm Pump Operating Data Analysis

3.1.1.1 Storm Pump Total Runtime

The storm pump total runtime data was reviewed to evaluate which pumps were operating most within the last three years. The total runtime hours on 9/1/2019 were subtracted from the total hours on 11/15/2022. The runtime hours on each of these dates and the total operating hours for the 3.2-year period analyzed are provided in **Table 3-1**. It is unknown if or when the runtime hours were reset prior to 9/1/2019, except for ST5 which appears to have been reset after the pump rehab was completed in 2022. It does not appear that any of the pump runtimes were reset during the evaluation period, since the runtime hours were always increasing.

Table 3-1 Storm Pump Operating Hours

Storm Pump	Total Runtime as of 9/1/2019	Total Runtime as of 11/15/2022	Total Hours Sep 2019-Nov 15, 2022
ST1	88	188	100
ST2	33	119	86
ST3	9	29	20
ST4	5	31	26
ST5	0.0	0.9	0.9
ST6	119	292	173
ST7	24	85	61
ST8	36	74	38

Note: ST5 - assume runtime reset when pump rehab completed.

The pump runtime data shows that pumps ST1 and ST6 were operated most often, followed by ST2 and ST7, with the fewest hours on ST8, ST4, and ST3 over the last three years. This application is similar to others with combination of VFD speed-controlled and constant speed pumps in which the VFD speed-controlled units are utilized most frequently.

3.1.1.2 Storm Pump Speed

Analysis of the pump speed data for the VFD controlled pumps, ST1, ST2, ST5, and ST6, indicates that these pumps typically run at 75-80% speed. Minimum speeds are set in Ovation system and cannot be changed by the operators. The minimum speeds are presently set to 75% for both the small and large pumps. **Table 3-2** shows the distribution of operating speed ranges for the 5-min averaged pump speed data in an evaluation period. The dominant operation at/near the minimum speed is driven by the common fill/draw operation of the pumping system coupled with the control logic which requires pumps operate at minimum speed when wet well level is dropping.

Table 3-2 Storm Pump VFD Operating Speed Ranges (Percent of Operating Time)

Range	ST1	ST2	Range	ST5	ST6
90-100%	5%	10%	100%	0%	6%
85-90%	1%	1%	93-100%	0%	1%
80-85%	1%	4%	87-93%	0%	2%
75-80%	89%	79%	80-87%	0%	3%
70-75%	1%	3%	75-80%	97%	85%
			70-75%	3%	2%

3.1.1.3 Storm Pump and Motor Vibration Monitoring

Pump and motor vibration sensors provide vibration velocity data to Ovation. Sensors were mounted on the pump discharge head (x-axis and y-axis), motor lower bearing (x and y), and motor

upper bearing (x, y, and z) locations/directions. General observations from review of this data are shown in **Table 3-3**. The constant speed pumps, ST3, ST4, ST7, and ST8 do not show any response or changes in the vibration data when the pumps are running or turned off. All the readings are very low 0.001 or 0.002 in/sec and likely are showing the background electronic signal offset which indicates sensors are not operating properly. ST1 and ST2 indicate vibration readings around 0.15-0.3 in/sec when the pumps are running typically. The maximum vibration readings for these two VFD speed-controlled pumps occur when the pump is not running which is potentially an indicator of sympathetic vibration from other sources in the pump station. The only pump that showed higher vibration readings than ST1 and ST2 was ST6.

Table 3-3 Storm Pump and Motor Vibration Data Summary

Storm Pump	Vibration Velocity Value Observations
ST1	Vibration velocity values observed. Typical values when pump runs were around 0.15-0.3 in/sec (for pump discharge, motor upper and lower bearing (brg) sensors). Some occurrences of higher vibration when pump was not running.
ST2	Vibration velocity values observed. Typical values when pump runs were around 0.15-0.3 in/sec with notable variation from event to event. - Pump discharge x, motor lower brg y, motor upper brg y&z were near upper end of range (0.2-0.3) or higher for motor upper brg x, y, z (0.3-0.5) at times. - Pump discharge y and lower motor x sensors read 0.15-0.2. - Some occurrences of higher vibration when pump ran for short duration with low wet well level (<60 ft) (due to testing?) or when pump is not running.
ST3	None of the pump vibration sensors were registering readings. Vibration measurement was same when pump off/on. Always reads 0.001 or 0.002. The motor upper brg x vibration drifts or was affected by other factors starting July 2022, with some higher spikes when the pump was not running.
ST4	None of the pump or motor vibration sensors were registering readings. Vibration measurement was same when pump off/on. Always reads 0.001 or 0.002.
ST5	Pump out of service for long duration. In 2022, ran a few times after rehab (reinstalled August 2022). Most of run time no vibration values, which is not possible. Some vibration when not running. One occurrence of 0.2-0.5 in/sec on Motor lower brg y and Pump discharge x vib sensors while running. Another with Vib of 0.2 in/sec on motor lower brg y and pump discharge x.
ST6	Pump Discharge x and y vibration was typically in range of 0.2-0.5 in/s, but has a few occurrences with spikes to 0.7-0.9 in/s during operation. Motor Lower Brg x Vib has frequent readings around 0.6 in/s when the pump was not running and no other sensors have elevated readings. The other motor lower and upper brg vibrations sensors were typically between 0.2-0.4 in/s when the pump runs but there were some events (July-Aug 2020, June-July 2021) with readings up to 0.6-1.0 in/s on motor upper brg x & y sensors.
ST7	None of the pump or motor vibration sensors were registering readings. Vibration measurement was same when pump off/on. Always reads 0.001 or 0.002.
ST8	None of the pump or motor vibration sensors were registering readings. Vibration measurement was same when pump off/on. Always reads 0.001 or 0.002.

The vibration velocity values observed indicate:

- The constant speed pump/motor vibration sensors are either all faulty or have been disconnected from the monitoring system.
- There appears to be activities in the pump station which result in elevated vibration levels which are translated through the structure to the pump/motor vibration sensors resulting in elevated values when pumping units are off-line.
 - The off-line elevated vibration levels were evaluated to assess if a correlation with other operating pumps in vicinity of units with elevated vibration amplitudes focused on ST1, ST2, & ST3 based on summary in **Table 3-3**. These are the units for which noted vibration >0.5 in/sec at times when pump not running. The dates with very high vibration spikes (>0.5 ips) for ST1 and ST3 did not have another pump in service. ST2 most of high vibrations for this pump were while the pump was running. When high vibration levels and pump is not running, there were no other pumps running either. There was one common date, 10/20/2022, between all three pumps, but at various times between 5:45-7:00 AM. This time frame could coincide with activities at the pump station which were independent of the storm pumps but resulted in vibration within the structure being transmitted to the pumping units.
- The Hydraulic Institute acceptance criteria (for new or rehabilitated) pumps is 0.17 ips RMS measured at the top of the pump discharge head (identified as “pump discharge” in **Table 3-3** when operating in POR and 0.22 ips RMS when operating in AOR. Elevated vibration velocity values are expected when operating outside the AOR which was occurring over significant portion of the lower wet well water elevations at or near minimum speed. Additionally, ANSI/HI 9.6.4 acceptance criteria includes displacement for units operating at or below 600 rpm, which would include all storm pumps, was not reported or calculated. The vibration levels could be elevated in part due to damage caused from frequent operation outside the AOR coupled with measurements recorded during operation when outside AOR. The measured elevated vibration is expected to be reduced through the rehabilitation of the pumps.
- The information provided in Appendix C of ANSI/HI 9.6.4 includes guidance level vibration values at the top of the motor when motor mounted to the discharge head, with the rather tall “motor stand” between the two components for this installation results in application of those values being a deviation from the intended configuration.

3.1.1.4 Storm Pump Motor Temperature Monitoring

The motor thrust bearing and the pump upper bearing temperature values were reviewed. The temperature data recorded were well below the alarm and trip temperatures (see **Table 2-2**) during pump operation. **Table 3-4** shows the maximum temperatures for each sensor on each pump/motor. The highest pump upper bearing temperatures were about 36 C on ST6 and 35 C on

ST8, while the alarm temperature is 65 C and the trip temperature is 71 C. The highest motor thrust bearing temperature is about 62 C on pump ST8, compared to an alarm temperature of 80 C and a trip temperature of 85 C.

Table 3-4 Storm Pump/Motor Maximum Temperature Data

Storm Pump	Max Temperature, Pump Upper Bearing (C)	Max Temperature, Motor Thrust Bearing (C)
ST1	30	53
ST2	29	55
ST3	32	59
ST4	31	55
ST5	--*	37
ST6	36	58
ST7	32	53
ST8	35	62

*Note: When ST5 back in service (Aug 2022), pump upper bearing temperature sensor not providing good data.

Given the storm pumping units typically do not run continuously for long durations it is not surprising that the maximum temperatures are quite low. It is likely that the equilibrium operating temperature was not reached in most run sequences. For example, motors of this size anticipate 6-8 hours to come up to temperature as confirmed with Ideal Electric.

3.1.1.5 Storm Pump Wet Well Level Monitoring and Associated Pump Operation

There are four level sensors located in the Oakwood pump station wet wells. One in each sanitary wet well, east and west, downstream of the sanitary bar screens, and one in each storm wet well, east and west, upstream of the sanitary bar screens. Review of the wet well level data confirmed that storm pump operation occurs when the level reaches about 73 ft and the pumps were turned off when the level is drawn down to about 65 ft. If the level continues to rise with one pump on then a second pump or more were turned on until start to draw down the wet well.

The levels vary between east and west and upstream to downstream for several reasons including minor differences in level sensor calibration and periodic operational issues. However, a main reason for differences between the upstream and downstream levels is the significant buildup of debris on the sanitary bar screen. Starting in July 2021 the upstream West Wet Well level minimum depth has been rising and has a typical depth between 52.5 ft and 53.5 ft in November 2022, while the downstream level sensor depth is between 41.5 and 49.5 ft as the sanitary pumps cycle. See **Figure 3-1** for approximately 1.5 years of wet well level data. Starting around June of 2022, the East Wet Well also has an elevated level around 58.5 ft during dry weather. The bottom of the storm pump bell is approximately at 53 ft elevation, so during dry weather the sanitary flow was backing up into the storm pumps on the west side due to the debris accumulation on the sanitary bar screen and in the wet well. The sanitary wet well level data and sanitary pump operation are discussed further in the next section.

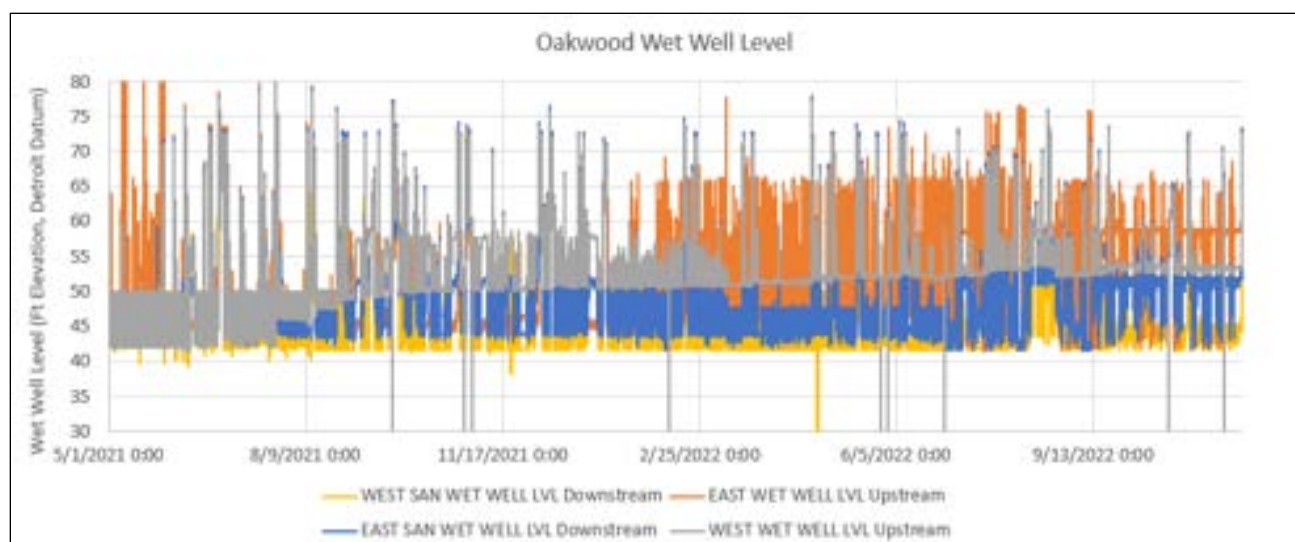


Figure 3-1
Oakwood Pump Station Wet Well Levels

3.1.1.6 Number of Storm Pumps Running Simultaneously

Data for storm pump operation, on/off times were retrieved from the Ovation system and through the GDRSS portal. The data was reviewed to identify large wet weather events when multiple storm pumps were running at the same time and compared to logbook records with operations staff. The largest events, based on number of pumps in operation are summarized in **Table 3-5**. Based on the event rainfall volumes for the largest events in the September 2019 through October 2022 data set, historical daily rainfall totals back to July 2014 were reviewed to identify earlier rainfall events of similar volume. The GLWA rainfall gauges located closest to the Oakwood storm pump station tributary area were utilized for the event rainfall. Specifically gauge PG004, located at the Water Resource Recovery Facility (WRRF), volumes are shown in **Table 3-5**. The next closest gauge PG006, located in Lincoln Park, was also reviewed but was not as reliable during all events. Based on the pump operation, wet well levels, rainfall volume, and peak hour rainfall for the events initially identified from September 2019 through October 2022, the rainfall totals at PG004 were reviewed and the events with total rainfall of greater than two inches back to July 2014 were selected for further evaluation and added to **Table 3-5**.

The largest number of operating storm pumps was five pumps during three events, 4/30/2019, 8/2/2020, and 8/28/2020. On 8/28/2020 at 3:40 AM, with a maximum wet well level of about 76 ft. The five storm pumps only ran for 5 minutes and then two of the pumps shut off. This period of operation occurred when the pumps were remotely operated prior to an operator arriving on-site, according to the notes in the logbook. Later during the same event, when there was an operator on-site, five pumps ran for 5 minutes while the wet well levels were drawing down from a maximum of about 75-76 ft.

In the eight years of data reviewed there were three events where the Oakwood RTB CSO facility was operated using five storm pumps. Typically, the larger wet weather events require between two and four storm pumps operating during the event peak for the present collection system configuration. Based on the historical maximum number of storm pumps in operation at one time (five) the design team recommends two pumps be rehabilitated simultaneously. This will maintain six pumps available to convey flow from collection system into the retention treatment basin.

Table 3-5 Number of Pumps Operating during Large Wet Weather Events (July 2014-Oct 2022)

Date/Time ^a	Max Number of Pumps On (Pump #s)	Duration Max Number of Pumps On (nearest 5 minutes)	Max ¹ Wet Well Level During or Before Pumps On (ft)	Event Rainfall (PG004, WRRF) (in)	Max Hour (in) ^b
8/11/2014 15:00	2 (ST1, ST7)	60	NA	4.11	1.59
8/16/2016 3:00	2 (ST1, ST7)	165	82 ⁶	3.34	1.75
9/20/2018 0:00	3 (ST1, 2, 3)	65	75	2.20	0.54
9/25/2018 4:50	3 (ST1, 6, 8)	85	75	3.62	1.44
4/30/2019 20:45	5 (ST1, 3, 4, 6, 7)	5 (5-pumps); 50 (4-pumps)	79	3.06	1.11
1/11/2020 8:40	3 (ST1, 2, 3)	5	73	2.66	0.46
7/10/2020 18:55	4 (ST1, 2, 6, 7)	15	78	2.23	1.27
8/2/2020 6:35	5 (ST1, 2, 5, 6, 7)	10	81	2.56	1.01
8/28/2020 3:40	5 (ST1, 2, 4, 6, 8) ²	5	76	4.29	1.13
8/28/2020 7:15	5 (ST1, 2, 4, 6, 8)	5	76		
9/7/2020 3:05	3 (ST4, 6, 8)	15	82	2.35	1.11
7/16/2021 8:55	3 (ST2, 6, 8)	90	78	3.22	1.20
6/25/2021 22:20	2 (ST6, 8) ⁵	75	78	2.16	0.38
7/24/2021 12:35	4 (ST2, 3, 6, 8) ³	45	81	2.14	2.00
8/12/2021 3:10	3 (ST2, 3, 8) ⁴	20	73	2.23	0.85

Table Notes:

NA=Not available (Historian data not readily available earlier than Oct 2017)

^aTime is approximate time start first pump

^bMax hour is based on clock hour, not a rolling average. This may slightly underestimate the max hour rainfall.

¹Max level among the available wet well level sensors (east upstream & downstream, west upstream & downstream)

²Under remote or automatic operation

³Attempted to start two more pumps but could not at time due to overload trip alarms.

⁴Logbook only indicates turning on 3 pumps. Data indicates that attempted to start ST4 and ST7 but each only ran 1 min.

⁵The storm track for this event was along the I-94 corridor. There was less rainfall, only 2.2 inches, near the Oakwood facility tributary area.

⁶Per level noted in logbook. Historian data not readily available earlier than Oct 2017. Only at peak level for short time (~10 min) then 2 pumps start to keep up.

3.1.2 Sanitary Pump Operating Data Analysis

Operating data reviewed from the sanitary pump station included the wet well levels and sanitary pump operating speeds. An example month of data from 10/20/2022 to 11/20/2022 has been provided in **Figure 3-2**, with pump speed on one graph and the four wet well level sensors on a second graph. At the time this data was collected SN-2 in the East Wet Well was out of service. SN-1 and SN-3 pumps were primarily used during dry weather at varying speeds to maintain the West Wet Well downstream level near the target operating level of 45 ft (see West Wet Well level downstream sensor in **Figure 3-2**). When SN-4 was utilized it appears to be running at full-speed continuous. This caused the East Wet Well downstream and upstream to draw down to a minimum of about 42 ft.

There was a large difference between the downstream and upstream (of screen) levels.

- On the west side the upstream level was 53.5ft when SN-1 or SN-3 was running and it draws down to 52.5 ft when SN-4, in the East Wet Well, was running. This was about 8 ft higher than the downstream level of 45 ft. This was an indication of the affect that screenings built up on the bar screen has on the level upstream assuming level sensor condition or calibration is not the cause for the differential.
- On the east side the upstream level was fairly constant at 58.6 ft and the downstream level was 51.8 ft, when SN-4 was not running. The difference between upstream and downstream on the east side is about 6.8 ft, when a pump in the other wet well was running. It was not readily apparent what may cause the differential when no pumps were operating in the East Wet Well. When SN-4 was running the levels are similar upstream and downstream as expected with the lower section of the screen removed.

From the review of the sanitary pumping system data below it appears that refinement of the existing control logic is required. This will include consideration of the intermittently operated third pump running at full speed which requires revision to facilitate operation within AOR. This will likely constrain the variability of level above and below target elevation within the hydraulic capacity of the operating pumping units.

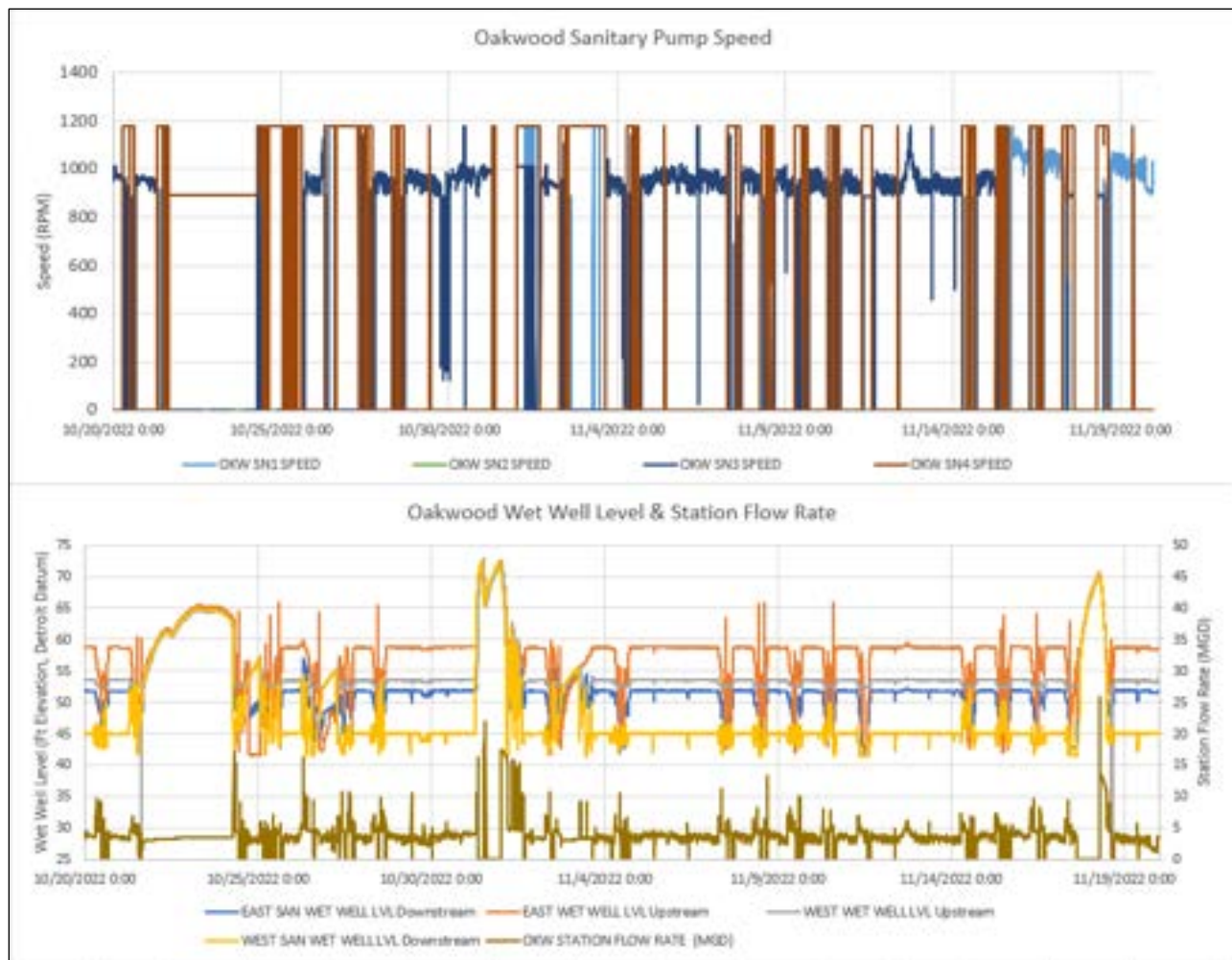


Figure 3-2
Oakwood Sanitary Pump Speed, Wet Well Level and Flow Rate

3.2 Operations Ride-Along Observations and Findings

The Design Team observed the pump operation during five ride-along events from October 31, 2022 through January 19, 2023. The purpose of the operations ride-along visits was to gain an understanding of the present process operations related to the storm and sanitary pumping systems at Oakwood. Information was obtained by observing the pump operations, collecting real-time data from the Ovation control system screens, and at times asking questions of the GLWA staff present at the facility.

The first three ride-along visits were completed by the Design Team lead for pumping improvements, Steve Fehniger, at Oakwood. These visits occurred during storm pumping events on 10/31/2022 with GLWA staff, Ira Hawkins, Art Folks, and Kelvin Jackson, onsite; 11/27/2022 with Art Folks onsite; and 12/15/2022 with Kelvin Jackson, Ira Hawkins, and Robert King onsite. Most of the information gathering and observations summarized below were obtained during these three

visits. Additional ride-along visits were performed which focused primarily on the screenings collection and handling in the screen facility but secondarily included gathering additional information and observations related to the storm pumps by Julie Aichler. These visits were completed on 12/30/2022 with Ira Hawkins onsite; and 1/19/2023 with Art Folks and Ira Hawkins onsite.

3.2.1 Storm Pump System Operations Ride-Along Observations and Findings

The ride-along visits provided an opportunity for the Design Team to observe the operation of the storm pumps at the Oakwood CSO RTB on several occasions as described above. Below is a summary of the findings based on these observations and operator interviews:

- Storm pumps operated manually from Ovation workstation in Control Room when operations staff were on-site during wet weather. At times when facility was not staffed, pumps set to turn on automatically if triggered by lead pump on level.
- Permissive of fine screens and conveyor in operation before starting first pump were active. The fine screens and conveyor were typically operated automatically and start based on wet well level before the first pump starts.
- Consistently turned first pump on at WSE 73 ft. Selection of the storm pump to operate was driven by combination of previous run time balanced with preference to run VFD speed-controlled pump which allowed longer run time to react to changes in the system; i.e. adjust disinfectant dose.
- Did not observe start of a second unit, as the storm events were not large enough to require two pumps operating at the same time to maintain level below two pump run level.
- For each fill/draw cycle a different storm pump was started and pump was turned on when WSE reached 73 ft. Selection of which pump to run appears to be driven by overall run time for each storm pump and providing motor cool down time after each run cycle, if feasible.
- Facility was not operated to try to maintain a constant level.
- Pumps are turned off when wet well level dropped to 65 ft (utilized since Fall 2018). In one case pump turned off at 62.5 ft (ST7).
- Changes to which pump placed in operation occurred when a storm pump was started and the chemical metering pump failed to start. This led to the unit being shut down and an alternate unit being operated instead. In addition, if the flow meter on the selected pump discharge was identified as not functioning then this may lead to shut down of the pump and switch to an alternate pump for which flow meter was operating.

- Levels would decrease for each event after pump start as pumped flow rate would exceed influent flow rate to the facility. This resulted in Ovation selecting minimum speed for each pump (programmed as 75% for both small and large pumps).
- Observations of the instruments on the cooling/seal/lube water during pump operation resulted in the following range of observed values as interpreted from existing pressure gauges and a rotameter:
 - Water pressure measured in storm pump motor room, 68-76 psi.
 - Water pressure measured at intermediate level, 13-24 psi and one reading of 48 psi.
 - Flow rate measured at intermediate level, 12-17 gpm.
- Discharge pressure, as measured at centerline of the discharge pipe via the pressure gauge:
 - ST1: 25-27 psi
 - ST5: 12-13 psi
 - ST6: 10.5 psi
 - ST8: 13 psi
 - ST7: 12 psi
- In general, VFD speed-controlled pumps observed some noise at intermediate level. The VFD pumps were louder with a deeper sound during operation, compared to generally quiet operation of the constant speed pumps. Storm pump 5 made intermittent “boom” sounds, which sounded like hitting a 55-gallon drum when running at minimum speed. The pumps will be noisier when outside AOR. However, the audible sound from pump 5 may not be caused only by operation outside AOR.
- It appears that several vibration sensors may not be functional or out of calibration. ST4, ST7, and ST8 vibration sensors displayed 0 in/sec whether the pump is running or not. Others, for example, ST3 were displaying 0.11 to 0.15 in/sec when off while others in same off condition displayed 0 in/sec.

3.2.2 Sanitary Pump System Operations Ride-Along Observations and Findings

The operations ride-along visits provided an opportunity for the Design Team to observe the operation of the sanitary pumps at the Oakwood CSO RTB on several occasions. These observations typically occurred as transitioned from sanitary to storm pumping. Below is a summary of the findings based on these observations and operator interviews:

- Typically the sanitary pumps are controlled by Ovation in automatic operating mode.

- Normal dry weather operation involves first unit start at WSE 46 ft; low level off level at 41 ft. This range is operator adjustable and has been constrained to 45 to 42-ft.
- In dry weather conditions it has been unusual to run more than two pumps.
- Dry weather average flow is 7-8 cfs which is 4.5-5.2 MGD (one pump running).
- Maximum operating condition is three pumps in service. With four pumps in service flow will overtop the weir in the surge relief chamber intended for recirculation of flow.
- If pumps operated manually typically done from Ovation workstation in the control room. Occasionally need to clear alarm at the VFD if not clear in Ovation.
- It appears that the sanitary pump moisture alarm may be treated like a nuisance alarm with a successful reset either in Ovation or at the VFD resulting in continued operation. From discussions with the Flygt local rep the pump protective device for high moisture will not necessarily repeat the moisture alarm which can then lead to more substantial damage to the motor with continued operation. The observed stator failures demonstrate the extent of damage which can occur prior to pump operation ceasing.
- Common to turn the sanitary pumps off several hours before an anticipated storm event to reduce the flow to the NWI and allow more capacity for wet weather flows from other areas as the collection system is filling. Typically turned off sanitary pumps during the storm event between Wet Well levels 62-67 ft and occasionally lower.
- Range of speed: 881 to 1175 rpm. The rated speed of the Flygt sanitary pumps is 1185 rpm, therefore the pumps are typically operated in the range of 74-99% speed.
- Sanitary pumps were not operated in recirculation mode during wet weather events and have not had a problem with grit clogging the pumps.
- Operations is aware of but does not choose to operate the cleaning cycle (draw down) with the sanitary pumps intermittently.

3.3 Storm Wet Well Minimum Operating Level

The storm wet well minimum operating level was evaluated by consideration of three key focus areas:

- Pump intake design acceptance criteria at minimum operating level
- Adequate NPSH margin
- Motors non-overloading for the new conditions of service

The above areas were evaluated in the stated order to determine the minimum storm wet well level while meeting associated constraints. The contract established a minimum of 65 ft for the lead storm pump shut off level as a goal. A summary of the evaluation for each focus area follows:

3.3.1 Pump Intake Design – Physical Model Study Acceptance Criteria

The pump intake design acceptance criteria, as summarized in ANSI/HI 9.8 Pump Intake Design standard relative to physical model studies, were evaluated through the physical hydraulic model study performed by Clemson Engineering Hydraulics (CEH). The details of the model study were included in the report prepared by CEH included as Appendix A.

Key findings included that the minimum water surface elevation at which the physical model study acceptance criteria are within tolerance for each pump size were as follows: 61 ft for the small pumps and 62.5 ft for the large pumps.

These values are an improvement relative to the goal 65 ft minimum level but require further evaluation in the other two areas summarized below to determine if technically feasible to shut down the lead pump at these lower minimum water surface elevations.

3.3.2 Adequate NPSH Margin

The NPSH Margin for the small and large storm pumps was calculated with the minimum water surface elevations determined by the physical model study as an input. The calculation also utilized the maximum combined sewage temperature, actual NPSH datum of each pump, and operation in the AOR with associated greater NPSH margin ratio.

The evaluation determined that the NPSH margin is adequate at the minimum water surface elevation for each pump with a margin ratio of 1.2 in accordance with ANSI/HI 9.6.1 for the pump impeller material (stainless steel), service (wastewater) and horsepower (≥ 100 HP).

This area of focus determined operation at the model study determined lower water surface elevations is technically feasible which resulted in evaluation of the motor load focus area summarized below.

3.3.3 Motors Non-overloading for the New Conditions of Service

The evaluation of the motor load capability for the new conditions of service (lower wet well elevation with resultant greater total head and revised minimum speed to maintain operation within the AOR) resulted in a focus on the available motor torque at minimum speed as compared to the pump required torque.

The evaluation included consideration of pump required torque at the higher head, lower speed condition and compared to the motor manufacturer's input regarding the motor torque available for these operating conditions to determine the motors will not be overloaded or unable to provide sufficient torque at the new conditions of service. Ideal Electric indicated existing motors can

operate at the horsepower and speeds provided (small pump: 88% speed , 885 HP, 523 rpm; large pump: 92% speed, 1,632 HP, 410 rpm) with no modifications or reduction in motor life expectancy.

3.3.4 Storm Wet Well Minimum Operating Level Conclusions

Therefore, based on the evaluation of the three focus areas summarized above the storm pumps can operate to shut off wet well levels (61 ft for the small pumps and 62.5 ft for the large pumps) lower than present practice (65 ft) although minimum pump speed will be higher than present practice to maintain operation within AOR as described in the next section.

3.4 Storm and Sanitary Pump System Curve Envelope & Overlay Plots – Viable Operating Conditions & Speeds

The storm and sanitary pump system curve envelopes were determined and then compared to the pump performance curves in overlay plots to assess the range of feasible operating conditions and speeds the pumps could operate for these applications and maintain operation within the AOR of each pumping unit. In addition, consideration was given to operation focused within the POR to the extent feasible.

The pump performance curves with AOR and POR for the small and large storm pumps as well as the sanitary pumps were included in Section 2.

3.4.1 Storm Pumps

3.4.1.1 System Curve Envelope Development

The storm pump system curves were developed using a spreadsheet-based tool developed by CDM Smith which develops system curves for range of static head over which the system will operate and estimates losses due to pipe friction and minor losses.

For this application, each pump is directly piped to the screen facility inlet chamber with a vertical standpipe terminated above downstream maximum water level as a hydraulic break such that the pumps do not convey flow in a common discharge header.

The system curve envelope covers the range from minimum water surface elevation for each pump (small and large) to the maximum level. Minimum levels selected based on the evaluation summarized in section above and maximum level based on original design which has worked in historical practice to minimize basement backups.

3.4.1.2 Overlay Plots

Overlay plots which combine the system curve envelopes discussed above with the pump performance curves for the application specific hydraulic performance characteristics are presented in **Figures 3-3, 3-4, and 3-5** for the small and large pumps, respectively.

The overlay plots reflect the output of a spreadsheet tool developed by CDM Smith for the graphical representation of the pump coverage of the system curve envelope.

The overlay plots provide a visual tool to estimate the operating range of each pump in the application with a focus on maximizing operation in the POR to extent feasible and avoiding sustained operation outside the AOR in accordance with pump manufacturer's input on operating range and with consideration of applicable HI standards and guidelines. The speed-controlled pumps include a series of speed reduced performance curves to represent performance over range of speed steps.

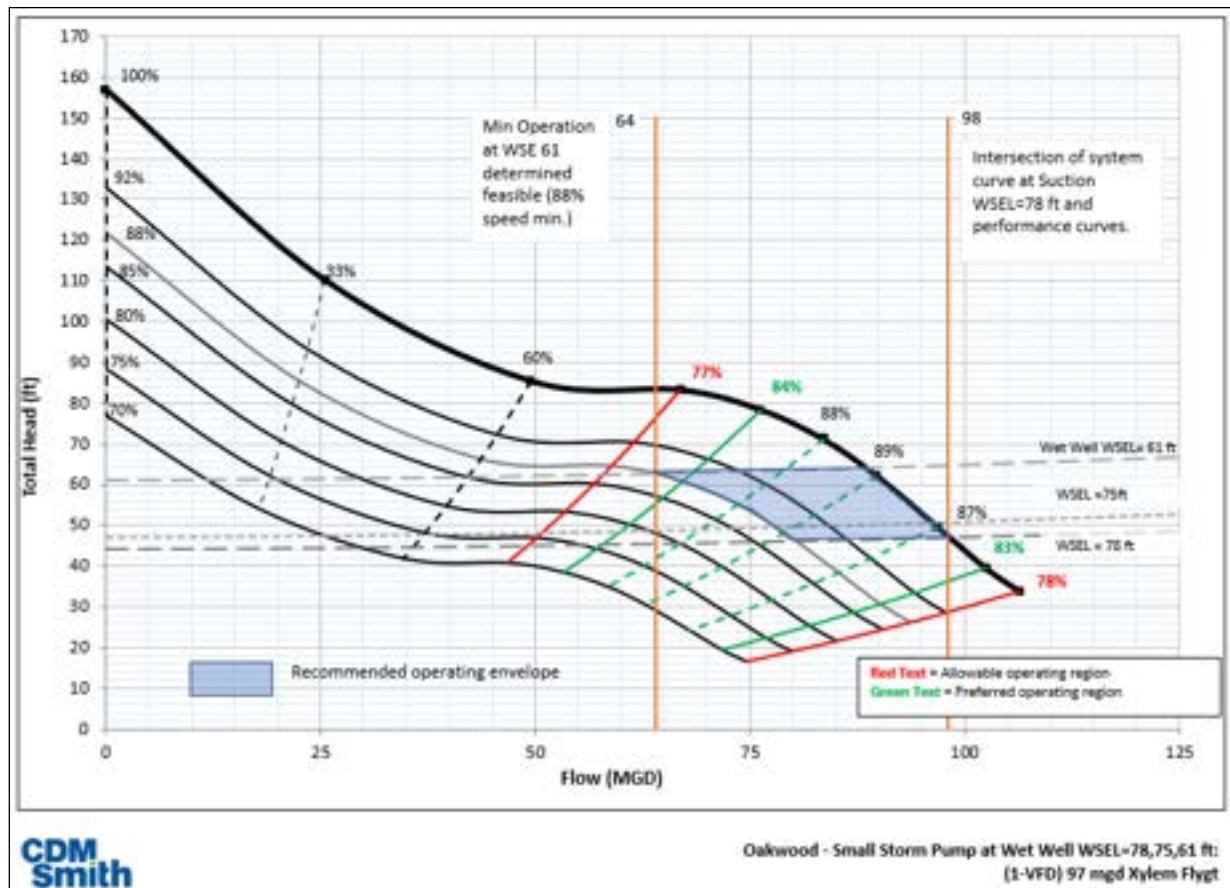


Figure 3-3
 Oakwood Small Storm Pump Overlay Plot

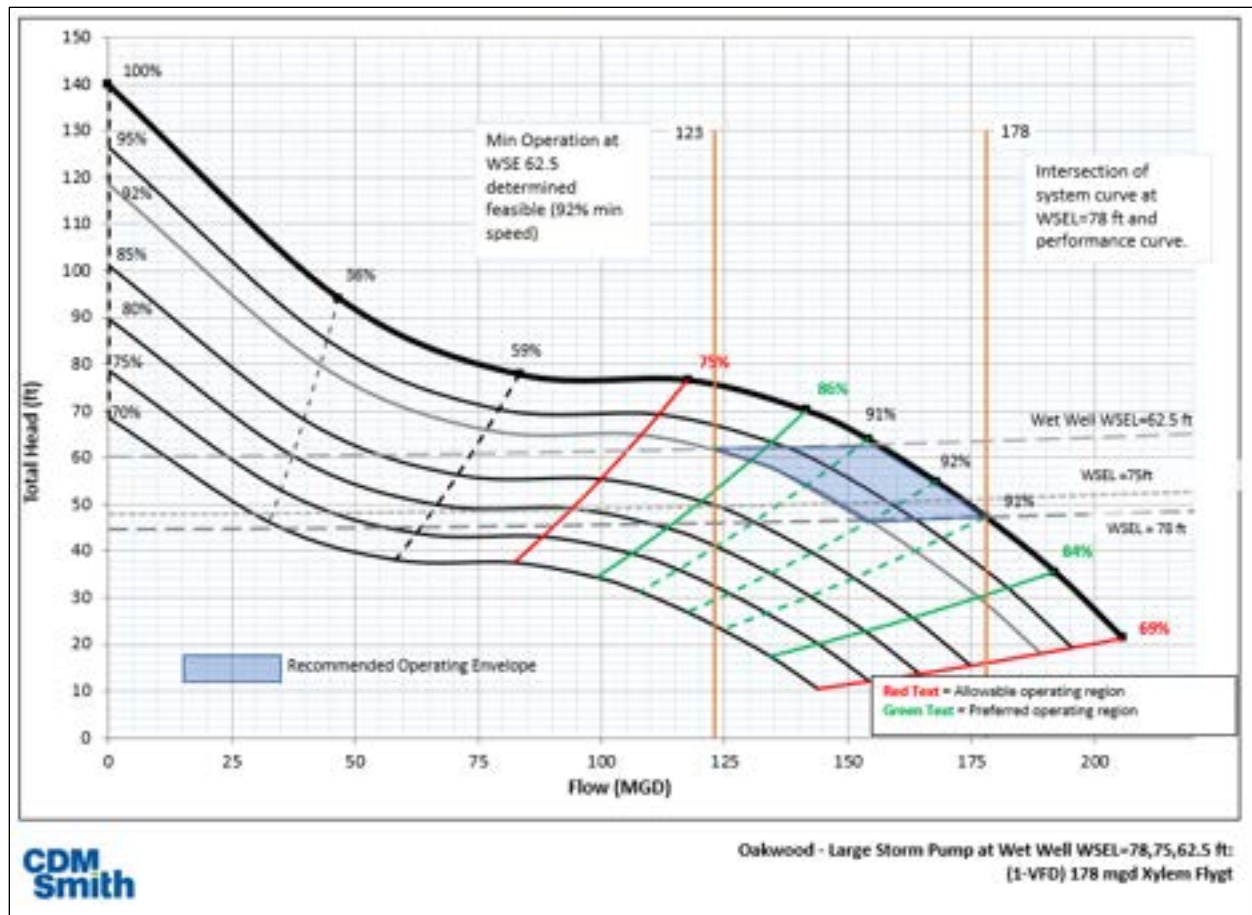


Figure 3-4
Oakwood Large Storm Pump Variable Speed Overlay Plot

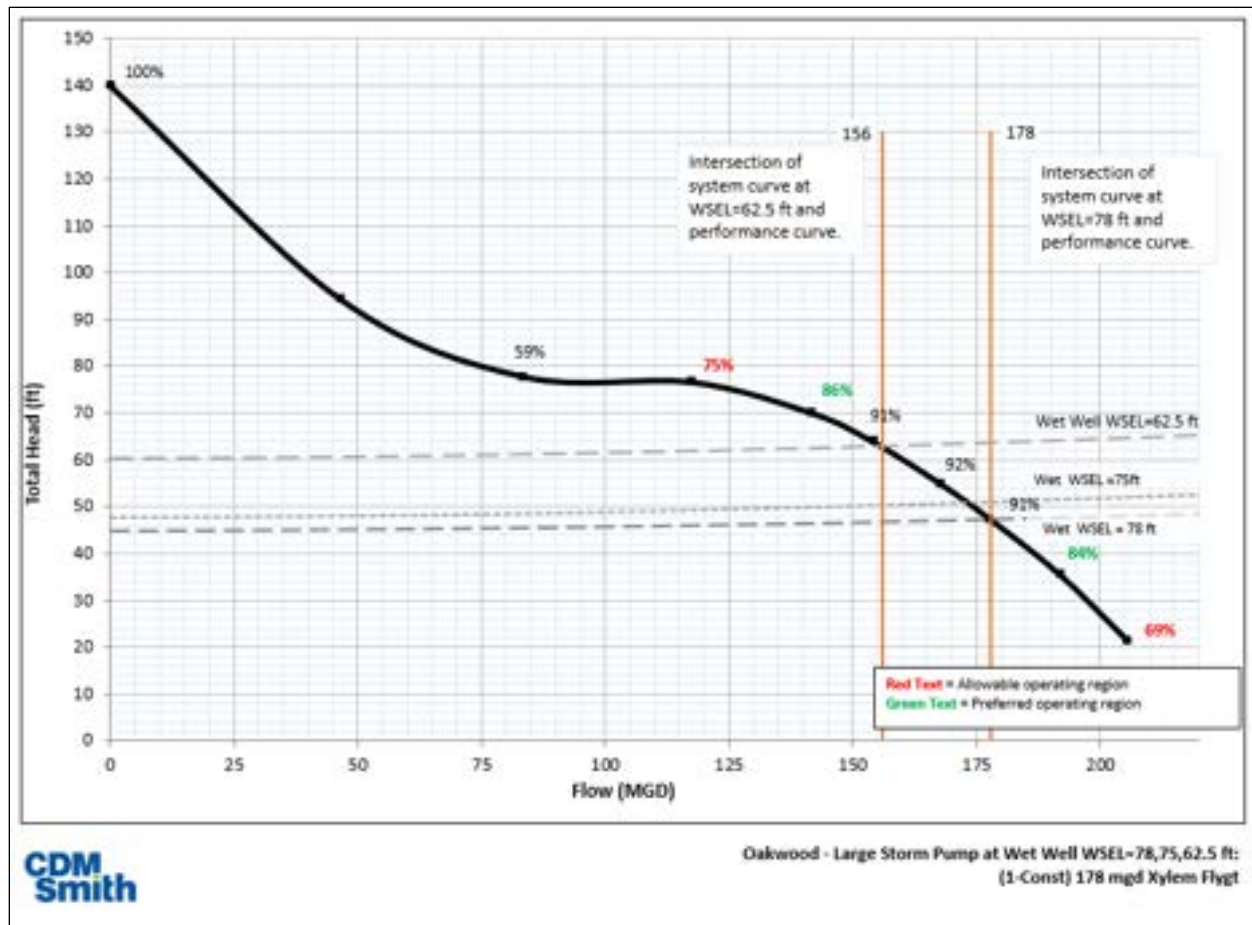


Figure 3-5
Oakwood Large Storm Pump Constant Speed Overlay Plot

In the figures above the acceptable operating envelope was shaded in blue. The range of conditions shown have been used for the development of the operational strategy improvements described below to determine how the pumping units should be operated. In addition, the minimum acceptable speed to maintain operation primarily in the POR to minimize operational costs and over entire operating envelope within the AOR (excludes the unstable portion of the performance curve) for each pump size are shown with minimum speed for small pumps of 88% speed and for large pumps 92% speed.

Although the overlay plots provide a “one pump” view of the system, the summation of capacities from each operating pump can be determined by summing capacities for various pump combinations/operating scenarios to determine the overall capacity and the gap (step in flow rate capacity) that will occur as the number of operating pumps change. **Table 3-6** provides an example with the large VFD speed-controlled pumps started first, followed by the small VFD speed-controlled pumps, then the constant speed pumps. Due to the capacity range of each pump the steps

(gaps) of flow rate are present despite ramping the operating speed-controlled pumps down to minimum speed when turning on the next pump.

Table 3-6 Storm Pump Sequence to Minimize the Capacity Gaps at Pump Transitions

Combination Order as Flows Increase	Operating pump combination			Min Flow, small VFD (mgd)	Max Flow, small VFD (mgd)	Min Flow, Large VFD (mgd)	Max Flow, Large VFD (mgd)	Flow, Large Const (mgd)	Total Min Flow (mgd)	Total Max Flow (mgd)	Limitation for Min Flow	Overlap with previous combo (mgd)	Pump, Min speed, %	Comments
Sequence 2	Number of Small VFD	Number of Large VFD	Number of Large constant	Values only used if # on is >0										
1	0	1	0			146	174		146	174	Min operation with given pump		92%	Starts with large VFD pump, then second large VFD, then small VFD, and constants last.
2	0	2	0			148	175		296	350	92% speed	-122	92%	Min flow at WW=73', max flow at WW=75' & 100% speed
3	1	2	0	84	97	150	175	175	384	447	92% speed	-34	92%	Min flow at WW=75.5', max flow at WW=76' & 100% speed
4	2	2	0	85	98	151	176	176	472	548	92% speed	-25	92%	Min flow at WW=76', max flow at WW=76.5' & 100% speed
5	2	2	1	85	98	152	176	176	650	724	92% speed	-102	92%	Min flow at WW=76.5', max flow at WW=77' & 100% speed
6	2	2	2	85	98	153	177	177	830	904	92% speed	-106	92%	Min flow at WW=77', max flow at WW=77.5' & 100% speed
7	2	2	3	85	98	154	178	178	1012	1066	92% speed	-108	92%	Min flow at WW=77.5', max flow at WW=78' & 100% speed. This combination covers Design Capacity Peak flow of 1660 cfs with

Notes: 1. Assume WSE is increasing 0.5' as each additional pump is called to turn on.
2. All VFD speed-controlled pumps operated at the same speed. This limits the operating speed of the small pumps to 92% to match minimum speed for the large pumps.
3. Flow rate is rounded to nearest whole number. At the given WSEs the flow rate has limited change as increase WSE in 6" increments, therefore rounded flow rate is the same across some increases in WSE.

3.4.2 Sanitary Pumps

3.4.2.1 System Curve Envelope Development

The sanitary pump system curve envelope was developed using AFT Fathom for the pressurized portion of the system and Visual Hydraulics for the gravity portion.

For this application each set of dedicated pumps convey flow into a common header that is then combined into a single force main downstream of the West Wet Well connection. Under nearly all operating conditions, the system transitions to gravity flow at the first manhole.

The system curve envelope covers the range from minimum water surface elevation to the maximum level. Minimum levels selected based on the operating practice and minimum

submergence required by Flygt based on their input to the historic maximum if sanitary pumps were to be operated during a storm in recirculation mode in the future.

The following summary provides background regarding the system curve development with a focus on the downstream water surface elevation.

The Storm Water Management Model (SWMM) hydraulic modeling of the collection system established a maximum dry weather water surface elevation of 94.1 ft in the sanitary manhole immediately downstream of the surge relief chamber. Visual Hydraulics (VH) was used to establish the upstream water surface elevation at the discharge of the sanitary pump force main (first manhole). This VH determined upstream water surface elevation was subsequently input into AFT Fathom as the “downstream” water surface elevation.

Under all modeled scenarios in which the surge relief chamber weir was not overtopped, the discharge of the 20” sanitary force main was not submerged. Therefore, the downstream water surface elevation input into the AFT Fathom model was 98.33 ft, equivalent to the centerline of the force main connection to the first manhole.

Under modeled scenarios with a high-water surface elevation (above 62 ft) in the sanitary wet well, it was assumed that only one sanitary pump was in use and that all flow passed over the surge relief chamber weir (recirculation mode). In these scenarios, the water surface elevation at the sanitary pump force main discharge was 98.6 ft, which was input into AFT Fathom as the model’s downstream water surface elevation.

The other elements of the system including pipe/fittings configuration and range of upstream water levels were input into the AFT Fathom model to complete the system and determine the system curve envelope.

3.4.2.2 Overlay Plots

Overlay plots which combine the system curve envelope discussed above with the pump performance curves for the application specific hydraulic performance characteristics are presented in **Figures 3-6, 3-7 and 3-8** for three pump combination operating conditions (one pump, two pump and three pump operation).

A sensitivity analysis was performed to determine how much the system curve varied from one pump to the next. The findings determined that the variation is limited relative to the total head such that these curves are representative of the four pump positions.

Refer to the general overview information regarding overlay plots in the storm pump overlay plot section above.

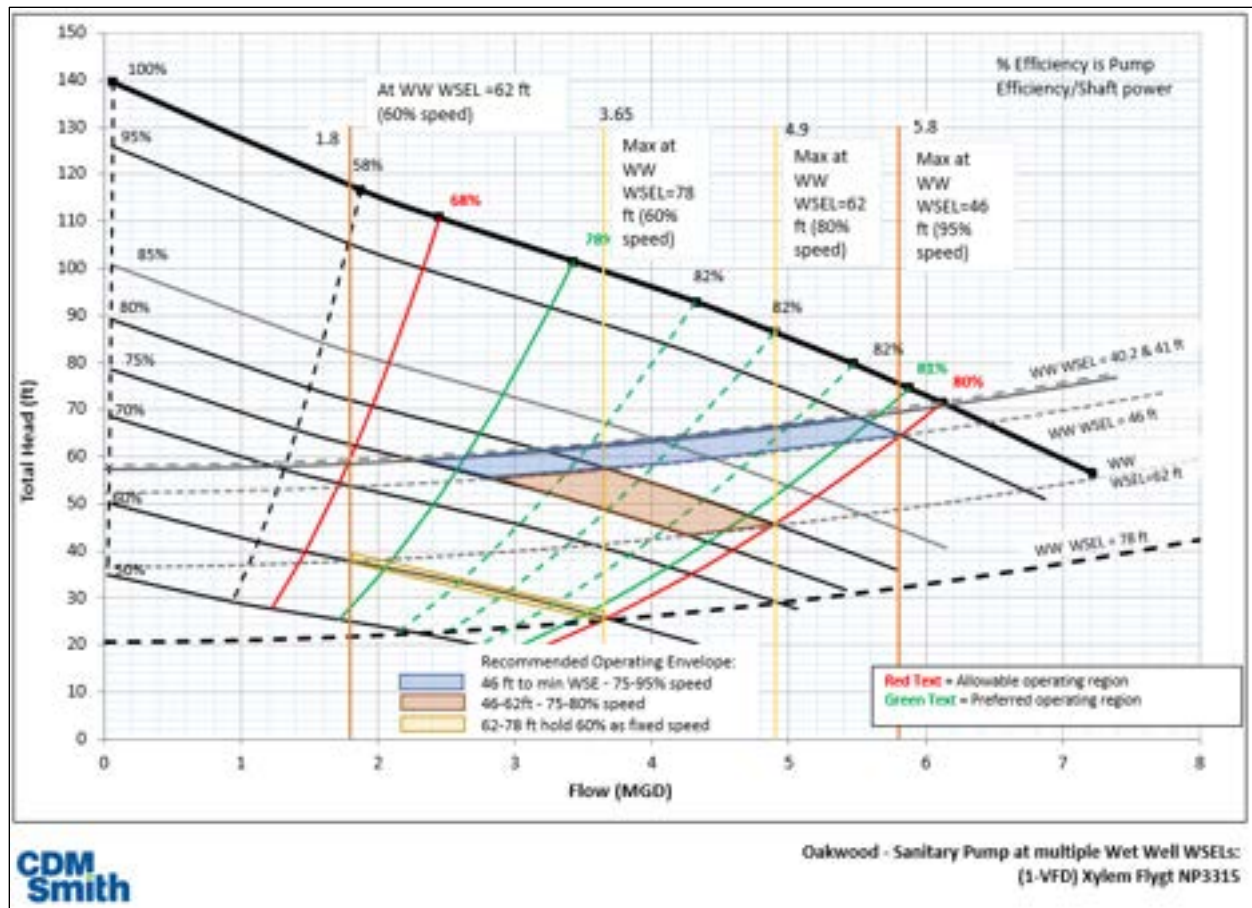


Figure 3-6
 Oakwood Sanitary One Pump Overlay Plot

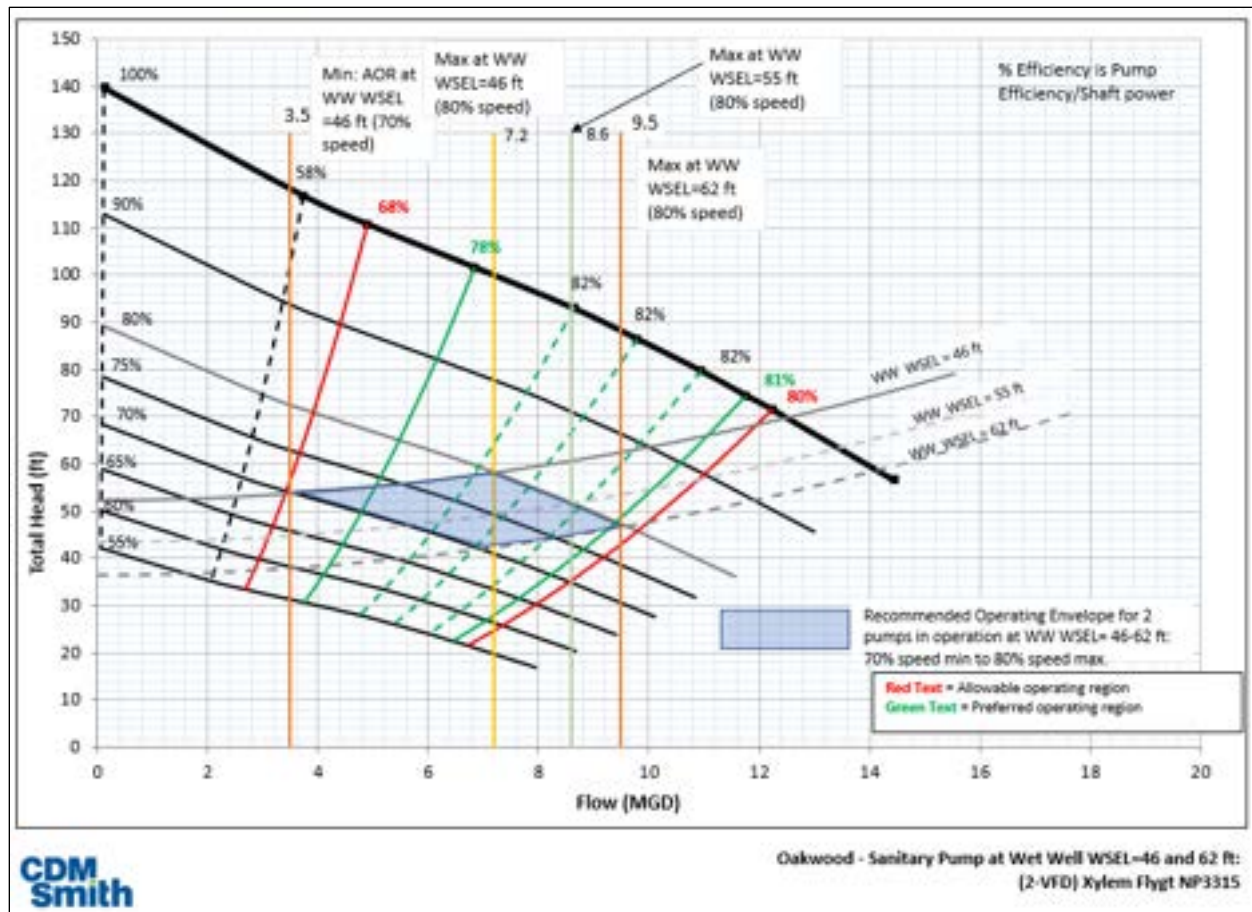


Figure 3-7
 Oakwood Sanitary Two Pump Overlay Plot

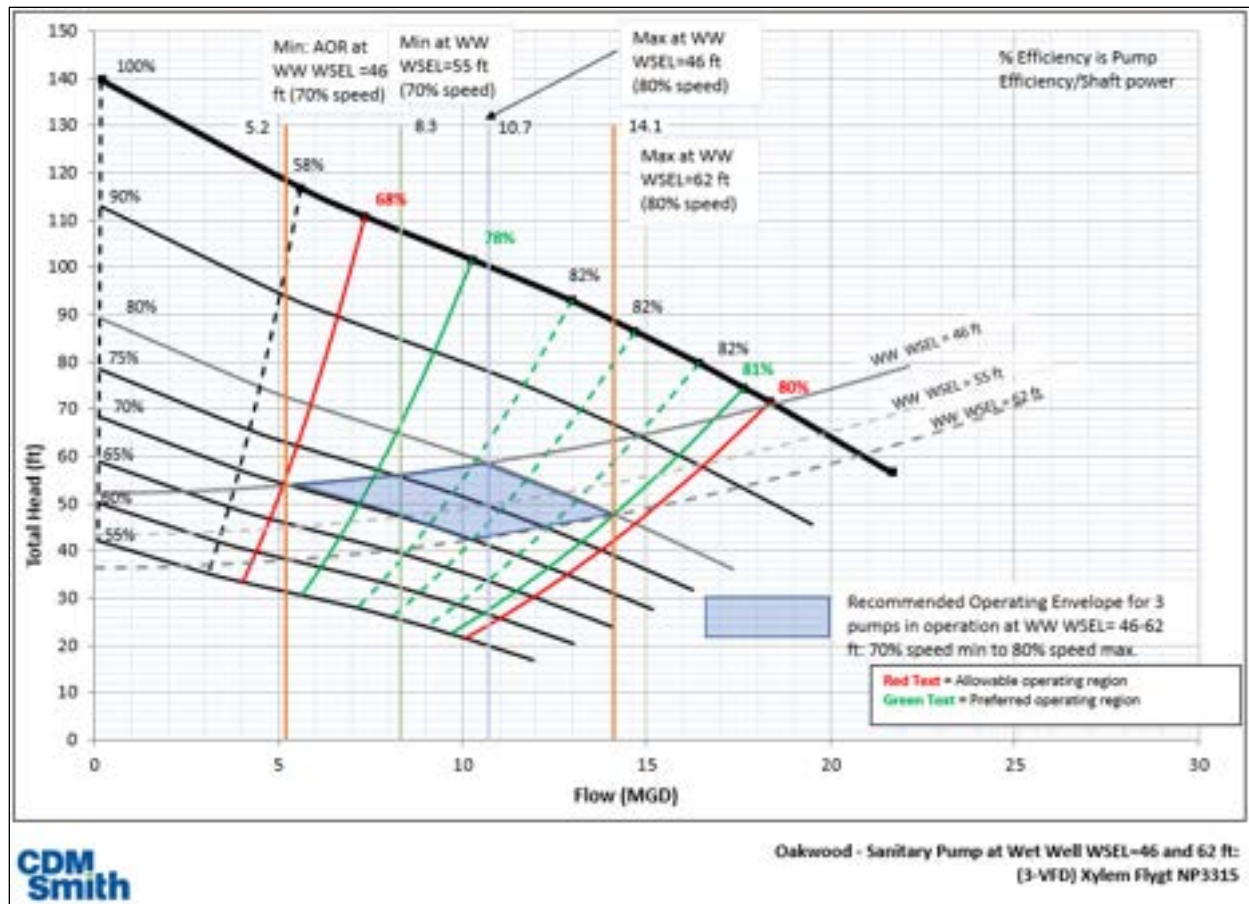


Figure 3-8
Oakwood Sanitary Three Pump Overlay Plot

In the sanitary pump overlay figures the acceptable operating envelope was shaded in blue. The range of conditions shown have been used for the development of the operational strategy improvements described below to determine how the pumping units should be operated. In addition, the minimum acceptable speed to maintain operation within the AOR are shown as a function of wet well water surface elevations due to the limited coverage of the system curve envelope on the right side of the performance curve. The right limit of the AOR was discussed with Xylem Flygt as summarized in Section 2.

Although the overlay plots provide a one, two and three pump view of the system, the summation of capacities is also represented in **Table 3-7** with associated operational constraints identified. The table demonstrates that limited overlap at pump transitions will be feasible if system is operated as represented in the overlay plots.

Table 3-7 Sanitary Pump Sequence Summary Tabulation

Combination Order as Flows Increase	Operating pump combination	Total Min Flow (mgd)	Total Max Flow (mgd)	Limitation for Min Flow	Overlap with previous combo (mgd)	Pump, Min speed, %	Comments
Sequence 1	Number of Sanitary Pumps (VFD)						Starts with one pump, transition to two pumps, then three pumps with constantly rising wet well
1	1	2.5	5.8	Min operation at WW WSE=41	NA	75%	Min flow at WW=41' (75% speed), max flow at WW=46' & 95% speed
2	2	3.5	8.6	70% speed	2.3	70%	Min flow at WW=46', max flow at WW=55' & 80% speed
3	3	8.3	14.1	70% speed	0.3	70%	Min flow at WW=55', max flow at WW=62' & 80% speed
1	1	1.8	3.65	60% speed		60%	Separate consideration of operating range for 1 pump between 62' and 78' at 60% speed

Notes: 1. Table provided sanitary pump example operations - starts with single pump between 40.2-46 ft, then 2 pumps between 46-62 ft, & 3 pumps up to 62 ft.
2. Refer to last row for 1-pump in operation (if recirculation mode reinstated) between 62 ft and 78 ft at constant reduced speed of 60%.

3.5 Storm and Sanitary Wet Well Sensor Selection Control Logic Evaluation

The importance of reliable level sensor signals and associated control logic utilized to select the signal for control basis of each pumping systems cannot be overstated. With a focus on the operational strategy in this TM, the Design Team has considered of the existing sensor selection logic summarized in Section 2 and has determined revision to address limitations of the present logic and modify to reflect the practice at other GLWA pump stations is required. A description of the proposed control logic follows.

As part of the system improvements, the control logic utilized for storm and sanitary wet well level selection will be updated to use the standard multiple-transmitter selection (2X-Select) logic. The new system will still use the two redundant level sensors as inputs, while the output signal used by the pump system could be one of five options:

- AVG - Average of the two inputs
- Max - Higher value input
- Min - Lower value input
- A – Input A
- B – Input B

Selection of which mode to use will be performed by the operator through a control faceplate. The standard faceplate shows the two input levels, current mode, and output level.

The updated logic will also check the quality of each input signal and defaults it's selection mode if one signal goes into bad quality due to a failed instrument, broken wire, etc. For example, if AVG is selected and input A fails, the logic will default to B mode. The logic inhibits the selection of a failed input. Once the failed input is returned back to service, the operator can switch modes.

3.6 CS-299 report and Brown & Caldwell (BC) TM Operational Strategy Recommendations

The CS-299 and BC TM operational strategy recommendations were reviewed and evaluated relative to the Design Team's evaluation of these systems. A list of the recommendations which differ from those discussed above are provided with an explanation of why not changing our approach to the evaluation.

- Potential storm pump setpoint modifications included:
 - Operating SP1 and SP2 within a speed range of 85 to 100% to avoid unstable operating zones.
 - *Design Team recommended range of 88 to 100% to maintain operation primarily in the POR and within AOR over the system curve envelope in lieu of the proposed speed range.*
 - Operating SP5 and SP6 within a speed range of 85 to 100% to avoid unstable operating zones.
 - *Design Team recommended range of 92 to 100% to maintain operation primarily in the POR and within AOR over the system curve envelope in lieu of the proposed speed range.*
- Lowering lead storm pump shut off water surface elevation from 71 ft to 65 ft.
 - *Design Team recommended a minimum of 61 ft for the small pumps and 62.5 ft for the large pumps in lieu of the proposed 65 ft.*

- Potential sanitary pump setpoint modifications included the following summarizing the setpoints from Table 5-5 of the BC TM:

Water Surface Elevation (ft)	Number of Pumps On	Motor Speed (%)	Approximate Discharge Flowrate Range (mgd)
EL 40 to EL 46	1	75% - 100% (varies)	2 - 6 mgd
EL 46 to EL 50	2	75% - 100% (varies)	6 - 14 mgd
EL 50 to EL 60	2	100% (fixed)	14 - 15 mgd
EL 60 to EL 72	3	85% (fixed)	16 - 20 mgd

- The Design Team recommended the operating conditions summarized in Table 3-8 for the sanitary pumps in lieu of the above to maintain operation in the AOR over the range of operating conditions.

Table 3-8 Sanitary Pump Operational Protocol

Wet Well Level (ft)	No. of Pumps On	Motor Speed (%)	Approx. Flow Rate (MGD)	Notes
40.2 to 46	1	75 to 95	2.3 to 5.8	Normal dry weather 41-46 with intermittent cleaning cycle to 40.2
46 to 62	1	75 to 80	2.9 to 4.9	Not anticipated to occur frequently (expect multiple pumps on-line at higher levels)
62 to 78	1	60 (constant)	1.8 to 3.7	If recirculate flow during wet weather
46 to 62	2	70 to 80	3.5 to 9.5	
46 to 62	3	70 to 80	5.2 to 14.1	Potential to raise upper motor speed slightly if additional capacity required

Note: Flow rate range stated was over full wet well level range for each operating condition.

The conditions proposed in the BC TM would result in operation outside the AOR. Therefore, the speed range as a function of wet well level and number of pumps in operation varies as summarized in **Table 3-8** and as shown graphically in the overlay plots. The motor speed upper limit could be expanded a couple percent for two and three pump operation if greater overall capacity required as approach potential wet weather event.

The selected Flygt pumps are unable to cover the right side of the system curve envelope as would be optimal for operational flexibility resulting in varied speed restrictions to maintain operation in the AOR. If additional pumps are purchased in the future consideration to an alternate hydraulic design which works within the horsepower constraints of the electrical gear and VFDs would be beneficial.

4.0 Conceptual Storm and Sanitary Pump Improved Operational Strategies Improvements

The conceptual operational strategies summarized in this section reflect Design Team proposed improvements to the present operational strategies for storm and sanitary pumping systems when operated in Auto mode based on evaluations and operational insights gained as summarized in Sections 2 and 3.

The conceptual improvements are summarized in the following subsections utilizing an improved description of the existing operational strategy included in Sections 2.1.3 (Storm) and 2.3.3 (Sanitary) for the present (existing) Auto mode operational strategy.

4.1 Storm Pumping System

The following is a summary of the improved storm pump Auto mode operational strategy. This strategy assumes that all storm pumps are operational and that all storm pumps are in Auto mode.

Prior to a storm event, the operator selects ST sequence. The sequence is selected from a selection screen in Ovation. The follow sequence is recommended to minimize the size of the gaps when transitioning from one pump combination to the next and is captured greater detail in Section 3: ST5, ST6, ST1, ST2, ST3, ST4, ST7 (or ST8). This sequence includes VFD speed-controlled pumps in operation before the constant speed pumps.

This example is based on the design condition in which the wet well level continuously rises requiring all seven duty pumps to be turned on.

This sequence no longer utilizes the target level to maintain in the wet well within so many feet of a target level due to limitations on the operating range of the pumps within their respective AOR's as constrained by the system curve envelope and limitations in stored volume relative to pump capacity. Instead of this method a ramp up/then down of level with associated pump starts/then stops was summarized.

The decision regarding lead pump selection is guided in part by desire to distribute the runtime between the storm pumps and if alternate lead pump is selected the incremental increase in flow when another pump is turned on will likely be greater.

During a wet weather event, the wet well levels will increase. When the wet well level rises to or above 73 ft, the first storm pump in the sequence will start. The pump will run at minimum speed (523 rpm for small pumps (88% speed); 410 rpm for large pumps (92% speed)) for 75 seconds to allow the discharge piping to fill up. After the 75-second timer expires, the control system will modulate the pump speed to attempt to maintain the level below second pump on level (75 ft). Below 73 feet pump will operate at minimum speed, between 73 and 75 ft pump will ramp up linearly to be at full speed when level reaches 75 ft.

The Ovation control system will compare the wet well level with the Ramping Level Setpoint. As the wet well level rises above the last ramping level setpoint, the control system will increase the speed of the speed-controlled pumps to attempt to maintain the wet well level. Similarly, if the wet well falls below the ramping level setpoint, the control system will decrease the speed to attempt to maintain the wet well level. If the lead pump is running at full speed and the wet well level is at or above 75 ft for more than 60 seconds, Ovation will start the next storm pump in the sequence.

The second pump will run at minimum speed for 75 seconds. Then the pump will ramp up and the operating pump will slow down to match speeds so not such a substantial increase in flow rate with additional pump. Both pumps run at the same speed (if a combination of small and large variable speed pumps the greater minimum speed will be utilized) and will be modulated to maintain the last Ramping Level Setpoint (75 ft).

If the wet well continues to rise and the two running pumps are at maximum speed and the wet well level is at or above 75.75 ft for more than 60 seconds, Ovation will start the next storm pump in the sequence. The third pump will run at minimum speed for 75 seconds. Then the pump will ramp up and the three operating pumps will slow down to match speeds and modulate speed to maintain the 75.75 ft setpoint.

If the wet well continues to rise and the three running pumps are at maximum speed and the wet well level is at or above 76.25 ft setpoint for more than 60 seconds, Ovation will start the next storm pump in the sequence. The fourth pump will run at minimum speed for 75 seconds. Then the pump will ramp up and the four operating pumps will slow down to match speeds and modulate speed to maintain the 76.25 ft setpoint.

If the wet well continues to rise and the four running pumps are at maximum speed and the wet well level is at or above the 76.75 ft setpoint for more than 60 seconds, Ovation will start the next storm pump in the sequence.

In this operational strategy, the remaining pumps in the sequence are constant speed pumps. The constant speed storm pumps are programmed internally (not through Ovation) to ramp up over a range of 0-180 seconds, with an initial setting of 75 seconds to allow discharge piping to fill up as the pump speed is increasing to full speed. After the constant speed pump has completed ramp up, the VFD speed-controlled pumps will all decrease to minimum speed to minimize the step increase in flow rate and then continue to modulate to maintain the last Ramping Level Setpoint (76.75 ft) while the constant speed pump runs at full speed.

If the wet well continues to rise and the five running pumps are at maximum speed and the wet well level is at or above the next Ramping Level Setpoint (77.25) for more than 60 seconds, Ovation will start the next storm pump in the sequence. The VFD speed-controlled pumps will step down in speed as described for five pumps in operation followed by continuation of modulation of speed to maintain the last wet well Ramping Level Setpoint while the constant speed pumps will run at full

speed. This sequence will continue until seven pumps are operating (7th pump on at 77.75 ft) or the wet well level begins to fall.

As the wet well level begins to fall, the pumps will shut down in order (first started of each pump size/ speed control type (VFD speed controlled or constant) will be first off as step pumps off to allow runtime distribution). As stated before, the VFD speed-controlled pumps will continue to modulate to maintain the Wet Well Falling (since level decreasing but same numerical value as the corresponding rising level setpoint) Level Setpoint while the constant speed pumps will run at full speed. If the wet well continues to fall and the four VFD speed-controlled pumps are running at minimum speed and the wet well level is 0.5 or 0.75 ft (match the same set point values as used for rising level) below next Falling Level Setpoint for more than 60 seconds, Ovation will stop the last storm pump that was started in the sequence. The VFD speed-controlled pumps will continue to modulate to maintain the Wet Well Falling Level Setpoint while the remaining constant speed pumps will run at full speed. If the wet well continues to fall and the four VFD speed-controlled pumps are running at minimum speed and the wet well level is 0.5 or 0.75 feet below the next Falling Level Setpoint for more than 60 seconds, Ovation will stop the next storm pump that was started in the sequence. This sequence continues with each pump turning off in the reverse order that they turned on until the last VFD speed-controlled pump is operating.

If the wet well continues to fall, the final VFD speed-controlled pump will continue to run at minimum speed until the level falls to 62.5 ft (large pumps) or 61 ft (small pumps) for 15 seconds.

4.1.1 Storm Pumping Unit Vibration and Temperature Monitoring

The Ovation system will continue to monitor each storm pumping unit's vibration and temperature sensors.

4.1.1.1 Vibration Monitoring

The vibration sensors, as presently configured and if sensors fully functional, cause an alarm for any of the pumping units if a sensor value exceeds 0.85 in/s independent of the location (pump, lower motor or upper motor) of the sensor. In preliminary design phase a recommended alternate set point for vibration alarm, which will likely vary by sensor location, as well as clarification of the vibration velocity units (peak or RMS) will be determined to refine this part of the operational strategy. The recommended alarm and trip set points will consider alignment with HI standards guidance and the pump manufacturer.

Discussion with GLWA is needed regarding their preference for the Multilin motor protection device for a representative pump to shut down if the vibration trip value is in excess of pump manufacturer recommended trip value. Presently the pumps do not shut down if a vibration trip set point is reached. The Design Team recommends shut down of the pump if this level of vibration is detected to minimize damage to the pump if this will not result in basement backups (if another pump can be started if wet well level is close to maximum).

4.1.1.2 Temperature Monitoring

The temperature sensor monitoring by Ovation includes set points for alarm and trip temperatures. In Section 2, **Table 2-2** provides the alarm and trip temperatures for the storm pumps. This protection due to elevated temperatures will continue to be part of the operational strategy.

The design team will confirm the present alarm and trip set points for the bearings with the pump and motor manufacturers in the preliminary design phase.

4.2 Storm and Sanitary Wet Well Level Sensor Selection

Section 3.5 includes the proposed operational strategy for the selection of the level sensor which is to be utilized for control at each level monitoring location (“upstream” for the storm wet well and “downstream” for the sanitary wet well).

As part of the system improvements, the control logic utilized for storm and sanitary wet well level selection will be a match to similar systems in other GLWA level sensing applications to use the standard multiple-transmitter selection (2X-Select) logic. The new system will still use the two redundant level sensors as inputs, while the output signal used by the pump system could be one of five options:

- AVG - Average of the two inputs
- Max - Higher value input
- Min - Lower value input
- A – Input A
- B – Input B

Selection of which mode to use will be performed by the operator through a control faceplate. The standard faceplate shows the two input levels, current mode, and output level.

4.3 Sanitary Pumping System

The following is a summary of the improved sanitary pump Auto mode operational strategy.

This strategy assumes:

- All sanitary pumps (four equally sized submersible pumps) are operational.
- All sanitary pumps are in Auto mode.
- Isolation gates (pinch valves) in upstream junction chamber (SG-9 and SG-10) are operational such that one sanitary wet well can be isolated from the influent flow which was not feasible at the time of this writing. Gates are planned for replacement as part of the Oakwood District Intercommunity Relief Sewer (ODRIS) project (No. 2002655). This fully functional gate

condition is critical for “normal” operation of the sanitary pumps as described below to be entirely feasible (unable to isolate wet well from influent flow) with the gates not fully functional.

Normal (Dry Weather) Operation (41 – 46 ft)

In normal (dry weather) operation, the pumps will be in Auto mode and the pumps will be controlled by a target level. The target level is to be operator adjustable (from 44.5 ft to 45.5 ft) and is assumed to be 45.0 ft for this example.

In this example, the East Wet Well was selected. Therefore, SG-9 is closed, and SG-10 is open. The opposite would apply if West Wet Well was selected.

If no pumps are presently running, the lead pump in the selected wet well will start if the level is greater than 44.5 ft for more than 30 seconds. Pump SN2 will start at 44.5 ft and run at minimum speed (75% = 889 rpm) until the target level of 45.0 ft is reached. Target level will be operator adjustable with the lead pump start level 6 inches below the target level. The pump speed will then be varied from minimum speed to maximum speed (95% = 1126 rpm) to maintain the target Level utilizing existing PID control.

For dry weather flow conditions recommend one pump in service with associated higher approach and discharge velocity for this high grit wastewater and operation at higher efficiency (in POR) as compared to two pump operation. This will include operation over level range of 46 to minimum level of 41 ft. Recommendation is based upon observations and discussions as part of the ride-along visits, where the Design Team identified one pump operation is common and suitable to convey the average dry weather flow (7-8 cfs which is 4.5-5.2 MGD).

Wet Weather Event Approaching (46 – 62 ft)

If the lead pump is operating at maximum speed at 46 ft (1126 rpm) and the selected wet well level is above the dry weather flow maximum (46 ft) level for more than 30 seconds, the lag sanitary pump in the selected wet well (SN4 in this case) will be started. SN4 will run at minimum speed (70% = 830 rpm) for 30 seconds. SN4 will be ramped up slowly (rate to be determined in design phase) and SN2 will be ramped down so both pumps run at the same speed. Both pumps will then run in tandem (varying speed together) to maintain the level between 46 and 55 ft. Pump speed will be ramped up linearly from minimum after second pump start-up complete up to maximum speed (80% = 948 rpm) at 55 ft. Speeds are constrained to maintain operation within AOR.

If both pumps are running together to maintain the setpoint (55 ft) and both pumps are at maximum speed (948 rpm) and the selected wet well (East Wet Well) level is increasing and greater than 55 ft for more than 60 seconds, the control system will open SG-9 to make both wet wells active. The lead pump in the other wet well (in this case SN1) will be started and ramped up slowly (rate to be determined in design phase) and SN2 and SN4 will be ramped down so all three pumps run at the same speed. The three pumps will operate together to attempt to control the wet well rise ramping linearly from minimum (830 rpm) at 55 ft to maximum at 62 ft (948 rpm).

It is recognized that the West Wet Well in this example will fill independent of the SG-9 position as at the level indicated for third pump start (55 ft) the gate will be overtopped and enter the wet well.

If the addition of SN1 succeeds in pumping down its wet well to below 46 ft, and both wet wells are decreasing, SG-9 will close, and the SN1 pump will stop. The remaining two pumps in the selected wet well will continue to run and vary their speeds in tandem to maintain the target level.

However, if the three sanitary pumps are running, and the wet wells are still increasing, eventually the lead storm pump will start. When this happens, the three sanitary pumps will stop at 62 ft assuming that the recirculation mode during wet weather event will not be operated based on limited value identified by operations.

One pump Operation Above Dry Weather Operation Level Range (46 – 62 ft)

For the unusual operating condition in which only one pump is operated between 46 and 62-ft the speed limitations to maintain operation within AOR are from minimum of 75% to maximum of 80%.

Maximum Flow Rate Constraint

The maximum flow rate the sanitary pumping system was intended to convey to NWI was determined to be 23.2 cfs (15 MGD) as part of the original design. Based on the above operational scenario with associated maximum operating speeds over the wet well ranges stated to maintain operation within the AOR this flow rate will not be exceeded. Rather the maximum at 62 ft will be approximately 22 cfs (14.1 MGD) as shown in the three-pump overlay plot in Section 3.

This revision is aligned with the one sanitary pump operational constraint focused on maximum sanitary flow rate including CSO basin dewatering of 23 cfs after a wet weather event.

Recirculation Mode (62 – 78 ft)

If recirculation mode during wet weather events is restarted, for levels above 62 ft the lead sanitary pump in each wet well will alternate running at fixed speed each hour to minimize grit accumulation near the pumps in the wet wells during the storm event. The lead sanitary pump in each wet well will also alternate with its corresponding lag pump each incremental start of recirculation mode in each wet well.

The speed of the running sanitary pump will be set to 60% (711 rpm) to maintain operation within AOR and continue to run until all storm pumps have been turned off. If Surge Relief Chamber is higher than 102.98 ft, sanitary pump operation will stop.

From discussions with GLWA and observations during ride-along visits common practice no longer includes running sanitary pumps during a wet weather event. Therefore, the logic described in this subsection should be removed/modified to stop the sanitary pumps when the storm pumps are running during a storm event if there is no intent to potentially restart this activity in the future.

Drawdown (Cleaning) Cycle (44 – 40.2 ft)

An automatic daily wet well drawdown for the sanitary pumps should be restarted as this operational practice has not been utilized recently given this could reduce the accumulation of debris thereby increasing the duration between manual cleaning. This procedure has been reviewed with Xylem Flygt which indicated that this operation is acceptable down to 40.2 ft (minimum water level for the sanitary pumps). The time the drawdown starts is configurable by the operator by entering the time in a pop-up window. In this example, the start time is 9:00 AM daily based on the controller clock. The drawdown process will start one pump in each wet well (if the wet well level is greater than 44 ft) and attempt to pump the wet wells down to 40.2 ft. A 15-minute timer is programmed to abort the process if 40.2 ft is not reached during that time. If practice identifies that the 15-minute timer is not allowing the cycle to complete then this time could be extended given not limited by motor exposure to air with the Flygt motors equipped with a cooling jacket. The process will also be aborted if a CSO Event is detected (storm pump is running). The pump that draws down its respective wet well will be alternated with its partner each day. If desired to increase the drawdown frequency to two times/day provide capability to accommodate two cycles/day.

Dewatering Cycle if Leaking Isolation Gate (41 – 49.5 ft)

It should be noted that in the past it was observed that SG-9 appeared to be “leaking”. Although this should not be an area of concern after the SG-9 and -10 gates are replaced, as part of a separate contract, in the future if the West Wet Well level rises even though SG-9 was fully closed (or vice versa) then a dewatering cycle will be initiated. To start a dewatering process on only the wet well with leaky isolation gate whenever the level is greater than 49 ft, the East Wet Well is less than 49 ft, and SG-9 was closed. The dewatering process would last for one hour or stop if the West Wet Well level was at 41 ft.

Other Operational Strategy Requirements

Sanitary pumps will be programmed to stop if in Auto and the wet well level falls below 40.2 ft.

When all pumps are stopped, the control system will automatically alternate the pump sequence based on run times so similar runtimes are maintained.

4.3.1 Sanitary Pumping Unit Moisture and Temperature Monitoring

The Ovation system monitors each sanitary pumping unit’s moisture and temperature sensors. Moisture detection is present to protect the motor internal components from exposure to the wet well contents. The temperature monitoring sensor protects the motor from an over-temperature condition. The system, as presently programmed will shut down the pumping unit if either trigger (high moisture or high temperature) is detected by the sensors. This shutdown practice should continue and should result in pump inspection to maximize the service life of each pumping unit.

Note that a finding from the ride-along insights discovered that the high moisture trigger, as configured, may only trip once if there is a leak which could persist but not necessarily trigger

another alarm. This highlights the importance to inspect the pump if this shutdown trigger were to occur.

4.4 Storm and Sanitary Wet Well Sensor Selection Operational Strategy Improvements

Refer to Section 3.5 for recommended operational strategy improvements.

5.0 Summary, Recommendations and Key Decisions

The review of operating data, enhanced understanding of operational practices gained from operations ride-along visits, evaluation of minimum storm pump operating level, determination of operational constraints to maintain storm and sanitary pumps within AOR, maintenance of storm pump maximum operating level to minimize potential for basement backups and consideration of recommendations from past studies provided the basis for improvements to the operational strategies.

The recommended improvements to the storm and sanitary pumping system operational strategies are captured in the conceptual strategies stated in Section 4. The improvements focus on maintaining operation of each pump within the AOR and to the extent feasible within the POR to maximize reliability/service life, optimize operation and reduce maintenance and downtime.

5.1 Key Decisions

Key decisions made during the course of review and presentation of this Technical Memorandum are as follows:

- Speed range changes for storm and sanitary pumps
- Changes to minimum wet well level (lead pump shutoff) for storm pumps
- Changes to overall control based on rising level setpoint for storm pumps
- Sanitary pump operation with one pump serving dry weather flow wet well level range in lieu of three
- Sanitary pump speed constraints to maintain operation within AOR
- Changes to number of operating sanitary pumps as a function of wet well level

6.0 Next Steps

The items which require advancement/further development as the design process advances include the following:

- Selected improvements to the operational strategies further detailed and coordinated at greater level of detail within the Design Team.

- Develop table to summarize the storm pump cycling through (turning on) pumps as flow rate increases as part of the control description specification.
- Development of full-scale test plan to evaluate storm and sanitary pump performance when operated in accordance with the selected operational strategy improvements as part of the construction of associated improvements.
- During construction, utilize the full-scale test plan to evaluate pump operation after changes made to storm and sanitary operational strategies to verify modified operations of storm and sanitary pumps provide acceptable performance.
- For storm and sanitary pumps, after future project phases completed and improved operational strategy implemented, tested and tuned, update select sections of the system O&M manual with the new operating procedures. In addition, provide operator training focused on the new operating procedures.
- The sanitary pump operational strategy updates will identify the high moisture alarm condition as basis to take pump out of service and placing another unit in service to allow pump to be removed and inspected to minimize the damage due to moisture intrusion.
- Determine vibration velocity units for the existing sensors (RMS or peak).
- Determine the constraints on the number of vibration signals that the Multilin protection relay can receive as independent signals to potentially allow different limits for top of pump and top of motor.
- After Multilin and vibration switch capabilities verified, discuss vibration alarm and recommended shutdown indication operational practices for the storm pump application with GLWA stakeholders along with the associated operational strategy improvements.
- Confirm bearing temperature, vibration alarm, and trip values with the pump and motor manufacturers.
- GLWA to consider if would like to move forward soon with recommendations to modify sanitary pump strategy changes to enhance service life of the pumps (maximize operation in AOR).
- Complete NPSH calculations for sanitary pumps to confirm that pumps not NPSH limited in the proposed cleaning cycle minimum level (40.2 ft) operating condition.

Appendices

Appendix A – CEH Storm Pump Station Physical Hydraulic Model Study Report

Appendix A

CEH Storm Pump Station Physical Hydraulic Model Study Report



OAKWOOD STORM PUMP STATION PHYSICAL HYDRAULIC MODEL STUDY

Final Report (Rev.1)

Conducted For

GLWA / CDM SMITH

CEH Report Number: 1063-23

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April 2023

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EXECUTIVE SUMMARY

A physical model study of the Oakwood storm pump station was conducted. A 1:12.1 scale model was constructed, and tests were conducted to determine the nature and severity of any adverse hydraulic conditions that may affect pump performance.

Baseline testing was used to determine minimum operating levels for both the small and large pumps and to evaluate the overall conditions in the wet well and around the pumps. Water level sensitivity testing indicated that when operating a single large pump at full speed, surface dimples were observed at El. 62.0 ft and when operating at minimum speed, surface dimples were observed at El. 61.0 ft. When operating the small pump at full speed, surface dimples were observed at EL. 61.0 ft and when operating at minimum speed, surface dimples were observed at EL. 60.0 ft.

Overall conditions around the pumps were very stable during single pump operation for both the small and large pumps. As the number of operating pumps increased overall conditions became less stable; however, flow still entered each of the operating pumps uniformly around the bell circumferences. A previous model study recommended both floor splitters as well as sidewall fillets for vortex suppression. These were installed for baseline testing and were effective at preventing floor vortex activity and minimizing sidewall vortex activity. Mild and infrequent vortex activity was still observed occurring on the sidewalls but typically flushed out or dissipated prior to or entering the pumps. In addition, when adjacent pumps were operating, mild interaction / swirl was observed forming in between the pumps but no organized vortices were observed. Velocity and turbulence variations as well as pre-swirl were within criteria for all baseline conditions. After submittal of the initial minimum water levels, CDM Smith further revised the final wet well operating levels, based on the initial findings. Final documentation tests were later used to document conditions at revised operating levels as well as to determine if there are any sensitivities related to non-uniform or skewed flow in the influent pipes.

After evaluating conditions with the pumps operating, CEH simulated the existing flushing system. It should be noted that spray and sediments will not scale precisely in the physical model but it does provide a reliable approach to evaluate relative differences and the impact of changes. This testing showed that the effectiveness of the flushing system could be improved by lowering the nozzles from the current elevation to just above the sidewall fillets and placing additional nozzles on the opposite (low flow trench) side to clean the “backside” of the splitters where the nozzles on the opposite side cannot reach.

It is recommended that the pump-off level for the large pumps be set at El. 62.5 ft and the minimum pump-off level for the small pump be set at El. 61.0 ft. The effectiveness of the flushing system can likely be improved by lower the elevation of the flushing nozzles and strategically placing the nozzles relative to the floor splitters. This is discussed in Section 5.5 of this report.

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1.0 INTRODUCTION

1.1 Revision 1 – April 7, 2023

Editorial comments addressed per CDM report review. Fig 3-2 was revised to include an updated dimension.

1.2 Background

Clemson Engineering Hydraulics, Inc. (CEH) conducted a physical hydraulic model study of the Great Lakes Water Authority (GLWA) Oakwood Storm Pump Station for CDM Smith and the GLWA. The existing pump station houses both dry-weather and wet-weather pumps. Flow enters the facility via two large sewers (one existing; one future) that combine in a common junction chamber. Two parallel 18-ft diameter influent pipes take flow from the junction chamber to two symmetrical wet wells (East and West) that both house four (4) wet weather pumps including three large pumps rated at 275 CFS and a smaller 150 CFS pump. Dry weather flows can pass through the wet wells via a low flow trench to a sanitary pump station located in a separate downstream chamber. While the low flow trench geometry was simulated, the dry-weather pumps were not included in this study.

1.3 Objectives

The objectives of this model study were as follows:

- Evaluate the performance of the existing pump intake and determine minimum operating levels based on potential air entrainment.
- Evaluate the performance of the wet well flushing system and determine if any revisions or modifications would increase flushing performance.
- Evaluate the intake over the range of expected pump operating combinations and water levels.

1.4 Sump Hydraulics & Pump Problems

The pump manufacturer typically develops pump curves at the manufacturing facility. The head-flow curves, efficiencies, net positive suction head, and power requirements are usually determined by conducting a pump test with the actual prototype pump or a geometrically similar model. This pump test is conducted in a controlled environment with uniform approach flow to the pumps. Therefore, to ensure that the pump will perform as tested at the manufacturing facility; the prototype field installation must also have similarly uniform approach flow conditions.

Failure to provide uniform approach flow hydraulics can result in pump performance that differs significantly from that predicted from the performance curves. The pump may not operate at its best efficiency point, flow or head may be less than expected, power requirements may vary, and if the approach flow conditions vary enough, significant damage could occur to the pump itself.

Pump intakes are often designed to adhere to the 2018 Hydraulic Institute Standards (ANSI HI 9.8-2018). A consortium of pump manufactures, engineers, and end users developed these standards. Failure to adhere to these standards can lead to a number of problems including air entrainment, vortex activity, skewed velocity distributions and turbulence at the pump impeller. Research has shown that these conditions can lead to fluctuating loading on pump impellers, vibration, cavitation, and decreased flow and efficiency (Sweeney and Rockwell 1982).

Following the HI standards helps to minimize adverse approach flow conditions within the pump sump. However, the standards were developed for pumps with individual capacities of 40,000 gallons per minute (gpm) or less for vertical pumps, 20,000 gpm or less in trench type wet wells, 7,000 gpm or less for “can” pumps and 5,000 gpm or less for pumps in circular wet wells. When dealing with pumps that exceed these capacities, or overall station capacities in excess of 100,000 gpm, it is necessary to utilize physical and numerical modeling techniques to investigate the hydraulic conditions within the sump.

Physical models are used to evaluate the level of temporal velocity fluctuations, or turbulence, within the pump bell. Changes in pressure are directly related to changes in velocity. Therefore, velocity fluctuations, whether temporal, or as a result of skewed approach flow, can cause pressure fluctuations on the pump impeller. These pressure fluctuations translate into a loading imbalance on the pump shaft, possibly causing vibration or pre-mature bearing wear.

Physical models are also used to evaluate the uniformity of the flow within the pump bell. Should more flow be traveling down one side of a pump bay than the other, such as that which occurs when there is flow separation at the bay entrance, the velocity may be higher on one side of the impeller or the other. This may cause pre-swirl of the flow entering the pump. Depending on the direction of the pre-swirl relative to the pump rotation, this may cause the pump to consume more or less power than anticipated, resulting in the pump operating at a point other than its best efficiency. The pre-swirl may also result in the flow hitting the impeller blade at an angle of attack other than what it was designed for. This can result in localized flow separation on the impeller. These separation zones can cause low-pressure regions, which result in localized areas of cavitation.

Vortices are another hydraulic phenomenon with which physical models are used to identify and eradicate. Vortices are localized regions of high velocity swirling flow. The velocity at the core of a vortex can be high enough that the pressure falls below the vapor pressure of the fluid. If the vortex forms below the surface, it is called a submerged vortex, and can result in vapor being pulled out of suspension. If it forms as a surface vortex, it can pull a vapor core into the pump. Either of these vortices can result in air entrainment or cavitation within the pump. Depending on the system, this entrained air may be able to accumulate within the downstream piping network, possibly causing damage to other system components. The low-pressure core of a vortex can also lead to localized cavitation, noise, decreased pump capacity, and vibration.

Numerical modeling of pump sumps is a relatively new approach to investigating wet-well hydraulics. The ability of numerical models to predict the general flow patterns within the sump is constantly improving. However, numerically modeling highly mobile surface vortices presents a challenge. Research is constantly being conducted to improve the ability to numerically predict mobile vortex activity. However, at the present, physical models remain the only method available to reliably simulate mobile prototype vortex activity.

2.0 MODEL SCALING AND ACCEPTANCE CRITERIA

2.1 Model Scaling

To obtain accurate results from a physical model study, there must be dynamic similitude between the model and the prototype. To satisfy this requirement, there must be exact geometric similitude. In addition, the ratio of the dynamic pressures must also be maintained. Strictly satisfying dynamic similitude requires a 1:1 scale model. This is usually not feasible, so some compromise is made. To accomplish this, geometric similarity is maintained and the dominant forces associated with the prototype are determined and maintained between the model and prototype.

The primary forces that affect fluid flow are viscosity, surface tension, velocity (inertial), pressure, gravity and elastic forces. In structures with a free surface, such as a pump intake, gravitational and inertial forces are far greater than the viscous and turbulent shear forces. Therefore, when modeling free surface structures, geometric similarity and the ratio of inertial to gravitational forces, or the Froude number, is maintained between the model and prototype.

Simply holding the Froude number constant violates the strict definition of dynamic similitude. However, if the model is operated within a high enough range of Reynolds numbers, viscous and surface tension scale effects may be minimized. The 2018 ANSI-9.8 Hydraulic Institute Standards recommends that the minimum Reynolds number at the pump inlet be greater than 6×10^4 . Therefore, when choosing the model scale, it is necessary to ensure that the scaled flow rate will result in a high enough Reynolds number to minimize scale effects. It is common to be conservative and select a scale that results in a Reynolds number closer to 1×10^5 .

Upon selecting an appropriate model or length scale, it is possible to determine relationships such as velocity, flow, and pressure between the model and prototype. This is accomplished by setting the model and prototype governing equations equal to one another. As mentioned above, the governing equation is determined by evaluating the dominating forces. These equations are typically dimensionless numbers such as the Froude, Reynolds, Weber, Euler, or Mach numbers. These common modeling relationships are shown below:

$$\text{Froude Number} \quad F = \frac{U}{\sqrt{gL}} = \frac{\text{Inertial Force}}{\text{Gravity Force}} \quad (2-1)$$

$$\text{Reynolds Number} \quad Re = \frac{UL}{\nu} = \frac{\text{Inertial Force}}{\text{Viscous Force}} \quad (2-2)$$

$$\text{Euler Number} \quad E = \frac{\rho U^2}{\Delta P} = \frac{\text{Inertial Force}}{\text{Pressure Force}} \quad (2-3)$$

$$\text{Weber Number} \quad W = \frac{U}{\sqrt{\sigma/\rho L}} = \frac{\text{Inertial Force}}{\text{Surface Tension Force}} \quad (2-4)$$

$$\text{Mach Number} \quad M = \frac{U}{\sqrt{K/\rho}} = \frac{\text{Inertial Force}}{\text{Compressive Force}} \quad (2-5)$$

Where:

U = characteristic velocity

g = gravitational constant

L = characteristic length

ρ = fluid density

ΔP = pressure difference

ν = kinematic viscosity of the fluid

σ = surface tension of the fluid

K = bulk modulus of elasticity of the fluid

If the governing equation is held constant between the model and prototype, the corresponding model flow rate, velocity, pressure, etc., can be solved directly. For example, setting the Froude number of the model equal to the prototype yields the following relationships, where the subscripts p & m denote prototype & model, respectively:

$$F_p = F_m \quad (2-6)$$

$$\frac{U_p}{\sqrt{gL_p}} = \frac{U_m}{\sqrt{gL_m}} \quad (2-7)$$

Using equation 2-7, the model velocity, and therefore, the flow rate Q can be solved for if the prototype velocity and length ratio is known. Typically, the model parameters are solved for based on the prototype to model length ratio, L_p/L_m , or L_R . Doing so yields the following equations for Q & U :

$$\frac{Q_p}{Q_m} = L_R^{5/2} \quad (2-8)$$

$$\frac{U_p}{U_m} = \sqrt{L_R} \quad (2-9)$$

Using these equations, it is possible to determine the flow rates at which the model should be operated. The Oakwood model was constructed at a 1:12.1 scale. The resulting model pump bell

Reynolds numbers and Weber numbers for both the large and small pump are shown in the table below.

Pump Size	Reynolds No.	Weber No.
150 cfs	8.4×10^4	600
275 cfs	1.1×10^5	820

All values exceed Hydraulic Institute criteria.

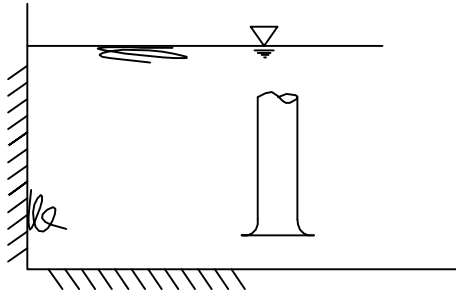
2.2 Acceptance Criteria

In addition to choosing an appropriate scale with which to construct the model, it is important to evaluate the performance of the model against a set of pre-determined acceptance criteria. The criteria used for this model study closely follow those suggested in the 2018 ANSI-9.8 Hydraulic Institute Standards and are as follows:

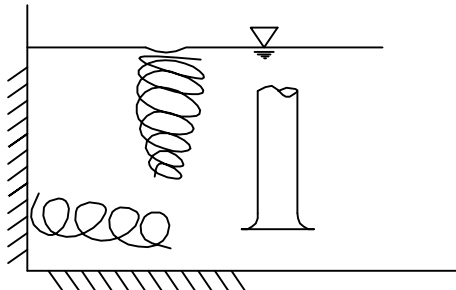
- No organized free surface or submerged vortices greater than a Type 1 (general rotation) should be permitted at Froude scaled flow rates. The HI standards suggest that a Type 3 vortex may be allowed to enter the pump if it occurs infrequently, such as less than 10-percent of the time; however, it is a goal of this study to eliminate any vortex greater than a Type 1.
- Pre-swirl should be less than 5.0-degrees at the pump impeller location per Hydraulic Institute.
- Time averaged velocities within the pump throat should not deviate more than 10 percent of the cross-sectional area average velocity.
- Time-varying velocity fluctuations (turbulence) at a point within the pump throat should be less than 10 percent.

Vortex activity is evaluated qualitatively. The Hydraulic Institute Standards suggest using a scale of 1 to 6 to rank the severity of a vortex. A scale of 1 to 5 was utilized for this study, with a Type 1 being the least severe and a Type 5 being the most severe, pulling air and trash into the intake. HI varies slightly by ranking a vortex that pulls trash into the intake as a Type 5 and one that pulls air as a Type 6. However, since the acceptance criteria do not permit vortices greater than a Type 1, this variation of the HI scale does not have any effect on the outcome of the model study. Figure 2-1 presents a graphical representation of the vortex ranking used in this study.

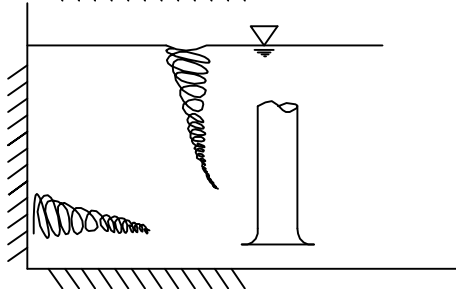
FIGURE 2-1 SURFACE & SUB-SURFACE VORTEX CLASSIFICATION



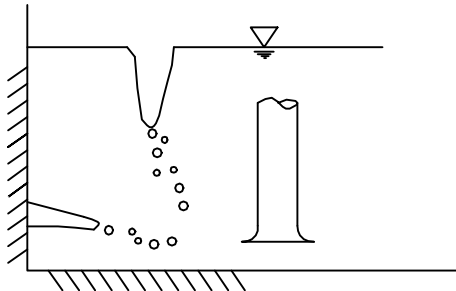
TYPE 1
SURFACE OR SUBSURFACE SWIRL



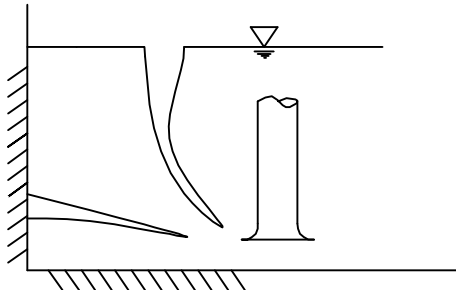
TYPE 2
SURFACE OR SUBSURFACE DIMPLE
COHERENT SWIRL



TYPE 3
ORGANIZED DYE CORE TO THE INTAKE
COHERENT SWIRL THROUGHOUT WATER
COLUMN



TYPE 4
COHERENT SWIRL AND ORGANIZED DYE CORE
PULLING BUBBLES AND SOME AIR INTO THE INTAKE



TYPE 5
COHERENT SWIRL AND SOLID AIR/VAPOR CORE PULLING DEBRIS
AND AIR INTO THE INTAKE

3.0 THE MODEL

3.1 *Model Boundaries*

When evaluating the portions of the pump station that are to be included in the model, it is necessary to include any components that could affect the approach flow to the pumps. This is first determined by evaluating the upstream and downstream controls. In this application, an upstream hydraulic control is a structure or component that controls the downstream flow. This may be a change in grade that results in critical flow, a sluice gate or opening that directs the flow, or simply a long stretch that results in uniform flow conditions. The Oakwood pump station consists of two separate mirrored wet wells that each receive flow from a common junction / splitter box that is supplied via two 120-inch influent pipes. A portion of the length of each of these influent pipes were included in the model and served as the upstream model boundary. Flow from the splitter / junction box enters into the separate wet wells (with no cross-over) via individual 216-in (18-ft) diameter supply pipes. The full geometry of the junction / splitter box including both 216-in supply pipes were included in the model. Given the symmetrical nature of each wet well, only one (East Wet Well) was simulated in detail, including all internal geometrical features and all four pumps (1 small and 3 large). The outer geometry of the other wet well was constructed and used to house simple withdraw lines to simulate operation.

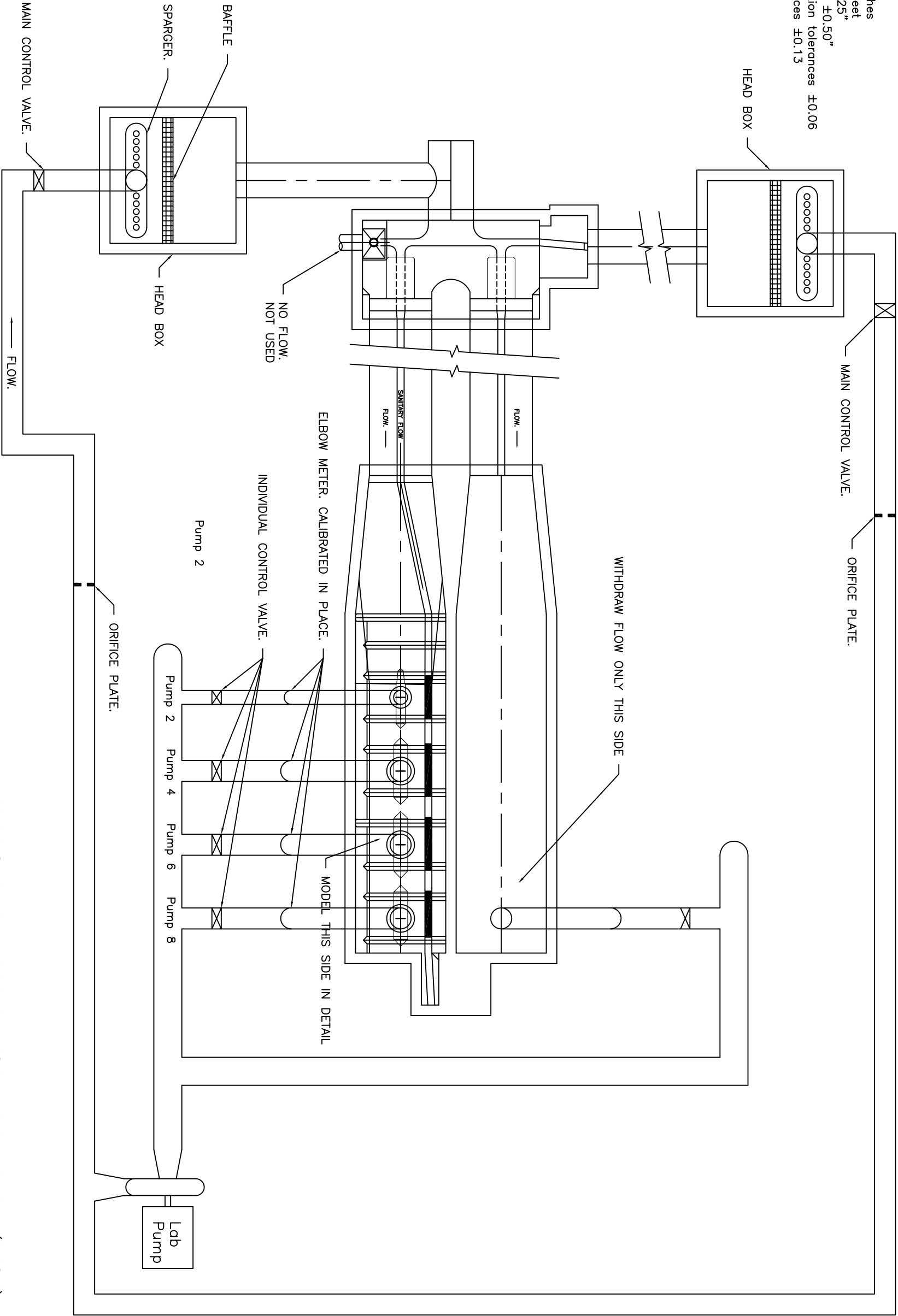
Physical model studies are used to evaluate the approach flow and ensure that the flow is uniform up to the pump impeller. Therefore, the downstream model boundary was chosen as the entrance to the pump impeller. It is not necessary to include a model pump impeller because the pump performance is tested at the manufacturer's facility. The manufacturers test was conducted with uniform approach flow conditions. Therefore, with other design considerations being equal, if those conditions can be duplicated in the prototype structure, the performance of the pump in the field should match that determined by the manufacturer.

3.2 *Model Construction*

The model was constructed on a raised deck to facilitate viewing and data collection. The model head box, floor, and sidewalls were constructed with waterproof wood. The model pumps, intake piping and pump bells were fabricated out of clear acrylic up to the impeller location. The additional piping was fabricated out of PVC pipe. Friction losses within the model limits are negligible when compared to form or boundary losses. Therefore, it is assumed that materials mentioned above were appropriate for model construction.

The overall model basin was constructed with a tolerance of +/- 6.3 mm (0.25 model inches). The model pumps were constructed to within +/- 1.5 mm (0.06 model inches). Valves were used to control the individual pump flows as well as the total model flow. A pump was installed downstream of the model pumps to re-circulate flow back to the model head box. Flow straightening devices were installed in the model head-box to ensure that flow entering the head box was uniform. The following figures and photos show the model.

- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances $\pm 0.25"$
 - 4) Head box construction tolerances $\pm 0.50"$
 - 5) Acrylic intake structures construction tolerances ± 0.06
 - 6) Acrylic intake bell location tolerances ± 0.13

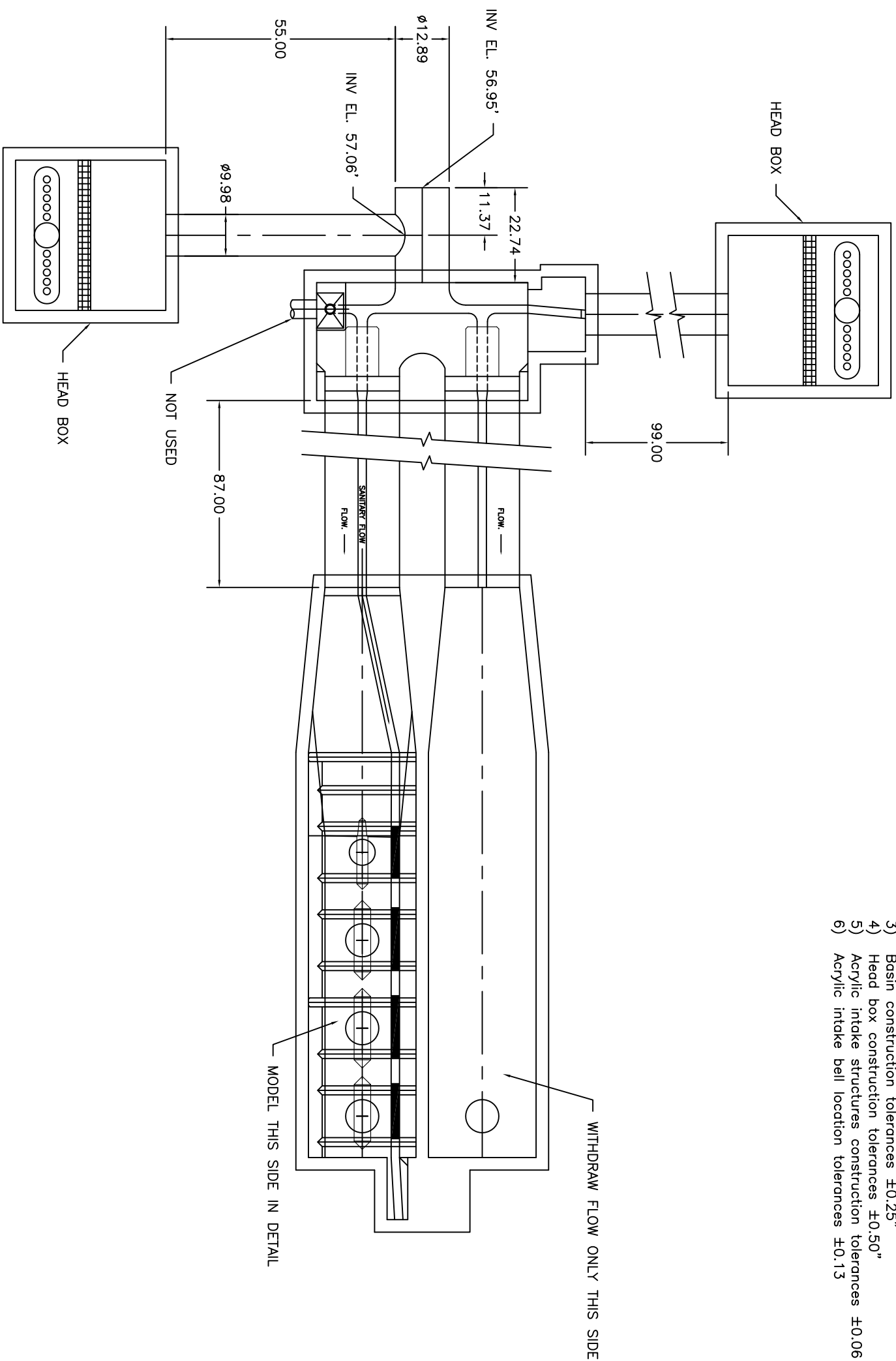


Model Scale: 1 model inch =12.1 prototype inches (1:12.1)

FIGURE 3-1									
MODEL OVERVIEW									
OAKWOOD STORMWATER PUMP STATION									
CDM SMITH and GLWA									

NO.	DATE:	REVISION	DRAWN:	CHK. BY:					
					DRAWN:	K. Dovy	DATE:	11/13/2022	PROJECT NO:
					FILE NO:	OVERVIEW	CHECKED:		

- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances $\pm 0.25"$
 - 4) Head box construction tolerances $\pm 0.50"$
 - 5) Acrylic intake structures construction tolerances ± 0.06
 - 6) Acrylic intake bell location tolerances ± 0.13

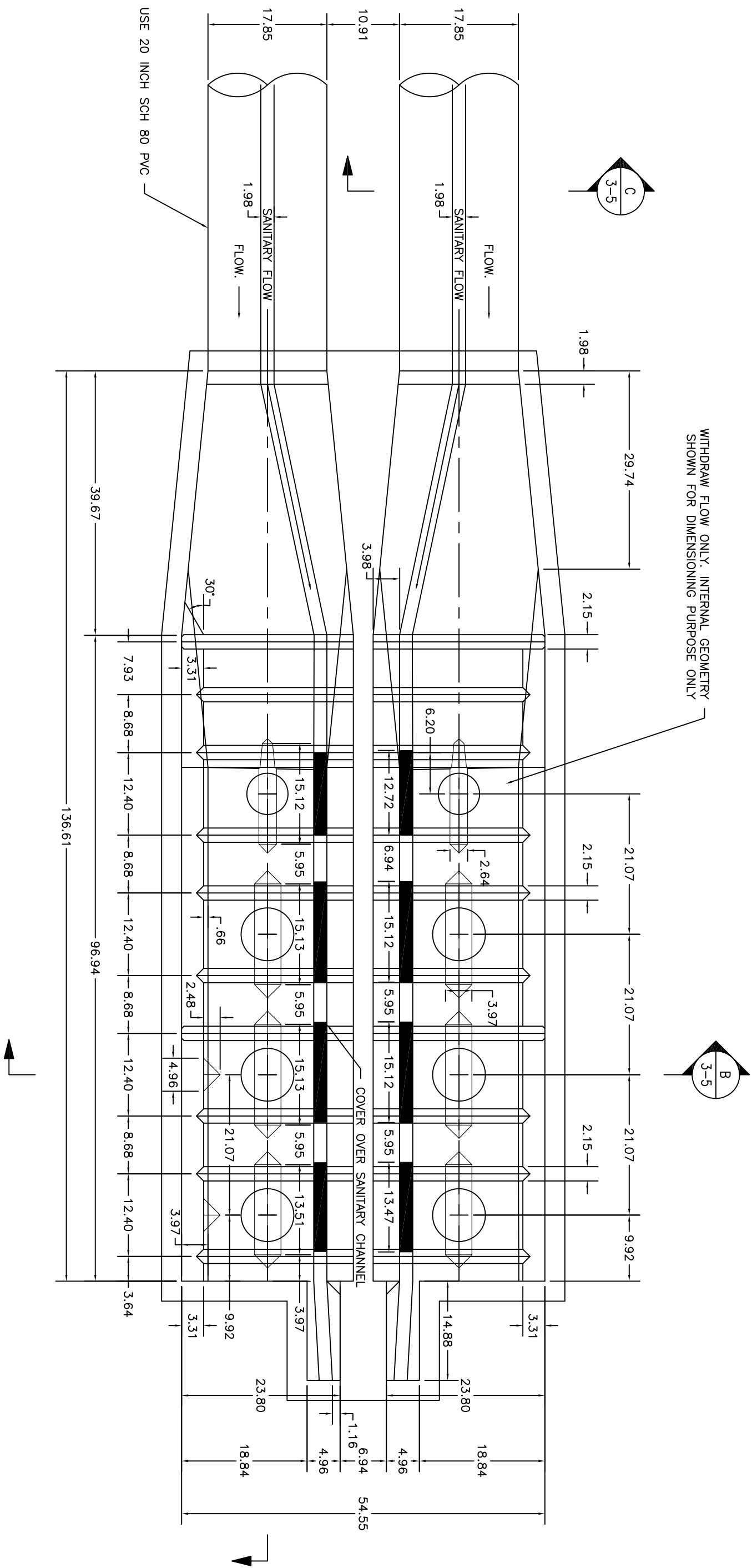


Model Scale: 1 model inch = 12.1 prototype inches (1:12.1)

FIGURE 3-2 (Rev. 1)					
OVERALL MODEL LAYOUT DETAILS					
OAKWOOD STORMWATER PUMP STATION					
CDM SMITH and GLWA					

- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances $\pm 0.25"$
 - 4) Head box construction tolerances $\pm 0.50"$
 - 5) Acrylic intake structures construction tolerances ± 0.06
 - 6) Acrylic intake bell location tolerances ± 0.13

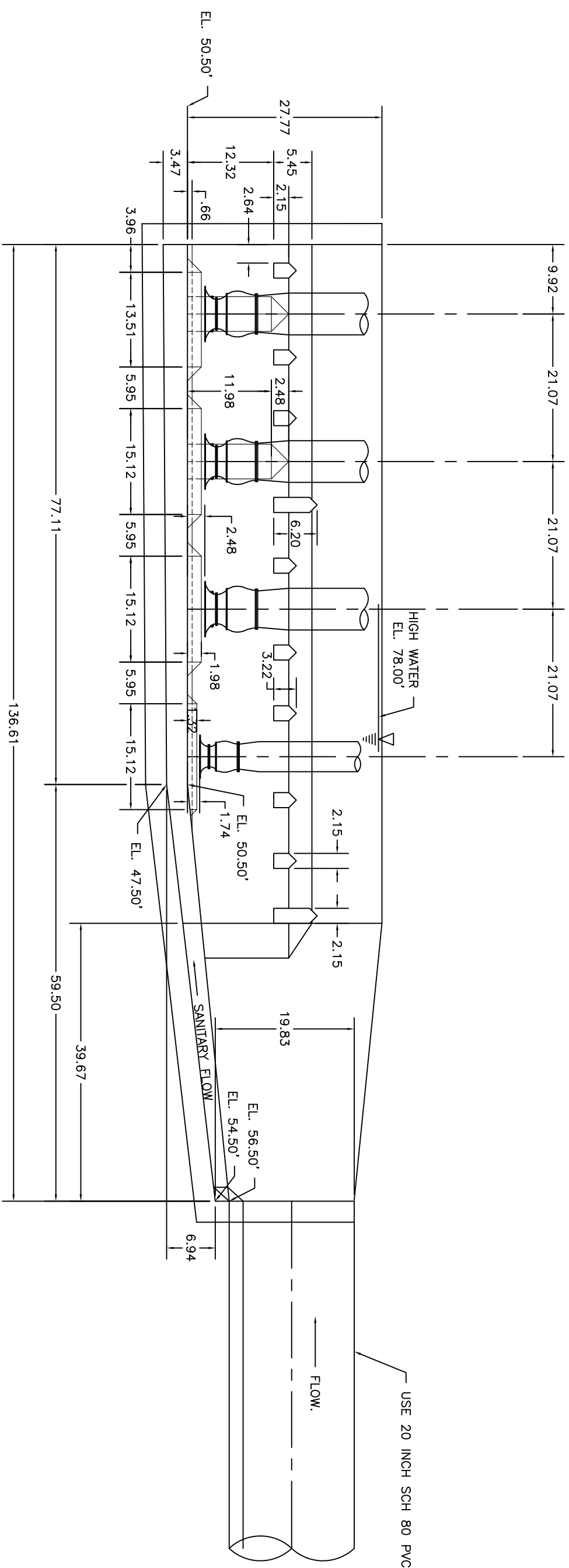
WITHDRAW FLOW ONLY. INTERNAL GEOMETRY SHOWN FOR DIMENSIONING PURPOSE ONLY



Model Scale: 1 model inch = 12.1 prototype inches (1:12.1)

				FIGURE 3-3 MODEL LAYOUT DETAILS OAKWOOD STORMWATER PUMP STATION CDM SMITH and GLWA			
NO.	DATE:	REVISION	DRAWN:	CHK. BY:			
					DRAWN:	K. Day	DATE: 11/11/2022
					FILE NO:	Plan	CHECKED:
							PROJECT NO:

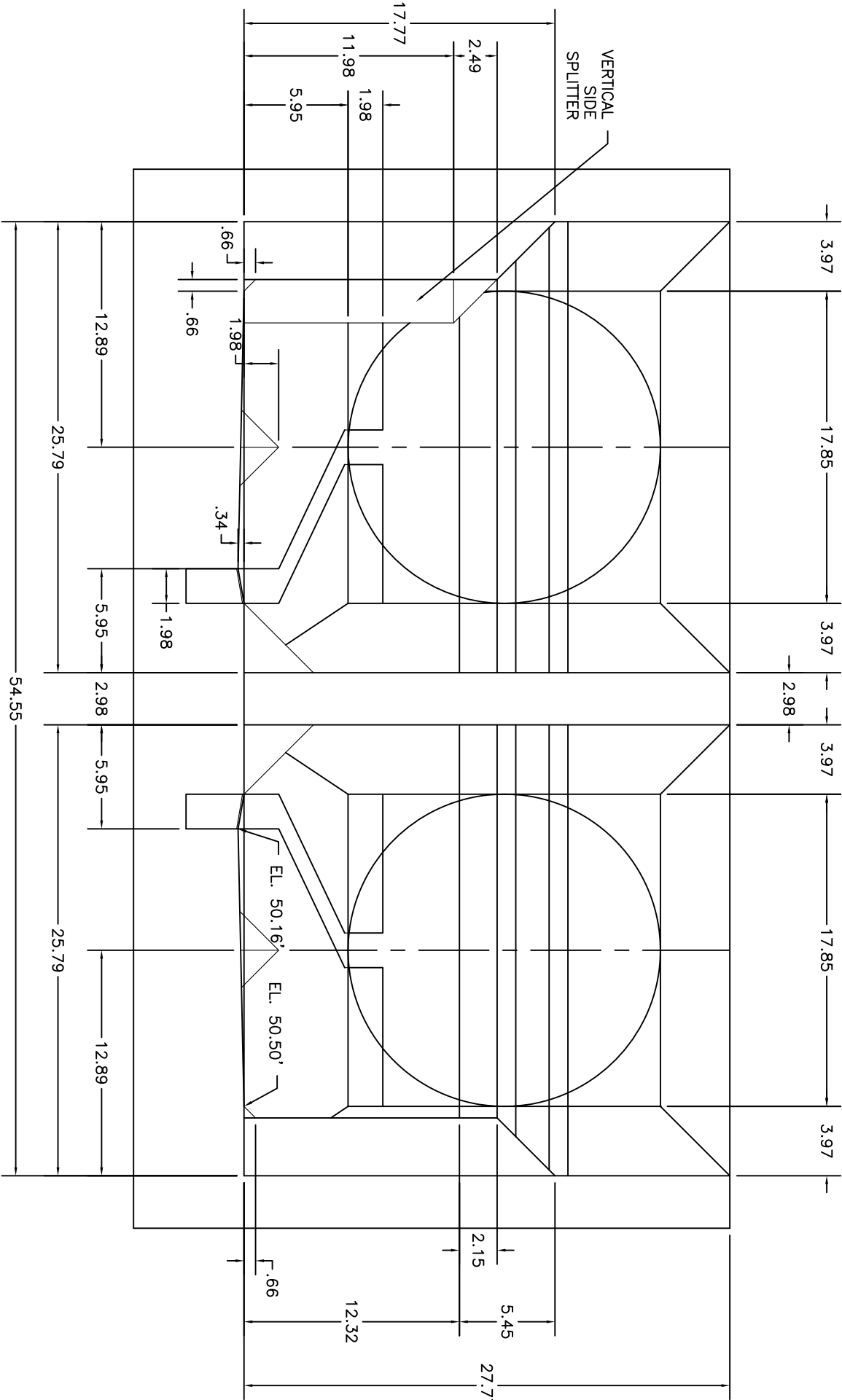
- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances $\pm 0.25"$
 - 4) Head box construction tolerances $\pm 0.50"$
 - 5) Acrylic intake structures construction tolerances ± 0.06
 - 6) Acrylic intake bell location tolerances ± 0.13



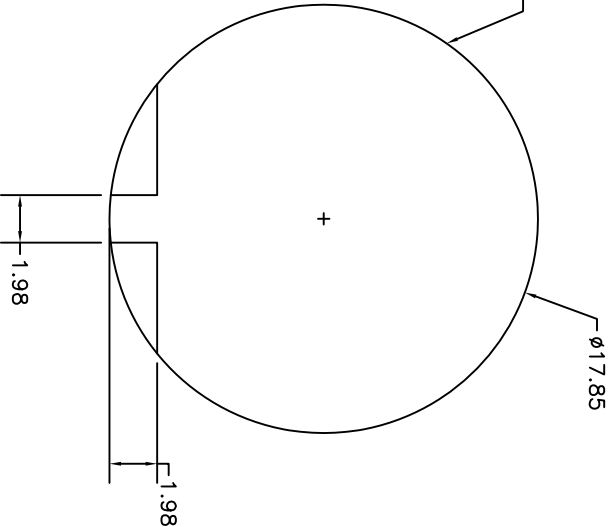
Model Scale: 1 model inch = 12.1 prototype inches (1:12.1)

FIGURE 3-4 MODEL SECTION A DETAILS OAKWOOD STORMWATER PUMP STATION CDM SMITH and GLWA									
NO.	DATE:		REVISION		DRAWN:	CHK. BY:	DRAWN: K. Day DATE: 11/11/2022 PROJECT NO:		
					FILE NO:	SECTION A	CHECKED:		

- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances $\pm 0.25''$
 - 4) Head box construction tolerances $\pm 0.50''$
 - 5) Acrylic intake structures construction tolerances ± 0.06
 - 6) Acrylic intake bell location tolerances ± 0.13



USE 20" SCH 80 PVC



SECTION
B

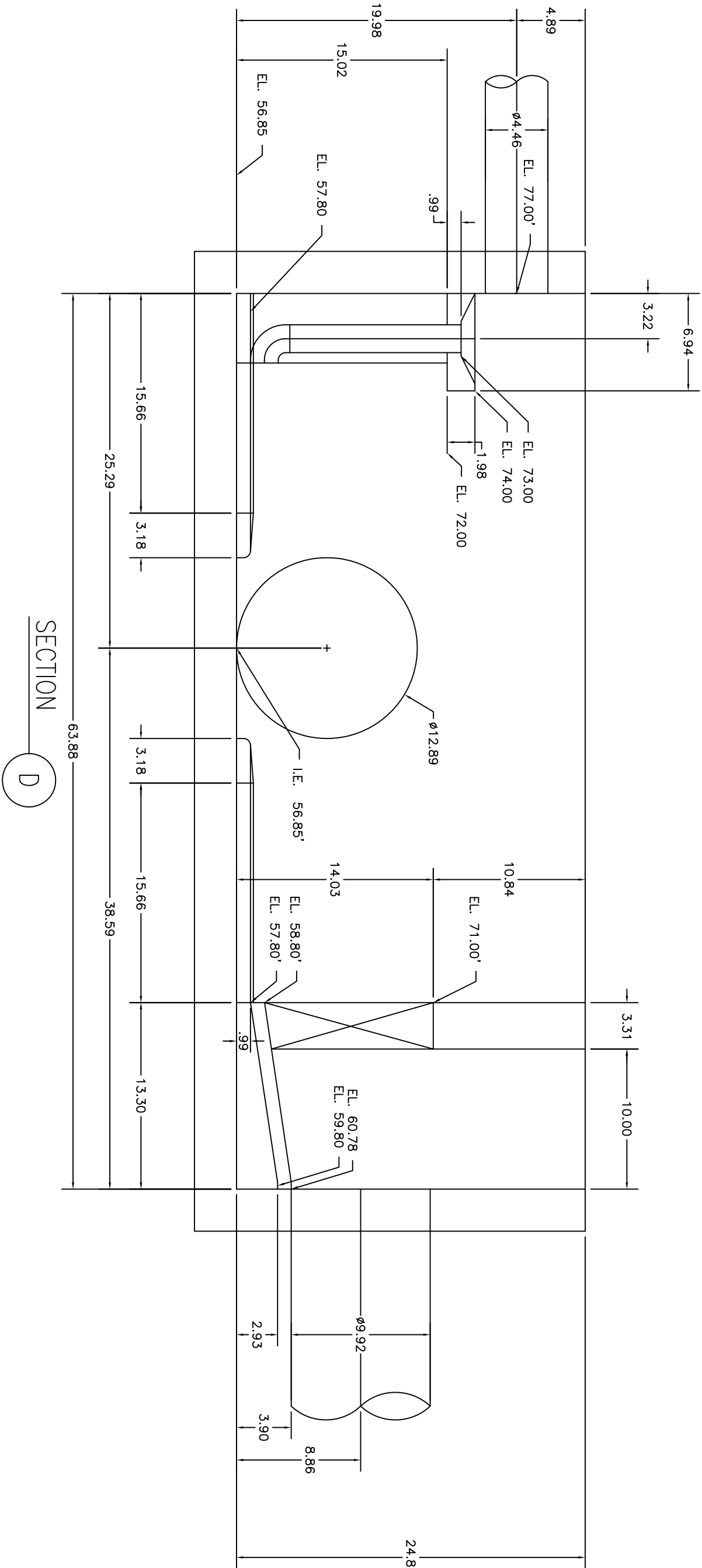
SECTION
C

Model Scale: 1 model inch =12.1 prototype inches (1:12.1)

NO.	DATE:	REVISION	DRAWN: CHK. BY:			
				DRAWN: K. Davy	DATE: 11/11/2022	PROJECT NO:
				FILE NO: SECTION B&C	CHECKED:	

FIGURE 3-5
MODEL SECTION B & C DETAILS
OAKWOOD STORMWATER PUMP STATION
CDM SMITH and GLWA

- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances $\pm 0.25''$
 - 4) Head box construction tolerances $\pm 0.50''$
 - 5) Acrylic intake structures construction tolerances ± 0.06
 - 6) Acrylic intake bell location tolerances ± 0.13

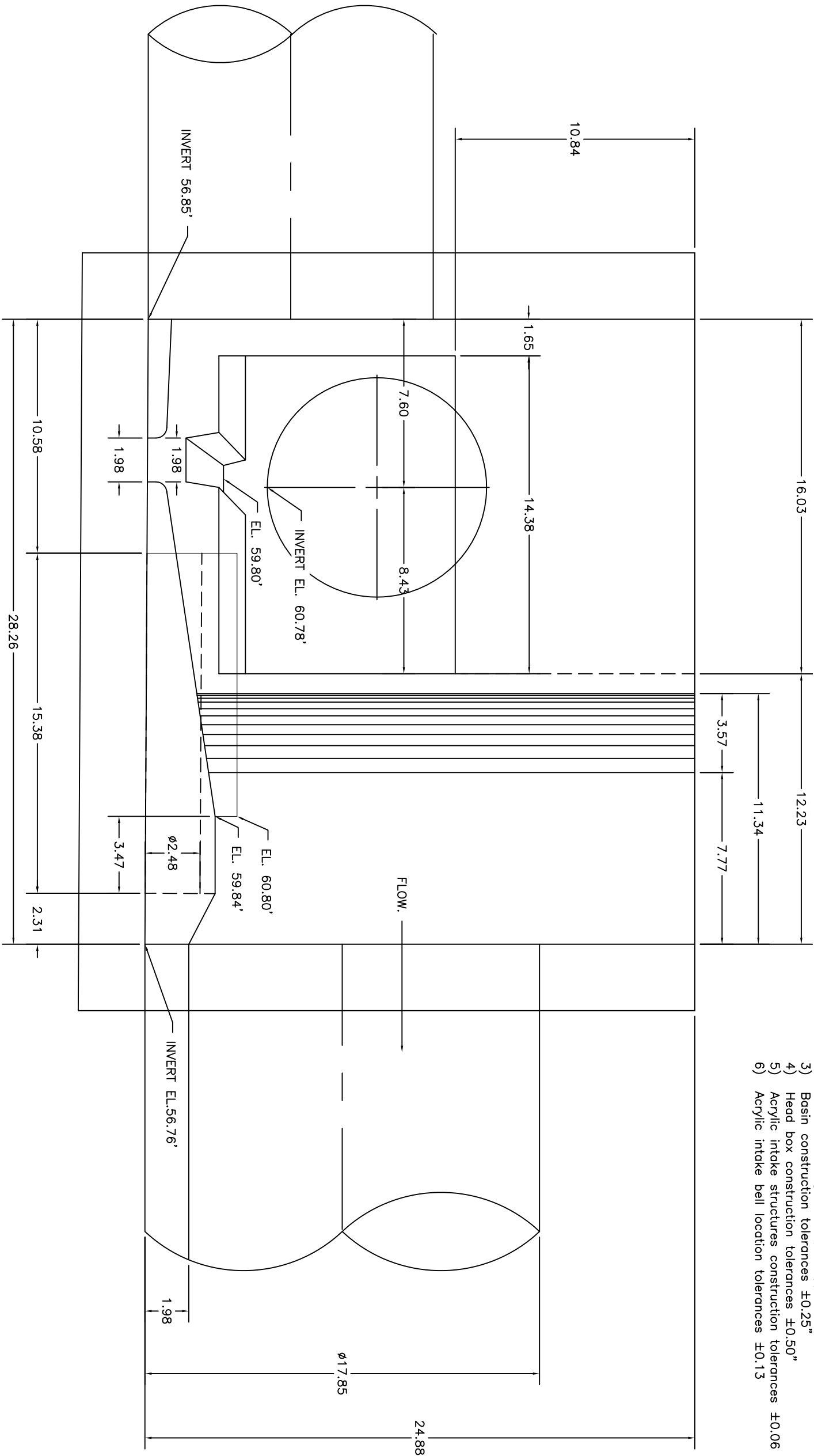


Model Scale: 1 model inch =12.1 prototype inches (1:12.1)

NO.	DATE:	REVISION	DRAWN: CHK. BY:		
				DRAWN: K. Dovy	DATE: 11/11/2022
				FILE NO: Junction D	CHECKED:

FIGURE 3-7
MODEL JUNCTION CHAMBER SECTION D
OAKWOOD STORMWATER PUMP STATION
CDM SMITH and GLWA

- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances ±0.25"
 - 4) Head box construction tolerances ±0.50"
 - 5) Acrylic intake structures construction tolerances ±0.06
 - 6) Acrylic intake bell location tolerances ±0.13



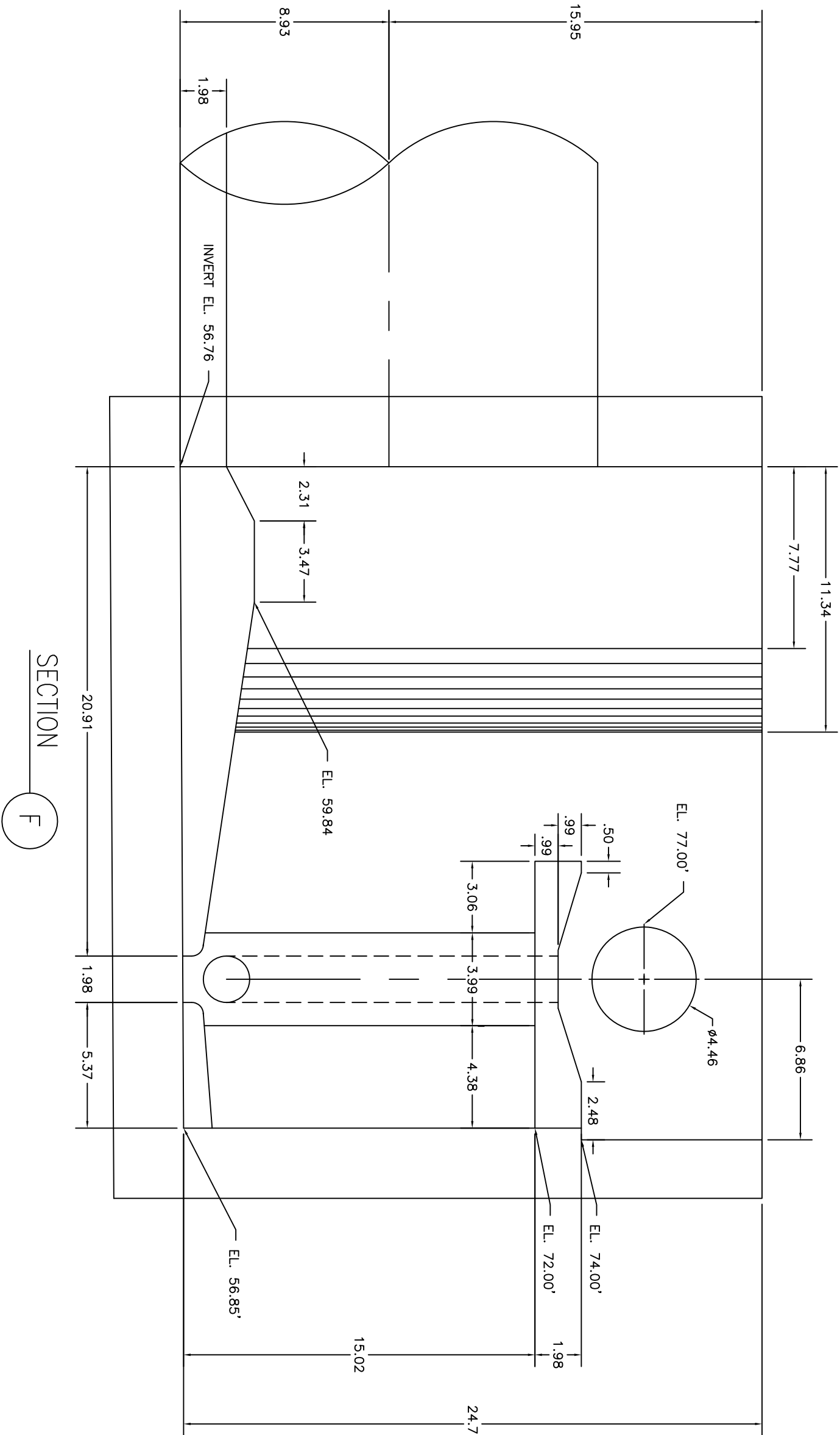
SECTION
E

Model Scale: 1 model inch =12.1 prototype inches (1:12.1)

NO.	DATE:	REVISION	DRAWN: CHK. BY:			PROJECT NO:
				DRAWN:	K. Dovy	DATE: 11/11/2022
				FILE NO:	Junction E	CHECKED:

FIGURE 3-8
MODEL JUNCTION CHAMBER SECTION E
OAKWOOD STORMWATER PUMP STATION
CDM SMITH and GLWA

- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances $\pm 0.25"$
 - 4) Head box construction tolerances $\pm 0.50"$
 - 5) Acrylic intake structures construction tolerances ± 0.06
 - 6) Acrylic intake bell location tolerances ± 0.13



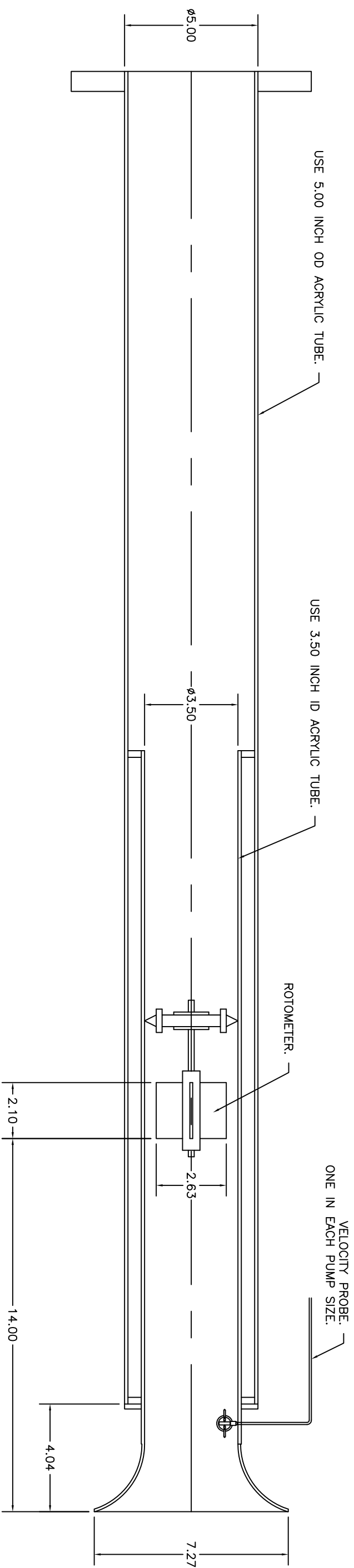
Model Scale: 1 model inch =12.1 prototype inches (1:12.1)

NO.	DATE:	REVISION	DRAWN: CHK. BY:

DRAWN:	K. Dovy	DATE:	11/11/2022	PROJECT NO:
FILE NO:	Junction F	CHECKED:		

FIGURE 3-9
MODEL JUNCTION CHAMBER SECTION F
OAKWOOD STORMWATER PUMP STATION
CDM SMITH and GLWA

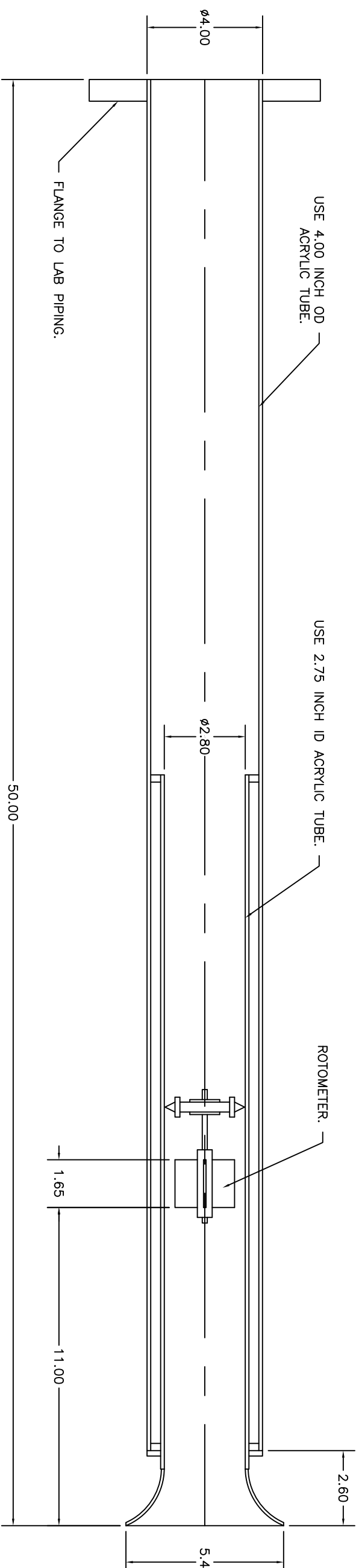
- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances $\pm 0.25"$
 - 4) Head box construction tolerances $\pm 0.50"$
 - 5) Acrylic intake structures construction tolerances ± 0.06
 - 6) Acrylic intake bell location tolerances ± 0.13



Model Scale: 1 model inch =12.1 prototype inches (1:12.1)

FIGURE 3-10									
MODEL LARGE PUMP DETAILS									
OAKWOOD STORMWATER PUMP STATION									
CDM SMITH and GLWA									
NO.	DATE:	REVISION	DRAWN:	CHK. BY:					
			DRAWN:	K. Dayy	DATE:	11/13/2022	PROJECT NO:		
			FILE NO:	Large Pump	CHECKED:				

- Note:
- 1) All dimensions given in model inches
 - 2) All elevations given in prototype feet
 - 3) Basin construction tolerances $\pm 0.25"$
 - 4) Head box construction tolerances $\pm 0.50"$
 - 5) Acrylic intake structures construction tolerances ± 0.06
 - 6) Acrylic intake bell location tolerances ± 0.13



Model Scale: 1 model inch = 12.1 prototype inches (1:12.1)

						FIGURE 3-11	
						MODEL SMALL PUMP DETAILS	
						OAKWOOD STORMWATER PUMP STATION	
						CDM SMITH and GLWA	



Photo 3-1 Model Overview



Photo 3-2 Junction / Splitter Box



Photo 3-3 Wet Wells

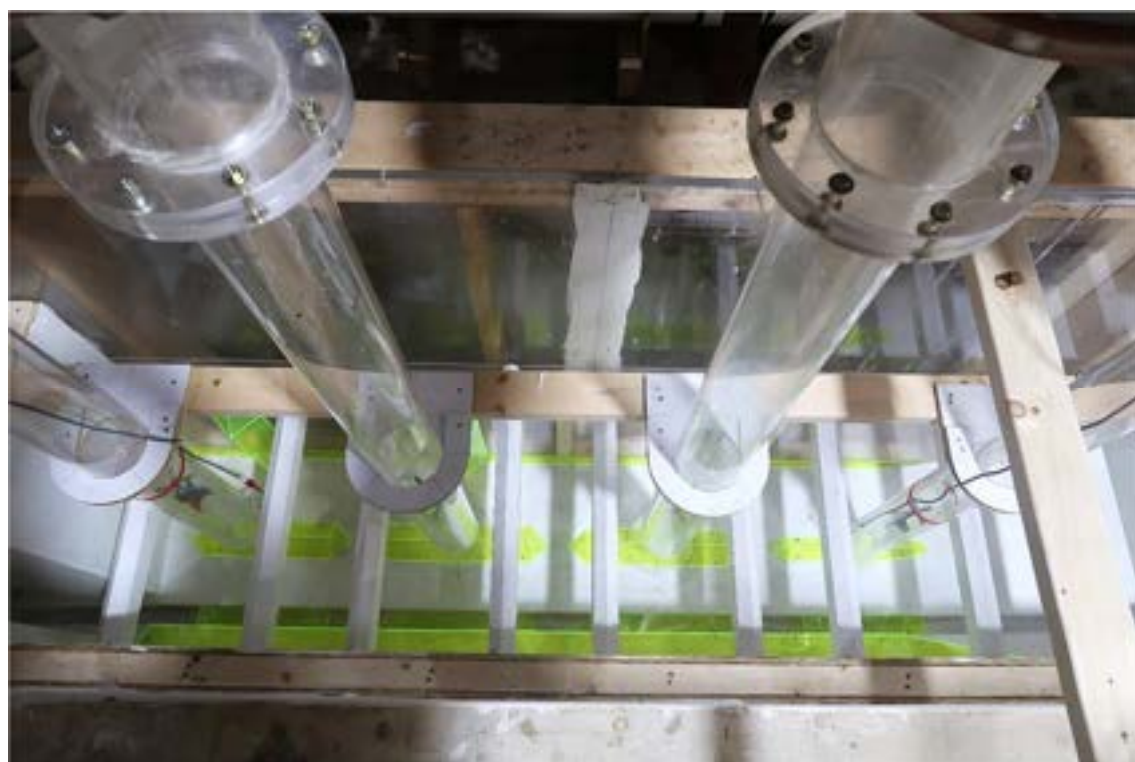


Photo 3-4 Detailed Wet Well

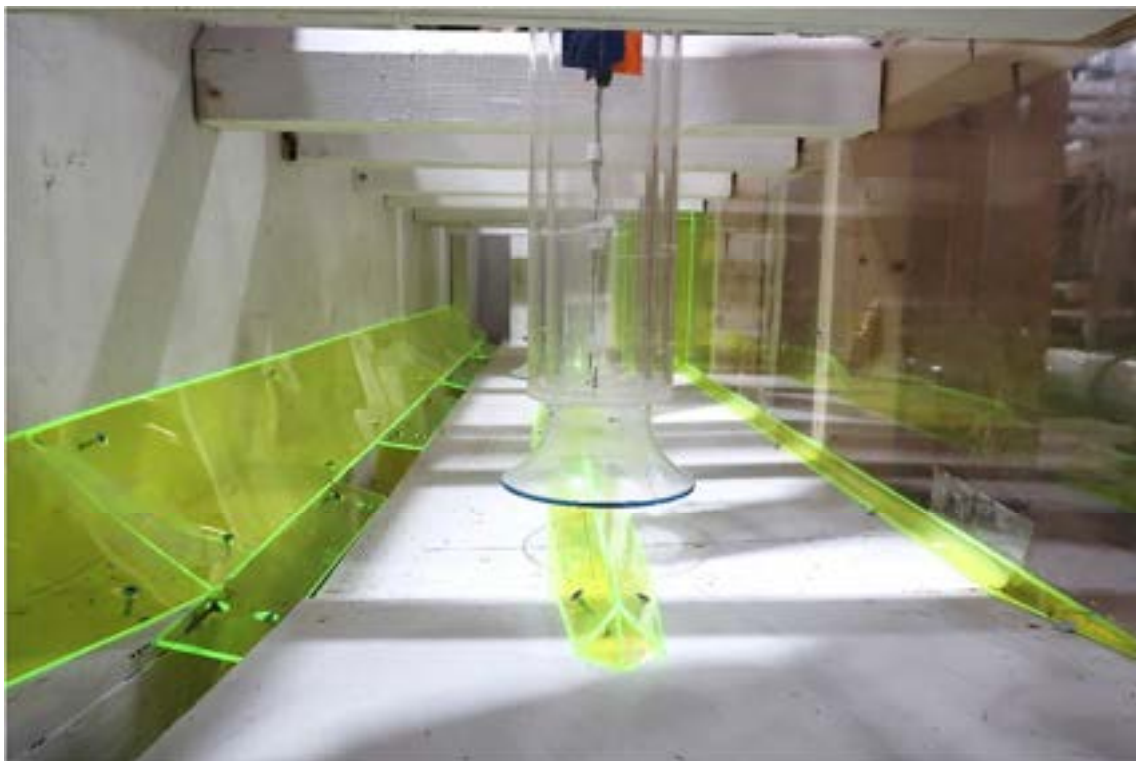


Photo 3-5 Model Pump / Fillets & Splitters

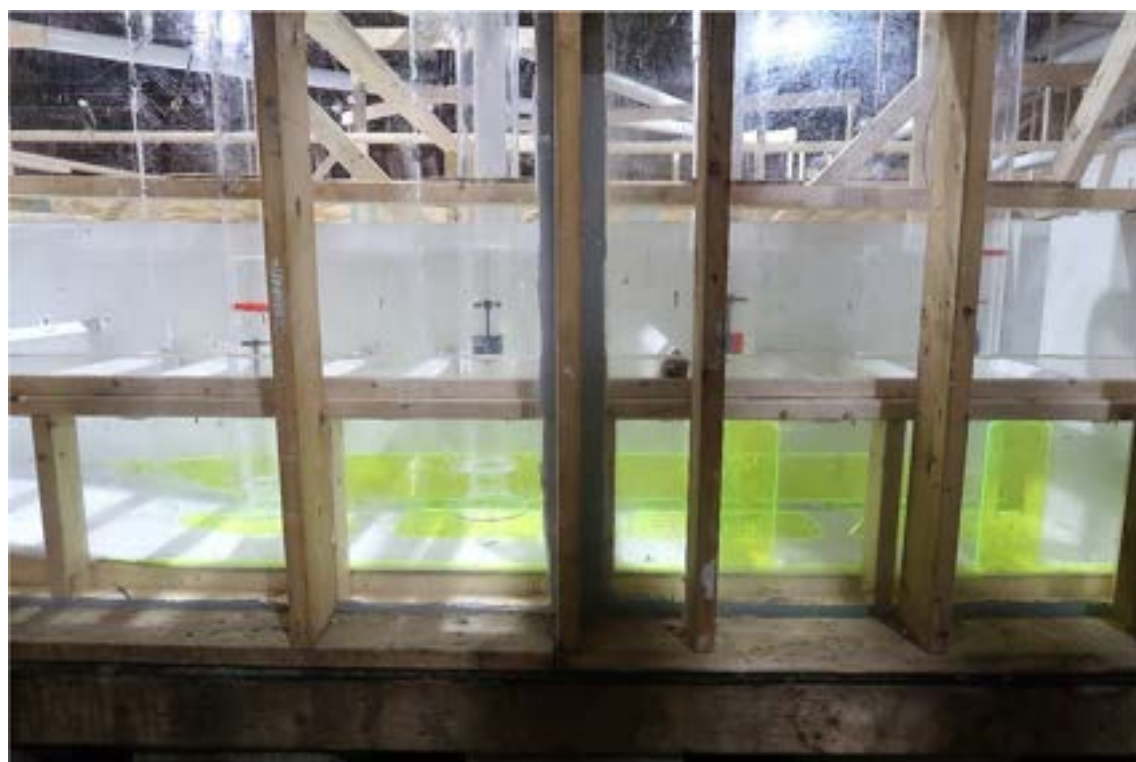


Photo 3-6 Model Pumps

4.0 INSTRUMENTATION AND TESTING PROCEDURES

4.1 Instrumentation and Data Collection

The individual model pump flow rates, as well as the total model flow rate were determined with an ASME standard orifice meter with an accuracy of +/- 2 percent or better. U-tube manometers as well as a Dwyer Series 475 differential manometer were used to measure the manometer deflection. Valves were adjusted in the model piping until the manometer deflections indicated that the proper flow rates were set.

The water levels in the pump sump were recorded with a staff gauge referenced to the sump floor with an accuracy of 3-mm (0.01-ft) or better). Vortex formation was visually observed. Dye was used to aid in the visualization of vortex formation. Vortex strength was rated according to the scale presented in Figure 2-1. Digital photographs and video footage were also used to document vortex formation.

Velocity fluctuations and turbulence levels were measured in one model pump, just upstream of the pump bell. A free spinning miniature propeller Model 412 Nixon Streamflow probe was used to measure the velocities. A data acquisition board was connected to the Nixon probe and recorded approximately 9000 samples over a 30-second period. The software program HPVEE was used to record this data and determine the mean and standard deviation of the velocity data. The pump bell was attached to a turn-column, which allowed the velocity probe to be rotated 360 degrees. Velocities were collected at 8 points around the pump bell, at a fixed radius, in 45-degree increments.

A swirl meter was installed in each pump located four (4) throat diameters downstream of the prototype impeller location (per HI) to measure the level of pre-swirl of flow entering the pump. Each swirl meter consists of 4 straight vanes mounted on a shaft. The swirl angle can be calculated with the following equation:

$$\theta = \tan^{-1} \left(\frac{\pi d n}{u} \right)$$

Where: u = average axial velocity

d = diameter of the pipe in which the swirl meter is installed

n = revolutions per second of the swirl meter

4.2 Test Program

Testing is conducted in three phases, baseline, modification, and final documentation testing. Each of these phases is described below:

- Baseline Testing: Tests were conducted with the intake structure design. These tests were conducted to evaluate the approach flow conditions, and to determine if any adverse hydraulic phenomena were present. In general, vortex activity, pre-swirl, velocity distribution, turbulence levels, and overall approach flow conditions were evaluated.
- Modification Testing: No modification testing was required or conducted for this model.
- Final Documentation Testing: Final testing was conducted to document conditions at the recommended minimum water levels and to evaluate the impact (none observed) based on non-uniform or skewed approach flow in the influent pipes.

5.0 TEST RESULTS

5.1 *Baseline Testing*

Baseline tests were conducted for the original design with several possible operating conditions. In general, the following observations were made:

1. Baseline testing was used to determine minimum operating levels for both the small and large pumps and to evaluate the overall conditions in the wet well and around the pumps.
2. Water level sensitivity testing indicated when operating a single large pump at full speed, surface dimples were observed at El. 62.0 ft and when operating at minimum speed, surface dimples were observed at El. 61.0 ft. When operating the small pump at full speed, surface dimples were observed at EL. 61.0 ft and when operating at minimum speed, surface dimples were observed at EL. 60.0 ft.
3. Overall conditions around the pumps were very stable during single pump operation for both the small and large pumps. As the number of operating pumps increased overall conditions became less stable; however, flow still entered each of the operating pumps uniformly around the bell circumferences.
4. A previous model study recommended both floor splitters as well as sidewall fillets for vortex suppression. These were installed for baseline testing and were effective at preventing floor vortex activity and minimizing sidewall vortex activity. Mild and infrequent vortex activity was still observed occurring on the sidewalls but typically flushed out or dissipated prior to or entering the pumps. In addition, when adjacent pumps were operating, mild interaction / swirl was observed forming in between the pumps but no organized vortices were observed.
5. Velocity and turbulence variations as well as pre-swirl were within criteria for all baseline conditions.
6. After submittal of the initial minimum water levels, CDM Smith further revised the final wet well operating levels, based on the initial findings. Final documentation tests were later used to document conditions at revised operating levels as well as to determine if there are any sensitivities related to non-uniform or skewed flow in the influent lines.

A summary of the baseline data is shown in Table 5-1.

Table 5-1 Baseline Data Summary

Note: See Figure 3-1 for pump orientation. A velocity probe was installed in Pumps 2 and 8. Pre-swirl meters were installed in all four pumps. Velocity and turbulence levels should be less than 10%, pre-swirl should be less than 5.0-degrees, and no vortices greater than Type 1 or weak Type 2 should enter the pump.

Floor splitters and sidewall fillets were installed for all baseline testing.

Base Line	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 1	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	0									
Pump 4 (large)	0									
Pump 6 (large)	0									
Pump 8 (large)	248	none	none	I 2*	none	none	-8.5	8.4	9.9	2.6
West Wet-Well	0	No flow withdrawn								
Comment: Low Water Level = El. 65.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 248 cfs East Influent Flow: 0 cfs Overall conditions are stable Flow enters the pump uniformly around the bell circumference *Infrequent sidewall vortices observed forming No surface vortex activity Pre-swirl is stable										

Base Line	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 2	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	0									
Pump 4 (large)	0									
Pump 6 (large)	0									
Pump 8 (large)	248	See notes	none	I 2	none	none	-7.9	6.9	8.7	4.1
West Wet-Well	0	No flow withdrawn								
Comment: Minimum Water Level = El. 62.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 47 cfs East Influent Flow: 201 cfs Minimum Water Level Test Surface dimples begin to form at El. 62.0 ft Overall conditions remain stable *Flow enters the pump uniformly around the bell circumference Infrequent sidewall vortices observed forming Pre-swirl is stable										

Base Line	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 3	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	0									
Pump 4 (large)	0									
Pump 6 (large)	177	See notes	none	I 2*	none	none	No probe installed			2.2
Pump 8 (large)	0									
West Wet-Well	0	No flow withdrawn								
Comment: Minimum Water Level = El. 61.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 34 cfs East Influent Flow: 143 cfs Minimum Water Level Test Surface dimples begin to form at El. 61.0 ft Overall conditions remain stable Flow enters the pump uniformly around the bell circumference *Infrequent sidewall vortices observed forming Pre-swirl is stable										

Base Line	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 4	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	141	See notes	none	I 2*	none	none	-2.8	7.9	3.6	3.5
Pump 4 (large)	0									
Pump 6 (large)	0									
Pump 8 (large)	0									
West Wet-Well	0	No flow withdrawn								
Comment: Minimum Water Level = El. 61.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 27 cfs East Influent Flow: 114 cfs Minimum Water Level Test Surface dimples begin to form at El. 61.0 ft Overall conditions remain stable Flow enters the pump uniformly around the bell circumference *Infrequent sidewall vortices observed forming Pre-swirl is stable										

Base Line	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 5	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	104	See notes	none	I 2	none	none	-6.0	2.0	8.2	4.8
Pump 4 (large)	0									
Pump 6 (large)	0									
Pump 8 (large)	0									
West Wet-Well	0	No flow withdrawn								
Comment: Minimum Water Level = El. 60.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 27 cfs East Influent Flow: 114 cfs Minimum Water Level Test Surface dimples begin to form at El. 60.0 ft Overall conditions remain stable Flow enters the pump uniformly around the bell circumference *Infrequent sidewall vortices observed forming Pre-swirl is stable										

Base Line	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 6	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	145	none	none	I 2	none	none	-7.4	9.7	5.0	0.5
Pump 4 (large)	258	none	none	I 2	none	none	No probe installed			2.9
Pump 6 (large)	0									
Pump 8 (large)	0									
West Wet-Well	0	No flow withdrawn								
Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 248 cfs East Influent Flow: 145 cfs Overall conditions are less stable Flow enters the pumps uniformly around the bell circumference *Infrequent sidewall vortices observed forming No surface or floor vortex activity Pre-swirl is stable										

Base Line	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 7	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	115	none	none	I 2	none	none	-4.4	5.9	4.3	0.1
Pump 4 (large)	0									
Pump 6 (large)	0									
Pump 8 (large)	245	none	none	I 2	none	none	-5.3	9.3	9.5	3.5
West Wet-Well	0	No flow withdrawn								
Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 20 cfs East Influent Flow: 340 cfs Overall conditions are less stable Flow enters the pumps uniformly around the bell circumference *Infrequent sidewall vortices observed forming No surface or floor vortex activity Pre-swirl is stable										

Base Line	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 8	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	150	none	none	I 2*	none	none	-7.4	6.4	7.0	1.9
Pump 4 (large)	275	none	none	I 2*	none	none	No probe installed			1.2
Pump 6 (large)	275	none	none	I 2*	none	none	No probe installed			3.5
Pump 8 (large)	275	none	none	I 2*	none	none	-3.2	2.8	9.2	4.7
West Wet-Well	685	Flow withdrawn to simulate west wet-well in operation								
Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 1060 cfs East Influent Flow: 600 cfs Overall conditions are less stable Flow enters the pumps uniformly around the bell circumference *Infrequent sidewall vortices observed forming No surface or floor vortex activity Pre-swirl is stable										

The photos below show a variety of the hydraulic phenomena observed during testing.

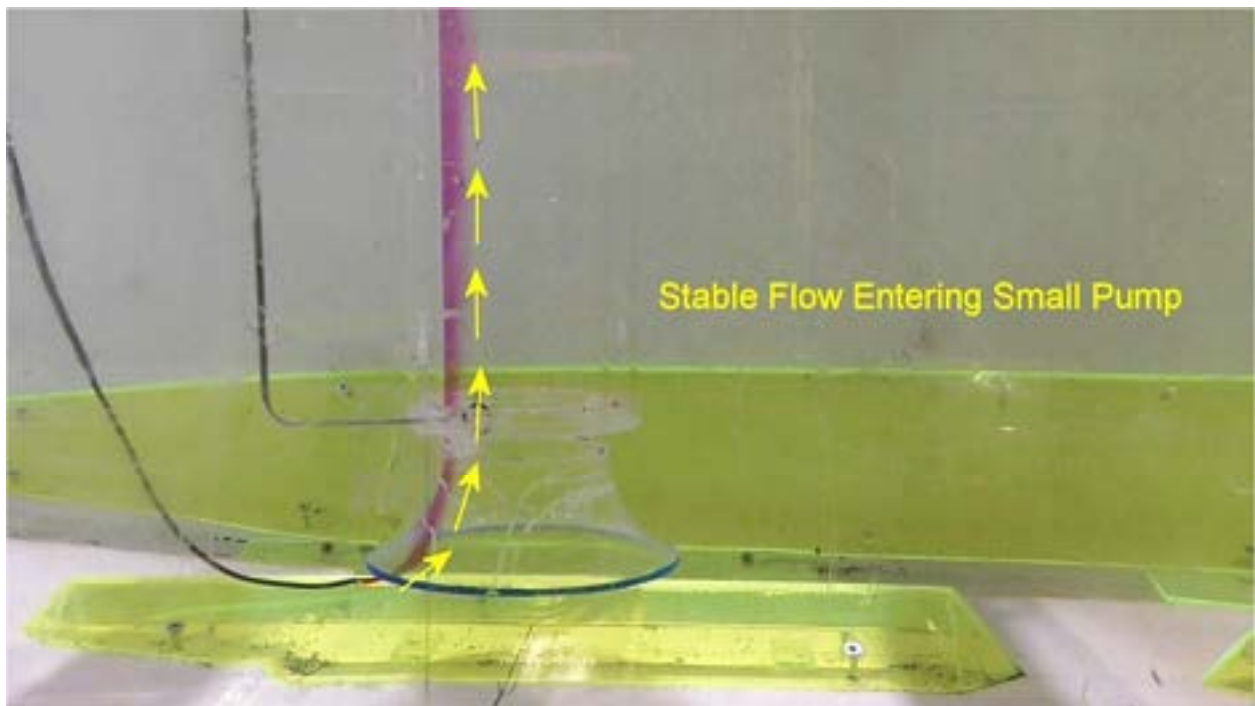


Photo 5-1 Stable Flow Entering Small Pump

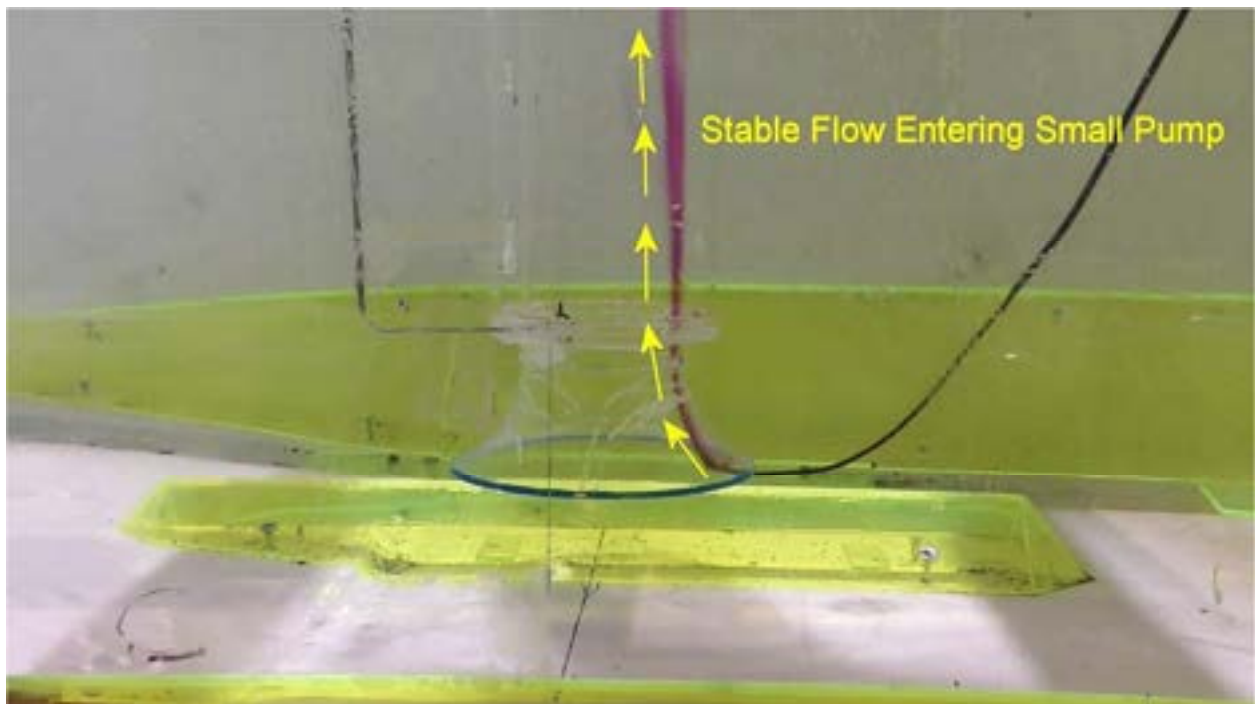


Photo 5-2 Stable Flow Entering Small Pump

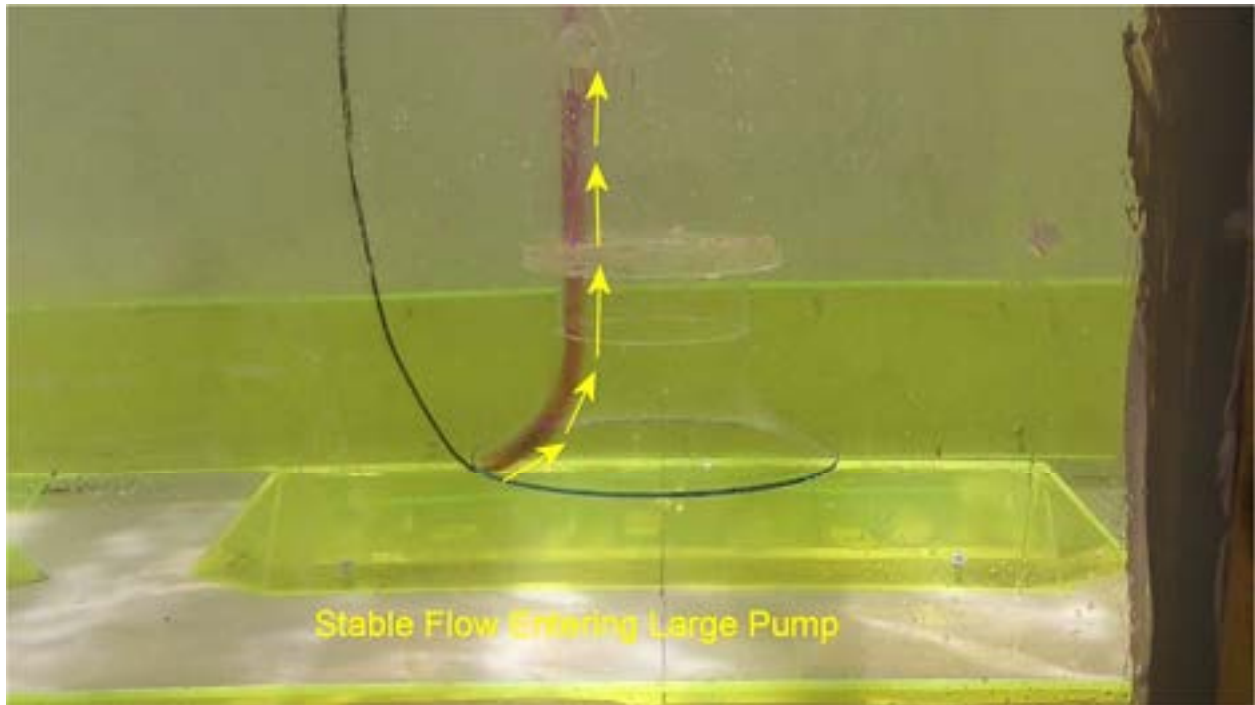


Photo 5-3 Stable Flow Entering Large Pump

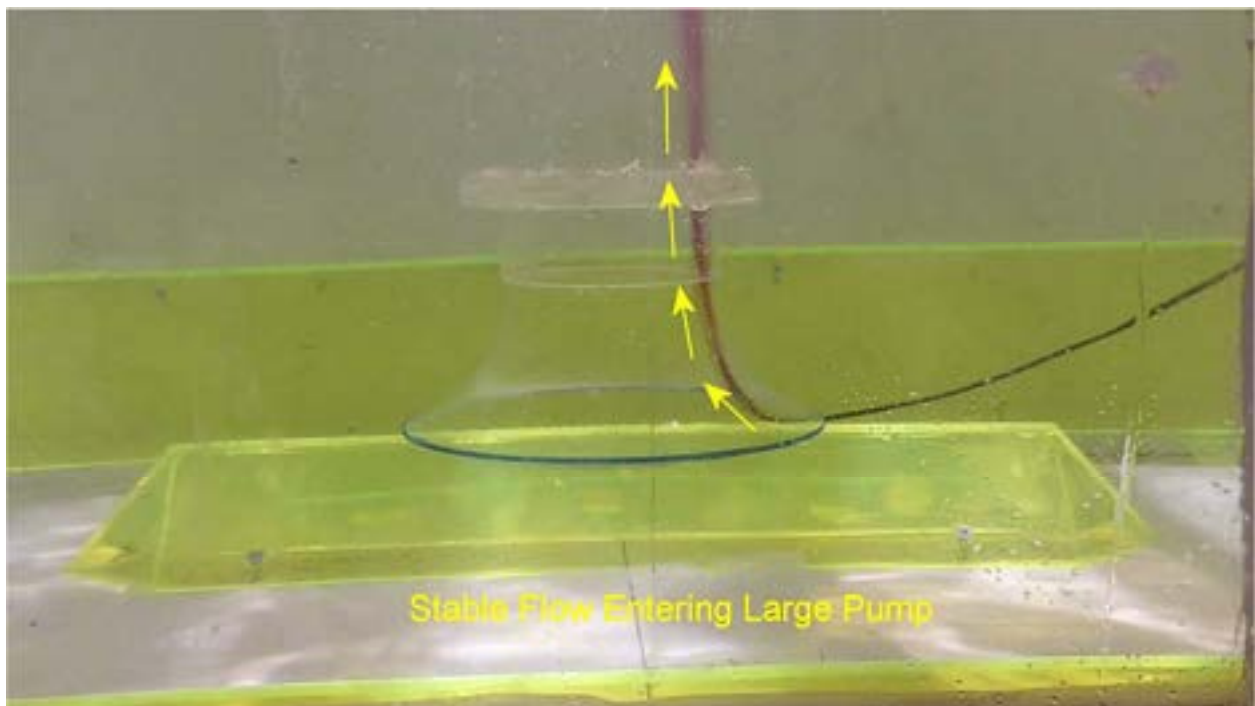


Photo 5-4 Stable Flow Entering Large Pump

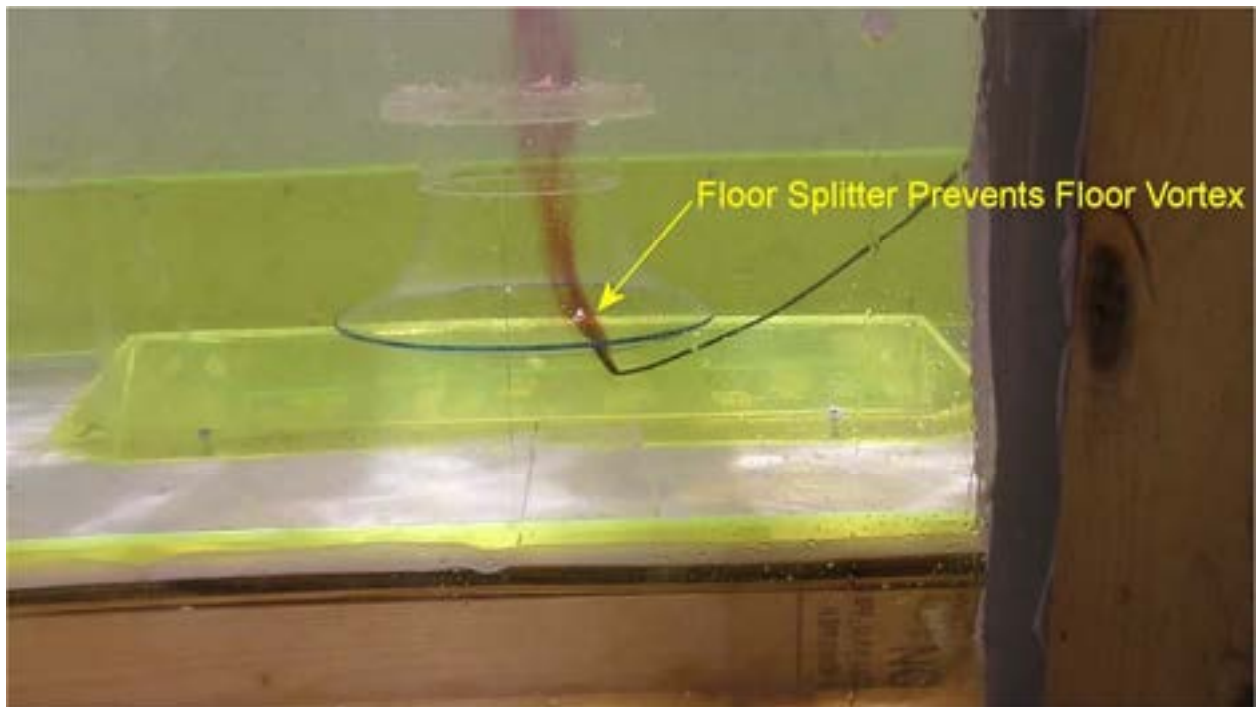


Photo 5-5 Floor Splitter Prevents Floor Vortex Activity

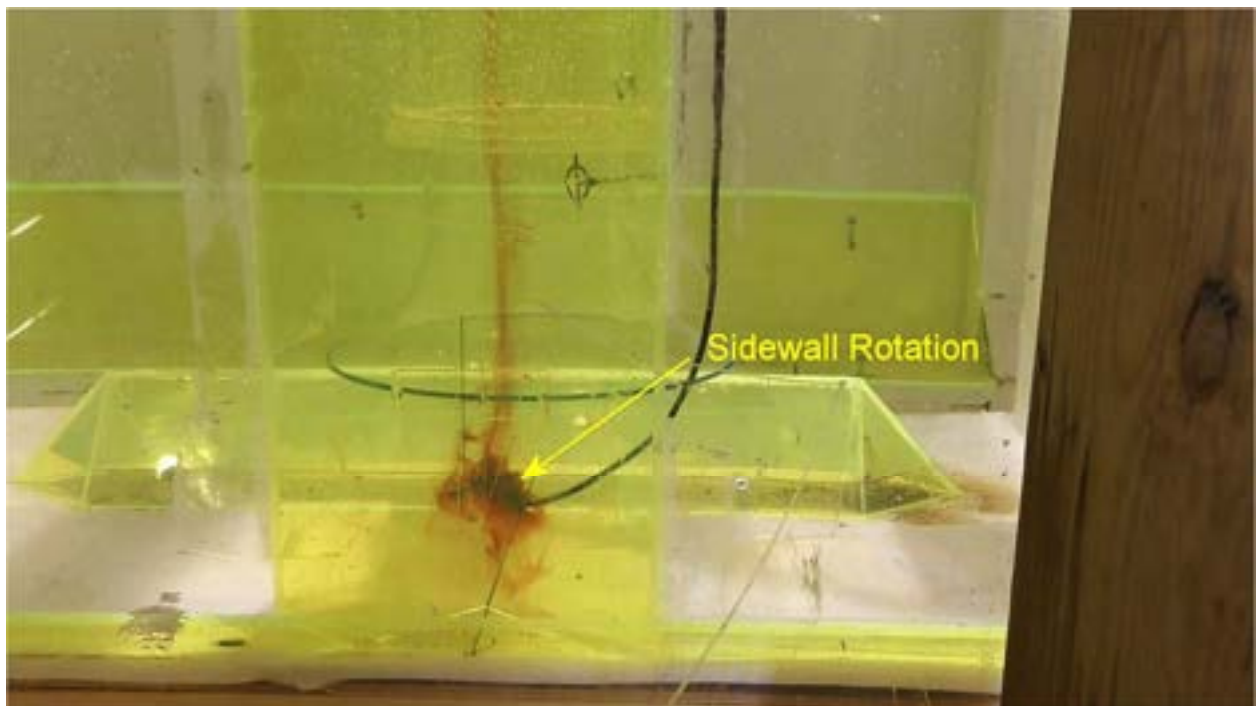


Photo 5-6 Sidewall Swirl (Infrequent Weak Sidewall Vortex Activity)

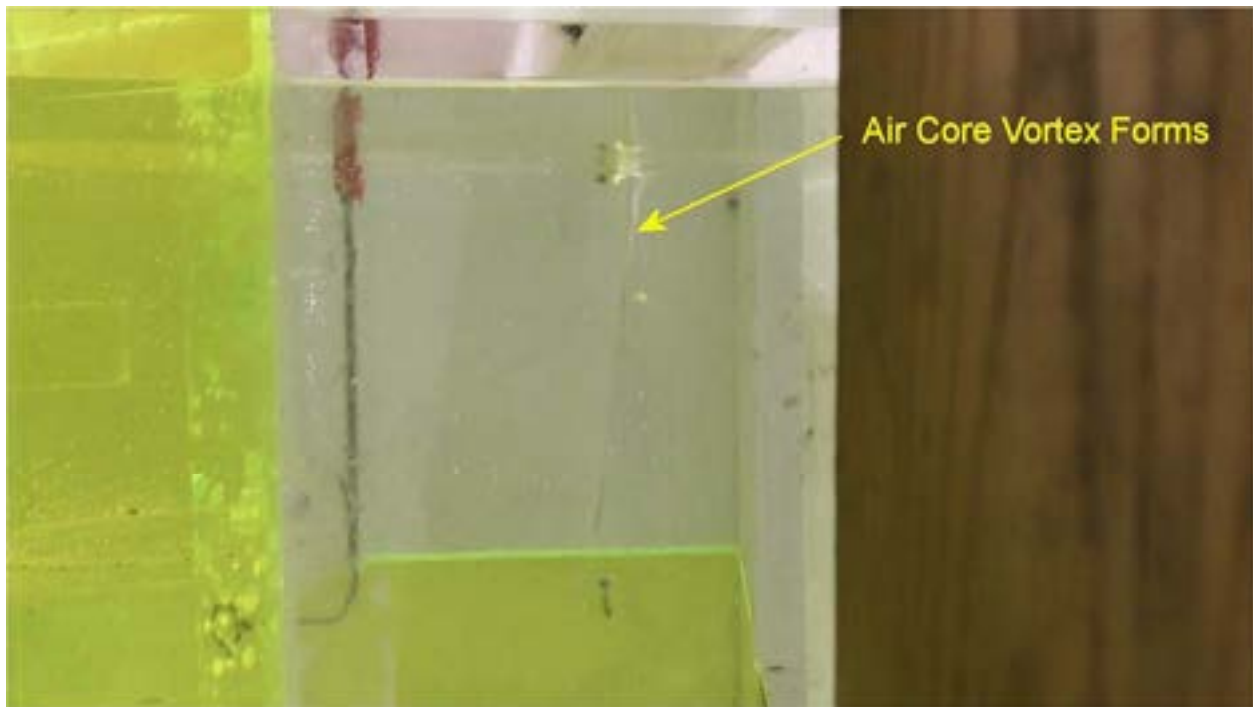


Photo 5-7 **Surface Dimple / Air Entrainment in Large Pump**

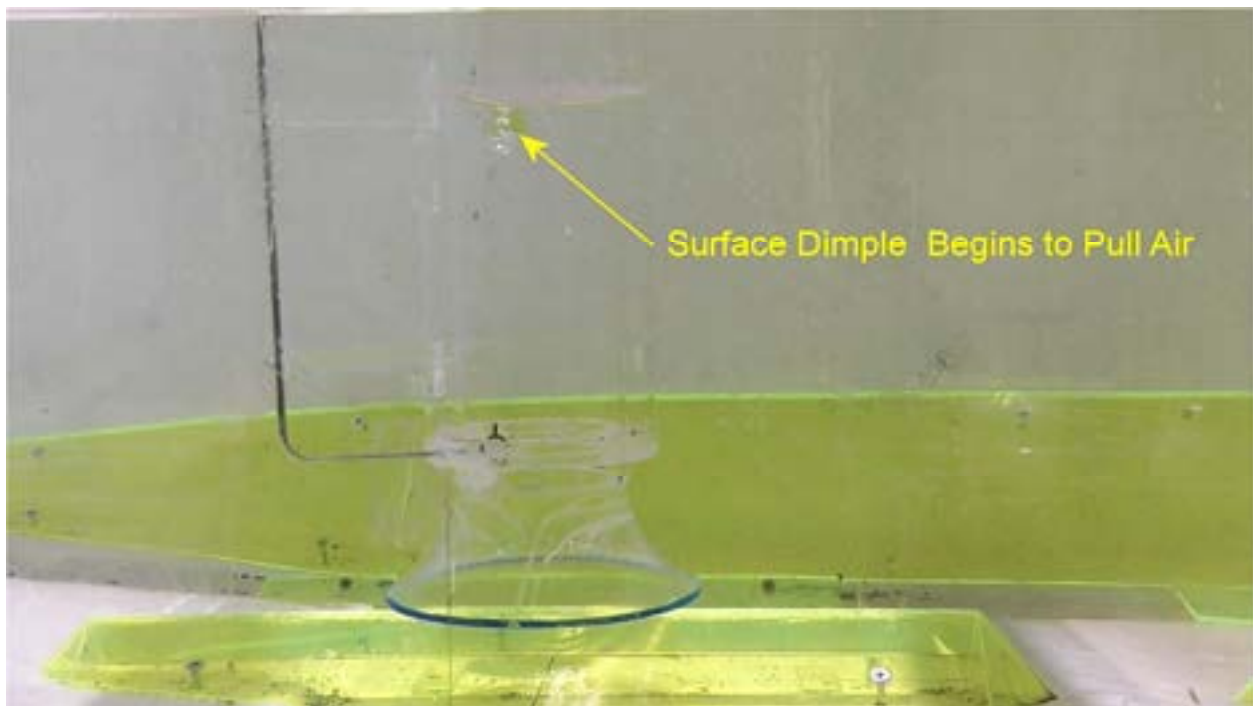


Photo 5-8 **Surface Dimple / Air Entrainment in Small Pump**

5.2 *Modification Testing*

Baseline testing showed infrequent sidewall vortex activity forming; however, these were infrequent, weak Type 2 (per our Figure 2-1), typically dissipated as they entered the pumps and did not result in out of criteria turbulence values. Velocity and turbulence variations, as well as pre-swirl values were within criteria for all baseline tests. Based on this, no additional modifications or revisions are required or recommended.

5.3 *Witness Testing*

No formal witness test was held for this model. Video of baseline testing will be included with the final report.

5.4 *Final Documentation Testing*

After submittal of the initial water level recommendations, CDM Smith further revised the levels to be utilized as minimum / pump off levels. These water levels were incorporated into the final documentation testing phase. In addition, final documentation tests were used to determine if conditions in the wet wells were sensitive to skewed or non-uniform flow in the influent pipes that would result from curvature or bends in the pipes upstream of the intake. The following water levels were used as the minimum operating levels for the final testing:

- Small pump minimum operating level (any speed): El. 61.0 ft
- Large pump minimum operating level (any speed): El. 62.5 ft

Table 5-2 shows the final documentation test data.

Table 5-2 Final Documentation Data Summary

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 1	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	150	none	none	I 2*	none	none	-7.4	6.4	7.0	1.9
Pump 4 (large)	275	none	none	I 2*	none	none	No probe installed			1.2
Pump 6 (large)	275	none	none	I 2*	none	none	No probe installed			3.5
Pump 8 (large)	275	none	none	I 2*	none	none	-3.2	2.8	9.2	4.7
West Wet-Well	975	Flow withdrawn to simulate west wet-well in operation								
Comment: Water Level = El. 78.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 1248 cfs East Influent Flow: 702 cfs Air entrainment observed in junction chamber – rises to surface as it enters wet well No air entrainment observed pumps Flow enters the pumps uniformly around the bell circumference *Infrequent sidewall vortices observed forming No surface or floor vortex activity Pre-swirl is stable										

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 2	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	150	none	none	I 2*	none	none	-6.1	3.5	5.6	0.5
Pump 4 (large)	275	none	none	I 2*	none	none	No probe installed			0.3
Pump 6 (large)	275	none	none	I 2*	none	none	No probe installed			2.5
Pump 8 (large)	275	none	none	I 2*	none	none	-6.7	4.0	9.8	4.3
West Wet-Well	685	Flow withdrawn to simulate west wet-well in operation								
Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 0 cfs East Influent Flow: 1660 cfs Flow enters the pumps uniformly around the bell circumference *Infrequent sidewall vortices observed forming No surface or floor vortex activity Pre-swirl is stable										

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 3	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	150	none	none	I 2*	none	none	-3.3	4.7	5.4	0.1
Pump 4 (large)	275	none	none	I 2*	none	none	No probe installed			1.3
Pump 6 (large)	275	none	none	I 2*	none	none	No probe installed			0.7
Pump 8 (large)	275	none	none	I 2*	none	none	-5.5	9.5	9.8	3.7
West Wet-Well	685	Flow withdrawn to simulate west wet-well in operation								
Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 1660 cfs East Influent Flow: 0 cfs Flow enters the pumps uniformly around the bell circumference *Infrequent sidewall vortices observed forming No surface or floor vortex activity Pre-swirl is stable										

Note: The following tests were conducted with all influent flow through a single influent line with 50-percent of the exit opening blocked, to simulate non-uniform or skewed flow in the influent lines due to pipe bends or curvature.

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 4	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	150	none	none	I 2*	none	none	-6.2	5.1	5.4	0.1
Pump 4 (large)	275	none	none	I 2*	none	none	No probe installed			1.5
Pump 6 (large)	275	none	none	I 2*	none	none	No probe installed			0.3
Pump 8 (large)	275	none	none	I 2*	none	none	-6.8	5.3	9.5	2.6
West Wet-Well	685	Flow withdrawn to simulate west wet-well in operation								
Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft One half of west influent line blocked West Influent Flow: 1660 cfs East Influent Flow: 0 cfs Flow enters the pumps uniformly around the bell circumference – no change from previous tests *Infrequent sidewall vortices observed forming No surface or floor vortex activity Pre-swirl is stable										

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 5	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	150	none	none	I 2*	none	none	-5.2	8.3	5.3	0.1
Pump 4 (large)	275	none	none	I 2*	none	none	No probe installed			0.5
Pump 6 (large)	275	none	none	I 2*	none	none	No probe installed			0.5
Pump 8 (large)	275	none	none	I 2*	none	none	-4.5	7.0	7.6	4.4
West Wet-Well	685	Flow withdrawn to simulate west wet-well in operation								
Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft The other half of west influent line blocked West Influent Flow: 1660 cfs East Influent Flow: 0 cfs Flow enters the pumps uniformly around the bell circumference – no change from previous tests *Infrequent sidewall vortices observed forming No surface or floor vortex activity Pre-swirl is stable										

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 6	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	150	none	none	I 2*	none	none	-5.5	3.3	7.0	0.3
Pump 4 (large)	275	none	none	I 2*	none	none	No probe installed			0.7
Pump 6 (large)	275	none	none	I 2*	none	none	No probe installed			1.7
Pump 8 (large)	275	none	none	I 2*	none	none	-8.9	6.5	8.0	3.3
West Wet-Well	685	Flow withdrawn to simulate west wet-well in operation								
Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft One half of east influent line blocked West Influent Flow: 0 cfs East Influent Flow: 1660 cfs Flow enters the pumps uniformly around the bell circumference – no change from previous tests *Infrequent sidewall vortices observed forming No surface or floor vortex activity Pre-swirl is stable										

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 7	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	150	none	none	I 2*	none	none	-8.8	4.2	5.6	0.1
Pump 4 (large)	275	none	none	I 2*	none	none	No probe installed			0.4
Pump 6 (large)	275	none	none	I 2*	none	none	No probe installed			1.3
Pump 8 (large)	275	none	none	I 2*	none	none	-2.8	2.6	9.1	3.0
West Wet-Well	685	Flow withdrawn to simulate west wet-well in operation								

Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft

The other half of east influent line blocked

West Influent Flow: 0 cfs

East Influent Flow: 1660 cfs

Flow enters the pumps uniformly around the bell circumference – no change from previous tests

*Infrequent sidewall vortices observed forming

No surface or floor vortex activity

Pre-swirl is stable

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 8	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	0									
Pump 4 (large)	0									
Pump 6 (large)	0									
Pump 8 (large)	248	See Notes	none	I 2*	none	none	-3.0	5.5	7.7	0.7
West Wet-Well	0	No flow withdrawn								

Comment: **Large Pump Minimum Water Level = El. 62.5 ft** – Sump Invert El. 50.5 ft

West Influent Flow: 47 cfs

East Influent Flow: 201 cfs

Flow enters the pumps uniformly around the bell circumference

*Infrequent sidewall vortices observed forming

Consistent surface swirl observed

Infrequent surface dimples begin to form

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 9	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	104	See Notes	none	I 2*	none	none	-4.1	4.6	7.1	4.1
Pump 4 (large)	0									
Pump 6 (large)	0									
Pump 8 (large)	0									
West Wet-Well	0	No flow withdrawn								
Comment: Small Pump Minimum Water Level = El. 61.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 20 cfs East Influent Flow: 84 cfs Flow enters the pumps uniformly around the bell circumference *Infrequent sidewall vortices observed forming Consistent surface swirl observed Infrequent surface dimples begin to form										

Note: One additional test was conducted with the low flow channel covers removed. Testing showed removing these had little to no impact on conditions at the pumps.

Doc	Prototype Flow	Vortex Activity (I = Intermittent C = Constant)					Velocity & Turbulence (Vel = % of average)			Pre-Swirl
Test 10	(cfs)	Surface	Back wall	Side wall	Floor	Midflow	Min. Vel.	Max. Vel.	Max. Turb. %	Max (deg.)
Pump 2 (small)	150	none	none	I 2*	none	none	-6.8	2.5	7.2	1.2
Pump 4 (large)	275	none	none	I 2*	none	none	No probe installed			2.0
Pump 6 (large)	275	none	none	I 2*	none	none	No probe installed			2.8
Pump 8 (large)	275	none	none	I 2*	none	none	-4.9	3.4	9.3	4.2
West Wet-Well	685	Flow withdrawn to simulate west wet-well in operation								
Comment: Water Level = El. 71.0 ft – Sump Invert El. 50.5 ft West Influent Flow: 1660 cfs East Influent Flow: 0 cfs Trash channel covers removed – no change in overall conditions Flow enters the pumps uniformly around the bell circumference *Infrequent sidewall vortices observed forming Consistent surface swirl observed Infrequent surface dimples begin to form										

5.5 *Flushing System Testing*

After evaluating conditions with the pumps operating, CEH simulated the existing flushing system. It should be noted that spray and sediments will not scale precisely in the physical model but it does provide a reliable approach to evaluate relative differences and the impact of changes.

The Oakwood Storm Pump Station flushing system consists of a horizontal pipe that runs along one wall (opposite the low flow trench) with a series of nozzles directed downward. The flushing system is broken down into four quadrants with two in the East Wet Well and two in the West Wet Well. Only one quadrant will operate at a time at a flow rate of 1770 gpm spread out over 11 nozzles. CEH simulated the existing flushing system by scaling the pipe and flowrates at the model scale. The nozzles were approximated with 40-degree spray patterns. One quadrant was operated at a time and simulated 1770 gpm.

To evaluate the general effectiveness the bottom of the wet well was loaded with a layer of crushed walnut shells. The existing flushing header and nozzles were simulated at the existing location and one of the two quadrants in the detailed wet well was operated for a period of time and then the second quadrant was operated. The tests were done with the water level up to the pump bell elevations and then repeated with an empty wet well. In summary, the spray nozzles were not effective at all when there was standing water in the wet well. With no water in the wet well, the existing nozzles were still only minimally effective as the spray spreading out and losing much of its concentrated energy before it reached the sediment.

A second test set of tests were done using a second flushing system, installed on the opposite side of the wet well but at a much lower (just above the existing side wall fillets) elevation. This testing showed a significant improvement over the existing system simply because the lowered nozzle elevations allowed for the energy to remain more concentrated before it impacted the sediment. Given the model observations, the following is recommended.

- 1) On the side with the low flow trench, it is recommended to lower the nozzles to just above the sidewall fillets (approximately El. 55.5-ft) with the spray directed to hit the toe of the splitters below the pump bells. A 40-degree wide spray angle and flat (thin rectangular) pattern was effective.
- 2) On the side opposite the low flow trench, it is recommended that the nozzles also be set at approximately El. 55.5-ft to match the elevation and mirror the spray angle of the nozzles on the side with the low flow trench. Two nozzles should be equally spaced ($1/3$ and $2/3$) the length of each pump's floor splitter and then one nozzle centered between the splitters to push debris through the openings.
- 3) It is also recommended that on the side housing the low flow trench, two nozzles should spray onto each splitter at $1/3$ and $2/3$ the length. This side should not have one centered on the opening as this will simply push sediment to the opposite side. This will help to move sediment on the "backside" of the splitters that the nozzles on the opposite side cannot reach.

The photos below show the qualitative and relative results. Video has also been provided and is considered to be an integral part of this report.

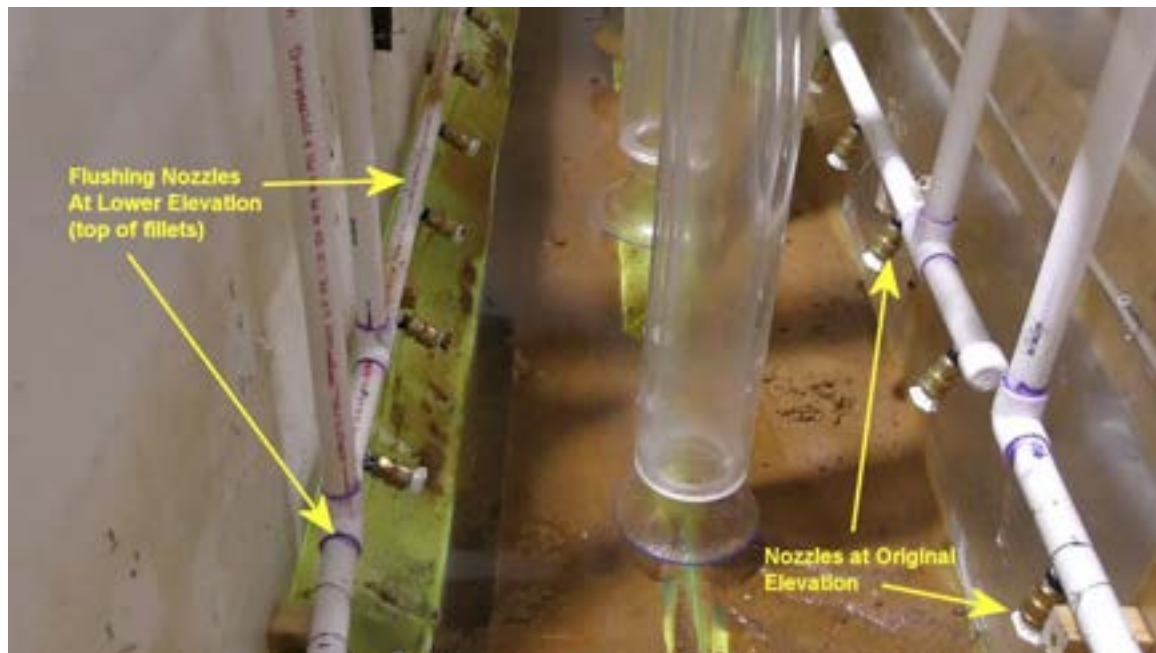


Photo 5-9 Nozzles and Sediment Prior to Flushing

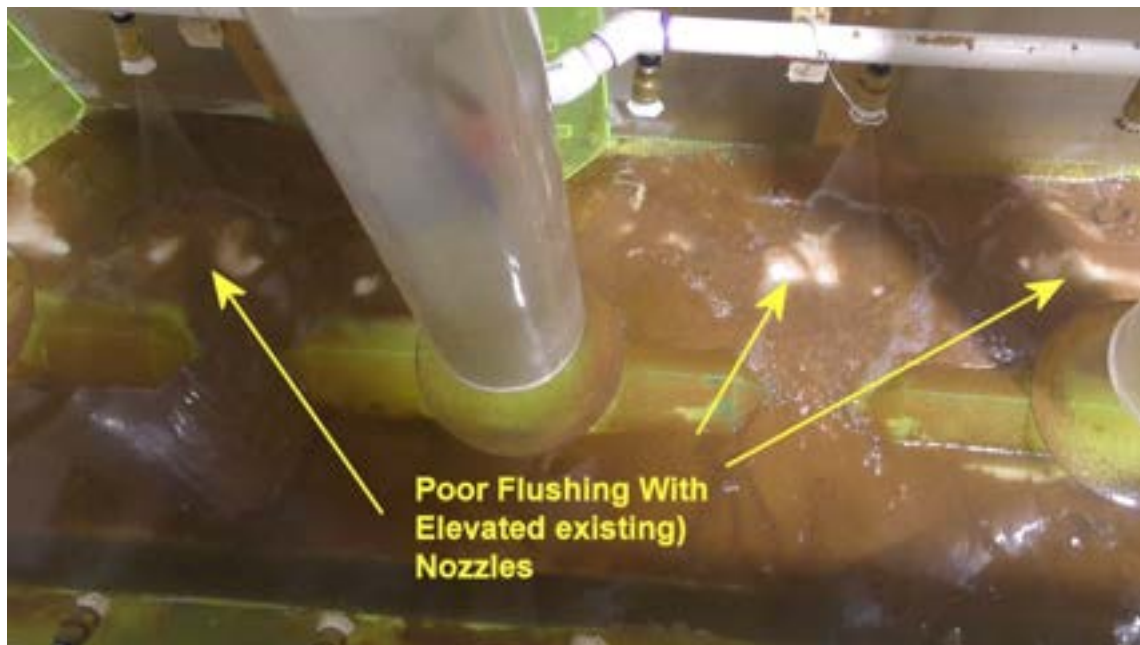


Photo 5-10 Flushing with Existing Nozzles

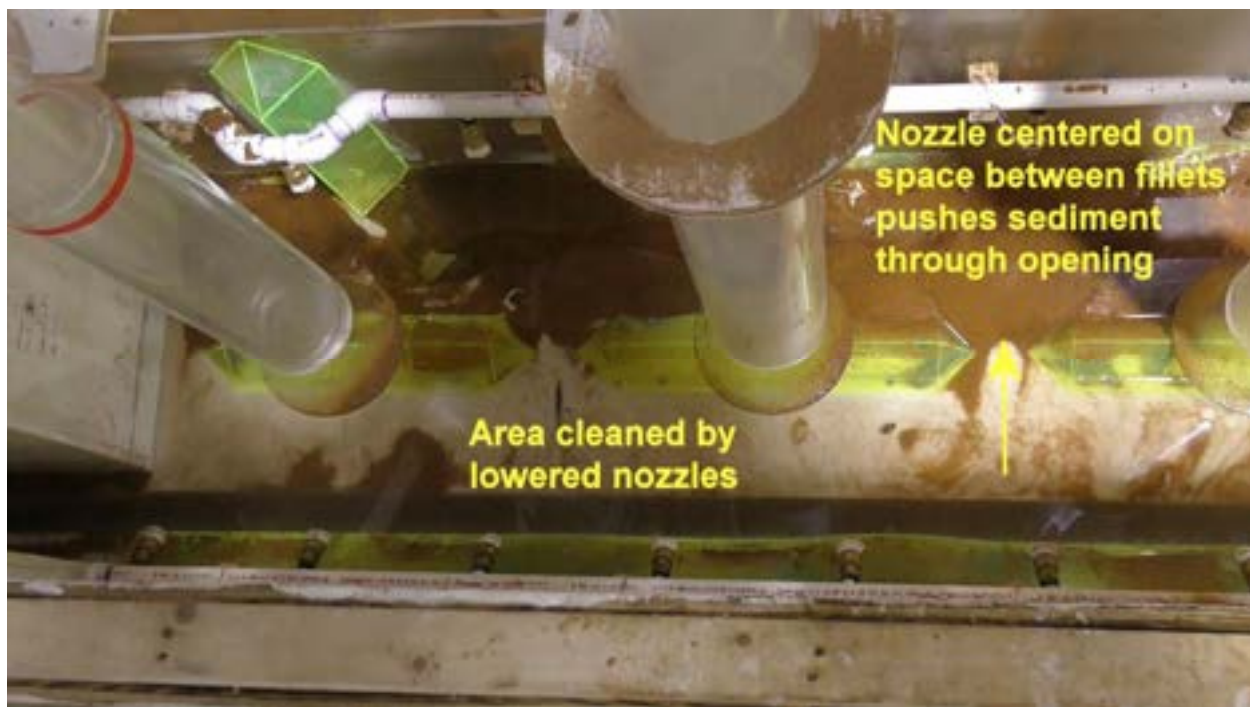


Photo 5-11 Flushing with Lowered Nozzles

6.0 CONCLUSIONS & RECOMMENDATIONS

6.1 *Conclusions*

Baseline testing was used to determine minimum operating levels for both the small and large pumps and to evaluate the overall conditions in the wet well and around the pumps. Water level sensitivity testing indicated that when operating a single large pump at full speed, surface dimples were observed at El. 62.0 ft and when operating at minimum speed, surface dimples were observed at El. 61.0 ft. When operating the small pump at full speed, surface dimples were observed at EL. 61.0 ft and when operating at minimum speed, surface dimples were observed at EL. 60.0 ft.

Overall conditions around the pumps were very stable during single pump operation for both the small and large pumps. As the number of operating pumps increased overall conditions became less stable; however, flow still entered each of the operating pumps uniformly around the bell circumferences. A previous model study recommended both floor splitters as well as sidewall fillets for vortex suppression. These were installed for baseline testing and were effective at preventing floor vortex activity and minimizing sidewall vortex activity. Mild and infrequent vortex activity was still observed occurring on the sidewalls but typically flushed out or dissipated prior to or entering the pumps. In addition, when adjacent pumps were operating, mild interaction / swirl was observed forming in between the pumps but no organized vortices were observed. Velocity and turbulence variations as well as pre-swirl were within criteria for all baseline conditions. After submittal of the initial minimum water levels, CDM Smith further revised the final wet well operating levels, based on the initial findings. Final documentation tests were later used to document conditions at revised operating levels as well as to determine if there are any sensitivities related to non-uniform or skewed flow in the influent lines.

After evaluating conditions with the pumps operating, CEH simulated the existing flushing system. It should be noted that spray and sediments will not scale precisely in the physical model but it does provide a reliable approach to evaluate relative differences and the impact of changes. This testing showed that the effectiveness of the flushing system could be improved by lowering the nozzles from the current elevation to just above the sidewall fillets and placing additional nozzles on the opposite (low flow trench) side to clean the “backside” of the splitters where the nozzles on the opposite side cannot reach.

6.2 *Recommendations*

It is recommended that the pump-off level for the large pumps be set at El. 62.5 ft and the minimum pump-off level for the small pump be set at El. 61.0 ft. The effectiveness of the flushing system can likely be improved by lower the elevation of the flushing nozzles and strategically placing the nozzles relative to the floor splitters. This is discussed in Section 5.5 of this report.

7.0 REFERENCES

Hydraulic Institute Standards, 2018. American National Standard for Pump Intake Design. Hydraulic Institute, Parsippany, New Jersey, 07054-3802

Sweeney, C.E. and G.E. Rockwell, 1982. Pump Sump Design Acceptance through Hydraulic Model Testing. Proc. of the International Association for Hydraulic Research: Symposium on Operating Problems of Pump Stations and Power Plants. Amsterdam, the Netherlands, pp. 13-17, September 1982.



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA Consultants, LLC*

*From: Keaton LeFevre, Applied Science, Inc.
John Michalski, Applied Science, Inc.
Steve Fehniger, CDM Smith (OKW-PUMP-1B)*

Date: June 1, 2023

*Subject: TM-22 Flushing Systems (Leib-FD-1, OKW-FD-2 and OKW-PUMP-1B)
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

This technical memorandum (TM) reviews the work studies/evaluations to develop the design of work that will improve the flushing systems at the Leib CSO Screening and Disinfection Facility (SDF), the Oakwood CSO Retention Treatment Basin (RTB), and for the Oakwood Storm Wet Well flushing systems. The goal of this work is to make improvements to the flushing systems that will reliably and simply reduce the Great Lakes Water Authority (GLWA) staff's time and effort required to clean and clear residuals after storm events in the facilities. The proposed improvements will improve on the safety of the staff and the operations and maintenance (O&M) activities required.

Leib SDF Recommendations

- The following improvements are recommended to provide a better means of flushing the screening inlet channels in the Screening Chamber after wet-weather events in the Leib SDF.
 - A piped service water main is to be installed to deliver water volume and spray area to the screening inlet channel. Additionally, a pipeline is recommended to be provided at the head end of the screening collection channel.
 - The stepped floor within the screening inlet channels are to be topped with a concrete coating to make the surface smooth.

Oakwood CSO RTB Recommendations

- The following improvements are recommended to make the flushing valves in the Oakwood CSO RTB more accessible for maintenance.

- The service water mains and valves in the Oakwood CSO RTB are to be relocated downstream of the flushing gates.
- The following improvements are recommended to provide a means to keep the Oakwood CSO RTB sumps and basin drain piping clean of debris that may result in issues draining the basin.
 - The addition of a conditioning pump that is specifically manufactured to recirculate sanitary flows is to be included within each sump. These pumps will operate during times where there is a sufficient depth of fluid in the sumps.
 - A new service water flushing header is to be routed from the existing lines to each sump. The ability to add clean, clear water to the flushing media will increase the conditioning pump's ability to keep the media suspended.

Oakwood Pump Station Storm Wet Well Recommendations

- For Oakwood storm wet well flushing system the following improvements serving each wet well are recommended:
 - Lower existing downstream header (located beside storm pumps) and direct discharge on top of the "short" sidewall fillet at elevation high enough to establish spray pattern and minimize gap between adjoining nozzle discharges.
 - In vicinity of storm pumps, add header on sanitary flow trench side of wet well. Mount above sidewall fillet, spray pattern to contact the toe of the splitter below each pump bell. Provide new isolation valve near other isolation valves on intermediate level dedicated to new header to facilitate automated or manual control from Ovation workstation.
 - Lower existing upstream header to elevation set to achieve intended spray pattern above top of expansion zone sloped concrete floor slab at upstream end of system where nozzles will be closest to floor slab.
 - Replace all nozzles with units providing 40–65-degree spray angle with a flat (even) spray pattern.
 - Maintain approximately the same number of nozzles in each zone of the flushing system to provide similar demand on the secondary water system as compared to existing wet well zones, unless selected per nozzle flow rate allows greater number.
 - Remove all sanitary flow trench covers in storm wet well to maximize trench length over which debris can be conveyed into trench and avoid debris accumulation on covers.

Description of Leib SDF Flushing System

The Leib SDF does not have a flushing system for the Screening Chamber beyond service water hose bibs located along the catwalks over the facility Influent Channel and the screening chamber. The area that is most problematic is the “stepped” sloped floor within the screening inlet channel and the screening collection channel. These areas receive the largest volume of debris after a wet weather event and have the highest concentration of the screenings.

Spray down and water distribution systems were reviewed, and two main recommendations have been identified. First the “stepped” sloped floor should be topped with a concrete coating to make the surface smooth. This will aid in the flow of the debris to the dry weather flow channel during dewatering. To aid in the effort and to reduce in the manual need to spray the area down, a piped service water main is proposed to deliver water volume and spray area to the screening inlet channel. Additionally, a pipeline is recommended to be provided at the head end of the screening collection channel.

Description of Oakwood CSO RTB Flushing Valves and Flushing System Improvements

The Oakwood CSO RTB has flushing water service pipelines that deliver water to the flushing gate reservoirs. The valves on these lines are located under the roof slab and are difficult to access for maintenance. The service water mains and valves are proposed to be relocated further into the basin at a location that can be more safely accessed.

The flushing gates transfer debris that has collected on the basin floor after dewatering. This debris is pushed to a collection channel that is dewatered through an 8 ft by 8 ft sump. There are two sumps (one per basin) and each sump has two drains that transfer dewatered flow and debris to either the sanitary gravity main or back to the upstream. High concentration of sludge and debris in the sumps have proven to be problematic and difficult to clear if the lines plug. GLWA has identified that only the lower drain, to the upstream junction chamber, has historically plugged. Several alternatives of methods to resuspend or keep suspended the debris in the sumps were researched. Two improvements are identified in this TM. The addition of a conditioning pump that is specifically manufactured to recirculate sanitary flows is proposed to be included within each sump. These pumps will operate during times where there is a sufficient depth of fluid in the sumps. This activity will lessen the potential of the drains clogging. To aid in the effort to improve on the concentrated flushing fluid’s ability to flow within the gravity drains, a new service water flushing header will be routed from the existing lines to each sump. The ability to add clean, clear water to the flushing media will increase the conditioning pump’s ability to keep the media suspended, and it will also be used to flush down the pipelines after flushing activities.

Oakwood Storm Wet Well Flushing System

The Oakwood storm wet well flushing system improvements evaluation was focused on assessment of the usefulness and operability of the existing system and to propose improvements to the system to aid in increased use and effectiveness. The evaluation of the system was conducted in two

phases, first existing system hydraulic characteristics and second use of a physical model study to assess existing system configuration performance and system modifications to improve flushing functionality.

1.0 Introduction and Purpose

TM-22 is focused on the evaluation of several flushing systems to be added or improved as part of this project. This includes the following:

- Leib SDF Flushing System
- Oakwood CSO RTB Flushing Valves and Drainage Sumps
- Improvements to the existing Oakwood storm wet well flushing system (both storm wet wells)

The TM is configured to first cover the Leib SDF flushing system, followed by the Oakwood CSO RTB flushing valves and drainage sumps, and finally the improvements to the Oakwood storm wet well flushing system within each section.

The Oakwood storm wet well flushing system improvements evaluation was focused on assessment of the usefulness and operability of the existing system and to propose improvements to the system to aid in increased use and effectiveness.

2.0 Existing Systems Description

2.1 Existing Leib SDF Flushing System

The Leib SDF does not have a dedicated system for flushing the screening chamber. The facility presently drains by gravity following storm events. Solids accumulation has not been a major issue due to limited use, with the exception of the screening inlet channels. The screening inlet channels are manually hosed down using city water following an event in which the screens are in use. Manual wash down is performed via hose reels that are located along catwalks above the screening channels. The hose reels are fed by a pipe header that extends down from the upper level of the facility. The facility operator presently uses a smooth bore fire nozzle on the end of the hose reels. This type of nozzle has been more effective than a standard spray nozzle.

The present manual wash down does not present issues in cleaning the facility. However, the process is difficult, time-consuming, and requires two operators to access all areas in need of wash down. Discussion with the Leib facility operator indicated that the present water pressure at the hose reels is adequate enough to perform the wash down, however a higher pressure is desired to wash down more efficiently.

The complete wash down process involves cleaning the screens and screening inlet channels, the influent channel and dry-weather flow trench, the screening outlet channels, and the screening collection channels. There are four screening inlet channels; two of the channels contain vertical

Romag screens, and two of the channels contain horizontal Copa screens. The channels with the Romag screens are easier to wash down as they are open from above and can be sprayed down from the catwalks. The channels with the Copa screens are entirely covered by the screen and are difficult to wash down. To clean the channels with the Copa screens, the operator must go down into the screening collection channel and wash the screen and screening inlet channel through a gate opening in the screening collection channel wall.

Figures 2-1 and 2-2 show a section and plan view of the present 2-inch water line in the Leib SDF. **Figure 2-3** shows the screening inlet channel for the Copa screens.

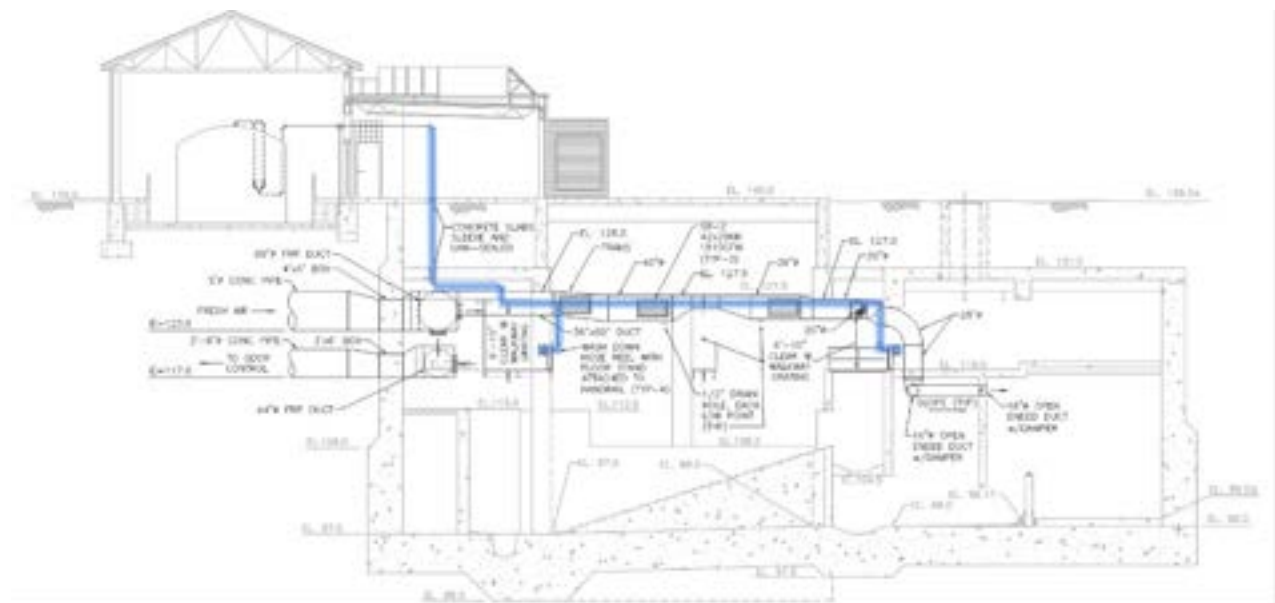


Figure 2-1
Section View of Existing 2-Inch Water Line in the Leib SDF

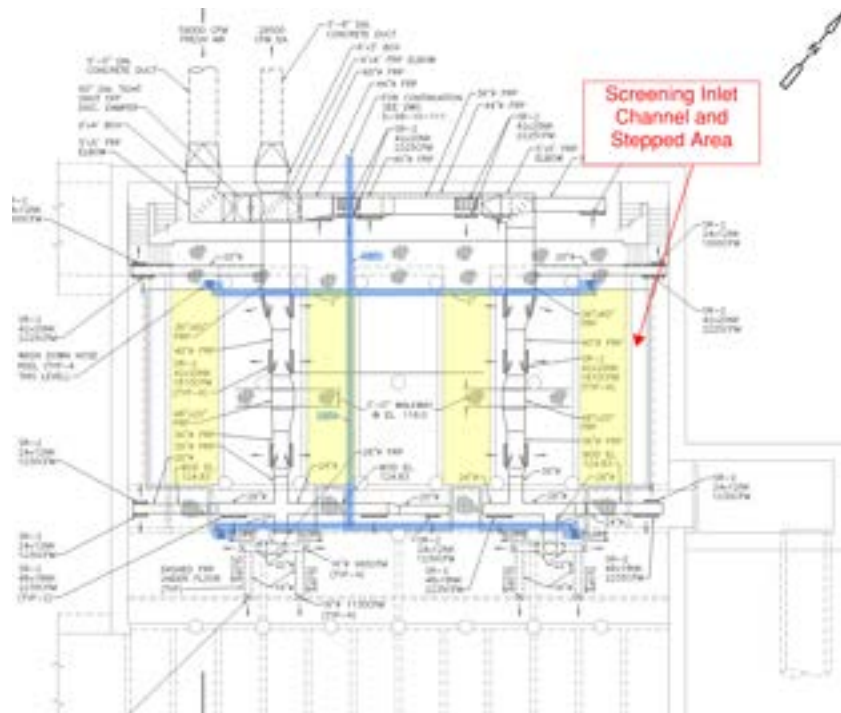


Figure 2-2
Plan View of Existing 2-Inch Water Line in the Leib SDF



Figure 2-3
Copa Screening Inlet Channel

The planned area for advanced flushing is the “stepped” area within the screening inlet channel. The channel floor is sloped from the back end of the screening inlet channel to the front end near

the influent dry weather flow channel This is the area with the highest concentration of debris which gets held up on the stepped surface. This surface is also shown in **Figure 2-2** and **Figure 2-3**.

2.2 Existing Oakwood CSO RTB Flushing Gates and Fill Valves

The basins at the Oakwood CSO RTB are primarily dewatered by gravity following use during a wet weather event. At the conclusion of basin dewatering, solids that had settled out of the water remain on the floor of the basin. The Oakwood CSO RTB presently has a flushing gate system in place to handle the removal of these solids. Both the east and west CSO basins utilize eight flushing gates for the basin floor and two for the basin influent channels for a total of twenty flushing gates.

Each flushing gate holds the chlorinated and screened combined sewage in an open flushing reservoir. The flushing reservoirs are filled as the basin is filled during a wet weather event. Flushing water remains in the flushing reservoirs after the basins have been dewatered. The reservoirs remain full until the control logic or Oakwood CSO RTB operators initiate the flushing sequence. The entire stored volume is then released to scour settled solids off the floor and flush the solids to the flushing sumps. This is done in a timed sequence in order to maintain continuous flow to the pump station. If the initial flushing sequence is not satisfactory, the flushing reservoirs may be refilled using the facility's secondary water system, and the flushing sequence is run again.

Secondary water fill valves used to control the additional flushing procedures are located above the influent channels and flushing reservoirs. These valves are on the secondary water lines. There are three secondary water fill valves in each basin, two for the flushing reservoirs and one for the influent channels. The valves are 4-inch motor operated gate valves. The actuators that operate the fill valves are located on the roof of the CSO basin. The actuators are located on the southern end of the basin roof; two actuators are located at each of the east and west edges of the roof, and two actuators are located centrally.

The secondary water fill valves, or flushing valves, are difficult to reach during maintenance activities due to their location over the basin influent channel. presently, scaffolding is set up to reach the valves, and it is difficult to set up the scaffolding due to the steep slope of the basin influent channel.

Figure 2-4 shows the shows the secondary water fill header and valves in the west CSO Basin.



Figure 2-4
Secondary Water Fill Valves for the Flushing Reservoirs (Both) and the Influent Channels (Left)

2.3 Existing Oakwood CSO RTB Sump Flushing

The basins at the Oakwood CSO RTB are primarily dewatered by gravity following use during a wet weather event. Each basin is connected to the “drain to Northwest Interceptor (NWI)” pipe through a “CSO Basin Drain to NWI” control valve. The basins are drained to the NWI until the water surface reaches an elevation of 94.5 feet (elevation may have changed based on operating experience). The remaining volume in the basins is drained back to the Oakwood Pump Station by gravity. A series of valves along the drains to the NWI and the drains to the Oakwood Pump Station regulate the timing of the dewatering operation as well as the dewatering flow rates.

Presently, significant grit accumulation at the flushing sumps is an issue. Grit accumulation leads to plugging of the drain lines leading out from the sumps. Presently, the drain lines are cleared manually by jetting the drains. Frequent jetting of the drain lines is difficult due to the configuration of the pipes below the facility’s slab and the depth to the flushing sump below the adjacent finger weir. An image of one of the sumps is shown in **Figure 2-5** for reference.



Figure 2-5
Sump at Effluent Side of Oakwood CSO RTB

2.4 Oakwood Storm Wet Well Flushing System

The existing Oakwood storm wet well flushing system is configured generally the same way in both wet wells with the flushing water header mounted to the outside wall and equipped with a series of fixed nozzles. The 8-inch header is mounted at CL El 61.5 which is approximately 11-ft above the wet well floor.

This flushing system is arranged with a total of six zones:

- Sanitary flow trench (two zones): Discharge into the sanitary flow trench within the upstream junction chamber (east and west) via outlet of the flushing water pipe (no nozzles)
- Storm wet well upstream (two zones): Discharge to the upstream portion of the wet well including the expansion zone (east and west) as shown in **Figure 2-6**.
- Storm wet well downstream (two zones): Discharge to the downstream portion of the wet well (east and west) as shown in **Figure 2-6**.

The system in the Oakwood Storm Pump Wet Well is represented graphically in **Figure 2-6** as shown in PC-755 record drawing D-04-08-409.

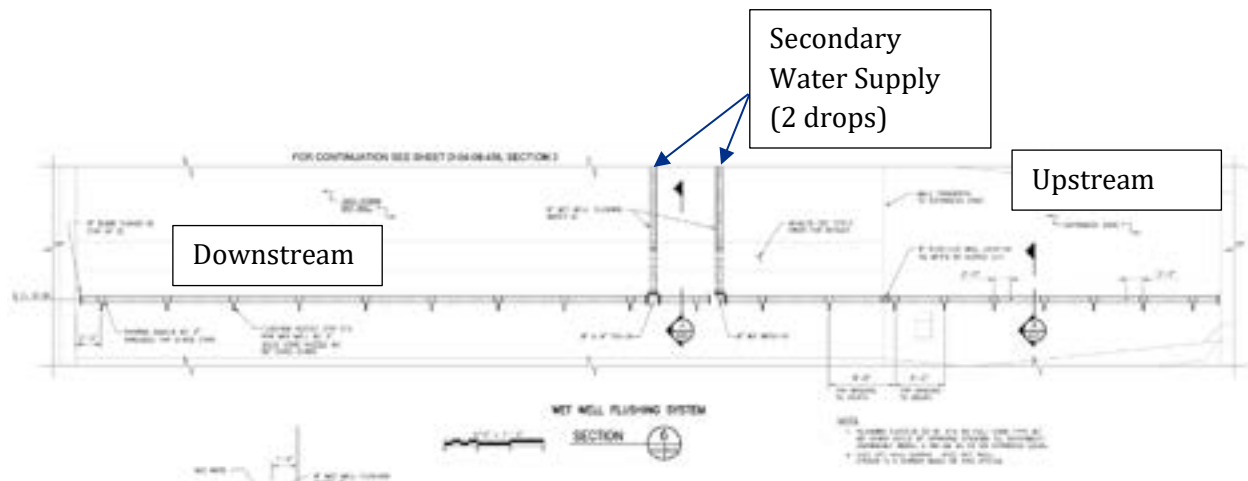


Figure 2-6
Existing Flushing System Section from PC-755 Record Drawings

Each zone is supplied by secondary water with supply on/off controlled by a motorized isolation valve. Only one zone is operated at a time to maximize the effectiveness of the system and to constrain reduction of secondary water system pressure during operation. Refer to Section 3 for the operation of the system.

Each zone of wet well/expansion zone is equipped with a series of nozzles with most directed generally down (20 degrees offset from vertically down) and two directed for horizontal discharge. Upstream zone includes 11 nozzles and the downstream zone includes 10 nozzles.

All nozzles were furnished as part the original construction and appear to be the PC-755 required product: 2-inch full-cone nozzle with 65-degree spray angle, Distribojet Model 2 RR-SS 65 45, manufactured by Spraying Systems Inc. as shown in **Figure 2-7**.



Figure 2-7
Existing Flushing System Nozzle (Oakwood Storm Wet Wells)

3.0 System Evaluation

3.1 Leib SDF Flushing System

A model of the service water system was developed in InfoWater. InfoWater is an advanced software for modeling and managing water distribution networks. This model was used to evaluate the feasibility of the Leib SDF flushing system alternatives. The model was also used to evaluate the need for a high-pressure water tank to provide the desired pressure at the flushing system nozzles. The model was developed with the assumption that the pressure delivered to the Leib SDF is 55 psi. The flushing system was modeled with a conceptual flow rate of 10 gpm through the nozzles and a conceptual minimum pressure of 10 psi at the nozzles.

The alternatives for this system are designed around an extension of the 2-inch diameter headers presently feeding water to the hose bibs in the SDF. Full cone spiral nozzles are to be placed at intervals along the new water line headers to provide complete coverage of the area for the chosen alternative. **Table 3-1** displays the theoretical spray coverage of these nozzles for a given spray angle and distance from the surface. Placement of nozzles along the header is ultimately subject to the header distance from the surface to be sprayed and the water pressure available at the nozzle.

Table 3-1 Theoretical Spray Coverage at Various Distances in Inches (cm) from Nozzle Orifice

Spray Angle	2 in.	5 cm	4 in.	10 cm	6 in.	15 cm	8 in.	20 cm	10 in.	25 cm	12 in.	30 cm	15 in.	40 cm	18 in.	50 cm	24 in.	60 cm	30 in.	70 cm	36 in.	90 cm	48 in.	100 cm
5°	.2	.4	.4	.9	.5	1.3	.7	1.8	.9	2.2	1.1	2.8	1.3	3.5	1.6	4.4	2.1	5.2	2.6	6.1	3.1	7.0	4.2	8.7
10°	.4	.9	.7	1.8	1.1	2.6	1.4	3.5	1.8	4.4	2.1	5.3	2.6	7.0	3.1	8.8	4.2	10.5	5.2	12.3	6.3	14.0	8.4	17.5
15°	.5	1.3	1.1	2.6	1.6	4.0	2.1	5.3	2.6	6.8	3.2	7.9	3.9	10.5	4.7	13.2	6.3	15.8	7.9	18.4	9.5	21.1	12.6	26.3
20°	.7	1.8	1.4	3.5	2.1	5.3	2.8	7.1	3.5	8.8	4.2	10.6	5.3	14.1	6.4	17.6	8.5	21.2	10.6	24.7	12.7	28.2	16.9	35.3
25°	.9	2.2	1.8	4.4	2.7	6.7	3.5	8.9	4.4	11.1	5.3	13.3	6.6	17.7	8.6	22.2	10.6	26.6	13.3	31.0	15.9	35.5	21.2	44.3
30°	1.1	2.7	2.1	5.4	3.2	8.0	4.3	10.7	5.4	13.4	6.4	16.1	8.1	21.4	9.7	26.8	12.8	32.2	16.1	37.5	19.3	42.9	25.7	53.6
35°	1.3	3.2	2.5	6.3	3.8	9.5	5.0	12.6	6.3	15.8	7.6	18.9	9.5	25.2	11.3	31.5	15.5	37.8	18.9	44.1	22.7	50.5	30.3	63.1
40°	1.5	3.6	2.9	7.3	4.4	10.9	5.8	14.6	7.3	18.2	8.7	21.8	10.9	29.1	13.1	36.4	17.5	43.7	21.8	51.0	26.2	58.2	34.9	72.8
45°	1.7	4.1	3.3	8.3	5.0	12.4	6.6	16.6	8.3	20.7	9.9	24.9	12.4	33.1	14.9	41.4	19.9	49.7	24.8	58.0	29.8	60.3	39.7	82.8
50°	1.9	4.7	3.7	9.3	5.6	14.0	7.5	18.7	9.3	23.3	11.2	28.0	14.0	37.3	16.8	46.6	22.4	56.0	28.0	65.3	33.8	74.6	44.8	93.3
55°	2.1	5.2	4.2	10.4	6.3	15.6	8.3	20.8	10.3	26.0	12.5	31.2	15.6	41.7	18.7	52.1	25.0	62.5	31.2	72.9	37.5	83.3	50.0	104
60°	2.3	5.8	4.6	11.6	6.9	17.3	9.2	23.1	11.5	28.9	13.8	34.6	17.3	46.2	20.6	57.7	27.7	69.3	34.6	80.8	41.6	92.4	55.4	115
65°	2.5	6.4	5.1	12.7	7.6	19.1	10.2	25.5	12.7	31.9	15.3	38.2	18.2	51.0	22.9	63.7	30.5	76.5	38.2	89.2	45.8	102	61.2	127
70°	2.8	7.0	5.6	14.0	8.4	21.0	11.2	28.0	14.0	35.0	16.8	42.0	21.0	58.0	25.2	70.0	33.6	84.0	42.0	98.0	50.4	112	67.2	140
75°	3.1	7.7	6.1	15.4	9.2	23.0	12.3	30.7	15.3	38.4	18.4	46.0	23.0	61.4	27.6	76.7	36.8	92.1	46.0	107	56.2	123	73.6	153
80°	3.4	8.4	6.7	16.8	10.1	25.2	13.4	33.6	16.8	42.0	20.2	50.4	25.2	67.1	30.3	83.9	40.3	101	50.4	118	60.4	134	80.6	168
85°	3.7	9.2	7.3	18.3	11.0	27.5	14.7	36.7	18.3	45.8	22.0	56.0	27.5	73.3	33.0	91.6	44.0	110	56.0	128	66.0	147	88.0	183
90°	4.0	10.0	8.0	20.0	12.0	30.0	16.0	40.0	20.0	50.0	24.0	60.0	30.0	80.0	36.0	100	48.0	120	60.0	140	72.0	160	96.0	200
95°	4.4	10.9	8.7	21.8	13.1	32.7	17.5	43.7	21.8	54.6	26.2	65.5	32.8	87.3	39.3	109	52.4	131	65.5	153	76.6	175	105	218
100°	4.8	11.9	9.5	23.8	14.3	35.8	19.1	47.7	23.8	59.6	28.6	71.5	35.8	95.3	43.0	119	57.2	143	71.6	167	85.9	191	114	238
110°	5.7	14.3	11.4	28.6	17.1	42.9	22.8	57.1	28.5	71.4	34.3	85.7	42.8	114	51.4	143	68.5	171	85.6	200	100	229	-	280
120°	6.9	17.3	13.9	34.6	20.8	52.0	27.7	69.3	34.6	86.6	41.6	104	52.0	138	62.4	173	83.2	208	104	243	-	-	-	-
130°	8.6	21.5	17.2	42.9	25.7	64.3	34.3	85.8	42.9	107	55.5	129	64.4	172	77.3	215	103	257	-	-	-	-	-	-
140°	10.9	27.5	21.9	55.0	32.9	82.4	43.8	110	54.8	137	65.7	165	82.2	220	98.6	275	-	-	-	-	-	-	-	-
150°	14.9	37.3	29.8	74.6	44.7	112	59.6	149	74.5	187	89.5	224	112	299	-	-	-	-	-	-	-	-	-	-
160°	22.7	56.7	45.4	113	68.0	170	90.6	227	113	284	-	-	-	-	-	-	-	-	-	-	-	-	-	-
170°	45.8	114	91.6	229	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Full cone spiral nozzles (**Figure 3-1**) spray water in a solid, cone shaped pattern and offer spray angles ranging from 60 to 170 degrees. Spiral nozzles are also designed to mitigate clogging due to debris buildup.



Figure 3-1
Full Cone Spiral Nozzle

3.2 Oakwood CSO RTB Flushing Valve Relocation

The flushing valves are difficult to reach during maintenance activities due to their location over the basin influent channel. Presently, scaffolding is set up to reach the valves, and it is difficult to set up the scaffolding due to the steep slope of the basin influent channel. To accommodate more convenient maintenance activities, the flushing valves would need to move roughly 50-ft north in the basin to move over the CSO Basin floor. This would allow scaffolding to be set up more easily, as the basin floor has a mild slope.

3.3 Oakwood CSO RTB Sump Flushing/Mixing

Grit accumulation at the flushing sumps has led to plugging of the drain lines leading out from the sumps. The design alternatives considered to resolve this issue center around the idea of introducing a form of positive agitation in the sump to resuspend and keep in suspension grit and sludge that has accumulated in the sump.

3.4 Oakwood Storm Wet Well Flushing System

The evaluation of the storm wet well flushing system focused on the use of two tools: first, modeling one quarter of the wet well system using WaterCAD software and second qualitative evaluation as part of the physical model study.

3.4.1 Evaluation of existing storm wet well flushing system hydraulic characteristics

The storm wet well flushing system hydraulic considerations were evaluated to facilitate estimation of the quantity of water required to operate the wet well portions of the system as presently configured.

WaterCAD model was built to represent the upstream portion of the wet well (one quarter of the system (11 nozzles in lieu of 10 nozzles downstream)) which was assumed to be generally representative of all four quadrants of this system with the common header configuration and slight variations between the quadrants.

Assumptions in the model included the following:

- Sanitary flow trench (two zones): Discharge into the sanitary flow trench within the upstream junction chamber (east and west) via outlet of the flushing water pipe (no nozzles) would be the first step in overall flushing procedure to reduce debris quantity in the sanitary flow trench but this was not included in the model. Assumed sanitary flow trench would be generally clear of debris given frequency of use recommended in section below.
- Distribution system pressure assumed to be between 50 psi and 70 psi (GLWA estimated 65-70 psi per SCC)
- Losses in backflow preventer (10 psi drop); flow meter (10 psi drop – likely conservative) upstream of the flushing system headers

- Nozzles modeled as “D2A” – discharge to atmosphere at a given design flow rate and head.
 - Checked and confirmed that model results were close to manufacturer’s nozzle design manual flow rate values

Hydraulic model results:

For one quarter of the wet well system (only one quarter operates at a time) in operation and distribution system pressure maximized (70 psi at elevation 96-ft in street) the total flow rate was estimated to be approximately 1,940 gpm (2.8 mgd) total with pressure immediately upstream of nozzle in range of 51-52 psi (estimated flow rate of 195 gpm/nozzle) at header CL elevation, 61-ft. This represents the maximum water usage of the system at the maximum operating pressure.

- This pressure immediately upstream of the nozzle was identified to be well above the assumed value for the original design pressure (3 psi).

Based on model results the Design Team concluded that greater loss at the nozzle would benefit the system to reduce overall water usage if cleaning functionality is not impacted.

Other observations from analysis:

The installed nozzle type distributes the spray pattern uniformly over a wide area which does not allow the energy in the flushing water system to be concentrated to effectively push the debris toward the sanitary flow trench. Therefore, an alternate spray pattern which concentrates the flushing system motive energy was evaluated as part of the physical model study.

3.4.2 Evaluation of storm wet well flushing system using physical model study

The physical model study was utilized to qualitatively evaluate the wet well flushing system performance. This was accomplished by comparing the reduced scale model performance of the system at existing mounted elevation (about 11-ft above the floor) to a significantly lower flushing system header (at approximately top of the center wall splitter which is about 4-ft above floor)).

The physical model was utilized to qualitatively evaluate the following:

- Relative performance of higher versus lower flushing water header
 - Lower flushing water header has superior performance as shown in **Figures 3-2 and 3-3** after or just before completion of flush cycle

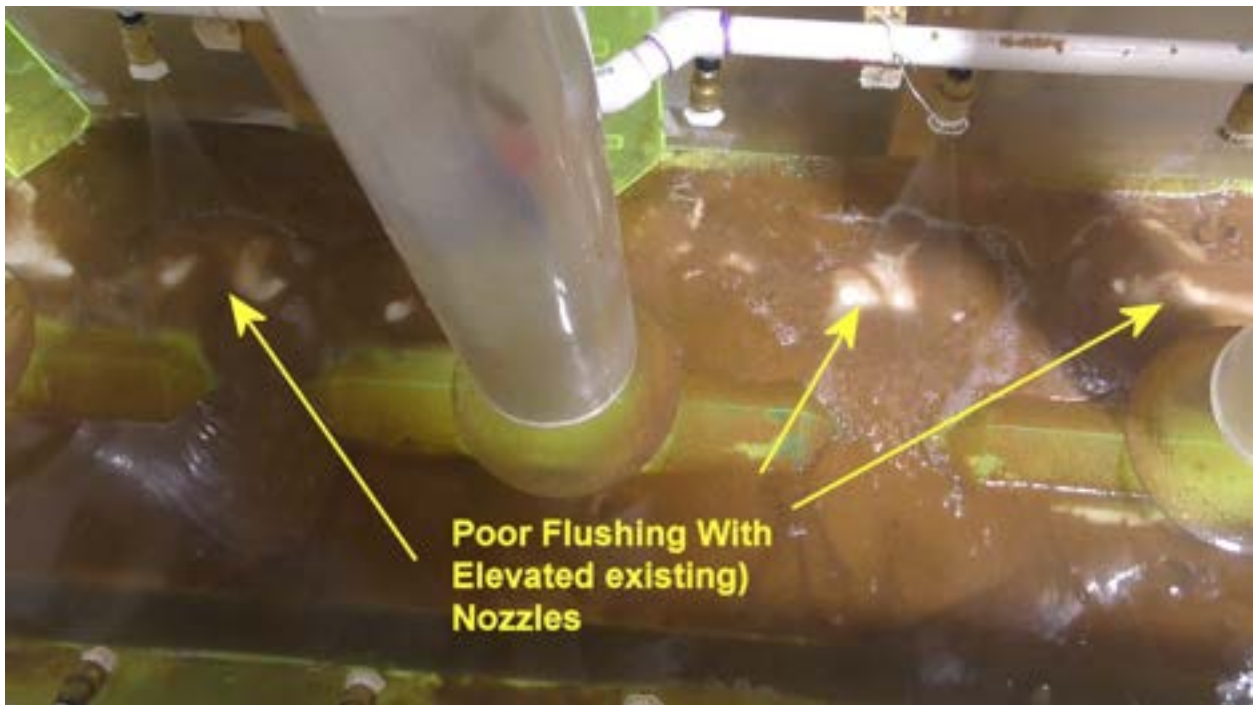


Figure 3-2
Flushing system ineffective at existing (high) mounting elevation, photo courtesy of CEH

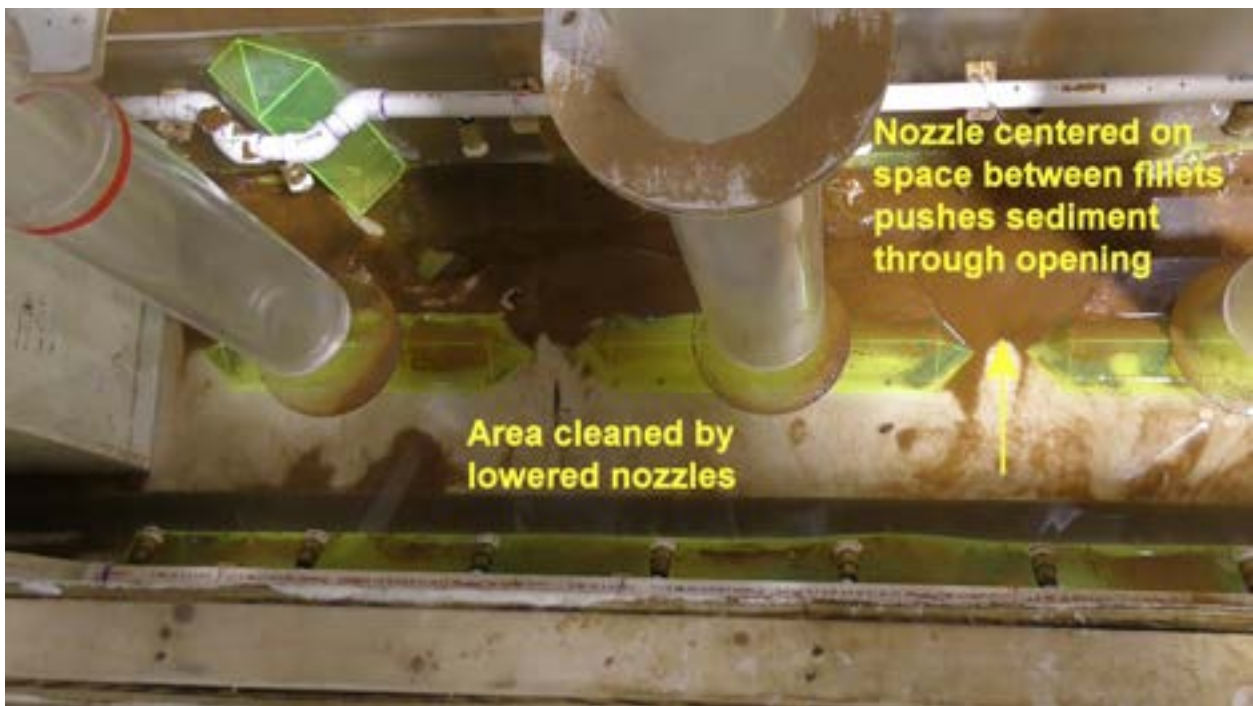


Figure 3-3
Flushing system effective at lower mounting elevation, photo courtesy of CEH

- Strategic placement of the nozzles along the header
 - Placement optimized to minimize debris remaining on wet well floor after flush cycle and convey debris to the sanitary flow trench as shown in **Figure 3-4**
 - On the side opposite the sanitary flow trench, position two nozzles along each pump spaced $\frac{1}{3}$ and $\frac{2}{3}$ of length of splitter and one nozzle centered between the splitters to push debris through the openings between splitters.
 - On the side of the sanitary flow trench, two nozzles positioned along each pump spaced $\frac{1}{3}$ and $\frac{2}{3}$ of length of floor splitter to cover area unreachable by other zone.
 - The targeted nozzle positions will be evaluated relative to the spray pattern reach.

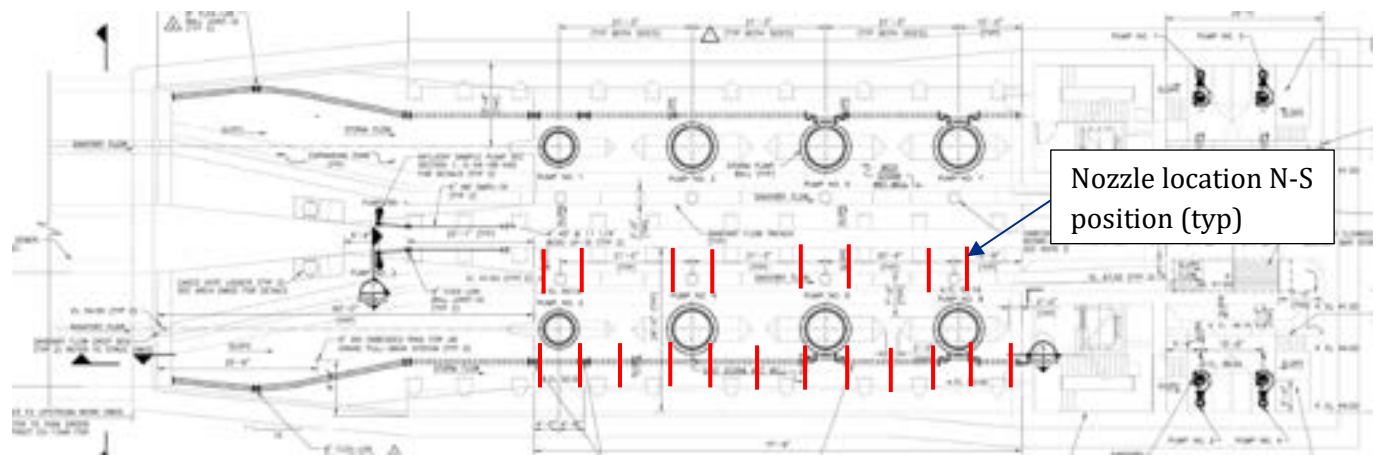


Figure 3-4

Conceptual nozzle location sketch for downstream flushing water headers in east storm wet well, similar in west wet well

- Preferred nozzle spray pattern and angle
 - Spray pattern to be flat (even) with thin rectangular profile at angle of 40-65 degrees. It may be necessary to increase spray angle above 40 degrees to establish nozzle discharge in contact at the point of impact as balance energy conveyed to the debris and reach to the debris within the constraints of the secondary water system.
- Elevation to mount the nozzles to maximize effectiveness
 - On sanitary flow trench side of the wet well, mount above sidewall fillet at elevation to allow spray pattern to contact the toe of the splitter below pump bell.

- On the opposite side, position nozzles to discharge on the top of the “short” sidewall fillet at elevation to establish the intended spray pattern and reach.
- Value of sanitary flow trench cover removal in vicinity of each storm pump bell to enhance opportunity to flush debris into the trench for conveyance downstream
 - The baseline physical model testing demonstrated that no adverse hydraulic conditions caused by the removal of the trench covers to storm pump intake conditions.
 - Benefit to provide maximum open length over which debris can be conveyed into the trench, unobstructed by the covers. In addition, removal of the covers will avoid accumulation of debris as observed in recent wet well entry on the first trench cover as shown in **Figure 3-5**.

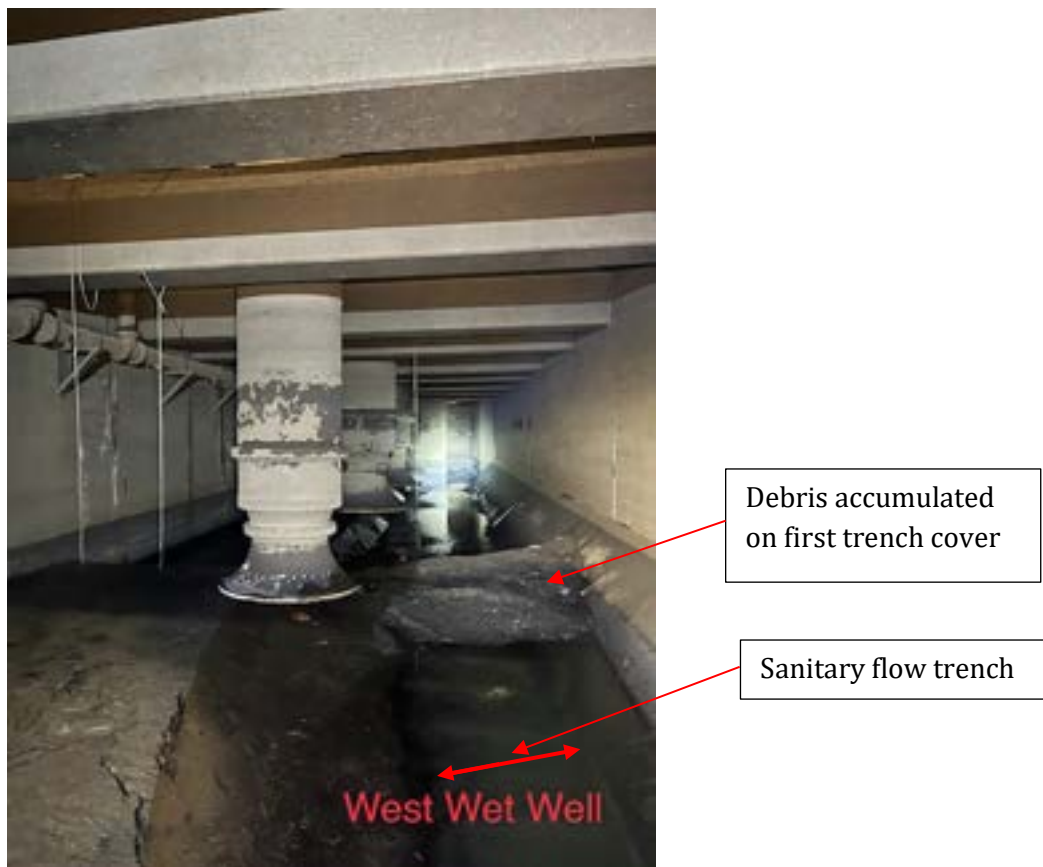


Figure 3-5

Debris accumulation on sanitary flow trench cover, photo courtesy of Pullman SST, Inc.

Model study assumptions:

- The number of nozzles will be maintained to be comparable to the existing condition in each zone to minimize the potential to increase the water demand of the system.
- One zone of the system will operate at a time with the upstream portion operating before the downstream portion for in-series cleaning within each wet well.
- Qualitative comparison with the physical size of nozzle/discharge location relative to face of wall not to scale due to limitations of commercially available nozzles.
- At reduced scale, crushed walnut shells approximate the behavior of the grit/sludge/silt which accumulates in the Oakwood wet wells.

3.4.3 Present operation considerations

The present operation of the storm wet well flushing system was evaluated through discussions with operations staff as part of our operation ride-alongs and interaction with the wet well cleaning contractor who was cleaning the wet wells at the time of this writing.

The findings of the evaluation follow:

- The flushing system is not presently utilized frequently.
- Given the “knee high” level of the debris observed in the wet well recently, as evidenced by the contractor’s photo in **Figure 3-6**, the existing system would not be effective to remove this quantity of silt/sediment/sludge (3 + years of accumulation coupled with sanitary flow backup due to sanitary influent screen debris accumulation over part of that time). The debris/sludge characteristics observed by the cleaning contractor (recent activity as part of a separate project) identified a material with high water content and fairly loose consistency which could be waded through.
- Several years ago the system was operated with some level of frequency but the loss of motor operator function on one of the four wet well flushing system isolation valves resulted in reduced level of usage.
- Mixed information received regarding the secondary water system pressure reduction when flushing system in use. One staff member noted no impact while another noted a one-time alarm from the fire suppression system for low pressure (both systems utilize the same source water but separated by backflow preventer).
- Information regarding effectiveness of cleaning if operated after each storm event was not available.



Figure 3-6
Wet Well Debris February 2023, photo courtesy Pullman SST, Inc.

3.4.4 Conceptual operating procedure after system improvements

The following conceptual operating procedure to be conducted after each wet weather event would apply after the flushing system has been optimized as part of this project (nozzle type/angle, number of nozzles, header elevation, etc.) to reduce the required frequency of manual cleaning:

- Procedure applies to east and west systems; complete one side then transition to the other side. The duration of each step will be defined in BOD phase.
- Wet well dewatered using the sanitary pumps to a water surface elevation below the invert of sanitary flow trench (El 47.0) which is 1-ft above the present normal operating level range of the sanitary pumps (El 41 – 46-ft) thus compatible to maintain no ponding water in storm wet well. This step is critical as the model study demonstrated the flushing system does not perform effectively with standing water in the wet well.
- Flushing water added to sanitary flow trench (at upstream junction chamber)
- Flush the upstream portion of wet well
- Flush the sanitary flow trench
- Flush the downstream portion of wet well on side opposite the sanitary flow trench

- Flush the sanitary flow trench
- Flush the downstream portion of wet well on side with sanitary flow trench
- Flush the sanitary flow trench
- Pump down the flushing water/debris using the sanitary pumps after/during each flushing procedure step
- Repeat for the other sanitary flow trench/wet well

4.0 Description of Alternatives

4.1 Leib SDF Flushing System

Both improvement alternatives to the Leib SDF flushing system are based on an extension of the existing header in the facility and the implementation of nozzles to spray water down into the areas with solids accumulation.

4.1.1 Screening Inlet Channel Flushing System

A proposed alternative is to install a new flushing system piped from the existing water line that presently supplies the hose reels. The new flushing system would extend lower into the facility and lie in and above the screening inlet channels where a configuration of nozzles would be located and aimed in a way to provide wash down coverage of the screening inlet channels at the upper end of the “stepped” slope in the channel. **Figure 4-1** highlights the area in the SDF to be flushed in this alternative.

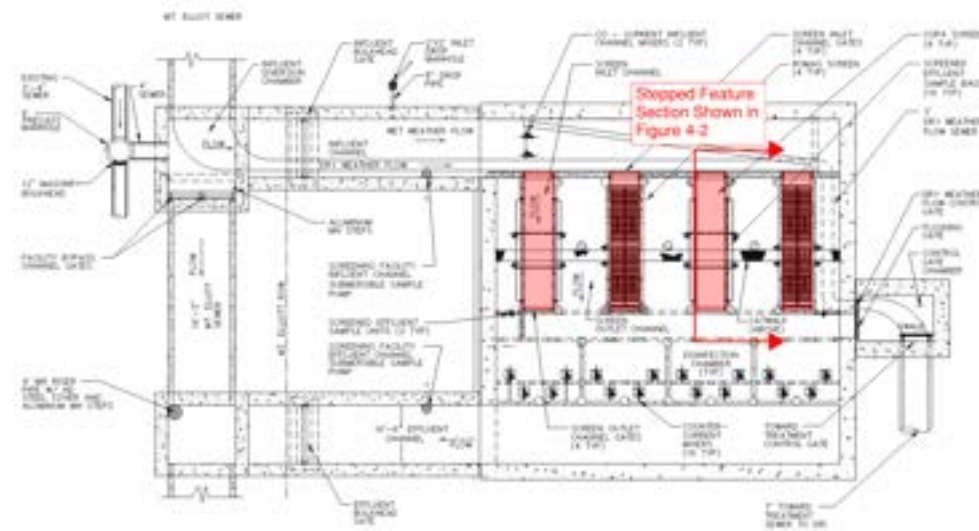


Figure 4-1
SDF Area Flushed in the Automated Flushing System Alternative

To aid further into the effectiveness of the flushing process the “stepped” feature of the sloped inlet channel can be modified to have a smooth surface. A smooth surface will improve the flushing systems ability to wash down debris to the sanitary channel. A section of the slope will need to include a stair section to allow personnel the ability to walk up the channel if needed.

To make the above improvement, the existing stairs would be modified by jackhammer or saw cutting to remove the steps, including the embedded rebars, down to a sloped surface with a surface roughness of approximately CSP7. The contractor would then scarify the surface to the roughness required for the repair mortar to bond. Once the contractor has prepped the surface, new concrete repair mortar will be applied in approximately a 2-inch-thick layer. At the bottom of the ramp a groove would be chipped out to avoid a feather edge at the low point of the ramp. The repair mortar would be troweled smooth to match the desired slope. **Figure 4-2** shows a cross section of the proposed work.

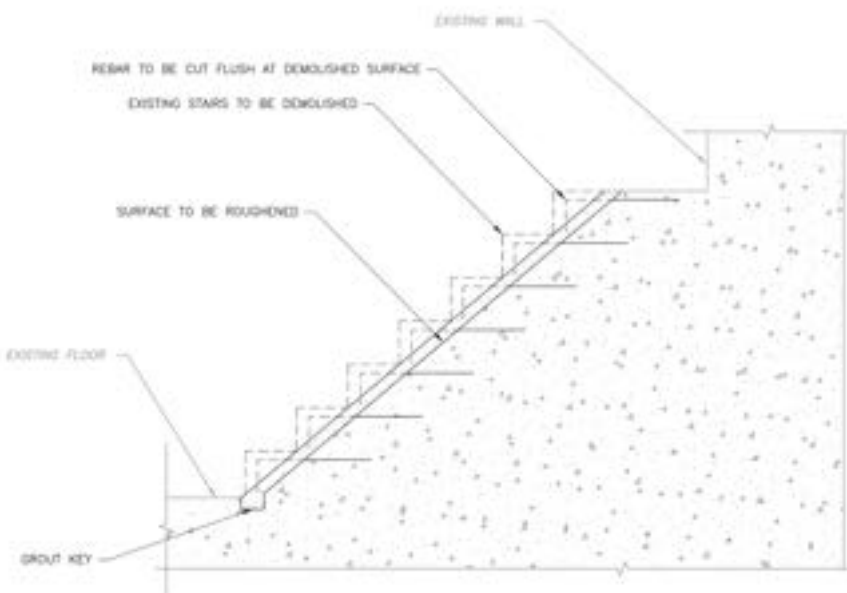


Figure 4-2
Proposed Modifications to the Stepped Feature in the Sloped Inlet Channel

4.1.2 Expanded Flushing System

A second proposed alternative is to expand upon the system described in Section 4.1.1. The same flushing system would be in place over the screening inlet channels. This alternative would expand the flushing system to provide coverage of the influent channel and dry-weather flow trench, the screening outlet channels, and the screening collection channel. This alternative provides an automated flushing system for all areas of the facility that are regularly washed down following storm events. **Figure 4-3** highlights the area in the SDF to be flushed in this alternative.

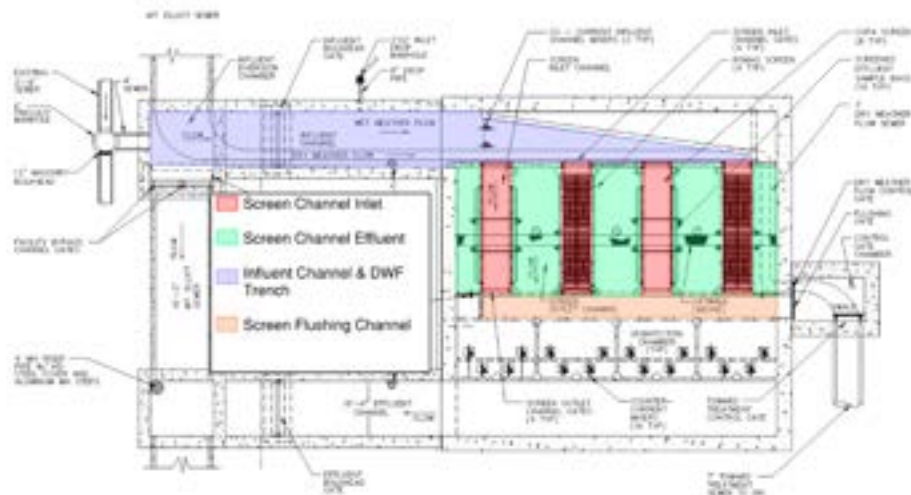


Figure 4-3
SDF Area Flushed in the Expanded Automated Flushing System Alternative

4.2 Oakwood CSO RTB Flushing Valve Relocation

4.2.1 Relocation of Flushing Valves and Header

A proposed alternative is to relocate the flushing valves and associated actuators to an area downstream of the flushing gates. The recommended relocation of the valves is over the CSO basin floor, which has a mild slope and should not pose issues when setting up scaffolding. Relocation of the valves in the CSO Basin would also require relocation of their respective actuators on the roof of the CSO Basin. This alternative would also require demolition of the existing pipes and installation of new pipes to accommodate the valve relocation. **Figure 4-4** shows a marked-up image of this alternative concept. **Figures 4-5** and **4-6** roughly show the proposed area for the relocation of the valve actuators.

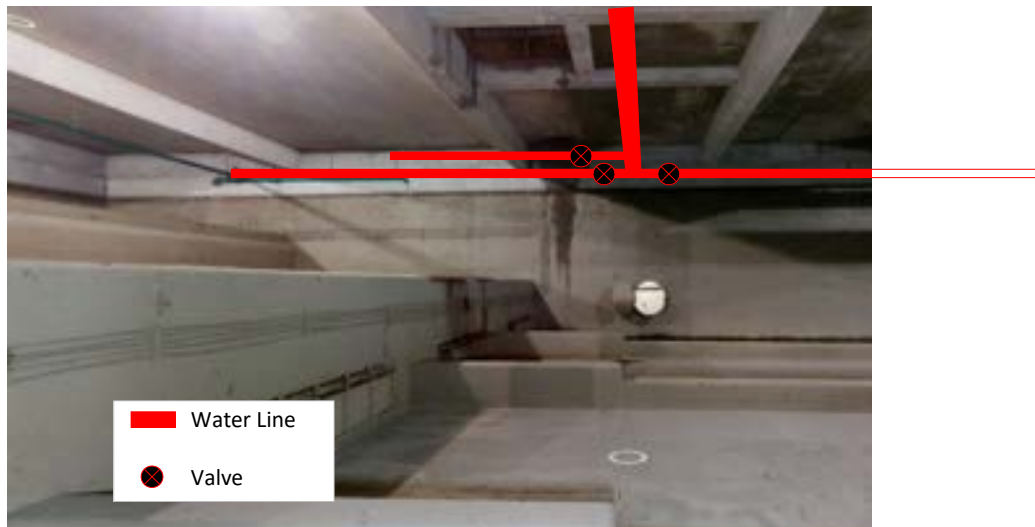


Figure 4-4
Image Markup Showing New Water Line Route and Valves over CSO Basin Floor



Figure 4-5
Image Markup Showing Rough Area of Valve Actuator Relocation (Red Indicates Existing and Green Indicates Proposed)

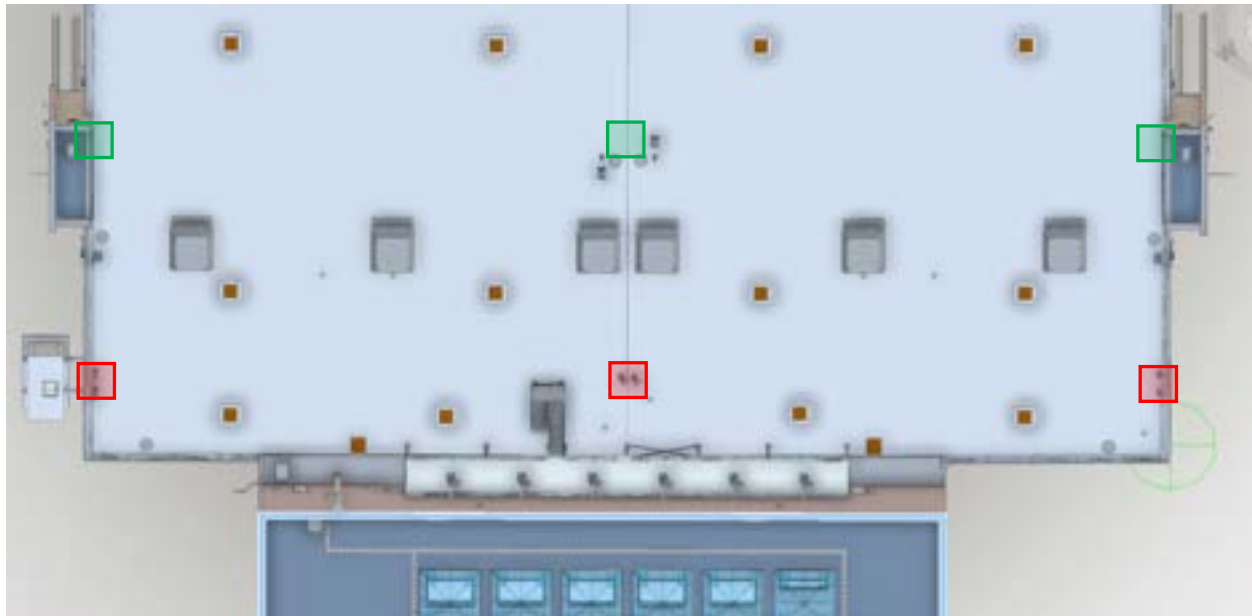


Figure 4-6
Aerial Markup Showing Rough Area of Valve Actuator Relocation (Red Indicates Existing and Green Indicates Proposed)

4.2.2 Relocation of Flushing Valves and Header, and Flushing Header Extension to Basin Sumps

This proposed alternative is an extension of the previous alternative and contains the same design elements as before. In addition to those proposed changes, this alternative would extend the flushing line towards the sump in both basins. The flushing line would conclude at a header located in the sump. The purpose of the header would be to spray flushing water on the sides of the sump walls to work in tandem with the alternatives presented in Section 4.3 to reduce grit accumulation in the sump. This header would also provide clear water volume to the collection of debris and sludge being flushed from the channels. The header in the sump would operate during the CSO Basin flushing process.

This extension of the flushing line to the basin sumps would also require the addition of two new actuators on the roof of the building to facilitate the control of the flushing water added to the sumps. **Figure 4-7** shows the general location of where these new actuators would need to be placed on the CSO Basin roof to sit atop the basin sumps.

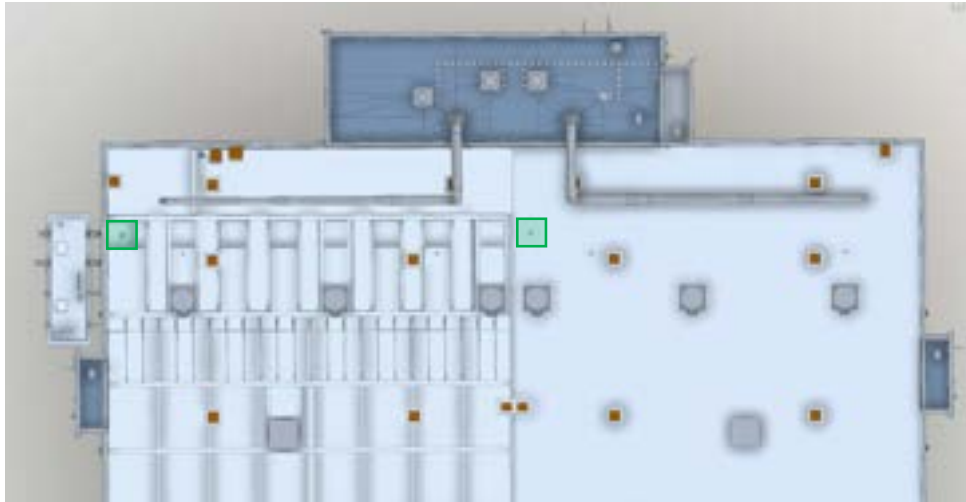


Figure 4-7
Aerial Markup Showing Area of Proposed Sump Pump Hatch Location

4.3 Oakwood CSO RTB Sump Flushing/Mixing

The following alternatives to reduce grit accumulation in the CSO basin sumps will be located in the 8-ft x 8-ft sumps themselves.

4.3.1 Submersible Solids Handling Pumps with Nozzles System

An alternative to mitigate the CSO basin sump pipe clogging issues include installing submersible solids handling pumps at each sump to recirculate effluent near the sump drains and resuspend accumulated materials. A 4-inch ductile iron pump discharge manifold mounted around the sump with two or three nozzles pointed toward the sump opening would support particulate resuspension while the basin is use.

As the facility comes into operation, the pumps would start operating and continue operation for the duration of the event and as the facility is drained. By preventing a large accumulation of grit at the sump, the draining process can more effectively dewater the facility and gradually remove settled materials. Pumps would be rail-mounted and removable to the surface through new hatched openings in the top of the structure.

A submersible solids handling pump will have estimated electrical demands of 5 HP, 480 Volts, 60 Hz, and 3-phase.

Figure 4-8 shows a plan view of the submersible solids handling pump alternative in the CSO Basin sump.

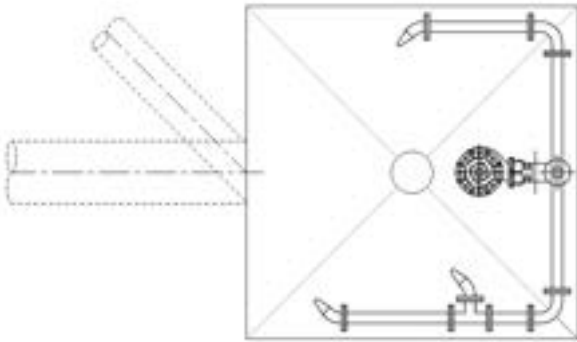


Figure 4-8
Plan View of the Submersible Solids Handling Pump with Nozzles System in the Basin Sump

4.3.2 Conditioning Sump Pumps with Direct Nozzle

Another alternative to mitigate the pipe clogging includes installing submersible conditioning sump pumps at each sump to recirculate effluent near the sump drains. The conditioning pumps would chop and mix accumulated materials to prevent clumping and clogging of grit in the sump drainpipes.

As the facility comes into operation, the pumps would start operating and continue operation for the duration of the event and as the facility is drained. By preventing a large accumulation of grit at the sump, the draining process can more effectively dewater the facility and gradually remove settled materials.

A conditioning sump pump will have estimated electrical demands of 15 HP, 480 Volts, 60 Hz, and 3-phase. **Figure 4-9** shows a plan view of the conditioning sump pump alternative in the CSO Basin sump.

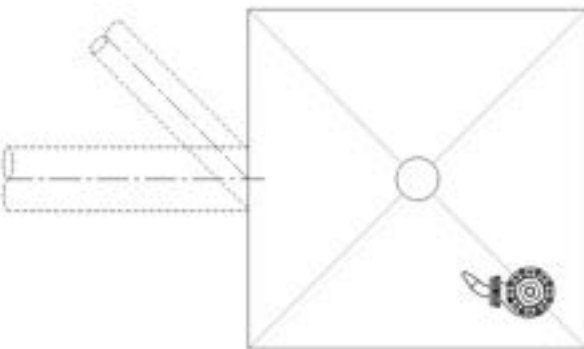


Figure 4-9
Plan View of the Conditioning Sump Pump with Direct Nozzle System in the Basin Sump

4.3.3 Air Induction Units to Generate Particle Suspension

A third alternative evaluated is an air induction unit (commercial brand Wet Well Wizard™). The air induction unit is a wet well aeration system with no moving parts and utilizes no electricity underwater. This technology consists of a set of antipodal bubble cleaving disks inside a confined tube that cuts and shapes large air bubbles into high speed, spinning “FOG cutters.” The ejection of a continuous flow of cleaved spinning bubbles into the wet well water breaks up and liquefies FOG and other viscous semi-solids. The only maintenance required is cleaning an air filter occasionally.

The manufacturer claims that the device will not become clogged with floating well debris. The air source is an industrial grade regenerative blower.

The air induction unit would operate as the CSO basin fills and dewateres. During these times, air would be continuously pumped into the bottom of the sump to mix up the screened wastewater and prevent solids from settling out.

An air induction unit will have estimated electrical demands of 3 HP, 480 Volts, 60 Hz, and 3-phase.

Figure 4-10 shows a plan view of the air induction units alternative in the CSO Basin sump.

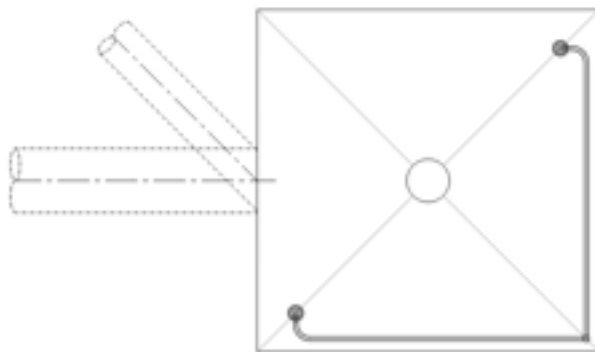


Figure 4-10
Plan View of the Air Induction Unit System in the Basin Sump

4.3.4 Gravity Line Clean Out

Common to all alternatives is the addition of clean out access lines on each gravity pipeline. The cleanouts will be located outside of the basin. These clean out lines will be accessed to snake the lines back toward the sump. Access to the cleanouts will be below the basin hydraulic grade line during wet weather events, therefore the connections need to be flanged for secure isolation from the hydraulic pressure within the basin. This service access provides a more accessible location, safer connection point, and is non-disruptive to the existing basin facility.

There are two options for locating the clean outs. The first option is to locate the clean outs within the valve chambers. The second option is to locate the clean outs between the valve chamber and the CSO Basin where a new connection can be added to the gravity line and brought to grade.

4.3.5 Flushing Header Extension to Basin Sumps

This section is redundant of Section 4.2.2, and a more detailed description of it can be found there.

This alternative would extend the flushing line towards the sump in both basins. The flushing line would conclude at a header located in the sump. The purpose of the header would be to spray flushing water on the sides of the sump walls to work in tandem with the alternatives presented earlier in this section to reduce grit accumulation in the sump. This header would also provide clear water volume to the collection of debris and sludge being flushed from the channels. The header in the sump would operate during the CSO Basin flushing process.

4.4 Oakwood Storm Wet Well Flushing System

Not used.

4.5 Alternatives Evaluation Criteria

Each recommendation reviewed in the alternatives were evaluated on the following criteria based on the GLWA CSO Improvement Project Guiding Principles.

- Increase operational flexibility for GLWA staff.
- Decrease amount of time require by staff for manual wash down and debris removal.
- Improve staff safety by reducing frequency of entrance to facility basins and SDF areas.
- Provide better access to equipment for maintenance.

5.0 Alternatives Analysis

5.1 Leib SDF Flushing System

5.1.1 Screening inlet Channel Flushing System

This alternative would address the issue of solids accumulation within the screening inlet channels. It would assist the Leib SDF operator in routine cleaning of the facility after storm events where the screens see use and cut down on time needed to manually clean the facility. Spray down from the catwalk areas will still be needed but the main area of the screening inlet will have the flushing system available through a valved piping connection.

Providing a flushing system for the screening inlet channels may prove to be difficult in providing complete coverage for both existing screen types and a proposed third screen type. However, this challenge is not unique to this alternative.

5.1.2 Expanded Flushing System

This alternative would provide the same services as the previous alternative but on a larger scale. This alternative would further reduce the time needed to manually clean the facility after screening and disinfection events by providing flushing water for even more areas of the facility.

Some of the areas, especially the screen faces and other remote sections of the facility, would require an extensive and complicated arrangement. The extended system would not eliminate the needs for manual spray down from the catwalk access as is done now.

This also would encounter the same challenge of designing a flushing system that provides complete coverage for each unique chamber given the different types of screens. This alternative would have a much more involved design than the previous alternative.

5.2 Oakwood CSO RTB Flushing Valve Relocation

5.2.1 Relocation of Flushing Valves and Header

Relocating the flushing valves and header to a point over the CSO Basin floor would accomplish the objective of providing easier access to the valves using scaffolding for maintenance purposes.

The downside to this alternative is the need to demolish and install new pipe headers to relocate the flushing valves as well as relocate the valve actuators on the roof of the basin.

5.2.2 Relocation of Flushing Valves and Header, and Flushing Header Extension to Basin Sumps

As this alternative is just an expansion of the previous alternative, it has the same advantages and disadvantages. This alternative, however, would also have the added benefit of providing more water to the sumps to wash clear solids out of the basin during the basin flushing process.

This alternative also presents the concern of adding additional equipment in the basin sumps. This has the negative effect of adding more surfaces for solids and grit to accumulate on, as well as potential equipment failure due to clogging of flushing water nozzles.

5.3 Oakwood CSO RTB Sump Flushing/Mixing

5.3.1 Submersible Solids Handling Pumps with Nozzles System

The submersible solids handling pump with nozzles has an advantage of being a known commodity for applications similar to the CSO basin sumps where the resuspension of solids in water is needed. A pump alternative would also allow the flexibility of the Design Team to select a pump sized to provide adequate pressure and disturbance in the sump. A submersible solids handling pump could also be rail mounted to provide easy removal for maintenance purposes.

The submersible pump has the disadvantage of requiring a significant amount of equipment in the sump on which solids can collect. This alternative introduces mechanical equipment into the sump which may lead to increased maintenance activities to sustain performance of the pump and nozzle system. The nozzles added for recirculation of the wastewater are also at risk of clogging due to the buildup of solids in the basin and sump during the flushing process.

5.3.2 Conditioning Sump Pumps with Direct Nozzle

The conditioning sump pump alternative also has the advantage of being a known commodity for this type of application, being specifically manufactured to break up and suspend solids. This would also afford the Design Team the flexibility to select a pump sized to provide adequate pressure and

disturbance in the sump. This alternative would not require a header and nozzle system and would be less intrusive in the sump compared to the submersible solids handling pump alternative.

Still, this alternative would contain mechanical equipment in the sump on which solids can collect and which may need increased maintenance activities in the basin to sustain pump performance. The conditioning sump pump would likely also require the greatest electrical load of all the presented alternatives.

5.3.3 Air Induction Units to Generate Particle Suspension

The air induction unit has the advantage of being both the cheapest alternative and the alternative requiring the lowest electrical load. This alternative is also the least intrusive in the sump and contains no mechanical equipment in the sump itself.

The air induction unit has the disadvantage of its effectiveness not being proven for this type of application as it mostly used to break up FOG in wet wells. This alternative also requires space for a blower, likely on the roof of the CSO basin. The blower for the system produces sound levels at 68 to 76 decibels. Prolonged noise at this level could result in noise complaints from residents in the Oakwood neighborhood if a means to control the sound is not implemented.

5.3.4 Gravity Line Clean Out

The addition of the gravity line clean outs is expected to improve upon the present maintenance activities required to wash out the gravity drain lines. This method of cleaning out the gravity lines is intended to be more efficient and effective than the present method of entering the CSO Basin and jetting the drain lines from the sump.

As previously mentioned, the access to the cleanouts will be below the basin hydraulic grade line during wet weather events. This raises concern of effluent spilling out of the clean outs should they open before the basin is dewatered. To mitigate this concern, the clean out connections will need to be flanged for secure isolation from the hydraulic pressure within the basin.

5.3.5 Flushing Header Extension to Basin Sumps

The inclusion of this alternative would increase the efficacy of the alternatives presented in Sections 5.3.1 through 5.3.3 if used in tandem. The addition of flushing water in the sumps themselves would assist in the previous alternatives abilities to keep grit in suspension. The additional water volume would also help in diluting the amount of sludge and debris flushed from the basin channels.

This alternative does have the drawback of implementing even more equipment in the sump for debris to catch on. This addition could also lead to an increase in the frequency or duration of maintenance needed in the sumps. Still, the benefits of this alternative are expected to outweigh the detriments.

5.4 Oakwood Storm Wet Well Flushing System

Not used.

6.0 Life Cycle Cost Analysis (for alternatives analysis - applies to most equipment systems)

The Life Cycle Cost Analysis (LCCA) was prepared for the new Oakwood CSO RTB sump flushing equipment alternatives. The analysis is for a 20-year period starting from the estimated end of project construction.

6.1 Approach

The LCCA provides comparative cost estimates intended to represent order-of-magnitude estimates for equipment capital, and operation and maintenance (O&M) costs. It is intended for planning purposes and comparing alternatives and does not serve as an opinion of probable construction cost (OPCC). The costs developed for this project phase are based on general requirements of each alternative. The alternatives that were not eliminated from further consideration based on technical feasibility to meet project goals and where there are at least two remaining viable alternatives, are included in the LCCA.

For the sump flushing equipment alternatives, this includes a comparison between the:

- Submersible Solids Handling Pumps with Nozzles System (Alternative 1)
- Conditioning Sump Pumps with Direct Nozzle (Alternative 2)
- Air Induction Units to Generate Particle Suspension (Alternative 3)

Escalation rates are applied to move present costs into the future to the time when the purchase, energy use, or maintenance will occur. Then a discount rate is applied to move those future costs back to the present and provide the net present value (NPV) of each alternative. The individual escalation rates are discussed in the following sections. The discount rate applied is 4%.

6.2 Initial Purchase and Installation

Initial purchase costs are based on budgetary costs estimates for the sump flushing equipment. The costs include the sump flushing equipment, structural and hatch modifications, piping and nozzles, and electrical panels.

Supporting component purchase costs were estimated as approximate percentage of primary equipment cost. For the sump flushing equipment these estimates included 15% for miscellaneous electrical and 5% for instrumentation and control.

Installation and labor were estimated as 30% of the equipment purchased. Commissioning costs were omitted from this analysis as they would be similar for each alternative.

Contractor costs, including general conditions, permits, insurance, bonds, overhead and profit, and 30% contingency were added to the purchase, installation, and commissioning costs as an overall percentage of 75%.

The total installation and commissioning costs were escalated from February 2023 to the approximate mid-point of construction, estimated to be May 2027, based on the project schedule at the time of the analysis. The escalation rate utilized is 6% annually.

6.3 Operation, Energy, and Maintenance

Operation and energy costs for all three alternatives were based on the duration of operation of the sump flushing equipment on a yearly basis. The operation duration of the sump flushing equipment alternatives for each year was calculated based on an estimation of the number of events in which the RTB fills over the course of a year. A detailed analysis of this estimation can be found in Section 3.1 of TM-4 Oakwood Screw Conveyor & Grinder System Modifications (OKW-SCR-2). This analysis estimates about 36 events per year. The Design Team assumed an average 30-hour runtime for the sump flushing equipment per event (6 hours for the storm event and 24 hours to dewater the basin). This totals to a sump flushing equipment runtime of 1080 hours for all three alternatives over the course of a year. The nominal horsepower (HP) of each alternative converted to kilowatts (kW) and the yearly runtime were used to calculate the energy usage costs for each alternative. The two submersible solids handling pumps are rated at 5 HP each. The two conditioning pumps are rated at 15 HP each. The four air induction units are rated at 3 HP each.

The cost of electricity was assumed to be \$0.1316 per kWh at the Oakwood CSO RTB, based on GLWA power bills. An annual escalation rate of 2.7% was applied to the energy cost rate.

Maintenance costs for all three alternatives were based on an estimation of the regularity and duration of service needed for the sump flushing equipment. For all alternatives, manual cleaning of the equipment in the sump was assumed to occur quarterly and removal of the equipment from the sump was assumed to occur yearly. For the submersible solids handling pumps with nozzles system alternative, manual cleaning in both sumps was assumed to take 4 hours and equipment removal from both sumps was assumed to take 8 hours. For the conditioning sump pumps with direct nozzles and air induction unit alternatives, manual cleaning in both sumps was assumed to take 4 hours and equipment removal from both sumps was assumed to take 16 hours.

An average labor rate of \$140/hour (including benefits) was utilized. Maintenance costs were escalated 3.5% from present (2023) to the year when performed.

6.4 Decommissioning/Salvage

The salvage value was estimated as 10% of the original equipment purchase cost (before sales tax), and then escalated to the end of the 20-year analysis period using a 3.5% annual escalation rate (consistent with the maintenance escalation rate). Salvage value is shown as a negative value in the LCCA because it is an income as compared to the other values included in the analysis, which are costs.

6.5 LCCA Results

Table 6-1 provides a summary of the LCCA for the Oakwood CSO RTB sump flushing alternatives. All values in the table are rounded to the nearest \$5,000.

This analysis shows a similar 20-year NPV for Alternatives 1 and 2. Alternative 3 has a comparatively lower 20-year NPV given the lower equipment cost and electrical cost with smaller HP motor.

Table 6-1 LCCA Summary for Oakwood CSO RTB Flushing Alternatives

Alternative	Capital Costs (Year 2027)			20-Year NPV of Capital Costs	O&M Cost Breakdown (20-Year Present Values)		20-Year NPV of O&M Costs	Salvage Value (NPV)	20-Year NPV
	Initial Capital Cost	Installation, Commissioning & Startup	Total Construction Cost		Electricity	Maintenance			
Alternative 1 Submersible Sump Pump	\$165,000	\$215,000	\$380,000	\$330,000	\$20,000	\$60,000	\$80,000	\$5,000	\$405,000
Alternative 2 Conditioning Pump	\$140,000	\$185,000	\$325,000	\$280,000	\$55,000	\$85,000	\$135,000	\$5,000	\$410,000
Alternative 3 Air Induction Unit	\$105,000	\$145,000	\$250,000	\$215,000	\$20,000	\$85,000	\$105,000	\$5,000	\$315,000

7.0 Summary, Recommendations and Key Decisions

7.1 Leib SDF Flushing System

The recommended alternative for the Leib SDF flushing system is to provide a flushing header and nozzle system that provides flushing coverage for the screening inlet channels and the screening collection channel. This recommendation calls for a slight extension of the originally proposed header system into the screening collection channel. The flushing system would add flushing water to the upstream end of the screening collection channel to assist in passing solids down into the Toward Treatment Sewer system.

It is believed that this adaptation of the alternatives will provide needed help to the washdown process for both the screening inlet channels and the screening collection channel without expanding the system for outside of the original scope of design.

7.2 Oakwood CSO RTB Flushing Valve Relocation

The Design Team's recommended alternative for the Oakwood CSO RTB flushing valve relocation is the alternative which relocates the flushing valves over the CSO basin floor and extends the flushing line towards the sumps for use in assisting the resuspension of grit in the sump.

Relocating the existing flushing valves over the floor of the CSO basin will solve the present issue of maintenance crews having difficulty accessing the flushing valves. The extension of the flushing line to the sumps of both CSO basins will aid in the effort to improve the removal of solids in the basin when flushed into the sump.

7.3 Oakwood CSO RTB Flushing/Mixing System

The recommended alternative for the Oakwood CSO RTB flushing system is the conditioning sump pump with direct nozzle. This alternative is recommended as it is a known solution for this kind of application, and the Design Team believes it will deliver the best performance of all the alternatives. With the addition of the flushing water supply and spray down the alternative becomes even more effective. The conditioning sump pump with a direct nozzle will provide improvements to the sump in three ways.

- The pump suction will lift settled solids from the floor of the sump.
- The conditioning pump will chop and break up clumped solids.
- The direct nozzle will maintain water circulation in the sump to keep solids in suspension.

The combination of the conditioning sump pump with direct nozzle and the flushing water supply and spray down is conceptualized in **Figure 7-1**.

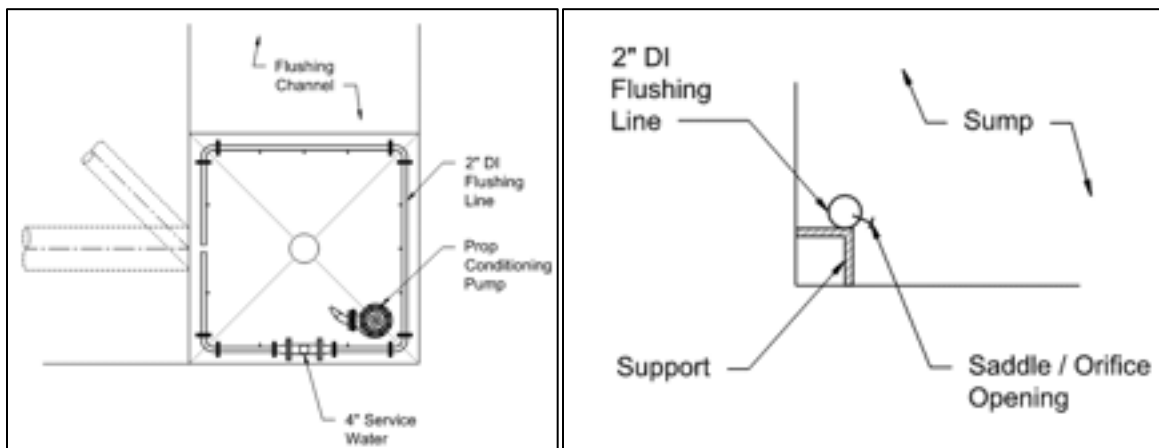


Figure 7-1
Plan View and Section View of the Combined Conditioning Sump Pump and Flushing Water Supply in the Basin Sump

The recommendation of adding accessible cleanouts outside of the basin will allow staff to access the most likely areas of plugs without having to enter the basin.

7.4 Oakwood Storm Wet Well Flushing System

The evaluation of the storm wet well flushing system demonstrated that improvements are required to maximize system effectiveness while utilizing a reasonable quantity of secondary water (not negatively impact other demands on the system).

Improvements developed based upon the physical model study qualitative evaluation.

Recommended improvements include the following:

- Operate in accordance with conceptual operating procedure above after each wet weather event
- Avoid back-up of sanitary wastewater above top of sanitary flow trench (between wet weather events due to high losses across the sanitary screen or other factors). At time of this writing, the lowest section of one screen had been removed and GLWA was considering making the same modification to the other screen when conditions allow.
- Lower existing downstream header (located beside storm pumps) and direct discharge on top of the “short” sidewall fillet at elevation high enough to establish spray pattern and minimize gap between adjoining nozzle discharges.
- In vicinity of storm pumps, add header on sanitary flow trench side of wet well. Mount above sidewall fillet, spray pattern to contact the toe of the splitter below each pump bell. Provide new isolation valve near other isolation valves on intermediate level dedicated to new header to facilitate automated or manual control from Ovation workstation.
- Lower existing upstream header to elevation set to achieve intended spray pattern above top of expansion zone sloped concrete floor slab at upstream end of system where nozzles will be closest to floor slab.
- Replace all nozzles with units providing 40–65-degree spray angle with a flat (even) spray pattern.
- Maintain approximately the same number of nozzles in each zone of the flushing system to provide similar demand on the secondary water system as compared to existing wet well zones, unless selected per nozzle flow rate allows greater number.
- Remove all sanitary flow trench covers in storm wet well to maximize trench length over which debris can be conveyed into trench and avoid debris accumulation on covers.

7.5 Key Decisions

Key decisions made during the course of review and presentation of this Technical Memorandum are as follows:

7.5.1 Leib SDF Flushing System

- GLWA confirmed the inclusion of the flushing system for the screening inlet channels and the screening collection channel.

7.5.2 Oakwood CSO RTB Flushing Valve Relocation

- GLWA confirmed relocation of flushing valves. Also confirmed extension of flushing water header to the RTB sumps.

7.5.3 Oakwood CSO RTB Flushing/Mixing System

- GLWA confirmed the implementation of the sump conditioning pump and flushing water manifold in the RTB sumps.

7.5.4 Oakwood Storm Wet Well Flushing System

- Do not add header on "back side" of splitters (sanitary trench side of the wet well).
- Lower the storm wet well flushing water header.
- Remove sanitary flow trench covers.
- Automation of flushing sequence approved and can storm wet well can be flushed after each event using the improved system/sequence.
- Do not need to maintain same water usage. Water use can be at the level needed to provide the flushing as evaluated by the Design Team.

8.0 Next Steps

The items which require advancement/further development as the design process advances includes the following.

8.1 Leib SDF Flushing System

- Select nozzle with appropriate flow and pressure characteristics for the selected area to be washed down.
- Configuration of the header location and nozzle sizing for the screening inlet channel selected for a future screen alternative will need to be developed and modified as the design progresses.
- Develop a safe method to access the proposed concrete ramp within the screening inlet channels.
- Field confirm the condition of the existing flushing water line to determine if suitable for continued use and modifications.

8.2 Oakwood CSO RTB Flushing Valve Relocation

- Development of an operational sequence for the additional flushing water added to the CSO Basin sumps. Ensure that the flushing sequence is compatible with the drain capacity and conditioning pump operations.

8.3 Oakwood CSO RTB Flushing/Mixing System

- For the recommended conditioning pump alternative, final pump size and flow rate is to be determined to provide sufficient agitation in sumps.
- Obtain life cycle cost information for sump agitation alternatives.
- Discuss with GLWA staff about prior experience with spray nozzles at other facilities, and obtain their input for the flushing water manifold at the RTB sumps.

8.4 Oakwood Storm Wet Well Flushing System

- Select nozzle with greater headloss to aid in managing quantity of water utilized for each flush cycle equipped to provide 40-65-degree spray angle, flat (even) spray pattern from the physical model study findings. This will balance water usage for this intermittent activity with projected flushing system effectiveness. Spray angle to be evaluated relative to achieving balance between energy applied to debris and reach of spray along the floor with secondary water supply limitation.
- Utilize hydraulic model to confirm water usage of improved system does not exceed usage of existing system to minimize impact to other demands on the secondary water system.
- Develop wet well flushing system design concept patterned after the optimal configuration as determined by the physical model study.
- Develop estimated duration of each flushing cycle step for inclusion in the flushing procedure as further detailed in the next phase.
- Determine how to accommodate a third header in wet well equipped with motorized isolation valve located on intermediate level.
- Consider if check valve suitable for dirty water applications should be located between header and each nozzle to minimize contents within the wet well entering the flushing water header.

2.6 Disinfection, TM-17, TM-18, TM-19, and TM-20

Oakwood RTB and Leib SDF

- Sample pumps
- TRC analyzers
- Replacement of Sodium Hypochlorite FRP storage tanks
- Replace all metering pumps with recirculation pumps, common discharge header and motorized flow control valves
- Replace chemical feed/transfer piping
- Temporary chemical feed system during construction
- Chemical mixer enclosures replacement



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Mohamad Baydoun, CDM Smith
Brian Hilts, CDM Smith
Ali Khraizat, CDM Smith*

Date: June 1, 2023

*Subject: TM-17 Influent WQ Sampling Program
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

The water quality sampling program includes reconnaissance of the Combined Sewer Overflow (CSO) system at the Oakwood CSO Retention Treatment Basin (RTB) and Pump Station, and at the Leib CSO Screening and Disinfection Facility (SDF), selection of the sampling locations, flow monitoring, wet weather sampling (two events per location), and samples handling and shipping for testing. Data collected during the field sampling program were used to define the Chlorine Dose-Response Strategy to improve the disinfection system in both facilities.

Chlorine demand, chlorine decay, and bacteria inactivation kinetics directly correlate to water quality. Understanding the influent water quality and how it changes over time is key to determining the integrated contact time (ICT) value that will be necessary to achieve bacteria permit limits.

CDM Smith successfully collected samples at Oakwood and Leib at different channel levels and flowrates during the wet weather events to collect representative samples.

1.0 Introduction and Purpose

Our approach to define the Chlorine Dose-Response Strategy begins with the collection of undisinfected influent samples during overflow events and performing chlorine dose response testing at CDM Smith's Research and Testing Laboratory in Bellevue, Washington (BLV RTL). The purpose of the water quality sampling plan is to define requirements for collection and containment of Influent CSO samples.

2.0 CSO Facilities Background

The Great Lakes Water Authority (GLWA) operates and maintains eight CSO facilities consisting of RTBs and SDFs. All the CSO facilities have screening capabilities upstream of their respective

retention or treatment basins consisting of either bar screens or perforated-plate screens. Disinfection at each CSO facility is primarily accomplished by adding sodium hypochlorite (NaOCl) to the CSO flow, typically near the headworks. Flow enters these facilities by gravity, except for the Oakwood CSO facility which receives flow through a series of eight storm flow pumps.

2.1 Oakwood Facility (12220 Pleasant St, Detroit, MI 48217)

The facility receives flow through the combined sewer collection system piping and conduits that convey combined wastewater into Junction Chamber No. 1, which is just upstream from the pumping station. Once all flows are combined at Junction Chamber No.1, they are conveyed into the pump station through a pair of 18-ft. diameter influent conduits. The combined wastewater, consisting of both sanitary and storm flows, are managed by the pump station. **Figure 2-1** provides an overall sewer schematic for the Oakwood RTB.

When the flows into the facility exceed the capacity of these pumps during storm events, the pump station storm pumps convey any excess flow to the Screenings Facility and then into two 4.5-million-gallon (MG) CSO Basins. When the facility's 9-million-gallon total storage capacity is exceeded, any additional flow is directed through two parallel outfall conduits into the O'Brien Drain and then into the Rouge River.

2.1.1 Oakwood Sampling Procedure Summary

The following is a summary of the sample collection procedures followed for samples tested on October 31, 2022 and November 27, 2022. Sample collection preparations were made, and all sampling equipment and items were stored at the Oakwood facility near the sampling location. The Field Team Coordinator called the Oakwood facility operators to check the status of the facility equipment and the wet weather event predictions.

When significant rainfall is predicted to take place in the next 24-hour period, the field sampling team is placed on alert. After the Field Team Coordinator received the GLWA text message "PE started" alert, a 5-minute call was held between the sampling team and the Oakwood operator to review the upcoming steps and make the sure that everything was ready. As the level at the Oakwood facility started to increase, the Oakwood operator opened the hatch cover at the influent pump station entrance. The field sampling team then installed the sampling tripod assist and other necessary equipment for sampling. All safety procedures were taken (Please see the Field Sampling Plan for more details).

Ice bags, jerricans and coolers were prepared before each sampling event. Grab samples were taken at the Oakwood facility using 5-gallon buckets with the tripod assist at different times depending on the channel level and the flowrates to make sure the field sampling team had a representative sample of the first flush, during, and at the end of the overflow event. The Sampling Team Coordinator made sure that the team was following the Field Sampling Plan. Upon collection, samples were labeled in accordance with the Field Sampling Plan, logged on chain of custody (COC) forms, and immediately transferred to coolers filled with ice and maintained at $4 \pm 2^{\circ}\text{C}$. The field team was able to ship three samples (5 gallons each) per event for a total of six samples to the

Design Team laboratory for testing on October 31, 2022 and November 27, 2022. During both sampling events, the Oakwood facility was not in full operation since the two events were short in time. All activities on the field were documented properly.

2.2 Leib Facility (2198 Mt Elliott St, Detroit, MI 48207)

The facility is located on the east side of Mt. Elliott between Waterloo St. and Kercheval Ave. It is designed to treat a total CSO flow of 1,550 cfs with a capacity for flows of up to 2,000 cfs to be conveyed through the facility with partial screening and disinfection with less contact time. Flows to the facility are via the 16-ft-diameter Mt. Elliott Sewer. The 16-ft-diameter Mt. Elliott Sewer is bulkheaded south of Waterloo St. thereby diverting all flows into the influent channel of the SDF.

Figure 2-2 provides an overall sewer schematic for the Leib SDF.

2.2.1 Leib Sampling procedure summary

The following is a summary of the sample collection procedures followed for samples tested on November 27, 2022 and January 19, 2023. Sample collection preparations were made, and all sampling equipment and items were stored at the Leib facility near the sampling location. The Field Team Coordinator called the Leib facility operator (or St Aubin facility Operator if the Leib operator is not available) to check the status of the facility equipment and the wet weather event predictions. In situations when the Leib facility operator is not available the call is placed to the St. Aubin facility operator.

When significant rainfall is predicted to take place in the next 24-hour period, the field sampling team is placed on alert. After the Field Team Coordinator received the GLWA text message “PE started” alert, a 5-minute call was held between the sampling team and the Leib operator to review the upcoming steps and make the sure that everything is ready. As the level at the Leib influent channel started to increase, the Leib operator opened the basement door to give the Design Team access to the influent channel. The field sampling team then installed the necessary equipment for grab sampling. All safety procedures were taken (Please see the Field Sampling Plan for more details).

Ice bags, jerricans and coolers were prepared before each sampling event. After confirming that the two chemical induction mixers in the influent channel were off, grab samples were taken at Leib facility using a 5-gallon bucket attached to a heavy-duty rope at different times depending on the channel level and the flowrates to make sure the field team had a representative sample of the coming influent during the overflow event. The Sampling Team Coordinator made sure that the team was following the Field Sampling Plan. Upon collection, samples were labeled in accordance with the Field Sampling Plan, logged on chain of custody (COC) forms, and immediately transferred to coolers filled with ice and maintained at $4 \pm 2^{\circ}\text{C}$. The field team was able to ship three samples (5 gallons each) per event for a total of six samples to the CDM Smith laboratory for testing on November 27, 2022, and January 19, 2023. During both sampling events, the Leib facility was not in full operation (screening operation was not active) since the level in the influent channel was not enough to turn on the screens at Leib. All activities on the field were documented properly.

Page 4



Page 5



3.0 System Evaluation

Not used.

4.0 Description of Alternatives

Not used.

5.0 Alternatives Analysis

Not used.

6.0 Life Cycle Cost Analysis

Not used.

7.0 Summary and Recommendations

Samples for each facility per overflow event were collected as planned by the disinfection team to support the chlorine dose response testing strategy in the aim to define the chlorine demand, chlorine decay, and bacteria inactivation kinetics and their correlation to Oakwood and Leib water quality. The testing results will help the Design Team to determine the ICT value that will be necessary to ***optimize the chlorination process, reduce capital improvement costs, and reduce operations life cycle cost as identified by project guiding principles***. This goal will be achieved while simultaneously meeting/exceeding permit bacteria limits and to improve the disinfection system at both facilities. This information is being used to help design/optimize the disinfection system from conceptual design through final design.

8.0 Next Steps

The Design Team understands the influent water quality and flow rates associated with each facility needed to prepare and initial ICT model and will continue to work with GLWA to obtain more CSO data (dosage, storage volumes, Flowrates, TRC, Fecal coliform, TSS etc.) to further refine the model. Updates to the chlorine dose response testing can continue to be performed to capture different water quality conditions during the project allowing the model to be refined as the disinfection system design progresses.

Appendix A – Field Sampling Plan (FSP)

Appendix A

Field Sampling Plan (FSP)

CSO Facilities Improvements

Field Sampling Plan (FSP)

PREPARED FOR: Great Lakes Water Authority

COPY TO: David Mccord; CSO Manager, david.mccord@glwater.org

PREPARED BY: CDM Smith Michigan, Inc.

DATE: October 18, 2022

PROJECT NAME: CSO Facilities Improvements_ Sampling phase for Disinfection Study

APPROVED BY:

1. Summary

The purpose of this technical sampling plan is to define requirements for collection and containment of Influent CSO samples. The field sampling program includes reconnaissance of the CSO system, selection of the sampling locations, flow monitoring, wet weather sampling (at least 2 events this year), and samples handling and shipping for testing. Data collected during the field sampling program will be used to define the Chlorine dose- Response Strategy to improve the disinfection system in Oakwood/Leib facilities. Understanding the influent quality and how it changes over time is key to determining the ICT value that will be necessary to achieve bacteria permit limits.

All field activities will be performed in accordance with the Health and Safety Plan (HASP) developed for this program.

2. General Responsibilities

Ali Khraizat, PE – Project Manager

Brian Hilts, PE – Disinfection Task Lead

Mohamad Baydoun, PhD – Field Team Coordinator

Julie Aichler, PE – Health and Safety Coordinator

Oakwood Sampling Team 1- Mohamad Baydoun

Leib Sampling Team 2- Nigel Beaton/ Ruby Barron

3. Sites Background

The Great Lakes Water Authority (GLWA) operates and maintains eight Combined Sewer Overflow (CSO) facilities consisting of Retention Treatment Basins (RTB) and Screening and Disinfection Facilities (SDF). All the CSO Facilities have screening capabilities upstream of their respective retention or treatment basins consisting of either bar screens or perforated-plate screens. Disinfection at each CSO Facility is primarily accomplished by adding sodium hypochlorite (NaOCl) to the CSO flow, typically near the headworks. Flow enters these facilities by gravity, except for the Oakwood CSO facility which receives flow through a series of eight storm flow pumps.

Oakwood Facility (12220 Pleasant St, Detroit, MI 48217) (Figure 1)

The facility receives flow through the combined sewer collection system piping and conduits that convey combined wastewater into Junction Chamber No. 1, which is just upstream from the Pumping Station. Once all flows are combined at Junction Chamber No.1, they are conveyed into the pump station through a pair of 18' diameter influent conduits. The combined wastewater, consisting of both sanitary and storm flows, are managed by the Pump Station.

When the flows into the facility exceed the capacity of these pumps during storm events, the pump station storm pumps convey any excess flow to the Screenings Facility and then into two 4.5-million-gallon (MG) CSO Basins. When the facility's 9-million-gallon total storage capacity is exceeded, any additional flow is directed through two parallel outfall conduits into the O'Brien Drain and then into the Rouge River. Figure 2 provides an overall sewer schematic for the Oakwood facility.

Leib Facility (2198 Mt Elliott St, Detroit, MI 48207) (Figure 1)

The facility is located on the east side of Mt. Elliott between Waterloo and Kercheval. It is designed to treat a total CSO flow of 1,550 cfs with a capacity for flows of up to 2,000 cfs to be conveyed through the facility with partial screening and disinfection with less contact time. Flows to the facility are via the 16-ft diameter Mt. Elliott Sewer. The 16-ft diameter Mt. Elliott Sewer is bulkheaded south of Waterloo thereby diverting all flows into the influent channel of the Screening and Disinfection Facility. Figure 5 provides an overall sewer schematic for the Leib Screening and Disinfection Facility.

4. Sampling Plan

4.1 Sampling Team

Sampling team will be assigned to pre-determined sampling sites during wet weather event sampling. The team is responsible for taking samples from two sites Oakwood and Leib.

During wet-weather sampling, the sampling team are responsible for assisting with pre-event planning, grab sample collection on First flush, during and before the end of the event. In addition, the sampling team is responsible for collection of flowmeter field measurements, accurate completion of data sheets and chain-of-custody forms, and delivery of samples to the Laboratory staff for testing and data to the Disinfection Task Lead.

All field personnel will undergo training prior to field sampling. A record of this training will be documented in the field notebook. One individual (with possibility of an assist from another

individual) is responsible for sampling and assigned the task of delivering samples to the appropriate laboratory.

During sampling events, the Field Team Coordinator, will serve as Event Coordinator who will be responsible for planning, oversight, and coordination of all field sampling teams, including mobilization of teams and equipment and preparation of sample Jerricans.

The Event Coordinator will also be the primary point of contact for sampling teams during the event and will coordinate between the CDM Smith and GLWA teams.

The sampling team will be equipped with a cellular communication device, maps showing the location of each station, driving directions, a list of all sampling location, the cell phone numbers of all Sampling team, GLWA operators, the Field Team Coordinator, and the Health and Safety Plan (See Appendix D for the HASP).

All necessary equipment is provided to the teams prior to each schedule event. Equipment includes safety equipment, personal protective equipment (PPE), sampling equipment, decontamination materials, rain gear, and trash bags.

4.2 Sampling Locations

Oakwood Sampling Location (Figure 2,3 and 4)

During wet weather storm conditions, combined wastewater enters the Oakwood Facility pump station through Junction Chamber No. 1, is distributed to the two well wells through the influent conduits and enters the expansion zone of the East and/or West Storm Wet wells.

There are eight duty Chemical Feed Pumps (Nos. 1 to 8) and two standby Chemical Feed Pumps (Nos. 9 and 10). Each of the duty pumps is paired to a corresponding storm pump. The chemical feed pump meters chemical to match the discharge flow and needed application rate for each pump.

LEIB Sampling Location (Figure 5,6 and 7)

During wet weather storm conditions, increased flows enter the Screening and Disinfection Facility via the Dry Weather/Influent Channel. However, since the outlet for this channel is only 3 ft in diameter the sewage flow will begin to back up in the influent channel as the flows into the facility continue to increase the longer the wet weather event lasts.

As the flow backs up, the sewage level in the influent channel rises. At 13-ft the 3-ft diameter Dry Weather Channel Isolation Gate closes forcing all the incoming sewage flow to remain in the facility's Screen Chamber. Flows will continue to rise in the influent channel as well as the four screening inlet channels and begin to pass through the COPA horizontal screens and the ROMAG vertical screens.

Disinfection chemical application at the Leib CSO facility is currently achieved with chemical induction mixers. There are two pre-chlorination mixers in the influent channel upstream of the screening channels and 16 chlorination mixers downstream of the screening channels where there are four rapid mix zones with four chlorination mixers in each zone.

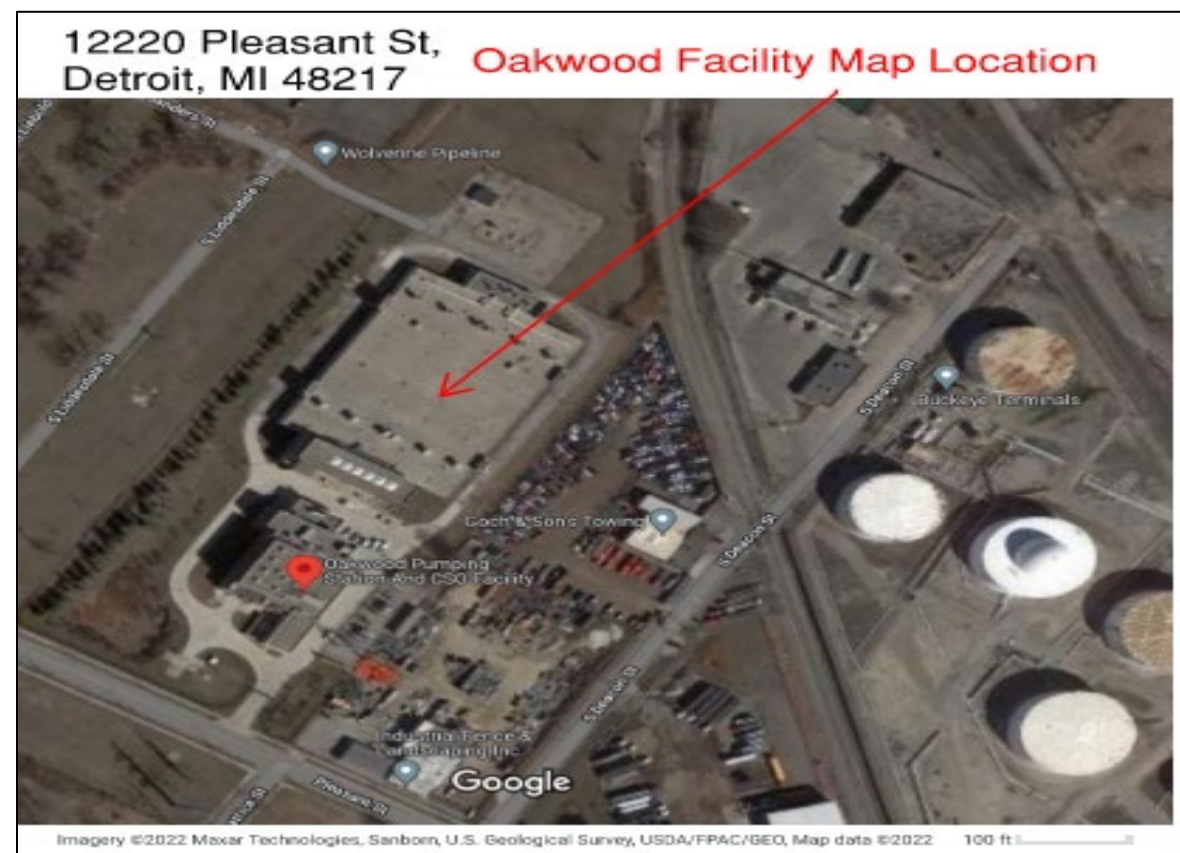


Figure 1 Oakwood and Leib Facilities Map Locations.

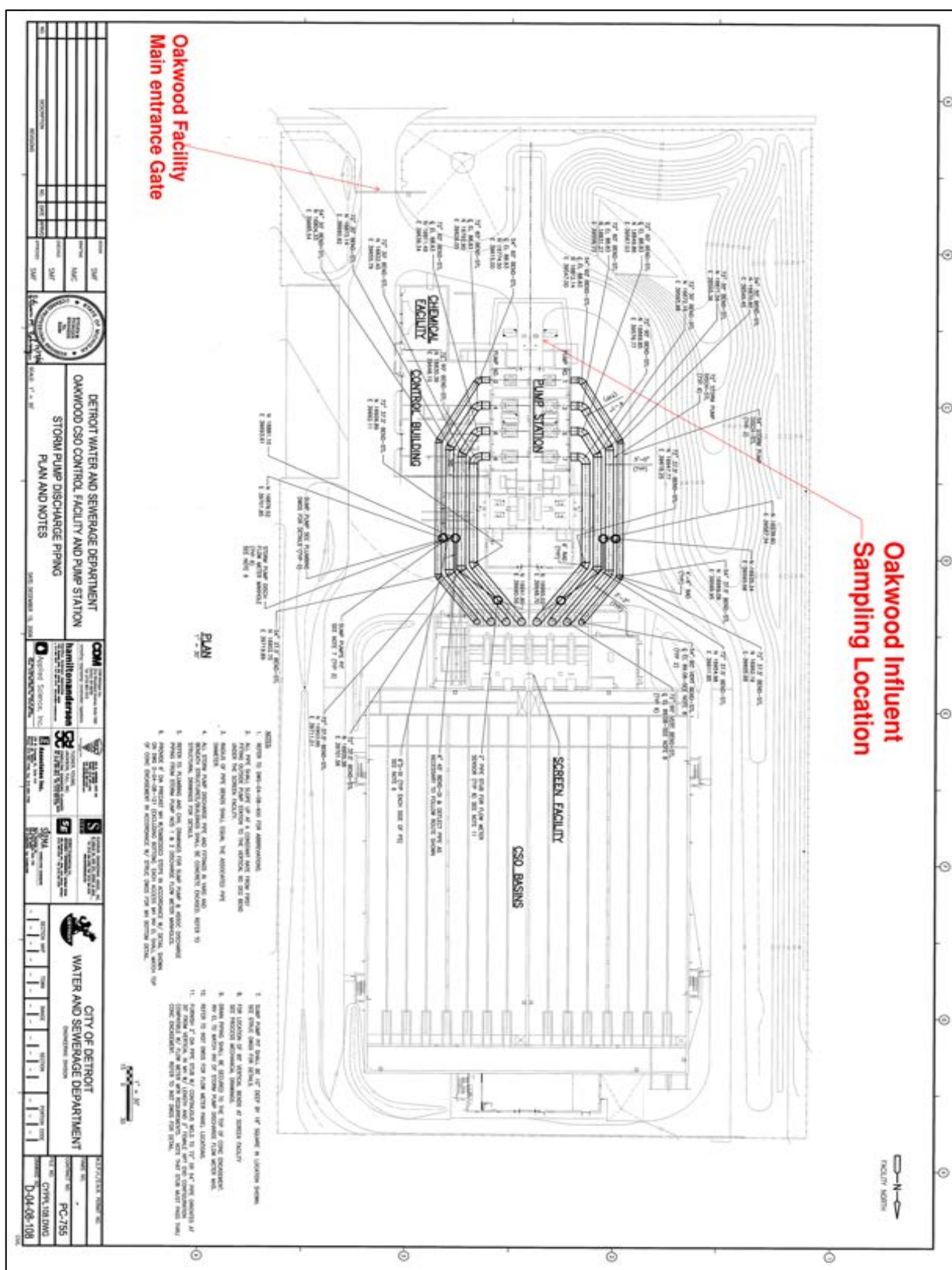


Figure 2 Oakwood Facility plan layout showing the Influent sampling location.

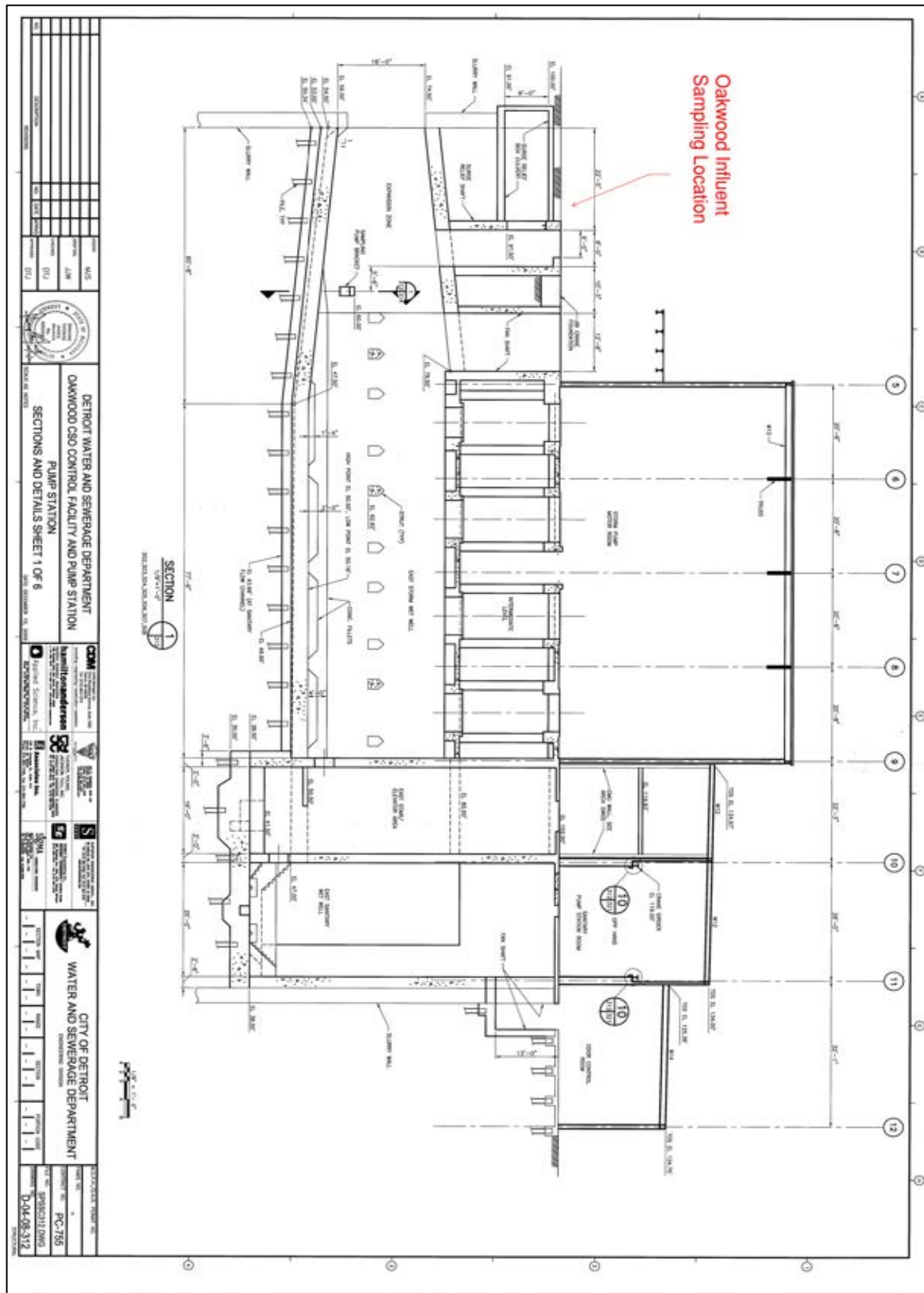


Figure 3 Oakwood Facility Section plan layout showing the Influent sampling location.



Figure 4 Oakwood Influent sampling location.

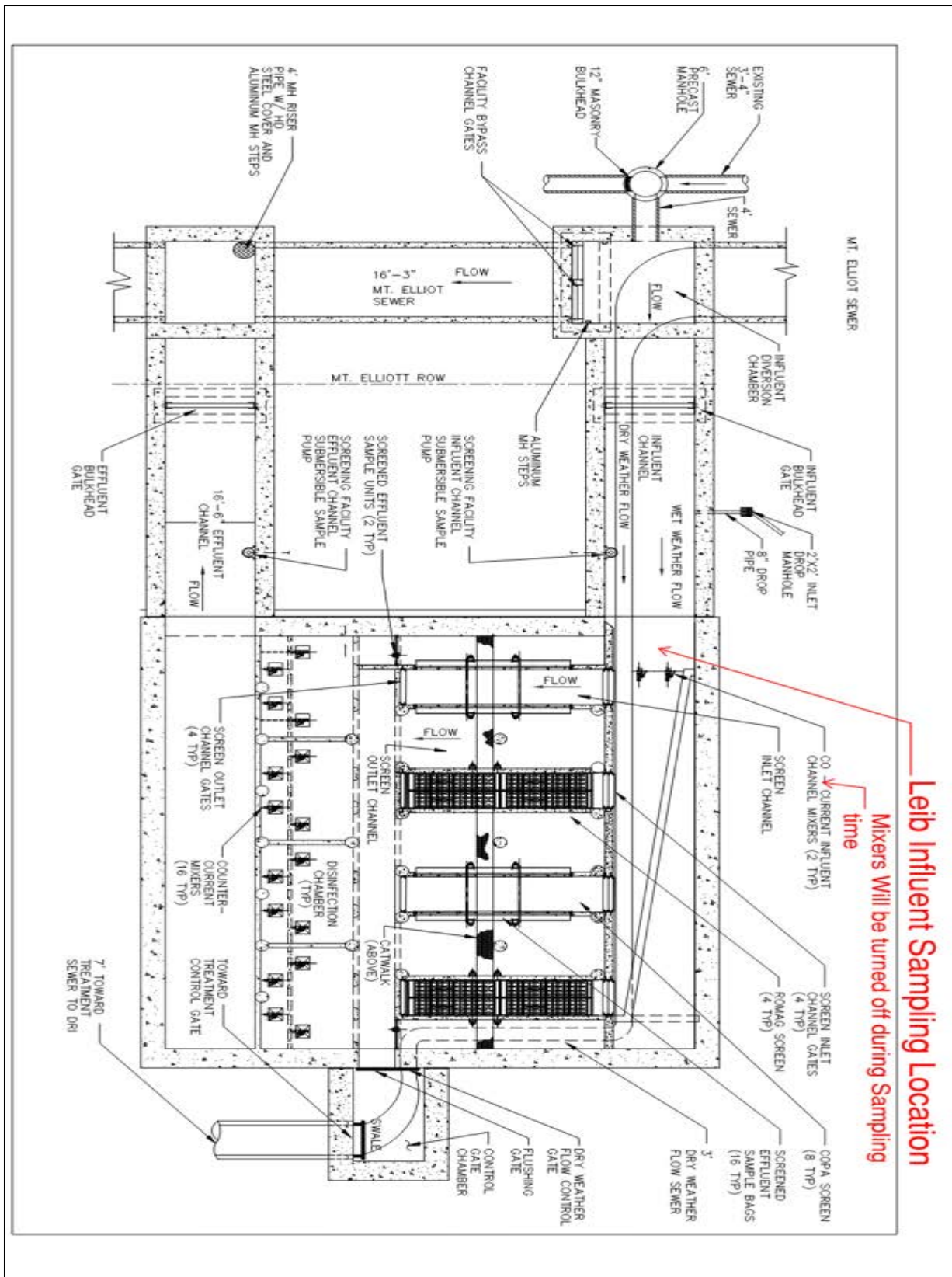


Figure 5 Leib Facility plan layout showing the Influent sampling location.

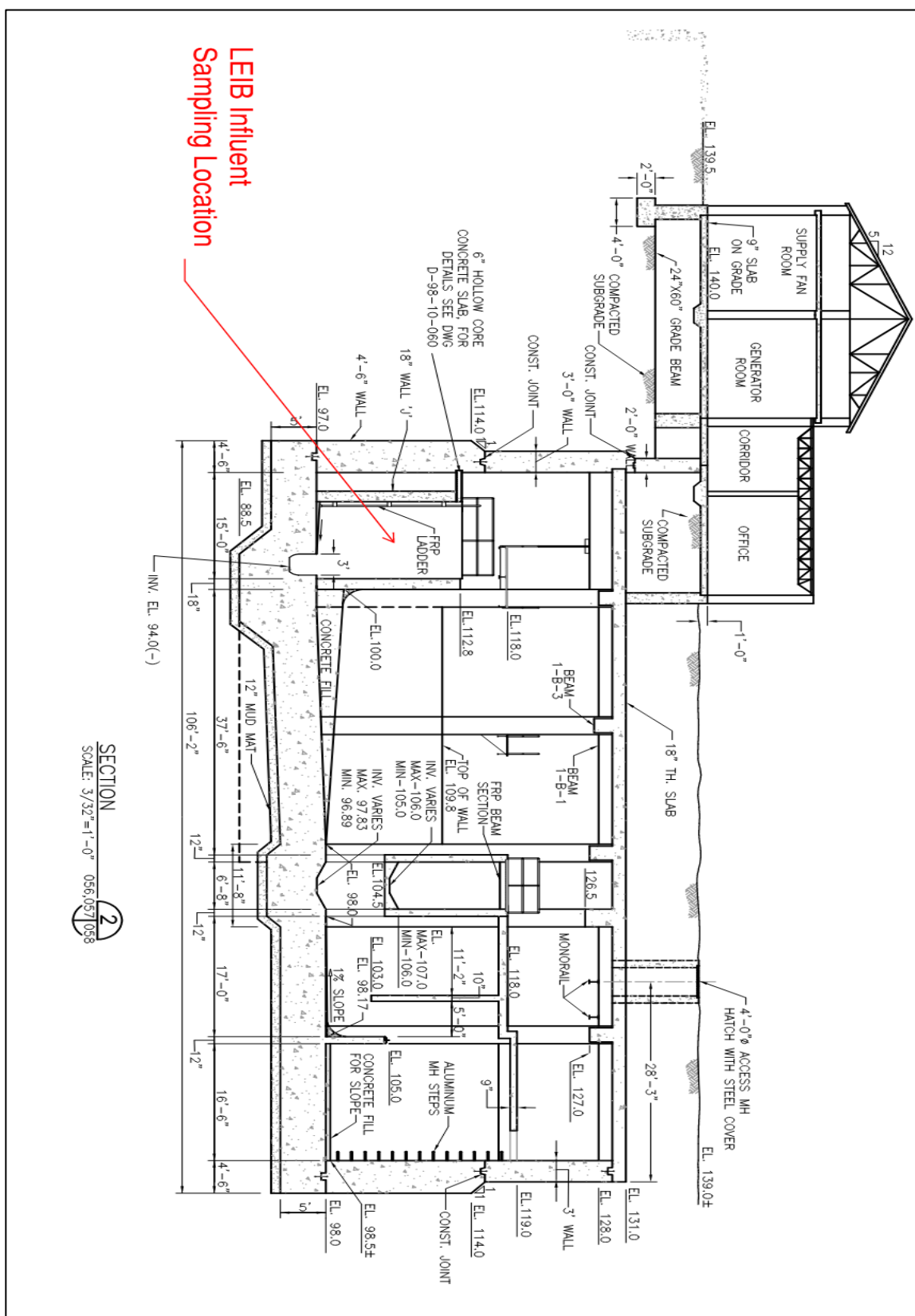


Figure 6 Leib Facility Section plan layout showing the Influent sampling location.

Influent Injection
Mixers- they will be
turned off during
Sampling Time



Walkable
access area

Metallic Chain
Holding the
Bucket

Sampling Bucket

Screens

Figure 7 Leib Influent sampling location.

4.3 Event Response Plan Summary

- Daily, the Field Team Coordinator will review predicted rainfall amounts and patterns for 5-7 days in advance.
- If significant rainfall is predicted to take place in the next 24-hour period, the field sampling team will be placed on alert.
- Sample collection preparations will be made. The Field Team coordinator will call the GLWA CSO Operators to check the status of the facility equipment and the wet weather event predictions.
- The Field Team Coordinator will keep monitoring the weather and the GLWA SCADA system with GLWA Operations staff to help make the decision.
- As the Field team coordinator receives the GLWA SMS “**pre-storm**” alert. A 5 min call between the sampling team and GLWA operator to review sampling plan and make the sure that everything is ready and alerted.
- GLWA staff phone numbers:
 - Georgianna Lindsey – Leib –, 313-400-6239
 - Kelvin Jackson and/or Ira Hawkings – Oakwood –313-999-0537 / 313-400-6900 respectively.
 - David Mccord- CSO Manager- 313.822.2017
- CDM sampling team phone numbers:
 - Mohamad Baydoun 313-230-5606
 - Ali Khraizat 313-230-5614
 - Ruby Barron 773-603-1144
 - Nigel Beaton 269-903-1218
- Field team coordinator monitors the SCADA system to determine the perfect time to go take samples
- Sampling team 1 and 2 will arrange time to pick up Ice bags for coolers on their way to the sampling locations.
- Once the team receives the “**wet weather**” alert, Field team coordinator along with sampling team will mobilize quickly to capture the event. Sampling team needs around 30 min to arrive at both facilities.

- Samples (3 five gallons jerricans) will be captured on first flush, during and before the end of the wet weather event.
- Samples will be collected and handled properly and then shipped after checking shipping company schedule (FedEx, UPS etc.) to the laboratory for testing with the chain of Custody sheet.
- The Field team coordinator will make an event stop call once discharges have ceased.

4.4 Field Mobilization

Once a wet-weather sampling event has been identified, the Event Coordinator and Sampling Teams are responsible for ensuring that all sampling-preparation activities are completed.

These activities include:

- Procurement of field equipment and calibrated sampling equipment
- Procurement of ice bags (35-40 pounds), sample Jerricans (3 per location), coolers (3 per location), and temperature blanks (3 per location).
- Ensuring that all sampling personnel have reviewed the Field Sampling Plan and the Health and Safety Plan, and have received instruction on sampling and measurement techniques, documentation, and sample custody procedures for the project.
- Confirmation of GLWA site access.
- Arrangement of transportation and availability of at least one personnel on-site and another on-call at the time of wet weather event.
- Coordination with all the teams involved between CDM Smith and GLWA on the sampling day.

4.5 Sampling Event Start Timing

The timing of wet-weather events is more uncertain than that of dry-weather events. The process requires adaptive planning both before and during events.

Each sampling location will have its own time of concentration to consider. Flow observations collected through GLWA SCADA system at each site, and the alert phone message system will be used to estimate appropriate timing of grabs for each location.

4.6 False Starts and Aborted Events

Given the uncertain nature of precipitation, there is potential for false starts and aborted sampling events because of changes in precipitation patterns, volumes and/or durations, particularly for wet-weather surveys.

In all cases, CDM will determine whether an event will be aborted following mobilization of sampling teams to the field. Under some circumstances, the event may not be fully aborted, but postponed based on predicted event timing. The Field Team Coordinator will notify sampling

teams and GLWA Operators in the event of termination or postponement due to weather conditions.

4.7 Flow Monitoring

Flow meters are working properly at both facilities. The Field team Coordinator will check the flow meters, and he will monitor the flow during the wet weather event. He will make sure to take the flow numbers at the same time of sampling.

4.8 Influent analysis parameters

A wide range of parameters were selected to effectively characterize water quality. Table 1 lists the Influent parameters selected for each sampling event at each location (see appendix E).

During a wet weather event all samples will be collected by grab. Grab sampling is the most appropriate for our testing to make sure we are targeting the rising-limb of the storm hydrograph.

4.9 Decontamination Procedures

All materials used during the collection of samples and any non-dedicated sampling equipment that may contact the sample, will be decontaminated (washed with 70% Isopropyl and rinsed with distilled water) before sample collections and after each use. The equipment will be rinsed with distilled water and allowed to air dry.

4.10 Grab Sample Collection Method

Grab samples will be taken at Oakwood facility using 5 gallons bucket with a tripod assist and at Leib facility using a 3-Gallons bucket attached to a Chain. Samples are 5 gallons volume for each sampling time, with 3 sampling times planned per event and per location, approximately one hour apart.

The jerrican used for sample collection will be triple rinsed with sample water and then returned to the site. That is, a small amount of sample (approximately 500 mL) will be dispensed into a given jerrican, thoroughly shaken and then dumped out; this is repeated three times before collecting the actual sample.

The sampler will have to completely filling the jerricans such that there is no remaining headspace. Multiple grab samples will be composited into a single jerrican for each sample point in the wet weather event.

The sample collection device will be disinfected with 70% isopropanol between sample points to prevent cross contamination. To prevent photooxidation and limit additional microbial growth, samples will be kept on ice in a cooler while sampling and not exposed to sunlight unnecessarily or for extended periods of time.

Samples stored in cooler with ice to be ready for shipping. temperature blank bottle will be filled with tap water and stored in the sample cooler. All field observations, including flow conditions, are recorded on a Sampling Worksheet filled out for each site.

4.11 Sample Jerricans handling

All samples sent for laboratory analysis will be collected directly into the 5 gallons Jerricans for testing. Upon collection, samples will be labeled in accordance with Section 5.12, logged on chain of custody (COC) forms, and immediately transferred to coolers filled with ice and maintained at $4 \pm 2^{\circ}\text{C}$.

Samples will not be allowed to freeze in transit. Jerricans with chips, cracks, or etched surfaces will be discarded and replaced. If damaged Jerricans cannot be replaced, samplers will collect the sample in the damaged Jerricans and make note on the label and chain of custody. Jerricans closures will be watertight. Sample Jerricans will be secured and not be totally immersed in water during transit or storage.

The COC form filled out for the jerrican in each cooler will be completed by the sampler, placed in a Ziploc™ bag, and taped to the inside lid of the sample cooler. For the first sample shipment only, a sample shipment memo (SSM) (Appendix B) is required. The SSM will be completed by the Field Coordinator and submitted by email to the CDM Smith RTL Chemical Hygiene Officer (CHO) Mary Lou Fox (FoxML@cdmsmith.com) and the CDM Smith RTL Technical Lead, Dung Nguyen (nguyendd@cdmsmith.com) prior to sample collection.

4.12 Sample Identification and Custody

Sample labelling

The jerrican will be numbered in the order of sample collection with the following naming convention: LOCATION-YYYYMMDD- SAMPLE POINT. For example, OAKWOOD-20221001-INITIAL. This jerrican identifier will also be what is entered on the COC. One jerrican will be placed in each cooler.

Sample labels will be pre-printed in adhesive paper and covered with clear tape after they are affixed to the sample Jerricans to prevent damage to the label during transport to the laboratory.

After collection of water, a permanent ink will be used to mark the sample labels with the initials of the person who obtained the sample, date and time collected, and other relevant information.

Ice will be filled in double bagged sealable Ziploc™ bags to fill the remaining space of each cooler. The double bagged ice fill be filled as shown in Figure 8, where the seals are oriented opposite each other to prevent leaking. Double-bagged ice will be placed on the bottom of the cooler, in-between sample and cooler, and on the top of samples.



Figure 8 Double-bagging technique to prevent leaking.

Chain of Custody

A chain-of-custody (COC) procedure will be used to properly document each sample to ensure timely analysis of all parameters requested and to track the progress of samples in the laboratories. The chain-of-custody forms for each set of samples are filled out before Shipping samples to the laboratory. The appropriate chain-of-custody form will be placed in a waterproof plastic bag and affixed to the inside cover of the cooler that is sent to the lab.

All samples within a given package will be recorded on the chain-of-custody form. The Field Team Coordinator is responsible for filling out the chain-of-custody form including signing and dating the form. One copy of the chain-of-custody form will be retained by CDM. This copy will be maintained in a notebook of sequentially numbered chain-of custody forms.

Each time the samples are transferred, the person accepting the samples must sign and date the chain-of custody form and indicate the time the transfer occurred. The laboratory will return the completed chain-of-custody form containing all original signatures to CDM with the data report that provides the results of the requested analyses on a given package of samples. A copy will also be retained by the laboratory for their records.

4.13 Sample delivery logistics

This section outlines delivery logistics that will be implemented by the sampling teams during sampling events.

During sampling events, the CDM office in Detroit will act as the centralized coordination location. Grab samples collected at the sampling sites will be transferred to the centralized coordination point. The Field Team Coordinator will be assigned the task of shipping the samples from CDM to the appropriate laboratory.

Prior to sample collection, a conference call among the CDM Smith team members will be held to discuss sample collection, packing, and shipping techniques (See Appendix B for an example sample shipment memorandum).

Samples will be shipped the day of collection with sufficient double-bagged ice via FedEx priority overnight or equivalent service to the following attention at Research and Testing Laboratory. If samples cannot be shipped out the day of collection, samples will be stored at 4°C until they can be shipped. Any storage of samples prior to shipment will be communicated by field staff to the CDM

Smith RTL staff and will not exceed 24 hours from sample collection. Each cooler must include a temperature blank and proper chain-of-custody (COC) documentation detailing the number of jerricans, time and date of sample collection. The COC form is included in Appendix C.

When sampling is complete, the field coordinator will email Dani Tran (trandn@cdmsmith.com), cc Dung Nguyen (nguyendd@cdmsmith.com) and provide information on the conditions at the facility at the day of sampling (water flows, any unique aspects of operations, and the procedures of sample collection).

The field coordinator will also email the tracking number to Dani Tran on the day the samples are shipped out. Each cooler will contain a temperature blank (tap water in a poly container), which will be used to evaluate temperature upon receipt of the sample water. If wet weather happens Monday through Wednesday, samples will be shipped to the CDM Smith RTL and analyzed immediately. If wet weather happens after Wednesday, then samples will be collected and shipped to the CDM Smith RTL, stored at the lab, and will be analyzed depending on the CDM Smith RTL staff schedule

For the first round of testing, once the samples are shipped, the Field Team Coordinator will participate in the first chlorine dose response analysis at the CDM Smith laboratory in Bellevue WA.

Samples will be shipped to the following address:

ATTN: Dani Tran
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007
Office: (425) 519-8321
Cell: (206) 370-9472

FedEx schedule and location

FedEx Office Print & Ship Center – **Latest time to drop off 06:00 pm**
3670 Woodward Ave Suite 102, Detroit, MI 48201
Monday – Friday 8AM–8PM
Saturday - 9AM–6PM
Sunday- Closed

UPS schedule and location

The UPS Store – **Latest time to drop off 06:30 pm**
535 Griswold St Suite 111, Detroit, MI 48226
Monday – Friday 9AM–7:30PM
Saturday - 9AM–2:30PM
Sunday- Closed

4.14 Field Documentation

Proper documentation of all field activities is essential to ensure that the data quality objectives are achieved. Sample teams should document any unusual or anomalous conditions that may later be useful for data interpretation and analysis.

During wet-weather events, data will be recorded on Sampling Worksheets. Information from the Sampling Worksheets will be converted to electronic databases after the event.

In addition to collecting grab samples, the sampling teams will note conditions near the sampling site. In particular, the sampling teams will be asked to record the flow conditions observed at the time of the grab.

5. Health and Safety Procedures

A separate Health and Safety Plan (HASP) was developed for Sampling plan and is included as Appendix D.

Appendix A

Wet Weather Event Activities

Mobilization Phase

Sampling equipment including sample Jerricans, field packets, Coolers, Sampling Buckets, and other field equipment must be collected from the CDM office in Detroit either the evening before or the morning of the anticipated wet-weather event. In between events, teams are allowed to store equipment in their vehicle, home, office, or other secure place at their convenience, as long as it is available during the events.

Planning is based on the forecasted grab-time announced in the 48-hour notification and updated as the event approaches.

Once the SMS GLWA message alert received declaring the “Pre-Storm” alert, a 5 min call will be performed between CDM Smith team and GLWA Team to coordinate the sampling plan while monitoring the SCADA system to identify timing of the wet weather event.

Activities performed at the time of the wet weather event:

- (1) Team will be at the first of two sampling locations at the forecasted grab-time wearing the prescribed PPE and have all the Grab sampling equipment and grab sample Jerricans.
- (2) Go to the sampling locations at both facilities where the grab is intended to be taken. Observe and report the flow condition sampling worksheet.
- (3) Take the 15 gallons sample (3 five gallons a different time points: first flush, during and before the end of the wet weather) by grab from each location.
- (4) Record a single time for the grab sample on each Jerricans and on the sampling worksheet.
- (5) When all grabs are finished. Make the area is safe around your sampling location. Perform a complete decontamination of the grab sampling equipment used.
- (6) Do the same sampling process for the other site (steps 1 through 6).
- (7) Immediately return to the CDM Smith office to prepare samples for shipping.

Appendix B

Sample Shipment Memorandum

To: Whom It May Concern

From: Dung Nguyen, CDM Smith Environmental Research and Testing Laboratory (Bellevue, WA)

Date: 10/01/2022

Subject: Procedure for Samples Shipping to Treatability Lab (Bellevue, WA)

This memo contains procedures for sending samples to the CDM Smith Research and Testing Laboratory located in Bellevue, Washington. It is intended to be used by anyone who sends environmental samples to the Research and Testing Laboratory, regardless of whether they are CDM Smith employees or not.

Research and Testing Laboratory staff or project managers will provide this memo to the sender prior to the sample shipment. Upon receipt, the sender must read it carefully and fill it out to the best of their knowledge before preparing the samples for shipping.

Once the memo is complete, it must be submitted to the Field Team Coordinator for review.

Upon the completion of review, a completed and approved copy of this memo must be shipped together with the sample(s) to the lab.

Before Shipping

It is the sender's responsibility to classify the samples to be shipped. If the samples are classified as Dangerous Goods, the sender must have applicable training on DOT and IATA regulations before initiating the shipment. For example, Fedex will not allow shipping of dangerous goods unless the sender has been trained on proper procedures. Furthermore, there can be significant penalties (up to \$50,000 per violation, per day) that can be imposed by DOT on the sender PERSONALLY (not just the company) if noncompliant shipments are offered by a shipper.

CDM employees should be familiar with CDM policy, located here:

http://cdmweblegacy/h&s/documents/hazmat_transport.doc

http://cdmweblegacy/h&s/hazmat_transport.html

Sample Shipment Procedures

1. Communicate with Research and Testing Laboratory Management regarding sample information and desired scope of work.

Charles Schaefer,

ETL Director

425-519-8300

schaefer@cdmsmith.com

Jennifer Hooper,
Technical Lead, Water and
Wastewater
hooperjl@cdmsmith.com

Zoom Nguyen, Technical
Lead, Remediation
nguyendd@cdmsmith.com

Mary Lou Fox,
Chemical Hygiene Officer
foxml@cdmsmith.com

2. Receive written approval from Research and Testing Laboratory Management for sample shipment (i.e. this memo, once completed and approved).

3. All the sample containers must bear a readable label with the sample name and contents, the related project name, the sender's name and company, the sample collection date, and any other appropriate sample information.

4. Prepare shipment per DOT and IATA regulations. Include a completed Chain-of-Custody form.

5. Send samples via overnight courier to the Research and Testing Laboratory:

CDM
Attn: Janelle Amador
14432 SE Eastgate Way, Suite 100, Bellevue, WA 98007

6. Inform Research and Testing Laboratory Management of shipping status and provide tracking number.

Sample Information Required Prior to Shipment

1. Source

Please check all of the following boxes that are applicable regarding the nature of the sample:

- | | | |
|--|--|---|
| ☐ Groundwater | ☐ Subsurface soil | ☐ Industrial Waste Water |
| ☐ Surface water | ☐ Surface soil | ☐ Municipal Waste Water |

2. Contaminants

Please check all of the following boxes that are applicable regarding contaminants in the sample:

- | | | |
|---|---|--------------------------------------|
| ☐ Chlorinated Solvents | ☐ Petroleum Hydrocarbons | ☐ Metals |
| ☐ Radioactive Substances | ☐ Pesticides/PCBs | ☐ Perchlorate |
| ☐ Unknown | | |

Please list specific contaminants:

3. Hazards Information

Based on the SDS or other sources of the sample hazards information, please check all of the following boxes that are applicable.

- | | | |
|------------------------------------|------------------------------------|--|
| ☐ Flammable | ☐ Toxic | ☐ Unknown, but is potentially hazardous |
| ☐ Reactive | ☐ Corrosive | ☐ None apply |

Notes:

4. Potential Headspace Gas Accumulation

- Sample will be shipped on ice? ☐ Yes ☐ No
- Any potential for gas generation/accumulation in the sample container during the transportation? ☐ Yes ☐ No
- If yes to the question above, please specify what are the gases could be encountered in the container upon receipt:

5. Sample handling information

- Does the sample require refrigeration on arrival? ☐Yes ☐No
- Will a temperature blank be included to verify appropriate temperature control during shipping? ☐Yes ☐No
- Does the sample require protection from oxygen contamination (i.e., should the containers be opened only in an anaerobic chamber)? ☐Yes ☐No

If yes:

- Water samples must be shipped in containers of 1L or smaller
- Soil cores must be no more than 16" long. Other containers should be no larger than 15" x 8" x 8".

6. Additional Sample Information

Please indicate if any of the following sources of information are included for the sample.

- ☐SDS ☐Product Sheet ☐Source Materials Information
☐No Additional Info Available

Notes: _____

Sample Sender's Name (print): _____

Sample Sender's Signature: _____

Date: _____

Approved for shipping? ☐Yes, ☐No,

☐Additional Information is needed, which includes:

Approved by: _____ (Print)

_____ (Signature)

**CDM
Smith**

Appendix D

Health and Safety Plan (HASP)



General Health and Safety Plan

General Information			
This task-specific health and safety plan (HASP) provides safety-related information and requirements specific to the task and work location(s) described. General requirements contained in the CDM Smith Health and Safety Program along with those described in this task-specific HASP will be implemented except where noted. Significant changes to this HASP shall be documented by resubmittal of a revised task-specific HASP.			
Project Name:	CSO Improvements Project	Client:	GLWA
Project No.:	276260	Date:	9/12/2022
Performing Organization(s):	CDM Smith Michigan, Inc.		
Planned Duration of Field Activities:	September 16, 2022 - May 31, 2024		
Project Location:	4 CSO control facilities in the GLWA system - Oakwood CSO facility (OKW) 12082 Pleasant Street, Detroit, MI 48217; Leib Screening and Disinfection Facility-2198 Mt. Elliott St.; Baby Creek (BC) S&D Facility 9545 Dix Road; Conner Creek (CC) CSO facility 11900 Freud St		
Key Personnel			
Project Manager:	Ali Khraizat	Telephone:	313-230-5614
Project Health and Safety Contact:	Julie Aichler	Telephone:	313-230-5631
Project Field Personnel	Responsibilities	Telephone	
Mohsen Sadatiyan	Field investigations	313-230-5605 (office)	
Julie Aichler	Field investigations	313-230-5631 (office)	
Nigel Beaton	Field investigations	313-230-5616 (office)	
Steve Fehniger	PTL, Field investigations	313-230-5604 (office)	
Sadaf Teimoori	Field investigations	313-230-5618 (office)	
Ruby Barron	Field investigations	773-603-1144 (cell)	
Mohammad (Mo) Baydoun	Field investigations & O&M	313-450-8576 (cell)	

CDM Smith		General Health and Safety Plan	
CDM Smith Activity Hazard Analysis			
Project Name:	CSO Improvements Project	Project No.:	276260
Analyzed by:	Julie Auchter	Date:	09/19/22
Reviewed by:	Jeffrey Rakowski	Date:	09/19/22
Description of Work Activity			
The tasks to be performed onsite are: Observe operation of CSO control facilities (OKW & Leib); Collect location and measurement information for various process equipment and potentially structures (all facilities, specifically for mixers at BC, CC, Leib); collect water samples from the treatment process (at the influent before the chemical injection); analyze water samples for TBD (potentially Free Chlorine, TRC, pH, Temp, TSS, BOD, TOC, Ammonia); transport samples to GLWA lab or for shipping to CDM Smith lab; remove and replace sample nets from flow chambers to analyze performance of screening system (Leib).			
Potential Hazards	Hazard Controls (Examples provided at this link)		
Slips, Trips, Falls	Samples & measurements (where feasible) will be collected at points engineered for the purpose. Use caution when working in the CSO facility and near the collection or the discharge point. Stay clear of any spills. Follow GLWA personnel instructions and floor markings when walking through the facilities to avoid tripping hazards.		
Falling hazards around open holes	The buddy system will be used at all times during work done near open holes. Crew members will approach open hatches with caution and determine safe places to stand and safe ways to approach and work near each hatch or opening. Plan ahead for field measurements/needs so bring necessary poles, boards, measurement tools, lights, etc. with you to perform work safely and effectively. Attempt to do the following as feasible: Stay low to the ground while performing inspections; Do not turn back from openings; Do not completely remove manhole cover from hole		
Physical hazards due to raising and lowering of hatches at the facilities and outfalls	Coordinate with GLWA staff prior to field visit to determine if they have staff person available to accompany CDM Smith staff and open/close hatches. Proper tools and lifting techniques must be used to lift the hatches, and extreme caution must be executed when closing the hatches to avoid bodily injury such as crushed toes or feet. Wear safety toe boots/shoes.		
Confined space accidents/sewer gas exposure	Comply with CDM's confined space entry requirements and procedures. Only CSE trained employees will perform work in confined spaces. Coordinate with GLWA staff prior to field visit to verify which spaces are classified as permit or non-permit confined spaces and any other site specific requirements & planning information needed.		
9/22/2022		AHA	

Potential Hazards	Hazard Controls (Examples provided at this link)
Exposure to non-hazardous calibration solutions (pH, chlorine residual analyzer)	Wear appropriate clothing at all times wear long sleeve shirt, pants, closed toed shoes, eye protection; wash hands before and after sample collection
Ingestion of chemicals or microbial agents	Wash Hands thoroughly. Avoid getting calibration solutions in mouth and chlorine reagents. Read the SDS of each chemical you are in contact with to make sure you are doing the right handling procedure.
Electrical Hazards	Care must be taken when working near electrical equipment and instruments. Only qualified personnel should work on or around this equipment. Operators shall become familiar with warnings, safety notices and maintenance procedures.
Sampling bottle & CSO screening net handling	Gloves will be worn when handling CSO samples or nets located on screen discharge. Do not touch the inside of the CSO sample bottle.
Mechanical hazards associated with the treatment process	Discuss our work with plant personnel whose operations may endanger the team, or that might be affected by our presence. Work out safe places to stand. For screenings characterization work out safe ways to access raw and processed screening material.
Lifting Injuries	Use proper lifting techniques to avoid lifting injuries
Night Time Sampling or Site Visits	Wear high visibility clothing (vest) and use proper work area lighting. Traffic safety plan if in or near traffic lanes. Perform work with another person (buddy system).
Cold Stress	Check the weather forecast prior to site visits. Account for higher winds outside facilities near the river or with elevated structures (i.e. on top of OKW basin) and dress accordingly. Take breaks inside the facility's heated spaces to warm up periodically if feel cold.
Exposure to microbial agents and debris from screenings	Wear protective eye wear and face shield in locations where samples or screenings samples are subject to splashing/splatter
Personal Security	Be aware of surroundings and security protocols arriving and leaving the site. Perform work with another person (buddy system). Choose areas with good lighting and visibility when parking vehicles.
Training Required	
Project Safety Orientation	All of the time - work clothes, cell phone
	For appropriate situations - safety toed shoes (opening/closing hatches, CSE, minimum)
	For appropriate situations - safety glasses
	Wear latex/nitril gloves when handling CSO samples

Potential Hazards	Hazard Controls (Examples provided at this link)
	Wear Leather gloves Opening/closing hatches or manholes
	Wear hard hat and safety glasses and high visibility vest in areas where required
	For problem situations - good judgment, first aid kit
Confined Space Entry Training	For CSEs - staff must be trained and have a health & safety manager approved permit prior to entry
HAZCOM Training	Employees potentially exposed to or working with chemicals are to take HAZCOM training prior to activities. Review SDS for all chemicals/reagents that will come in contact with.

Emergency Plan and Information			
Basic Approach:	If an emergency happens, the CDM Smith team will rapidly, but without haste, withdraw to a safe location and notify the appropriate emergency agencies listed below.		
Police:	Dial 911		
Fire:	Dial 911		
CDM Smith H & S Manager	Joe Sabo	857 / 500 - 3636	
Poison Control Center	Nationwide	1 800 / 222 - 1222	
State Spill Number:	Michigan	(800) 292-4706	
24-Hr. First Aid/Non-Emergency Medical Services:	1-800-350-4511, Press 1		
	For non-emergency medical services: 1. Call WorkCare (formerly AllOne Health) at 1.800.350.4511, PRESS 1, and tell them you are reporting an injury for CDM Smith. Supply requested information. 2. Follow the instructions provided (e.g., first aid, go to clinic, etc.). 3. After care, follow-up with WorkCare at the 1-800 #.		
Ambulance:	See attached maps for hospitals closest to each site		
Client's Emergency Number:	David McCord, CSO Team Leader (313) 999-2646 (cell)		
Nearest Medical Facility:	See attached maps for hospitals closest to each site		
Address:			
Telephone:			
Driving Directions: (Attach Map)	See Attached		
Reviews			
Project Manager:	Ali Khraizat	Date:	9/21/2022
Health and Safety Manager:	J. Rakowski for Joe Sabo	857 / 500 - 3636	

Google Maps

12082 Pleasant St, Detroit, MI 48217 to Emergency Center - Beaumont Hospital, Dearborn, 18101 Oakwood Blvd, Dearborn, MI 48124
Drive 4.8 miles, 16 min
Oakwood CSO Facility & PS to Hospital Emergency room



Map data ©2022 Google 2000 ft



via Oakwood Blvd

16 min

Fastest route now due to traffic conditions

4.8 miles



via Schaefer Hwy and Oakwood Blvd

16 min

Some traffic, as usual

4.9 miles

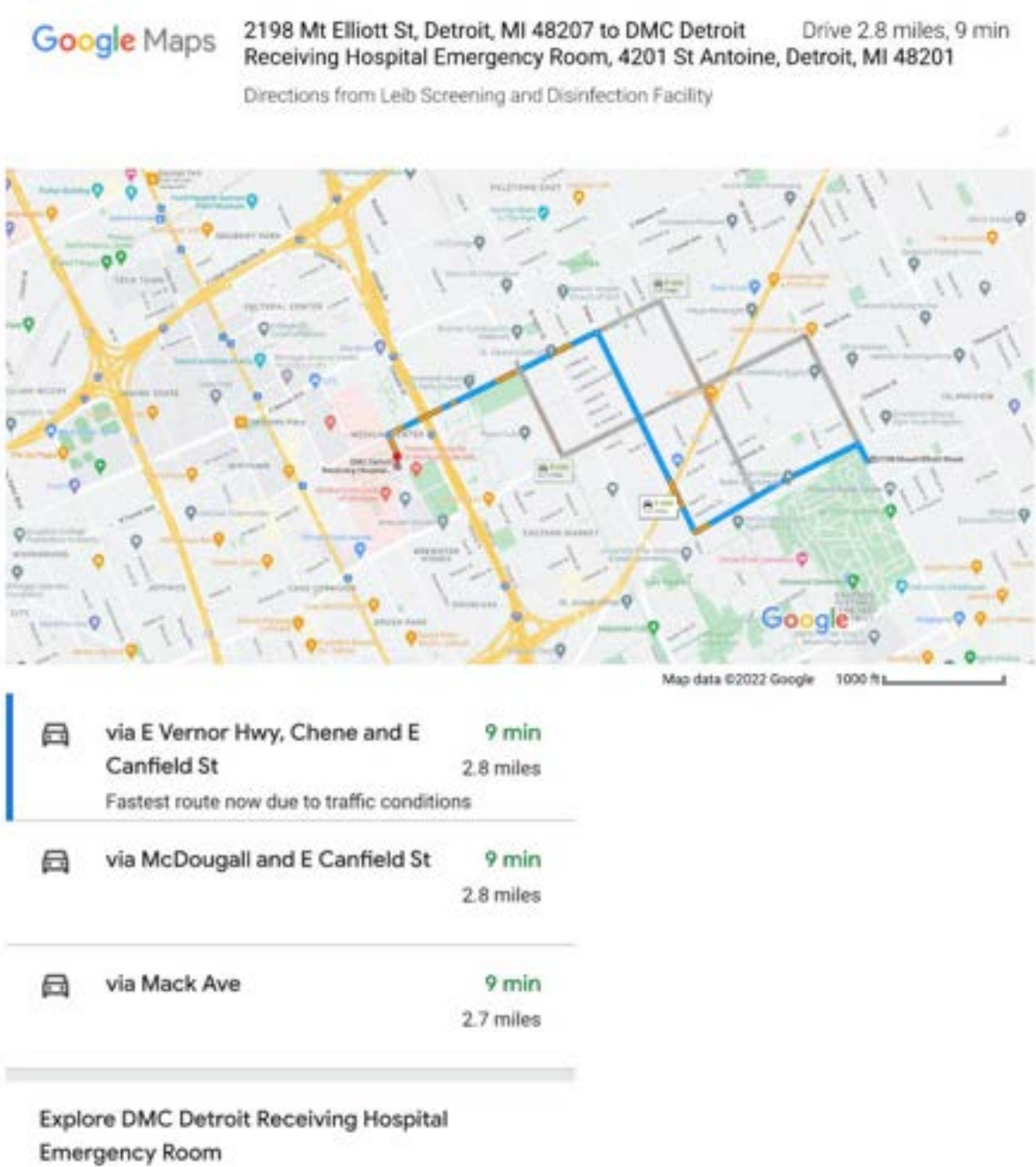


via Schaefer Hwy

16 min

6.2 miles

Explore Emergency Center - Beaumont Hospital, Dearborn



Appendix E

Influent analysis parameters type and methods

Analyte	Analysis Type	Method	Volume Required (mL)
Fecal Coliform; MF	Sub-contract Laboratory	SM9222D	100
TOC	Sub-contract Laboratory	SM 5310B	250
TSS	Sub-contract Laboratory	SM2540D	500
Ammonia	RTL	HACH Method TNT830	5
pH	RTL	probe	10
Temperature	RTL	probe	10
Color (Apparent)	RTL	SM5910	15
UV-254 (Unfiltered)	RTL	SM5910	30
Free Chlorine	RTL	HACH Method 8121	10
Total Residual Chlorine	RTL	HACH Method 8167	10
COD	RTL	HACH Method 8000	2



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

From: CDM Smith

Date: June 1, 2023

Subject: TM-18 Chlorine Dose Response Results and ICT Model

1.0 Executive Summary

The Design Team developed CSO disinfection efficacy models to determine the integrated contact time (ICT) necessary to achieve bacteria permit requirements at the Oakwood Combined Sewer Overflow (CSO) Retention and Treatment Basin (RTB) (Oakwood) and Leib Screening and Disinfection Facility (SDF) (Leib). The models were developed and calibrated using data from benchtop chlorine dose response tests from several wet weather events at both facilities in 2022 and 2023. Correlations between demand-dose responses and water quality were also explored. The data from these tests resulted in “high” ICT values of 120 and 142 mg-min/L, and “average” ICT values of 50 and 50 mg-min/L at Oakwood and Leib, respectively. The ICTs were selected based on log inactivation and final bacteria counts in accordance with each facility's permit requirement. The ICT values were utilized to size the improvements to the sodium hypochlorite storage and feed systems for both Oakwood and Leib.

2.0 Introduction

As part of the CSO Facility Improvements project the Great Lakes Water Authority (GLWA) is making disinfection system improvements to the Oakwood RTB and Leib SDF. Those improvements include upgrading the sodium hypochlorite storage, feed, and mixing systems at both facilities to improve their reliability, flexibility, simplicity, ease of operation and maintenance, and robustness, all with an eye toward doing so in a way that optimizes the amount of chemical utilized to meet the discharge permit requirements. In order to meet these project goals, the design criteria, specifically identifying the appropriate chlorine dose, for the new sodium hypochlorite systems had to be established.

The Design Team conducted a disinfection study to determine the chlorine dose required to treat CSO at Oakwood and Leib. The study centered around performing bench-scale chlorine dose response tests on undisinfected, wet weather samples collected at both Oakwood and Leib, where chlorine doses and contact times were varied and correlated with the log inactivation of fecal coliform. Water quality characteristics were measured as they varied through wet weather events and tend to correlate with chlorine demand. The study utilizes the data generated from the chlorine

dose response tests to develop a disinfection efficacy model that can determine the appropriate ICT value required to meet the bacteria limits in the discharge permit. The ICT value is then utilized in conjunction with the facility specific effective contact time and the chlorine demand and decay to calculate the chlorine dose required.

This technical memorandum (TM) summarizes the study objectives, the testing plan, the analytical procedures performed, the analysis of the data, the results of the study, and the conclusions and recommendation based on these results. TM-20 further explains how the chlorine dose is calculated using the results from this disinfection study.

3.0 Objectives

The purpose of the testing outlined in this memo was to:

- Gather data on the water quality of wet weather events at Oakwood and Leib by collecting samples for analysis.
- Generate disinfection efficacy models to determine the required ICT value to meet the design target for fecal coliform.
- Determine what correlations exist between water quality and ICT values.

4.0 Testing Plan

Three separate samples were collected for each of two wet weather events at Oakwood and Leib. One additional sample at Oakwood and two additional samples at Leib were collected on 2/27/2023 to supplement the initial testing. It is assumed that the water quality of the flows from Meldrum Sewer and Leib are comparable given that the contributing areas were developed around the same time, and both are comprised of a mix of residential, industrial, and transportation land uses. Therefore, it is assumed that the sampling conducting is representative of both the Meldrum Sewer and Leib collection area water quality characteristics. Samples were kept at or below 4°Celsius (C) and sent with overnight delivery to CDM Smith's Research and Testing Laboratory in Bellevue, Washington (BLV RTL) to perform the chlorine dose response testing. TM-17 summarizes the effort associated with the influent water quality sampling program.

An experimental matrix was developed, prior to initiating the sampling, with chlorine doses and contact times that would generate a wide range of ICT values necessary to develop robust disinfection efficacy models for the water quality represented in these samples. The experimental matrix for all samples is shown in **Table 4-1**.

Initial chlorine demand testing was performed for each sample upon arrival at the lab. These tests were used to determine the chlorine doses for each facility and event. The doses delivered at Oakwood ranged from 2 to 9 mg/L and were different for each event. The doses delivered at Leib were always 5, 8, and 12 mg/L, regardless of the event.

Table 4-1 Initial Test Matrix

Facility	Sampling Date	Disinfectant	Doses (mg/L)	Contact Times (minutes)
Oakwood	10/31/2022	Chlorine	2, 4, 6	0, 1, 3, 7, 15, 30
	11/27/2022	Chlorine	3, 5, 8	0, 1, 3, 7, 15, 30
	2/27/2023	Chlorine	4, 6, 9	0, 1, 3, 7, 15, 30
Leib	11/27/2022	Chlorine	5, 8, 12	0, 1, 3, 7, 15, 30
	1/19/2023	Chlorine	5, 8, 12	0, 1, 3, 7, 15, 30
	2/27/2023	Chlorine	5, 8, 12	0, 1, 3, 7, 15, 30

Table 4-2 lists the parameters and analysis methods performed as part of the chlorine dose response testing. Measurements of fecal coliform, total organic carbon (TOC), and time series studies (TSS), were performed by AmTest to simplify sampling and improve cost effectiveness. All other lab analysis was performed by CDM Smith at BLV RTL.

Table 4-2 Test Methods Performed by Testing Labs

Parameter	Lab	Analysis Method
Fecal Coliform	AmTest	SM9223B
TOC	AmTest	SM5410B
TSS	AmTest	SM2540D
Ammonia	BLV RTL	HACH Method TNT830
pH, Temp	BLV RTL	Probe
COD	BLV RTL	HACH Method 8000
Color (Apparent)	BLV RTL	SM5910
UV-254 (Unfiltered)	BLV RTL	SM5910
Free Chlorine	BLV RTL	HACH Method 8121
Total Residual Chlorine	BLV RTL	HACH Method 8167

5.0 Analytical Procedure

This section describes the chlorine dose response test procedures performed by the Design Team. The analytical procedures were developed by the Design Team specifically for this project to ensure that reliable results were obtained for design purposes. The full procedure is included as Appendix A.

Upon receipt of water samples by BLV RTL a chlorine demand test was performed by dosing each sample with a known volume of chlorine stock solution and measuring the residual chlorine concentration at several known intervals. The total residual chlorine analysis was completed using a Hach kit. The results from the chlorine demand test helped the team refine the chlorine doses to be utilized in the chlorine dose response tests as the water quality variability of each sample can render the dose response tests useless if a dose is too high or too low. Chlorine dose response tests were performed by dosing the samples with a known volume of chlorine stock solution and

measuring both the total residual chlorine and fecal coliform concentration at specific contact times.

Two sets of the wet weather samples presented complications in the analytical procedures to measure bacteria. Typically, samples are warmed up to room temperature prior to measuring undisinfected bacteria and performing chlorine dose response tests. However, for the 10/31/2022 event at Oakwood, the undisinfected bacteria measurements for fecal coliform were taken from a sample shipping container that had not warmed up to room temperature. The lower temperature of the undisinfected bacteria sample resulted in lower fecal coliform counts when compared to the bacteria counts at the first two contact times of the first chlorine dose response test. All subsequent chlorine dose response tests were performed correctly by allowing the sample container to warm up to room temperature prior to collecting samples. For modeling purposes, the undisinfected count was taken as the maximum fecal coliform observed, typically occurring at either the 1- or 3-minute mark of the chlorine dose response tests. One measurement of fecal coliform taken at the 15-minute interval was omitted given that it was higher than the previous four measurements taken (**Figure 5-1**). In addition to the outlier fecal coliform count, one outlier measurement of total residual chlorine (TRC) (**Figure 5-2**) taken at 30 minutes was higher than the preceding five measurements and omitted prior to disinfection modeling.

For the 11/27/2022 event at Leib, The Design Team identified several outlier measurements of fecal coliform. These outliers (**Figure 5-1**) differed by more than one order of magnitude (one log) from both the preceding and subsequent measurements. The four outliers were removed prior to disinfection modeling to avoid compromising model performance. Data from and analysis procedures for these chlorine dose response tests, including the duplicate QAQC samples, were reviewed and no issues were found. The outlier measurements from Leib are discussed further in Section 6.1. A summary of all omitted values is provided in **Table 5-1**.

GLWA Chlorine Dose Response Results and ICT Model

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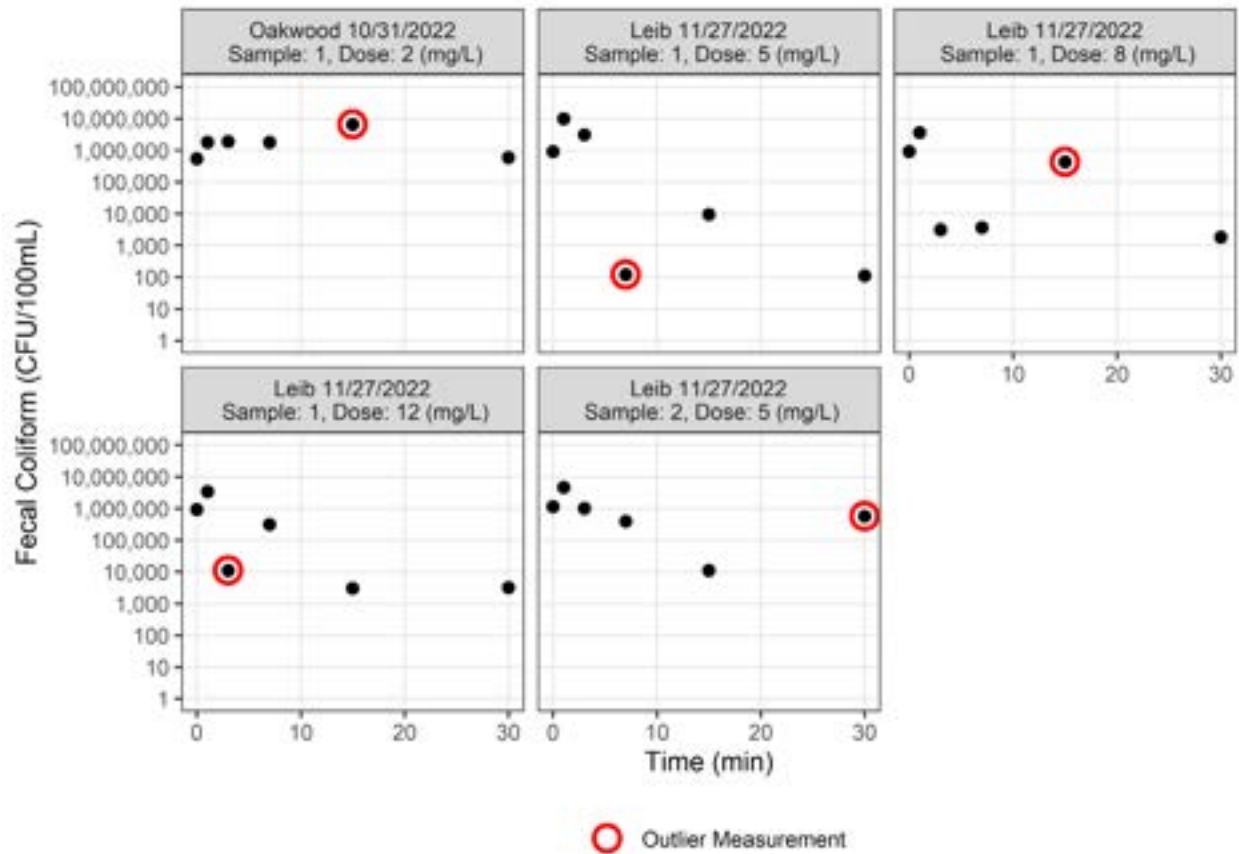


Figure 5-1
Omitted Fecal Coliform Measurements at Oakwood (10/31/2022) and Leib (11/27/2022).

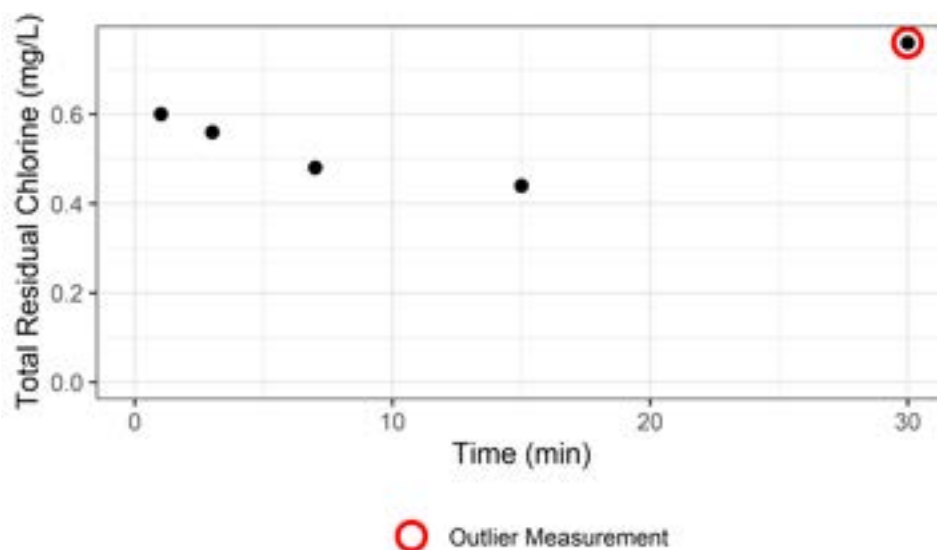


Figure 5-2

Omitted Total Residual Chlorine Measurement at Oakwood (10/31).

Table 5-1: Summary of Omitted Total Residual Chlorine and Fecal Coliform Measurements.

Facility	Event	Sample	Chlorine Dose (mg/L)	Parameter	Time (min)	Omitted Value
Oakwood	10/31/2022	1	2	Total Residual Chlorine (mg/L)	30	0.76
		1	2	Fecal Coliform (CFU/100mL)	15	6,500,000
Leib	11/27/2022	1	5	Fecal Coliform (CFU/100mL)	7	120
		1	8	Fecal Coliform (CFU/100mL)	15	430,000
		1	12	Fecal Coliform (CFU/100mL)	3	11,000
		2	5	Fecal Coliform (CFU/100mL)	30	570,000

6.0 Results

The following subsections present raw CSO water quality data, describe the disinfection modeling approach, and provide disinfection modeling results.

6.1 Water Quality

When chlorine is added to wastewater in a combined sewer system, some fraction of it is instantly consumed, and is referred to as chlorine demand. The magnitude of this instantaneous demand is dependent on water quality of the water being disinfected. The concentrations of certain water quality parameters, such as organic matter (total suspended solids), nitrite and ammonia will have a significant impact on the chlorine demand. Ammonia, for example, reacts with chlorine to form chloramines. The chloramines are a weaker, yet effective, disinfectant than free chlorine, and the specific types and amounts are pH dependent. Reactions with organic matter and nitrite can increase chlorine demand, thereby reducing the residual chlorine available for disinfection.

Disinfection efficacy is directly correlated to ICT (mg-min/L), defined as the area under a chlorine dose response curve and is dependent upon the total residual chlorine concentration (C) (mg/L) and the effective contact time (T) (min). Total residual chlorine (TRC) includes free chlorine residual, which is a strong oxidant, chloramine residual, which generally are moderate oxidants, and chlorine reducing compounds, which have no disinfection value. Total chlorine residual at a given time is affected by water quality, so water quality characteristics are a key factor in disinfection efficacy. An ICT value is determined from chlorine dose response testing using **Equation 1** shown below.

Equation 1 Integrated Contact Time Formula

$$ICT = \frac{C_o - D}{k} * (1 - e^{-kt})$$

Where,

ICT = integrated CT (mg-min/L)

t = the effective contact time (theoretical contact time x baffling factor) (mins)

C_o = Chlorine dose (mg/L)

D = Chlorine demand (mg/L) (from chlorine dose response testing)

k = Chlorine decay (mg/L) (from chlorine dose response testing)

Water quality results from each sampling event for Oakwood and Leib are presented in **Table 6-1** and **Table 6-2**, respectively. Samples for each wet weather event are identified as “1”, “2”, and “3”, and reflect the order of sample collection during the wet weather event.

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Table 6-1 Undisinfected Water Quality Data at Oakwood Measured by BLV RTL and AmTest

Parameter	Units	10/31/2022			11/27/2022			2/27/2023
		1	2	3	1	2	3	1
Fecal Coliform (Max)	CFU/100mL	6,500,000	9,200,000	1,400,000	5,800,000	1,450,000	7,100,000	85,000
Fecal Coliform (Geometric Mean)	CFU/100mL	2,430,000	1,950,000	1,240,000	1,690,000	1,450,000	5,370,000	64,300
Ammonia	mg/L NH3-N	9.0	9.5	16.8	14.7	17.3	16.0	0.40
COD	mg/L	63.1	51.9	64.0	46.6	48.8	40.4	38.2
Color (Apparent)	Pt-Co	700	572	493	424	210	226	1,153
pH	SU	7.6	7.6	7.7	7.5	7.5	7.3	8.0
TOC	mg/L	16.0	12.0	14.0	16.0	13.5	12.0	4.6
TSS	mg/L	69	40	47	68	42	31	12
UV 254 (Apparent)	abs/cm	0.31	0.28	0.31	0.54	0.42	0.34	0.5

Table 6-2 Undisinfected Water Quality Data at Leib Measured by BLV RTL and AmTEST

Parameter	Units	11/27/2022			1/19/2023			2/27/2023	
		1	2	3	1	2	3	1	2
Fecal Coliform (Max)	CFU/100mL	10,000,000	4,600,000	670,000	455,000	270,000	600,000	1,200,000	670,000
Fecal Coliform (Geometric Mean)	CFU/100mL	4,970,000	1,830,000	670,000	350,000	237,000	506,000	886,000	548,000
Ammonia	mg/L NH3-N	4.5	4.4	4.6	5.2	4.4	5.2	2.4	2.4
COD	mg/L	115.0	125.5	72.1	62.1	42.0	50.5	85.2	10.2
Color (Apparent)	Pt-Co	756	722	429	496	470	801	769	615
pH	SU	7.0	7.1	7.2	7.1	7.2	7.2	7.5	7.4
TOC	mg/L	28.0	31.0	34.5	14.5	19.5	16.0	9.8	10.8
TSS	mg/L	116	85	101	105.5	98.0	87.0	14.5	16.0
UV 254 (Apparent)	abs/cm	0.68	0.60	0.48	0.44	0.25	0.32	0.36	0.36

It is important to note the highly variable water quality characteristics in all four sampling events, and even between the first, second, and third samples within a sampling event. The variability in water quality helps establish a rough operational envelope a disinfection system will be required to perform within. Given this variability in water quality, without any predictable pattern, it will be important to utilize conservative design criteria to ensure that the disinfection system will be effective under a wide range water quality conditions (i.e. both high and low organic loading). Seasonal variations in water quality of wastewater treatment plant influent served by combined and sanitary collection systems are well documented and understood in the water industry. In the same way, seasonal variations in water quality are typically observed in combined collection system wet weather events. Therefore, collecting additional samples for both water quality analysis and chlorine dose response testing over a 12-month period provides an opportunity to characterize the water quality during those wet weather events and allow for a refinement and increase in confidence of the results from this study.

For example, as shown in **Figure 6-1**, TSS concentrations were approximately two times greater in Leib than in Oakwood during the first two sample events at each facility. 2/27/2023 TSS measurements at both Oakwood and Leib were significantly lower than measurements collected during previous events. Daily precipitation was analyzed across several rain gages in proximity to the Oakwood and Leib facilities. Daily event and previous 14-day totals are averages between gages per facility and summarized in **Table 6-3**. Previous 14-day totals at Oakwood (1.1") and Leib (0.7") were significantly larger on 2/27/2023 when compared to the other events, suggesting a "first-flush" in which pollutant build up over a dry period washes off during a wet weather event, may have occurred prior to the sampling event and contributed to lower TSS on 2/27/2023. It is worth noting that the rainfall measured for the previous 14 days period ahead of the 2/27/23 sampling event all occurred during a single storm event on 2/23/23. Low snowfall totals in the 14 days prior to sampling indicate snowmelt was not likely to be a significant factor in flushing the collection system. The higher concentrations of particulate matter (sample photos shown in **Figure 6-2**) likely contributed to lab measurement complications and the subsequent fecal coliform omissions presented in **Figure 5-1** and **Table 5-1**.

Table 6-3 Summary of Rainfall and Snowfall Totals by Facility and Event

Event	Oakwood		Leib		Previous 14-day Total Snowfall (in)
	Day of Event Total Rainfall (in)	Previous 14-day Total Rainfall (in) ¹	Day of Event Total Rainfall (in)	Previous 14-day Total Rainfall (in) ¹	
10/31/2022	0.43	0.38	No bacteria samples collected		0.0
11/27/2022	1.0	0.2	1.0	0.2	2.0
1/19/2023	No bacteria samples collected		1.0	0.4	0.2
2/27/2023	1.2	1.1	0.9	0.7	1.9

¹Previous 14-day total excludes event daily total.

Ammonia timeseries (**Figure 6-3**) at Oakwood show increasing concentrations for the initial two samples, followed by a sharp increase on 10/31/2022 and slight decrease on 11/27/2022 in the

final sample. Ammonia concentrations at Leib were stagnant at approximately 5.0 mg/L. Again, the 2/27/2023 ammonia concentrations were significantly lower due to diluted samples from the higher-flow event.

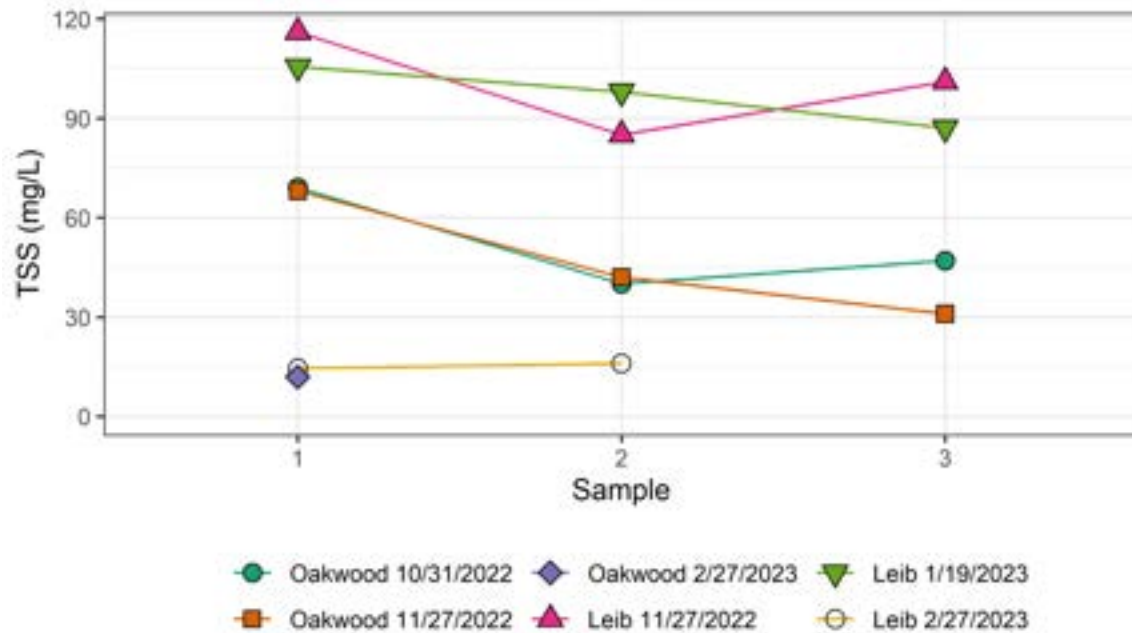


Figure 6-1
TSS as a Function of Time During Wet Weather Events



Figure 6-2
Particulate Concentration in Fecal Coliform Samples from Leib (11/27/2022).

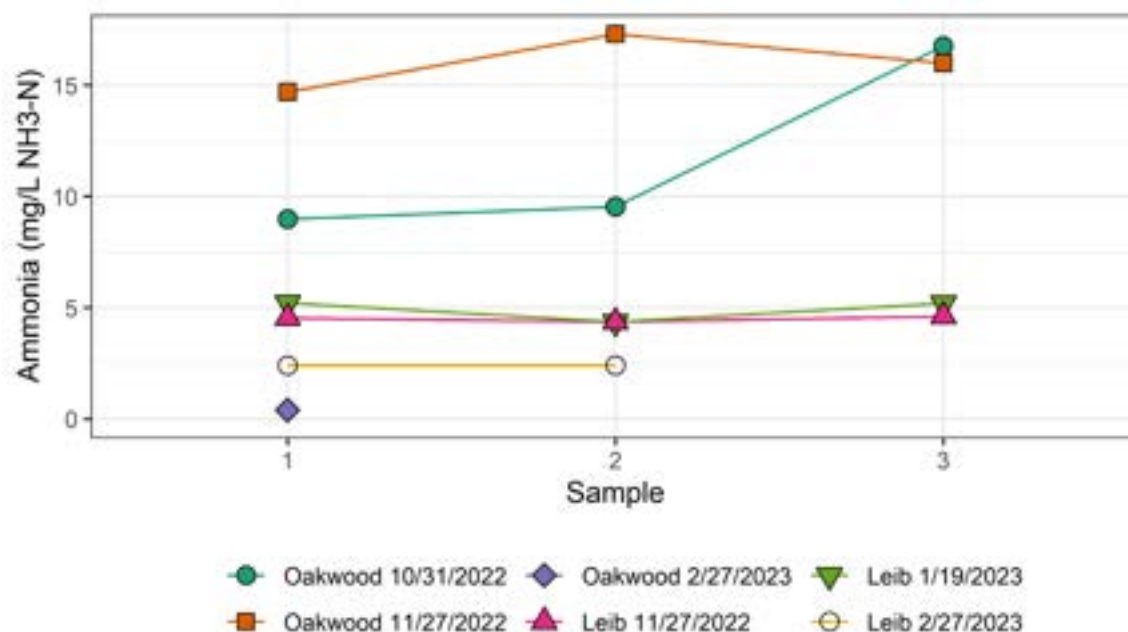


Figure 6-3
Ammonia as a Function of Time During Wet Weather Events

6.2 Chlorine Demand

Chlorine demand may be calculated from the dose response tests by subtracting TRC measured at a 30 or 60 second contact time from the initial chlorine dose. This approach recognizes the fast kinetics that occur in the water matrix after chlorine is added. Chlorine decay is calculated as the difference between TRC measured at a 30 or 60 second contact time and the final TRC measurement (30 minutes). In one instance, the Design Team used TRC at 15 minutes to calculate decay due to an error in measurement at 30 minutes.

Chlorine demand (with decay included) patterns at each facility and sample (**Figure 6-4**) indicate a positive correlation between chlorine demand and dose. The highest demands were observed at Leib, where doses ranged from 5 to 12 mg/L. Chlorine demands on 11/27/2022 at Leib also consistently decreased over the duration of the event. There was no clear and persistent relationship between demand and time for the 1/19/2023 weather event at Leib nor with the samples taken at Oakwood. As shown in **Figure 6-4**, the chlorine decay observed in the chlorine dose response tests was typically a small fraction of the total chlorine demand. Meaning that the majority of the difference between the TRC after a contact time and the chlorine dose stems from the chlorine demand exerted. Several outliers exist where chlorine decay comprises more than half of the chlorine demand (11/27/2022) at Leib, sample #1; dose = 12 mg/L and 2/27/2023 at Oakwood). Sample timing nor dose correlate with chlorine decay.

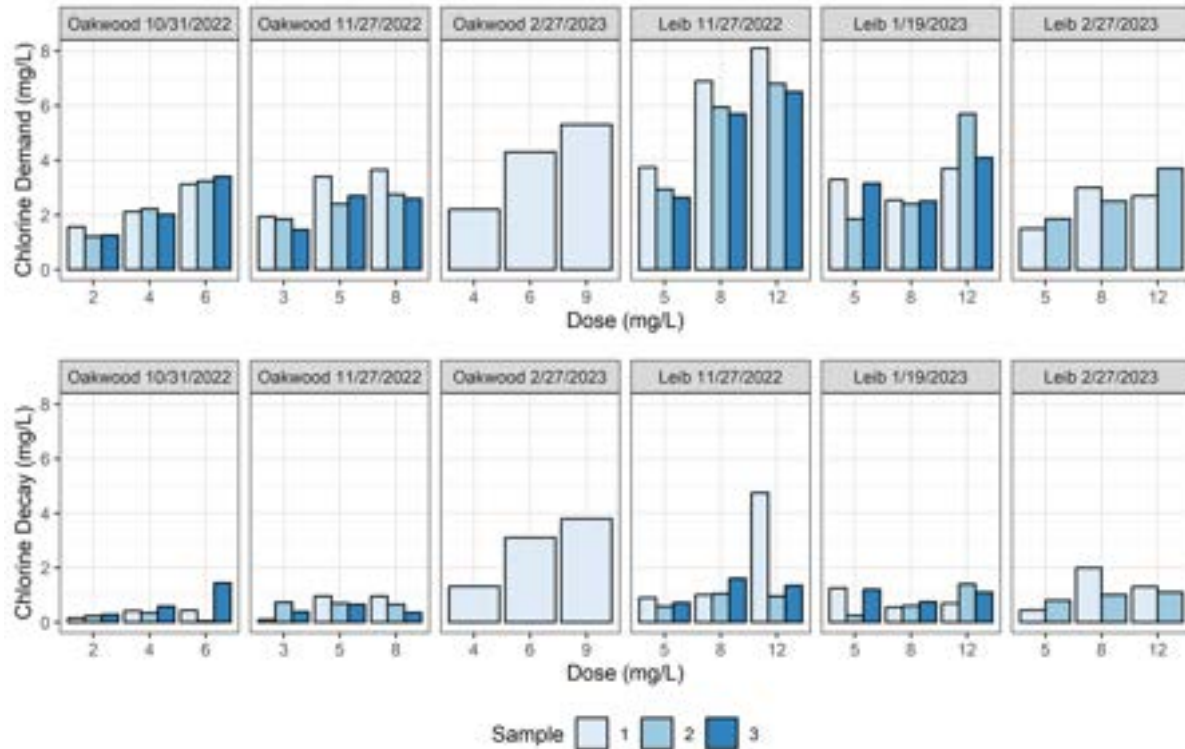


Figure 6-4
Chlorine Demand (Top) and Decay (Bottom) by Dose and Sample for All Wet Weather Events

The average chlorine demands per dose (i.e., all samples per dose included in average) are plotted as a function of dose (**Figure 6-5**) for all sampling events. Demand increases steadily between a dose of 2 mg/L and 5 mg/L at Oakwood before presenting with scattered results at doses of 6 mg/L and above. The demand response to dose at Leib are scattered and do not follow any consistent trend. The higher demand for the first Leib wet weather event, compared to the Oakwood events, could be attributed to the higher TSS values observed (average TSS of 100 mg/L vs. 52 mg/L and 47 mg/L for the Oakwood events).

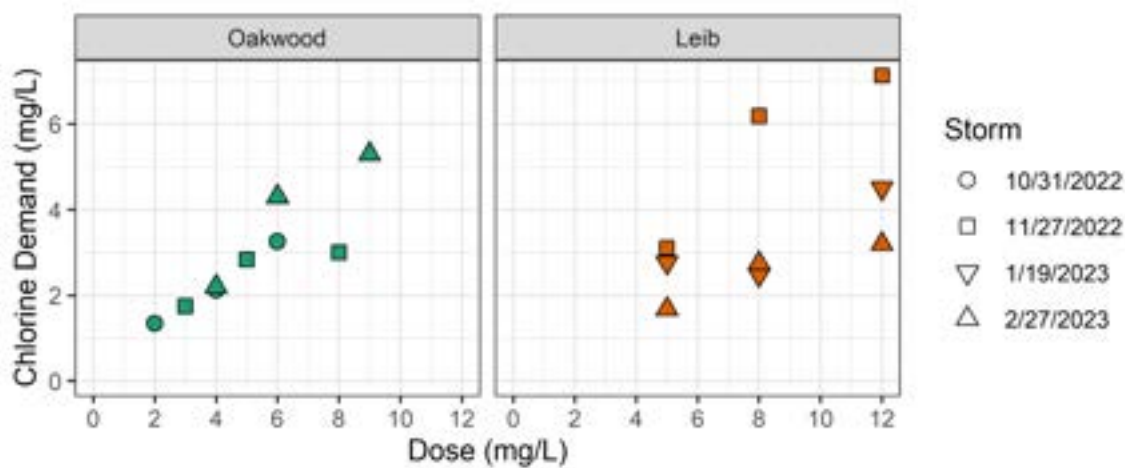


Figure 6-5
Chlorine Residual as a Function of Dose (Oakwood and Leib)

The 1/19/2023 and 2/27/2023 events at Leib produce significantly lower demand responses at doses of 8 and 12 mg/L when compared to the 11/27/2022 event. Chlorine demand as a function of TOC (**Figure 6-6**) show higher demands at Leib correlating with higher constituent concentrations (TOC $R^2=0.57$). Positive, yet weaker correlations are apparent between chlorine demand and chemical oxygen demand (COD) (**Figure 6-7**) and TSS (**Figure 6-8**). However, there is no correlation between demand and TSS when isolating just the Leib samples.

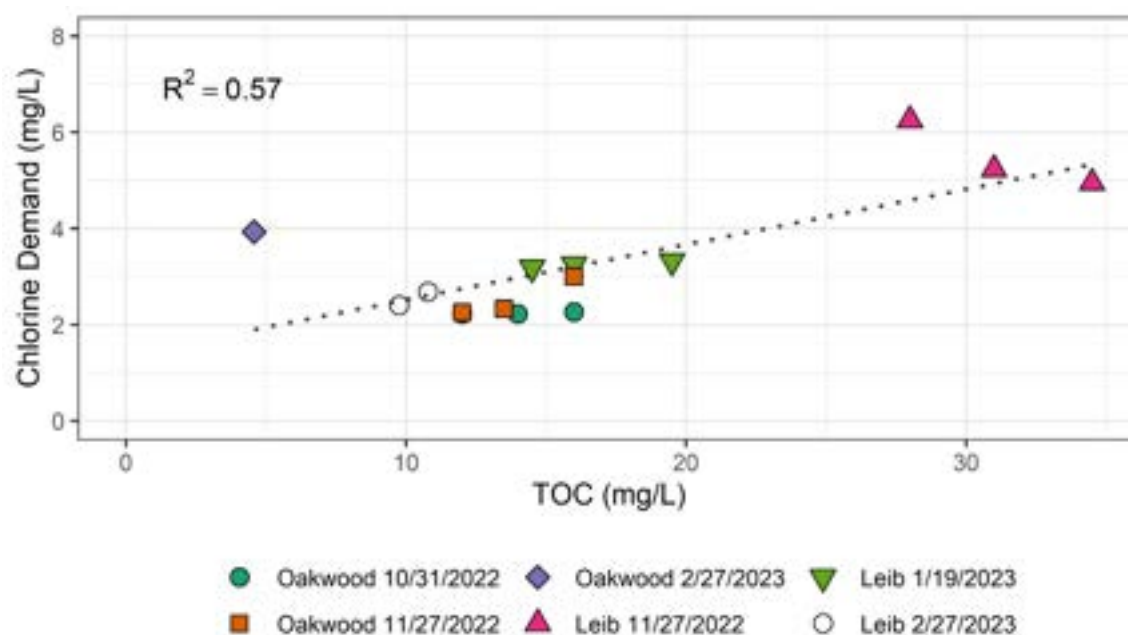


Figure 6-6
Chlorine Demand as a Function of TOC During Wet Weather Events

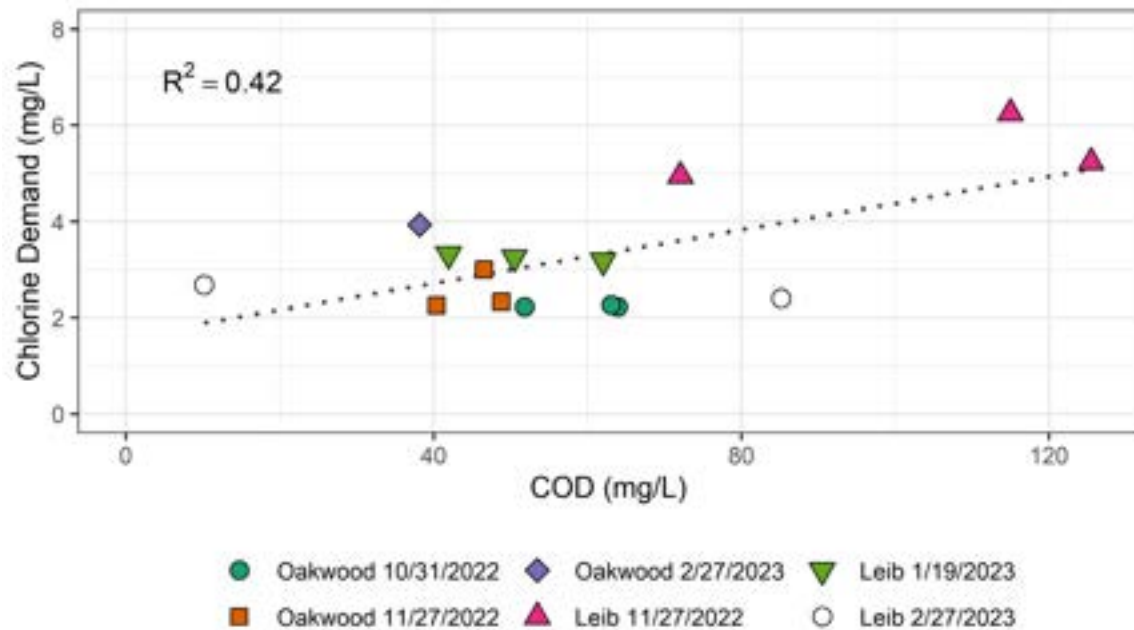


Figure 6-7
 Chlorine Demand as a Function of COD During Wet Weather Events

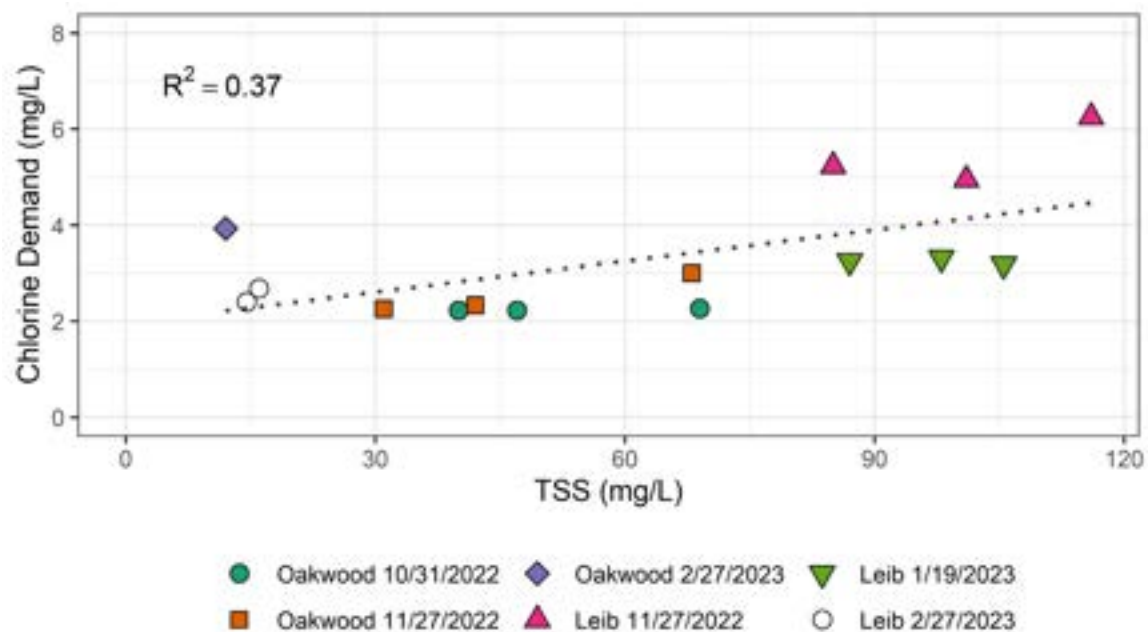


Figure 6-8
 Chlorine Demand as a Function of TSS During Wet Weather Events

6.3 Chlorine Demand and Decay Characteristics

Chlorine dose and residual concentrations over time at Oakwood and Leib (**Figure 6-9** and **Figure 6-10, respectively**) show the time required for residual stabilization. There is no clear relationship between dose and time required for TRC to stabilize. The Design Team identified two unusual TRC measurements that are not consistent with the expected trends in TRC. The “Sample 1” TRC at a contact time of 1-minute and chlorine dose of 3 mg/L in Oakwood (**Figure 6-9**) is less than the subsequent TRC measurements at 3-minutes, 7-minutes, and 15-minutes. The “Sample 1” TRC at 7-minutes and chlorine dose of 12 mg/L in Leib (**Figure 6-10**) is less than the following TRC measurement at 15-minutes. While unusual, these data points were not removed prior to disinfection modeling as they do not compromise model results.

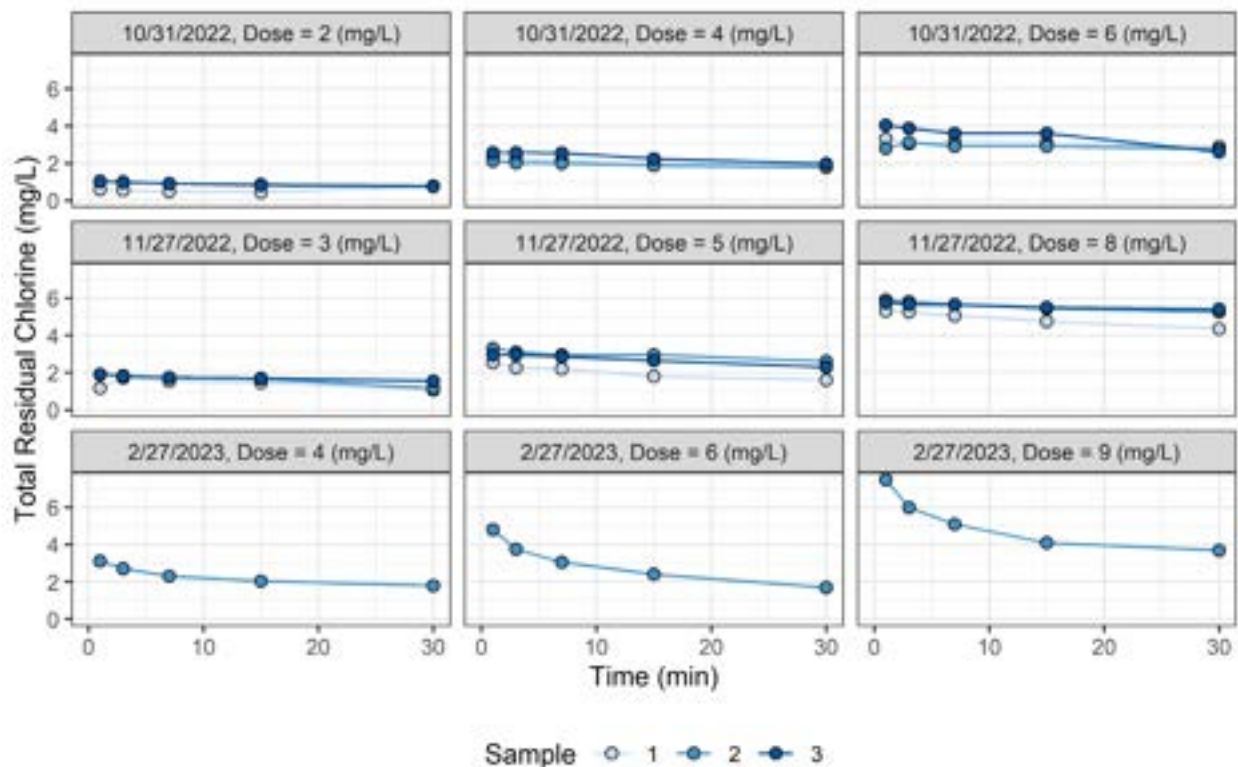


Figure 6-9
Total Residual Chlorine as a Function of Time for Oakwood Samples Separated by Dose.

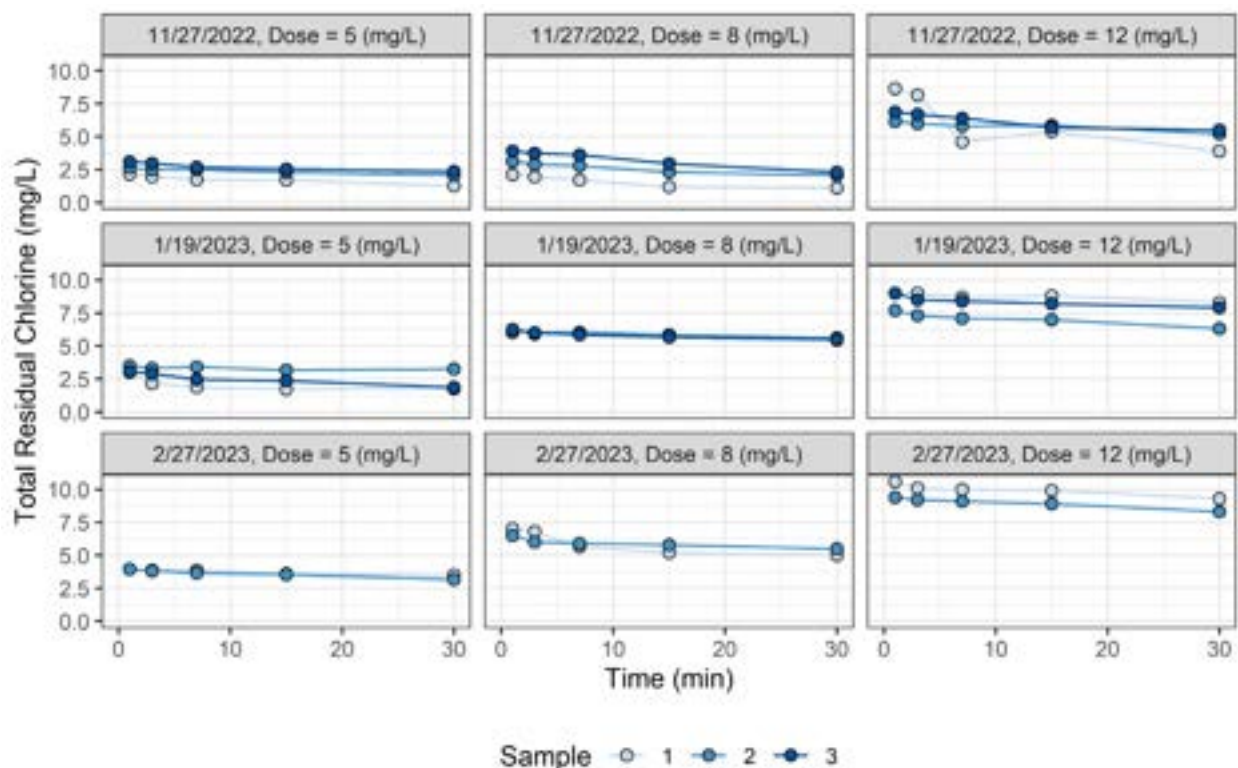


Figure 6-10

Total Residual Chlorine as a Function of Time for Leib Samples Separated by Dose and Wet Weather Event.

6.4 Bacteria Modeling Approach

For wastewater disinfection and CSO discharge, it is common for the disinfection characteristics to follow a dual population type disinfection pattern. The total population of fecal coliform in the water can be thought of as having two distinct parts. The first part contains bacteria that are not associated with particles and are affected quickly by chlorine. The second part is more difficult to disinfect either because they are innately less sensitive to chlorine or because they are associated with particles or exist in clumps that prevent chlorine from reaching them as quickly. Therefore, there is usually an initial decrease of bacteria that happens quickly followed by a slower decrease in bacteria. The dose response for each part of the population can be described by a first order decay coefficient. These coefficients are determined by fitting the disinfection kinetics to **Equation 2**.

Equation 2 Dual Population Disinfection Model

$$N = N_o(1 - B)e^{(-K_d*ICT^m)} + (N_o \times B)e^{(-K_p*ICT)}$$

Where:

N = Fecal coliform concentration after applied ICT

No = initial fecal coliform concentration

β = Coefficient for particle based (“hard to inactivate”) fecal coliform population

k_p = the first order decay rate of “hard to kill” fecal coliform

k_d = the first order decay rate of “easy to kill” fecal coliform

ICT = Area under the chlorine dose response curve at a given contact time

m = Coefficient for magnitude of k_d

The Design Team developed models to best fit the observed fecal coliform counts. The Design Team optimized four parameters (β, k_d, k_p, and m) to produce a model that minimizes the residual sum of squares (RSS) (**Equation 3**) between modeled and observed data points. Model and observed fecal coliform counts are log transformed prior to RSS calculation to ensure the model doesn’t prioritize prediction at higher bacteria counts (where squared residuals are much greater).

Equation 3 Residual Sum of Squares (RSS) Formula

$$RSS = \sum_{i=1}^n (y_i - \hat{y}_i)^2$$

where:

y = modeled result

ŷ = observed data

n = number of observations

i = observation

An example disinfection model fit to observed fecal coliform counts is shown in **Figure 6-11**. There is a significant amount of variability in observed fecal coliform, which makes the modeling process difficult. The example model in **Figure 6-11** tends to underestimate fecal coliform at low ICTs and overestimate fecal coliform at high ICTs. The approach of minimizing residual sum of squares helps eliminate model bias, in which a model may consistently over or underestimate predictions and provides an objective statistical justification in determining a final model.

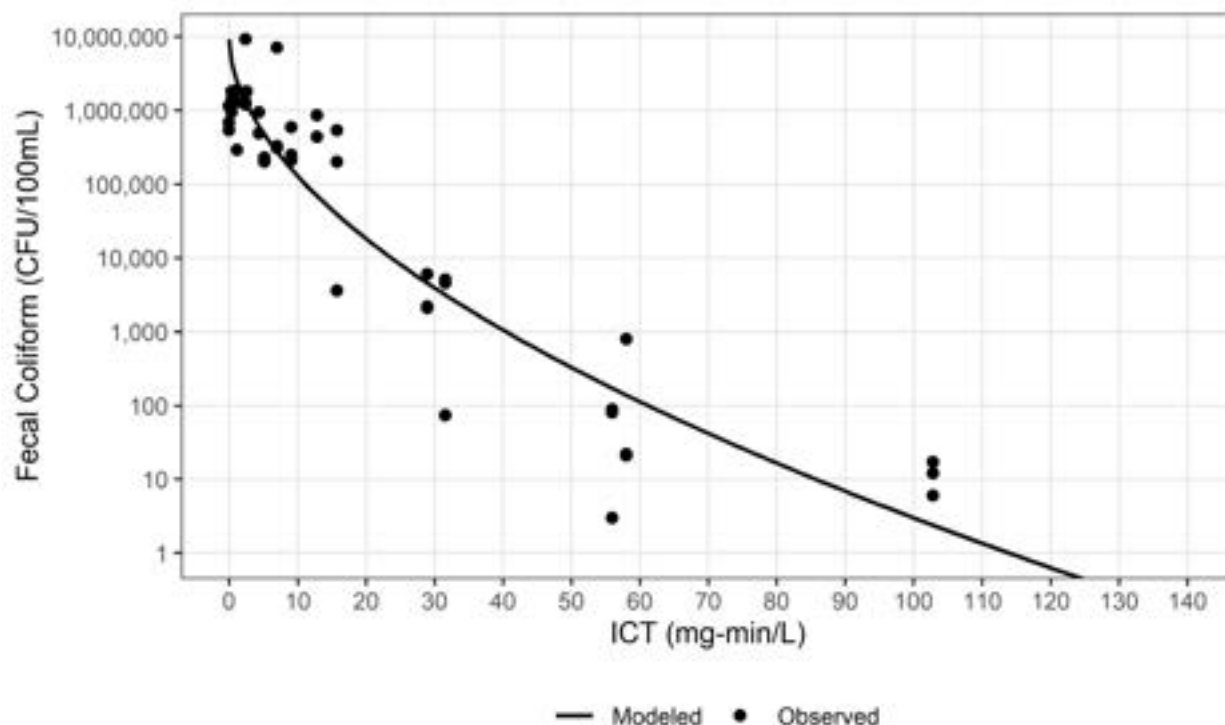


Figure 6-11
Example Disinfection Model Fit to Observed Fecal Coliform Counts

6.5 CSO Discharge Permit Limits

The disinfection facility must meet the National Pollution Discharge Elimination System (NPDES) permit requirements and state limits for fecal coliform. Wet weather goals are established for total residual chlorine and presented along with fecal coliform permit limits in **Table 6-4**. Additionally, the Oakwood NPDES permit includes a wet weather event average TRC goal of 1.5 mg/L. It is worth noting that the fecal coliform permit value during the recreation season is a maximum value of 400 CFU/100mL. Because exceeding this value would be a permit violation, the disinfection system must be able to consistently treat the wet weather flow to values under that maximum value. In other words, targeting a lower bacteria count will account for variability in influent water quality and system performance. Therefore, a target of 200 CFU/100mL of fecal coliform is utilized for some of the system performance criteria.

Table 6-4 NPDES TRC Goals and Fecal Coliform Limits

Period	Event Instantaneous Maximum TRC (mg/L)	Maximum Fecal Coliform (CFU/100mL)
November 1 - April 1	2.0	1,000
May 1 – October 31	3.0	400

The Design Team evaluated disinfection performance to several operating targets to ensure an appropriate design. The operating targets are based on NPDES bacteria permit limits (**Table 6-4**) and their associated log inactivation (**Table 6-5**). Log inactivation, along with actual bacteria counts, from the chlorine dose response testing is used to determine the site-specific ICT value that will be utilized to set the design criteria for the sodium hypochlorite storage and feed systems. When establishing the fecal coliform log inactivation values for selecting the ICT values, the Design Team used the following three conditions:

- Average undisinfected fecal coliform counts down to half of the recreational season max value (200 CFU/100mL)
- Maximum fecal coliform value measured down to the recreational season max value (400 CFU/100mL)
- Maximum fecal coliform value measured down to half of the recreational seasonal bacteria limit (200 CFU/100mL).

As shown in **Table 6-5**, using a target fecal coliform count of 200 CFU/100mL, compared to 400 CFU/100mL, increases the log inactivation required by 0.3, which provides a factor of safety to the design.

Table 6-5 Log Inactivation Permit Limits by Facility and Wet Weather Event

Inactivation Goal (IG)	Description	Oakwood			Leib		
		10/31	11/27	2/27	11/27	1/19	2/27
1	Average undisinfected bacteria to 200 CFU/100mL	3.8	4.1	2.5	4.0	3.2	3.5
2	Maximum bacteria to 400 CFU/100mL	4.4	4.2	2.3	4.4	3.2	3.5
3	Maximum bacteria to 200 CFU/100mL	4.7	4.6	2.6	4.7	3.5	3.8

When evaluating the disinfection performance results against the required inactivation goals (IG), the same IGs will be used for Oakwood (i.e. log inactivation from the 10/31/2022 testing). The 10/31/2022 IGs allow for a more conservative design as they are slightly higher at the maximum bacteria conditions than the 11/27/2022 testing. The 2/27/2023 IGs are considered outliers when trying to determine the high and average ICT values due to lower undisinfected bacteria counts. The 2/27/23 storm event data was used to determine the low ICT value for the system, which will impact the minimum capacity of the feed system. The second IG from 2/27/2023 (2.3) is lower than the first (2.5) because the average (70,600 CFU/100mL) and maximum (85,000 CFU/100mL) undisinfected bacteria counts used to calculate these IGs are similar in magnitude on a log scale. Therefore, the log inactivation goals for 2/27/2023 are more sensitive to differences in the target bacteria count. For Leib, the log inactivation requirements for the IGs are quite different between the three samples. The log inactivation required when starting with the maximum fecal coliform

counts from the 11/27/2022 sample is over 1 log inactivation greater than that for the 1/19/2023 sample. Applying the 11/27/2022 log inactivation requirements (4.4 and 4.7) to the 1/19/2023 disinfection model could be done, however that would yield exceptionally conservative ICT values as the undisinfected bacteria counts for the January wet weather event are approximately a log lower than that from the 11/27/2022 sample. As a result, the Leib wet weather events will use their own log inactivation values when determining the ICT value, and the highest one of the three will be utilized as the basis of design.

6.6 Bacteria Modeling Results

Disinfection efficacy is controlled by ICT, the product of the stabilized TRC and the contact time that the residual has with the water being disinfected prior to being neutralized. Typically, there is a strong, reproducible relationship between ICT and log inactivation of bacteria. The chlorine demand pattern discussed in the previous section illustrates how important water quality is to dose determination because it dictates the magnitude of the stabilized TRC concentration.

The Design Team determined design ICT values, and ultimately dosing requirements, by identifying the point at which modeled fecal coliform (or log inactivation) meet various NPDES permit -based log inactivation requirements.

Modeled and observed log inactivation (**Figure 6-12**, **Figure 6-14**, and **Figure 6-16**) and fecal coliform (**Figure 6-13**, **Figure 6-15**, and **Figure 6-17**) at Oakwood are expressed as a function of ICT and differentiated by sample event. Models fit to observed fecal coliform at Oakwood across all three sampling events (per storm) are expressed as log inactivation (**Figure 6-18**) and bacteria count (**Figure 6-19**), and it is these two figures that are used to determine the ICT values for a given facility. These two figures are used, rather than the model results for the individual samples taken during a wet weather event, because the combined models better represent the overall disinfection results for the samples collected and tested, and do not over emphasize the best or worst results.

Disinfection models expressed as log inactivation and bacteria count by sample for Leib are presented in **Figures 6-20** through **6-25**. Models fit to observed fecal coliform at Leib across all three samples (per storm) are expressed as log inactivation (**Figure 6-26**) and bacteria count (**Figure 6-27**). Like **Figure 6-18** and **Figure 6-19** for Oakwood, it is **Figure 6-26** and **Figure 6-27** that are utilized to determine the ICT value for the facility. The log inactivation permit limits in accordance with **Table 6-5** and bacteria count targets (200 CFU/100mL and 400 CFU/100mL) are represented by horizontal red lines.

ICT requirements may be discerned from **Figures 6-12** through **6-27** by reading the ICT value at each intersection between a modeled curve and permit limit. For example, an ICT of approximately 35 mg-min/L is required to meet the least conservative log inactivation permit limit of 3.8 at Oakwood on 10/31/2022 for “Sample 1.”

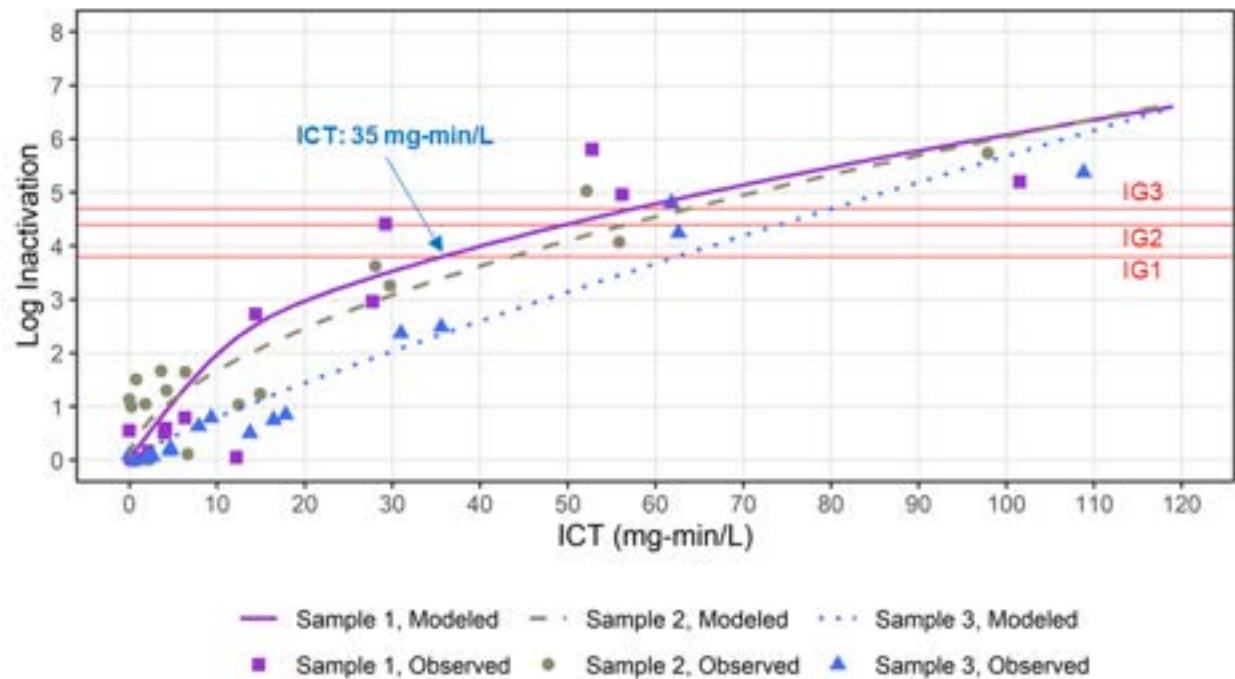


Figure 6-12
Modeled and Observed Fecal Coliform Log Inactivation by Sample as a Function of ICT on 10/31 at Oakwood. Log Inactivation Goals as Red Lines.

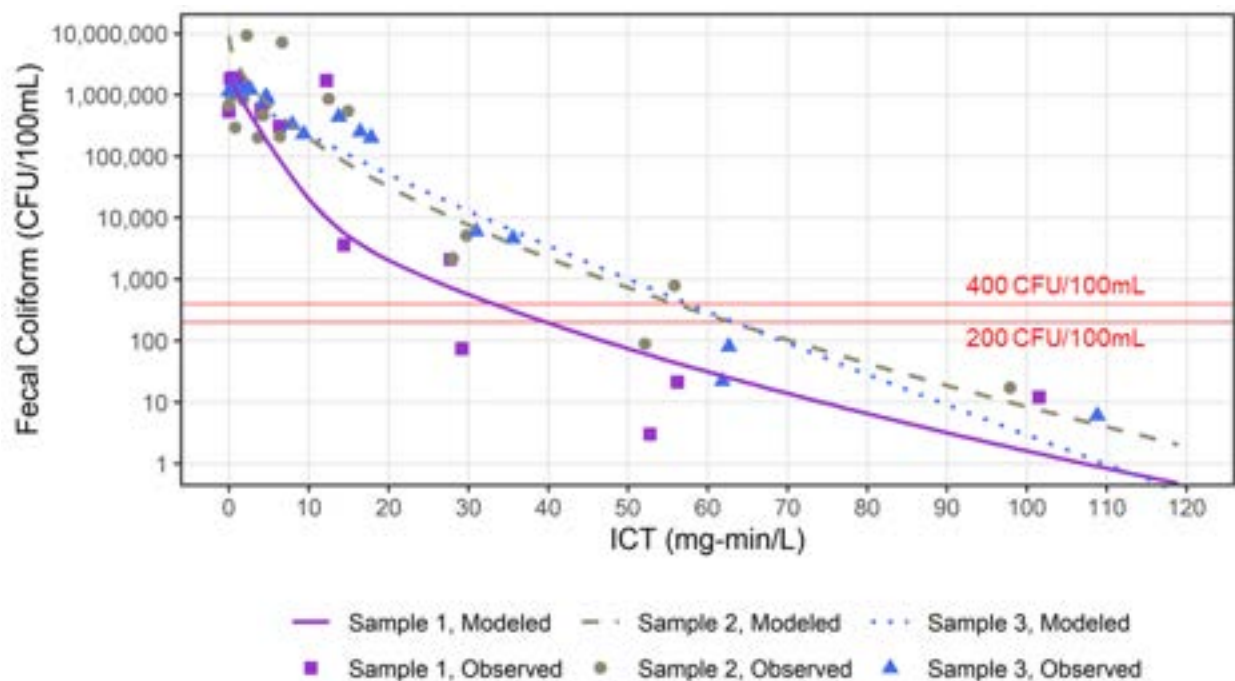


Figure 6-13
Modeled and Observed Fecal Coliform Bacteria Counts by Sample as a Function of ICT on 10/31 at Oakwood. Permit Limits as Red Lines.

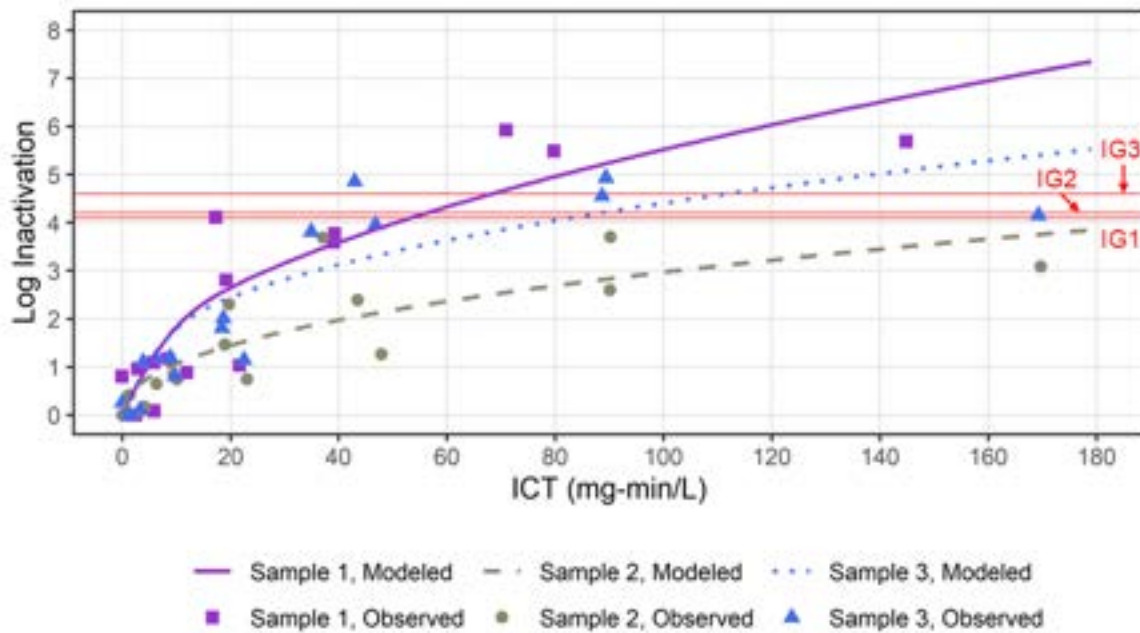


Figure 6-14
Modeled and Observed Fecal Coliform Log Inactivation by Sample as a Function of ICT on 11/27/2022 at Oakwood. Log Inactivation Goals as Red Lines.

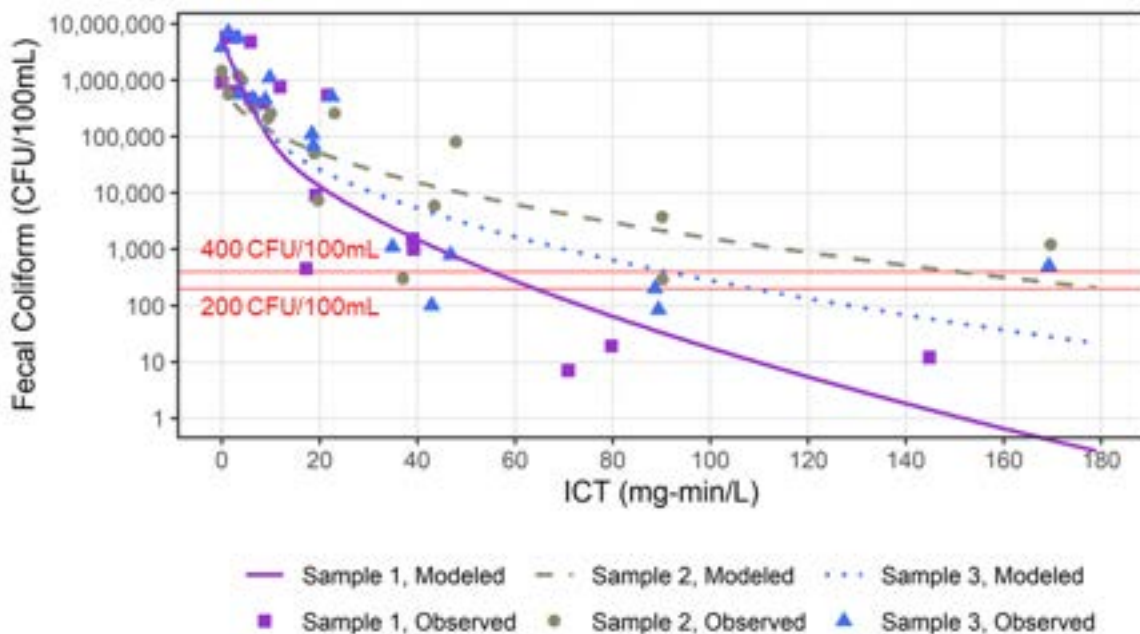


Figure 6-15
Modeled and Observed Fecal Coliform Bacteria Counts by Sample as a Function of ICT on 11/27/2022 at Oakwood. Permit Limits as Red Lines.

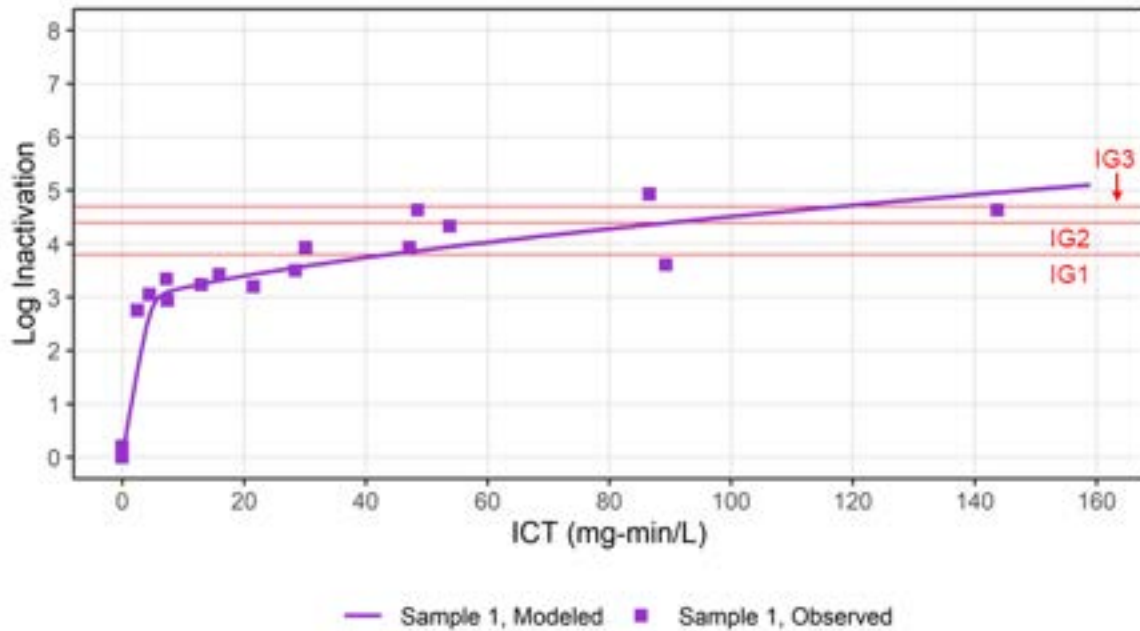


Figure 6-16
Modeled and Observed Fecal Coliform Log Inactivation by Sample as a Function of ICT on 2/27/2023 at Oakwood. Log Inactivation Goals as Red Lines.

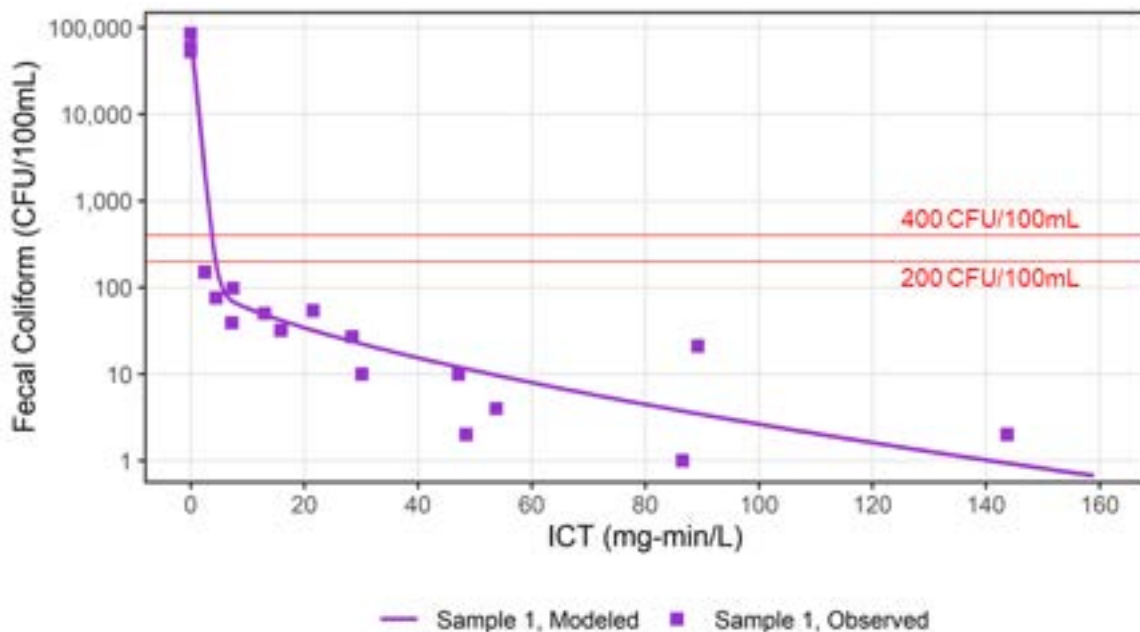


Figure 6-17
Modeled and Observed Fecal Coliform Bacteria Counts by Sample as a Function of ICT on 2/27/2023 at Oakwood. Permit Limits as Red Lines.

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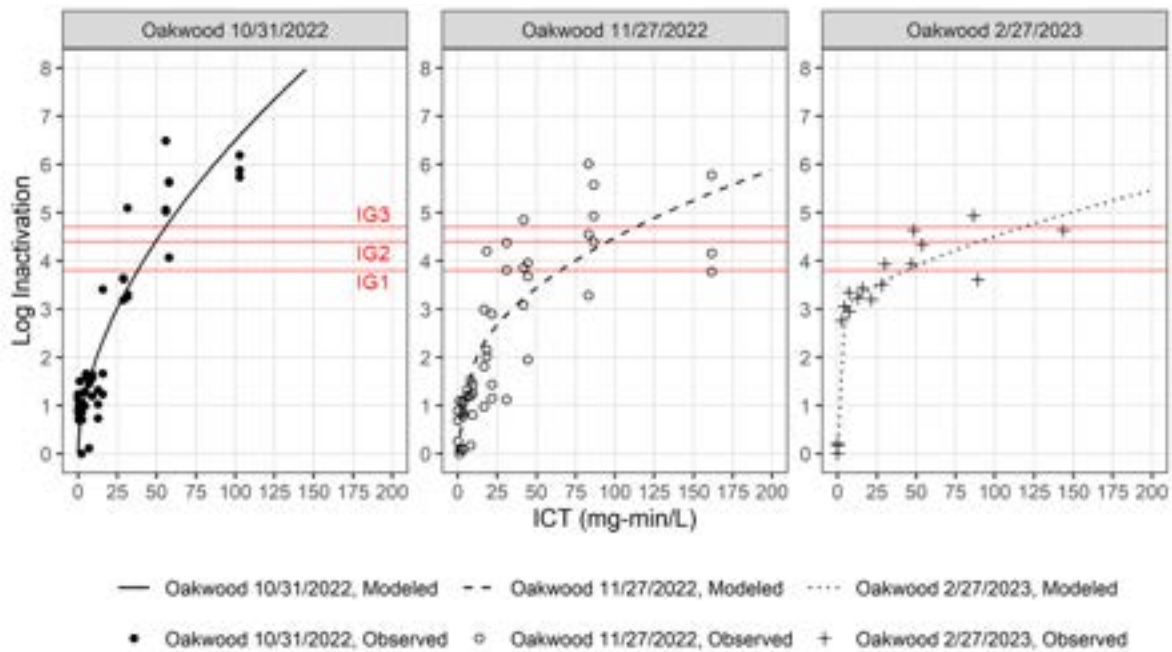


Figure 6-18
Modeled and Observed Fecal Coliform Log Inactivation by Wet Weather Event as a Function of ICT at Oakwood. Log Inactivation Goals as Red Lines.

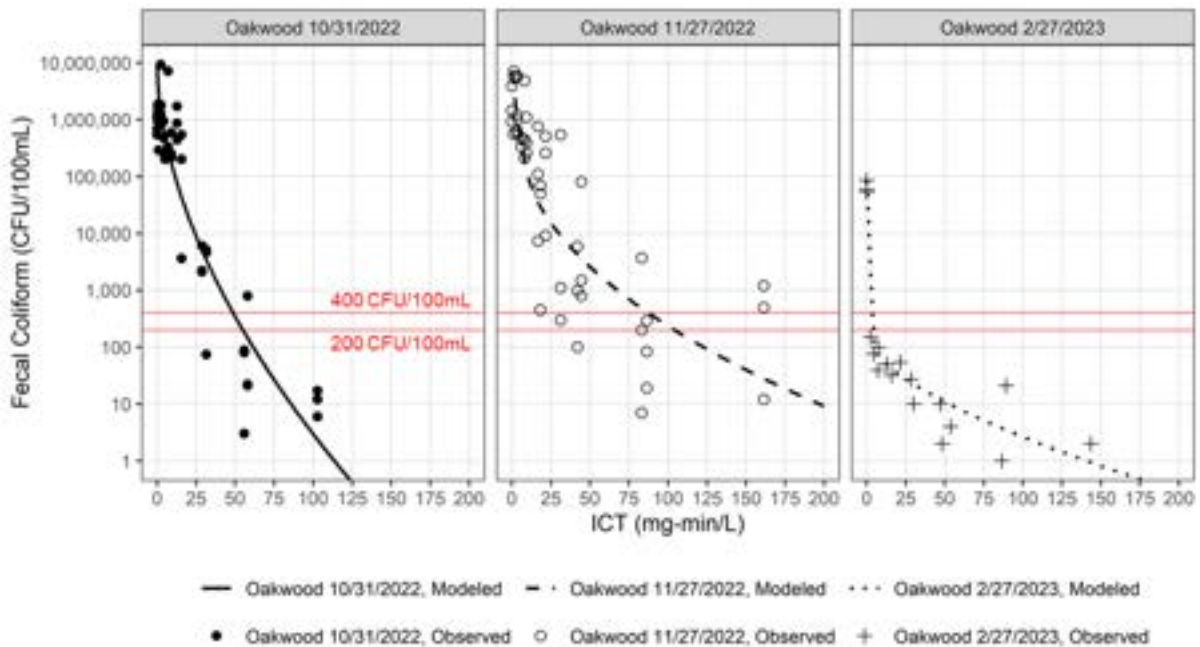


Figure 6-19
Modeled and Observed Fecal Coliform Bacteria Counts by Wet Weather Event as a Function of ICT at Oakwood. Permit Limits as Red Lines.

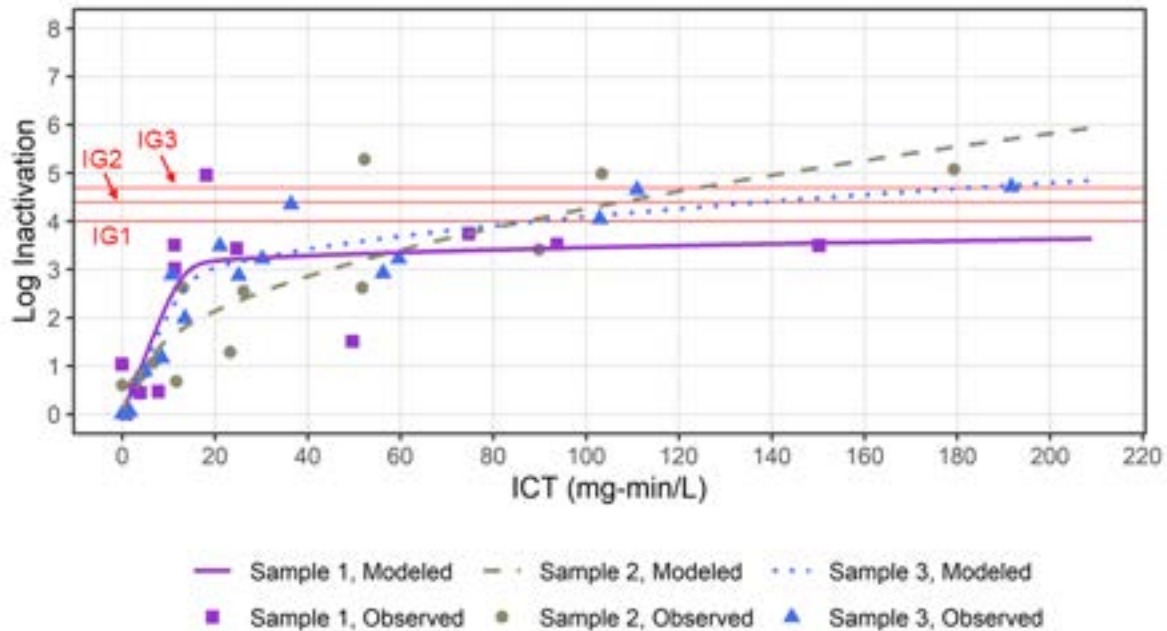


Figure 6-20
Modeled and Observed Fecal Coliform Log Inactivation by Sample as a Function of ICT on 11/27/2022 at Leib. Log Inactivation Goals as Red Lines.

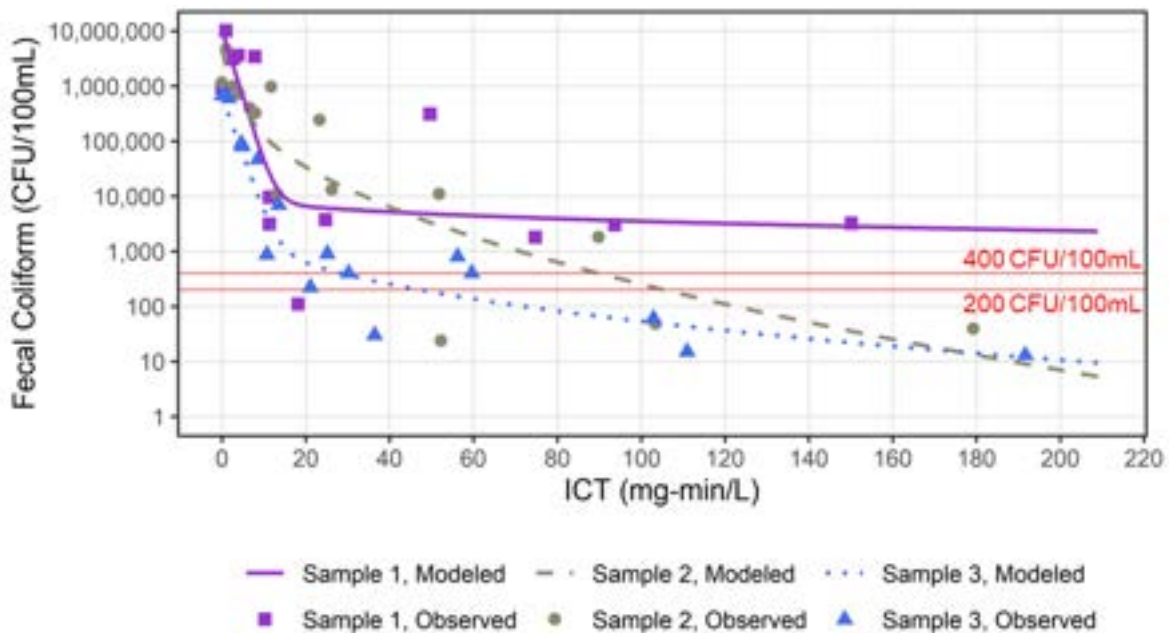


Figure 6-21
Modeled and Observed Fecal Coliform Bacteria Counts by Sample as a Function of ICT on 11/27/2022 at Leib. Permit Limits as Red Lines.

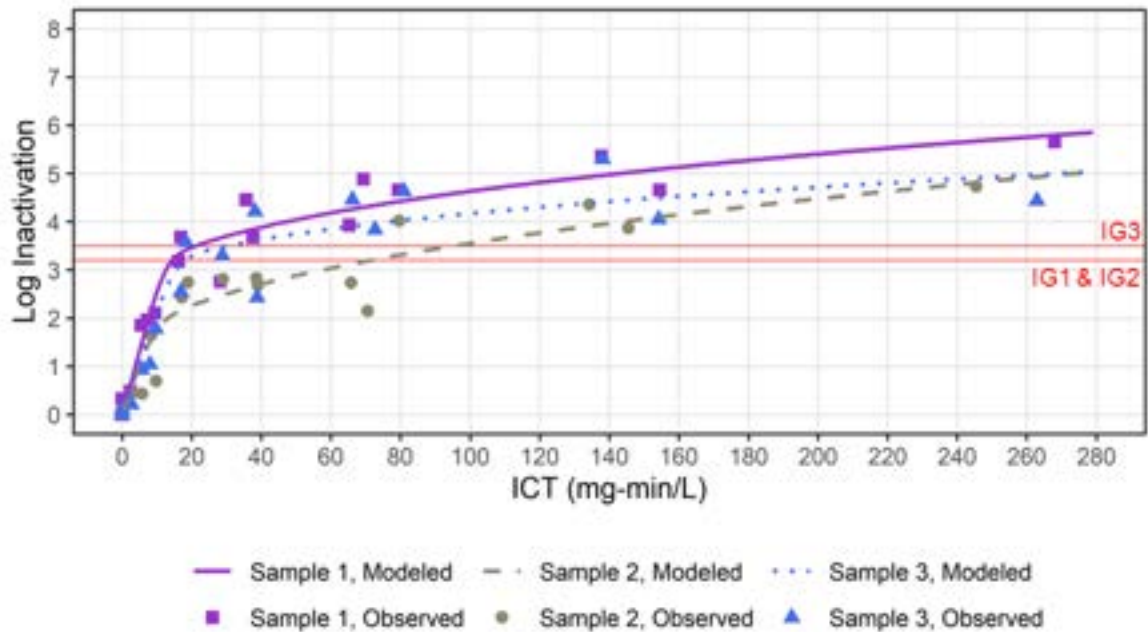


Figure 6-22
Modeled and Observed Fecal Coliform Log Inactivation by Sample as a Function of ICT on 1/19/2023 at Leib. Log Inactivation Goals as Red Lines.

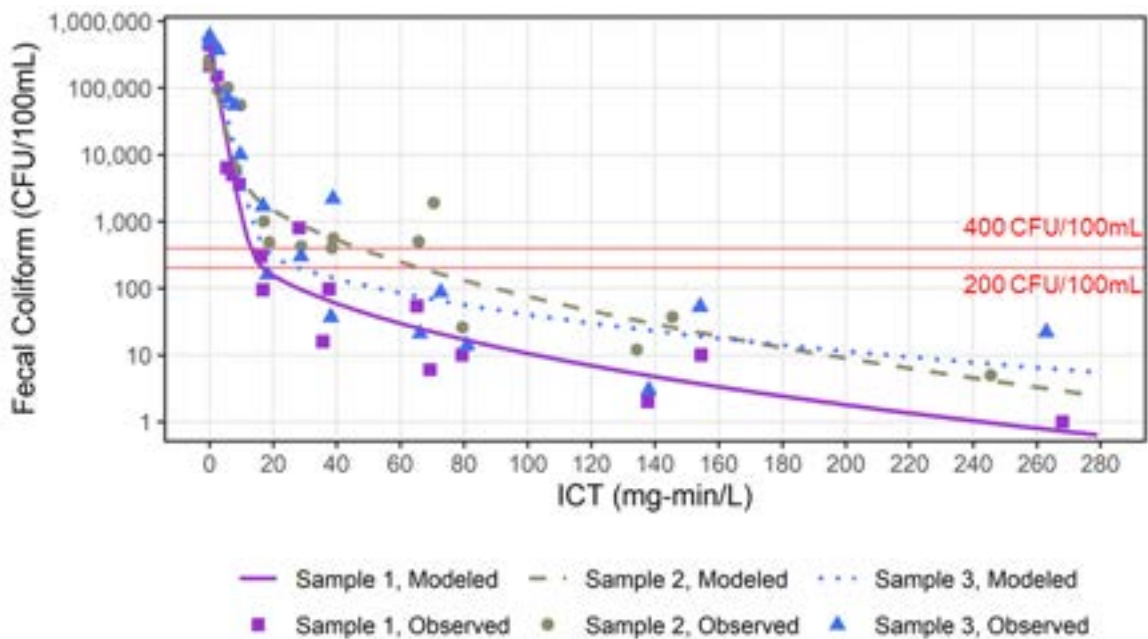


Figure 6-23
Modeled and Observed Fecal Coliform Bacteria Counts by Sample as a Function of ICT on 1/19/2023 at Leib. Permit Limits as Red Lines.

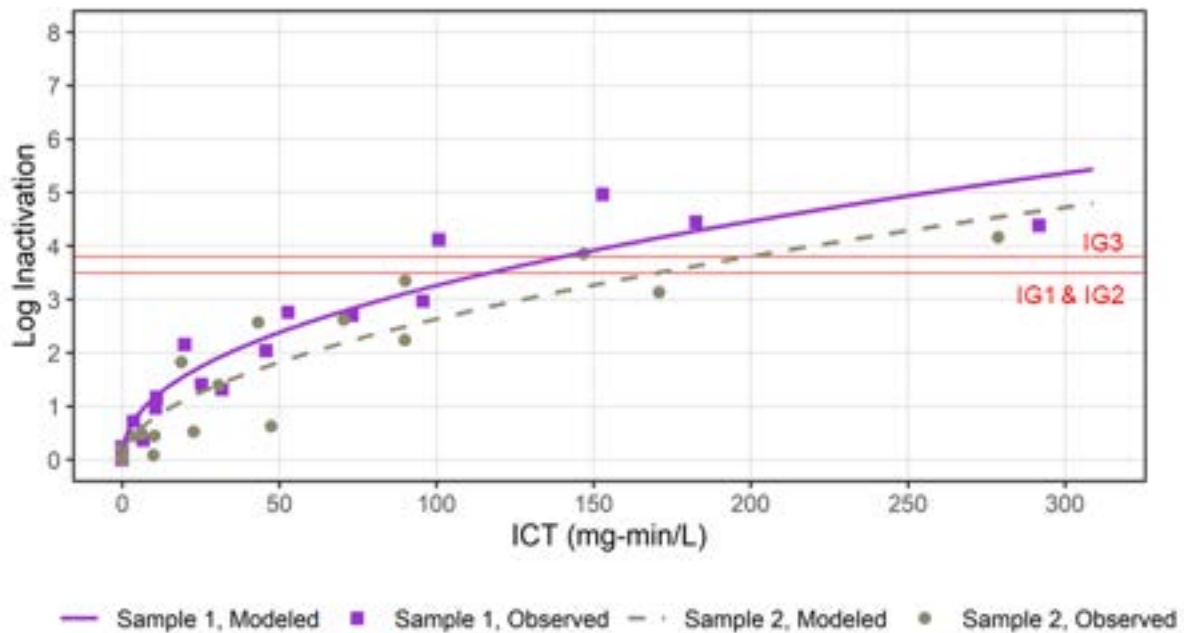


Figure 6-24
Modeled and Observed Fecal Coliform Log Inactivation by Sample as a Function of ICT on 2/27/2023 at Leib. Log Inactivation Goals as Red Lines.

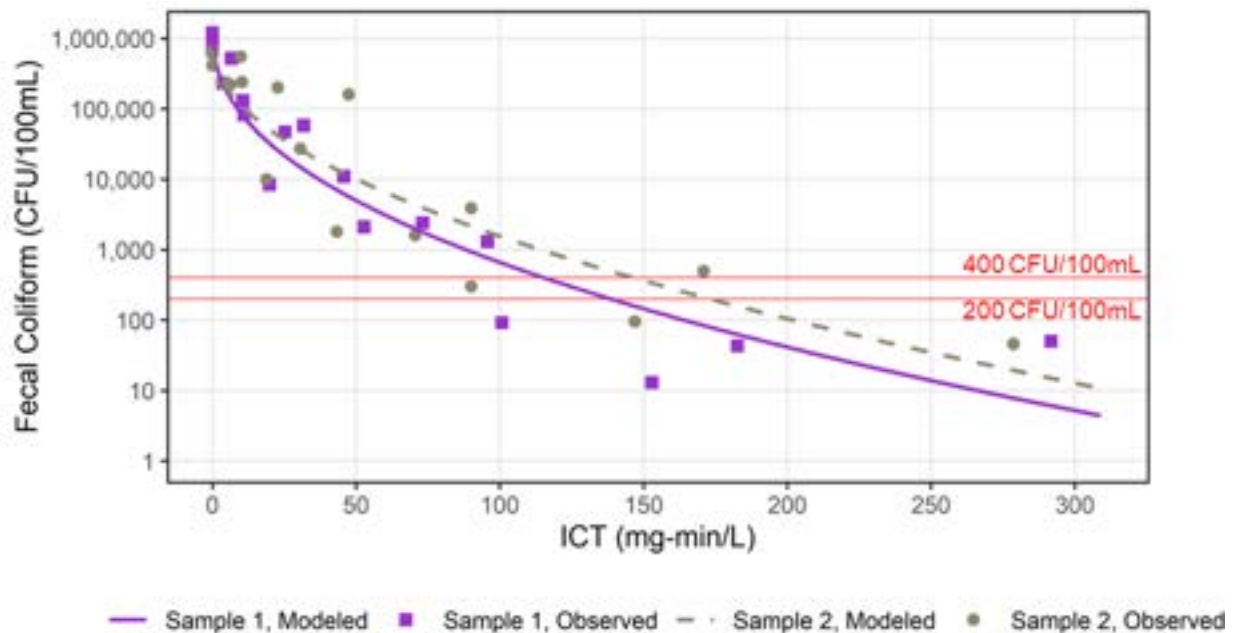


Figure 6-25
Modeled and Observed Fecal Coliform Bacteria Counts by Sample as a Function of ICT on 2/27/2023 at Leib. Permit Limits as Red Lines.

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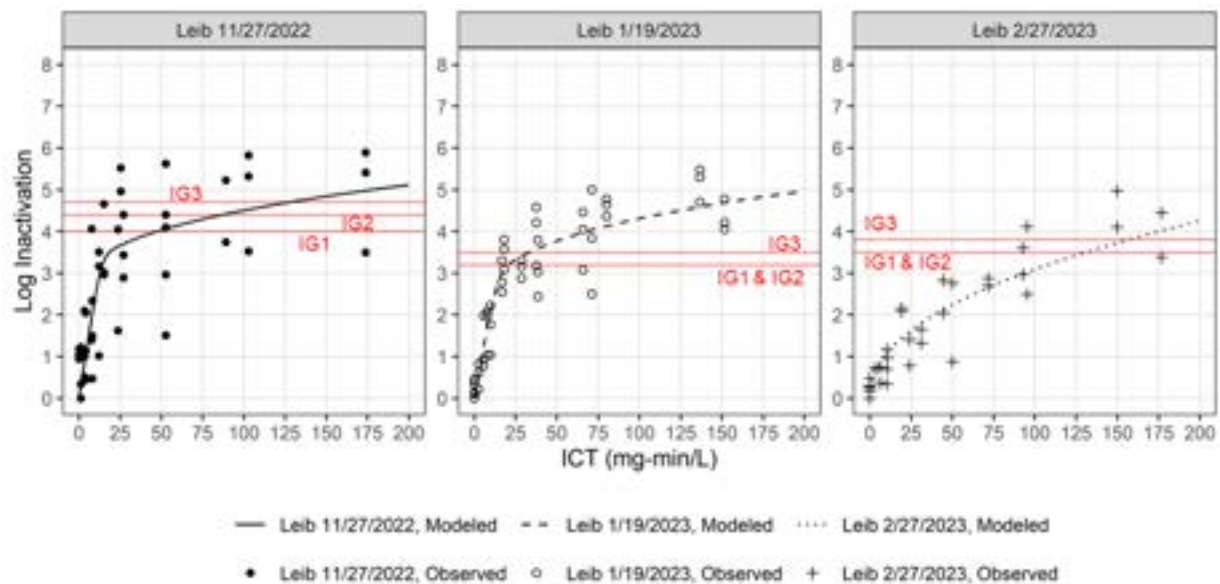


Figure 6-26
Modeled and Observed Fecal Coliform Log Inactivation as a Function of ICT on 11/27/2022 at Leib. Permit Limits as Red Lines.

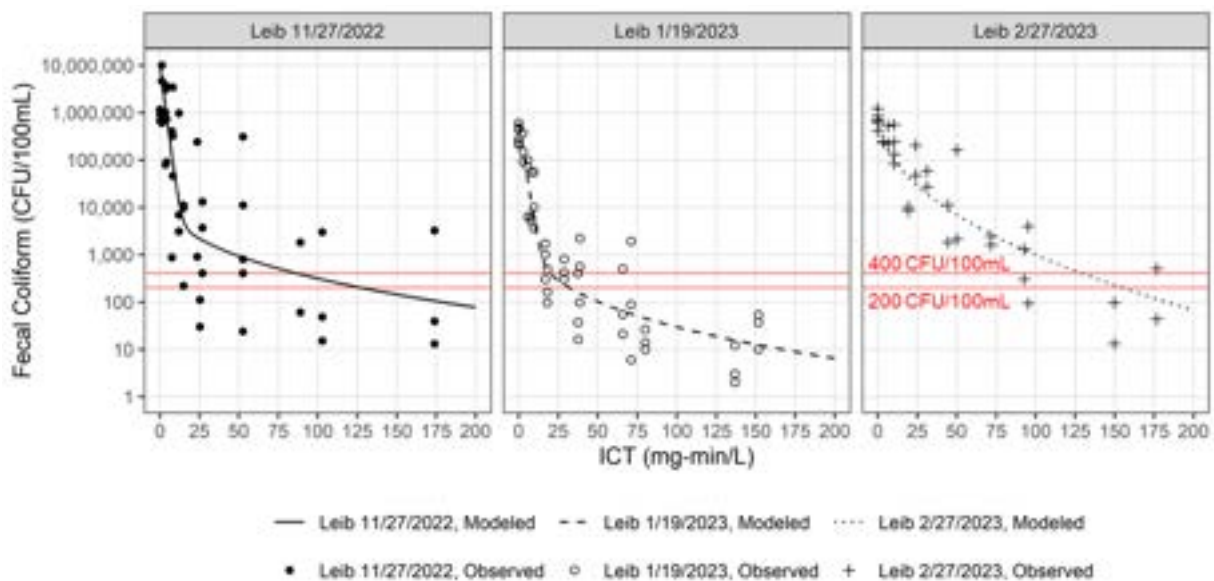


Figure 6-27
Modeled and Observed Fecal Coliform Bacteria Counts as a Function of ICT on 11/27/2022 at Leib. Permit Limits as Red Lines.

A comparison of ICT requirements required to reach the various inactivation goals (IG) for the event-based models (**Figures 6-18 and 6-19**, and **Figures 6-26 and 6-27**) are summarized in **Table 6-6** for both Oakwood and Leib.

Table 6-6 Summary of ICT Requirements For Event-Models by IG

Location	Event	Inactivation-Based ICTs				Count-Based ICTs		
		IG1	IG2	IG3	Max	400	200	Max
Oakwood	10/31/2022	38	50	56	56	49	55	55
	11/27/2022	65	96	113	113 ²	87	104	104
	2/27/2023	44 ¹	90	118	118 ²	4 ⁵	5	5
Leib	11/27/2022	47 ³	87	127	127 ⁴	87	127	127
	1/19/2023	21	21	33	33	20 ⁶	32	32
	2/27/2023	131	131	157	157 ⁴	129	155	155

¹ Median value used to determine design “average” Oakwood ICT

² Values used to determine design “high” Oakwood ICT

³ Median value used to determine design “average” Leib ICT

⁴ Values used to determine design “high” Leib ICT

⁵ Value used to determine design “low” Oakwood ICT

⁶ Value used to determine design “low” Leib ICT

The ICT values for Oakwood ranged from 38 to 118 across the various IGs. Higher ICTs of 113 (IG3 on 11/27/2022) and 118 (IG3 on 2/27/2023) were driven by higher stabilized fecal coliform counts and lower undisinfected counts, respectively (**Figure 6-19**). This restricted distribution of fecal coliform resulted in a more conservative model that failed to disinfect CSO as quickly as the 10/31/2022 model for Oakwood. There were no distinguishable characteristics in water quality between events. The ICT values for Leib ranged from 21 to 157 across the various IGs. Again, there were no patterns in water quality at Leib that explain the ICT variation.

The Design Team recommends a “high” ICT value of 120 mg-min/L for Oakwood and 142 mg-min/L for Leib. The Oakwood ICT value is based on achieving a permit log inactivation of 4.7 and extracted from the 11/27/2022 and 2/27/2023 event-wide models presented in **Figure 6-18** (rounded up to the nearest 10 mg-min/L). The Leib ICT value is based on an average of the two largest ICTs calculated (127 and 157). Accordance with log inactivation permit limits resulted in more conservative (higher) “high” ICT values and were thus selected over fecal coliform permit limits.

The Design Team recommends “average” ICT values of 50 mg-min/L for both Oakwood (**Figure 6-18**) and Leib (**Figure 6-26**). These are intended to represent “average” conditions and are derived from the median (middle) ICT across the three samples required to meet IG1, rounded up to the nearest 10 (**Table 6-6**).

The Design Team recommends “low” ICT values of 4 mg-min/L for Oakwood (**Figure 6-19**) and 20 mg-min/L for Leib (**Figure 6-27**). These are intended to represent a bare minimum for disinfection and will ensure a flexible feed system capable of disinfecting a range of water quality and flow. The values are derived from the ICTs for count-based disinfection to 400 CFU/100mL, which are the lowest modeled ICTs found in the study (**Table 6-6**).

7.0 Conclusion

The water industry is using an integrated CT approach to optimize chemical disinfection processes as it has been shown to best represent the disinfectant and bacteria inactivation kinetics observed within the disinfected water matrix. The Design Team utilized an integrated CT approach to size the sodium hypochlorite disinfection feed and storage systems for the Oakwood and Leib CSO treatment facilities. As part of the scope for this project, The Design Team collected six undisinfected samples during three wet weather events from both facilities and had multiple chlorine dose response test performed. The data from these tests resulted in “high” ICT values of 120 mg-min/L for Oakwood and 142 mg-min/L for Leib, “average” ICT values of 50 and 50 mg-min/L for both Oakwood and Leib, and “low” ICT values of 4 mg-min/L for Oakwood and 20 mg-min/L for Leib. Utilizing the ICT values selected from the modeling results described above, is discussed in TM-20. The Design Team recommends that GLWA begin collecting undisinfected wet weather bacteria counts throughout the year to better understand the seasonal variability of the undisinfected water quality characteristics, which so greatly impact disinfection performance.

Based upon sampling and analysis performed to date, ICT values have been determined to establish the design criteria for the disinfection storage and feed systems. In order to further refine the ICT values and better characterize impacts of seasonal effects on water quality, additional sampling and analysis of untreated wet-weather flows should be performed. This should include blending samples to better characterize the untreated flow for each facility after future collection system tie-ins have been made.

8.0 Next Steps

The following are next steps required to advance the disinfection system improvements at Oakwood and Leib.

- It is recommended that GLWA obtain additional untreated wet-weather water quality data (e.g., undisinfected bacteria, TSS, COD, ammonia at the beginning, middle, and end of each storm event) for both facilities for approximately one year to further refine chlorine demand/decay evaluation results and ICT values. At the conclusion of the sampling program, the results can be discussed with CDM Smith.
- Consider sampling at various depths during storm events to further validate samples are representative.
 - For Oakwood, it is recommended that GLWA blend untreated wet-weather samples (beginning, middle and end of each storm event) from the Northwest Interceptor (NWI) and Oakwood subdistrict (currently discharges to OKW) and analyze them for undisinfected bacteria and TSS. In addition, GLWA ought to perform periodic chlorine dose response tests on the blend untreated wet-weather samples. The recommended blend is four parts NWI to one part Oakwood to simulate future collection system conditions.

Appendix

Appendix A Wet Weather Chlorine Disinfection Testing Protocol

Appendix A

Wet Weather Chlorine Disinfection Testing Protocol

Wet Weather
Chlorine Disinfection
Testing Protocol

**Great Lakes Water Authority
(GLWA)**

October 31, 2022



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Appendices

Appendix A Chain of Custody

Appendix B Sample Shipment Memo

Appendix C Standard Method 1060 for Sample Collection

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Section 1

Introduction

This section provides a brief description of site background and the overall work plan organization.

1.1 Project Background

The Great Lakes Water Authority (GLWA) has an Interim Wet Weather Operating Plan (IWOP) that optimizes the use of 183 miles of regional pipelines, the Water Resources Recovery Facility (WRRF), remote pumping and combined sewer overflows (CSO) treatment facilities located in Detroit, Michigan. The Rouge River watershed's 127 stream miles naturally drain 466 square miles of Detroit's west side and its northwestern suburbs and has been greatly influenced by the development history of metropolitan Detroit. Development of the river's natural floodplain has led to typical watershed urbanization issues, including pollution from various sources, flooding, high streamflow variability and habitat degradation. It is one of 43 Areas of Concern within the Great Lakes watershed. The Great Lakes Water Quality Agreement (GLWQA) of 1978 between the United States and Canada requires the development of a Remedial Action Plan for each Area of Concern. Starting in 1992, Wayne County led the Rouge River restoration initiative through the support of the USEPA Rouge River National Wet Weather Demonstration Project funding. Numerous CSO control, stormwater management, stream restoration, and contaminated sediment projects were completed across Wayne, Oakland, and parts of Washtenaw Counties from 1992 to 2008, including eleven combined sewer Retention Treatment Basins, six Sanitary Retention Basins and one Screening and Disinfection Facility. These improvements reduced CSO discharge volume by 4 billion gallons per year and resulted in a 50% reduction in CSO impacted stream miles. These investments combined with subsequent projects by Detroit Water & Sewerage Department (DWSD) through 2013 have dramatically improved dissolved oxygen levels and restored native fish species and other aquatic life to the river. In addition, bacteria levels decreased significantly during wet weather. However, not all sewer overflows were addressed, and the river is still subject to discharges from 17 yet uncontrolled CSOs, which contribute to exceedances of water quality standards for bacteria and dissolved oxygen.

As part of the GLWA Wastewater Master Plan, the Oakwood Retention Treatment Basin (RTB) and the Leib Screening and Disinfection Facility (SDF) have been identified as sources of uncontrolled CSO discharges during wet weather events. The primary objective of this study is to optimize chlorine disinfection processes during a wet weather events at both the Oakwood RTB and Leib SDF.

1.2 Work Plan Organization

This bench-scale work plan is organized as follows:

1. **Section 1: Introduction** – Provides a background of the study, organization of the work plan, and general information about the study.

2. **Section 2: Scope, Objectives, and Technical Approach** – Provides a brief description of the scope of work to be performed by CDM Smith, the project objectives, and the overall technical approach.
3. **Section 3: Field and Laboratory Methods** – Describes the field procedures to collect site-specific water at the WWTF for bench-scale testing and details pertinent to the experimental setup and bench testing sampling and analysis plan.
4. **Section 4: Sampling and Analysis plan**– Presents the sampling and analysis plan that will be executed to achieve the project-specific objectives.
5. **Section 5: Reporting**– Describes the task- and overall project-specific reporting requirements for implementation of the bench-scale study.
6. **Section 6: Health and Safety** – Describes the health and safety procedures to be followed by field and laboratory personnel supporting this project.
7. **Section 7: Waste Management** – Summarizes how waste generated as part of this bench-scale study will be managed and disposed

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Section 2

Scope, Objectives, and Technical Approach

This section describes the overall scope of work, project objectives, and technical approach.

2.1 Scope of Work

This laboratory testing protocol includes chlorine dose response testing on water collected from the Oakwood RTB and Leib SDF effluent prior to disinfection. Sampling will occur at three separate time points (initial, peak, and final) of a wet weather event to evaluate the chlorine dose response under different water quality conditions. Testing will be performed using a single-step chlorine dosing scheme. Free chlorine residual, total chlorine residual, and fecal coliform will be evaluated at three different chlorine doses and five different chlorine contact times. Based on the log-inactivation results of fecal coliforms from the bench-scale testing, CDM Smith will make recommendations on the chlorine dose that should be implemented to meet disinfection goals.

2.2 Overall Objectives

The overall objectives of the bench-scale study include the following:

- Determine doses and contact times for chlorine that are most effective for fecal coliform treatment at each site; and
- Determine chlorine dose response under different water quality conditions.

2.3 Overall Technical Approach

Water samples from Oakwood RTB and Leib SDF will be collected during a wet weather event at three different sample points (initial, peak, and final) for each storm event. Samples will be collected simultaneously from both sites during a wet weather event. Samples will be collected in 5-gallon plastic jerricans and shipped with CDM Smith's Research and Testing Laboratory (RTL) on ice using FedEx priority first overnight (8:30 AM arrival). If the FedEx shipment is delayed for any reason, there will be a conference call with the technical lead to discuss remedial action and if there will be a reduction in testing scope will be necessary.

Chlorine dose bench testing is expected to take two full days. Upon sample arrival, testing will be performed on the three sample points from one site and the samples from the other site will be stored in the walk-in fridge at 4°C to be tested the following day. Due to testing time constraints, samples collected on Wednesday or Thursday will be shipped to the RTL and kept cold in the walk-in fridge to be tested the following Monday. Sample collected on a Friday will be kept cold in coolers with ice over the weekend and shipped to the RTL the following Monday with new ice.

Samples will not be collected for the subsequent wet weather event until results from the first event is received, analyzed, and checked for quality assurance and quality control (QA/QC). This delay is recommended to account for any adjustments in chlorine dose or contact time conditions.

Upon receipt at the RTL, the sample temperature will be collected and baseline water quality parameters measured (**Section 3.4.1**). Samples will then be brought to room temperature at or near 20°C and testing will begin immediately. A 5-minute and 30-minute chlorine demand pre-test will be performed at the lowest and highest disinfectant doses to confirm the presence of chlorine residual.

Individual bench disinfection tests will then be executed, and samples will be collected for analysis for each dose and timepoint. Samples will be collected and analyzed for pertinent parameters at the RTL and/or submitted to a contracted laboratory. **Table 2-1** outlines the analytical sampling matrix.

Detailed experimental procedures can be found in **Section 3**. Details relevant to the experimental setup and sampling and analysis plan are provided in the subsequent sections.

Table 2-1. Analytical Matrix

Analyte	Lab	Method	0-minute (baseline)	DOSE	1-minute	3-minute	7-minute	15-minute	30-minute
Fecal Coliform	AMTEST	SM9223B	✓		✓	✓	✓	✓	✓
TOC	AMTEST	SM 5310B	✓						✓
TSS	AMTEST	SM2540D	✓						
Ammonia	BLV RTL	HACH Method TNT830	✓						
pH Temp	BLV RTL	probe	✓						
COD	BLV RTL	HACH Method 8000	✓						✓
Color (Apparent)	BLV RTL	SM5910	✓						✓
UV-254 (Unfiltered)	BLV RTL	SM5910	✓						✓
Free Chlorine	BLV RTL	HACH Method 8121	✓		✓	✓	✓	✓	✓
Total Residual Chlorine	BLV RTL	HACH Method 8167	✓		✓	✓	✓	✓	✓

Notes: BLV- Bellevue, COD- chemical oxygen demand, SM-standard method, TOC – total organic carbon, TSS- total suspended solids, UV- ultraviolet 254 nm

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Section 3

Field and Laboratory Methods

This section describes the procedures that will be utilized to collect site-specific water samples. In addition, details pertinent to the experimental setup of the bench-scale studies are provided herein.

3.1 Sample Collection

Prior to sample collection, local CDM Smith field personnel will coordinate with Oakwood RTB and Leib SDF staff to access the site. A kick-off conference call with CDM Smith RTL and field sampling personnel will be held to coordinate proper water collection procedures and specify the volumes of water required for bench testing.

Prior to sampling, CDM Smith RTL personnel will ship a sampling kit containing the equipment required for collection to the field sampling staff. The kit will be in a hard side cooler and contain Ziploc™ bags for ice, a centrifuge tube with tap water labeled “temperature blank”, the necessary number of 5-gallon jerrican and a Chain of Custody (COC) form (**Attachment A**).

For each round of wet weather testing, approximately thirty gallons (six 5-gallon jerricans) of sample will be required for testing. The COC form filled out for the jerrican in each cooler will be completed by the sampler, placed in a Ziploc™ bag and taped to the inside lid of the sample cooler. For the first sample shipment only, a sample shipment memo (SSM) (**Attachment B**) is required. The SSM will be completed by the sampler and submitted by email to the CDM Smith RTL Chemical Hygiene Officer (CHO) Mary Lou Fox (FoxML@cdmsmith.com) and the CDM Smith RTL Technical Lead, Dung Nguyen (nguyendd@cdmsmith.com) prior to sample collection.

The jerrican used for sample collection will be triple rinsed with sample water and then returned to the site. That is, a small amount of sample (approximately 500 mL) will be dispensed into a given jerrican, thoroughly shaken and then dumped out; this is repeated three times before collecting the actual sample.

Samples will be collected in such a way that limits potential for changes in water quality. Proper sampling techniques will be employed per Standard Method 1060 (**Attachment C**). These procedures include completely filling the jerrican such that there is no remaining headspace. Multiple grab samples will be composited into a single jerrican using a pail fixed to a rope for each sample point in the wet weather event. The sample collection device will be disinfected with 70% isopropanol or 10% bleach solution between sample points to prevent cross contamination. To prevent photooxidation and limit additional microbial growth, samples will be kept on ice in a cooler while sampling and not exposed to sunlight unnecessarily or for extended periods of time. The jerrican will be numbered in the order of sample collection with the following naming convention: LOCATION-YYYYMMDD-SAMPLE POINT. For example, OAKWOOD-20221001-INITIAL. This jerrican identifier will also be what is entered on the COC. One jerrican will be placed in each cooler. Ice will be filled in double bagged sealable

Ziploc™ bags to fill the remaining space of each cooler. The double bagged ice fill be filled as shown in **Figure 3-1**, where the seals are oriented opposite each other to prevent leaking. Double-bagged ice will be placed on the bottom of the cooler, in-between sample and cooler, and on the top of samples.

Samples will be shipped the day of collection overnight on ice directly to CDM Smith's RTL (address below). If samples cannot be shipped out the day of collection, samples will be stored at 4°C until they can be shipped. Any storage of samples prior to shipment will be communicated by field staff to the CDM Smith RTL staff. Each cooler must include a temperature blank and proper chain-of-custody (COC) documentation detailing the number of jerricans, time and date of sample collection. The COC form is included in Appendix B. When sampling is complete, the sampler will email Dani Tran (trandn@cdmsmith.com), cc Dung Nguyen (nguyendd@cdmsmith.com) and provide information on the conditions at the facility at the day of sampling (water flows, any unique aspects of operations, and the procedures of sample collection). The sampler will also email the tracking number to Dani Tran on the day the samples are shipped out. Each cooler will contain a temperature blank (tap water in a poly container), which will be used to evaluate temperature upon receipt of the sample water. Samples will only be shipped to the CDM Smith RTL on Mondays, Tuesdays, Wednesdays and Thursdays. Samples will be shipped to the following address:

ATTN: Dani Tran
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007
Office: (425) 519-8321
Cell: (206) 370-9472



Figure 3-1 Double-bagging technique to prevent leaking

3.2 Shipment to Outside Laboratories

After bench testing, CDM Smith will send appropriate samples to an external lab (AMTEST, or similar) for the analysis of fecal coliform, total suspended solids, and total organic carbon. Each cooler will be dropped off or picked up via courier on ice containing a temperature blank and a COC specifying which analyses will be performed. Unless otherwise specified, all results will be reported within a standard turnaround time (TAT) as determined by the external lab.

3.3 Laboratory Testing

This section describes the operational details for bench testing. The testing window for wet weather events is expected to start in October and end in late December/early January before the freezing temperatures affect storm water flows, for up to two wet weather events. For each wet weather event, there are 18 unique test conditions (9 for each site location, with 3 sample points and 3 chlorine doses). Therefore, multiple tests will need be executed concurrently. Three CDM Smith staff members will be needed to support the execution of the experiment. A detailed example of concurrent disinfection study execution is further explained below, and a reference is shown in **Table 3-2**.

Table 3-1. Experimental Matrix

Water Types	# of Wet Weather Events	Sample Points	Chlorine Doses ¹ (mg/L)	Chlorine Contact Times ¹ (mins)	Analyses
Oakwood RTB & Leib SDF	2	Initial, Peak, Final	0	0	Fecal coliform COD TOC TSS pH Temperature Ammonia Color (apparent) UV-254 (unfiltered) Free chlorine Total Chlorine
			4	1	<u>At each chlorine contact time:</u> Fecal coliform Free chlorine Total chlorine
				3	
				7	
				15	
				30	
			10	1	<u>At 30 mins chlorine contact time:</u> Fecal coliform Free chlorine Total chlorine COD TOC Color (apparent) UV-254 (unfiltered)
				3	
				7	
				15	
				30	
			16	1	
				3	
				7	
				15	
				30	

¹ Subject to change based on disinfection performance

Notes: COD- chemical oxygen demand, TOC – total organic carbon, TSS- total suspended solids, UV- ultraviolet 254 nm

3.3.1 Chlorine Dose Testing

A concentrated sodium hypochlorite stock will be prepared from analytical grade sodium hypochlorite. The stock will be prepared at a concentration such that the volume used to spike the sample is less than 1% of the test volume. The concentration of the stock solution will be confirmed in triplicate before testing, and spiking volumes will be adjusted to reflect the actual chlorine concentration in the stock.

The jerricans with sample water will be thoroughly shaken to ensure homogeneous distribution of particles. Each test will require two liters (L) of well-mixed sample be collected in a 4-L beaker with a

large stir bar. The sample will be placed on a stir plate and mixed so that particles are evenly suspended.

Aseptic technique will be used for collecting samples for microbial analysis. All labware will be either sterile or disinfected prior to use 70% isopropanol or 10% bleach solution. Samples will be collected using sterile 50 mL serological pipettes. After disinfection studies are complete, the samples will be picked up by a courier service or dropped off to a local analytical laboratory to maintain sampling holding time.

Sodium hypochlorite will be dosed using a 10,000 mg/L Cl_2 stock solution from analytical grade sodium hypochlorite. Stock solutions will be used to dose the water already dispensed into the test beaker. Each test condition will have a timer assigned to it for ease of noting time elapsed, and the timer will be started as soon as the sodium hypochlorite is added. Due to the number of tests being performed for each site location, the 9 test conditions for each site will be executed in the staggered fashion shown in **Table 3-2**. The first test condition will be dosed with chlorine and the time of day will be recorded and timer will be started. After 1-minute, samples will be collected using sterile serological pipettes. Two people will be responsible for filling fecal coliform bottles, and testing free and total chlorine, while a third person will be recording sample collection times and facilitating general organization throughout the testing. This process will be repeated at 3, 5, 7, 15 and 30 minutes (subject to change). After the 15-minute contact time is collected from the first test condition, the second test condition will be dosed with chlorine. Samples will be collected from the second jar similar fashion to the first jar at 1, 3, 5, and 7 minutes before returning to the first jar to collect the 30-minute sample. This is repeated for all subsequent jar tests.

Table 3-2 Example sampling protocol for concurrent disinfection studies

Total elapsed time (min)	Test 1		Test 2		Test 3		Test 4		Test 5	
	Minute	Event	Minute	Event	Minute	Event	Minute	Event	Minute	Event
1	0	D								
2	1	X								
4	3	X								
9	7	X								
16	15	X								
20	19		0	D						
21	20		1	X						
23	22		3	X						
28	27		7	X						
31	30	✓	11							
35			15	X						
39			19							
40			20		0	D				
42			22		1	X				
47			27		3	X				
50			30	✓	7	X				
54					11					
58					15	X				
59					19		0	D		
61					20		1	X		
66					22		3	X		
69					27		7	X		
73					30	✓	11			
77							15	X		
78							19			
80							20			
85							22			
88							27			
92							30	✓		
107									15	X
									30	✓

D-dose with hypochlorite

X-sample for fecal coliform and F&T chlorine

✓-sample for fecal coliform, Ammonia, COD, TOC TSS, pH, temp and F&T chlorine

3.3.2 Baseline and Water Chemistry Parameters

Measurements for COD, pH, temperature, ammonia, color (apparent), UV-254 (unfiltered), free chlorine, and total chlorine will be performed the same day the sample arrives. Samples for TOC, TSS, and fecal coliform will be subsampled from the carboy into the appropriately preserved sample bottles provided by the subcontracted analytical laboratory and shipped on ice for analysis.

3.3.3 Free and Total Chlorine

Free chlorine is the chlorine still available to react (i.e., disinfect; OCl) and total chlorine is comprised of both combined (i.e. chloramines) and free chlorine. Both are measured in order to calculate demand. Both free and total chlorine will be measured at the RTL using HACH methods 8021 and 8167, respectively. The detection limit for the free and total chlorine are 0.2 mg/L. Dilutions will be made accordingly.

3.3.4 Microbiology

Samples will be collected for microbial analysis to assess disinfection of fecal coliform. AmTest will perform the fecal coliform analysis. Microbial data will be plotted as log inactivation versus concentration-time (CT, Samples will be collected for microbial analysis to assess disinfection of fecal coliform. AmTest (or similar laboratory) will perform the fecal coliform analysis. Microbial data will be plotted as log inactivation versus concentration-time (CT, mg/L*min).

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Section 4

Sampling and Analysis Plan

This section provides details pertinent to the sampling and analysis for each bench-scale test. Specifically, the type of analytes collected, sampling frequency performed, and laboratory methods employed are discussed herein.

4.1 Analytical Testing

Samples for fecal coliform, free chlorine, and total chlorine residual will be collected at approximately 1, 3, 7, 15, and 30 minutes. pH, temperature, TOC, TSS, ammonia, color (apparent), UV-254 (unfiltered) will be evaluated for baseline. pH and temperature will be monitored with a probe and are important for determining the chlorine kinetics. TOC, TSS, color, and UV-254 will be monitored as they exert some chlorine demand. Ammonia will react with free chlorine to form chloramines. The analytical details of these parameters are detailed in **Table 4-1**.

Table 4-1 Analytical Methods

Parameter	Laboratory	Method	Method Detection Limit	Reporting Limit	Volume Required (mL)	Preservatives	Hold time
pH	RTL	Probe	-	-	3	N/A	Immediate Analysis
Temperature	RTL	Probe	-	-	3	N/A	
TSS	AMTEST	SM2540D	4.44 mg/L	10 mg/L	100	N/A	7 day
Ammonia	RTL	HACH Method TNT830	0.003 mg/L	0.05 mg/L	100	0.5mL 50% H2SO4	28 day
COD	RTL	SM 5220	3-150mg/L (LR)	-	2	N/A	Immediate Analysis
TOC	AMTEST	SM 5310B	0.025 mg/L	0.25	2	N/A	Immediate Analysis
Color (Apparent)	RTL	SM 2120	-		15	N/A	Immediate Analysis
UV 254 (un-filtered)	RTL	SM 5910	-		30	N/A	Immediate Analysis
Fecal Coliform	AMTEST	SM9223B		1CFU/100mL	100	Sodium Thiosulfate	6 hours
Free Chlorine	RTL	HACH Method 8021	0.02-2 mg/L		3	N/A	Immediate Analysis
Total Chlorine	RTL	HACH Method 8167	0-2 mg/L		30	N/A	

Notes: NA – not applicable, RTL – Research and Testing Laboratory, SM – Standard Methods, mg/L – milligrams per liter, TOC – total organic carbon, TSS – total suspended solids, UV 254 – ultraviolet absorbance at 254 nanometers

4.2 Quality Assurance and Quality Control (QA/QC)

Experimental replication will be performed at a rate of 1 in 10 (10%). Analytical replication will be collected at a rate of 1 in 20 (5%). Appropriate quality control procedures will be utilized for analysis, including blanks, laboratory control standards, calibration standards, and standard checks for each analytical run.

4.2.1 Interferences

This project will include analyses that can detect individual colonies of bacteria. Therefore, it is important to minimize cross contamination or interferences. The following are potential sources of interferences during sampling:

- Improper sample collection through the use of contaminated equipment and personnel, disturbance of the sampling site during collection, and sampling in an obviously disturbed area.
- Improper preservation and/or failure to preserve sample containers requiring preservation.
- Cross-contamination can occur if sample containers have not been properly sanitized and stored.
- Utilizing sampling materials or containers with inappropriate materials (e.g., plastic in the place of glass or stainless steel).
- Exceeding the hold times established for the analyte.

Review all of the procedures and quality assurance documents carefully.

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Section 5

Reporting

The RTL will validate the data collected during the disinfection study and provide plots of chlorine demand and decay and fecal coliform activation over time. All samples will be analyzed in a standard turnaround time (two to three weeks). The data from the bench testing will be entered into a project database by the RTL staff, as well as develop graphs of notable data trends. The fecal coliform, free chlorine, and total chlorine data will be used to generate graphs illustrating log inactivation vs. integrated concentration time (ICT) and fecal coliform vs. ICT, which will then be utilized with the historical plant data to determine the required ICT value to meet disinfection goals.

Up to three one (1) hour conference calls will be held between the RTL and technical leader to discuss findings and recommendations. A spreadsheet summary of all laboratory activities performed, discussion of notable results, and implications for disinfection with respect to anticipated regulations will be provided as a final deliverable. Specifically, CDM Smith will evaluate chlorine doses over the three sample points at each site location. A technical memorandum or report of the bench testing results will not be provided by the RTL staff.

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Section 6

Health and Safety

Field sample collection will be conducted by site staff in accordance with the site-specific health and safety procedures. RTL staff will adhere to the Chemical Hygiene Plan, Biosafety Level 2 protocols, and the project health and safety plan for execution of experiments. A health and safety plan (HASP) will be prepared and reviewed with the CHO prior to any lab activities; all relevant personnel will review, acknowledge, and sign off on this before work begins. All safety considerations will also be discussed during the kickoff meeting held prior to commencement of laboratory work.

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Section 7

Waste Management

All water samples will be properly disinfected disposed on site by the RTL. Chemical reagents in excess of those required for the experiments described herein will be disposed of by a waste disposal subcontractor in accordance with all relevant local, state, and federal regulations.

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Appendix A

Chain of Custody



CHAIN-OF-CUSTODY

Date _____ Page _____ of _____

PROJECT INFORMATION					ANALYSIS REQUEST																													
Project Manager: _____																																		
Project Name: _____																																		
Project Number: _____																																		
Site Location: _____ Sampled By: _____																																		
DISPOSAL INFORMATION																																		
☐ Lab Disposal (return if not indicated)																																		
Disposal Method: _____																																		
Disposed by: _____ Disposal Date: _____																																		
QC INFORMATION (check one)																																		
☐ SW-846 ☐ CLP ☐ Screening ☐ CDM Std. ☐ Special																																		
SAMPLE ID	DATE	TIME	MATRIX	LAB ID	PETROLEUM HYDROCARBONS		ORGANIC COMPOUNDS							PESTS/PCBs			METALS			LEACHING TESTS		OTHER			NUMBER OF CONTAINERS									
					TPH-HCID	TPH-G	TPH-D	TPH-418.1	8015M Fuel Hydrocarbon	TPH Special Instructions	8010 Halogenated VOCs	8020 Aromatic VOCs	8020M - BETX only	8260 GC/MS Volatiles	8270 GC/MS Semivolatiles	8310 PAHs	8040 Phenols	DWS - Volatiles and Semivolatiles	8081 OC Pest/PCBs	8082 PCBs only	8141 OP Pesticides	8151 OC Herbicides	DWS - Herb/Pest	Selected Metals: list		RCRA Metals (8)	TCL Metals (23)	Priority Poll. Metals (13)	DWS - Metals	M-FSP - Metals (Wa)	TCLP - Volatiles (ZHE)	TCLP - Semivolatiles	TCLP - Pesticides	TCLP - Metals

LAB INFORMATION		SAMPLE RECEIPT		RELINQUISHED BY: 1.		RELINQUISHED BY: 2.		RELINQUISHED BY: 3.	
Lab Name:		Total Number of Containers:		Signature: _____ Time: _____		Signature: _____ Time: _____		Signature: _____ Time: _____	
Lab Address:		Chain-of-Custody Seals: Y/N/NA		Printed Name: _____ Date: _____		Printed Name: _____ Date: _____		Printed Name: _____ Date: _____	
		Intact?: Y/N/NA		Company: _____		Company: _____		Company: _____	
Via:		Received in Good Condition/Cold:							
Turn Around Time: ☐ Standard ☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 1 wk.				RECEIVED BY: 1.		RECEIVED BY: 2.		RECEIVED BY: 3.	
PRIOR AUTHORIZATION IS REQUIRED FOR RUSH DATA				Signature: _____ Time: _____		Signature: _____ Time: _____		Signature: _____ Time: _____	
				Printed Name: _____ Date: _____		Printed Name: _____ Date: _____		Printed Name: _____ Date: _____	
				Company: _____		Company: _____		Company: _____	

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Appendix B

Sample Shipment Memo



Memorandum

To: Whom It May Concern

*From: Jennifer Hooper, CDM Smith Research and Testing Laboratory
(Bellevue, WA)*

Date: 5/22/20

Subject: Procedure for Samples Shipping to Treatability Lab

This memo contains procedures for sending samples to the CDM Smith Research and Testing Laboratory (RTL). It is intended to be used by anyone who sends environmental samples to the ETL, regardless of whether they are CDM Smith employees or not.

RTL staff or project managers will provide this memo to the sender prior to the sample shipment. Upon receipt, the sender must read it carefully and fill it out to the best of their knowledge before preparing the samples for shipping.

Once the memo is complete, it must be submitted to Jennifer Hooper or Zoom Nguen for review. Upon the completion of review, the sender will be informed if the sample(s) is approved to be shipped or if additional information is required prior to shipping. A completed and approved copy of this memo must be shipped together with the sample(s) to the lab.

Before Shipping

It is the sender's responsibility to classify the samples to be shipped. If the samples are classified as Dangerous Goods, the sender must have applicable training on DOT and IATA regulations before initiating the shipment. For example, Fedex will not allow shipping of dangerous goods unless the sender has been trained on proper procedures. Furthermore, there can be significant penalties (up to \$50,000 per violation, per day) that can be imposed by DOT on the sender PERSONALLY (not just the company) if noncompliant shipments are offered by a shipper.

CDM employees should be familiar with CDM policy, located here:

http://cdmweblegacy/h&s/documents/hazmat_transport.doc
http://cdmweblegacy/h&s/hazmat_transport.html

Sample Shipment Procedures

1. Communicate with Treatability Laboratory Management regarding below sample information and desired scope of work.

Charles Schaefer, ETL Director	425-519-8300	schaeferce@cdmsmith.com
Jennifer Hooper, Technical Lead, Water and Wastewater		hooperjl@cdmsmith.com
Zoom Nguyen, Technical Lead, Remediation		nguyendd@cdmsmith.com
Mary Lou Fox, Chemical Hygiene Officer		foxml@cdmsmith.com

2. Receive written approval from Laboratory Management for sample shipment (i.e. this memo, once completed and approved).
3. All the sample containers must bear a readable label with the sample name and contents, the related project name, the sender's name and company, the sample collection date, and any other appropriate sample information.
4. Prepare shipment per DOT and IATA regulations. Include a completed Chain-of-Custody form.
5. Send samples via overnight courier to the RTL:
CDM
Attn: Janelle Amador
14432 SE Eastgate Way, Suite 100, Bellevue, WA 98007
6. Inform Laboratory Management of shipping status and provide tracking number.

Sample Information Required Prior to Shipment

1. Source

Please check all of the following boxes that are applicable regarding the nature of the sample:

- | | | |
|--|--|---|
| ☐ Groundwater | ☐ Subsurface soil | ☐ Industrial Waste Water |
| ☐ Surface water | ☐ Surface soil | ☐ Municipal Waste Water |

2. Contaminants

Please check all of the following boxes that are applicable regarding contaminants in the sample:

- | | | |
|---|---|--------------------------------------|
| ☐ Chlorinated Solvents | ☐ Petroleum Hydrocarbons | ☐ Metals |
| ☐ Radioactive Substances | ☐ Pesticides/PCBs | ☐ Perchlorate |
| ☐ Unknown | | |

Please list specific contaminants: _____

3. Hazards Information

Based on the MSDS or other sources of the sample hazards information, please check all of the following boxes that are applicable.

- | | | |
|------------------------------------|------------------------------------|--|
| ☐ Flammable | ☐ Toxic | ☐ Unknown, but is potentially hazardous |
| ☐ Reactive | ☐ Corrosive | ☐ None apply |

Notes: _____

4. Potential Headspace Gas Accumulation

- Sample will be shipped on ice? ☐ Yes ☐ No
- Any potential for gas generation/accumulation in the sample container during the transportation? ☐ Yes ☐ No
- If yes to the question above, please specify what are the gases could be encountered in the container upon receipt:

5. Sample handling information

- Does the sample require refrigeration on arrival? ☐Yes ☐No
- Will a temperature blank be included to verify appropriate temperature control during shipping? ☐Yes ☐No
- Does the sample require protection from oxygen contamination (i.e., should the containers be opened only in an anaerobic chamber)? ☐Yes ☐No

If yes:

- Water samples must be shipped in containers of 1L or smaller
- Soil cores must be no more than 16" long. Other containers should be no larger than 15" x 8" x 8".

6. Additional Sample Information

Please indicate if any of the following sources of information are included for the sample.

- ☐SDS ☐Product Sheet ☐Source Materials Information
☐No Additional Info Available

Notes: _____

Sample Sender's Name (print): _____

Sample Sender's Signature: _____

Date: _____

Approved for shipping? ☐ Yes, ☐ No,

☐ Additional Information is needed, which includes:

Approved by: _____ (Print)

_____ (Signature)

Date: _____

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Appendix C

Standard Method 1060 for Sample Collection

1060 A. Introduction

It is an old axiom that the result of any testing method can be no better than the sample on which it is performed. It is beyond the scope of this publication to specify detailed procedures for the collection of all samples because of varied purposes and analytical procedures. Detailed information is presented in specific methods. This section presents general considerations, applicable primarily to chemical analyses. See appropriate sections for samples to be used in toxicity testing and microbiological, biological, and radiological examinations.

The objective of sampling is to collect a portion of material small enough in volume to be transported conveniently and yet large enough for analytical purposes while still accurately representing the material being sampled. This objective implies that the relative proportions or concentrations of all pertinent components will be the same in the samples as in the material being sampled, and that the sample will be handled in such a way that no significant changes in composition occur before the tests are made.

Frequently, the objective of sampling and testing is to demonstrate whether continuing compliance with specific regulatory requirements has been achieved. Samples are presented to the laboratory for specific determinations, with the sampler being responsible for collecting a valid and representative sample. Because of the increasing importance placed on verifying the accuracy and representativeness of data, greater emphasis is placed on proper sample collection, tracking, and preservation techniques. Often, laboratory personnel help plan a sampling program in consultation with the user of the test results. Such consultation is essential to ensure selected samples and analytical methods provide a sound and valid basis for answering the questions that prompted the sampling and that will meet regulatory and/or project-specific requirements.

This section addresses the collection and preservation of water and wastewater samples; the general principles also apply to the sampling of solid or semisolid matrices.

1. General Requirements

Obtain a sample that meets the requirements of the sampling program and handle it so it does not deteriorate or become contaminated or compromised before it is analyzed.

Ensure that all sampling equipment is clean and quality-assured before use. Use sample containers that are clean and free of contaminants. Bake at 450°C all bottles to be used for organic-analysis sampling.

Fill sample containers—without prerinsing—with sample; prerinsing results in loss of any pre-added preservative and sometimes

can bias results high when certain components adhere to the sides of the container. Depending on determinations to be performed, fill the container full (most organic compound determinations) or leave space for aeration, mixing, etc. (microbiological and inorganic analyses). If a bottle already contains preservative, take care not to overfill the bottle, as preservative may be lost or diluted. Except when sampling for analysis of volatile organic compounds or radon, leave an air space equivalent to approximately 1% of the container volume to allow for thermal expansion during shipment.

Special precautions (discussed below) are necessary for samples containing organic compounds and trace metals. Because many constituents may be present at low concentrations (micrograms or nanograms per liter), they may be totally or partially lost or easily contaminated when proper sampling and preservation procedures are not followed.

Composite samples can be obtained by collecting over a period of time, depth, or at many different sampling points. The details of collection vary with local conditions, so specific recommendations are not universally applicable. Sometimes it is more informative to analyze numerous separate samples instead of one composite so variability, maxima, and minima can be determined.

Because of the inherent instability of certain properties and compounds, composite sampling for some analytes is not recommended where quantitative values are desired (examples include oil and grease, acidity, alkalinity, carbon dioxide, chlorine residual, iodine, hexavalent chromium, nitrite, volatile organic compounds, radon-222, dissolved oxygen, ozone, temperature, and pH). In certain cases, such as for BOD, phenolics, sulfite, and cyanide, composite samples are routinely required by regulatory agencies. Refrigerate composite samples for BOD, nitrate, ammonia, TKN, TSS, COD, and TOC.

Sample carefully to ensure that analytical results represent actual sample composition. Important factors affecting results are the presence of suspended matter or turbidity, the method chosen for removing a sample from its container, and the physical and chemical changes brought about by storage or aeration. Detailed procedures are essential when processing (blending, sieving, filtering) samples to be analyzed for trace constituents, especially metals and organic compounds. Some determinations can be invalidated by contamination during processing. Treat each sample individually with regard to the substances to be determined, the amount and nature of turbidity present, and other conditions that may influence the results.

Carefully consider the technique for collecting a representative sample and define it in the sampling plan. For metals, it often is appropriate to collect both a filtered and an unfiltered sample to differentiate between total and dissolved metals present in the matrix. Be aware that some metals may partially sorb to filters. Beforehand, determine the acid requirements to bring the pH to <2 on a separate sample. Add the same relative amount of acid to all samples; use ultrapure acid preservative to prevent contamination. Be sure that the dilution caused by acidifying is negligible or sufficiently reproducible for a dilution correction factor. When

* Reviewed by Standard Methods Committee, 2011.

2011 revisions by L. Malcom Baker, Rodger B. Baird, Nilda B. Cox, Andrew D. Eaton.

Joint Task Group: 20th Edition—Lawrence H. Keith (chair), Clifford G. Annis, Gary L. DeKock, Carleton P. Edmunds, Scott J. Mickelson, Mark Wyzalek.

filtered samples will be collected, filter them in the field, if possible, or at the point of collection before preservation with acid. Filter samples in a laboratory-controlled environment if field conditions could cause error or contamination; in this case, filter as soon as possible. Often, slight turbidity can be tolerated if experience shows that it will cause no interference in gravimetric or volumetric tests and that its influence can be corrected in colorimetric tests, where it has potentially the greatest interfering effect. Sample collector must state whether the sample has been filtered.

Make a record of every sample collected and identify every bottle with a unique sample number, preferably by attaching an appropriately inscribed tag or label. Document sufficient information to provide positive sample identification at a later date, including the unique sample identification number, the name of the sample collector, the date, hour, exact location, and, if possible, sample type (e.g., grab or composite) and any other data that may be needed for correlation, such as water temperature, weather conditions, water level, stream flow, and post-collection conditions. If all pertinent information will not fit on a label or attached tag, record information in a bound sample log book at the sampling site at the time of sample collection. Use waterproof ink to record all information (preferably with black, non-solvent-based ink). Fix sampling points by detailed description in the sampling plan, by maps, or with the aid of stakes, buoys, or landmarks in a manner that will permit their identification by other persons without reliance on memory or personal guidance. Global positioning systems (GPS) also can supply accurate sampling position data. Particularly when sample results are expected to be involved in litigation, use formal "chain-of-custody" procedures (see 1060B.2), which trace sample history from collection to final reporting.

Before collecting samples from distribution systems, flush lines with three to five pipe volumes (or until water is being drawn from the main source) to ensure that the sample is representative of the supply, taking into account the volume of pipe to be flushed and the flow velocity. If the distribution system volume is unavailable, flush with tap fully open for at least 2 to 3 min before sampling. An exception to these guidelines (i.e., collecting a first-draw sample) is when information on areas of reduced or restricted flow is desired or when samples for lead in drinking water are being collected.

Although well-pumping protocols depend on the objectives of an investigation and other factors, such as well characteristics and available equipment, a general rule is to collect samples from wells only after the well has been purged sufficiently (usually with three to ten well volumes) to ensure that the sample represents the groundwater. Purging stagnant water is critical. Sometimes it will be necessary to pump at a specified rate to achieve a characteristic drawdown, if this determines the zones from which the well is supplied; record purging rate and drawdown, if necessary. By using methods with minimal drawdown, purging volumes can be reduced significantly.

When samples are collected from a river or stream, observed results may vary with depth, stream flow, and distance from each shore. Selection of the number and distribution of sites at which samples should be collected depends on study objectives, stream characteristics, available equipment, and other factors. If equipment is available, take an integrated sample from top to bottom in the middle of the main channel of the stream or from side to

side at mid-depth. If only grab or catch samples can be collected, preferably take them at various points of equal distance across the stream; if only one sample can be collected, take it in the middle of the main channel of the stream and at mid-depth. Integrated samples are described further in 1060B.1c.

Rivers, streams, lakes, and reservoirs are subject to considerable variations from normal causes (e.g., seasonal stratification, diurnal variations, rainfall, runoff, and wind). Choose location, depth, and frequency of sampling depending on local conditions and the purpose of the investigation.

Use the following examples for general guidance. Avoid areas of excessive turbulence because of potential loss of volatile constituents and potential presence of denser-than-air toxic vapors. Avoid sampling at weirs, if possible, because such locations tend to favor retrieval of lighter-than-water immiscible compounds. Generally, collect samples beneath the surface in quiescent areas and open sampling container below surface with the mouth directed toward the current to avoid collecting surface scum unless oil and grease is a constituent of interest; then collect water at the surface. If composite samples are required, ensure that sample constituents are not lost during compositing because of improper handling of portions being composited. If samples will be analyzed for organic constituents, refrigerate composited portions. Do not composite samples for VOC analysis because some of the components will be lost through volatilization.

2. Safety Considerations

Because sample constituents may be toxic, take adequate precautions during sampling and sample handling. Toxic substances can enter through the skin and eyes and, in the case of vapors, also through the lungs. Ingestion can occur via direct contact of toxic materials with foods or by adsorption of vapors onto foods. Precautions may be limited to wearing gloves or may include coveralls, aprons, or other protective apparel. Often, the degree of protection provided by chemical protective clothing (CPC) is specific for different manufacturers and their product models¹; ensure that the clothing chosen will offer adequate protection. Always wear eye protection (e.g., safety glasses with side shields or goggles). When toxic vapors may be present, sample only in well-ventilated areas, or use an appropriate respirator or self-contained breathing apparatus. In a laboratory, open sample containers in a fume hood. Never have food in the laboratory, near samples, or near sampling locations; always wash hands thoroughly before handling food.²

Always prohibit eating, drinking, or smoking near samples, sampling locations, and in the laboratory. Keep sparks, flames, and excessive heat sources away from samples and sampling locations. If flammable compounds are suspected or known to be present and samples will be refrigerated, use only specially designed explosion-proof refrigerators.²

Collect samples safely, avoiding situations that may lead to accidents. When in doubt as to the level of safety precautions needed, consult a knowledgeable industrial hygienist or safety professional. Samples with radioactive contaminants may require other safety considerations; consult a health physicist.

Label adequately any sample known or suspected to be hazardous because of flammability, corrosivity, toxicity, oxidizing chemicals, or radioactivity, so appropriate precautions can be taken during sample handling, storage, and disposal.

3. References

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2. WATER POLLUTION CONTROL FEDERATION. 1986. Removal of Hazardous Wastes in Wastewater Facilities—Halogenated Organics; Manual of Practice FD-11. Alexandria, Va.

1060 B. Collection of Samples

1. Types of Samples

a. Grab samples: Grab samples are single samples collected at a specific spot at a site over a short period of time (typically seconds or minutes). Thus, they represent a “snapshot” in both space and time of a sampling area. Discrete grab samples are taken at a selected location, depth, and time. Depth-integrated grab samples are collected over a predetermined part or the entire depth of a water column, at a selected location and time in a given body of water.

A sample can represent only the composition of its source at the time and place of collection. However, when a source is known to be relatively constant in composition over an extended time or over substantial distances in all directions, then the sample may represent a longer time period and/or a larger volume than the specific time and place at which it was collected. In such circumstances, a source may be represented adequately by single grab samples. Examples are protected groundwater supplies, water supplies receiving conventional treatment, some well-mixed surface waters, but rarely wastewater streams, rivers, large lakes, shorelines, estuaries, and groundwater plumes.

When a source is known to vary with time, grab samples collected at suitable intervals and analyzed separately can document the extent, frequency, and duration of these variations. Choose sampling intervals on the basis of the expected frequency of changes, which may vary from 5 min to 1 h or more. Seasonal variations in natural systems may necessitate sampling over months. When the source composition varies in space (i.e., from location to location) rather than time, collect samples from appropriate locations that will meet the objectives of the study (for example, upstream and downstream from a point source).

The same principles apply to sampling wastewater sludges, sludge banks, and muds, although these matrices are not specifically addressed in this section. Take every possible precaution to obtain a representative sample or one conforming to a sampling program.

b. Composite samples: Composite samples should provide a more representative sampling of heterogeneous matrices in which the concentration of the analytes of interest may vary over short periods of time and/or space. Composite samples can be obtained by combining portions of multiple grab samples or by using specially designed automatic sampling devices. Sequential (time) composite samples are collected by using continuous, constant sample pumping or by mixing equal water volumes collected at regular time intervals. Flow-proportional composites are collected by continuous pumping at a rate proportional to the flow, by mixing equal volumes of water collected at time intervals that are inversely proportional to the volume of flow, or by mixing volumes of water proportional to the flow collected during or at regular time intervals.

Advantages of composite samples include reduced costs of analyzing a large number of samples, more representative samples of heterogeneous matrices, and larger sample sizes when amounts of test samples are limited. Disadvantages of composite samples include loss of analyte relationships in individual samples, potential dilution of analytes below detection levels, increased potential analytical interferences, and increased possibility of analyte interactions. In addition, use of composite samples may reduce the number of samples analyzed below the required statistical need for specified data quality objectives or project-specific objectives.

Do not use composite samples with components or characteristics subject to significant and unavoidable changes during storage. Analyze individual samples as soon as possible after collection and preferably at the sampling point. Examples are dissolved gases, residual chlorine, soluble sulfide, temperature, and pH. Changes in components, such as dissolved oxygen or carbon dioxide, pH, or temperature, may produce secondary changes in certain inorganic constituents, such as iron, manganese, alkalinity, or hardness. Some organic analytes also may be changed by changes in the foregoing components. Use time-composite samples only for determining components that can be demonstrated to remain unchanged under the conditions of sample collection, preservation, and storage.

Collect individual portions in a wide-mouth bottle every hour (in some cases, every half hour or even every 5 min) and mix at the end of the sampling period or combine in a single bottle as collected. If preservatives are used, add them to the sample bottle initially so all portions of the composite are preserved as soon as collected.

Automatic sampling devices are available; however, do not use them unless the sample is preserved as described below. Composite samplers running for extended periods (weeks to months) should undergo routine cleaning of containers and sample lines to minimize sample growth and deposits.

c. Integrated (discharge-weighted) samples: For certain purposes, the information needed is best provided by analyzing mixtures of grab samples collected from different points simultaneously, or as nearly so as possible, using discharge-weighted methods [e.g., equal-width increment (EWI) or equal discharge-increment (EDI) procedures and equipment]. An example of the need for integrated sampling occurs in a river or stream that varies in composition across its width and depth. To evaluate average composition or total loading, use a mixture of samples representing various points in the cross-section, in proportion to their relative flows. The need for integrated samples also may exist if combined treatment is proposed for several separate wastewater streams, the interaction of which may have a significant effect on treatability or even on composition. Mathematical prediction of the interactions among chemical components may

be inaccurate or impossible, and testing a suitable integrated sample may provide more useful information.

Both lakes and reservoirs show spatial variations of composition (depth and horizontal location). However, there are conditions under which neither total nor average results are especially useful, but local variations are more important. In such cases, examine samples separately (i.e., do not integrate them).

Preparation of integrated samples usually requires equipment designed to collect a sample water uniformly across the depth profile. Knowledge of the volume, movement, and composition of the various parts of the water being sampled usually is required. Collecting integrated samples is a complicated and specialized process that must be described adequately in a sampling plan.

2. Chain-of-Custody Procedures

Properly designed and executed chain-of-custody forms will ensure sample integrity from collection to data reporting. This includes the ability to trace possession and handling of the sample from the time of collection through analysis and final disposition. This process is referred to as *chain of custody* and is required to demonstrate sample control when the data are to be used for regulation or litigation. Where litigation is not involved, chain-of-custody procedures are useful for routine control of samples.

A sample is considered to be under a person's custody if it is in the individual's physical possession, in the individual's sight, secured and tamper-proofed by that individual, or secured in an area restricted to authorized personnel. The following procedures summarize the major aspects of chain of custody. More detailed discussions are available.^{1,2}

a. Sample labels (including bar-code labels): Use labels to prevent sample misidentification. Gummed paper labels or tags generally are adequate. Include at least the following information: a unique sample number, sample type, name of collector, date and time of collection, place of collection, and sample preservative. Also include date and time of preservation for comparison to date and time of collection. Affix tags or self-adhesive labels to sample containers before, or at the time of, sample collection.

b. Sample seals: Use sample seals to detect unauthorized tampering with samples up to the time of analysis. Use self-adhesive paper seals that include at least the following information: sample number (identical with number on sample label), collector's name, and date and time of sampling. Plastic shrink seals also may be used.

Attach seal so that it must be broken to open the sample container or the sample shipping container (e.g., a cooler). Affix seal to container before sample leaves custody of sampling personnel.

c. Field log book: Record all information pertinent to a field survey or sampling in a bound log book. As a minimum, include the following in the log book: purpose of sampling; location of sampling point; name and address of field contact; producer of material being sampled and address (if different from location); type of sample; and method, date, and time of preservation. If the sample is wastewater, identify process producing waste stream. Also provide suspected sample composition, including concentrations; number and volume of sample(s) taken; description of sampling point and sampling method; date and time of collection; collector's sample identification number(s); sample distribution and how transported; references (e.g., maps or photographs of the sampling site); field

observations and measurements; and signatures of personnel responsible for observations. Because sampling situations vary widely, it is essential to record sufficient information so one could reconstruct the sampling event without reliance on the collector's memory. Protect log book and keep it in a safe place.

d. Chain-of-custody record: Fill out a chain-of-custody record to accompany each sample or group of samples. The record includes the following information: sample number; signature of collector; date, time, and address of collection; sample type; sample preservation requirements; signatures of persons involved in the chain of possession; and inclusive dates and times of possession.

e. Sample analysis request sheet: The sample analysis request sheet accompanies samples to the laboratory. The collector completes the field portion of the form, which includes most of the pertinent information noted in the log book. The laboratory portion of the form is to be completed by laboratory personnel and includes: name of person receiving the sample, laboratory sample number, date of sample receipt, condition of each sample (if it is cold or warm, whether the container is full or not, color, if more than one phase is present, etc.), and determinations to be performed.

f. Sample delivery to the laboratory: Deliver sample(s) to laboratory as soon as practicable after collection, typically within 2 d. If shorter sample holding times are required, make special arrangements to ensure timely delivery to the laboratory. If samples are shipped by a commercial carrier, include the waybill number in the sample custody documentation. Ensure that samples are accompanied by a completed chain-of-custody record and a sample analysis request sheet. Deliver sample to sample custodian.

g. Receipt and logging of sample: In the laboratory, the sample custodian inspects the condition and seal of the sample and reconciles label information and seal against the chain-of-custody record before the sample is accepted for analysis. After acceptance, the custodian assigns a laboratory number, logs sample in the laboratory log book and/or computerized laboratory information management system, and stores it in a secured storage room or cabinet or refrigerator at the specified temperature until it is assigned to an analyst.

h. Assignment of sample for analysis: The laboratory supervisor usually assigns the sample for analysis. Once the sample is in the laboratory, the supervisor or analyst is responsible for its care and custody.

i. Disposal: Hold samples for the prescribed amount of time for the project or until the data have been reviewed and accepted. Document the disposition of samples. Ensure that disposal is in accordance with local-, state-, and U.S. EPA-approved methods.

3. Sampling Methods

a. Manual sampling: Manual sampling involves minimal equipment but may be unduly costly and time-consuming for routine or large-scale sampling programs. It requires trained field technicians and is often necessary for regulatory and research investigations for which critical appraisal of field conditions and complex sample-collection techniques are essential. Manually collect certain samples, such as waters containing oil and grease.

b. Automatic sampling: Automatic samplers can eliminate human errors in manual sampling, can reduce labor costs, may

provide the means for more frequent sampling,³ and are increasingly used. Be sure that the automatic sampler does not contaminate the sample. For example, plastic components may be incompatible with certain organic compounds that are soluble in the plastic parts or that can be contaminated (e.g., from phthalate esters) by contact with them. If sample constituents are generally known, contact the manufacturer of an automatic sampler regarding potential incompatibility of plastic components.

Program an automatic sampler in accordance with sampling needs. Carefully match pump speeds and tubing sizes to the type of sample to be taken.

c. Sorbent sampling: Use of solid sorbents, particularly membrane-type disks, is becoming more frequent. These methods offer rapid, inexpensive sampling if the analytes of interest can be adsorbed and desorbed efficiently and the water matrix is free of particulates that plug the sorbent.

4. Sample Containers

The type of sample container used is of utmost importance. Test sample containers and document that they are free of analytes of interest, especially when sampling and analyzing for very low analyte levels. Containers typically are made of plastic or glass, but one material may be preferred over the other. For example, silica, sodium, and boron may be leached from soft glass, but not plastic, and trace levels of some pesticides and metals may sorb onto the walls of glass containers.⁴ Thus, hard glass containers* are preferred. For samples containing organic compounds, do not use plastic containers except those made of fluorinated polymers, such as polytetrafluoroethylene (PTFE).³

Some sample analytes may dissolve (be absorbed) into the walls of plastic containers; similarly, contaminants from plastic containers may leach into samples. Avoid plastics wherever possible because of potential contamination from phthalate esters. Container failure due to breakdown of the plastic is possible. Therefore, use glass containers for all organics analyses, such as volatile organics, semivolatile organics, pesticides, PCBs, and oil and grease. Some analytes (e.g., bromine-containing compounds and some pesticides, and polynuclear aromatic compounds) are light-sensitive; collect them in amber-colored glass containers to minimize photodegradation. Container caps, typically plastic, also can be a problem. Do not use caps with paper liners. Use foil or PTFE liners but be aware that metal liners can contaminate samples collected for metals analysis and they may also react with the sample if it is acidic or alkaline. Serum vials with PTFE-lined rubber or plastic septa are useful.

In rare situations, it may be necessary to use sample containers not specifically prepared for use, or otherwise unsuitable for the particular situation; thoroughly document these deviations. Documentation should include type and source of container, and the preparation technique (e.g., acid washed with reagent water rinse). For QA purposes, the inclusion of a bottle blank may be necessary.

5. Number of Samples

Because of variability from analytical and sampling procedures (i.e., population variability), a single sample is insufficient to reach any reasonable desired level of confidence. If an overall standard

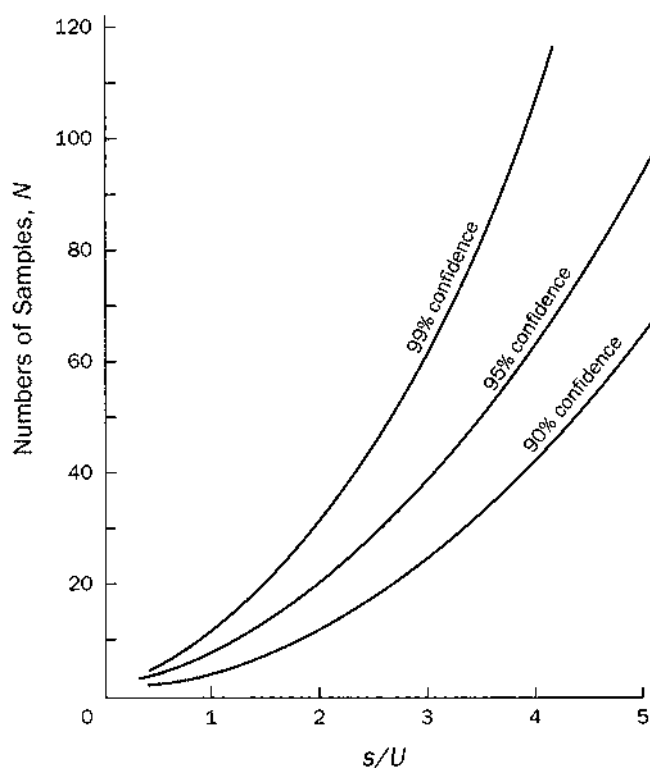


Figure 1060:1. Approximate number of samples required in estimating a mean concentration. SOURCE: Methods for the Examination of Waters and Associated Materials: General Principles of Sampling and Accuracy of Results. 1980. Her Majesty's Stationery Off., London, England.

deviation (i.e., the standard deviation of combined sampling and analysis) is known, the required number of samples for a mobile matrix, such as water, may be estimated as follows:⁴

$$N \geq \left(\frac{ts}{U} \right)^2$$

where:

- N = number of samples,
- t = Student's t statistic for a given confidence level,
- s = overall standard deviation, and
- U = acceptable level of uncertainty.

To assist in calculations, use curves such as those in Figure 1060:1. As an example, if s is 0.5 mg/L, U is ± 0.2 mg/L, and a 95% confidence level is desired, approximately 25 to 30 samples must be taken.

The above equation assumes that total error (population variability) is known. Total variability consists of all sources of variability, including the distribution of the analytes of interest within the sampling site; collection, preservation, preparation, and analysis of samples; and data handling and reporting. In simpler terms, error (variability) can be divided into sampling and analysis components. Sampling error due to population variability (including heterogeneous distribution of analytes in the environmental matrix) usually is much larger than analytical error components. Unfortunately, sampling error usually is not

* Pyrex, or equivalent.

available and the analyst is left with only the published error of the measurement system (typically obtained by using a reagent water matrix under the best analytical conditions).

More accurate equations are available.⁵ These are based on the Z distribution for determining the number of samples needed to estimate a mean concentration when variability is estimated in absolute terms using the standard deviation. The coefficient of variation [relative standard deviation (RSD)] is used when variability is estimated in relative terms.

The number of random samples to be collected at a site can be influenced partly by the method that will be used. The values for standard deviation (SD) or RSD may be obtained from each of the methods or in the literature.⁶ However, calculations of estimated numbers of samples needed based only on this information will result in underestimated numbers of samples because only the analytical variances are considered, and the typically larger variances from the sampling operations are not included. Preferably, determine and use SDs or RSDs from overall sampling and analysis operations.

For estimates of numbers of samples needed for systematic sampling (e.g., drilling wells for sampling groundwater or for systematically sampling large water bodies, such as lakes), equations are available⁷ that relate number of samples to shape of grid, area covered, and space between nodes of grid. The grid spacing is a complex calculation that depends on the size and shape of any contaminated spot (such as a groundwater plume) to be identified, in addition to the geometric shape of the sampling grid.

See individual methods for types and numbers of quality assurance (QA) and quality control (QC) samples [e.g., for normal-level (procedural) or low-level (contamination) bias or for precision] involving sampling or laboratory analysis (either overall or individually). Estimates of numbers of QC samples needed to achieve specified confidence levels also can be calculated. Rates of false positives (Type I error) and false negatives (Type II error) are useful parameters for estimating required numbers of QC samples. A false positive is the incorrect conclusion that an analyte is present when it is absent. A false negative is the incorrect conclusion that an analyte is absent when it is present. If the frequency of false positives or false negatives desired to be detected is <10%, then

$$n = \frac{\ln \alpha}{\ln (1 - Y)}$$

where:

α = (1 - desired confidence level), and
 Y = frequency to detect (<10%).

If the frequency that is desirable to detect is >10%, iterative solution of a binomial equation is necessary.^{5,8}

Equations are available as a computer program[†] for computing sample number by the Z distribution, for estimating samples needed in systematic sampling, and for estimating required number of QC samples.

6. Sample Volumes

Collect a 1-L sample for most physical and chemical analyses. For certain determinations, larger samples may be necessary. Table 1060:I lists volumes ordinarily required for analyses, but it is strongly recommended that the laboratory that will conduct the analyses also be consulted to verify the analytical needs of sampling procedures as they pertain to the goals and data quality objective of an investigation.

Do not use samples from the same container for multiple testing requirements (e.g., organic, inorganic, radiological, bacteriological, and microscopic examinations) because methods of collecting and handling are different for each type of test. Always collect enough sample volume in the appropriate container in order to comply with sample handling, storage, and preservation requirements.

7. References

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10. U.S. ENVIRONMENTAL PROTECTION AGENCY. 1992. Rules and Regulations. 40 CFR Parts 100–149.

[†] DQO-PRO, available (free) by downloading from Instant Reference Sources, Inc., <http://instantref.com/dqo-form.htm>.

COLLECTION AND PRESERVATION OF SAMPLES (1060)/Collection of Samples

TABLE 1060:I. SUMMARY OF SPECIAL SAMPLING AND HANDLING REQUIREMENTS*

Determination	Container†	Minimum Sample Size mL	Sample Type‡	Preservation§	Maximum Storage Recommended	Regulatory
Acidity	P, G(B), FP	100	g	Cool, $\leq 6^{\circ}\text{C}$	24 h	14 d
Alkalinity	P, G, FP	200	g	Cool, $\leq 6^{\circ}\text{C}$	24 h	14 d
BOD	P, G, FP	1000	g, c	Cool, $\leq 6^{\circ}\text{C}$	6 h	48 h
Boron	F, P (PTFE) or quartz	1000	g, c	HNO_3 to $\text{pH} < 2$	28 d	6 months
Bromide	P, G, FP	100	g, c	None required	28 d	28 d
Carbon, organic, total	G(B), P, FP	100	g, c	Analyze immediately, or cool $\leq 6^{\circ}\text{C}$ and add HCl , H_3PO_4 , or H_2SO_4 to pH	7 d	28 d
Carbon dioxide	P, G	100	g	Analyze immediately	0.25 h	N.S.
COD	P, G, FP	100	g, c	Analyze as soon as possible, or add H_2SO_4 to $\text{pH} < 2$; Cool, $\leq 6^{\circ}\text{C}$	7 d	28 d
Chloride	P, G, FP	50	g, c	None required	N.S.	28 d
Chlorine, total, residual	P, G	500	g	Analyze immediately	0.25 h	0.25 h
Chlorine dioxide	P, G	500	g	Analyze immediately	0.25 h	N.S.
Chlorophyll	P, G	500	g	Unfiltered, dark, $\leq 6^{\circ}\text{C}$ Filtered, dark, -20°C (Do not store in frost-free freezer)	24–48 h 28 d	N.S.
Color	P, G, FP	500	g, c	Cool, $\leq 6^{\circ}\text{C}$	24 h	48 h
Specific conductance	P, G, FP	500	g, c	Cool, $\leq 6^{\circ}\text{C}$	28 d	28 d
Cyanide						
Total	P, G, FP	1000	g, c	Analyze within 15 min. Add NaOH to $\text{pH} > 12$ if sample is to be stored, Cool, $\leq 6^{\circ}\text{C}$, in dark. Add thiosulfate if residual chlorine present	24 h	14 d; 24 h if sulfide present
Amenable to chlorination	P, G, FP	1000	g, c	Remove residual chlorine with thiosulfate and cool $\leq 6^{\circ}\text{C}$	stat	14 d; 24 h if sulfide present
Fluoride	P	100	g, c	None required	28 d	28 d
Hardness	P, G, FP	100	g, c	Add HNO_3 or H_2SO_4 to $\text{pH} < 2$	6 months	6 months
Iodine	P, G	500	g	Analyze immediately	0.25 h	N.S.
Metals	P(A), G(A), FP (A)	1000	g, c	For dissolved metals filter immediately, add HNO_3 to $\text{pH} < 2$	6 months	6 months
Chromium VI	P(A), G(A), FP (A)	250	g	Cool, $\leq 6^{\circ}\text{C}$, pH 9.3–9.7, ammonium sulfate buffer preservative as specified in method 3500-Cr to extend to 28 d HT	28 d	28 d
Copper by colorimetry	—*	—	g, c	—	—	—
Mercury	P(A), G(A), FP(A)	500	g, c	Add HNO_3 to $\text{pH} < 2$, Cool $\leq 6^{\circ}\text{C}$	28 d	28 d
Nitrogen						
Ammonia	P, G, FP	500	g, c	Analyze as soon as possible or add H_2SO_4 to $\text{pH} < 2$, Cool, $\leq 6^{\circ}\text{C}$	7 d	28 d
Nitrate	P, G, FP	100	g, c	Analyze as soon as possible; Cool, $\leq 6^{\circ}\text{C}$	48 h	48 h (14 d for chlorinated samples)
Nitrate + nitrite	P, G, FP	200	g, c	Add H_2SO_4 to $\text{pH} < 2$, Cool, $\leq 6^{\circ}\text{C}$	1–2 d	28 d
Nitrite	P, G, FP	100	g, c	Analyze as soon as possible; Cool, $\leq 6^{\circ}\text{C}$	none	48 h
Organic, Kjeldahl	P, G, FP	500	g, c	Cool, $\leq 6^{\circ}\text{C}$, add H_2SO_4 to $\text{pH} < 2$	7 d	28 d
Odor	G	500	g	Analyze as soon as possible; Cool $\leq 6^{\circ}\text{C}$	6 h	24 h (EPA Manual drinking water)
Oil and grease	G, wide-mouth calibrated	1000	g	Add HCl or H_2SO_4 to $\text{pH} < 2$, Cool, $\leq 6^{\circ}\text{C}$	28 d	28 d

COLLECTION AND PRESERVATION OF SAMPLES (1060)/Collection of Samples

TABLE 1060:I. CONT.

Determination	Container†	Minimum Sample Size mL	Sample Type‡	Preservation§	Maximum Storage Recommended	Regulatory
Organic Compounds						
MBAS	P, G, FP	250	g, c	Cool, $\leq 6^{\circ}\text{C}$	48 h	48 h as per CFR 136
Pesticides*	G(S), PTFE-lined cap	1000	g, c	Cool, $\leq 6^{\circ}\text{C}$, add 1000 mg ascorbic acid/L if residual chlorine present (0.008% sodium thiosulfate in CFR 136)	7 d	7 d until extraction; 40 d after extraction
Phenols	P, G, PTFE-lined cap	500	g, c	Cool, $\leq 6^{\circ}\text{C}$, add H_2SO_4 to $\text{pH} < 2$	*	28 d until extraction, 2 d after extraction
Purgeables* by purge and trap	G, PTFE-lined cap	2×40	g	Cool, $\leq 6^{\circ}\text{C}$; add HCl to $\text{pH} < 2$; add 1000 mg ascorbic acid/L if residual chlorine present (0.008% sodium thiosulfate in CFR 136)	7 d	14 d
Base/neutrals & acids	G(S) amber	1000	g, c	Cool, $\leq 6^{\circ}\text{C}$, 0.008% sodium thiosulfate in CFR 136 if chlorine is present	7 d	7 d until extraction; 40 d after extraction
Oxygen, dissolved	G, BOD bottle	300	g	Analyze immediately	0.25 h	0.25 h
Electrode				Titration may be delayed after acidification	8 h	8 h
Winkler						
Ozone	G	1000	g	Analyze immediately	0.25 h	N.S.
pH	P, G	50	g	Analyze immediately	0.25 h	0.25 h
Phosphate	G(A)	100	g	For dissolved phosphate filter immediately; Cool, $\leq 6^{\circ}\text{C}$	48 h	48 h as per EPA manual for DW
Phosphorus, total	P, G, FP	100	g, c	Add H_2SO_4 to $\text{pH} < 2$ and cool, $\leq 6^{\circ}\text{C}$	28 d	28 d
Salinity	G, wax seal	240	g	Analyze immediately or use wax seal	6 months	N.S.
Silica	F, P (PTFE) or quartz	200	g, c	Cool, $\leq 6^{\circ}\text{C}$, do not freeze	28 d	28 d
Sludge digester gas	G, gas bottle	—	g	—	N.S.	
Solids ⁹	P, G	200	g, c	Cool, $\leq 6^{\circ}\text{C}$	7 d	2–7 d; see cited reference
Sulfate	P, G, FP	100	g, c	Cool, $\leq 6^{\circ}\text{C}$	28 d	28 d
Sulfide	P, G, FP	100	g, c	Cool, $\leq 6^{\circ}\text{C}$; add 4 drops 2N zinc acetate/100 mL; add NaOH to $\text{pH} > 9$	28 d	7 d
Temperature	P, G, FP	—	g	Analyze immediately	0.25 h	0.25 h
Turbidity	P, G, FP	100	g, c	Analyze same day; store in dark up to 24 h, Cool, $\leq 6^{\circ}\text{C}$	24 h	48 h

* For determinations not listed, use glass or plastic containers; preferably refrigerate during storage and analyze as soon as possible.

† P = plastic (polyethylene or equivalent); G = glass; G(A) or P(A) = rinsed with 1 + 1 HNO_3 ; G(B) = glass, borosilicate; G(S) = glass, rinsed with organic solvents or baked; FP = fluoropolymer [polytetrafluoroethylene (PTFE, Teflon) or other fluoropolymer].

‡ g = grab; c = composite.

§ Cool = storage at, $> 0^{\circ}\text{C}$, $\leq 6^{\circ}\text{C}$ (above freezing point of water); in the dark; analyze immediately = analyze usually within 15 min of sample collection.

|| See citation¹⁰ for possible differences regarding container and preservation requirements. N.S. = not stated in cited reference; stat = no storage allowed; analyze immediately (within 15 min).

Some drinking water (DW) and treated wastewater (WW) matrices may be subject to positive interference as a result of preservation. If such interference is demonstrable, samples should be analyzed as soon as possible without preservation. Do not hold for more than 15 min without demonstrating that cyanide (CN) is stable for longer periods in a specific matrix.

NOTE: This table is intended for guidance only. If there is a discrepancy between this table and the method, the information in the current method takes precedence. If performing the method for compliance purposes, be aware that alternative preservation and holding-time requirements may exist. If so, the regulatory requirements should be used.

1060 C. Sample Storage and Preservation

Complete and unequivocal preservation of samples, whether domestic wastewater, industrial wastes, or natural waters, is a practical impossibility because complete stability for every constituent never can be achieved. At best, preservation techniques only retard chemical and biological changes that inevitably continue after sample collection.

1. Sample Storage before Analysis

a. Nature of sample changes: Some determinations are more affected by sample storage than others. Certain cations are subject to loss by adsorption to, or ion exchange with, the walls of glass containers. These include aluminum, cadmium, chromium, copper, iron, lead, manganese, silver, and zinc, which are best collected in a separate clean bottle and acidified with nitric acid to a pH <2.0 to minimize precipitation and adsorption on container walls. Also, some organics may be subject to loss by adsorption to the walls of glass containers.

Temperature changes quickly; pH may change significantly in a matter of minutes; dissolved gases (oxygen, carbon dioxide) may be lost. Because changes in such basic water quality properties may occur so quickly, determine temperature, reduction-oxidation potential, and dissolved gases *in situ* and pH, specific conductance, turbidity, and alkalinity immediately after sample collection. Many organic compounds are sensitive to changes in pH and/or temperature resulting in reduced concentrations during storage.

Changes in the pH-alkalinity-carbon dioxide balance may cause calcium carbonate to precipitate, decreasing the values for calcium and total hardness.

Iron and manganese are readily soluble in their lower oxidation states but relatively insoluble in their higher oxidation states; therefore, these cations may precipitate or they may dissolve from a sediment, depending on the redox potential of the sample. Microbiological activity may affect the nitrate-nitrite-ammonia content, phenol or BOD concentration, or the reduction of sulfate to sulfide. Residual chlorine is reduced to chloride. Sulfide, sulfite, ferrous iron, iodide, and cyanide may be lost through oxidation. Color, odor, and turbidity may increase, decrease, or change in quality. Sodium, silica, and boron may be leached from the glass container. Hexavalent chromium may be reduced to trivalent chromium.

The biological activity in a sample may change the oxidation state of some constituents. Soluble constituents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution. The well-known nitrogen and phosphorus cycles are examples of biological influences on sample composition.

Zero headspace is important in preservation of samples with volatile organic compounds and radon. Avoid loss of volatile materials by collecting sample in a completely filled container. Achieve this by carefully filling the bottle so top of meniscus is above the top of the bottle rim. It is important to avoid spillage or air entrapment if preservatives, such as HCl or ascorbic acid, have already been added to the bottle. After capping or sealing bottle, check for air bubbles by inverting and gently tapping it; if one or more air bubbles are observed then, if practical, discard

the sample and repeat refilling bottle with new sample until no air bubbles are observed (this cannot be done if bottle contained preservatives before it was filled).

Serum vials with septum caps are particularly useful in that a sample portion for analysis can be taken through the cap by using a syringe,¹ although the effect of pressure reduction in the headspace must be considered. Pulling a sample into a syringe under vacuum can result in low bias data for volatile compounds and the resulting headspace precludes taking further subsamples.

b. Time interval between collection and analysis: In general, the shorter the time that elapses between collection of a sample and its analysis, the more reliable will be the analytical results. For certain constituents and physical values, immediate analysis in the field is required. For composited samples, it is common practice to use the time at the end of composite collection as the sample-collection time.

Check with the analyzing laboratory to determine how much elapsed time may be allowed between sample collection and analysis; this depends on the character of the sample and the stability of the target analytes under storage conditions. Many regulatory methods limit the elapsed time between sample collection and analysis (see Table 1060:I). Changes caused by growth of microorganisms are greatly retarded by keeping the sample at a low temperature (<6°C but above freezing). When the interval between sample collection and analysis is long enough to produce changes in either the concentration or physical state of the constituent to be measured, follow the preservation practices given in Table 1060:I. Record time elapsed between sampling and analysis, and which preservative, if any, was added.

2. Preservation Techniques

To minimize the potential for volatilization or biodegradation between sampling and analysis, keep samples as cool as possible without freezing. Preferably pack samples in crushed or cubed ice or commercial ice substitutes before shipment. Avoid using dry ice because it will freeze samples and may cause glass containers to break. Dry ice also may effect a pH change in samples. Keep composite samples cool with ice or a refrigeration system set at ≤6°C during compositing. Analyze samples as quickly as possible on arrival at the laboratory. If immediate analysis is not possible, preferably store at ≤6°C.¹

No single method of preservation is entirely satisfactory; choose the preservative with due regard to the determinations to be made. Use chemical preservatives only when they do not interfere with the analysis being made. When they are used, add them to the sample bottle initially so all sample portions are preserved as soon as collected. Because a preservation method for one determination may interfere with another one, samples for multiple determinations may need to be split and preserved separately. All preservation methods may be inadequate when applied to suspended matter. Do not use formaldehyde as a preservative for samples collected for chemical analysis because it affects many of the target analytes.

Preservation methods are relatively limited and are intended generally to retard biological action, retard hydrolysis of chemical compounds and complexes, and reduce volatility of constituents.

Preservation methods are limited to pH control, chemical addition, the use of amber and opaque bottles, refrigeration, filtration, and freezing. Table 1060:I lists preservation methods by constituent. See Section 7010B for sample collection and preservation requirements for radionuclides.

The foregoing discussion is by no means exhaustive and comprehensive. Clearly, it is impossible to prescribe absolute rules for preventing all possible changes. Additional advice will be found in the discussions under individual determinations, but to a large degree, the dependability of an analytical determination rests on the experience and good judgment of the person

collecting the sample. Numbers of samples required for confidence levels in data quality objectives, however, rely on statistical equations, such as those discussed earlier.

3. Reference

1. WATER POLLUTION CONTROL FEDERATION. 1986. Removal of Hazardous Wastes in Wastewater Facilities—Halogenated Organics; Manual of Practice FD-11. Alexandria, Va.

4. Bibliography

- KEITH, L.H., ed. 1996. Principles of Environmental Sampling, 2nd ed. ACS Professional Reference Book, American Chemical Soc., Washington, D.C.

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Technical Memorandum

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*From: Francisco Alcala, CDMS
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Date: June 1, 2023

*Subject: Chlorine System Automation Evaluation, TM -19
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

This technical memorandum (TM) evaluates the opportunities for automation based on flow and total residual chlorine of the chlorine disinfection system at the Oakwood Combined Sewer Overflow (CSO) Retention and Treatment Basin (RTB) (Oakwood) and Leib Screening and Disinfection Facility (SDF) (Leib) as the objective of the task OKW-DIS-2 and LEIB-DIS-2. This TM is focused on determining the chlorine demand using instantaneously available data which will allow for more optimized system that uses less sodium hypochlorite to confidently meet a desired effluent quality. This TM describes the disinfection system control, online analyzers and sampling system at Oakwood and Leib.

Existing Disinfection Control System

Disinfection system control is implemented manually at local control panels and remotely through the Emerson Ovation Distributed Control System (DCS). The Oakwood facility presently utilizes the Ovation DCS platform, while the Leib facility will be upgraded to the Ovation DCS platform under CIP 260617 prior to this project being commissioned. Presently, the Leib facility utilizes a Rockwell control system platform that provides local monitoring and control within the facility at the operator workstations and remote monitoring from the PCC. Once the control system platform is upgraded at Leib, remote control capability will be available. At Oakwood, each storm pump has a dedicated sodium hypochlorite feed pump with three modes of controls: manual from the local control panel, and two automatic modes. In automatic mode, programming within Ovation Control System can be used to vary the feed rate in the two ways, the sodium hypochlorite dose multiplied by Contact Time (also called CT method) or Total Suspended Solids (TSS) method. Operators at Oakwood indicated that presently the chemical feed pumps are operated manually with the manual

total residual chlorine (TRC) check as guide to make changes to the sodium hypochlorite feed rates. As the storm flow measurement is questionable, operators do not rely on the sodium hypochlorite feed rate determined by the control system and tend to use high sodium hypochlorite feed rates to make sure the required disinfection is being achieved. At Leib, disinfection is performed using a CT method.

Existing Sampling System

At both facilities, influent sampling is not needed for facility operation, so no sampling pumps are used. At Leib, the sampling pumps in the Influent Channel and Effluent Channel are not in use. Thus, the samplers for the untreated flow from the Influent Channel and the screened and disinfected flow in the Effluent Channel were removed. The Outfall Sampling unit was turned off because there is no potable water source for standby operation. The effluent sampling at both facilities are used to monitor effluent water quality as needed for the National Pollutant Discharge Elimination System (NPDES) permit compliance.

Disinfection Control Functionality

The four modes of controlling the chlorination system will be: Manual Control, Flow Paced, Integrated Contact Time (ICT) Dose Paced with TRC Analyzers, and Machine Learning (ML) Dosing Model.

Manual Control:

In this mode the sodium hypochlorite feed system will be started, stopped, and controlled manually from either local control panel or Ovation Control System. Operators will use the selected ICT value, the sodium hypochlorite concentration, and inputs from storm flow meter(s) to determine the sodium hypochlorite feed rate. If the online TRC analyzer sampling system is implemented, it will provide a tool to manually adjust the feed rate. This mode will have lowest data requirement and no complex instrumentation. This control will require the use of higher safety factors in sodium hypochlorite feed rates to account for the uncertainty to achieve required disinfection and increasing sodium hypochlorite usage and costs and potential corrosion due to high sodium hypochlorite dose and off gassing of chlorine at the downstream processes.

Flow Paced:

In this mode the chemical feed system will be started, stopped, and controlled based on the flow inputs from the storm flow meter. Operators will select the chemical dose based on the selected ICT value and the stored sodium hypochlorite trade percent by weight concentration. Flow paced control will have less amount of automation as it is only related to the influent flow and chemical feed rate. It will lower the safety factor and will result in chemical savings compared to the manual control mode.

ICT Dose Paced with TRC Analyzers:

ICT dose pacing with TRC analyzers is similar to flow paced using ICT dose but adds a continuous feedback of TRC concentration data to optimize chemical dosage. The initial sodium hypochlorite

dose during an event will be based on the ICT dose developed as part of this project, thereafter the dose will be continuously adjusted to maintain a selected effluent TRC. This control mode will provide data driven high confidence in chemical dose optimization and minimization in dose safety factor resulting in lower sodium hypochlorite usage reduced chemical costs and potential corrosion due to high sodium hypochlorite dose and off gassing of chlorine at the downstream processes corrosion. It will have less manual operation and staff involvement. The continuous data collection by analyzers will incrementally improve the dosing algorithm. This control mode will involve automation and higher capital investment in analyzers and SCADA integration.

Machine Learning Dosing Model:

Machine Learning is a branch of computer science field dedicated to developing and implementing algorithms that allow computers to learn without being explicitly programmed to provide predictions and pattern recognition. Influent water quality is correlated to chlorine demand, and upstream environmental and system characteristics drive influent water quality. ML dosing models use predictive algorithms to characterize the relationship between the CSO flow, water quality parameters, and chlorine demand. This subsection will provide information on the basic concepts, chlorine demand prediction model approach, ML workflow, and project work plan. There are two groups of ML models, supervised learning and unsupervised learning.

The ML model predicts changes in the present chlorine demand using the historical chlorine dose collected during a year of operation, TRC, and upstream water characteristics such as organic load, precipitation data, radar imagery, flow information, and date-time information, gathered through the Ovation integration from water quality analyzers at the influent of each facility, along with weather information from outside sources. ML workflow will include data identification and collection, data collection design, data processing, exploratory data analysis, model development, model deployment, and computing. The project work plan will be evaluated during the design, construction, and development phases. A well-trained model would provide minimized dose safety factors lowering chemical costs and corrosion. Continuous data collected by analyzers incrementally improve the dosing algorithm and potential to optimize the disinfection process further and reduce operator work. This model will need the highest capital involvement in analyzers and SCADA integration and will depend on the operation and maintenance of analyzers.

The recommendation is to train the ML model to optimize disinfectant usage by learning from historical system performance after 1 year of operation post upgrades. The investigation will identify which correlations between data from influent water quality online analyzers and disinfection performance to determine if the chlorine dose can be optimized in a broader range of conditions. If more data is collected after the first year of operation, a ML model could be continuously retrained to improve its accuracy over time. The recommendation is to have a discussion with the Great Lakes Water Authority (GLWA) about the group of staff to be involved in the ML aspect of the project, and the associated testing and research and development group could be more suitable for this task.

Analyzer Type

The recommendation is to provide on-line TRC analyzers to measure the real-time TRC concentrations at both facilities. The analyzers will provide inputs to the Ovation DCS for adjustment of the chemical feed rates, viewing of real-time data from the Ovation operator workstations, historical data collection from the Ovation historian, and provides the data necessary for the ML dosing model. Use of online analyzers in intermittent flow applications, like CSO treatment facilities is a challenge. However, providing a continuous flow stream for keeping the sensors wet and providing routine maintenance help mitigate these challenges. GLWA presently utilizes on-line TRC analyzers on an intermittent flow stream at the Water Resource Recovery Facility (WRRF) to monitor the TRC in the Rouge River Outfall (RRO) that is placed into service during wet weather events. The colorimetric TRC analyzer is recommended based on its advantages over amperometric technology. During Workshop No. 3 (TM Set 2A) on May 12, 2023 it was determined to use the colorimetric TRC analyzer manufactured by the SWAN Analytical Instruments.

Sampling System Functionality

The automatic/online sampling is required to implement on-line analyzers to measure parameters in real time. The sampling system functionality recommendations are summarized in the **Table ES-1** for Oakwood and **Table ES-2** for Leib.

Table ES-1 Recommended Sampling System at Oakwood

Sampling System	Sample Location	Sample Collection System	Sampler /Analyzer Location	Parameters	Need
Influent Sampling System	Influent East and West Wet Wells	- Replace existing influent sample pumps with similar type - Reuse existing sampling piping	Influent Sampling Room in the Control Building	- TSS (Sensor) - COD (REDOX Titration after oxidation by potassium dichromate) - Turbidity (Sensor) - Temp/pH (Sensor) - TOC (Infrared) - UVA (UV absorption) - Bacteria Indication (ColiMinder™) (To be evaluated)	Machine learning model training
Chlorine Demand Sampling System	At Screen Inlet Chamber upstream of screens	- Three sample locations between pump discharge standpipes and screen inlets. - Three submersible sample pumps located in Screen Inlet Chamber	Outside of Screen Room on Screen Inlet Chamber Roof Or Mechanical Room of Screen Facility (feasibility of location to be further evaluated in the Basis of Design)	TRC (Colorimetric by the SWAN Analytical Instruments)	To determine chlorine demand and provide feedback to the DCS.
Chlorine Decay Sampling System	One sample location at each CSO basin before effluent weir	One sample pump at each CSO Basin	Outside of Screen Room on Screen Inlet Chamber Roof Or Mechanical Room of Screen Facility (feasibility of location to be further evaluated in the Basis of Design)	TRC (Colorimetric by the SWAN Analytical Instruments)	To determine chlorine decay and provide feedback to the DCS.
Effluent Sampling System	Effluent channel	Continue using existing system	Effluent Sample Room	Parameters required for NPDES permit compliance or monitoring	NPDES permit compliance or monitoring

Table ES-2 Recommended Sampling System at Leib

Sampling System	Sample Location	Sample Collection System	Sampler Location	Parameters	Need
Influent Sampling System	Influent Channel	- Replace existing influent sample pump with similar type - Reuse existing sampling piping	Sample Room in the Control Building	- TSS (Sensor) - COD (REDOX Titration after oxidation by potassium dichromate) - Turbidity (Sensor) - Temp/pH (Sensor) - TOC (Infrared) - UVA (UV absorption) - Bacteria Indication (ColiMinder™) (To be evaluated)	Machine learning model training
Chlorine Demand Sampling System	Effluent Channel right after the end of facility	- One sample location. - Two sample pumps (one duty / one standby) located in the Effluent Channel	Sample Room in the Control Building	TRC (Colorimetric by the SWAN Analytical Instruments)	To determine chlorine demand and provide feedback to the DCS.
Chlorine Decay Sampling System ¹	Outfall (if online analyzer needed)	Outfall (if online analyzer selected)	Outfall Sample Pit (if online analyzer selected)	TRC	To determine chlorine decay and provide feedback to the DCS.
Effluent Sampling System	Continue using existing location	Continue using existing system	Effluent Sample Room	Parameters required for NPDES permit compliance or monitoring	NPDES permit compliance or monitoring

Note: 1. Online TRC analyzer not proposed for the Chlorine Decay Sampling due to the challenges with the remote location.

1.0 Introduction and Purpose

As part of the CSO Facility Improvements project the GLWA is making disinfection system improvements to the Oakwood Retention and Treatment Basin and Leib Screening and Disinfection Facility. Those improvements include upgrading the sodium hypochlorite storage, and feed systems at both facilities to improve their reliability, flexibility, simplicity, ease of operation and maintenance, and robustness, all with an eye toward doing so in a way that optimizes the amount of sodium hypochlorite utilized to meet the discharge permit requirements and TRC goals. The objective of the task OKW-DIS-2 and LEIB-DIS-2 is to address GLWA's goal of optimizing and automating the chlorine disinfection system. The task is achieving optimization with four steps approach and summarizing the work performed under each step in the respective technical memorandums (TMs).

- Review of historical data and supplemental sampling (refer to TMs-20 and 17 respectively)
- Assess hydraulic efficiency of chemical mixing and downstream contact volume (refer to TM – 20 for computational fluid dynamic (CFD) analysis (refer to TM-20 Appendix B) and contact volume)
- Optimizing chlorination process by performing dose response testing and determining the appropriate integrated contact time (ICT) (refer to TM-18 Chlorine Dose Response Results and ICT Model)
- Evaluate opportunities for automation (presented in this TM)

The chlorine dose response tests provide initial estimates of chlorine demand and decay from the sampled storm events. This TM is focused on determining the chlorine demand using on-line analyzers or readily available real-time data which will allow for more optimized system that uses less chemicals to confidently meet a desired effluent quality.

As presented in TM-18, the data generated from the chlorine dose response testing is utilized to develop facility and storm event specific disinfection efficacy models. The efficacy models, used in conjunction with log inactivation goals, are able to determine an ICT value required to achieve the bacteria permit limits. ICT stands for integrated residual concentration multiplied by contact time, and has units of mg-min/L. A disinfection control system can utilize an ICT dose pacing algorithm, in lieu of a traditional flow pace system. The advantage of an ICT dose pacing system compared to a flow pacing system is the inclusion of effective contact time. A flow pacing system with a compound loop using a TRC analyzer has a limited adjustment range or may continuously seek if the range is too wide. The ICT dose pacing factors in more variables by incorporating the hydraulic efficiency of a contact volume as well as the chlorine demand and decay rates in the control algorithm. Because of the water quality variability seen in CSO, understanding bacteria loading, chlorine demand and decay rates in real-time is essential to optimizing the chlorine disinfection process.

In addition to providing manual control, this TM will present the following three means of optimizing and controlling the chlorine disinfection process:

- Flow Paced
- ICT Dose Paced with TRC Analyzers
- ML Dosing Model

Understanding how influent water quality is correlated to chlorine demand and decay, and upstream environmental and system characteristics are critical to optimizing the disinfection process. Use of on-line TRC analyzers is one way to determine chlorine demand and decay. Another approach is to utilize ML dosing models to characterize the relationship between upstream characteristics and influent water quality and chlorine demand and decay. This TM presents basic

concepts of ML to help understand the technical vocabulary and the key definitions, modeling approach to be considered during design, general workflow for the prediction model development and deployment, and the project work plan.

The TM is also structured to cover the present disinfection system control, facility Ovation DCS, and sampling system functionality.

Guiding Principles

The guiding principles were developed in collaboration with GLWA for the CSO Improvements Project. The guiding principles provided guidelines for conducting evaluations, identified general areas for improvement, and defined overarching outcomes for the project. **Figure 1-1** summarizes the guiding principles that governed the approach to the disinfection systems evaluation and informed key decisions.

Equipment

- Do not replace equipment in kind – improve equipment
- Provide operational flexibility, cost savings (lifecycle cost basis) including current operational costs
- Reduce human capital and maintenance
- Provide equipment which is accessible and easy to maintain
- Equipment selection to accommodate intermittent use

O&M/System Considerations

- Process must operate reliably “on demand” (intermittent use)
- Keep operations and system improvements simple to extent feasible. Specifically provide a system (or equipment within the system) that can be operated simply in manual mode when needed
- Minimize single points of failure
- Provide sufficient redundancy for each equipment system (balance with reduced O&M)
- Maintain operation of Oakwood and Leib throughout construction phase

Collaboration

- Involve O&M staff in design development process, listen to them and effectively communicate with them
- Design with consistency in materials of construction across disciplines in each room/area

General

- Use same facility, area and room name by all disciplines

Figure 1-1
Summary of Guiding Principles

2.0 Existing System(s) Description (and/or Conditions)

The following subsections describe the disinfection system control, present chemical dosing system, and sampling system at Oakwood and Leib.

2.1 Disinfection System Control

Disinfection system control is implemented manually at local control panels and remotely through the Emerson Ovation DCS. Local control panels provide a manual backup to the Ovation DCS. The Oakwood facility presently utilizes the Ovation DCS platform, while the Leib facility will be upgraded to the Ovation DCS platform under another capital improvement project (CIP) prior to this project being commissioned. The Ovation DCS platform consists of the following components at each facility:

- Redundant root network switches enabling communication between the Ovation process controllers, operator workstations (OWS), database server, and information network.
- Redundant Ovation process controllers (OCR-1100) located in an Ovation controller cabinet with redundant power supplies.
- Input/output (I/O) modules for integrating hardwired signals (digital inputs, digital outputs, analog inputs, analog outputs) into the Ovation system.
- Communication modules for integration of digitally communicated signals from motorized valve actuators, variable frequency drives (VFDs), and third-party programmable logic controllers (PLCs). Communication modules include serial communication modules integrating fieldbus protocols (Modbus RTU, RS-233, RS-485, DF1, etc.) and Ethernet protocols (Modbus TCP/IP, Ethernet/IP, etc.).
- Ovation DCS server housing the database configuration for the facility and enabling modifications, additions, and changes to be implemented locally for equipment and instrument updates.
- Ovation operator workstations (OWS) providing access to the human-machine interface (HMI) graphics for the facility and enabling operations personnel to monitor and initiate control changes for process equipment at the site.
- Communication to the sites is implemented through third-party internet service for normal high-bandwidth communications back to the WRRF. A radio communication link provides back-up communication to the WRRF for transmission of critical signals in the event of the internet communication failure.
- Network communication, data routing, and firewall protection for the sites are provided through Cisco hardware devices.

2.1.1 Oakwood

At Oakwood, each chemical feed pump is dedicated to a storm pump. When the Ovation Control Station begins storm pump operation, the Ovation Control Station will start the storm pump's associated chemical feed pump. In addition, the Ovation control Station will provide a flow value from the flow meter in the storm pump discharge pipe and as a back-up will calculate a flow produced by the storm pump based on speed and wet well level (pump curve). This flow value will be one of the parameters utilized by the Ovation Control Station to calculate the needed chemical feed rate for the chemical feed pump. Additional chemical feed pumps are started as additional storm pumps come online. Each chemical feed pump has a pressure relief valve, suction and discharge isolation valves, and a check valve associated with it as well.

There are three modes of control for each pump – one Manual and two Automatic:

- Manual control from the local control panel (LCP) in the Chemical Facility Control Room.
- Automatic control from the Ovation Control Station. In the automatic mode, programming within the Ovation Control Station can be used to vary the chemical feed pump flow rate in one of two ways, the sodium hypochlorite dose multiplied by Contact Time (also called CT method) or Total Suspended Solids (TSS) method.

CT Method – The feed rate will be based on either the product of chlorine concentration of the initial dose leaving the feed pump and the contact time (maximum CxT=125, minimum CxT=100) or based on a chlorine dose (maximum Cl₂ dose=12.0 mg/L) set point. Based on the set point (CxT or Cl₂ dose) and stored sodium hypochlorite trade percent by weight concentration, the sodium hypochlorite feed rate necessary for the total calculated flow from each storm pump will be calculated.

TSS Method – The total suspended solids (TSS) of the incoming sewage during a wet weather pumping (storm) event is continuously being monitored via a Hach TSS monitor located on the influent sample line in the Influent Sample Room of the Pump Station (PS) Control Building (Status unknown). The Ovation Control System uses a formula that considers the sewage flow rate, the concentration of the sodium hypochlorite disinfectant and the total suspended solids value of the incoming sewage to automatically calculate the hypochlorite dosing rate required to meet the facility's NPDES permit requirements.

The Ovation Control Station is also programmed to start the chemical feed pump to run at maximum speed for an initial period to minimize the time required to fill the discharge pipe with full strength chemical. The maximum run period is an operator adjustable setpoint.

2.1.2 Leib

At Leib disinfection is performed using a CT method (product of chlorine concentration of the initial dose leaving the feed pump and the contact time) (Leib Operations and Maintenance manual referred

as CT). Using the CT method, a constant CT goal (mg/L x minutes contact time) is established, and the disinfectant dose is varied as the contact time changes to maintain the CT goal.

The facility is designed to operate automatically based on programmed controls and feedback from automatic TRC analyzers, but it does not provide control using the CT method. Therefore, operators need to manually input dosages as influent flow rates change. This is accomplished by providing the operators with tables showing the required dosage to achieve the target CT (presently 100 mg-min/L) at various influent flow rates. Operators reference the table for the solution strength closest to the actual analyzed concentration of the present hypochlorite feed solution at the facility. If the facility TRC analyzer is working and accurate, actual dosage concentrations will be recorded automatically. If the TRC analyzer is not operational, TRC will be measured periodically taking samples (a minimum of every ½ hours) from mixing chamber sample pump, and test using colorimeter.

2.2 Sampling System

The sampling system at both facilities is used to monitor water quality at the effluent. The NPDES permit requires the TRC and Fecal coliform to be measured at the effluent of each facility multiple times during a storm event. Grab samples are taken from the effluent sampling system. Sampling systems at both facilities are original and had not been upgraded over time.

2.2.1 Oakwood

The influent sampling system receives flow from sample pumps located in the storm pump station East and West Wet Wells. Influent sample pumps and related piping and valves are installed, the facility influent sampling is not needed for facility operation, so no sampling pumps are used. The effluent sampling system uses one effluent sample pump located in the CSO basin effluent channel just upstream of the CSO basin effluent conduits. The effluent sample pump conveys samples to the effluent sample room, where effluent flow is tested for compliance. The sampling pumps are vertical, heavy-duty, solids handling, non-clogging, and chopper-type pumps. The information of influent sample pumps and effluent sample pumps is presented in **Table 2-1** and **Table 2-2**. As influent sampling is not needed for the operation of facility, influent sampling pumps not in operation. The sampler keypad allows staff to turn the sampler on or off and to program the desired sampling mode(s). Information is displayed on the LED screen. There are three modes of control for each pump:

- Local/Manual control at the Local Control Panel (LCP)
- Remote/Manual control from the Ovation Control Station
- Remote/Automatic control from the Ovation Control Station

Table 2-1 Information of Influent Sample Pumps at Oakwood

Component/Criteria	Value
Service	Influent Sampling
Liquid	Unscreened Combined Stormwater and Wastewater
Name	Influent Sample Pumps Nos.1 and 2
Location	East and West Storm Wet Well Expansion Zones
Number of Pumps	2 (one in each expansion zone)
Configuration	Vertical, Submersible, Chopper type
Design Capacity (gpm:TDH)	144 each, 0.32 cfs, Design total head conditions: 54 ft TDH
Frequency of Pump Starts	4 times in 1 hour
Minimum Efficiency as Design Capacity	20%
Pump Speed at Design Capacity (Maximum)	1750 rpm
Minimum Shutoff Head	50 ft
Maximum Motor Hp	7.5
Net Positive Suction Head Available	36 ft
Pump Discharge Size	3-in
Pump Inlet Size	6-in
Vaughan Model NO. and Impeller Size	SE3M with 8-in impeller

Table 2-2 Information of the Effluent Sample Pump at Oakwood

Component/Criteria	Value
Service	Effluent Sampling
Name	Effluent Sample Pump
Location	CSO Basin Effluent Channel near effluent weir wall which is immediate upstream of effluent conduits
Number of Pumps	1
Configuration	Vertical, Submersible, Chopper type
Design Capacity (gpm:TDH)	120 each, 0.27 cfs, Design total head conditions: 38 ft TDH
Frequency of Pump Starts	4 times in 1 hour
Minimum Efficiency as Design Capacity	35%
Pump Speed at Design Capacity (Maximum)	1750 rpm
Minimum Shutoff Head	44 ft
Maximum Motor Hp	5
Net Positive Suction Head Available	31 ft
Pump Discharge Size	3-in
Pump Inlet Size	6-in
Vaughan Model NO. and Impeller Size	SE3G with 6.5-in impeller

The Influent Sampling Room and Effluent Sampling Room were originally provided with Isco 6712FR composite samplers. The influent sampler has been removed, and effluent sampler is operational. The sampler controller (interface on sampler) will allow mode selection, timer settings, and other parameter settings to be performed locally at the sampler. The Ovation Control Station uses a 4-20 mA totalized flow signal generated from the storm pump flow meters to pace the sampler in the Composite mode and a pulse output to make the sampler sample at a selected flow rate (measured in cfs) of storm pump flow (setpoint adjusted based on operating experience). A selector switch is provided at the Ovation Control Station screen to select between sending flow pacing or quantity pacing signals to the sampler.

2.2.2 Leib

Three EMU constant speed, submersible, grinder pumps are in place at the Leib SDF and Outfall Structure to provide continuous sample of the associated CSO flow during a wet weather event. The first pump is in the Influent Channel, and the second one located in the Effluent Channel just downstream from the Mixing Chamber. Each pump delivers flow to one of the two refrigerated samplers located in the Sampler Room. The sampling pumps in the Influent Channel and Effluent Channel are not in use. A third sample pump is located at the outfall and provides flow to the refrigerated sampler and TRC and oxidation-reduction potential (ORP) monitoring equipment located in the sampling pit at the outfall. **Table 2-3** presents the design criteria of the sample pumps.

Table 2-3 Design Criteria of the Sample Pumps at Leib.

Component/Criteria	Value
No. Sample Pumps	3
Size	2 inches
Type	Submersible Grinder
Capacity	50 gpm @50 ft TDH
Motor	4.7 HP, 460 V, 3480 rpm, 3 Phase

Two Isco 6700 refrigerated samplers are in the Sampler Room of the Control Building, and one is in the sampling pit at the Outfall Structure. Of the two samplers located in the Sampler Room, one is for the untreated flow that is pumped from the Influent Channel and the other one is for the screened and disinfected flow in the Effluent Channel. The controllers for the samplers contain two programming modes, standard and extended, with a keypad for program entries. Standard programming allows to set up typical sampling program easily and efficiently while the extended mode allows for more sophisticated and complex program.

The TRC analyzer system, manufactured by Capital Controls, consists of an amperometric analyzer and a millivolt to current transducer measuring free or total residual chlorine. The unit associated with the facility discharge sample pump is located in the Control Building, while the unit associated

with the outfall is located in the outfall sampling pit. The Outfall Sampling unit is turned off because there is no potable source for standby operation.

Sample is delivered to the sample-screening chamber of the TRC analyzer at an approximate rate of 500 ml/min. The excess overflows to drain. The sample then passes into a measuring cell of the flow-thru type with two dissimilar metal electrodes, which produces a signal proportional to chlorine residual. During non-operational / sampling periods the TRC Analyzer in the facility sampling room is fed a continuous stream of clean water. This water stream allows the TRC unit to maintain its calibration between wet weather event samples. This water stream will automatically be shut off when the effluent channel sample pump and sampler are activated. Shutoff is accomplished by closing a solenoid valve on the water supply line. The valve is wired to the sampler.

3.0 System Evaluation

This section presents the evaluation of operation of the existing chlorine disinfection system operation and sampling system at Oakwood and Leib.

3.1 Disinfection System

3.1.1 Oakwood

The Ovation Control Station provides a flow value from the flow meter in the storm pump discharge pipe. This flow value is one of the parameters utilized by the Ovation Control Station to calculate the needed chemical feed rate for the chemical feed pump. The reliability of storm pump flow measurement came into question, and an evaluation of the reliability of the flow meters is part of this project which is not covered under this TM.

Operators indicated that presently the sodium hypochlorite feed pumps are operated manually with manual TRC measurements used as a guide to make changes to the sodium hypochlorite flow rates. TRC check is done by grabbing the sample at the screen facility, upstream of screens and analyzing for TRC with a Hach device. Based on the first TRC check, the sodium hypochlorite feed rate is adjusted.

As the storm flow measurement is questionable, operators do not rely on the sodium hypochlorite flow rate determined by the control system as it is not providing reasonable dose in their assessment. Thus, the operators tend to use high sodium hypochlorite feed rates to make sure the required disinfection is being achieved. Recent site visits during storm events, it was observed that the high sodium hypochlorite feed rates early in the storm events results in chlorine off gassing being observed where the storm pump discharge into the screening chamber. Excessive chlorine off gassing may result in corrosion of metal items and be a health and safety concern in the vicinity.

3.1.2 Leib

The operator indicated that the sodium hypochlorite feed at the pre-chlorination mixers is manually operated while the feed at the mixing chambers is automatic. Operator enters in the

control system the stored sodium hypochlorite trade percent by weight concentration and the sodium hypochlorite application rate based on the CT tables from operation and maintenance manual. The control system paces the sodium hypochlorite feed rate to achieve sodium hypochlorite application concentration. As the influent flow rate changes, the operator adjust the sodium hypochlorite application rate based on the CT tables from operation and maintenance manual. The effluent TRC analyzer is not in operation and does not provide feedback in sodium hypochlorite feed rate.

3.2 Sampling System

3.2.1 Oakwood

Influent sample pumps and related piping and valves are installed, but not used since the CSO operators aren't in need of them to operate the facility. Therefore, the influent samplers were removed from Oakwood. If the influent sampling is to be used, the influent pumps should be replaced instead of reusing them.

3.2.2 Leib

The sampling pumps in the Influent Channel and Effluent Channel are not in use. Thus, the samplers for the untreated flow from the Influent Channel and the screened and disinfected flow in the Effluent Channel were removed. The Outfall Sampling unit was turned off because there is no potable water source for standby operation.

4.0 Description of Alternatives

4.1 Disinfection Control Functionality

The four modes of controlling the chlorination system will be:

1. Manual Control
2. Flow Paced
3. ICT Dose Paced with TRC Analyzers
4. ML Dosing Model

TM-18 summarized the results from the disinfection modeling and recommended the high and average ICT values for both Oakwood and Leib. TM-20 further determined the sodium hypochlorite dose for the respective ICT values based on the sodium hypochlorite solution. For Oakwood, TM-20 also determined the dose for CSO basin with baffles. The stored sodium hypochlorite trade percent by weight concentration and ICT values will be key parameters in determining the sodium hypochlorite feed rates under four control methods.

4.1.1 Manual Control

In this mode the sodium hypochlorite feed system will be started, stopped, and controlled manually from either local control panel or Ovation Control System. Operators will use the selected ICT value,

the stored sodium hypochlorite trade percent by weight concentration, and inputs from storm flow meter(s) to determine the sodium hypochlorite feed rate. If the online TRC analyzer sampling system is implemented, it will provide tool to manually adjust the feed rate.

Manual control will not have automation and will be based on the operator's familiarity with the CSO and chlorination system, experience with the system and operational judgement. It will have lowest data requirement, no complex instrumentation. This control will require the use of higher safety factors in sodium hypochlorite feed rates to account for the uncertainty to achieve required disinfection and increasing sodium hypochlorite usage and costs and potential corrosion due to high sodium hypochlorite dose and off gassing of chlorine at the downstream processes. Also, it will need more manual operation and staff involvement.

4.1.2 Flow Paced

In this mode the chemical feed system will be started, stopped, and controlled based on the flow inputs from the flow meter(s). Operators will select the chlorine dose, input the stored sodium hypochlorite trade percent by weight concentration, and the control system will automatically adjust the chemical feed rate based on the influent flow to the CSO facility.

Flow paced control will have less amount of automation compared to the ICT dose paced with TRC analyzers and ML dose model modes as only related to the influent flow and chemical feed rate. It will have lower safety factor than the manual mode and will result in sodium hypochlorite savings compared to the manual control mode which could potentially overshoot sodium hypochlorite dose to achieve required disinfection. This control will require less manual operation and staff involvement than the manual control mode.

4.1.3 ICT Dose Paced with TRC Analyzers

The efficacy models, used in conjunction with log inactivation goals, are able to determine an integrated CT (ICT) value required to achieve the bacteria permit limits. ICT stands for integrated residual concentration multiplied by contact time and has units of mg-min/L. A disinfection control system can utilize an ICT dose pacing algorithm, in lieu of a traditional flow pace system. The advantage of an ICT dose pacing system compared to a flow pacing system is the inclusion of effective contact time. A flow pacing system with a compound loop using a TRC analyzer has a limited adjustment range or may continuously seek if the range is too wide. The ICT dose pacing factors in more variables by incorporating the hydraulic efficiency of a contact volume as well as the chlorine demand and decay rates in the control algorithm. The flow rate is utilized in the algorithm to calculate an effective contact time, and the chlorine demand and decay are included in determining the sodium hypochlorite flow rate. The stored sodium hypochlorite trade percent by weight concentration is also an input into this control approach. The initial ICT can be adjusted in future years based on the historical data and additional upstream water quality sampling and analysis.

Two TRC analyzers will be utilized, one shortly after chlorine addition, and the second further down the contact volume. The first TRC analyzer will allow for the chlorine demand to be

determined, while the second TRC analyzer will allow for the chlorine decay to be determined. These inputs into the ICT model will allow for real-time adjustment to the chlorine dose based upon the changing water quality and contact times observed during storm events. In-lieu of using online TRC analyzers, operator can elect to enter chlorine demand and chlorine decay value based on the seasonal variation typically observed in CSO collection system. The on-line TRC analyzer details are presented in Section 4.2.

This control method provides confidence by using data driven disinfection optimization to reduce the amount sodium hypochlorite used while meeting permit limits. It will have less manual operation and staff involvement. The continuous data collection by analyzers will incrementally improve dosing algorithm. This control mode will involve a higher degree of automation and higher capital investment in analyzers and SCADA integration than manual control and flow paced modes.

4.1.4 Machine Learning Dosing Model

Influent water quality is correlated to chlorine demand and decay, and upstream environmental and system characteristics have a large impact on the influent water quality. ML dosing models are looking to characterize the relationship between upstream flow characteristics, influent water quality and chlorine demand and decay. Because chlorine decay is typically quite small, the focus will be on chlorine demand which changes significantly based upon the influent water quality. This section presents a technical approach related to the studies and alternatives development to delineate the design process to evaluate the feasibility of incorporating modification of the CTI approach and the potential for a ML dosing model to optimize system operation across multiple flows and bacterial loading scenarios estimating. The evaluated model will be trained to optimize disinfectant usage by learning from historical system performance after one (1) year of operation post upgrades. Correlations between upstream online analyzer data and disinfection performance will be investigated to determine if they can optimize chemical dosage in a broader range of conditions. If more data is collected after the first year of operation, a ML model could be continuously retrained to improve its accuracy over time. This subsection will provide information on the basic concepts, chlorine demand and decay prediction model approach, ML workflow, and project work plan.

4.1.4.1 Basic concepts of Artificial Intelligence (AI) and Machine Learning

AI focuses on developing human-like intelligence systems, with ML as a subfield creating algorithms for computers to learn and recognize patterns. ML models are categorized into supervised learning (trained on labeled data for predictions) and unsupervised learning (identifying patterns without initial labeling). These algorithms utilize data for training to generate predictive models for new data, differing from deterministic programming-based process control algorithms. **Figure 4-1** presents example plots showing supervised learning and unsupervised learning.

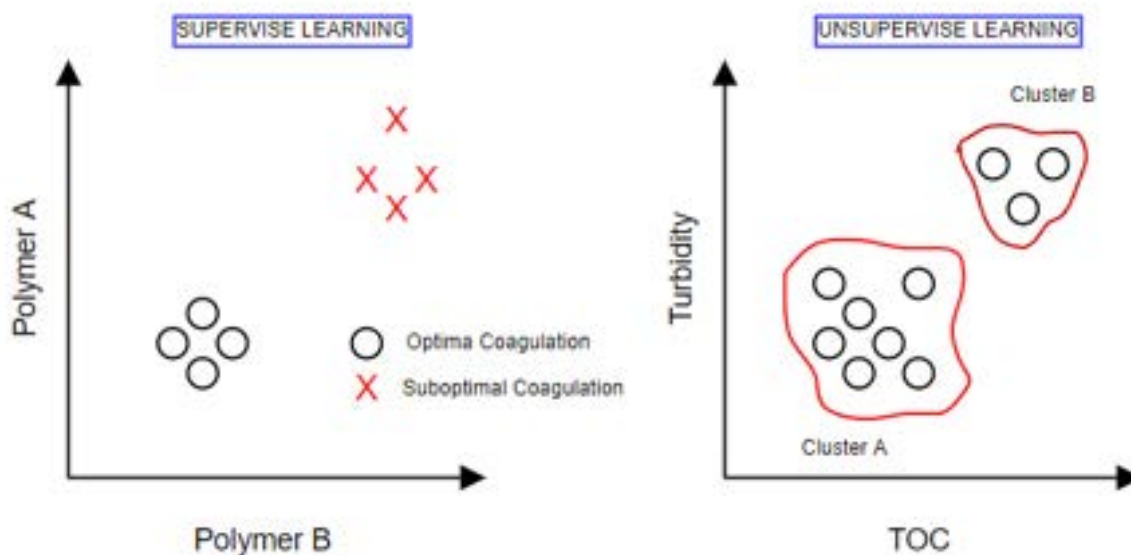


Figure 4-1
Supervised and Unsupervised Learning

ML problems include classification and regression. Classification groups data based on predetermined characteristics, such as categorizing water reservoir statuses using dissolved oxygen and total organic carbon values. Regression models continuous relationships between variables, like estimating manganese levels in a reservoir using pH, TOC, DO, and temperature. Examples of classification and regression plots are presented in Figure 4-2.

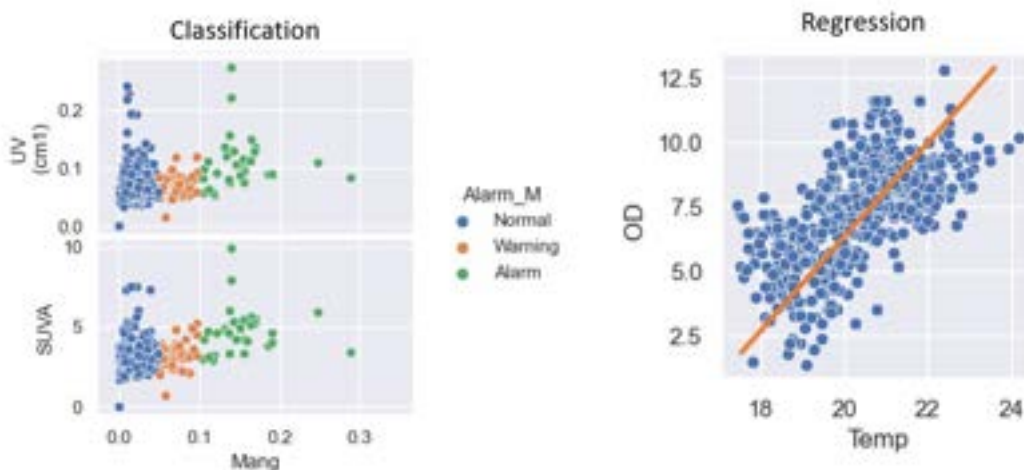


Figure 4-2
Classification and Regression Problems

Model performance metrics evaluate ML model accuracy and effectiveness. Regression metrics include Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and R-squared. Classification metrics encompass accuracy, precision, recall, and F1-score. The choice of metric depends on the problem type, data nature, and desired outcome.

4.1.4.2 Chlorine Demand Prediction Model Approach

The ML problem to be resolved requires the development of a supervised regression model to predict chlorine demand based on CSO flow, environmental factors, and upstream properties. During the project's design phase, various methods will be used to characterize influent water quality parameters. The process involves developing and evaluating two cascade models. The first model estimates influent forecasts using data from the Oakwood pump station, weather stations, and rainfall metrics. This model also characterizes CSO flow events for optimization. The second model utilizes influent flow forecasts and water quality data to estimate chlorine demand. Two initial approaches, Chlorine Demand Prediction (CDP) and Chlorine Dosage Model (CSP), are considered, with the possibility of an additional modeling approach during the design phase. The ML models estimate the chlorine demand based on environmental and upstream characteristics. Influent water quality parameters can be characterized by several approaches that will be defined during the project's design phase. However, in general terms, the initial approach requires the evaluation and development of two models in a cascade. The first model will be oriented to estimate the influent forecast to determine the surge of flow correlated with the influent pumps station (Oakwood), real-time weather station, etc., to capture point estimates of rainfall intensity and duration. The flow model evaluation also includes the characterization of the flow CSO event in terms of its applicability to the overall optimization objective. This characterization includes determining whether it is practical to estimate the Chlorine demand over real-time values of CSO influent flow/level or window horizon of the CSO flow inrush flow has value for operational purposes. The second model will use the influent flow forecast or real time values as input and water quality data to estimate the chlorine demand. Having the Chlorine demand estimated by the ML model, the control approach could be to implement a model predictive control to optimize the chlorine injection based on the trajectory of the Chlorine demand or provide the information to the operator on the DCS in advisory mode. For Chlorine demand prediction, two initial approaches are considered. However, additional approaches may be considered during the design phase. The two models' approaches are Chlorine Demand Prediction and Chlorine Dosage Model.

Chlorine Demand Prediction (CDP)

The **CDP** model is intended to predict changes in the present chlorine demand using the historical chlorine dosage, collected during a year of operation, TRC, and upstream water characteristics such as organic load, precipitation data, radar imagery, flow information, and date-time information. This information will be used to calculate changes in chlorine dosage based on the ICT value to be

shown in an advisory mode or automatic change of setpoint in the Distributer Controller System (DCS). Process of CDP model training and deployment is presented in **Figure 4-3** and **Figure 4-4**.

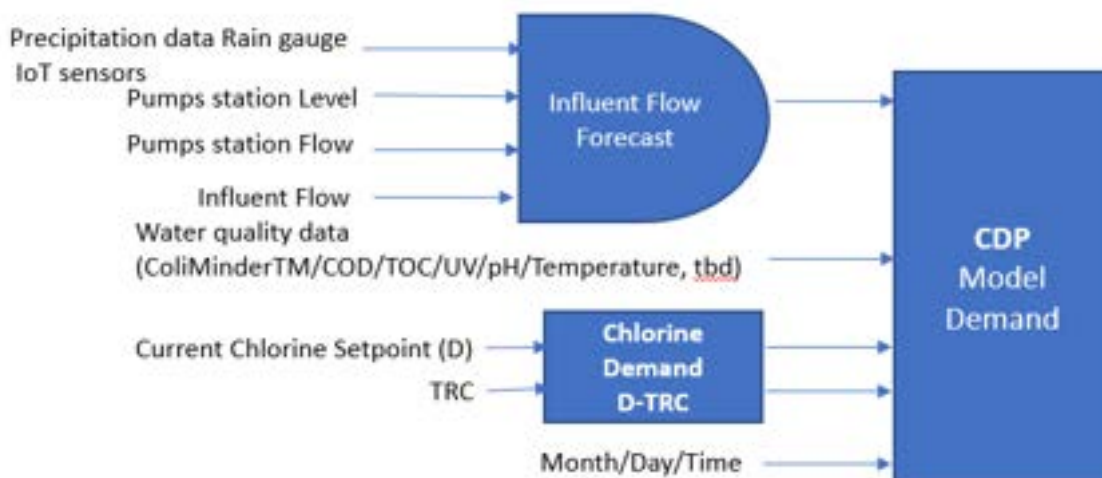


Figure 4-3
 Chlorine Demand Prediction (CDP)_Model Training

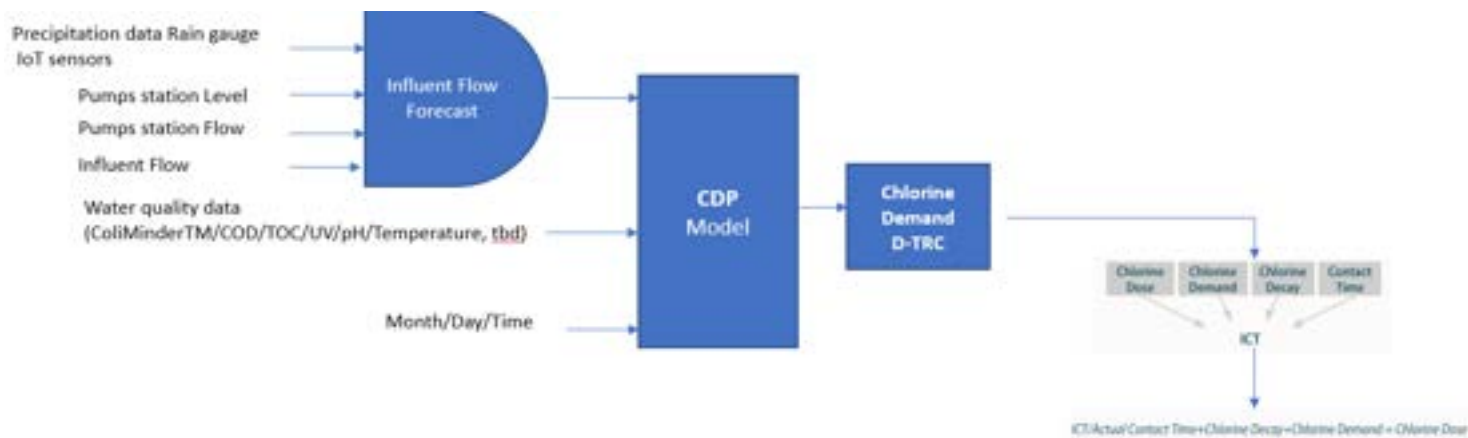


Figure 4-4
 Chlorine Demand Prediction (CDP) Model Deployment

Total Residual Chlorine Limit

The CSP model intends to predict changes in chlorine dosage based on historical data such as present chlorine dosage, desired TRC limit, and upstream water characteristics such as organic load, precipitation data, radar imagery, flow information, date-time information, etc. The optimal dosage could be predicted by providing the model's expected TRC limit and present condition. The new setpoint could be provided in an advisory mode in the DCS or an automatic change of setpoint in the DCS. Process of CSP model training and deployment is presented in **Figure 4-5** and **Figure 4-6**.

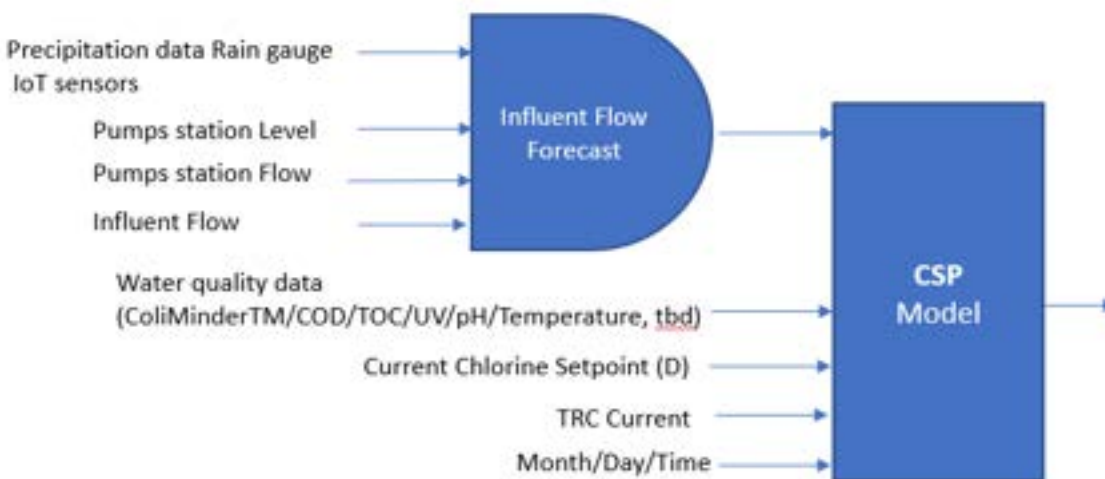


Figure 4-5
Chlorine Dosage Model (CSP) Training

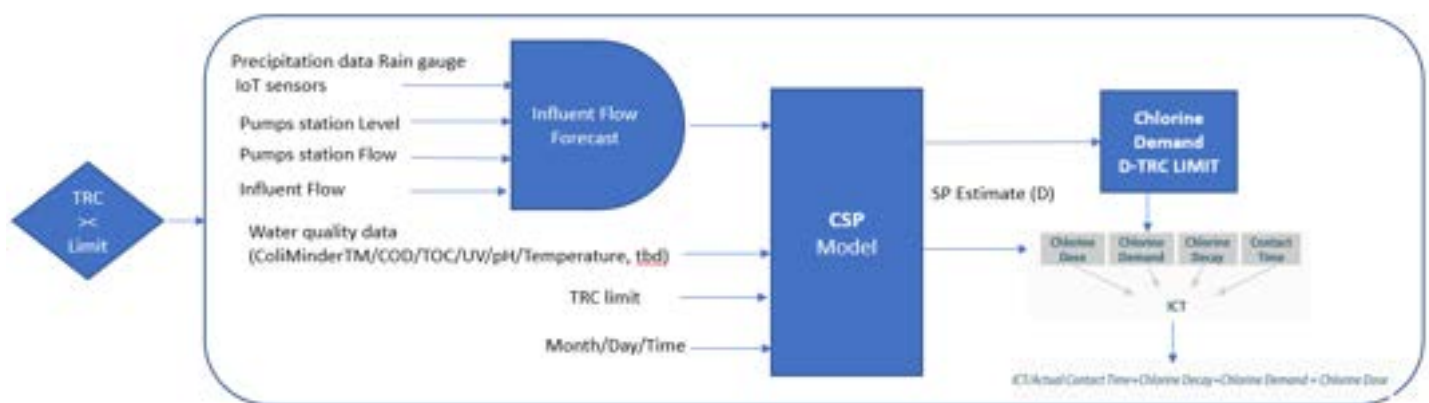


Figure 4-6
Chlorine Dosage Model (CSP) Deployment

4.1.4.3 Machine Learning Workflow

Data Identification and Collection: In this phase, defining variables and sensors for model training is crucial for feature selection and accuracy. Preparing the DCS and other data sources to collect necessary information involves selecting appropriate sensors and data. This step is vital for developing an accurate model and considers various sensors as potential candidates. The following sensors, but not limited to them, will be considered:

- Ground/Well levels and flow IoT sensors + weather stations and National Oceanic and Atmospheric Administration (NOAA) radar imagery and Sewer distribution flows
- Influent flow metering data and pump stations effluent data
- Hydraulic model data
- Water Quality Data
 - TSS
 - Turbidity
 - Chemical Oxygen Demand (COD)
 - Total Organic Carbon (TOC)
 - UV Absorption (UVA)
 - pH
 - Temperature
 - TRC influent, TRC mid-contact basin, and TRC effluent
 - Bacteria activity from online analyzers for E. coli and an organic surrogate (ColiMinder™)

During this phase, assistance to the Instrumentation and Control (I&C) designer will be provided to establish instrumentation selection and the metrological aspect of the data collection, including accuracy, sensibility, repeatability, calibration accuracy, calibration frequency, etc.

Data Collection Design

The problem approach involves building a ML model using data from various sources including online data from DCS on water quality parameters, asynchronous laboratory results on similar or additional quality parameters, and data from physically distributed well level, flow, and rain gauge samples.

To synchronize the data from different sources, the following design considerations need to be incorporated:

- Time alignment is crucial as data is produced at varying intervals. Aligning data to a common time frame, such as resampling and event labeling, ensures consistency across different data sources like DSC real-time data, distributed level and flow data, rain gauges, and autosampler laboratory data.
- Data imputation involves inputting autosampler laboratory results and rain gauge data into the selected time frame and event. Rain gauge data provided in daily records must be adjusted to include datetime labels and logged every 15 seconds during rain events..
- Data integration involves merging data from various sources into a single dataset using common identifiers like date-time and flow. For instance, laboratory results can be linked to DCS data through CSO event labels and flow information.

Data Preprocessing: Once the data is collected, preprocess the data by cleaning, filtering, denoising, and transforming the data into a format suitable for analysis. This may include handling missing values, dealing with outliers, and normalizing or standardizing the data.

Exploratory Data Analysis (EDA): This involves examining and visualizing the data to understand its characteristics, identify patterns using unsupervised modeling, and gain insights that can guide the modeling process. In the context of time series analysis with cross-correlation for multivariate analysis, the process of EDA can be broken down into several key steps, described below.

- Data Collection: The first step in the EDA process is to collect the relevant data, including multiple time series and their associated variables.
- Data Cleaning and Preparation: Once the data has been collected, it needs to be cleaned and prepared for analysis. This involves removing missing values and outliers and normalizing or transforming the data.
- Exploratory Data Analysis: The next step is to conduct exploratory data analysis, which involves visualizing the data to identify trends, patterns, and relationships. This can be done with various techniques, such as scatter plots, line charts, histograms, and box plots. This phase will include the possible development of clustering analysis using unsupervised learning looking to evaluate flow pattern between the rain gauges, sewer level and flows.

Time Series Analysis: After conducting the EDA, the next step is to perform a time series analysis. This involves analyzing the data for trends, seasonal patterns, and other temporal effects and estimating and modeling any relevant time series models.

Cross-Correlation Analysis: Identify lagged relationships between series and determine which variables most predict the target variable.

Multivariate Analysis: Examines the relationship between multiple variables and how they influence each other using unsupervised algorithms as principal component analysis (PCA) or factor analysis to help identify underlying patterns and relationships between variables.

Feature Selection: Identify relevant features from the collected data likely to be correlated with the chlorine demand. This may involve analyzing correlations between variables, identifying relevant variables defined by context knowledge experts, or using ML algorithms such as PCA or LASSO (Least Absolute Shrinkage and Selection Operator) to identify the most relevant features.

The feature selection process must be particularly important to developing a model because it intends to filter data that may not be valuable for an accurate prediction. For example, CDM Smith's experience with NOAA radar imagery for precipitation and flow forecast had been the challenge in providing accurate estimation for near real-time prediction because the NOAA radar transmits a few seconds every hour. Another factor that does not favor a near real-time prediction is the nature of technology based on doppler radar designed to measure reflectivity at an elevation that made the prediction of the approximate location of the precipitation and concurrent effect of a CSO influent flow quite challenging. For this purpose, distributed IoT sensors for rain, wet level, and sewer and storm flow have shown to be the preferred features for the understanding of the dynamics of flow on time series as documented in several research publications including:

- Hazhar Sufi Karimi et al, "[*Comparison of learning-based wastewater flow prediction methodologies for smart sewer management*](#)", Journal of Hydrology, Volume 577, 2019, 123977
- Zhang, Duo, Geir Lindholm, and Harsha Ratnaweera. "[*DeepCSO: Forecasting of combined sewer overflow at a citywide level using multi-task deep learning*](#)." arXiv preprint arXiv:1811.06368 (2018).

The correct selection of the water quality parameter is key to achieving acceptable chlorine demand prediction. Although there are not many research papers related to chlorine demand prediction, research papers targeting chlorine residual prediction for drinking water have shown an increase in accuracy prediction when the model is built with at least three water quality input parameters. Examples of this approach are published in:

- Wadkar, Dnyaneshwar & Kote, Alka. (2017). [*Prediction of residual chlorine in a water treatment plant using generalized regression neural network*](#). International Journal of Civil Engineering and Technology. 8. 1264-1270.
- Wiley Speir Helm , "[*Master's Thesis titled Machine Learning Applied to Chlorine Residual Data*](#)"

Model Development: Developing an ML model to predict the chlorine demand will be performed by the training using different existing ML algorithms, such as linear regression, decision trees, random forests, support vector machines, and neural networks. The model development may

include performing Ensemble techniques that combine multiple models to make a more accurate prediction than a single model. The specific algorithm chosen will depend on the amount and quality of data available and the desired level of accuracy.

Model Evaluation: Evaluate the performance of the developed model using appropriate metrics such as MSE, RMSE, R-squared, or other suitable performance metrics. The model's performance will be evaluated using cross-validation techniques or splitting the data into training and testing sets. Model training will utilize 70-80% of the data gathered, while the remaining 30-20% of the data will be used to test the model. The selected performance metrics will be used to determine the accuracy of the model, and thus its feasibility.

Model Optimization: Optimize the model by fine-tuning the model parameters or exploring alternative algorithms and re-evaluating the model's performance.

Machine learning workflow diagram is shown in **Figure 4-7**.

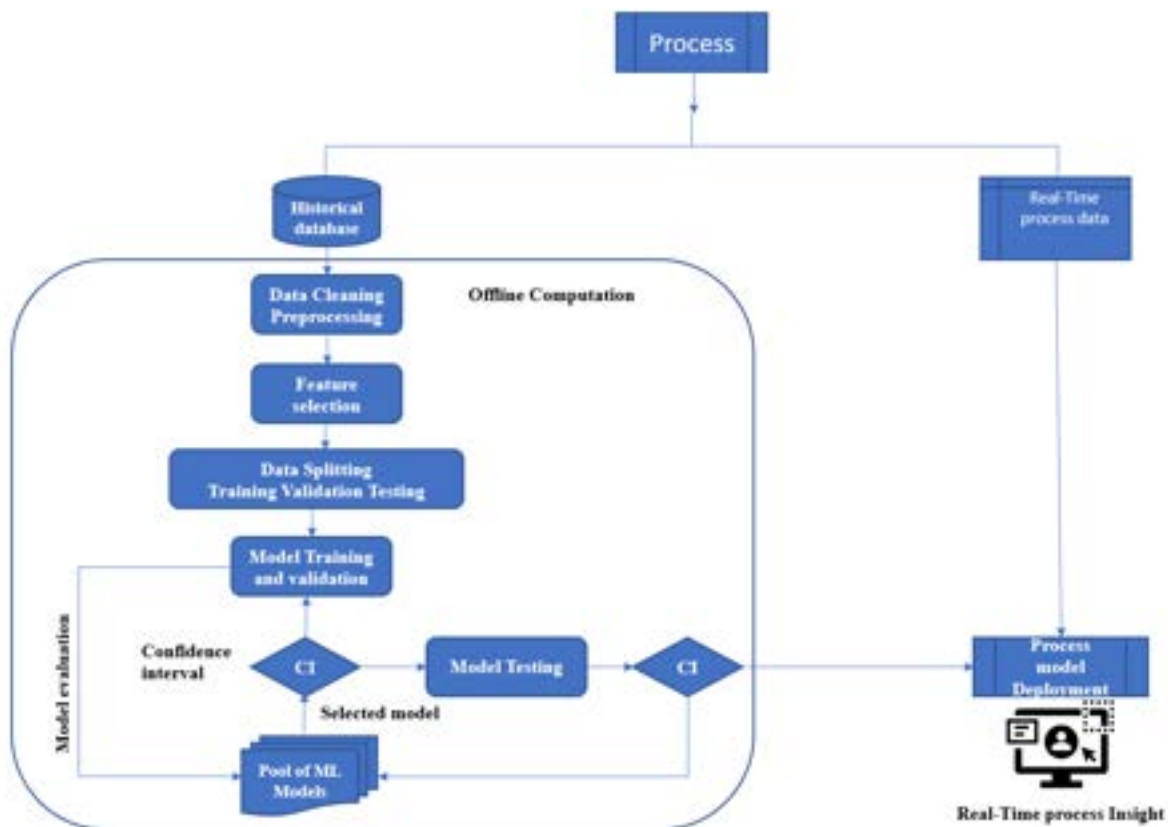


Figure 4-7
Machine learning Workflow

ML model implementation (Edge Computing):

Deploying an ML model on Edge Computing involves running it in a local Industrial Processor instead of a centralized cloud server. Edge Computing could be done by a state-of-the-art ML module installed in the backplane of a PLC or by an industrial PC with communication integration capabilities. See **Figure 4-8**, showing typical edge device implementation architecture.

The facility's edge computer would be used to provide inputs to and outputs from the Ovation system for process analysis. This computer could be developed to operate in advisory mode or control mode. In advisory mode, it would indicate a recommended value that should be used in the facility operations. Then the operator has to make a decision and change the setpoint. In control mode, the Edge computer would send the set point directly to a PLC/control system and modulate the dosage.

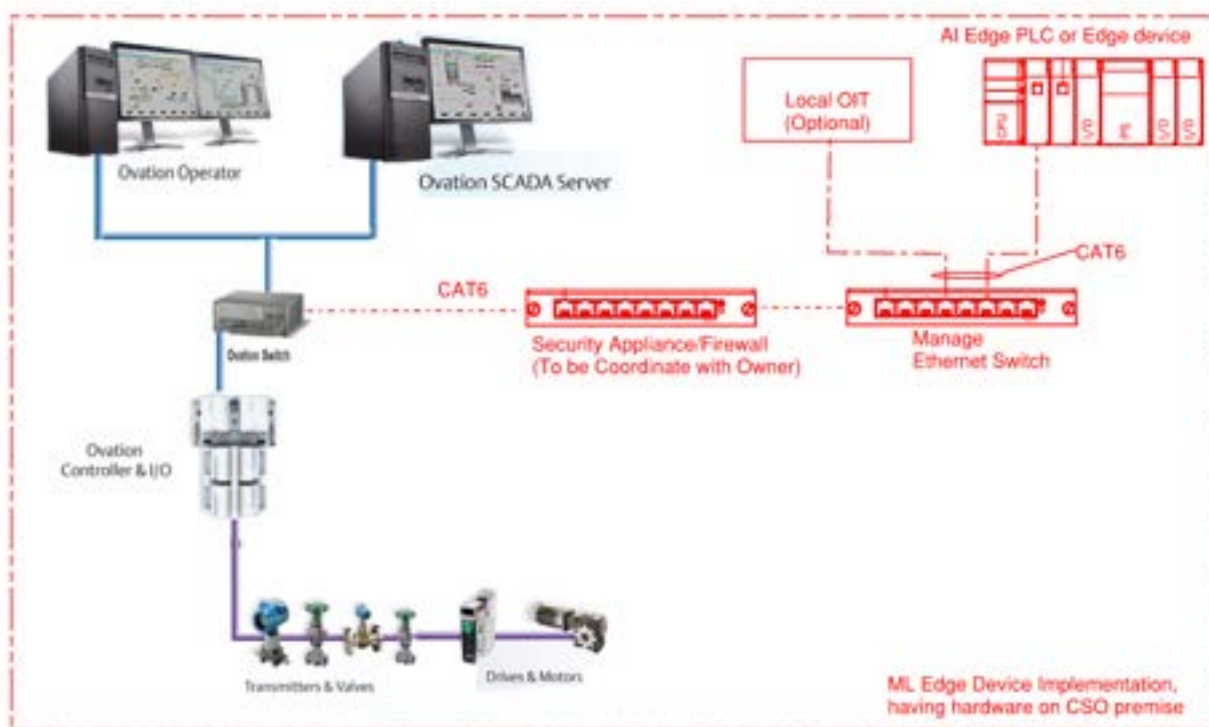


Figure 4-8
Typical Edge Device Implementation Architecture

4.1.4.3 Project Work Plan

This work plan aims to develop a ML model to predict the chlorine demand in a CSO process. The CSO process is a key component of wastewater treatment systems and understanding the chlorine

demand is crucial for ensuring effective treatment. To achieve this goal, the work plan includes three main phases: the design phase, the construction phase, and the developing phase.

In the design phase, the tasks involve gaining a deep understanding of the context and instrumentation of the CSO process, selecting relevant variables, designing the data source, and sampling strategy, research review and conducting exploratory data analysis on historical records, defining the model metric.

The construction phase includes a submittal review of sensors, data, hardware, and software components to ensure the components meet the goal of the intended design will be provided. This phase also includes commissioning verification and data collection quality validation during the operation.

Data quality verification and validation is crucial during the process of collecting data from sensors for ML modeling. The quality of the data directly affects the performance and accuracy of the ML models, and inaccurate or unreliable data can lead to incorrect predictions and decisions. The most common reason why data quality validation is important:

- Accuracy: If the data collected from sensors is inaccurate or unreliable, the resulting models will be inaccurate as well.
- Completeness: Missing or incomplete data can cause issues with the model's accuracy and reliability.
- Consistency: Inconsistent data can also lead to inaccuracies in ML models. Data quality validation can ensure that data is consistent and meets the required standards.
- Outliers: Data quality validation can help identify outliers and determine whether they should be removed or corrected.
- Bias: Biased data can lead to biased models, which can have serious consequences in certain applications. Data quality validation can help identify and correct bias in the data.

After a minimum of one year of data collection, the developing phase will begin. This phase focuses on modeling following the workflow described above.

Design Phase Tasks

1. Research review of related modeling projects.
2. Develop alternative analysis to define model approaches for influent flow forecasting.
3. Develop alternative analysis to define model approaches for Chlorine demand prediction.

4. Field sensor evaluation and selection, data collection for preliminary Analysis, and concept modeling.
 - a) Sensor for estimation of rainfall intensity, duration, and influent flow.
 - b) Sensor evaluation to identifying surrogates for chlorine demand or TRC.
 - c) Develop alternative analysis for to ensure the quality and accountability of the data collected, evaluating the following three alternative.
 - i) Permanent metering infrastructure with maintained by contractor or owner.
 - ii) Turnkey monitoring analyzer panels with maintenance and calibration services.
 - iii) Sensor leasing with maintenance and calibration services and data collection services.
5. Develop alternative analysis and specification definitions for the qualifications of the ML engineering service provider.
6. I&C consultancy during control design and context knowledge analysis for instrumentation and variables selection, sampling infrastructure, sensor selection, and online data collection.
7. Model metric definition and analysis.
8. Develop training and testing specification.

Construction Phase

- 1) Submittal review of sensors, data, sensors, analyzers, and software components.
- 2) Commissioning Data collection quality verification.
- 3) Operation Data collection quality validation.

Modeling Developing phase (After a minimum of one year of data collection)

- 1) Historical records Exploratory Data Analysis
- 2) Influent forecast Model development
- 3) Chlorine demand Model development
- 4) Models testing and performance metric evaluation.
- 5) Develop result reports and recommendations.

Risks Involved

There are certain aspects of this project that involve a certain level of uncertainty either due to data availability or level of detail associated with data which presents a risk to the project. Such potential risks may include:

- The rainfall data that may not be available at the horizon intervals required by the controls while other data from analyzers will be available at finer time intervals.
- Problems with the analyzers and other sensors may not be known until the data is adequately analyzed.
- Since CSO events are rare, the model's performance may depend on the quantity of data available. It is possible that one year of data may not provide enough information to create an accurate model.
- Model performance also relies on data quality. Thus, selecting the appropriate analyzer skid alternative and ensuring data quality during the collection period are crucial for the feasibility analysis's success.

4.2 Analyzer Type

Chlorine residual analyzers are available in manual (handheld) and on-line types. A manual (handheld) chlorine residual analyzer enables quick analysis of grab samples. On-line chlorine residual analyzers provide output capability to a process control system or DCS. For on-line chlorine residual analyzers, two technologies are typically utilized to determine the total chlorine residual. Amperometric units, such as the HACH CL10sc, use two electrodes (anode and cathode) that measure a change in current caused by the chemical reduction of hypochlorous acid at the cathode. The current generated due to this reduction is proportional to the concentration of chlorine. Amperometric units are suitable for a flow stream that provides a relatively constant pH range. For applications with wide pH range, some manufacturers provide extended pH range sensor or include a pH sensor to compensate for the change in pH. Colorimetric (DPD) analyzers use reagents and a buffer solution to react with the active free chlorine to generate a colored product that is read photometrically to identify the amount of chlorine present. The HACH CL17sc analyzer widely utilized throughout GLWA uses this method of measurement. **Table 4-1** identifies the ranges, reagents, flow requirements, and typical manufacturers for both types of on-line chlorine residual analyzers.

Table 4-1 On-line Total Chlorine Analyzer Attributes

Analyzer Type	TRC Measurement Range, mg/L	Basis of Technology	Reagents for CSO Applications	Continuous Liquid Flow Required	Manufacturers
Amperometric	0-20	Uses electrode in flow through cell to electric current as a surrogate for TRC	Buffer Electrolyte solution Iodide solution	Yes	Evoqua Micro/2000; Hach CLT10sc
Colorimetric	0-10	Uses reagents for DPD chlorine reaction and analyzer measures color at a given wavelength as a surrogate for TRC	Buffer Iodide solution	Yes	Hach CL17sc SWAN AMI Codes-II TC (Selected for design)

Critical to the operation of the TRC analyzers is the routine maintenance required for either amperometric or colorimetric units. Amperometric units must ensure pH levels are remaining within the unit range or the unit is calibrated to a new pH level if a pH probe is not integrally provided with the unit. Colorimetric units must be routinely checked to ensure adequate reagent and buffer solution is available to the unit. This process becomes critical when utilized on facilities where intermittent use of the analyzers will occur. Routine maintenance must also include regular calibration of the units. Calibration and maintenance will be essential to obtaining accurate inputs to the control system or ML algorithms.

Microbial Water Quality Analyzer

Advances in real-time microbial water quality analysis have paved the way for utilizing a fully automated, rapid on-line analyzer that is able to estimate bacteria enumeration. Vienna Water Monitoring Solutions (VWMS) has developed the ColiMinder™, which is able to measure *Enterococci*, *E. coli*, and total activity. Traditionally enumerating bacteria is a 24- to 30-hour process, most of which is incubation time to allow the bacteria to grow colonies that are large enough to see and count with the naked eye. The ColiMinder™ directly measures the enzymatic activity of a water sample as a surrogate for bacteria concentration, allowing for enumeration to be provided in 15 minutes. This technology may be a significant step forward in optimizing disinfection processes. The analyzer is not fully developed for the intermittent CSO application. However, an adaptation of the technology for on-demand CSO monitoring is basically possible. An operation mode for the ColiMinder™ in which operation is triggered by events would need to be developed, implemented and tested. Further investigation will be needed to evaluate the feasibility of the full-scale pilot testing. A successful pilot will test and provide ability to monitor influent and effluent bacteria counts against flow rates at the facilities to optimize the disinfection process across flow rates during individual wet weather events, and the seasonal variations typically seen in CSO collection systems.

Summary of on-line analyzers recommended for Oakwood and Leib is presented in **Table 4-2**.

Table 4-2 On-line Analyzers Recommended for Oakwood and Leib Applications

	Analyzer Type	Analyzer Type	Manufacturers	Models	Measurement Range	Require Continuous Flow?
1.	TRC	Colorimetric	HACH SWAN	CL17sc Colorimetric AMI Codes-II TC Colorimetric	0 - 10 mg/L	yes Not needed but advantageous
2.	TSS	Sensor	HACH	Solitax sc INSERTION highline sc Solitax sc INSERTION inline sc	0.001 mg/L to 500 g/L 0.001 mg/L to 50 g/L	yes
3.	COD	REDOX Titration after oxidation by potassium dichromate solution, conform with ISO 6060 method	HACH	EZ7000 Series	5-10000 mg/L O ₂	yes
4.	Turbidity	Sensor	HACH	Solitax sc INSERTION highline sc or Inline TU5 Series	0.001 to 4000 NTU 0.001 to 1000 NTU	yes yes
5.	Temp/pH	Sensor	HACH	Digital pHD sc sensors	-5 - 70 °C (23 - 158 °F) pH and ORP 0 - 50 °C (32 - 122 °F) SS pHD/-2.0 to 14.0 pH	yes
7.	TOC	Infrared	HACH	B3500e	0 - 250 mg/L C, 0 - 1000 mg/L C	yes
8	UVA	UV absorption	HACH	UVAS PLUS sc SENSOR	0-50 mm	yes
9	Bacteria Indication (<i>Enterococci</i> , <i>E. Coli</i> , and total activity)		Vienna Water Monitoring Solutions (VWMS)	ColiMinder™ (see note 1)		

Note: 1. Full scale pilot testing evaluation for CSO application is recommended.

4.3 Sampling System Functionality

The two approaches to water quality sampling at Oakwood and Leib are manual/grab and automatic/online. The manual/grab sampling is labor intensive and requires additional efforts during storm events. The time period required in manual/grab sampling and lag in getting results will reduce efficiency in optimizing the chemical dose and will result in a higher factor of safety and higher chemical dosing. The automatic/online sampling will have benefit for the on-line analyzers to measure parameters in real time and provide inputs to the Ovation DCS. The real time parameters measurement will be necessary for the sophisticated automation of the disinfection control system. The automatic/online sampling will need extensive sample collection system with sample pumping and piping and returning the sample back. It will have additional equipment to maintain.

4.2.1 Oakwood

Influent Sampling System

Influent water quality sampling is necessary for ML model training to further optimize disinfection. The two influent sampling pumps have not been used for an extended period of time, therefore instead of performing pump condition assessment, it is proposed to replace the pumping system with similar type. During basis of design phase, the feasibility of reducing flow capacity and option of Flygt N series pump will be evaluated. The influent sample piping could be potentially reused. During detailed design, the condition assessment of piping can be done. The influent sampling system is presented in **Figure 4-9**.

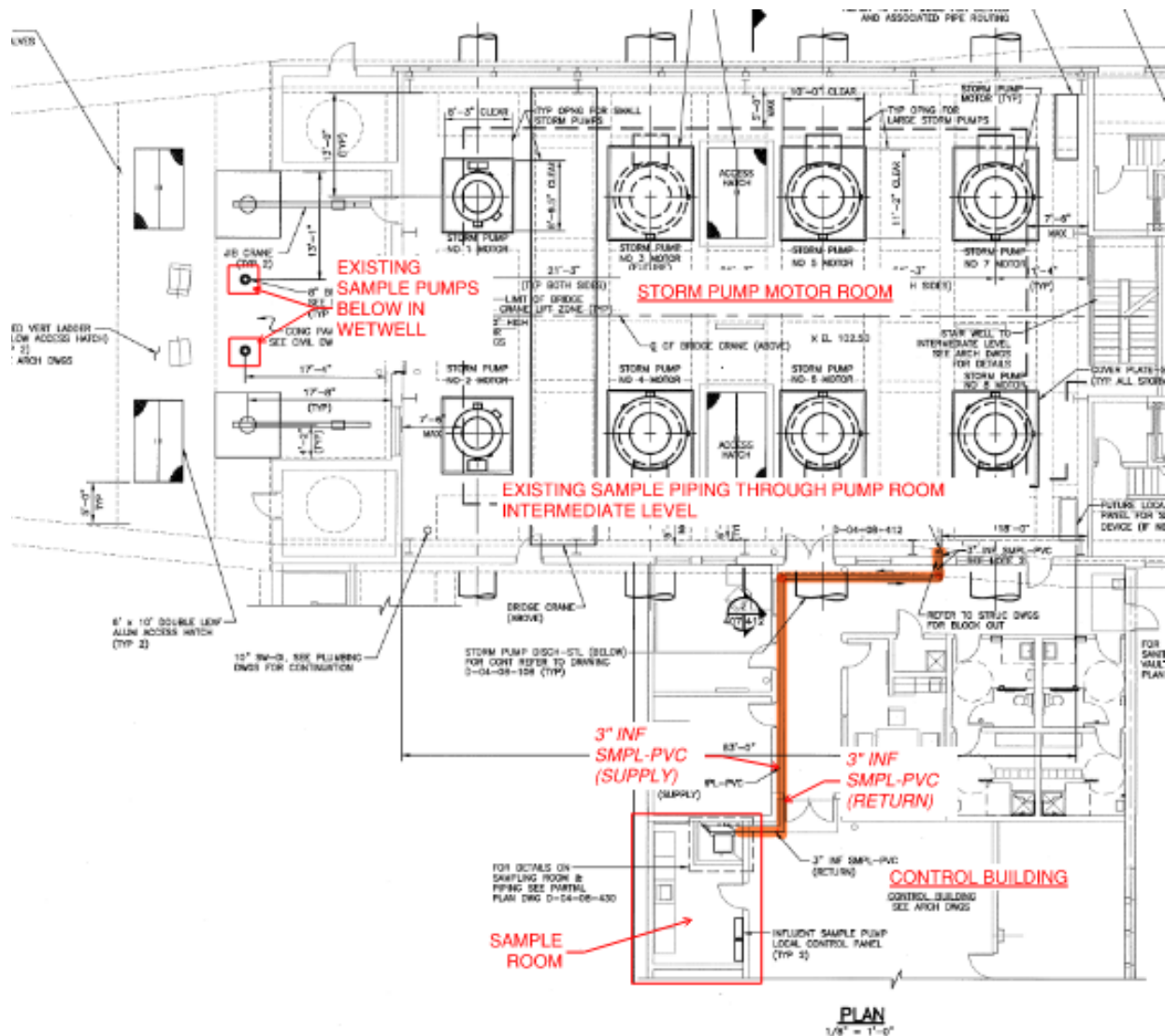


Figure 4-9
Oakwood Influent Sampling Pumps and Piping System

As part of the ML model training, new online analyzers are proposed to monitor the TRC, TSS, COD, turbidity, temperature/pH, TOC and UVA. Hach provides TRC, multi-parameter and COD analyzers. **Figure 4-10** presents the proposed location of analyzer panels inside the Influent Sample Room.

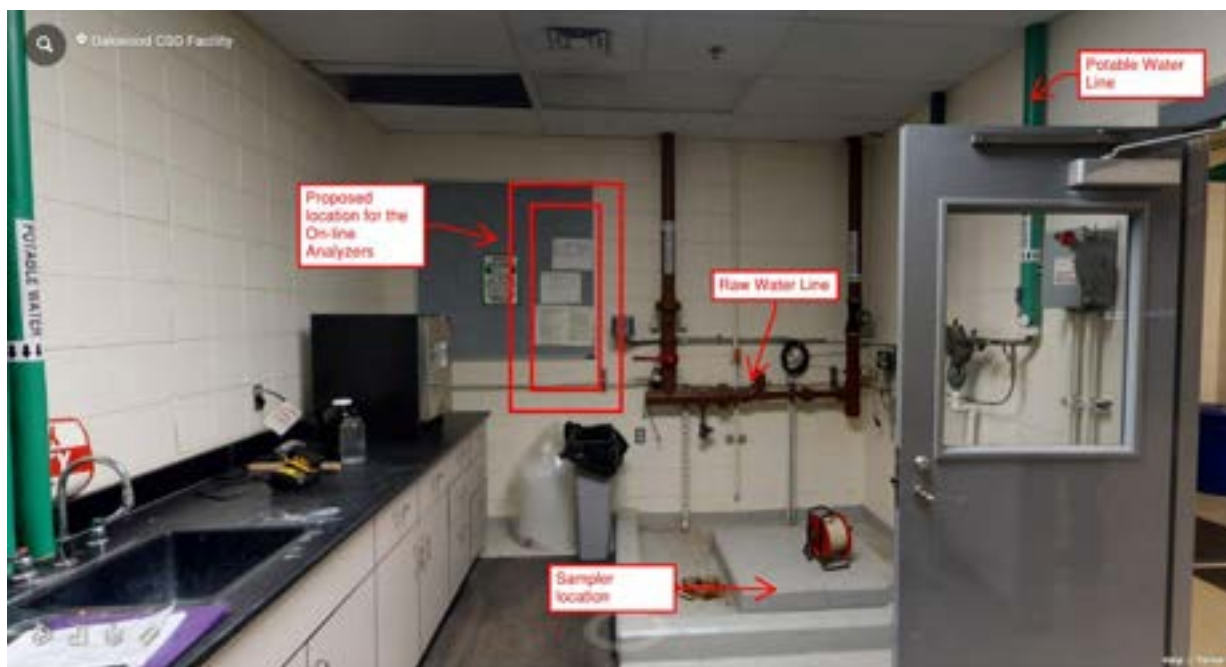


Figure 4-10
Oakwood Influent Sampling and Analyzers Proposed Location

Chlorine Demand Sampling System at Screen Inlet Chamber

TRC sampling shortly after chlorine addition will allow for chlorine demand to be determined. Ideally the sampling location will provide a 30 second to 120 second contact time between the application point and the TRC analyzer. Based on the contact time for respective storm pump discharge standpipe and flow scenarios, and the CFD modeling results the proposed location for sampling is Screen Inlet Chamber. **Table 4-3** presents the calculated contact times for different flow conditions. Multiple sampling locations will be needed to cover the different flow scenarios, operation of different storm pumps, and different screens in operations. **Figure 4-11** presents the option of six sampling locations paired with three sample pumps, and TRC analyzer location. The sample pumps in this option will be self-priming trash pumps. The sample pump and analyzer location inside the Screen Room was eliminated due to the hazard classification of Class 1, Division 1, Group D of the Screen Room. **Figure 4-12** presents the three submersible sample pumps and TRC analyzers located outside of Screen Room on the roof of Screen Inlet Chamber. The chlorine demand and chlorine decay TRC analyzers will be housed inside the FRP enclosure with necessary HVAC equipment. **Figure 4-13** shows option of location TRC analyzers inside the Mechanical Room of the Screen Facility. The feasibility of this location with respect to the available space and implication on the hazard classification of the Mechanical Room due to the drain from sampling piping or analyzer will be further evaluated during the Basis of Design phase.

Two TRC analyzers one duty and one redundant will be provided. On the shelf spare for sample pumps will be utilized for redundancy.

Table 4-3 Estimated Contact Time for Chlorine Demand TRC Sample Location at Screen Inlet Chamber for Different Flow Conditions

Flow Conditions	Flow, Cfs/MGD	Estimated Contact Time ¹ , seconds	Assumed Pumps in Operation
Minimum Flow	99/64	51 ²	One small pump
Avg Flow – Existing Collection System	135/87	82 ²	Two small pumps
Avg Flow – Future Collection System Configuration	531/343	42	Two small, one large pumps
Peak Flow - Existing Collection System	765/494	30	Two small, one large pumps
Peak Flow – Future Collection System Configuration	1,231/794	32	Two small, four large pumps
Design Peak Flow	1,660/1,071	28	Two small, five large pumps

Notes:

1. Conveyance through the sampling piping will add contact time up to 20 seconds (assumed 100 feet pipe at 5 velocity 5 fps) at TRC analyzer location.
2. Contact time assumed based on the sample location near the small pump discharge pipe.

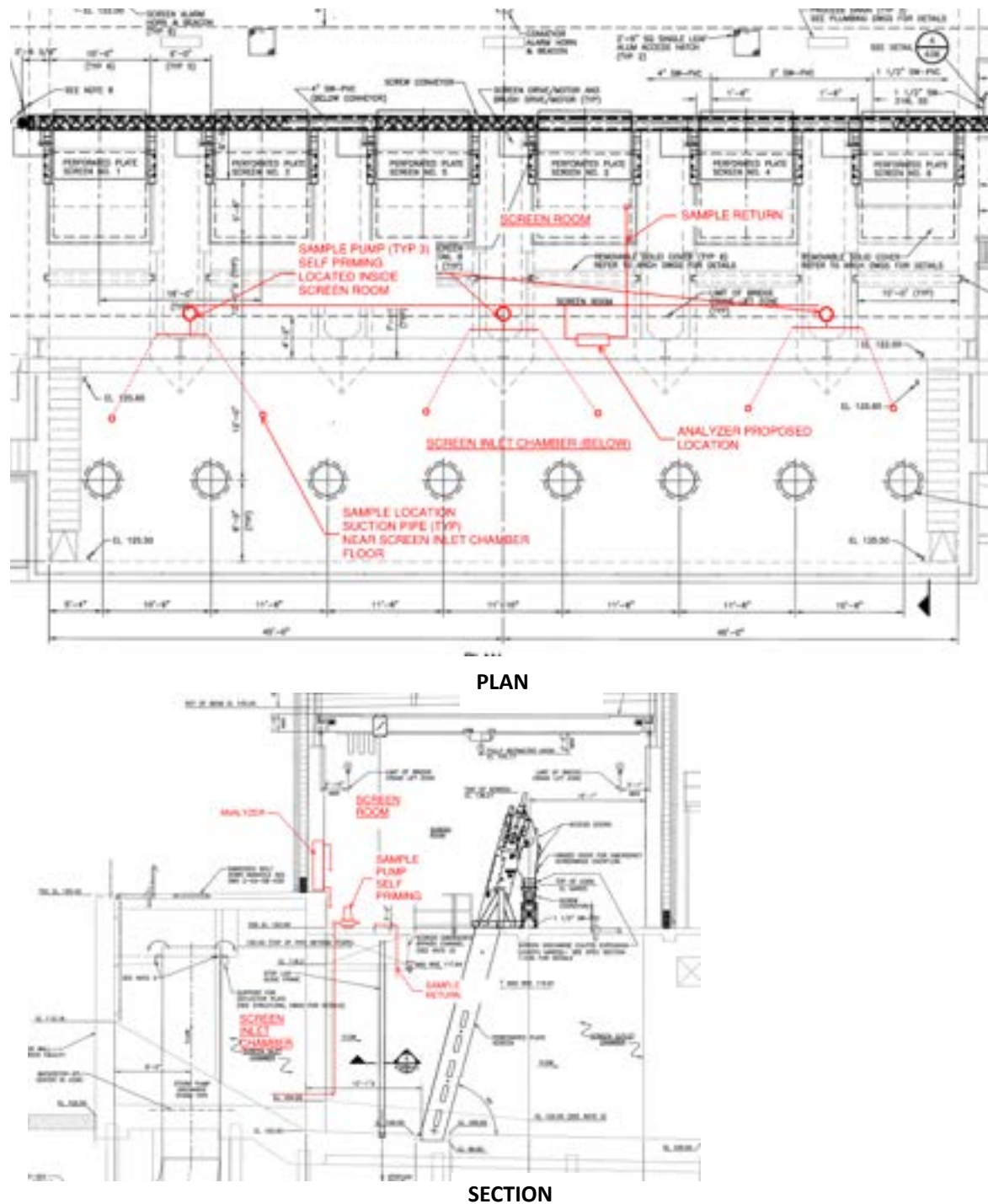


Figure 4-11
Oakwood Chlorine Demand Sampling at Screen Inlet Chamber and Screen Room

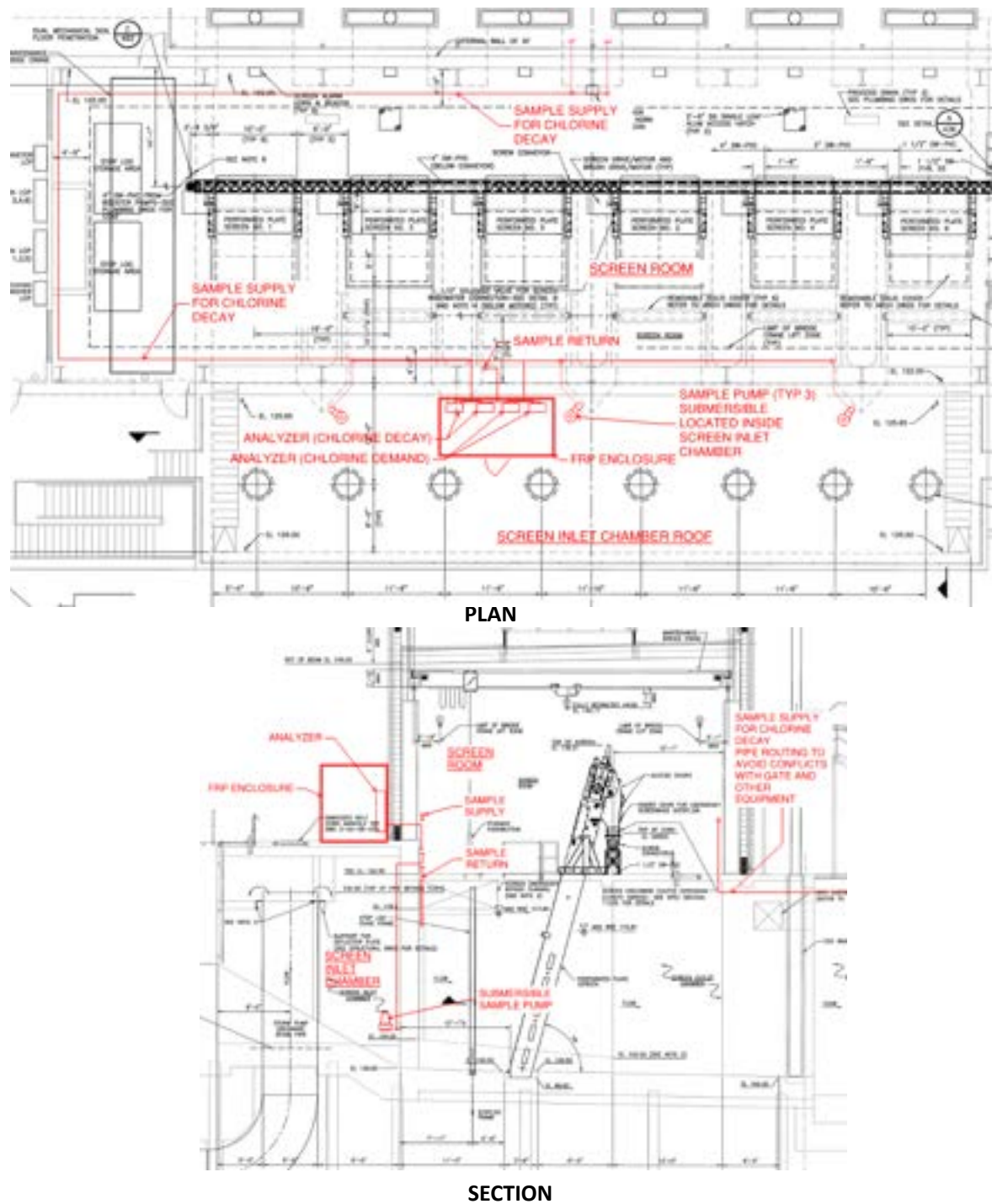
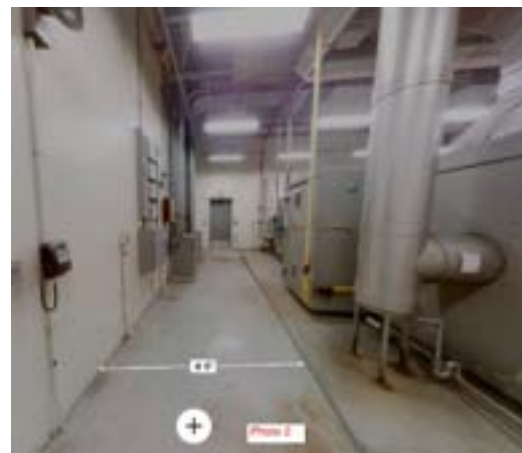


Figure 4-12
Oakwood Chlorine Demand Sampling at Screen Inlet Chamber and TRC Analyzers on Roof

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Chlorine Decay Sampling System at CSO Basin

To determine the real-time chlorine decay, a new sample pump and TRC analyzer can be installed in the CSO Basin. The input from chlorine decay TRC analyzer will allow for real-time chlorine decay values to be provided to the control algorithm based upon the changing water quality and contact times observed during storm events. The proposed sample location will be inside each CSO basin downstream of oil/grease baffle at approximately 120 feet from the CSO basin influent gates. This will allow the TRC to be measured during the first 15-30 minutes of contact time, and it allows TRC values to be measured even during the fill-draw storm events that do not result in the overflow over effluent weir to effluent channel to outfall. If baffle configuration of CSO Basin is selected, the sampling location could be further evaluated during detail design. The Oakwood CFD model of the CSO basin to help determine a representative elevation and distance from the basin wall for the chlorine decay sample point. The future sewer collection system configuration with the Northwest Interceptor interconnection (NWI) will have significantly higher average storm flows and the sample pump will need to be relocated further downstream. These sampling pumps will be similar to influent sampling pumps. On the shelf spare pump will be utilized for sample pump redundancy. To facilitate access/removal of these sampling pumps, new access hatches will need to be cut into the top of the basin roof. The Two TRC analyzers one duty and one redundant will be provided. TRC analyzers will be located next to the proposed TRC analyzers for chlorine demand. **Figure 4-14** presents the proposed sample pumps location.

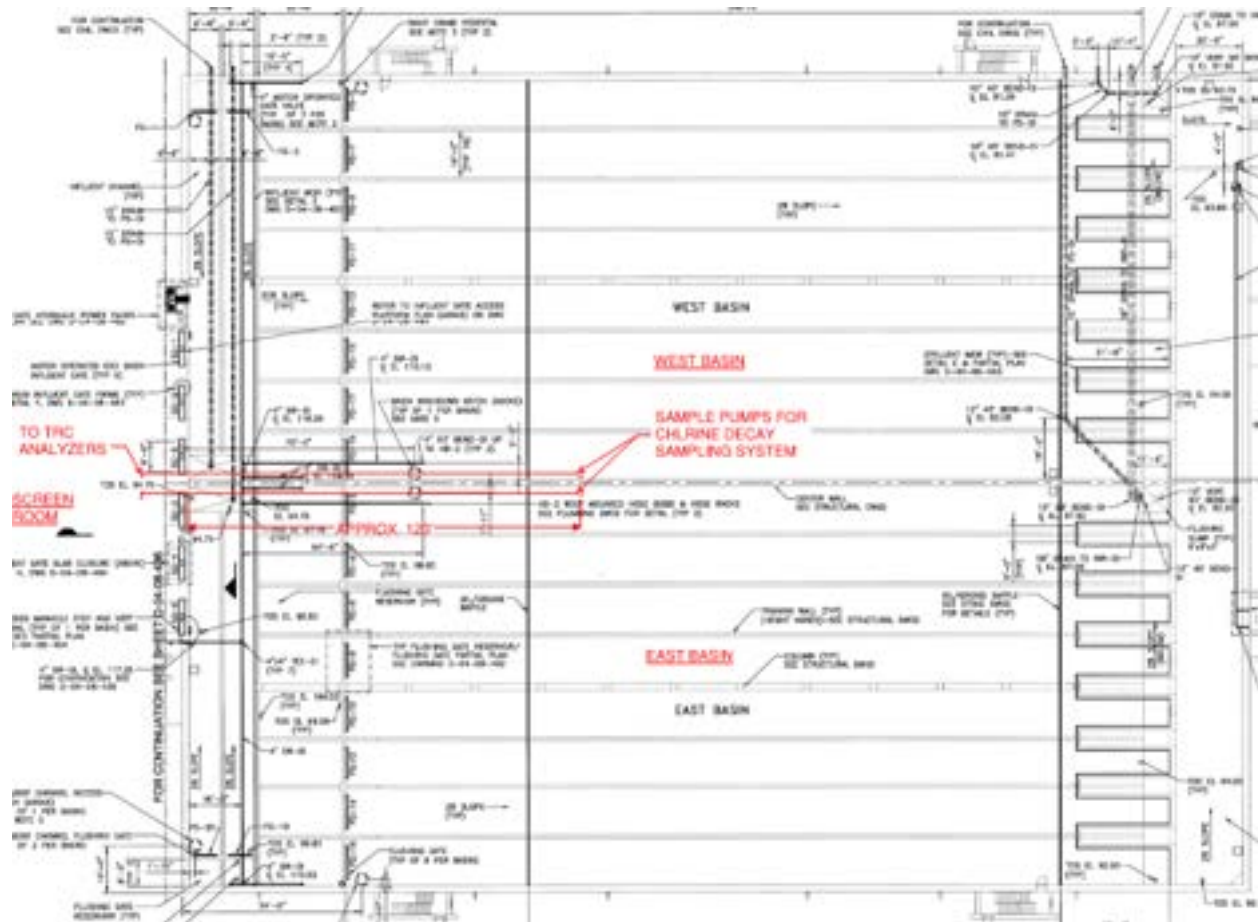


Figure 4-14
Oakwood Chlorine Decay Sampling at CSO Basin

Effluent Sampling System

The existing effluent sample pumping and piping system will be kept. New online analyzers are proposed to continue monitoring parameters required for NPDES permit compliance. Each provides multi-parameter analyzer and COD analyzer. **Figure 4-15** presents the proposed location of analyzer panels inside the Effluent Sample Room.



Figure 4-15
Oakwood Effluent Sampling and Analyzers Locations

The sampling system functionality recommendations for Oakwood are summarized in the **Table 4-4**.

Table 4-4 Recommended Sampling System at Oakwood

Sampling System	Sample Location	Sample Collection System	Sampler /Analyzer Location	Parameters	Need
Influent Sampling System	Influent East and West Wet Wells	- Replace existing influent sample pumps with similar type - Reuse existing sampling piping	Influent Sampling Room in the Control Building	- TSS (Sensor) - COD (REDOX Titration after oxidation by potassium dichromate) - Turbidity (Sensor) - Temp/pH (Sensor) - TOC (Infrared) - UVA (UV absorption) - Bacteria Indication (ColiMinder™) (To be evaluated)	Machine learning model training
Chlorine Demand Sampling System	At Screen Inlet Chamber upstream of screens	- Three sample locations between pump discharge standpipes and screen inlets. - Three submersible sample pumps located in Screen Inlet Chamber	Outside of Screen Room on Screen Inlet Chamber Roof Or Mechanical Room of Screen Facility (feasibility of location to be further evaluated in the Basis of Design)	TRC (Colorimetric by the SWAN Analytical Instruments)	To determine chlorine demand and provide feedback to the DCS.
Chlorine Decay Sampling System	One sample location at each CSO basin before effluent weir	One sample pump at each CSO Basin before effluent weir	Outside of Screen Room on Screen Inlet Chamber Roof Or Mechanical Room of Screen Facility (feasibility of location to be further evaluated in the Basis of Design)	TRC (Colorimetric by the SWAN Analytical Instruments)	To determine chlorine decay and provide feedback to the DCS.
Effluent Sampling System	Effluent channel	Continue using existing system	Effluent Sample Room	Parameters required for NPDES permit compliance or monitoring	NPDES permit compliance or monitoring

4.2.2 Leib

Influent Sampling System

Influent water quality sampling is necessary for ML model training to further optimize disinfection. The influent sampling pump has not been used for an extended period of time, therefore instead of performing pump condition assessment, it is proposed to replace the pumping system similar type. During basis of design phase, option of Flygt N series pump will be evaluated. The influent sample piping could be potentially reused. During detailed design, the condition assessment of piping can be done. As part of the ML model training, new online analyzers are proposed to monitor the TRC, TSS, COD, turbidity, temperature/pH, TOC and UVA. Hach provides TRC, multi-parameter and COD analyzers. **Figure 4-16** presents the location of influent sample pump. **Figure 4-17** shows proposed location of analyzer panels inside the Influent Sample Room for analyzers.

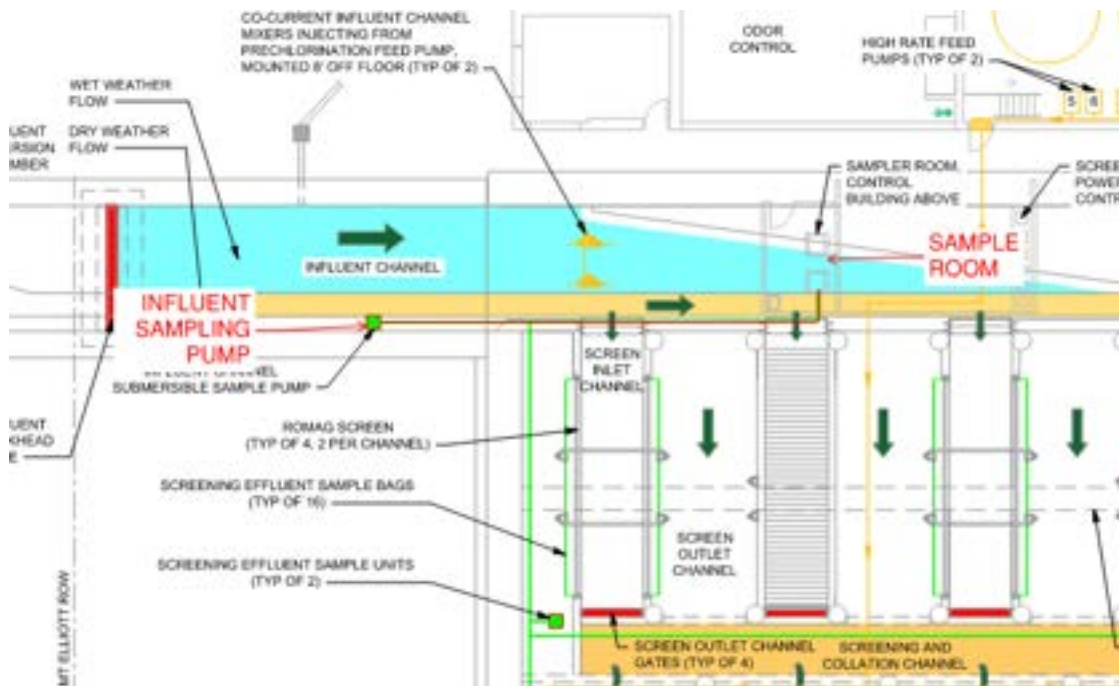


Figure 4-16 Leib Influent Sample Pumping System

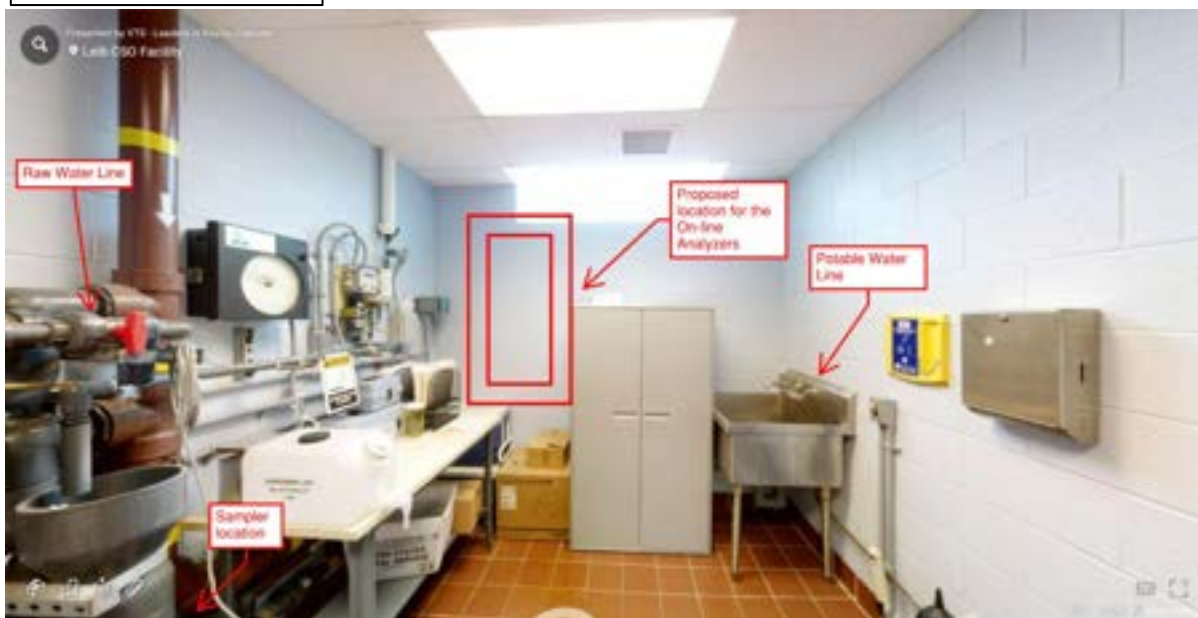
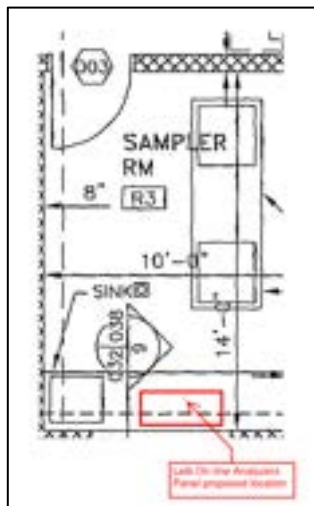


Figure 4-17
Leib Influent Sampling and Analyzers Locations

Chlorine Demand Sampling System at Screen Inlet Chamber

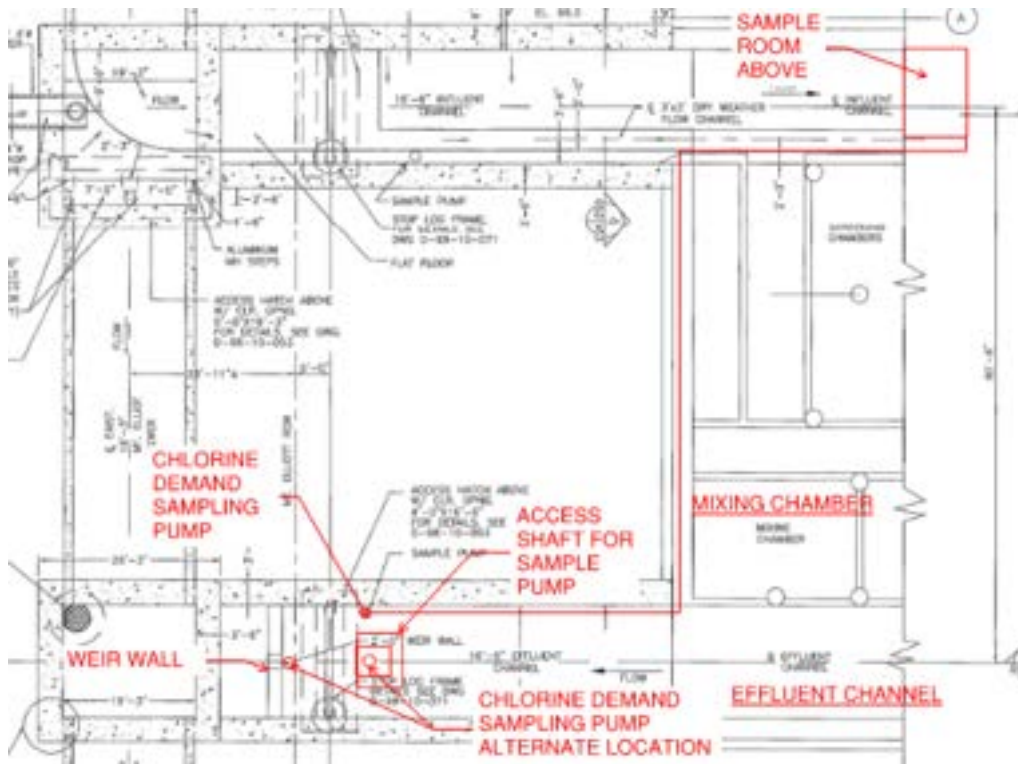
TRC sampling shortly after chlorine addition will allow for chlorine demand to be determined. Ideally the sampling location will provide a 30 second to 120 second contact time between the application point and the TRC analyzer. The existing effluent channel sample pump location will provide an estimated contact time between 14 seconds at peak flow for future sewer collection system configuration and 73 seconds for average flow of 50 cfs. For a more representative sample, it is recommended that the location of the sample pump be moved into the center line of the channel. While this location will have challenges associated with providing access (via new access hatch at grade and structure from the channel roof to grade) and supporting the guide rails, this

location will provide for a more representative demand sample. Alternate location for a more representative sample will be upstream of weir wall, but this location will have challenge with accessing the pump and the sample piping will conflict with the use of bulkhead stop log. If the TRC analyzer is located inside the Sample Room, the sampling pipe will be approximately 250 feet long and at velocity 5 fps, the contact time within the sample pipe will be 50 seconds. This will be a few seconds over the 120 second contact time target after the application point. **Table 4-5** summarizes the estimated contact time from the sodium hypochlorite application point for different flow conditions. **Figure 4-18** shows chlorine demand sampling system. Two TRC analyzers one duty and one redundant will be provided. Feasibility of locating both TRC analyzers inside the Sample Room will be further evaluated in the Basis of Design phase.

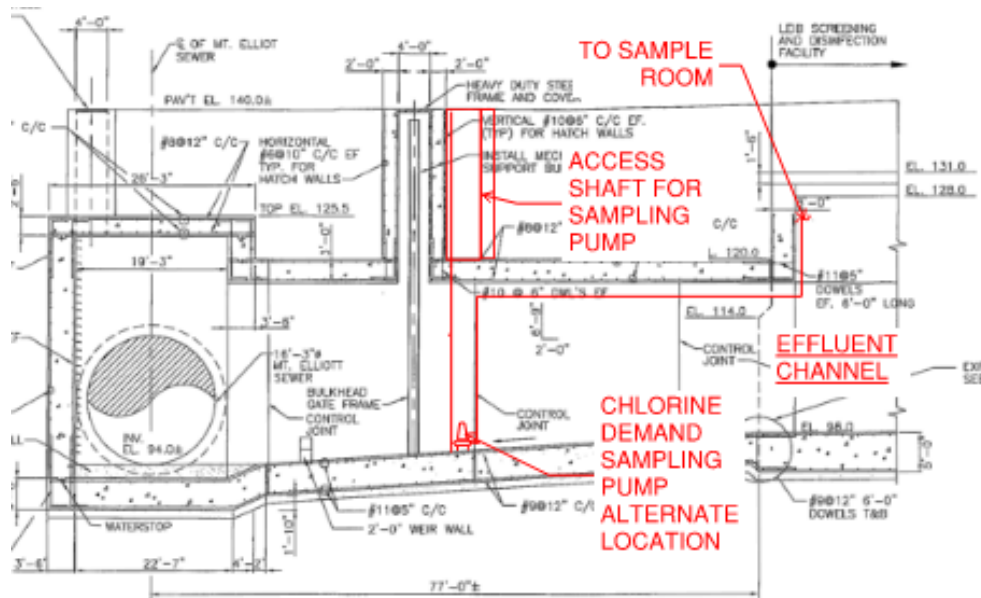
Table 4-5 Estimated Contact Time for Chlorine Demand TRC Sample Location at Effluent Channel for Different Flow Conditions

Flow Conditions	Flow, Cfs/MGD	Estimated Contact Time to Sample Location, seconds	Estimated Contact Time in the Sampling Pipe (250 feet long pipe at 5 fps velocity), seconds	Estimated Contact Time at Analyzer Location, seconds
Minimum Flow	50/32	73	50	123
Avg Flow – Existing Collection System	118/76	36	50	86
Avg Flow – Future Collection System Configuration	380/245	17	50	67
Peak Flow - Existing Collection System	520/335	17	50	67
Peak Flow – Future Collection System Configuration	950/613	14	50	64

Note 1. Contact time in the effluent channel is function of the water depth at respective flow. The water depth increases with the flow.



PLAN



SECTION

Figure 4-18
 Leib Chlorine Demand Sampling System

Chlorine Decay Sampling System

To determine the real-time chlorine decay, the TRC should be measured ideally during the first 15-30 minutes of contact time which will need sample to be collected in the sewer downstream of Leib Regulator Chamber. The estimated contact time at the existing effluent sampling location at the Outfall Structure for different flow conditions is presented in the **Table 4-6**.

Table 4-6 Estimated Contact Time for Chlorine Demand TRC Sample Location at Outfall Structure for Different Flow Conditions

Flow Conditions	Flow, Cfs/MGD	Estimated Contact Time at Outfall Structure, minutes
Minimum Flow	50/32	82
Avg Flow – Existing Collection System	118/76	43
Avg Flow – Future Collection System Configuration	380/245	23
Peak Flow - Existing Collection System	520/335	20
Peak Flow – Future Collection System Configuration	950/613	15

Note 1. TRC Analyzer location assumed at the Outfall Structure same as original effluent TRC analyzer for outfall.

Locating the remote TRC analyzer will have the same challenges as the original effluent sampling system and TRC analyzer at the Outfall Structure, like remote location operation and maintenance and requirement of continuous water supply for online TRC analyzer. There will be possibility of the TRC analyzer not being maintained and calibrated resulting in questionable TRC results. Also locating TRC analyzer further upstream on the sewer system will have similar challenges.

Instead of using online TRC analyzer to provide real time TRC, manual grab samples could be collected for manual TRC measurements. The samples could be collected to develop trends for seasonal variation and variation during storm with respect to the first flush and post first flush storm partitioning.

The sampling system functionality recommendations for Leib are summarized in the **Table 4-7**.

Table 4-7 Recommended Sampling System at Leib

Sampling System	Sample Location	Sample Collection System	Sampler Location	Parameters	Need
Influent Sampling System	Influent Channel	- Replace existing influent sample pump with similar type - Reuse existing sampling piping	Sample Room in the Control Building	- TSS (Sensor) - COD (REDOX Titration after oxidation by potassium dichromate) - Turbidity (Sensor) - Temp/pH (Sensor) - TOC (Infrared) - UVA (UV absorption) - Bacteria Indication (ColiMinder™) (To be evaluated)	Machine learning model training
Chlorine Demand Sampling System	Effluent Channel right after the end of facility	- One sample location. - Two sample pumps (one duty / one standby) located in the Effluent Channel	Sample Room in the Control Building	TRC (Colorimetric by the SWAN Analytical Instruments)	To determine chlorine demand and provide feedback to the DCS.
Chlorine Decay Sampling System ¹	Outfall (if online analyzer selected)	Outfall (if online analyzer selected)	Outfall Sample Pit (if online analyzer selected)	TRC	To determine chlorine decay and provide feedback to the DCS.
Effluent Sampling System	Continue using existing location	Continue using existing system	Effluent Sample Room	Parameters required for NPDES permit compliance or monitoring	NPDES permit compliance or monitoring

Note: 1. Online TRC analyzer not proposed for the Chlorine Decay Sampling due to the challenges with the remote location.

5.0 Alternatives Analysis

5.1 Disinfection Control

All four modes of controlling the chlorination system will be included in the control system, with each mode having benefits and drawbacks. The advantages and disadvantages for all four modes are presented in **Table 5-1**.

Table 5-1 Disinfection Control Modes Advantages / Disadvantages

Control Mode	Advantages	Disadvantages
Manual Control	- Less amount of automation as only related to the influent flow and chemical feed rate - Lower data requirement, no complex instrumentation - No complex/costly instruments involved	- Requires highest safety factor on chlorine dose, increasing chemical costs compared to other three operation modes - More manual operation and staff involvement
Flow Paced	- Meets the guiding principle: keep operations and system improvements simple to extent feasible. Specifically provide a system (or equipment within the system) that can be operated simply in manual mode when needed - Lowest data requirement, no complex instrumentation - No complex/costly instruments involved	- Requires higher safety factor on chlorine dose, increasing chemical costs compared to ICT dose paced with TRC analyzers and machine learning model modes - More manual operation and staff involvement
ICT Dose Paced with TRC Analyzers	- Meets the guiding principle: keep operations and system improvements simple to extent feasible. Specifically provide a system (or equipment within the system) that can be operated simply in manual mode when needed - Lowest data requirement, no complex instrumentation - No complex/costly instruments involved	- Higher capital investment in analyzers and SCADA integration - Dependent on operations and maintenance of analyzers
Machine Learning Dosing Model	- Least manual operation and staff involvement - A well-trained model would provide minimized dose safety factor lowering chemical costs - Continuous data collected by analyzers and incrementally improve dosing algorithm and potential to further optimize the disinfection process and reduce operator work - Can be implemented in phased approach taking advantage of valuable data collected during initial facility operations	- Higher capital investment in analyzers and SCADA integration - Dependent on operations and maintenance of analyzers - Problems with the analyzers and other sensors may not be known until the data is adequately analyzed

5.2 Analyzers

Use of online instruments in intermittent flow applications, like CSO treatment facilities, for process control is a challenge. However, a well-thought-out design and a diligent maintenance approach to both the sampling system and the analyzers can result in a system that provides reliable and accurate results. These challenges relate to providing a continuous flow stream for keeping the sensors wet, and routine calibration and maintenance to ensure the sensors have not fouled. GLWA presently utilizes on-line TRC analyzers on an intermittent flow stream at the WRRF to monitor the total chlorine residual in the RRO that is placed into service during wet weather events. The sampling system for the TRC analyzers was designed to use the process flow stream, RRO effluent, when the outfall was in-service, and potable water to continuously keep the sensors wet when the outfall was not in service during dry weather conditions. Automated valves on the sampling piping were initiated on the level within the outfall. Evoqua Micro 2000 units with SFC analyzer / controller were installed for monitoring total residual chlorine upstream and downstream of the chemical injection points. GLWA performs routine maintenance on the analyzers as the TRC outputs are utilized by the control system for trimming the chemical feed rates. One important differentiator between the RRO sampling system and the design of a similar system for the CSO facilities is the flow stream composition. The RRO flow stream consists of mainly secondary effluent. During Workshop No. 3 (TM Set 2A) on May 12, 2023, GLWA described the colorimetric analyzer testing at Hubbell-Southfield facility. During workshop it was determined to use the colorimetric TRC analyzer manufactured by the SWAN Analytical Instruments. SWAN's initial model recommendation is AMI Codes-II TC which they have installed at multiple CSO application in Michigan.

On-line instrumentation is preferred for this application as it provides inputs to the Ovation DCS for adjustment of the chemical feed rates, viewing of real-time data from the Ovation operator workstations, historical data collection from the Ovation historian, and provides the data necessary for the ML model. However, on-line instrumentation will result in a higher level of maintenance on the system. **Table 5-2** summarizes the advantages and disadvantages of the on-line sensors. Manual (handheld) analyzers were not included as these devices offer far less maintenance, but do not provide any remote monitoring or integration with the control strategy.

Table 5-2. Total Residual Chlorine Analyzers Advantages / Disadvantages

Analyzer Type	Advantages	Disadvantages
Amperometric	- Wide measuring range - Integrated into Ovation DCS for viewing on operator workstations and historical data collection	- Need continuous flow for keeping sensor wet which will require automated valves and potable water source at times facility is not in service - Measurement dependent upon pH, may require separate pH sensor - Fouling concern with CSO flow stream - Additional instrument for GLWA to maintain - Routine maintenance and calibration requirement for analyzers as well electrolyte and membranes
Colorimetric	- Measurement independent of pH, temperature - Integrated into Ovation DCS for viewing on operator workstations and historical data collection - Recommended by HACH for CSO applications	- Need continuous flow for keeping sensor wet which will require automated valves and potable water source at times facility is not in service - Requires use of reagents and frequent replacement is required - Fouling concern with CSO flow stream - Additional instrument for GLWA to maintain

6.0 Life Cycle Cost Analysis

Not used.

7.0 Summary, Recommendations and Key Decisions

The recommendations for the disinfection control functionality, analyzer type, and sampling system functionality are presented in this section. Greater detail is provided in the preceding sections.

7.1 Disinfection Control Functionality

In addition to providing manual control, the following three means of optimizing and controlling the chlorine disinfection process are recommended:

- Flow paced
- ICT dose paced with TRC analyzer
- ML dosing model

7.1.1 Flow Paced

In the flow paced mode the operators will select the chlorine dose, input the stored sodium hypochlorite trade percent by weight and the control system will automatically adjust the sodium hypochlorite feed rate based on the influent flow to the CSO facility.

7.1.2 ICT Dose Paced with TRC Analyzer

Integrated CT dose paced with TRC analyzers is similar to flow paced using ICT value and continuous feedback of TRC concentration data to optimize sodium hypochlorite dose. The ICT dose pacing factors in more variables by incorporating the hydraulic efficiency of a contact volume as well as the chlorine demand and decay rates in the control algorithm. Two TRC analyzers are recommended, one shortly after chlorine addition, and the second further down the contact volume. The first TRC analyzer will allow for the chlorine demand to be determined, while the second TRC analyzer will allow for the chlorine decay to be determined. These inputs into the ICT model will allow for real-time adjustment to the chlorine dose based upon the changing water quality and contact times observed during storm events. In-lieu of using online TRC analyzers, operator can elect to enter chlorine demand and chlorine decay value based on bench-scale chlorine dose response testing performed periodically to capture the seasonal variation typically observed in CSO collection system.

7.1.3 Machine Learning Dosing Model

ML is a branch of computer science field dedicated to developing and implementing algorithms that allow computers to learn without being explicitly programmed to provide predictions and pattern recognition. The ML model predict changes in the present chlorine demand using the historical chlorine dosage, collected during a year of operation, TRC, and upstream water characteristics such as organic load, precipitation data, radar imagery, flow information, and date-time information. Because chlorine decay is typically quite small, the focus will be on chlorine demand which changes significantly based upon the influent water quality. The recommendation is to study and develop alternatives to delineate the design process to evaluate the feasibility of incorporating modification of the ICT approach and the potential for a ML to optimize system operation across multiple flows and bacterial loading scenarios. The recommendation is to train the model to optimize disinfectant usage by learning from historical system performance after 1 year of operation post upgrades. The investigation will identify which correlations between data from influent water quality online analyzers and disinfection performance to determine if the chlorine dose can be optimized in a broader range of conditions. If more data is collected after the first year of operation, a ML model could be continuously retrained to improve its accuracy over time. The recommendation is to have a discussion with the GLWA about the group of staff to be involved in the ML aspect of the project and the associated testing and research and development group could be more suitable for this task.

7.2 Analyzer Type

The recommendation is to provide on-line TRC analyzers to measure the real-time TRC concentrations at both facilities. The analyzers will provide inputs to the Ovation DCS for adjustment of the chemical feed rates, viewing of real-time data from the Ovation operator workstations, historical data collection from the Ovation historian, and provides the data necessary for the ML dosing model. Use of online analyzers in intermittent flow applications, like CSO treatment facilities is a challenge. However, providing a continuous flow stream for keeping the sensors wet and providing routine maintenance help mitigate these challenges. GLWA presently

utilizes on-line TRC analyzers on an intermittent flow stream at the WRRF to monitor the TRC in the Rouge River Outfall (RRO) that is placed into service during wet weather events through an automated system of motorized valves and a secondary water source. The colorimetric TRC analyzer is recommended based on the discussions with analyzer manufacturers and GLWA staff. Specifically the SWAN AMI Codes-II TC TRC analyzer will be utilized on the project. The analyzer design may include a small filtration system built in before the analyzer to handle solids and a flowmeter to ensure flow is delivered to the analyzer both when the CSO facility is in use and when the secondary water system is called to operate for providing a continuous flow to the analyzer.

7.3 Sampling System Functionality

The automatic/online sampling is required to implement on-line analyzers to measure parameters in real time. The sampling system functionality recommendations are summarized in the **Table 7-1** for Oakwood and **Table 7-2** for Leib.

Table 7-1 Recommended Sampling System at Oakwood

Sampling System	Sample Location	Sample Collection System	Sampler /Analyzer Location	Parameters	Need
Influent Sampling System	Influent East and West Wet Wells	- Replace existing influent sample pumps with similar type - Reuse existing sampling piping	Influent Sampling Room in the Control Building	- TSS (Sensor) - COD (REDOX Titration after oxidation by potassium dichromate) - Turbidity (Sensor) - Temp/pH (Sensor) - TOC (Infrared) - UVA (UV absorption) - Bacteria Indication (ColiMinder™) (To be evaluated)	Machine learning model training
Chlorine Demand Sampling System	At Screen Inlet Chamber upstream of screens	- Six sample locations between pump discharge standpipes and screen inlets. - Three submersible sample pumps in Screen Inlet Chamber	Outside of Screen Room on Screen Inlet Chamber Roof Or Mechanical Room of Screen Facility (feasibility of location to be further evaluated in the Basis of Design)	TRC (Colorimetric by the SWAN Analytical Instruments)	To determine chlorine demand and provide feedback to the DCS.
Chlorine Decay Sampling System	One sample location at each CSO basin before effluent weir	One sample pump at each CSO Basin	Outside of Screen Room on Screen Inlet Chamber Roof Or Mechanical Room of Screen Facility (feasibility of location to be further evaluated in the Basis of Design)	TRC (Colorimetric by the SWAN Analytical Instruments)	To determine chlorine decay and provide feedback to the DCS.
Effluent Sampling System	Effluent channel	Continue using existing system	Effluent Sample Room	Parameters required for NPDES permit compliance or monitoring	NPDES permit compliance or monitoring

Table 7-2 Recommended Sampling System at Leib

Sampling System	Sample Location	Sample Collection System	Sampler Location	Parameters	Need
Influent Sampling System	Influent Channel	- Replace existing influent sample pump with similar type - Reuse existing sampling piping	Sample Room in the Control Building	- TSS (Sensor) - COD (REDOX Titration after oxidation by potassium dichromate) - Turbidity (Sensor) - Temp/pH (Sensor) - TOC (Infrared) - UVA (UV absorption) - Bacteria Indication (ColiMinder™) (To be evaluated)	Machine learning model training
Chlorine Demand Sampling System	Effluent Channel right after the end of facility	- One sample location. - Two sample pumps (one duty / one standby) located in the Effluent Channel	Sample Room in the Control Building	TRC (Colorimetric by the SWAN Analytical Instruments)	To determine chlorine demand and provide feedback to the DCS.
Chlorine Decay Sampling System ¹	Outfall (if online analyzer needed)	Outfall (if online analyzer needed)	Outfall Sample Pit (if online analyzer needed)	TRC	To determine chlorine decay and provide feedback to the DCS.
Effluent Sampling System	Continue using existing location	Continue using existing system	Effluent Sample Room	Parameters required for NPDES permit compliance or monitoring	NPDES permit compliance or monitoring

Note: 1. Online TRC analyzer not proposed for the Chlorine Decay Sampling due to the challenges with the remote location.

7.3 Key Decisions

- Use colorimetric TRC analyzers and SWAN as the manufacturer.
- Agreement with means of controlling and optimizing the chlorine disinfection process: Manual Control, Flow Paced, ICT Dose Paced with TRC Analyzers, and Machine Learning (ML) Dosing model.
- Chlorine demand sampling location at Oakwood will be at Screen Inlet Chamber and chlorine decay sampling location at Oakwood will be in the CSO basin. TRC analyzer locations for chlorine demand and chlorine decay at Oakwood at Screen Facility will be potentially on the roof of Screen Inlet Chamber or Mechanical Room of Screen Facility feasibility of location will be evaluated during Basis of Design.

- Chlorine demand sampling location Leib will be in the Effluent Channel. Leib will not have online TRC analyzer for chlorine decay.
- Redundant TRC analyzers will be provided.
- Redundant sample pump with self-spares will be provided.

8.0 Next Steps

The items which require advancement/further development as the design process advances include the following:

8.1 Disinfection Control Functionality

8.1.1 Machine Learning Dosing Model

- The next steps in the development of ML model are laid out in the subsection 4.1.4.3 ML Workflow and 4.1.4.4 Project Work Plan.
- For ML model implementation using Edge computing, have meeting with GLWA PACS team to discuss security related considerations for the Edge computer and integrating data from external weather sources and new on-line analyzers into the Ovation system.

8.2 Analyzers

- Contact other analyzer manufacturers: ChemScan, Inc.
- Contact Vienna Water Monitoring Solutions for ColiMinder™ to investigate the adaption of technology for intermittent CSO application.

8.3 Sampling System Functionality

- Further evaluate the sampling location, sampling pumping and piping system and location of analyzers for the chlorine demand sampling system and chlorine decay sampling system for Oakwood and Leib.
 - Evaluate the feasibility of locating chlorine demand and chlorine decay TRC analyzers at Oakwood inside the Mechanical Room of the Screen Facility with respect to the available space and implication on the hazard classification.
 - Evaluate the location of influent water quality analyzers and chlorine demand TRC analyzers in the Leib sample room.
 - Review the Oakwood CFD model of the CSO basin to help determine a representative elevation and distance from the basin wall for the chlorine decay sample point.
- Develop the necessary water supply system for the continuous operation of analyzers and switching to the CSO sampling during the storm event.



Technical Memorandum

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*From: Brian Hilts, CDMS
Brian Zuidervliet, CDMS
Arun Mande, CDMS
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Date: June 1, 2023

*Subject: TM-20: Chlorine System Alternatives
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

The Great Lakes Water Authority (GLWA) retained the services of CDM Smith to evaluate and improve the existing disinfection systems at the Oakwood Combined Sewer Overflow (CSO) Retention and Treatment Basin (Oakwood) and Leib Screening and Disinfection Facility (Leib). The evaluation primarily included:

- Reviewing historic data associated with disinfection systems at both Oakwood and Leib.
- Bench top chlorine dose response analysis using wet weather samples from both facilities in 2022 and 2023 to determine the integrated contact time (ICT) value necessary to achieve the bacteria log inactivation to meet the permit requirements (discussed in TM-18).
- Modeling of the average (6-month, 24-hour storm) and peak (10-year, 24-hour storm) design storms for current and future collection system configurations to quantify storm and first flush volumes.
- Application of the ICT method (area under the dose response curve) to establish sodium hypochlorite storage requirements based upon the design storm and first flush volumes, and develop alternative feed system configurations.

The guiding principles for the GLWA CSO Improvement Project informed the sodium hypochlorite storage and feed system analysis and overall approach to the evaluation with an emphasis on operations and maintenance (O&M) improvements for the chemical storage and feed system. GLWA personnel indicated that the existing chemical feed systems at Oakwood and Leib are unreliable, expensive to maintain, and/or approaching the end of its useful life and need to be replaced.

The key findings from this evaluation are:

- Future collection system modifications (interconnections) will increase storm volumes considerably in comparison to the original basis of design (BOD) at both facilities. The peak design storm volume is anticipated to increase approximately 375% at Oakwood and 63% at Leib, which is the primary catalyst to the increase in sodium hypochlorite storage capacity.
- The existing sodium hypochlorite storage (two, 11,500-gallon tanks) at Oakwood is sufficient to treat two average design storms but will need to be replaced with larger tanks (two, 15,000-gallon tanks) once the proposed collection system interconnection is completed.
 - Computational Fluid Dynamic (CFD) analysis indicated that baffles could be installed in the existing basins to improve the hydraulic efficiency (i.e., baffling factor) associated with the basins, which could reduce storage requirements under the peak design storm condition by approximately 3,000 gallons. The baffles would not provide enough storage savings to avoid the need for new chemical storage tanks.
 - The sodium hypochlorite concentration would need to remain above the historic median concentration, 10.5% (trade percent by weight) to meet the storage requirements associated with the future collection system peak design storm. This may result in more frequent dumping and replenishing of sodium hypochlorite.
- The existing sodium hypochlorite storage (two, 10,450-gallon tanks) at Leib is sufficient to treat two average design storms but will need to be replaced with larger tanks (two, 12,600-gallon tanks) in anticipation of the proposed collection system interconnection is completed.
 - The sodium hypochlorite concentration would need to remain above 10.0% (trade percent by weight) to meet the storage requirements associated with the future collection system peak design storm. For reference, the historic median sodium hypochlorite concentration after dilution was 7.5% (trade percent by weight) between 2005 and 2022. This may result in more frequent dumping and replenishing of sodium hypochlorite.
- Recommend replacing the existing gear pumps at Oakwood and diaphragm (low-rate) and centrifugal pumps (high-rate) at Leib with redundant recirculation loops with centrifugal pumps and dedicated flow control valves for each sodium hypochlorite application point. This proposed chemical feed system will provide a more reliable and simple chemical feed system without compromising redundancy.

1.0 Introduction and Purpose

GLWA constructed the Oakwood and Leib facilities to meet National Pollution Discharge Elimination Program (NPDES) permit requirements. Oakwood was constructed in 2006 and Leib was constructed in 2002. The facilities remove screenings and disinfect combined sewer flows,

while Oakwood also provides flow retention. Both facilities utilize sodium hypochlorite to meet disinfection requirements.

The purpose of this technical memorandum is to document the results of the disinfection system evaluation, including;

- Overview of existing systems, original basis of design, regulatory requirements
- Evaluation of the existing system, summary of historic flow data and anticipated future flows, alternative sodium hypochlorite storage and feed solutions

1.1 Approach

Generally, the approach to the Oakwood and Leib disinfection system evaluation included:

- Chlorine dose response sampling for storm events in 2022 and 2023, including:
 - Oakwood October 31, 2022
 - Oakwood November 27, 2022
 - Oakwood February 27, 2023
 - Leib November 27, 2022
 - Leib January 19, 2023
 - Leib February 27, 2023
- Established the ICT and demand/decay at each facility based on the sampling results to establish a required dose (documented in TM-18)
- Applied the “high ICT” to the “first flush” volume to represent the challenging water quality conditions experienced in the “first flush” (i.e. higher chlorine demand and decay, higher bacteria concentration, etc.) and the “average ICT” to the remainder of the design storm volume to represent less challenging water quality conditions (i.e. lower chlorine demand and decay, lower bacteria concentration, etc.)
 - High ICT = observed ICT value required to achieve the inactivation goal to reduce maximum measured fecal coliform value down to half of the recreational seasonal bacteria limit (200 CFU/100 mL)
 - Average ICT = observed ICT value required to achieve inactivation goal to reduce the average undisinfected fecal coliform down to half of the recreational seasonal bacteria limit (200 CFU/100 mL)

- First Flush = initial volume of CSO overflow where the highest concentrations of contaminants and bacteria counts are observed because the ratio of wastewater to stormwater is relatively high. As the storm progresses, the ratio of wastewater to stormwater decreases, the wastewater is diluted, and the concentration of contaminants and bacteria counts are relatively low in comparison to the first flush.
- Used the required chlorine dose to establish sodium hypochlorite storage and feed requirements based on current and future design storms volumes and flows
- Based on the results, evaluated sodium hypochlorite storage and feed equipment alternatives, and made recommendations based on the guiding principles and technical feasibility of each alternative

The volume of the design storms attributed to the first flush was established based on information from the *2020 Wastewater Master Plan* where the first flush was simulated by using *E. coli* concentration curves input into Hydrological Simulation Program-Fortran (HSPF) and Storm Water Management Model (SWMM) models and grab samples to validate the model results. The models used influent water quality data from the Hubbell-Southfield, Conner Creek, Dearborn Height, and Inkster CSO facilities. The following key findings were used as the basis for establishing the first flush design storm volume:

- For smaller storms (i.e., 6-month, 24-hour) the first flush can be characterized as the first 20% of the overflow volume.
- For larger storms (i.e., 10-year, 24-hour) the first flush can be characterized as the first ¾-inches of rainfall.

The estimated first flush volumes are presented and discussed in Section 3.2.

1.1.1 Sodium Hypochlorite Storage Sizing

The approach to sizing the disinfection storage systems at Oakwood and Leib were discussed with GLWA. A summary of the discussion is included in Appendix A. **Table 1-1** shows the design storms that were used to size the sodium hypochlorite storage tanks at Leib and Oakwood.

Table 1-1 Design Storms for Sodium Hypochlorite Storage Sizing

Condition	Leib	Oakwood
Average	6-month, 24-hour storm	6-month, 24-hour storm
Peak	10-year, 24-hour storm	10-year, 24-hour storm

The chlorine dose required was calculated using Equation 1.

Equation 1

$$C_o = \frac{ICT}{C_T} + D$$

Where,

C_o = chlorine dose required (mg/L)

C_t = the effective contact time (theoretical contact time x baffling factor) (mins)

ICT = integrated CT (mg-min/L)

D = sodium hypochlorite demand and decay (mg/L) (from chlorine dose response sampling)

The required chemical storage was based on:

- The average and peak design storm volume.
- An average chlorine dose determined using the ICT value.
- A safety factor (i.e., two for average design storm events, and one for the peak design storm).
- Sodium hypochlorite concentration of:
 - 10.5% (trade percent by weight) at Oakwood, which is the historic median concentration.
 - 10% (trade percent by weight) at Leib, which is higher than the historic median concentration of 7.5% (trade percent by weight after dilution, see discussion in Section 3.3).

Sodium hypochlorite concentrations presented herein are trade percent by weight regardless of whether this is explicitly stated in the text, figure, or table.

1.1.2 Sodium Hypochlorite Chemical Feed Sizing and Configuration

The chemical feed system sizing was evaluated using:

- The applied chlorine dose established through the chlorine dose response testing (documented in TM-18)
- The baffling factor determined through computational fluid dynamics (CFD) modeling (Appendix B)
- Calculated disinfection contact volume
- Design flows

The design flows for each facility are shown in **Table 1-2**. Flow data is based on currently available and future predicted rainfall and sewerage flow data.

Table 1-2 Design Flows for Oakwood and Leib

Design Flow	Units	Oakwood	Leib	Reference
Min Flow	cfs/mgd	99/64	5/3	Leib – min. historic flow Oakwood – min. storm pump flow
Avg Flow – Current Collection System Configuration ¹	cfs/mgd	135/87	118/76	6-month, 24hr
Avg Flow – Future Collection System Configuration ¹	cfs/mgd	531/343	380/245	6-month, 24hr
Peak Flow – Current Collection System Configuration ¹	cfs/mgd	765/494	520/335	10yr, 24hr
Peak Flow – Future Collection System Configuration ¹	cfs/mgd	1,231/794	950/613	10yr, 24hr Leib – max. disinfection flow, 1 basin in operation Oakwood – max. disinfection flow
Design Peak Flow	cfs/mgd	1,660/1,071	2,000/1,290	Leib – max. hydraulic flow, flow does not bypass mixing chambers, 950 cfs/613 mgd disinfected Oakwood – max. hydraulic flow, 2 basins in operation, 1,231 cfs/794 mgd disinfected

¹ Predicted 5-minute peak flow rate

Oakwood has a maximum hydraulic peak flow capacity of 1,660 cfs (1,071 mgd) and maximum disinfection flow capacity of 1,231 cfs (794 mgd). Two CSO basins are used at flows greater than 1,231 cfs (794 mgd), which is an abnormal high flow condition. Leib has a maximum hydraulic peak flow capacity of 2,000 cfs (1,290 mgd) and maximum disinfection flow capacity of 950 cfs (613 mgd). At flows greater than 950 cfs (613 mgd), the gates to North Interceptor-East Arm (NIEA) are closed and excess flows continue through facility (i.e., not bypassed) and 950 cfs (613 mgd) is disinfected. This is an emergency, high flow condition. At the design peak flow condition (hydraulic maximum), the required chlorine dose was calculated using the effective contact time for the peak flow condition and the required sodium hypochlorite feed rate was based on the peak flow – future collection system configuration as this represents the maximum disinfected flow at both facilities. **Table 1-3** shows the design storm volumes that were used to establish the sodium hypochlorite storage and feed equipment sizing.

Table 1-3 Design Storm Volumes for Oakwood and Leib

Design Storm	Units	Oakwood	Leib	Reference
Avg Storm - Current Collection System Configuration	MG	17	21	6-month, 24hr
Avg Storm - Future Collection System Configuration	MG	92	54	6-month, 24hr
Peak Storm - Current Collection System Configuration	MG	81	185	10yr, 24hr
Peak Storm - Future Collection System Configuration	MG	368	367	10yr, 24hr

1.1.3 Guiding Principles

The guiding principles were developed in collaboration with GLWA for the CSO Improvements Project. The guiding principles provided guidelines for conducting evaluations, identified general areas for improvement, and defined overarching outcomes for the project. **Figure 1-1** summarizes the guiding principles that governed the approach to the disinfection systems evaluation and informed key decisions.

Equipment

- Do not replace equipment in kind – improve equipment
- Provide operational flexibility, cost savings (lifecycle cost basis) including current operational costs
- Reduce human capital and maintenance
- Provide equipment which is accessible and easy to maintain
- Equipment selection to accommodate intermittent use

O&M/System Considerations

- Process must operate reliably “on demand” (intermittent use)
- Keep operations and system improvements simple to extent feasible. Specifically provide a system (or equipment within the system) that can be operated simply in manual mode when needed
- Minimize single points of failure
- Provide sufficient redundancy for each equipment system (balance with reduced O&M)
- Maintain operation of Oakwood and Leib throughout construction phase

Collaboration

- Involve O&M staff in design development process, listen to them and effectively communicate with them
- Design with consistency in materials of construction across disciplines in each room/area

General

- Use same facility, area and room name by all disciplines

Figure 1-1
Summary of Guiding Principles

2.0 Existing System(s) Description (and/or Conditions)

The following subsections describe the existing CSO systems at Oakwood and Leib and design criteria for the respective sodium hypochlorite storage and feed systems.

2.1 Oakwood

Oakwood consists of the following major components:

- Two 18-foot inlet conduits
- Expansion zone with influent sample points
- East and west storm wet well with eight storm pumps and associated storm discharge standpipes
 - Two small variable frequency drive (VFD) storm pumps (P1 and P2)
 - Two large VFD storm pumps (P5 and P6)
 - Four large constant speed pumps (P3, P4, P7, and P8)
- Odor Control unit
- East and West sanitary wet well with manually cleaned bar screens and four submersible solids handling pumps
- Screenings Channel with six perforated plate screens
- Influent channel
- East and West CSO Basins with oil/grease baffles
- Effluent launder
- Effluent channel and conduit to the Rouge River via the O'Brien drain

Figure 2-1 shows a process flow diagram with the major system components at Oakwood.

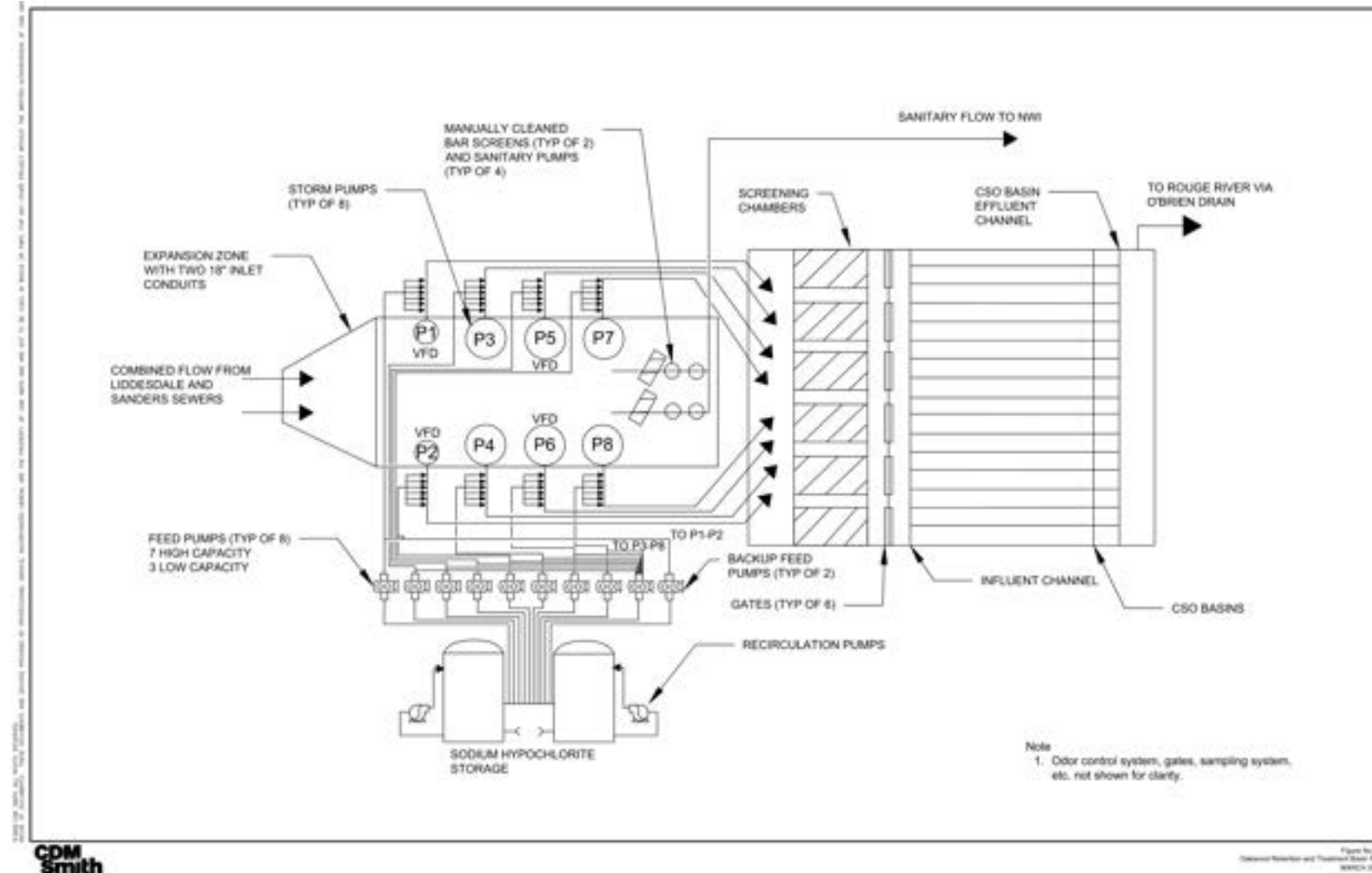


Figure 2-1
 Oakwood Process Flow Diagram

2.1.1 Basis of Design and Existing Design Criteria

The existing design criteria for Oakwood is shown in **Table 2-1**. Oakwood's maximum hydraulic capacity is 1,660 cfs (1,071 million gallons per day [mgd]) and 48.5 million gallons (MG), which is based on the 10-year, 1-hour storm event.

Table 2-1 Oakwood Design Criteria from Basis of Design Report

Parameter	Units	Value	Reference
Maximum Hydraulic Capacity	cfs/mgd	1,660/1,071	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Minimum CSO Facility Pumping Rate	cfs/mgd	80/52	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Design Storm Type	-	10-year, 1-hour	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Design Storm Volume	MG	48.5	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Maximum 7-Day CSO Volume	MG	98	Contract CS-1281
Safety Factor (SF)	-	2.0	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
CT Value	mg-min/L	125	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Total CSO Basin Contact Volume	MG	9	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Minimum Chlorine Dose	mg/L	2.0	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Maximum Chlorine Dose	mg/L	12.0	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Maximum Sodium Hypochlorite Concentration Delivered	% ¹	15	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Maximum Sodium Hypochlorite Concentration Diluted for Operations	% ¹	10	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System
Minimum Sodium Hypochlorite Concentration Diluted for Operations	% ¹	5	CS-1364 Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System

¹trade percent by weight

2.1.2 Sodium Hypochlorite Storage and Feed Systems

The sodium hypochlorite storage and feed system consist of the following major components:

- Storage Tanks
- Small and Large Feed Pumps

- Recirculation Pumps
- Basket Strainers
- Injection Nozzles
- Isolation, flow control, and check valves
- Flow metering and pressure instrumentation
- Carrier Water System

Chemical tanker trucks deliver sodium hypochlorite to Oakwood and the sodium hypochlorite is stored in two 11,500-gallon fiberglass tanks. A total of ten (eight duty/two standby, comprised of small and large pumps) positive displacement, magnetic-drive gear pumps feed sodium hypochlorite to each of the storm pump discharge pipes using injection nozzles (six per storm pump discharge). Carrier water is added to the chemical feed piping to ensure adequate flow through the injection nozzles. The small feed pumps (three duty/one standby) deliver sodium hypochlorite to the small VFD storm pumps (P1 and P2), and the large feed pumps (six duty/one standby) deliver sodium hypochlorite to the large storm pumps (P3 through P8). Two recirculation pumps are used to mitigate stratification of sodium hypochlorite in the storage tanks. Two titanium basket strainers are located on each of the 8-inch chemical feed pump suction lines from each of the storage tanks to protect the feed pumps from debris. **Table 2-2** and **Table 2-3** summarizes the design criteria for the sodium hypochlorite storage and feed equipment at Oakwood.

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Table 2-2 Oakwood Sodium Hypochlorite Storage and Feed Equipment

Equipment	Units	Design Criteria
Sodium Hypochlorite Storage		
Number of Tanks	No.	2
Tank Type	-	Fiberglass
Tank Working Storage Volume, each	gal.	11,500
Tank Storage Volume, each	gal.	11,500
Tank Working Sidewall Height	feet-inches	10'-0"
Tank Diameter	feet-inches	14'-0"
Delivered Hypochlorite Concentration	% ¹	13
Sodium Hypochlorite Metering Pumps		
Total Number Pumps	No.	10
Number of Large Pumps	No.	7 (6 duty/1 standby)
Number of Small Pumps	No.	3 (2 duty/1 standby)
Pump Type	Type	Magnetic Gear
Manufacturer	-	Pulsafeeder
Small Pump		
Model	-	Isochem GM-12
Motor Power	hp	5
Total Head	feet	173
Design Capacity	gpm	26
Turndown Capacity	-	50:1
Large Pump		
Model	-	Isochem GM-16
Motor Power	hp	10
Motor Phase/ Cycle/Voltage	ph/Hz/Vac	3/60/460
Total Head	feet	173
Design Capacity	gpm	51
Turndown Capacity	-	50:1
Sodium Hypochlorite Recirculation Pumps		
Number of Pumps	No.	2
Type	--	Sealless Horizontal Centrifugal, End Suction
Pump Manufacturer	-	Flowserve
Motor Power	hp	1.5
Motor Phase/ Cycle/Voltage	ph/Hz/Vac	3/60/460
Design Capacity	gpm	80
Total Head	feet	20

¹trade percent by weight

Table 2-3 Oakwood Sodium Hypochlorite Dissolution

Equipment	Units	Design Criteria
Total Number of Chemical Injectors	No.	48
Injectors		
Number of Chemical Injectors per Storm Pump	No.	6
Number of Storm Pumps	No.	8
Type	--	Threaded Titanium
Size	Inch	2

2.1.3 Operation of System

Oakwood receives sanitary and storm flows. During dry weather events, flow pumped from the sanitary wet well to the Northwest Interceptor (NWI) and treated at the Water Resource Recovery Facility (WRRF). During wet weather events when the flow exceeds the sanitary pump capacity (wet well level 73 feet):

- The storm pumps are placed in operation.
- Sanitary pumps are placed offline.
- Sodium hypochlorite feed begins, (For the initial injection of sodium hypochlorite at the onset of the storm, operators often manually increase the chlorine dose to reduce the relatively high fecal bacteria count associated with the first flush of the storm event. Based on discussions with Oakwood facility staff, the chemical feed flowmeters are not accurate. Therefore, the chemical feed is typically not based on flow measurement, but rather based on the operator's experience and how much storm volume the facility is receiving.
- Stormwater is pumped to the perforated screens and CSO basins.
- Once the level in the basin exceeds 114 feet, treated stormwater is conveyed by gravity through two effluent conduits through the O'Brien Drain and then to Outfall 109 and discharged to the Rouge River.

The two storm wet wells and downstream CSO basins can be operated in first-flush (flow to one storm wet well) or flow-through mode (flow to both storm wet wells). Chemical feed pumps operate in tandem with storm pumps and come online and offline as storm pumps come online and offline. There are two standby chemical feed pumps. One standby pump serves as a backup to storm pump P1 and P2 and the other standby pump serves as a backup to storm pumps P3 to P8. Chemical feed pumps can be operated in the following control modes:

- Manual from local control panel

- Contact time (CT) Method – logic varies pump speed to achieve a chlorine dose setpoint (max dose = 12 mg/L) or CT (chlorine concentration x contact time, max CT = 125 mg-min/L and min CT = 100 mg-min/L))
- Total Suspended Solids (TSS) Method – logic calculates required dose based on influent TSS, sodium hypochlorite concentration, influent flow

2.1.4 Regulatory Requirements

GLWA's Long Term CSO Control Plan incorporated Oakwood into the 1997 National Pollutant Discharge Elimination System (NPDES) permit. At the time of this TM, the NPDES permit requirements include:

- Report event influent and effluent flows (mgd)
- Report flow-weighted composite sampling results for:
 - carbonaceous biochemical oxygen demand (mg/L)
 - total suspended solids (mg/L)
 - ammonia nitrogen (mg/L as N)
 - total phosphorus (mg/L as P)
- Report event average and maximum total residual chlorine (TRC) (mg/L)
 - Goal: event average of 1.5 mg/L
 - Goal: event instantaneous maximum of 2.0 mg/L November – April
 - Goal: event instantaneous maximum of 3.0 mg/L May – October
- Report monthly and event (daily during discharge) oil and grease concentration (mg/L) from monitoring point 109A
- Report event minimum and maximum pH (S.U.)
- Report event minimum dissolved oxygen (mg/L)
- For daily Discharge Monitoring Reports (DMRs), report the geometric mean of all fecal coliform samples taken during an event, provided three or more samples are collected. Sample every two hours for the first six hours and every four hours thereafter for the duration of the discharge.
 - Limit: Fecal Coliform must be <400 cts/mL for each event May 1 – October 31
 - Limit: Fecal Coliform must be <1,000 cts/mL for each event November 1 – April 30

For monthly DMRs, report the highest Fecal Coliform event averages the “Maximum” columns under “Quality and Concentration.” Fecal coliform is the only parameter with a regulatory limit. The NPDES permit stated goal of the program is to operate the CSO retention treatment basins and the CSO screening and disinfection facilities in a manner which will provide consistent, effective disinfection while minimizing the discharge of TRC. The permit includes goals to limit TRC with reporting requirements should TRC concentrations exceed the goals. The disinfection optimization evaluation was conducted to aid GLWA in meeting the regulatory limit for fecal coliform count and TRC minimization goals. The Oakwood Project Performance Certificate (i.e., TRC Minimization Assessments) was submitted to Michigan Department of Environment, Great Lakes, and Energy (EGLE) [formerly MDEQ] in 2013, which documented the facility’s performance during wet weather events as required in the facilities NPDES permits.

2.2 Leib

Leib consists of the following major components:

- Influent channel
 - Two Water Champ rapid mixing chemical induction units (CIUs)
- Four screen channels with 12 screens
 - Four Vertical ROMAG CSO Screens
 - Eight Horizontal COPA Raked Storm Screen
- Screen outlet channel
- Screen collection channel
- Facility bypass channel and gates
- Mixing chambers
 - Sixteen Water Champ rapid mixing CIUs, four in each of the four rapid mixing chambers
- Disinfection chamber
- Dry weather channel
- Effluent channel

GLWA is considering alternative mixing technologies to replace the existing Water Champ rapid mixing CIUs. GLWA staff indicated that the seals on the Water Champ mixers need to be replaced relatively often and the motor must be bumped monthly. This is discussed further in the Mixing Technology Evaluation completed under a separate cover as part of this project.

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Figure 2-2 shows a process flow diagram with the major system components at Leib.

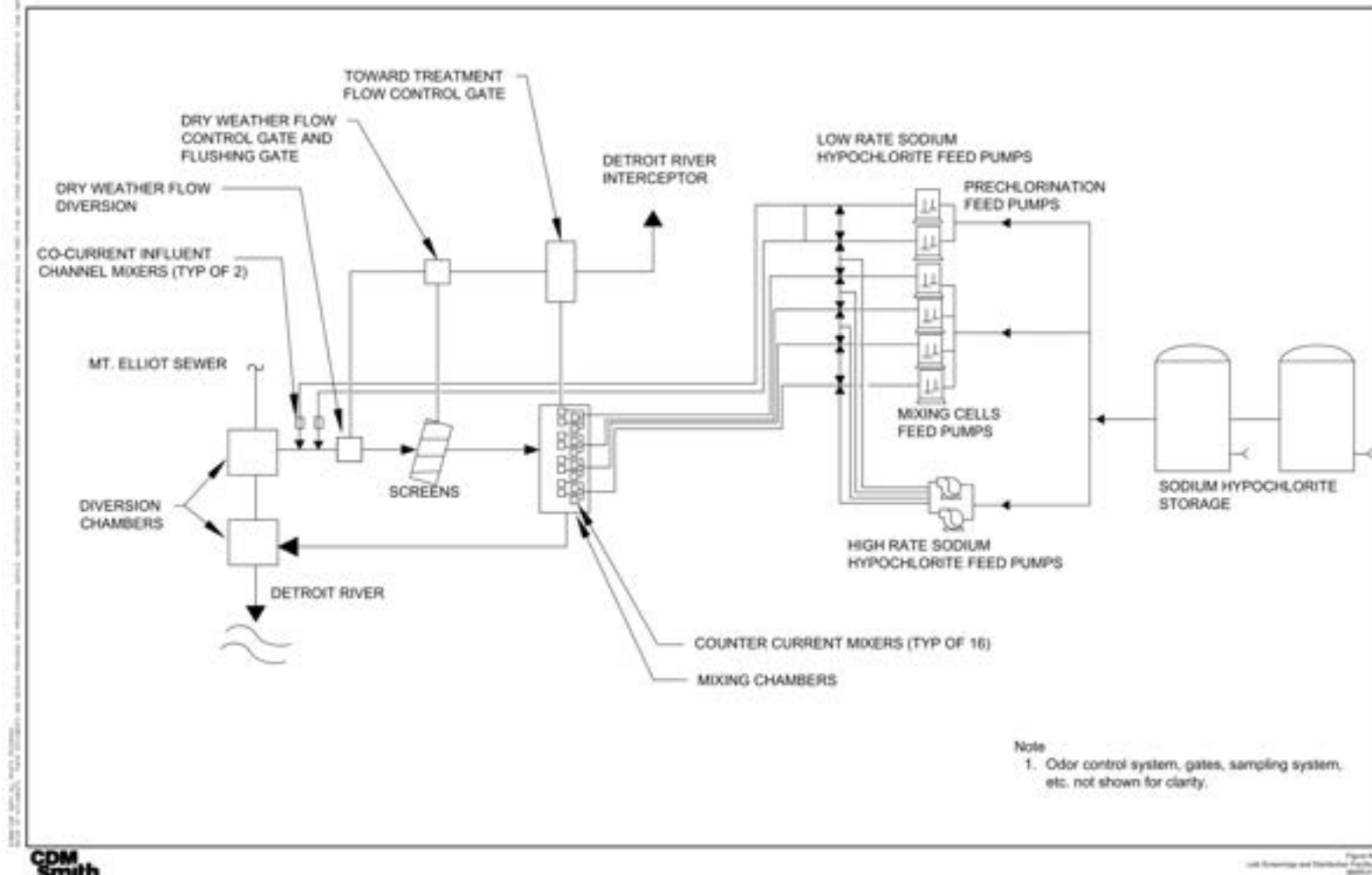


Figure 2-2
Leib Process Flow Diagram

2.2.1 Existing Design Criteria

The existing design criteria for Leib is shown in **Table 2-4**. Leib is designed to handle 1,550 cfs (peak design flow) and convey 2,000 cfs.

Table 2-4 Leib Design Criteria from Basis of Design Report

Parameter	Units	Value	Reference
Maximum Hydraulic Capacity	cfs/mgd	1,550/1,000	Leib Screening and Disinfection Facility Operation and Maintenance Manual
Design Storm Type	-	10-year, 1-hour	Leib Screening and Disinfection Facility Operation and Maintenance Manual
Design Storm Volume	MG	131	Leib Screening and Disinfection Facility Operation and Maintenance Manual
Maximum 7-Day CSO Volume	MG	225	Leib Screening and Disinfection Facility Operation and Maintenance Manual
Safety Factor	-	1.5	Leib Screening and Disinfection Facility Operation and Maintenance Manual
CT Value	mg-min/L	100	Leib Screening and Disinfection Facility Operation and Maintenance Manual
Effluent Channel Contact Volume	MG	6.5	Leib Screening and Disinfection Facility Operation and Maintenance Manual
Maximum Chlorine Dose	mg/L	38	Leib Screening and Disinfection Facility Operation and Maintenance Manual
Design Chlorine Dose	mg/L	10	Leib Screening and Disinfection Facility Operation and Maintenance Manual
Maximum Sodium Hypochlorite Concentration	% ¹	15	Leib Screening and Disinfection Facility Operation and Maintenance Manual
Minimum Sodium Hypochlorite Concentration	% ¹	10	Leib Screening and Disinfection Facility Operation and Maintenance Manual

¹trade percent by weight

2.2.2 Sodium Hypochlorite Storage and Feed Systems

The sodium hypochlorite storage and feed system consist of the following major components:

- Storage Tanks
- Prechlorination Feed Pumps
- Low- and High-Rate Mixing Chamber Feed Pumps
- Basket Strainers
- Prechlorination and Mixing Chamber Rapid Mixing CIUs

- Isolation, flow control, and check valves
- Flow metering and pressure instrumentation

Chemical tanker trucks deliver sodium hypochlorite to Leib and the sodium hypochlorite is stored in two 10,450-gallon fiberglass tanks. Sodium hypochlorite can be added to the process flow in two locations using positive displacement, diaphragm feed pumps and CIUs: namely, the influent channel upstream of the screens (prechlorination) and the mixing chambers downstream of the screens. Sodium hypochlorite is only fed at the prechlorination location at the onset of a storm event or when the mixing chamber sodium hypochlorite addition location cannot meet the chlorine demand.

Two prechlorination feed pumps (duty/standby) deliver sodium hypochlorite to the co-current CIUs located in the influent channel and four low-rate mixing chamber feed pumps (three duty/one standby) or two high-rate mixing chamber feed pumps (duty/standby) deliver sodium hypochlorite to sixteen counter-current CIUs (four rapid mixers per mixing chamber with four mixing chambers).

Table 2-5 and **Table 2-6** summarizes the design criteria for the sodium hypochlorite storage and feed equipment at Leib.

Table 2-5 Leib Sodium Hypochlorite Storage and Feed Equipment

Equipment	Units	Design Criteria
Sodium Hypochlorite Storage		
Number of Tanks	No.	2
Tank Type	-	Fiberglass
Tank Working Storage Volume, each	gal.	10,450
Tank Working Sidewall Height	feet-inches	14'-8"
Tank Diameter	feet-inches	11'-0"
Delivered Hypochlorite Concentration	% ¹	12.5
Prechlorination Feed Pumps		
Number Pumps	No.	2 (duty/standby)
Pump Type	Type	Positive Displacement Diaphragm, Palsa Series 7660-H-S-E
Manufacturer	-	Pulsafeeder
Motor Power	hp	1.5
Motor Power Requirements	v/ph	180 / 1
Motor Speed	rpm	1750
Variable Speed?	-	Yes
Operating Pressure	psig	75
Gear Ratio	-	15:1
Design Capacity	gpm	7.6

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Equipment	Units	Design Criteria
Low-Rate Mixing Chamber Feed Pumps		
Number Pumps	No.	4 (3 duty/ 1 standby)
Pump Type	Type	Positive Displacement Diaphragm, Palsa Series 7660-H-S-E
Pump Manufacturer	-	Pulsafeeder
Motor Manufacturer	-	Baldor
Motor Power	hp	1.5
Motor Power Requirements	v/ph	180 / 1
Motor Speed	rpm	1750
Variable Speed	-	Yes
Maximum Pressure	psig	85
Design Capacity	gpm	7.6
High-Rate Mixing Chamber Feed Pumps		
Number Pumps	No.	2 (Duty/Standby)
Pump Type	Type	Centrifugal, Variable Speed
Pump Manufacturer	-	Flowserve Innomag
Motor Manufacturer	-	Baldor
Motor Power	hp	5
Motor Power Requirements	v/ph	480 / 3
Motor Speed	rpm	1200
Variable Speed?	-	Yes
Design Capacity	gpm	112

¹trade percent by weight

Table 2-6 Leib Sodium Hypochlorite Dissolution

Equipment	Units	Design Criteria
Total Number of CIUs	No.	18
Prechlorination		
Number of Prechlorination CIUs	No.	2
Type of CIU	-	Co-current Chemical Induction
Blade Material	-	Titanium
Motor Power	hp	15
Motor Power Requirements	v/ph	460 / 3
Motor Speed	rpm	3450
Mixing Chambers		
Number of CIUs per Mixing Chamber	No.	4
Type of CIU	-	Counter-current Chemical Induction
Blade Material	-	Titanium
Number of Mixing Chamber Mixers	No.	4
Mean Velocity Gradient 2 Mixers Operating	sec ⁻¹	600
Mean Velocity Gradient 3 Mixers Operating	sec ⁻¹	600 – 1600
Mean Velocity Gradient 4 Mixers Operating	sec ⁻¹	1200 – 1600
Total Number of Mixing Chamber Mixers	No.	16
Motor	hp	15
Motor Power Requirements	v/ph	460 / 3
Motor Speed	rpm	3450

The Leib O&M manual indicates the tank volume is 10,450-gallons, while the tank nameplates indicate the tank volume is 13,611-gallons. Neither data source specified whether the listed volume was the working volume or nominal tank volume. To investigate this discrepancy, CDM Smith collected field measurements and used 3D laser scan survey data to measure the tank dimensions. The dimensions generally matched the dimensions shown in the record drawings. Based on these investigations, it appears the 10,450-gallons is the volume of the tank from the top of the pump suction nozzle to the top of the tank sidewall (i.e., tank volume excluding dead space below suction nozzle and dome top of tank). While the 13,611-gallons appears to be the volume of the tank including the volume in the dome at the top of the tank. It is not clear if this includes the dead space volume occupied by the level sensor mounted on top of the tank. During the CSO Facilities Improvements workshop, GLWA and CDM Smith agreed given the age of the tanks (~23-years) it would be prudent to replace the tanks regardless of the tank working volume (i.e., 10,450-gallons vs 13,611-gallons). For the purposes of this technical memorandum, the volume from the O&M manual (i.e., 10,450-gallons) was used as the working volume for the tank.

2.2.3 Operation of System

During a CSO event water begins to flow over the effluent weir in the effluent channel and the chemical feed pump and counter-current CIUs are turned on. The prechlorination CIUs are manually operated and used 1) when flow exceeds 50 cfs with the anticipation that flow will increase and start flowing to the screens (~118 cfs), and 2) when the sixteen CIUs in the downstream mixing chambers cannot meet the disinfection chlorine residual requirements. The gate to the Toward Interceptor conveys screenings flow to the Detroit River Interceptor during wet weather events. When the wet weather flows decrease to the point where water stops flowing over the effluent weir, the sodium hypochlorite feed system turns off. During dry weather flow is diverted from the influent channel to the Toward Interceptor.

2.2.4 Regulatory Requirements

GLWA's Long Term CSO Control Plan incorporated Leib into the 1997 National Pollutant Discharge Elimination System (NPDES) permit. At the time of this TM, the NPDES permit requirements include:

- Report event influent and effluent flows (mgd)
- Report flow-weighted composite sampling results for:
 - carbonaceous biochemical oxygen demand (mg/L)
 - total suspended solids (mg/L)
 - ammonia nitrogen (mg/L as N)
 - total phosphorus (mg/L as P)
- Report event average and maximum total residual chlorine (TRC) (mg/L)
 - Goal: event average of 2.0 mg/L November – April
 - Goal: event average of 3.0 mg/L May – October
- Report event minimum and maximum pH (S.U.)
- Report event minimum dissolved oxygen (mg/L)
- For daily DMRs, report the geometric mean of all fecal coliform samples taken during an event, provided three or more samples are collected. Sample every two hours for the first six hours and every four hours thereafter for the duration of the discharge.
 - Limit: Fecal Coliform must be <400 cts/mL for each event May 1 – October 31
 - Limit: Fecal Coliform must be <1,000 cts/mL for each event November 1 – April 30

- For monthly DMRs, report the highest Fecal Coliform event averages.

Fecal coliform is the only parameter with a regulatory limit. The NPDES permit includes goals to limit TRC with reporting requirements should TRC concentrations exceed the goals. The disinfection optimization evaluation was conducted to aid GLWA in meeting the regulatory limit for fecal coliform count and TRC minimization goals. A Total Residual Chlorine Minimization Assessment was submitted to EGLE for Baby Creek, Belle Isle, Conner Creek, St. Aubin, and Leib CSO facilities in 2012 (i.e., TRC Minimization Assessments), which documented the facility's performance during wet weather events as required in the facilities NPDES permits.

3.0 System Evaluation

This section summarizes the review of historic data associated with both CSO treatment facilities, presents the anticipated future collection system configurations, and discusses the design criteria for the storage and feed systems.

3.1 Review of Historic Data

3.1.1 CSO Events Flows and Duration

The Design team reviewed the CSO events reported EGLE for a three-year period of 2019-2021 for the Oakwood and Leib facilities. The CSO events reported to EGLE are events where combined sewer flow was discharged from the facility to an outfall structure. The findings from that review are discussed below.

3.1.1.1 Oakwood

Table 3-1 summarizes the CSO events reported to the EGLE per year, maximum and average volumes discharged and duration for a single event for 2019-2021.

Table 3-1 Summary of CSO Events Reported to EGLE During 2019-2021

Parameters		Units	Oakwood Facility
Number of Reported Events	2019	No.	11
	2020	No.	11
	2021	No.	14
Maximum Volume Discharged in a Single Event		MG	110.4
Average Volume Discharged in a Single Event		MG	26.6
Maximum Duration of a Single Event		Hrs	223.5
Average Duration of a Single Event		Hrs	34.3

Between 2019 and 2021, there were 36 storm events at Oakwood where combined sewer flows were discharged to the outfall. Based on the DMRs from 2019 to 2022, there was a total of 79 storm events that were treated at Oakwood; however, only 36 of the events resulted in an outfall discharge and were subsequently reported to EGLE. The remaining 43 storm events from the DMRs

were events where combined sewer flows were treated (disinfection and screening) at Oakwood and diverted to the WRRF as flows allowed, which prevented the need to discharge at the outfall. The duration and volume for the 36 CSO outfall discharge events at Oakwood are shown in **Figure 3-1** and **Figure 3-2**.

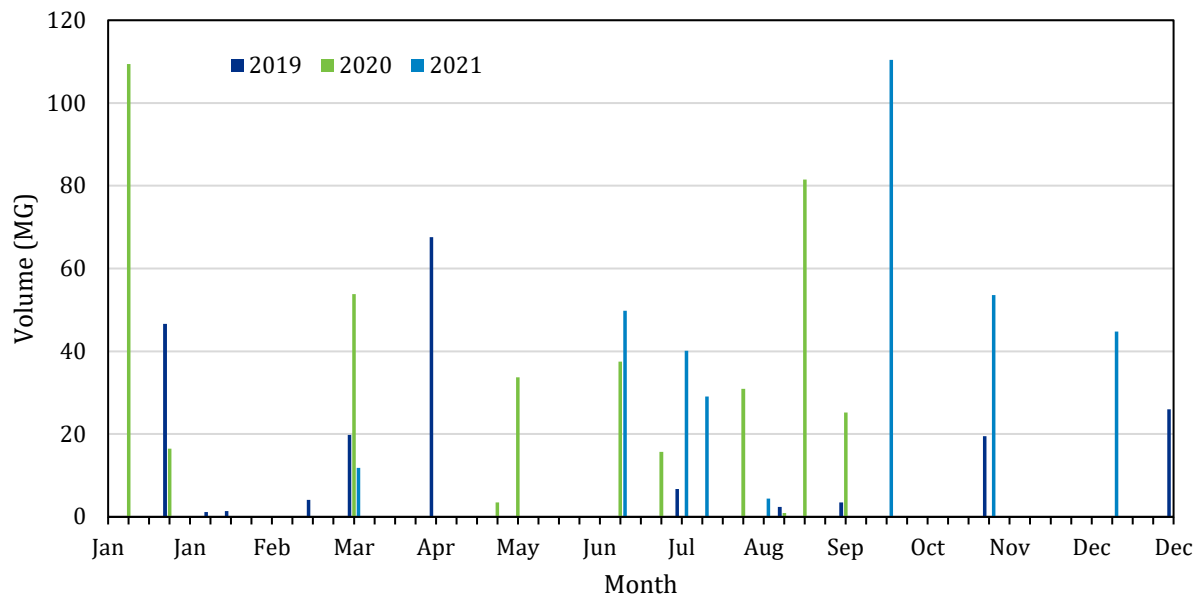


Figure 3-1
Oakwood CSO Volumes Reported to EGLE in 2019-2021

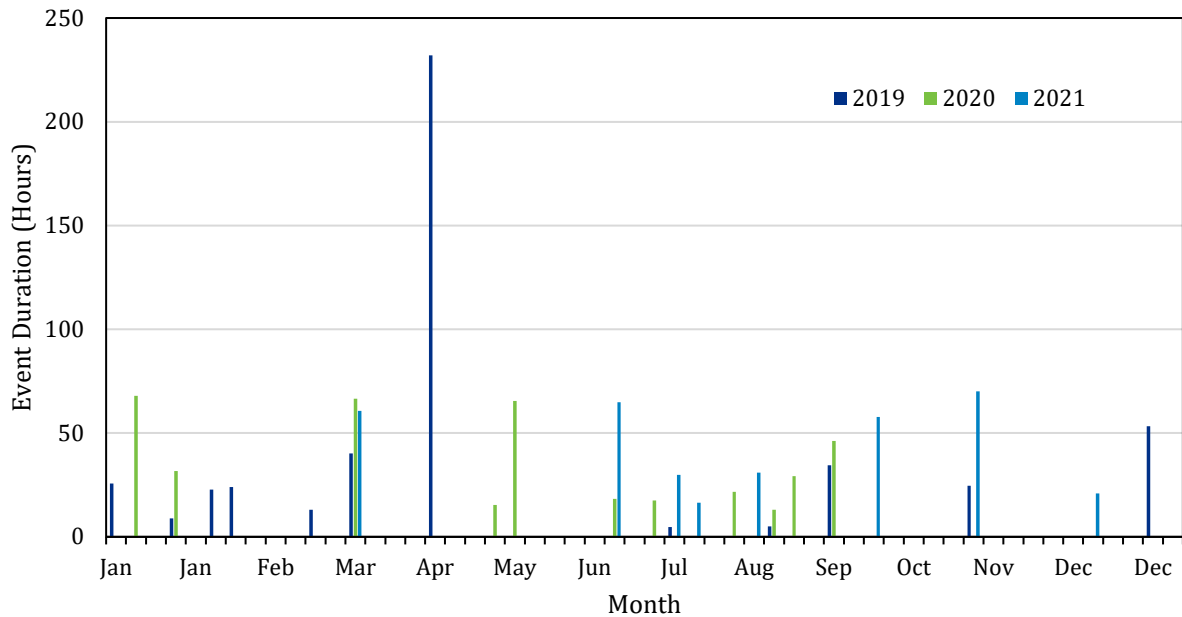


Figure 3-2
Oakwood CSO Event Durations Reported to EGLE in 2019-2021

3.1.1.2 Leib

Table 3-2 summarizes the CSO events reported to the EGLE per year, maximum and average volumes discharged and duration for a single event for 2019-2021.

Table 3-2 Summary of CSO Events Reported to EGLE During 2019-2021

Parameters		Units	Leib Facility
Number of Reported Events	2019	No.	1
	2020	No.	3
	2021	No.	6
Maximum Volume Discharged in a Single Event		MG	165.8
Average Volume Discharged in a Single Event		MG	66.7
Maximum Duration of a Single Event		Hrs	35.8
Average Duration of a Single Event		Hrs	12.5

The duration and volume for the 36 CSO events at Leib are shown in **Figure 3-3** and **Figure 3-4**.

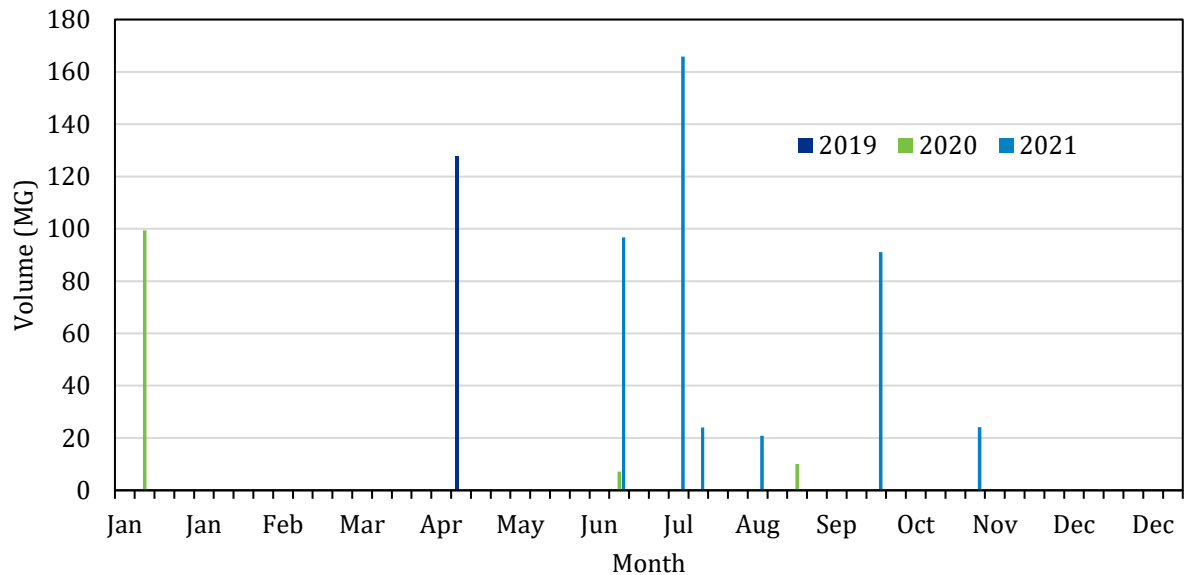


Figure 3-3
Leib CSO Volumes Reported to EGLE in 2019-2021

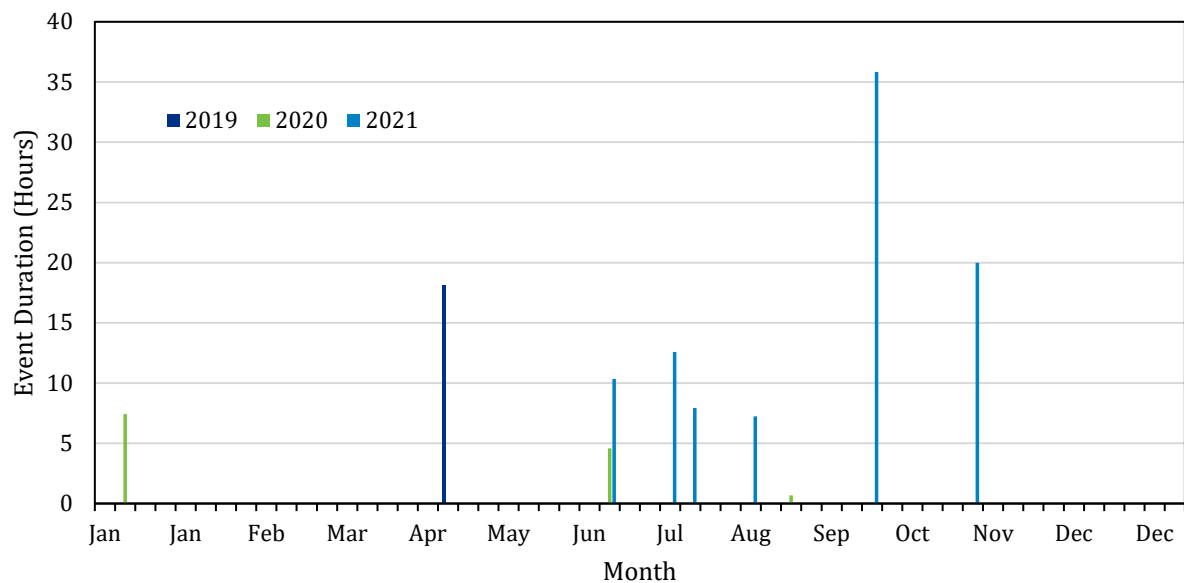


Figure 3-4
Leib CSO Event Durations Reported to EGLE in 2019-2021

3.1.2 Historic Sodium Hypochlorite Concentration

Historically, sodium hypochlorite delivered at both facilities has a concentration of 12% (trade percent by weight). GLWA staff measure the concentration of sodium hypochlorite as delivered and

periodically in each storage tank to verify the concentration delivered. GLWA standard operating procedure has staff discard sodium hypochlorite when the concentration drops below 5%. Measuring the sodium hypochlorite concentration allows GLWA staff to better manage the chemical inventory, and to determine how many pounds of chlorine are being added depending upon the sodium hypochlorite concentration and flow rate to the application points. The concentration of sodium hypochlorite at Oakwood from 2012 to 2022 and at Leib from 2005 to 2022 is shown in **Figure 3-5**.

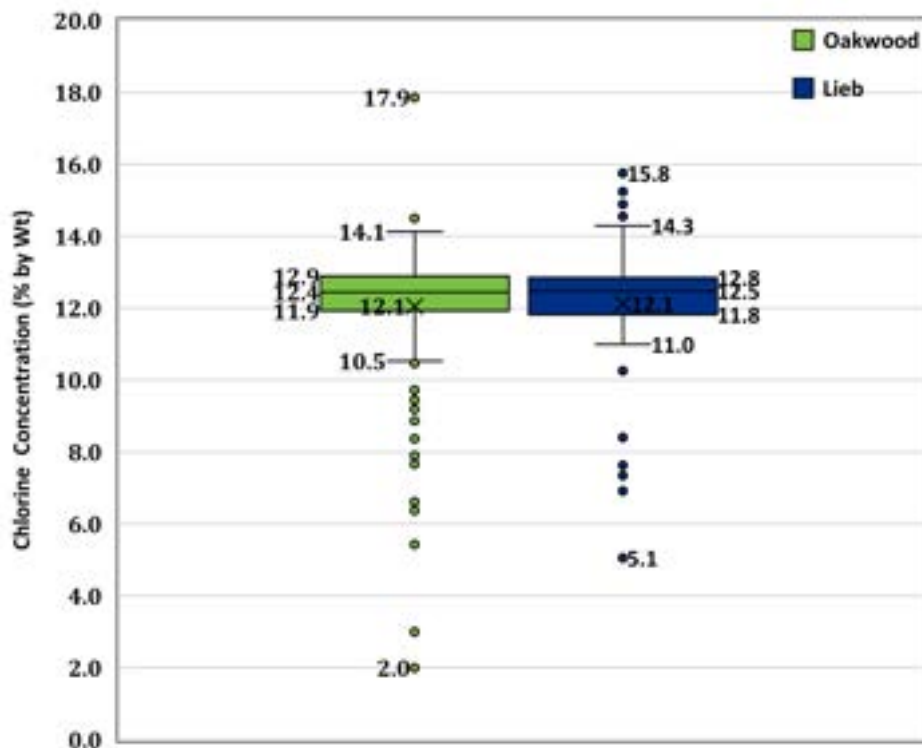


Figure 3-5
Historic Sodium Hypochlorite Concentration as Delivered at Oakwood and Leib

The 75th percentile of the as delivered sodium hypochlorite concentration at both facilities is roughly 13% (trade percent by weight) as chlorine, which represents the maximum sodium hypochlorite concentration at Oakwood and Leib. The outliers shown in **Figure 3-5** are likely a function of sampling and testing errors or anomalies rather than poor product quality, particularly for the low concentrations reported (i.e., 2-3% trade percent by weight at Oakwood and 5% trade percent by weight at Leib). The historic sodium hypochlorite concentrations in each chemical storage tank are shown in **Figure 3-6**. The concentration decreases from the maximum concentration as delivered (~13% trade percent by weight) because the sodium hypochlorite degrades over time. The sodium hypochlorite is replenished after storm events or in coordination

with routine dumping procedures to restore the sodium hypochlorite concentration after prolonged dry weather periods and in anticipation of storm events.

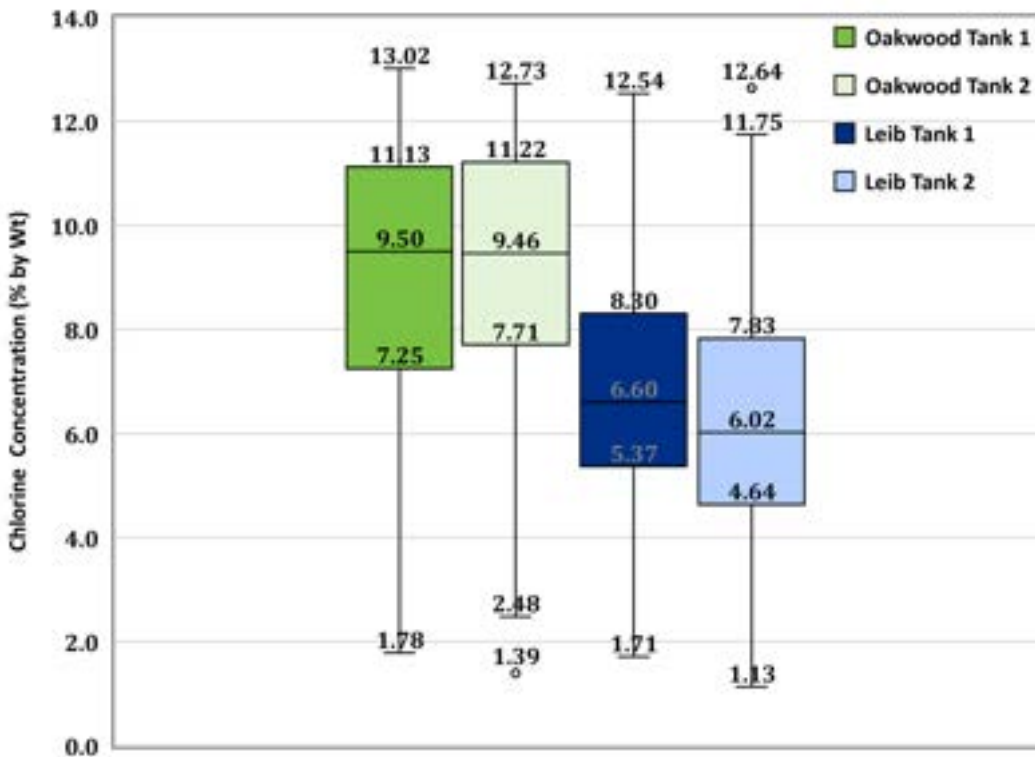


Figure 3-6
Historic Sodium Hypochlorite Concentration as Stored at Oakwood and Leib

The concentration in the chemical storage tanks at Oakwood and Leib generally vary between 11% and 7%, and 8% and 5% (trade percent by weight), respectively. This generally matches the Standard Operating Procedures (SOPs) for both facilities. The concentrations lower than 7% at Oakwood and 5% (trade percent by weight) at Leib (i.e., ~2% trade percent by weight) can be attributed to prolong periods of dry weather.

3.1.3 Historic Sodium Hypochlorite Dose and Usage

In order to calculate the approximate historic chlorine dose (mg/L), The Design Team reviewed:

- 2020 and 2021 historic storm event flow data from GLWA's SCADA system
 - During this evaluation it was identified that Oakwood storm pump flow data may be unreliable; however, for the purposes of this technical memorandum and in the absence of more reliable data it was assumed the flow data was reasonably accurate.

- Where effluent data was available (i.e., events with flow discharged to outfall), effluent data was used in lieu of influent flow data. Where effluent data was not available (i.e., events where no flow was discharged to outfall and sodium hypochlorite was used), influent flow data was used. The majority of events included in this analysis were based on effluent flow data.
- Sodium hypochlorite storage tanks levels SCADA data
- Sodium hypochlorite concentration data from GLWA bleach report test results

At Oakwood, the historic chlorine dose evaluation was limited to

- Events with flows reported by EGLE, which include all outfall events
- Storm events with a volume greater than 4 MG and average flow greater than 50 cfs
 - Based on historic SCADA data analysis, it is assumed that decreases in tank levels without storm flows or when storm event volumes were less than 4 MG and the average flow is less than 50 cfs represent chemical purge events to restore the sodium hypochlorite concentration in alignment with SOPs. Prolonged decreases in tank levels were attributed to leaking drain valves and was also not included in the historic dose evaluation.

At Leib, the historic chlorine dose evaluation was limited to

- Events with flows reported by EGLE, which include all discharge events
- Events with an average flow greater than 50 cfs and peak flow greater than 100 cfs, which represents the conditions required to start sodium hypochlorite in anticipation of a discharge event.

The average historic sodium hypochlorite concentration during the evaluated storm events was 8.3% at Leib and 10.7% (trade percent by weight) at Oakwood. As shown in **Figure 3-7**, the average chlorine dose was 6.6 mg/L at Leib and 22.6 mg/L at Oakwood. The maximum chlorine dose at Leib and Oakwood was 19 mg/L and 85 mg/L, respectively. The calculated doses may be artificially high, particularly at Oakwood, because the existing storm pump flow meters may be missing reads or reporting artificially low flows resulting in artificially low values for volume disinfected. At Oakwood, the unreliable storm flow meters make flow pace dosing challenging and the operators tend to feed sodium hypochlorite manually at higher rates to make sure disinfection permit requirements are met. These statements are based on observations made during site visits during storm events and discussions with GLWA staff.

For example, during one ride-along event CDM Smith staff observed a flow measurement of approximately 30 cfs for Storm Pump 1. Using the factory test curve to approximate the flow rate at the observed field conditions results in an anticipated flow of approximately 47 cfs. The impeller to

wear area clearance may have changed since the factory test, which may be contributing to the differences in observed and anticipated flows. The extent of the metering challenges can be explored further through more detailed discussions with GLWA staff.

Based on the historical chlorine usage and the total storm volume treated, the chlorine used per unit storm volume was determined in lbs/MG and presented in **Figures 3-8** and **3-9**. To approximate the potential impact of flow measurement inaccuracies at Oakwood on the historic chlorine dose analysis, the ratio between the observed flow measurement and anticipated flow measurement from the factory pump test curve were extrapolated to the historic flows. The historical flows and modified historical flows were included in **Figure 3-8** for comparison. The chlorine dose in the modified historical flow evaluation, decreased by approximately 36% which is equivalent to the difference between the field observation and factory pump test curve anticipated flows.

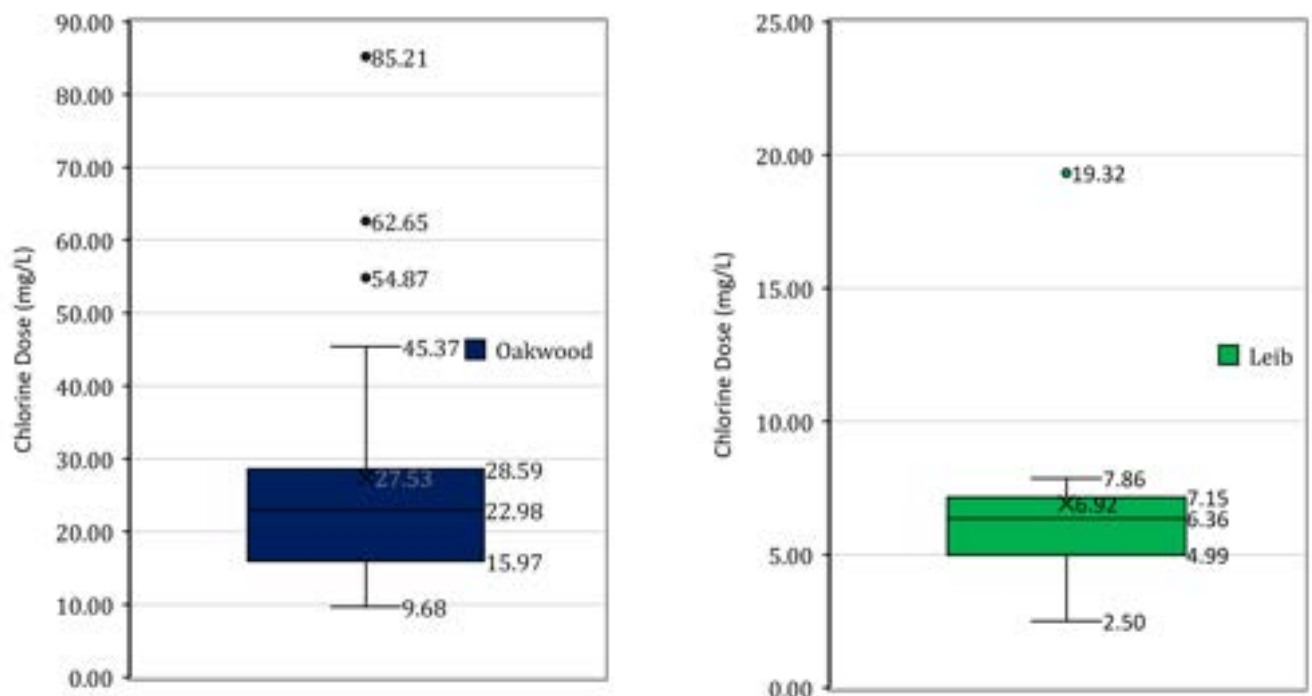


Figure 3-7
Calculated Historic Chlorine Dose at Oakwood and Leib

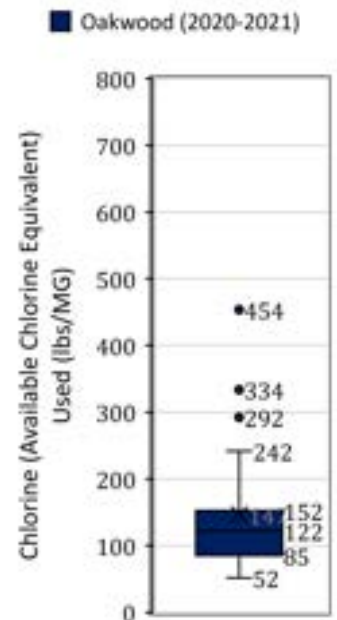
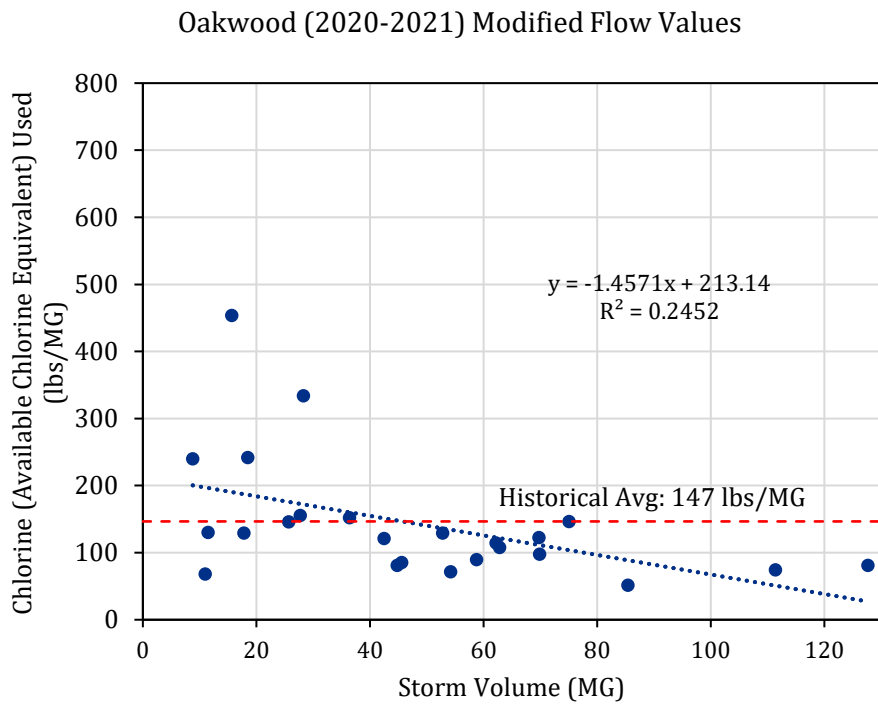
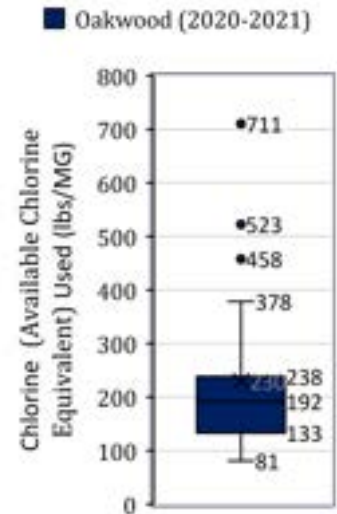
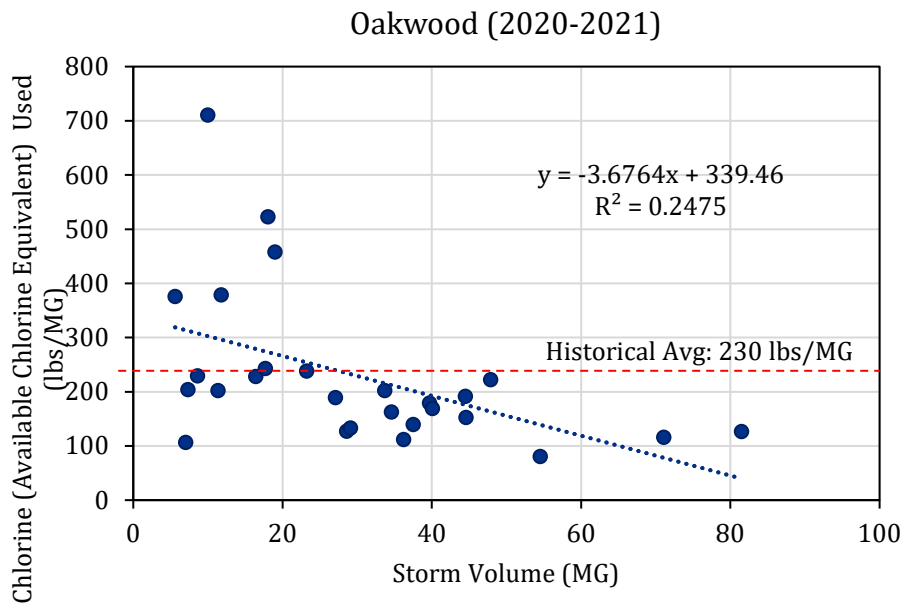


Figure 3-8
Calculated Historic Chlorine Used per Unit Storm Volume (lb/MG) at Oakwood

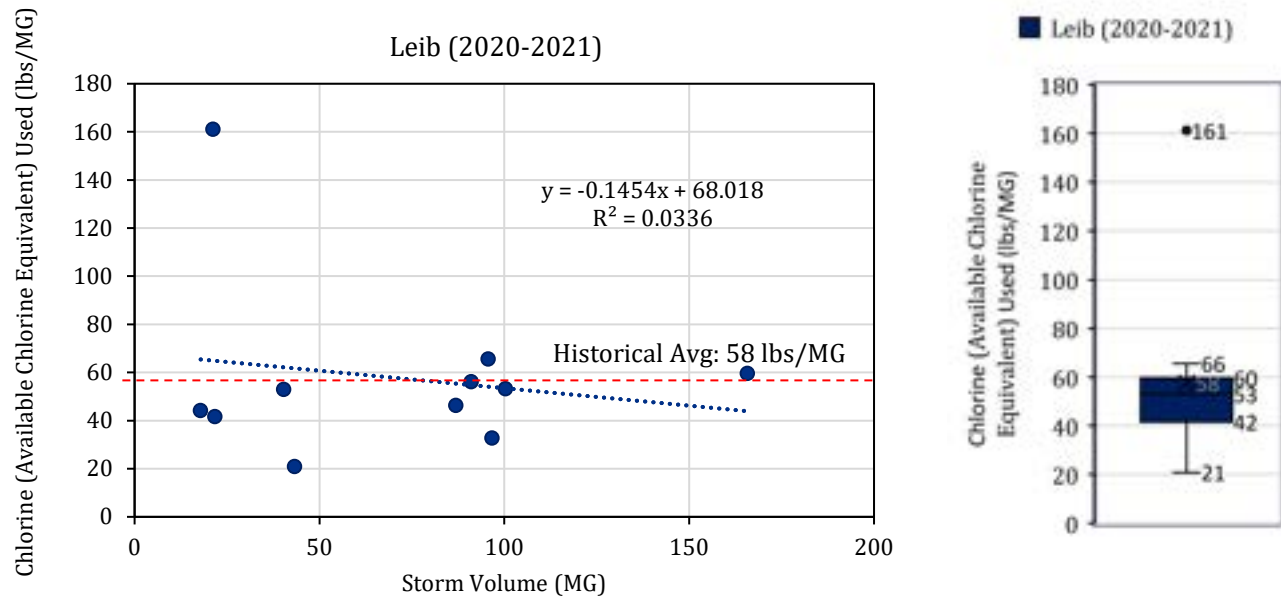


Figure 3-9
 Calculated Historic Chlorine Used per Unit Storm Volume (lb/MG) at Leib

3.2 Anticipated Future Collection System Configuration Conditions

Modeling conducted by the Design Team evaluated existing collection system configuration design storm event flow conditions (flow, duration, and intensity), anticipated future collection system configuration storm event flow conditions, and the impact of the proposed Oakwood District Intercommunity Relief Sewer (ODIRS) at Oakwood and Meldrum Sewer connection at Leib. The evaluation included the 6-month, 24-hour storm event (average design storm event) and 10-year, 24-hour storm event (peak design storm event). **Figure 3-10** and **Figure 3-12** show the model results for the existing and future collection system configuration average design storm event at Oakwood and Leib, respectively. **Figure 3-11** and **Figure 3-13** show the model results for the existing and future collection system configuration peak design storm event at Oakwood and Leib, respectively.

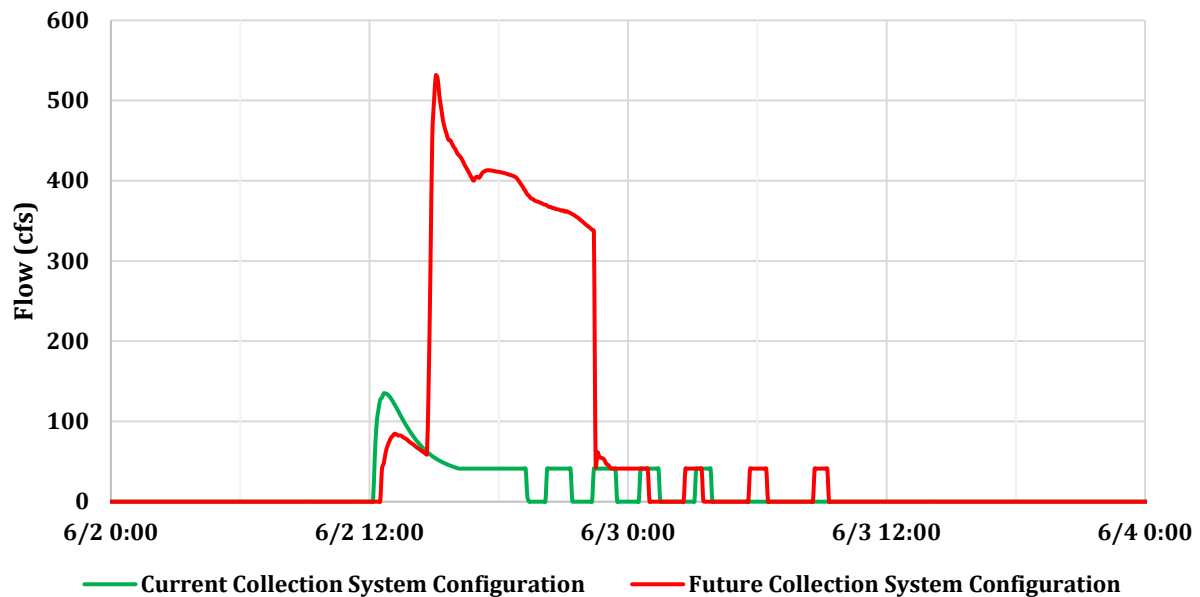


Figure 3-10
Oakwood 6-month, 24-hour Storm Event with Existing and Future Collection System Configurations

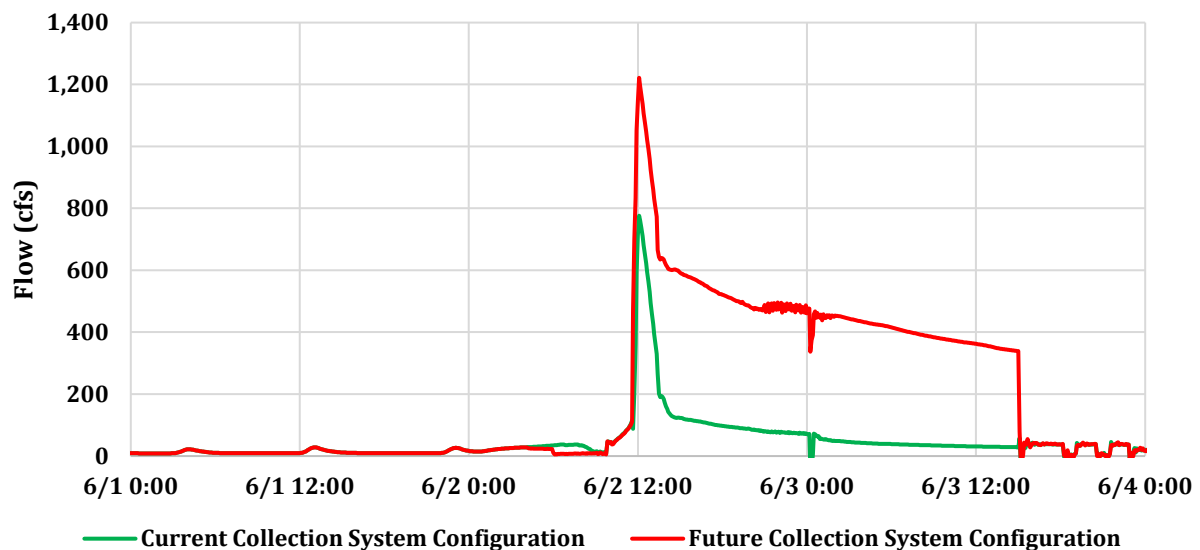


Figure 3-11
Oakwood 10-year, 24-hour Storm Event with Existing and Future Collection System Configurations

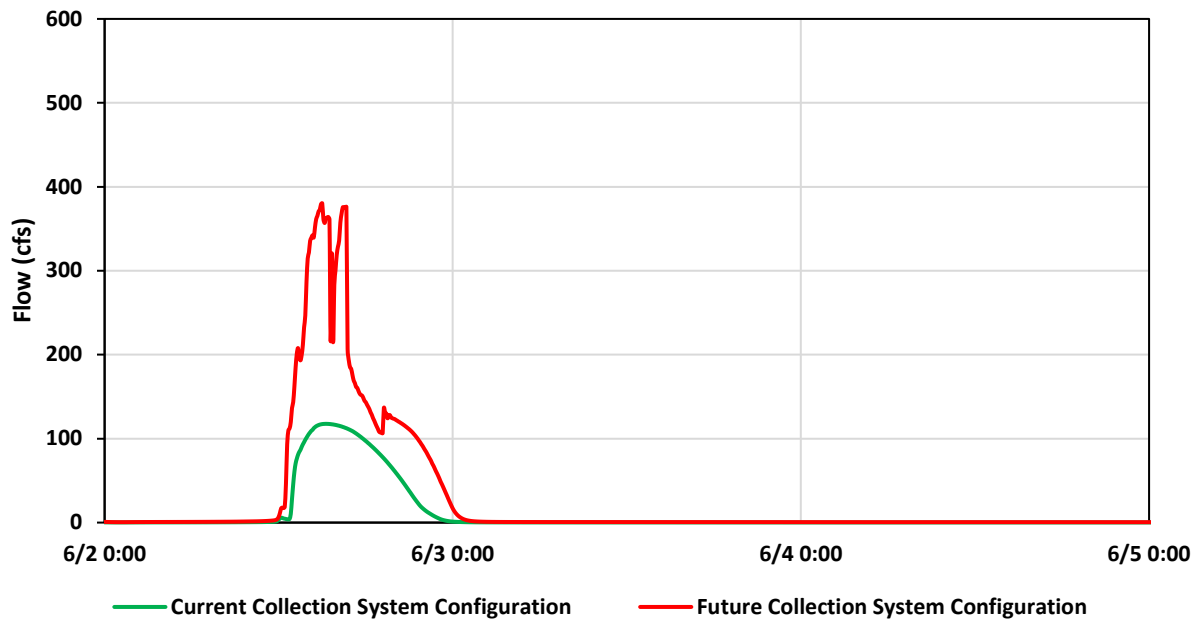


Figure 3-12
Leib 6-month, 24-hour Storm Event with Existing and Future Collection System Configurations

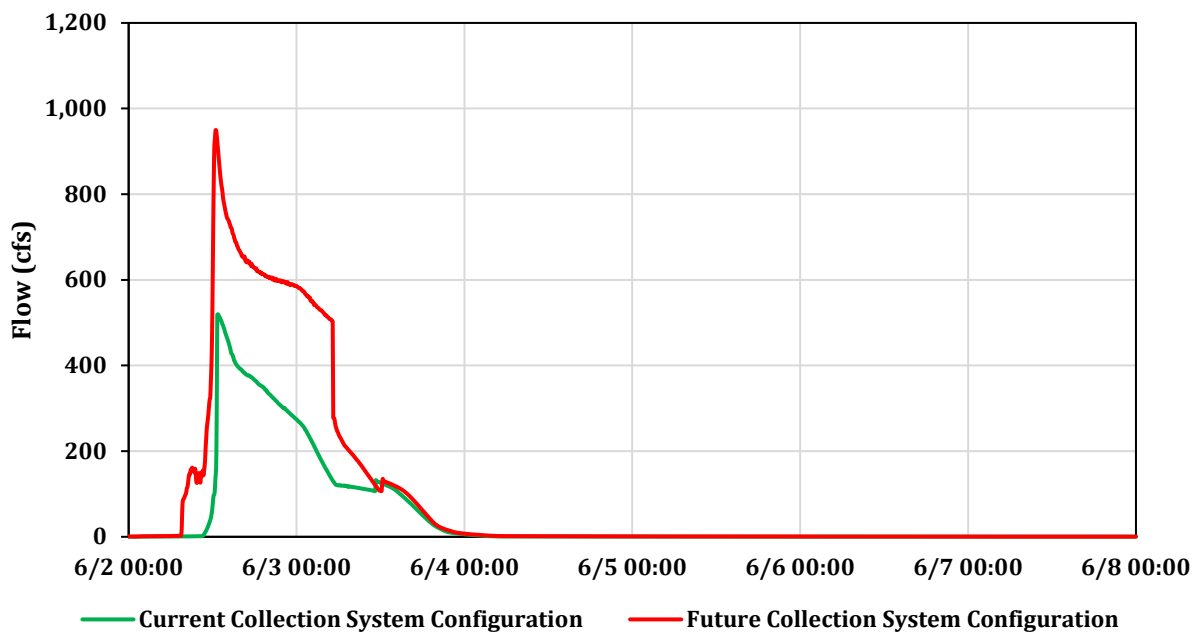


Figure 3-13
Leib 10-year, 24-hour Storm Event with Existing and Future Collection System Configurations

The key findings from this evaluation as they relate to the assessment of the existing sodium hypochlorite storage and feed system are

- Increases in anticipated storm volume summarized in **Table 3-3**
- Longer periods of sustained flow after the tie-in of the proposed ODIRS

Table 3-3 Increase in Storm Volumes for Future Collection System Conditions for Oakwood and Leib

Design Storm	Current Collection System Conditions	Future Collection System Conditions	
	Total Treated Volume, MG	Total Treated Volume, MG	Total Treated Volume, % Increase
Oakwood			
6-month, 24-hours	16.5	92.3	460%
10-year, 24-hours	80.5	368.3	358%
Leib			
6-month, 24-hours	21.2	53.9	155%
10-year, 24-hours	185.4	366.6	98%

At Oakwood, it is unclear how relatively small storm events will behave in relation to minimum pump capacity. If the influent flow is less than the minimum pump capacity, this causes Oakwood to operate in a “draw fill” mode. Under this mode of operation, contact times can be relatively long as the CSO basins are filled intermittently with pumps turning on and off as the influent volume is drawn down. Conversely, when the influent flow is greater than the minimum pump capacity, the facility can operate in a more continuous mode.

The modeled design storm hydrographs were used to estimate the first flush volume for each design storm, which were used to calculate the required sodium hypochlorite storage capacity. The approach to establishing the first flush volume is included in Section 1.1 The estimated first flush volumes are included in **Table 3-4**.

Table 3-4 Estimated First Flush Volumes for Oakwood and Leib

Design Flow	Units	Oakwood	Leib	Reference
Avg Storm – Current Collection System	MG (% of design storm volume)	4 (20%)	4 (20%)	6-month, 24hr
Avg Storm - Future Collection System	MG (% of design storm volume)	19 (20%)	11 (20%)	6-month, 24hr
Peak Storm - Current Collection System	MG (% of design storm volume)	12 (3%)	5 (15%)	10yr, 24hr
Peak Storm - Future Collection System	MG (% of design storm volume)	66 (10%)	37 (18%)	10yr, 24hr

3.3 Design Criteria

The design criteria for the proposed sodium hypochlorite storage and feed improvements were based on the following inputs and outputs.

Inputs:

- ICT values (See TM-18 for ICT value determination)
- Chlorine Demand and Decay (See TM-18 for values)
- Sodium Hypochlorite Concentration (based on historic bleach test results when chemical was used for treatment – excludes concentration data for routine dumping and when chemical was not being used).
 - Median concentration for Oakwood, which is 10.5% (trade percent by weight)
 - The median concentration for Leib is 7.5% (trade percent by weight after dilution); however, 10.0% (trade percent by weight) was used for chemical storage sizing to reduce storage requirements and allow proposed larger storage tanks to fit within existing chemical room (see detailed discussion Section 3.2.2.1 Leib Chemical Storage Evaluation)
- Baffling Factor
 - Established through CFD analysis at Oakwood
 - For the purposes of the technical memorandum, a representative baffling factor was assigned to the Leib facility based on the Chlorine Contact Chamber Design and Flow Evaluation worksheet v1.04 published by the California Department of Health Services (Appendix C). It is recognized that the California Department of Health Services does not have jurisdiction for GLWA; however, in the absence of similar guidance from Michigan/EGLE, tracer study data, or CFD study results this reference provides a basis for the evaluation.
- Contact Time
 - Calculated at the design flows and volume limitations (i.e., existing structures).
- Safety Factor
- Design Storm Volume
- Estimated First Flush Volume
- Design Storm Flow

Outputs

- Required Chlorine Dose (mg/L)
- Required Sodium Hypochlorite Storage (gallons)

- Required Sodium Hypochlorite Feed Flow (gpm)

The design criteria for Oakwood and Leib are presented in the following subsections. All sodium hypochlorite storage volumes presented herein are working storage volumes (does not include volume 6 in. below the top of the suction connection and 6 in. above the invert of overflow connection).

3.2.1 Oakwood

The required chlorine dose calculated at each design flow is shown in **Table 3-5**. The low, average, and high ICT values were established through dose response testing and discussed in TM-18. The high ICT is based on achieving inactivation goal of a maximum measured fecal coliform value down to half of the recreational seasonal bacteria limit (200 CFU/100 mL) and the average ICT is based on the average undisinfected fecal coliform down to half of the recreational seasonal bacteria limit (200 CFU/100 mL). The low ICT value represents a theoretical minimum required dose and was established by using the minimum demand and decay value from the dose response testing.

Table 3-5 Summary of Design Flows and Dose Requirements at Oakwood

Parameter	Units	Design Peak	Future Collection System Max	Current Collection System Max	Future Collection System Average	Current Collection System Average	Current Collection System Min
Total Design Storm Flow	mgd	1,071	794	494	343	87	64
Number of CSO Basins in Service	No.	2	1	1	1	1	1
Existing Screenings Channel and Basins							
Baffling Factor ¹	-	0.6	0.6	0.6	0.6	0.6	0.6
Effective Contact Time	min	7.5	5.4	8.3	11.8	45.2	61.1
Assumed Average to High Chlorine Demand and Decay	mg/L	1.6	1.6	2.0	3.0	3.8	4.0
Low Demand and Decay	mg/L	1.1	1.1	1.1	1.1	1.1	1.1
High ICT (120)							
TRC Required	mg/L	16.1	22.4	14.5	10.2	2.7	2.0
Chlorine Dose	mg/L	17.7	24.0	16.5	13.2	6.5	6.0
Avg ICT (50)							
TRC Required	mg/L	6.7	9.3	6.0	4.2	1.1	0.8
Chlorine Dose	mg/L	8.3	10.9	8.0	7.2	4.9	4.8
Low ICT (4)							
TRC Required	mg/L	0.5	0.7	0.5	0.3	0.1	0.1
Chlorine Dose	mg/L	1.6	1.8	1.6	1.4	1.2	1.2

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Parameter	Units	Design Peak	Future Collection System Max	Current Collection System Max	Future Collection System Average	Current Collection System Average	Current Collection System Min
Basins with Baffle Alternative							
Baffling Factor ¹	-	0.7	0.7	0.7	0.7	0.7	0.7
Effective Contact Time	min	8.7	6.2	9.6	13.8	52.7	71.3
Demand and Decay	mg/L	1.6	1.6	2.0	3.0	3.8	4.0
High ICT (120)							
TRC Required	mg/L	13.8	19.2	12.4	8.7	2.3	1.7
Chlorine Dose	mg/L	15.4	20.8	14.4	11.7	6.0	5.7
Avg ICT (50)							
TRC Required	mg/L	5.7	8.0	5.2	3.6	0.9	0.7
Chlorine Dose	mg/L	7.3	9.6	7.2	6.6	4.7	4.7
Low ICT (4)							
TRC Required	mg/L	0.5	0.6	0.4	0.3	0.1	0.1
Chlorine Dose	mg/L	1.6	1.8	1.5	1.4	1.2	1.2

¹baffling factor from CFD analysis for CSO basin baffle alternative

The TRC required is based on the existing effluent channel sample pump location. The TRC required for the current collection system average and minimum design storm flows are generally in alignment with the NPDES TRC operational goals (1.5 mg/L event average, 2.0 mg/L November – April and 3.0 mg/L May – October event instantaneous maximum). Under current collection system average flow conditions and with an average ICT, the TRC required at the end of the CSO basins meets the NPDES TRC operational goals. The required TRC increases as storm flows increase and the effective contact times decrease. The ICT values can be refined through additional testing, particularly during high flow events once the proposed ODIRS is constructed, which may reduce the TRC required.

The low ICT value will be used to define the minimum chemical feed requirements and equipment sizing. The low ICT value is not used for chemical storage sizing. The high and average ICT values represent the normal to high range in anticipated chemical dose requirements for appropriately sizing the chemical storage tanks.

The required chlorine doses were averaged for each design condition (high and average ICT) and these values were used as the basis for calculating the required sodium hypochlorite storage. The average required chlorine doses are shown in **Table 3-6**. Averaging the required doses (high and average ICT separately) represents a combination of the challenging water quality experienced during the first flush, less challenging water quality during high flows, and poor water quality at the tail of wet weather events when sewerage is less dilute with receding storm flows. This is also accounted for in assigning the higher demand and decay values from the sampling to the lower flows. The average maximum chlorine demand value of 4.0 mg/L (average of two maximum

chlorine demand values, 3.5 and 4.5 mg/L) was assigned to the current collection system minimum design storm (64 mgd) to account for the less dilute sewerage flows. Conversely, the minimum chlorine demand value of 1.6 mg/L was assigned to the future collection system max (794 mgd) and design peak storm flows (1,071 mgd) to account for the dilution of the sewerage flow with increased storm flows. The chlorine demand response data is included in TM-18.

Table 3-6 Average Required Chlorine Dose at Oakwood

Parameter	Units	No Baffles	Baffle Alternative	Dose Reduction (%)
High ICT	mg/L	14.0	12.3	12%
Avg ICT	mg/L	7.4	6.7	9.5%

3.2.1.1 Oakwood Storage Evaluation

The following design bases were evaluated to compare the required storage volumes. The original BOD and draw fill scenarios were included in the evaluation to compare the proposed design criteria with the original BOD and alternative mode of operation (non-continuous) design criteria and resulting sodium hypochlorite storage requirements.

- Original BOD– represents the original design criteria from CS-1364 *Oakwood CSO Control Facility and Pump Station Design Memorandum 11 – Disinfection System*. The design criteria were developed based on chlorine residual and bacteria sampling results at Puritan-Fenkell and Hubbell-Southfield CSO Detention Basins and Conner Creek Pilot CSO Control Facility CT test results.
- Average ICT – represents achieving inactivation goal to reduce average undisinfected fecal coliform to half of the recreational seasonal bacteria limit (200 CFU/100 mL), which results in a lower chlorine dose requirements than the High ICT condition.
- High ICT – represents achieving inactivation goal to reduce maximum measured fecal coliform value to half of the recreational seasonal bacteria limit (200 CFU/ 100 mL), which results in a higher chlorine dose requirements than the Average ICT condition.
- Draw Fill – represents low flow conditions where the influent flow is close to the minimum storm pump flow resulting in periodic cycling of the small storm pumps that draws down the wet well and portions of the upstream conduit. This mode of operation commonly occurs with relatively small storm events that do not produce enough volume to trigger an outfall event. This mode of operation results in indeterminately long contact times rather than a continuous flow mode.

To calculate the required sodium hypochlorite storage for the ICT method, the design storm volumes were partitioned into the first flush volume and remaining storm volume (i.e., post first flush volume). The high ICT dose was used to calculate the required storage associated with the first flush portion of the design storm volume and the average ICT dose was used to calculate the

required storage for the post first flush design storm volume. This approach accounts for the poor water quality experienced during the first flush and estimates the impacts on chemical storage requirements. The required sodium hypochlorite for the first flush, post first flush, and total design storm volume are shown in **Table 3-7**.

Table 3-7 Summary of Required Storage at Oakwood Under Various Design Conditions

Parameter ¹	Units	Current Collection System Conditions		Future Collection System Conditions	
		Ex. Condition	Baffle Alternative	Ex. Condition	Baffle Alternative
Design Storm Type	-	Average Design Storm: 6-month, 24-hour			
Average Design Storm Volume	MG	16.5	16.5	92.3	92.3
First Flush Storm Volume	MG	3.5	3.5	19.0	19.0
High ICT Dose	mg/L	14.0	12.3	14.0	12.3
10.5% Hypo Required First Flush	gal	465	411	2,528	2,236
Post First Flush Storm Volume	MG	13.0	13.0	73.3	73.3
Avg ICT Dose	mg/L	7.4	6.7	7.4	6.7
10.5% Hypo Required Post First Flush	gal	911	828	5,137	4,668
Total 10.5% Hypo Required	gal/design storm	1,376	1,239	7,665	6,904
Design Storm Type	-	Peak Design Storm: 10-year, 24-hour			
Average Design Storm Volume	MG	80.5	80.5	368.3	368.3
First Flush Storm Volume	MG	12.3	12.3	65.7	65.7
High ICT Dose	mg/L	14.0	12.3	14.0	12.3
10.5% Hypo Required First Flush	gal	1,634	1,445	8,728	7,719
Post First Flush Storm Volume	MG	68.2	68.2	302.6	302.6
Avg ICT Dose	mg/L	7.4	6.7	7.4	6.7
10.5% Hypo Required Post First Flush	gal	4,782	4,345	21,216	19,278
Total 10.5% Hypo Required	gal/design storm	6,416	5,790	29,944	26,997

¹All sodium hypochlorite concentration presented are trade percent by weight.

The required storage volumes calculated from the original BOD, as-built, and this disinfection evaluation design criteria are shown in **Table 3-8**.

Table 3-8 Summary of Required Storage at Oakwood Under Various Design Conditions

Parameter	Units	Original BOD	Partitioned Design Storm ICT				Draw Fill	
			Current Collection System Conditions		Future Collection System Conditions		Current Collection System Conditions	Future Collection System Conditions
		Ex. Condition	Ex. Condition	Baffle Alternative	Ex. Condition	Baffle Alternative	Ex. Condition	Ex. Condition
Design Hypo Concentration	% ¹	5.0	10.5				10.5	
CT or ICT	mg-min/L	125	120 (high ICT), 50 (avg ICT)				n/a	
Chlorine Dose	mg/l	12.0	14.0 (high ICT) 7.4 (avg ICT)	12.3 (high ICT) 6.7 (avg ICT)	14.0 (high ICT) 7.4 (avg ICT)	12.3 (high ICT) 6.7 (avg ICT)	7.0	7.0
Average Design Storm Type	-	10-year, 1-hour	6-month, 24-hour				6-month, 24-hour	
Number of Design Storms	No.	Two Storms in Rapid Succession	Two Storms in Rapid Succession				Two Storms in Rapid Succession	
Average Storm Volume	MG	48.5	17	17	92	92	17	92
Two Average Design Storms Required Hypo Storage	gal	23,000	2,753	2,479	15,330	13,807	2,200	12,300
Peak Design Storm Type	-	7-Day CSO Max	10-year, 24-hour				10-year, 24-hour	
Number of Design Storms	No.	One Storm	One Storm				One Storm	
Peak Storm Volume	MG	98	81	81	368	368	81	368
One Peak Design Storm Required Hypo Storage	gal	23,600	6,416	5,790	29,944	26,997	5,400	24,600

¹ trade percent by weight

Figure 3-14 through **Figure 3-16**, show the required storage volume under the various design conditions in comparison to the existing storage volume and modified/expanded storage volumes. The red lines represent the existing storage volume (solid red line) and the available storage if the existing tanks were replaced with larger tanks with limited or no modification to the existing storage room (dotted red line). The modified/expanded storage volume (dotted red line) is only shown on the peak design storm graph as this condition dictates the chemical storage requirements (i.e., storage requirements for one peak design storm is greater than two average design storms). The storage alternatives may not be applicable to all design conditions but rather serve as a comparison to contextualize the required storage volume in comparison to the existing storage tanks.

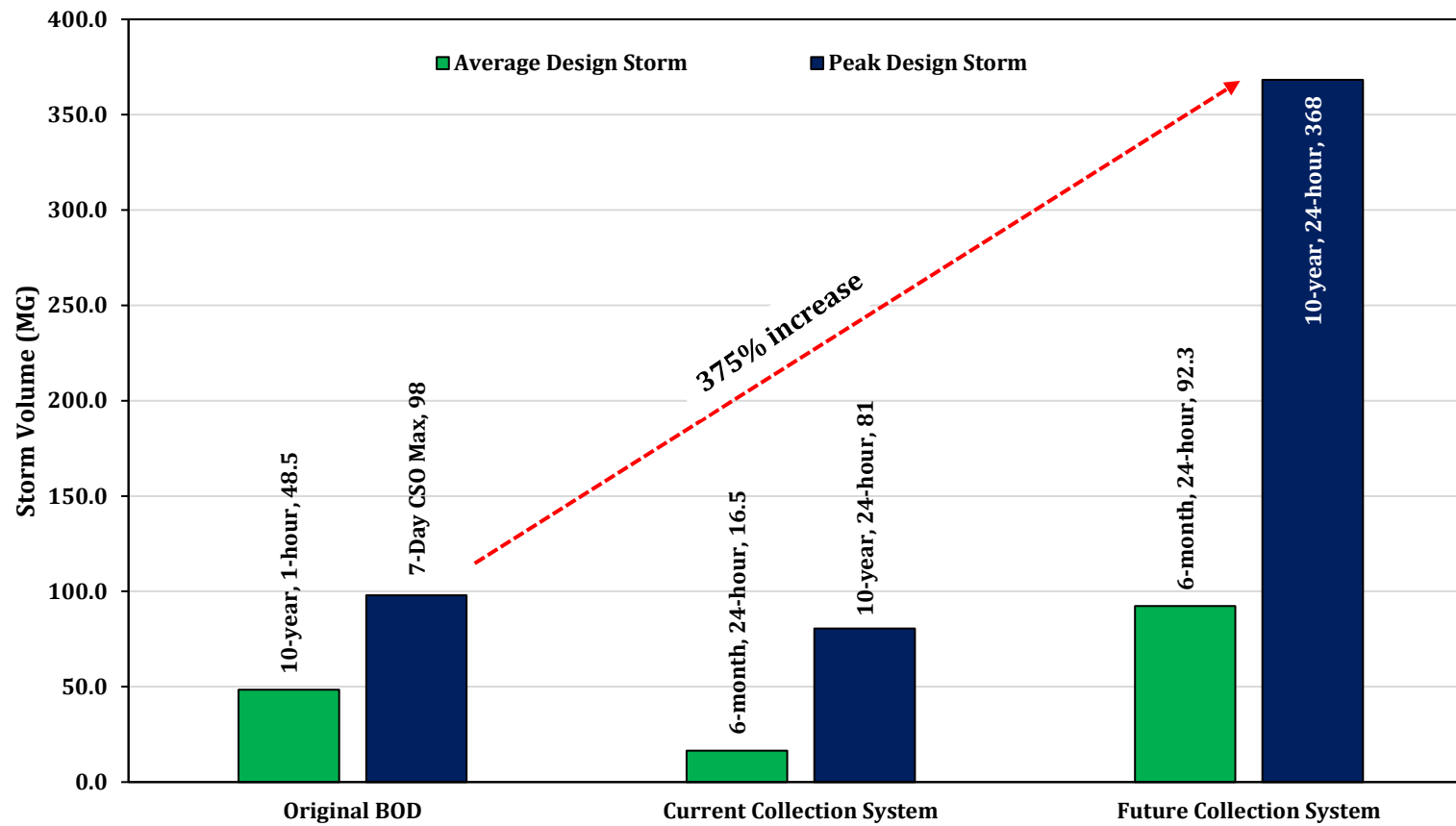


Figure 3-14
Oakwood Design Storm Comparison

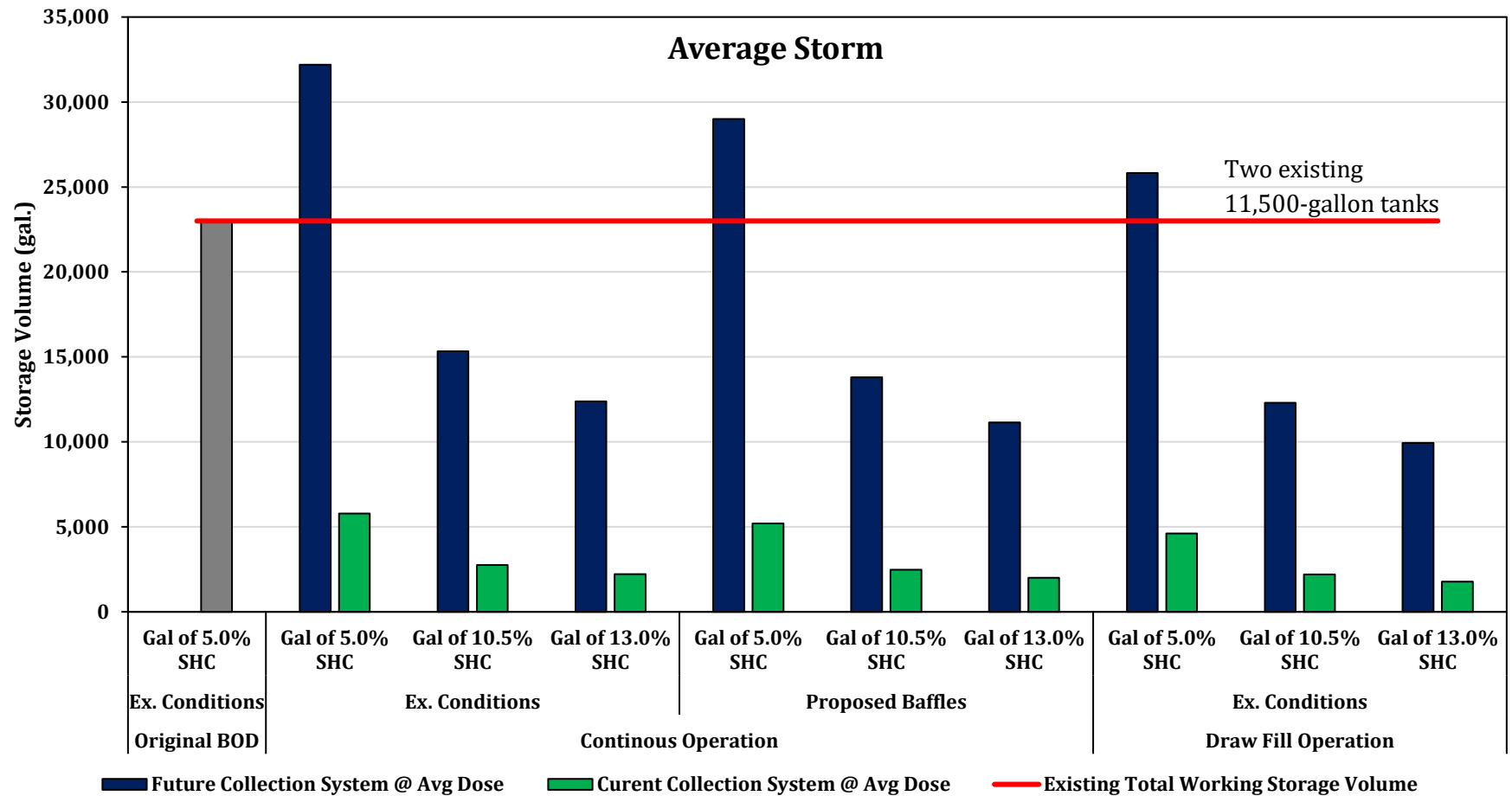


Figure 3-15
Oakwood Sodium Hypochlorite Storage Requirements for Current and Future Collection System Average Design Storm

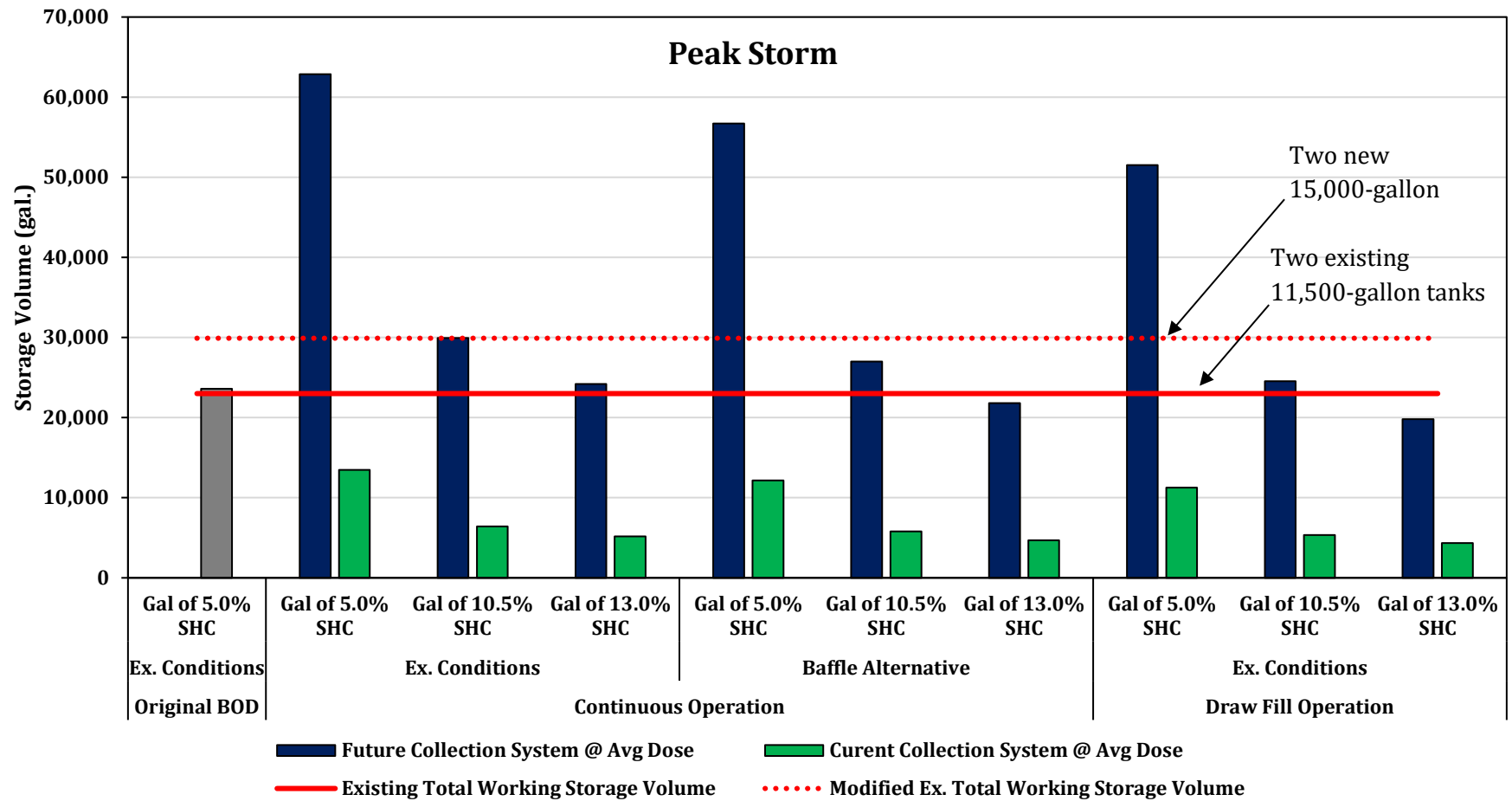


Figure 3-16
Oakwood Sodium Hypochlorite Storage Requirements for Current and Future Collection System Peak Design Storm

The key takeaways from the storage evaluation are:

- The primary driver for the increase in required sodium hypochlorite storage is an increase in the projected future flow (see **Figure 3-14**) associated with the connection of the proposed ODIRS. For example, the original BOD had a peak design storm volume of 98 MG (7-day CSO max.) and the future collection system peak design storm volume for this evaluation is 368 MG (10-year, 24-hour storm), which is a 375% increase in volume.
- Average Design Storm (two events)
 - The existing chemical storage tanks provide sufficient storage to treat two current collection system average design storms with 5.0 to 13.0% (trade percent by weight) sodium hypochlorite concentration (see **Figure 3-15**).
 - If sodium hypochlorite concentration is greater than 5.0% (trade percent by weight), the existing chemical storage tanks provide sufficient storage to treat two future collection system average design storms (see **Figure 3-15**).
- Peak Design Storm (one event)
 - The storage requirements for a single peak design storm are greater than the storage requirements for two average design storm events; therefore, the single peak design storm dictates the maximum storage requirement.
 - There is sufficient storage to treat one current collection system peak design storm (5.0% to 13.0% trade percent by weight)
 - With 10.5 % (trade percent by weight) sodium hypochlorite, replacing the existing chemical storage tanks with two larger chemical storage tanks will provide enough chemical storage to meet the future collection system peak design storm demand (see **Figure 3-16**).
 - Installing baffles in the CSO basins could reduce the storage requirement by approximately 3,000 gallons; however, the existing storage tanks would still need to be replaced with larger tanks (see **Figure 3-16**).
 - The SOP should be updated when the ODIRS is connected to replenish sodium hypochlorite when the concentration is less than 10% (trade percent by weight) to meet future collection system storm event storage requirements.
- Additional undisinfected bacteria and chlorine demand sampling and testing will help further refine the high ICT and average ICT values.

The challenges associated with installing new larger sodium hypochlorite storage tanks at the existing facility are discussed in Section 4.

3.2.1.2 Oakwood Chemical Feed Evaluation

The sodium hypochlorite feed rate requirements were established based on the minimum and maximum feed requirements across the full range of design conditions (min flow to design peak flow, sodium hypochlorite concentration of 5% to 13% (trade percent by weight) and min to high ICT). The full facility sodium hypochlorite feed requirements are shown in **Table 3-9**.

- The minimum and maximum feed requirement at Oakwood are 0.4 gpm and 126.0 gpm, respectively. This represents a very large turndown ratio (315:1), which will need to be accounted for in the chemical feed alternatives.
 - Sizing of flow control valves and chemical feed recirculation pumps will be completed in the BOD phase based on system feed rate.
- Adding baffles would reduce the maximum feed requirements by approximately 15% (126.0 gpm no baffles to 107.1 gpm with baffles). Reductions in the minimum feed requirement would be negligible (~5%).
- Updating the SOP to replenish the sodium hypochlorite concentration when it falls below 10.5% and not allowing the sodium hypochlorite to reach 5% reduces the maximum feed rate by roughly half (264.7 gpm to 126.0 gpm)

Table 3-9 Summary of Total Sodium Flows Requirements at Oakwood

Parameter	Units	Current Collection System Average	Future Collection System Average
Min Flow	gpm	0.4 ³	0.4 ³
Average Flow	gpm	2.8 ²	16.4 ²
Peak Flow	gpm	113.1 ¹	126.0 ²

¹sodium hypochlorite concentration of 5.0%, high ICT

²sodium hypochlorite concentration of 10.5%, average ICT

³sodium hypochlorite concentration of 13.0%, low ICT

3.2.2 Leib

The required dose calculated at each design flow is shown in **Table 3-10**.

Table 3-10 Summary of Design Flows and Chlorine Dose Requirements at Leib

Parameter	Units	Design Peak	Future Collection System Max	Current Collection System Max	Future Collection System Average	Current Collection System Average	Current Collection System Min
Flow	mgd	1,290	613	335	245	76	32
Effective Contact Time	min	9.5	14.1	18.8	21.9	39.3	73.5 ¹
Assumed Average to High Chlorine Demand and Decay	mg/L	2.5	2.5	3.7	3.7	4.8	4.8
Low Chlorine Demand and Decay	mg/L	1.2	1.2	1.2	1.2	1.2	1.2
High ICT (142)							
TRC Required	mg/L	14.9	10.0	7.5	6.5	3.6	1.9
Chlorine Dose	mg/L	17.4	12.5	11.2	10.1	8.4	6.7
Avg ICT (50)							
TRC Required	mg/L	5.2	3.5	2.7	2.3	1.3	0.7
Chlorine Dose	mg/L	7.7	6.0	6.3	5.9	6.0	5.4
Low ICT (20)							
TRC Required	mg/L	2.1	1.4	1.1	0.9	0.5	0.3
Chlorine Dose	mg/L	3.3	2.6	2.3	2.1	1.7	1.5

¹Contact volume calculated using linear interpolation of model results for other flow conditions assuming sodium hypochlorite is added at prechlorination application points at 50 cfs in anticipation of storm event (based on GLWA staff feedback on facility operation).

The TRC required is based on the existing sampling station located at the outfall. The TRC required for the current collection system average and minimum design storm flows are generally in alignment with the NPDES TRC operational goals (1.5 mg/L event average, 2.0 mg/L November – April and 3.0 mg/L May – October event instantaneous maximum). Under current collection system average flow conditions and with an average ICT, the TRC required at the end of the CSO basins meets the NPDES TRC operational goals. The required TRC increases as storm flows increase and the effective contact times decrease. The ICT values can be refined through additional testing, particularly during high flow events once the proposed Meldrum connection is constructed, which may reduce the TRC required.

The low ICT value will be used to define the minimum chemical feed requirements and equipment sizing. The low ICT value is not used for chemical storage sizing. The high and average ICT values represent the normal to high range in anticipated chemical dose requirements for appropriately sizing the chemical storage tanks.

The average maximum chlorine demand value of 4.8 mg/L (average of maximum chlorine demand values, 3.0, 4.3, and 7.0 mg/L) was assigned to the current collection system minimum design storm (32 mgd) to account for the less dilute sewerage flows. Conversely, the minimum chlorine demand value of 2.5 mg/L (median of minimum chlorine demand values, 2.5, 2.5, and 1.9 mg/L) was assigned to the future collection system max (613 mgd) and design peak storm flows (1,290 mgd) to account for the dilution of the sewerage flow with increased storm flows. The chlorine demand response data is included in TM-18. Similar to the approach with Oakwood, the required chlorine doses were averaged for each design condition and these values were used as the basis for calculating the required sodium hypochlorite storage. The average required chlorine doses are shown in **Table 3-11**.

Table 3-11 Average Required Chlorine Dose at Leib

Parameter	Units	Required Chlorine Dose
High ICT	mg/L	11.1
Avg ICT	mg/L	6.3

3.2.2.1 Leib Chemical Storage Evaluation

The following design bases were evaluated to compare the required storage volumes. The original BOD and as-built scenarios were included in the evaluation to compare the proposed design criteria with the original BOD and as-built design criteria and resulting sodium hypochlorite storage requirements.

- Original BOD – represents the original design criteria from CS-1285 *Leib and St. Aubin Screening and Disinfection Facilities Basis of Design Report*, which was derived from chlorine dose response testing.
- As Built Condition – represents the as constructed design criteria which is different from the BOD. Specifically, the chlorine dose was 25 mg/L in the original BOD and was revised to 10 mg/L (as documented in the 2005 O&M manual) as a result of chlorine dose response testing completed after the BOD report but before the detailed design was completed. This reduced the required storage volume by about 250%.
- Average ICT – represents achieving inactivation goal to reduce average undisinfected fecal coliform to half of the recreational seasonal bacteria limit (200 CFU/100 mL), which results in a lower chlorine dose requirements than the High ICT condition.
- High ICT – represents achieving inactivation goal to reduce maximum measured fecal coliform value to half of the recreational seasonal bacteria limit (200 CFU/ 100 mL), which results in a higher chlorine dose requirements than the Average ICT condition.

The same approach to calculating the required sodium hypochlorite storage as Oakwood was applied to Leib (i.e., ICT method partitioning the first flush volume and post first flush volume). The

required sodium hypochlorite for the first flush, post first flush, and total design storm volume are shown in **Table 3-12**.

Table 3-12 Summary of Required Storage at Leib Under Various Design Conditions

Parameter ¹	Units	Current Collection System Conditions	Future Collection System Conditions
Design Storm Type	-	Average Design Storm: 6-month, 24-hour	
Average Design Storm Volume	MG	21.2	53.9
First Flush Storm Volume	MG	4.3	10.8
High ICT Dose	mg/L	11.1	11.1
10.0% Hypo Required First Flush	gal	475	1,197
Post First Flush Storm Volume	MG	16.9	43.1
Avg ICT Dose	mg/L	6.3	6.3
10.0% Hypo Required Post First Flush	gal	1,056	2,689
Total 10.0% Hypo Required	gal/design storm	1,531	3,887
Design Storm Type	-	Peak Design Storm: 10-year, 24-hour	
Average Design Storm Volume	MG	185.4	366.6
First Flush Storm Volume	MG	5.4	37.1
High ICT Dose	mg/L	11.1	11.1
10.0% Hypo Required First Flush	gal	597	4,098
Post First Flush Storm Volume	MG	180	329.5
Avg ICT Dose	mg/L	6.3	6.3
10.0% Hypo Required Post First Flush	gal	11,242	20,579
Total 10.0% Hypo Required	gal/design storm	11,839	24,678

¹All sodium hypochlorite concentration presented are trade percent by weight.

The required storage volumes calculated from the original BOD, as-built, and this disinfection evaluation design criteria are shown in **Table 3-13**.

Table 3-13 Summary of Required Storage at Leib Under Various Design Conditions

Parameter	Units	Original BOD	As-Built Condition	Partitioned Design Storm ICT	
				Current Collection System Conditions	Future Collection System Conditions
Design Hypo Concentration	% ¹	10.0	10.0	10.0	
CT or ICT	mg-min/L	²	²	142 (high ICT), 50 (avg ICT)	
Chlorine Dose	mg/L	25.0	10.0	11.1 (high ICT), 6.3 (avg ICT)	11.1 (high ICT), 6.3 (avg ICT)
Average Design Storm Type	-	10-year, 1-hour	10-year, 1-hour	6-month, 24-hour	
Number of Design Storms	No.	Two Storms in Rapid Succession	Two Storms in Rapid Succession	Two Storms in Rapid Succession	
Average Design Storm Volume	MG	131	131	21.2	53.9
Two Average Design Storms Required Hypo Storage	gal.	49,000	19,000	3,061	7,774
Peak Design Storm Type	-	7-Day CSO Max	7-Day CSO Max	10-year, 24-hour	
Number of Design Storms	No.	One Storm	One Storm	One Storm	
Peak Storm Volume	MG	225	225	185.4	366.6
One Peak Design Storm Required Sodium Hypochlorite Storage		56,000	22,000	11,839	24,678

¹ trade percent by weight

²CT values were not include in the BOD (*CS-1285 Basis of Design Report Leib & St. Aubin Screening & Disinfection Facilities*) or as-built documentation (*Leib Screening and Disinfection Facility Operation and Maintenance Manual*) for Leib

Figure 3-17 through **Figure 3-19**, show the required storage volume under the various design conditions in comparison to the existing storage volume and modified/expanded storage volumes. The red lines represent the existing storage volume (solid red line) and the available storage if the existing tanks were replaced with larger tanks with limited or no modification to the existing storage room (dotted red line). The modified/expanded storage volume (dotted red line) is only shown on the peak design storm graph as this condition dictates the chemical storage requirements (i.e., storage requirements for one peak design storm is greater than two average design storms). The storage alternatives may not be applicable to all design conditions but rather serve as a comparison to contextualize the required storage volume in comparison to the existing storage tanks.

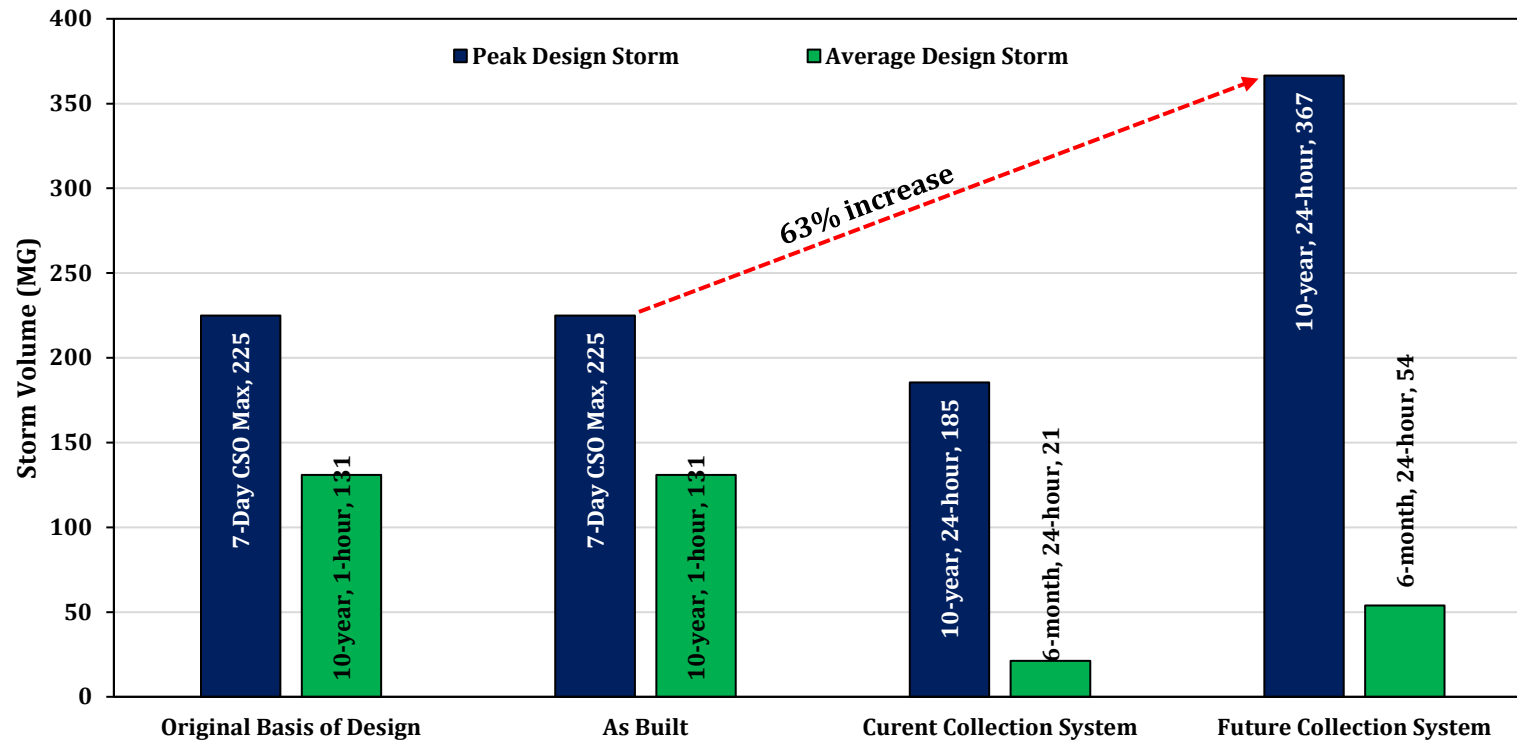


Figure 3-17
Leib Design Storm Comparison

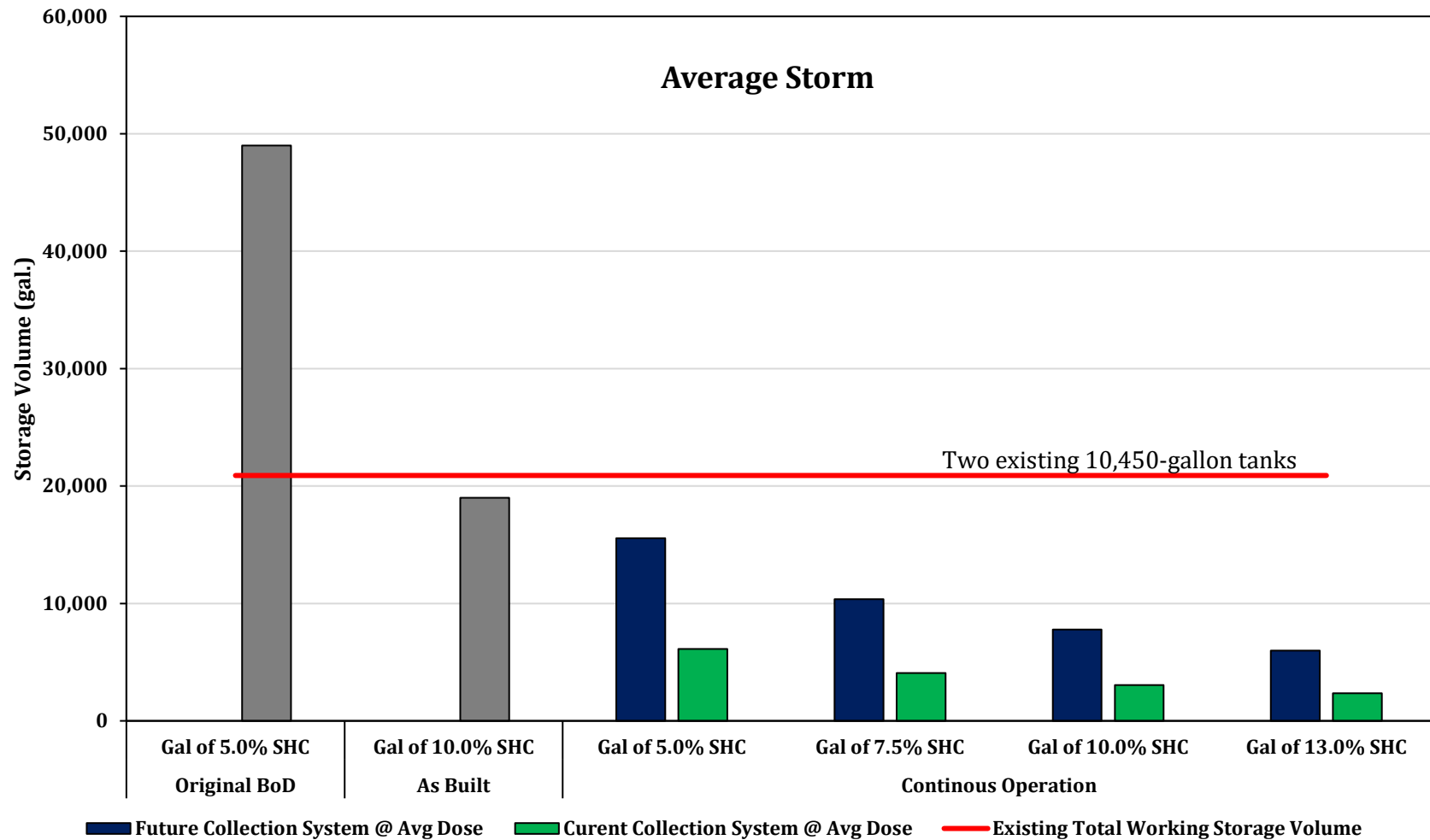


Figure 3-18
Leib Sodium Hypochlorite Storage Requirements for Current and Future Collection System Average Design Storm

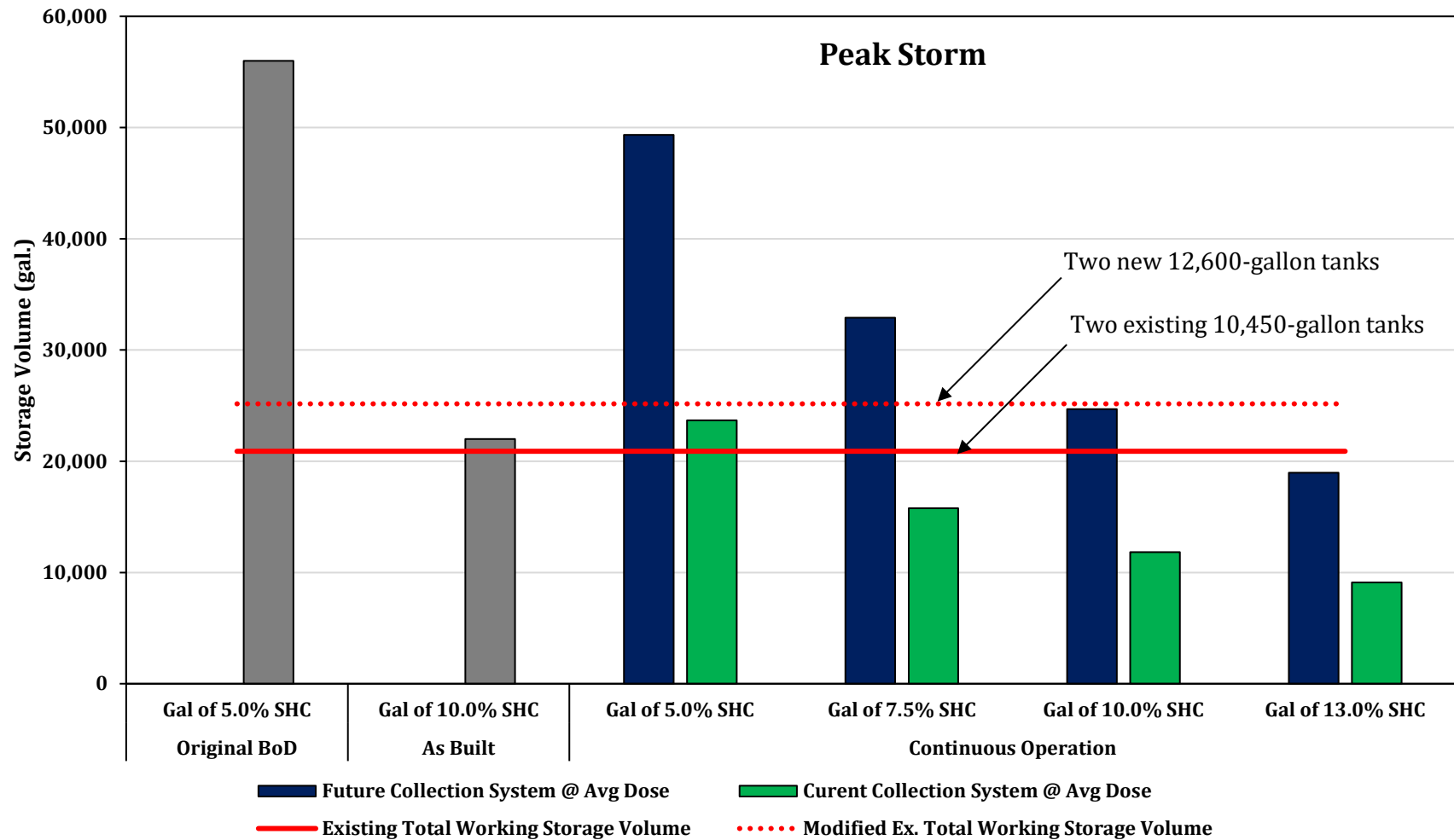


Figure 3-19
Leib Sodium Hypochlorite Storage Requirements for Current and Future Collection System Peak Design Storm

The key takeaways from the storage evaluation are:

- The primary driver for the increase in required sodium hypochlorite storage is an increase in the projected future collection system flow (see **Figure 3-17**). For example, the original BOD had a peak design storm volume of 225 MG (7-day CSO max.) and the future collection system peak design storm volume for this evaluation is 367 MG (10-year, 24-hour storm), which is a 63% increase in volume.
- Average Design Storm (two events)
 - The existing chemical storage tanks provide sufficient storage for two current or future collection system average design storms for all conditions evaluated (5.0 to 13.0% trade percent by weight) sodium hypochlorite by weight, see green bars in **Figure 3-18**.
- Peak Design Storm (one event)
 - The storage requirements for a single peak design storm are greater than the storage requirements for two average design storm events; therefore, the single peak design storm will dictate the maximum storage requirement.
 - There is sufficient storage to meet current collection system peak design storm demands down to nearly 5% (trade percent by weight) concentration (see blue bars in **Figure 3-19**).
 - There is not enough storage to meet future collection system peak design storm demands (see blue bars in **Figure 3-19**). At 10.0% (trade percent by weight), two new larger capacity storage tanks (~12,600-gallon tanks) would be required.
 - The SOP should be updated to replenish sodium hypochlorite when the concentration is less than 10% (trade percent by weight) to help meet future collection system storm event storage requirements.
- Additional undisinfected bacteria and chlorine demand sampling and testing will help further refine the high ICT and average ICT values.

The challenges associated with installing new larger sodium hypochlorite storage tanks at the existing facility are discussed in Section 4.

3.2.2.2 Leib Chemical Feed Evaluation

The sodium hypochlorite feed rate requirements were established based on the minimum and maximum feed requirements across the full range of design conditions (min flow to design peak flow, sodium hypochlorite concentration of 5% to 13% (trade percent by weight) and min to high ICT). The full facility sodium hypochlorite feed rate requirements are shown in **Table 3-14**.

- The minimum and maximum feed requirement at Leib are 0.3 gpm and 74.0 gpm, respectively. This represents a very large turndown ratio, which will need to be accounted for in the chemical feed alternatives.
- Sizing of flow control valves and chemical feed recirculation pumps will be completed in the BOD phase based on system feed rate.
- Updating the SOP to replenish the sodium hypochlorite concentration when it falls below 10.0% (trade percent by weight) reduces the maximum feed rate by half (148 gpm to 74 gpm)

Table 3-14 Summary of Total Sodium Hypochlorite Feed Rate Requirements at Leib

Parameter	Units	Current Collection System Average	Future Collection System Average
Min Flow	gpm	0.3 ³	0.3 ³
Average Flow	gpm	3.2 ²	10.1 ²
Peak Flow	gpm	52.2 ¹	74.0 ²

¹sodium hypochlorite concentration of 5.0%, high ICT

²sodium hypochlorite concentration of 10.0%, average ICT

³sodium hypochlorite concentration of 13.0%, low ICT

A comparison of the historic and proposed sodium hypochlorite usage (lbs/MG) is shown in **Table 3-15**. The historic usage is based on historic storm event data and sodium hypochlorite storage tank levels from GLWA's SCADA system and GLWA's bleach report test results. The proposed sodium hypochlorite usage is based on the chlorine dose response testing results, ICT values, and portioning of the design storm first flush and post first flush storm volumes. For Oakwood, the proposed ICT method would result in a 105% difference (320% decrease) for the existing basins without the baffle alternative or approximately 112% difference (353% decrease) with the baffle alternative installed in the existing basins. For Leib, there is virtually no difference in proposed and historic sodium hypochlorite usage.

Table 3-15 Comparison of Historic and Proposed Sodium Hypochlorite Usage

Parameter	Units	Oakwood	Leib
Average Historic Sodium Hypochlorite Usage ¹	lbs/MG	230	58
Proposed Sodium Hypochlorite Usage ²	lbs/MG	72 (existing basins without baffles) 65 (with baffle alternative)	58
Percent Reduction	%	105 (existing basins without baffles) 112 (with baffle alternative)	0

¹historic data from **Figures 3-8 and 3-9**, usage based on proportioned ICT method with high ICT for first flush storm volume and average ICT for post first flush storm volume.

²usage based on proportioned ICT method with high ICT for first flush storm volume and average ICT for post first flush storm volume, averaged usage across design storms (6-month, 24-hour,10-year, 24-hour)

The relatively large difference between historic and proposed sodium hypochlorite usage at Oakwood (105 to 112% different) is largely a function of the average historic sodium hypochlorite at Oakwood being considerably higher (230 lbs/MG) than the historic average at Leib (58 lbs/MG). By reducing the amount of sodium hypochlorite (lb.) added per a unit storm volume (MG) while maintaining disinfection compliance, GLWA can optimize the sodium hypochlorite feed system, reduce sodium hypochlorite usage, and ultimately reduce operating cost.

4.0 Description of Alternatives

The following sodium hypochlorite feed alternatives were evaluated:

- Recirculation loop with control valves (Section 4.1)
- Gravity feed with control valves (Section 4.2)
- Metering pumps (Section 4.3)
 - Gear pumps
 - Diaphragm pumps
 - Peristaltic pumps

Each alternative is described in the following subsections.

Per the scope of work, the “status quo” option for keeping or replacing in kind the existing chemical feed system at Oakwood and Leib was not evaluated as the existing chemical feed systems do not meet project goals (simplify feed system, improve maintenance access, increase turndown capability, replace aging, unreliable, and/or expensive to maintain existing feed equipment, etc.).

As discussed in Section 3, the existing sodium hypochlorite storage tanks do not provide adequate storage for the future collection system peak design storm and will need to be replaced in coordination with proposed collection system modifications. Accordingly, keeping the existing storage tanks was not considered as an alternative; however, the existing storage tanks can be used until the proposed collection system modifications are substantially completed. Installing new larger capacity tanks within the existing chemical storage rooms at each facility was evaluated because expanding the existing chemical storage rooms and providing additional tanks was not warranted based on the results of the chlorine dose response testing and design storm evaluations. The installation of the new larger capacity tanks is discussed in additional detail in Section 4.4.

4.1 Recirculation Loop with Centrifugal Pumps and Flow Control Valves

A recirculation loop system consisting of centrifugal sealless, magnetic drive pumps with a common discharge and suction header (with redundant backup discharge header), and motorized flow control valves (FCV) at each feed point is recommended as an alternative to the existing chemical feed systems at both Oakwood and Leib for the following reasons.

Flow and head capacity:

- Pumps can provide up to 1,450 gpm and 490 feet of head (maximums are mutually exclusive), which provides sufficient flow capacity and head for Oakwood and Leib's feed systems (current and predicted future flows).
- The recirculation loop can require up to four times the design flow to maintain adequate pressure and flow across the discharge header under the various design conditions. The recirculation loop flow requirements will be further evaluated through detailed hydraulic modeling during the preliminary design phase.
- Provides the ability to reduce the number of feed pumps and simplify O&M activities.

Materials of construction:

- This type of pump is offered with non-metallic materials of construction with excellent resistance to sodium hypochlorite (<20% trade percent by weight).
 - Fiberglass reinforced plastic (FRP)
 - Glass-fiber reinforced polypropylene (GF PP)
 - Carbon-fiber reinforced PVDF (CF PVDF)

Flow control valve considerations:

- **Turndown limitations:** The turndown capacity and ability to meet low flow requirements is largely dictated by the FCV stroke. Typically, FCV can achieve a turndown of 50:1.

- **Accuracy and Repeatability:** high-performance FCV can provide consistent flow across a broad range of flows and pressures.
- **Reliability:** FCV operate on the basic principle of restricting flow through a select orifice size to induce a specific headloss resulting in a corresponding flow

The valve will need a minimum 10% stroke to ensure adequate flow control is provided under the low flow condition. The FCV will need a large turndown capacity (typically 1:50 or greater) within the recommended percent valve opening (10% to 90% of stroke rule of thumb) to provide sufficient operational flexibility and meet low and high flow requirements. These requirements will need to be carefully evaluated and coordinated with valve manufacturers throughout design progression to verify the FCVs can reliably meet the design requirements. This approach to chemical feed with a recirculation loop and FCVs was discussed and recommended in CS-299 CSO Facilities Assessment. The advantages and disadvantages associated with this chemical feed alternative are shown in **Table 4-1**.

Table 4-1 Advantages and Disadvantages for Chemical Feed Recirculation Loop with Centrifugal Pumps and Flow Control Valves

Advantages	Disadvantages
Simplifies sodium hypochlorite feed system by reducing the number of pumps, which may provide additional space for operation and maintenance activities in the existing chemical storage and feed rooms	High performance FCVs for sodium hypochlorite application can be costly. Opportunities to use less costly valves with downstream backpressure valves can be further evaluated through design progression.
Offers excellent chemical compatibility with non-metallic materials of construction to extend service life	Numerous valves and actuators that will require maintenance to ensure accurate flow control
FCVs offer large turndown capacity (typically 1:50)	Backup manual flow control would be complex when multiple storm pumps are active
By reducing the number of pumps, centrifugal pumps can be less maintenance intensive than gear, diaphragm, and hose pumps.	Chemical feed recirculation loops are used throughout the water and wastewater industry for sodium hypochlorite applications; however, not to the same degree as gear, diaphragm, and hose pumps (i.e., less industry experience to leverage).
Maintains existing chemical feed system redundancy (n+1)	
Reduction in number of pumps will reduce capital, operation, and maintenance costs	
GLWA staff at Oakwood and Leib are experienced with the operation and maintenance of centrifugal pumps.	

4.2 Gravity Feed with Control Valve

This alternative utilizes the gravity head available between the liquid level in the chemical storage tank and the elevation of injection location and FCV for chemical feed. **Figure 4-1** shows the simple schematic of the gravity feed with control valve alternative. The motor actuated control valve could be a typical FCV used for accuracy, reliability, and repeatability. The FCV will need to have

minimum 10% stroke for controllability for the low flow condition. Manufacturers recommended having a minimum 3 psig pressure drop across the valve and a minimum 5 psig upstream pressure for reliable, accurate and repeatable flow control.

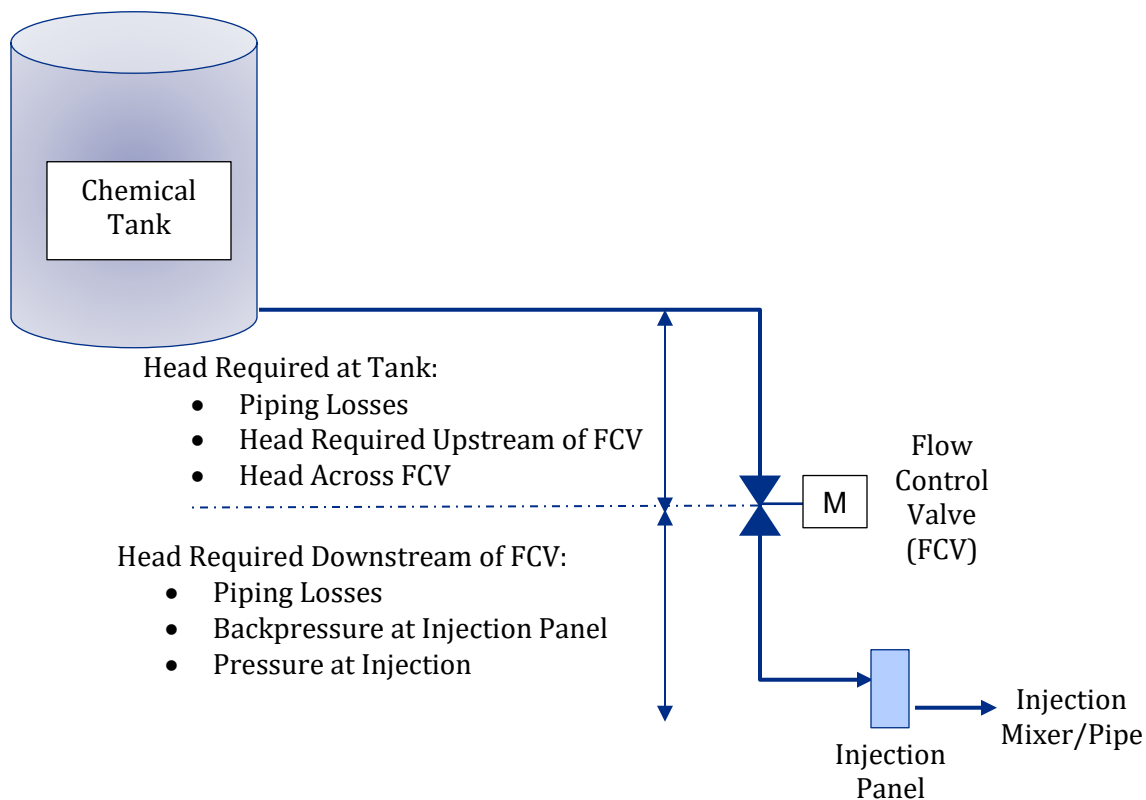


Figure 4-1
Gravity Flow Control Valve Alternative Schematic

Table 4-2 summarizes the pressure needed upstream and downstream of the FCV and respective FCV elevation and the tank minimum liquid levels required for use of gravity FCV. The lack of valve upstream pressure generated with a gravity feed do not make the application feasible.

Table 4-2 Gravity Flow Control Valve Feasibility

Parameters	Units	Oakwood Facility	Leib Facility
Assumed Pressure at Injection	psig	15.7	--
Assumed Minimum Back Pressure at Injection Mixer Panel	psig	10	10
Assumed Piping Losses from FCV to the Mixer Panel	psig	2	2
<i>Pressure Needed Downstream of FCV (Subtotal of Pressure Needed Downstream of FCV)</i>	<i>Psig/Ft</i>	<i>27.7/64</i>	<i>12/27.7</i>
Pressure Drop Across FCV Needed for Appropriate Valve Sizing	psig	3	3
Assumed Piping Losses from Chemical Storage Tank to FCV	psig	3	3
Total Pressure Difference from Tank Liquid Level to Injection Location	psig/Ft	33.7/77.8	18.0/41.6
Injection Panel Location Approximate EL	Ft	92.0	120.0
Minimum Liquid Level Needed EL	Ft	169.8	161.6
Existing Chemical Tank Approximate Maximum Liquid Level EL	Ft	114.0	147.5
Existing Chemical Tank Approximate Minimum Liquid Level EL	Ft	103.8	138.5
<i>Feasible by Gravity Flow?</i>		<i>No</i>	<i>No</i>

Note: 1. Pressures and elevations are assumed approximately for the feasibility evaluation.

A safety factor will need to be added in the required gravity head for the accurate and reliable chemical application. As presented in **Table 4-2**, gravity feed with FCVs is not feasible a feasible option for disinfection application at both Oakwood and Leib. Accordingly, the advantages and disadvantages associated with this chemical feed alternative are not discussed.

4.3 Metering Pumps

Metering pumps discharge a known volume of chemical per pump action, are commonly used in chemical injection applications, and are presently used at Leib (diaphragm pumps) and Oakwood (gear pumps). Gear, diaphragm, and peristaltic pumps are discussed in the following subsections.

4.3.1 Gear Pumps

Gear pumps are used at Oakwood to feed sodium hypochlorite. GLWA reported the gear pumps perform well; however, rebuild cost is considerable because of the cost of the materials of construction. CDM Smith consulted with gear pump manufacturers to evaluate available alternative materials of construction that are compatible with sodium hypochlorite and available for pumps that provide adequate flow and head for the Leib and Oakwood feed systems.

Gear pumps are not recommended as an alternative for the following reasons:

- **Capacity limitations:** Seven of the existing ten gear pumps are the largest available gear pumps so opportunities to consolidate and simplify the existing gear pump-based feed system without sacrificing redundancy does not exist.
- **Materials of construction limitations:** Materials of construction vary with pump capacity based on available pump configurations and are summarized below. This list is not exhaustive and includes materials available from sampling of qualified pump manufacturers. Existing pumps are constructed of Hastelloy C wetted components, which appears to be the most cost-effective material of construction considering the desire to simplify chemical feed systems and reduce lifecycle costs.
 - **Titanium:** Titanium provides excellent resistance to sodium hypochlorite (<20% trade percent by weight). Only very small (<4 gpm) pumps are available with titanium wetted components.
 - **PTFE lined PVDF(Kynar):** PTFE and PVDF provide excellent resistance to sodium hypochlorite (<20% trade percent by weight). However, PTFE lined PVDF pumps have a maximum flow capacity of 33 gpm, which would require nearly the same pumps as the existing feed system to meet the maximum flow requirements.
 - **Hastelloy C:** Hastelloy C provides good sodium hypochlorite resistance (<20% trade percent by weight). Manufacturers only offer Hastelloy C wetted components for pumps large enough to meet the maximum flow requirements at Oakwood and Leib.
 - **Per- and polyfluoroalkyl (PFA) lined 316 Stainless Steel:** PFA offers excellent resistance to sodium hypochlorite (<20% trade percent by weight); however, once the lining fails the base material (316 stainless steel) offers poor resistance to sodium hypochlorite. Smaller pumps (<25 gpm) are available with PFA lined 316 stainless steel wetted components. The lining would have to be periodically inspected, which would require dismantling the pump head (i.e., additional O&M).

The advantages and disadvantages associated with this chemical feed alternative are shown in **Table 4-3**.

Table 4-3 Advantages and Disadvantages for Chemical Feed Using Gear Pumps

Advantages	Disadvantages
GLWA staff at Oakwood and Leib are experienced with the operation and maintenance of gear pumps.	Capacity limitations of gear pumps does not allow feed system to be simplified.
Gear pumps are used throughout the water and wastewater industry for sodium hypochlorite applications, which provides considerable industry knowledge and experience.	Materials of construction are relatively expensive and only Hastelloy C and PFA lined 316 stainless steel are offered in pumps with sufficient capacity to meet the feed requirements at Oakwood and Leib.
	Given multiple gear pumps are required to meet chemical feed requirements, gear pumps can be more maintenance intensive than centrifugal pumps.
	Multiple gear pumps will increase capital, operation, and maintenance cost in comparison to recirculation loop alternative.

4.3.2 Diaphragm Pumps

Diaphragm metering pumps are used at Leib. GLWA staff reported that the pumps perform relatively well. However, the chemical feed system is complex, crowded within the containment area, and pump maintenance is relatively expensive due to the materials of construction.

Diaphragm pumps are not recommended as an alternative due to capacity limitations, specifically:

- **Capacity limitations:** the maximum flow capacity of available diaphragm pumps (~40 gpm) is considerably lower than the required flow, which limits opportunities to reduce the number of pumps, decrease O&M cost, and chemical feed system complexity.

The advantages and disadvantages associated with this chemical feed alternative are shown in **Table 4-4**.

Table 4-4 Advantages and Disadvantages for Chemical Feed Using Diaphragm Metering Pumps

Advantages	Disadvantages
Materials of construction (e.g., glass filled PTFE) are robust and compatible with sodium hypochlorite (<20% trade percent by weight) allowing for reasonably long service life.	Capacity limitations of diaphragm metering pumps does not allow feed system to be simplified.
GLWA staff at Oakwood and Leib are experienced with the operation and maintenance of diaphragm pumps.	Given multiple diaphragm pumps are required to meet chemical feed requirements, diaphragm metering pumps can be more maintenance intensive than centrifugal pumps.
Diaphragm pumps are used throughout the water and wastewater industry for sodium hypochlorite applications, which provides considerable industry knowledge and experience.	Multiple diaphragm pumps will increase capital, operation, and maintenance cost in comparison to recirculation loop alternative.
	Materials of construction are relatively expensive

4.3.3 Peristaltic Pumps

Peristaltic pumps are not used a Leib or Oakwood; however, are a viable option in terms of flow capacity (up to 317 gpm) and materials compatibility (variety of compatible hose materials).

Peristaltic pumps are not recommended as an alternative for the following reasons:

Maintenance Challenges:

- Hoses can break which can:
 - Require staff to handle corrosive sodium hypochlorite in the pump head in order to replace the hose.
 - Require backup pump to maintain operations.
- Requires additional O&M in comparison to centrifugal and gear pumps:
 - Pulsation dampeners.
 - Bump pumps periodically for rotation to relieve pressure points that form when rollers sit idle and to keep the hose lubricated/wet so it does not dry out.
 - Replace hose periodically.

The advantages and disadvantages associated with this chemical feed alternative are shown in **Table 4-5**.

Table 4-5 Advantages and Disadvantages for Chemical Feed Using Peristaltic Metering Pumps

Advantages	Disadvantages
Wide variety of hose materials that are compatible with sodium hypochlorite (<20% trade percent by weight).	Peristaltic metering pumps can be more maintenance intensive than other metering pump options, particularly the hoses which can become a nuisance.
Capacity of peristaltic metering pumps allows the existing feed system to be simplified but not to the same degree at centrifugal pumps with a recirculation loop.	Given multiple peristaltic metering pumps are required to meet chemical feed requirements, peristaltic metering pumps can be more maintenance intensive than centrifugal pumps.
Peristaltic metering pumps are used throughout the water and wastewater industry for sodium hypochlorite applications, which provides considerable industry knowledge and experience.	Multiple peristaltic metering pumps will increase capital, operation, and maintenance cost in comparison to recirculation loop alternative.
Materials of construction are relatively inexpensive, although some hose materials can be costly and require relatively frequent replacement.	GLWA staff at Oakwood and Leib may not be as experienced with the operation and maintenance of peristaltic pumps as gear, diaphragm, or centrifugal pumps.

4.3 Alternatives Recommended for Analysis

4.3.1 Not Recommended Alternatives

The following alternative are not recommended for analysis at Oakwood and Leib:

- Gravity feed with control valve
- Gear pumps
- Diaphragm pumps
- Peristaltic pumps

4.3.2 Recommended Alternatives

The following alternatives are recommended for analysis at Oakwood:

- Recirculation loop with centrifugal pumps and FCVs

The following alternatives are recommended for analysis at Leib:

- Recirculation loop with centrifugal pumps and FCVs

4.4 Increasing Sodium Hypochlorite Storage Capacity

The chemical storage rooms at Oakwood and Leib are compact and installing larger tanks will be challenging. The existing tanks can be removed, and new tanks can be installed using the knockout walls at each facility. The sequence of construction and other constraints are discussed in additional detail in the following subsections.

4.4.1 Oakwood

The existing sodium hypochlorite storage room is shown in plan and section view in **Figure 4-2** and **Figure 4-3**. The two existing 11,500-gallon tanks are located on concrete tank pads and aligned with two 16 ft 0 in. x 16 ft-0 in. (length x width) removable wall systems (i.e., concrete masonry unit (CMU) knockout walls). Using taller storage tanks would preclude the need to modify the existing concrete tank pads to accommodate larger diameter tanks. Based on initial evaluations, it does not appear necessary to consider larger diameter tanks, which can be more difficult to ship and install within the existing chemical storage room. The new larger storage tanks would be taller tanks given the tight footprint of the existing room and limited space to increase the existing tank pads if needed to accommodate larger diameter tanks.

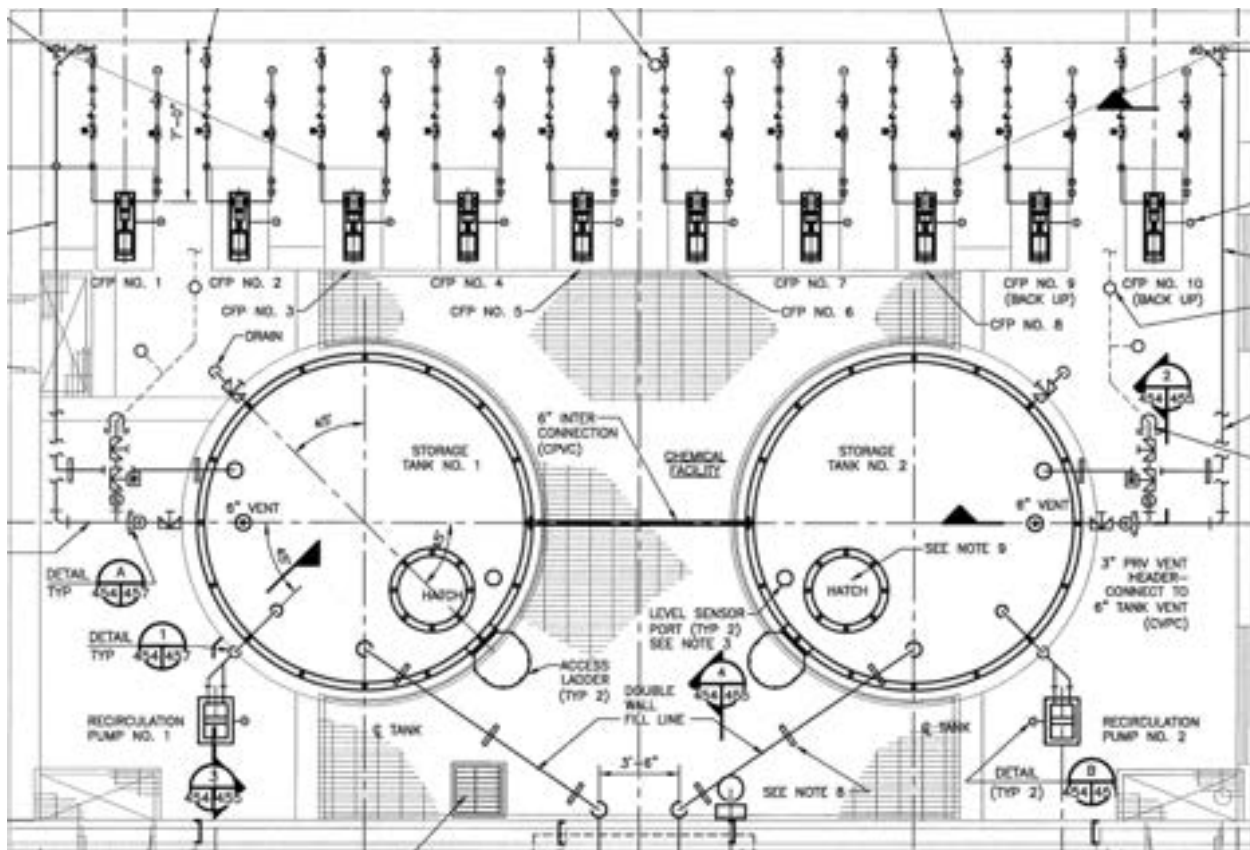


Figure 4-2
Existing Chemical Storage Room at Oakwood Plan View

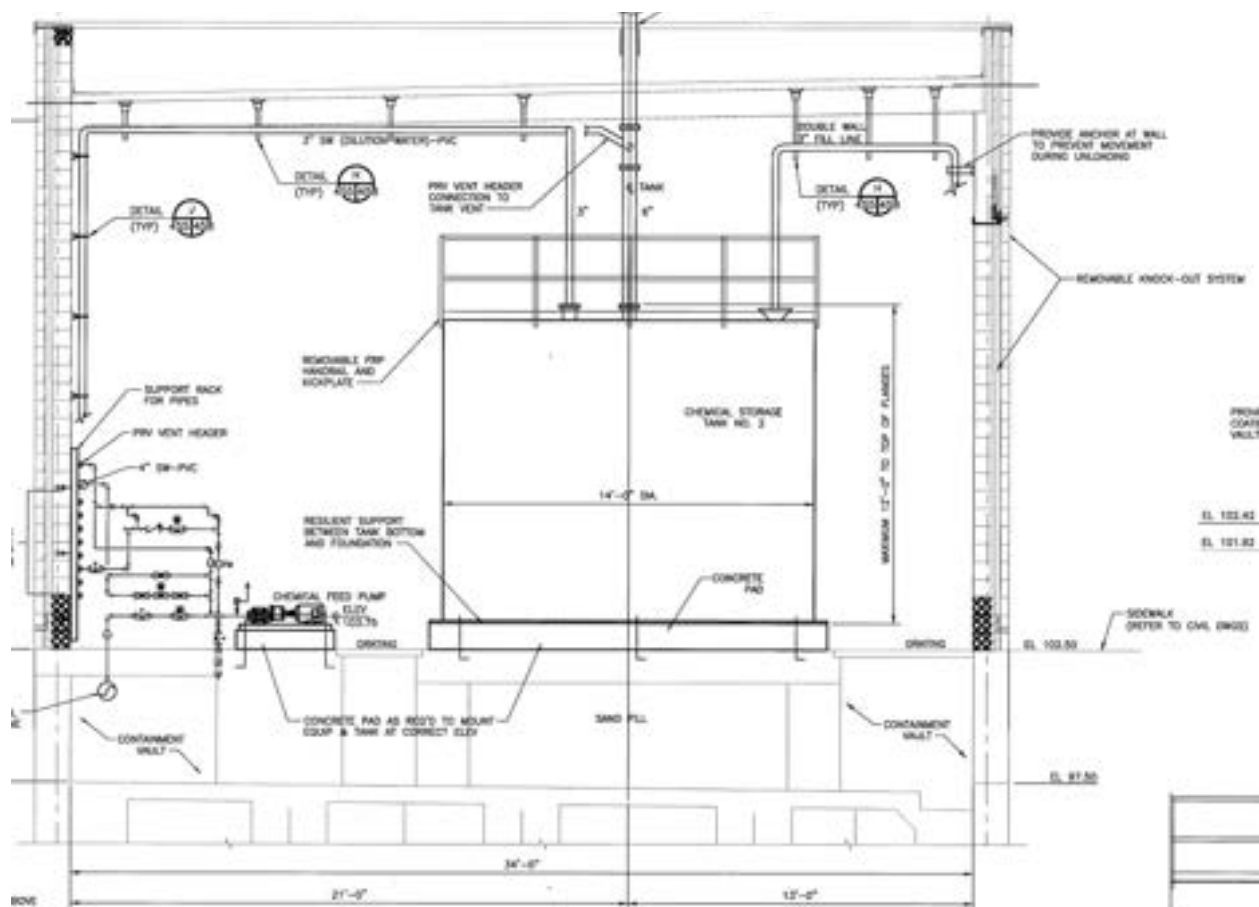


Figure 4-3
Existing Chemical Storage Room at Oakwood Section View

The proposed 15,000-gallon storage tanks are shown conceptually in **Figure 4-4**. The height of the tanks would need to increase approximately 3 feet to provide the required storage as discussed in Section 3. cursory field investigations and review of record drawings indicate the existing chemical storage room can accommodate the taller tanks; however, a more detailed field investigation is warranted to confirm field conditions and further evaluate construction constraints. A preliminary structural evaluation of the existing concrete tank pads was conducted, and the existing pads can accommodate the additional loads associated with the proposed larger sodium hypochlorite storage tanks. A more robust analysis should be completed as the design advances and the chemical storage sizing is further refined.

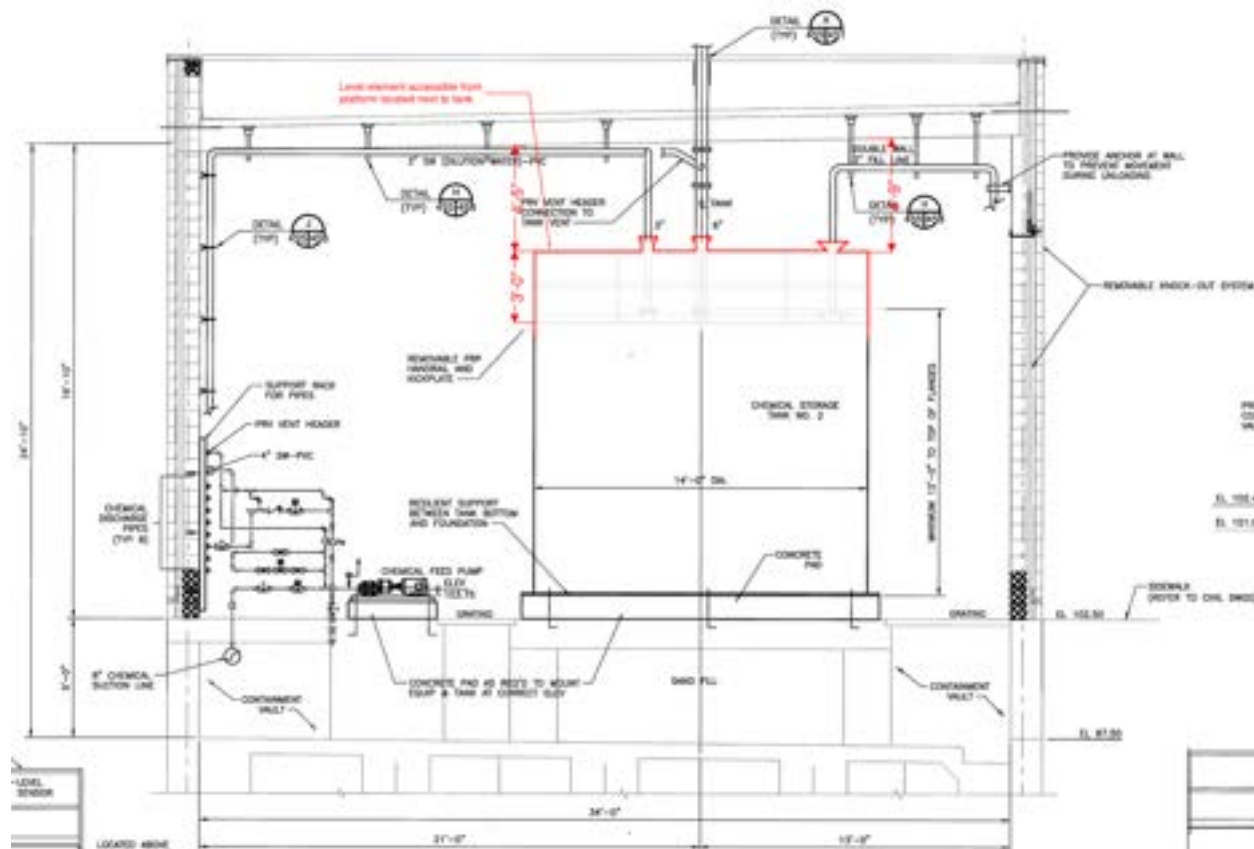


Figure 4-4
Proposed Larger Chemical Storage Tanks at Oakwood

The existing vent, overflow, water, and fill lines shown in **Figure 4-5** would need to be modified to accommodate the taller tanks. It appears there is sufficient clearance between the existing ceiling system and the top connections for the proposed taller tanks to allow for these piping modifications. There does not appear to be any conflicts with structural members, lighting, or HVAC ducts; however, conduit to the level sensor would need to be relocated and the clearance for the fire suppression system would need to be field verified. It appears there is adequate secondary and chemical spill containment volume to accommodate the proposed larger capacity tanks. A more detailed evaluation should be completed in subsequent design phases to verify the existing secondary chemical storage volume based on field conditions. This would include field investigations and field measurements.

There is between 4 ft-5 in. and 4 ft-9 in. feet of headspace above the proposed taller storage tanks, which does not provide adequate height for someone to stand on the tank. Access platforms would be located adjacent to the tanks to provide access to the tank connections and level sensor. To the extent practical, tank connections (piping and instrumentation) should be located along the perimeter of the tank to allow the connections to be accessed from the side of the tank. The piping

connections would only need to be accessed to address a leak or to replace the piping, which would be an infrequent activity. The level sensor needs to be routinely calibrated. Locating the level sensor connection near the sidewall of the tank would provide adequate access from the proposed access platform to remove, calibrate, and reinstall the sensor.

During the CSO Facilities Improvements Workshop GWLA requested that the access to the top of the tanks be interconnected with a catwalk or similar access platform to allow someone to access the top of the tanks from a single ladder climb. CDM Smith will explore opportunities to incorporate this access feature into the design during the basis of design phase.



Figure 4-5
Existing Sodium Hypochlorite Storage Tank at Oakwood

Installation of the proposed new sodium hypochlorite tanks will generally include:

- Temporarily disconnecting

- Emergency eyewash and shower supply (provide temporary eyewash and shower, storage tank no. 2 only)
- Conduit and associated junction boxes along east wall mounted to removable wall system
- Chemical sump suction and discharge piping (storage tank no. 1 only)
- Removing CMU knockout wall section(s)
- Verifying there is a relatively dry weather outlook to avoid undue risk of a large storm event occurring during storage tank replacement work
- Providing temporary wall system and temperature controls to prevent freezing temperatures, reduce degradation of sodium hypochlorite at high temperatures, and keep facility secure during replacement.
- Disconnecting piping, instruments, and appurtenance from one tank and removing the tank
- Installing new tank, piping, instruments, and appurtenances
- Test and commission tank
- Disconnecting piping, instruments, and appurtenances from second tank and removing the tank
- Installing second new tank, piping, instruments, and appurtenances
- Test and commission second tank

4.4.2 Leib

The existing sodium hypochlorite storage room is shown in plan and section view in **Figure 4-6** and **Figure 4-7**. The two existing 10,450-gallon tanks are located on concrete tank pads and aligned with the single 16 ft-0 in. x 13 ft-0 in. (length x width) removable wall system (i.e., CMU knockout wall). The new larger storage tanks would be taller tanks given the tight footprint of the room and limited space to expand the existing tank pads if needed to accommodate larger diameter tanks.

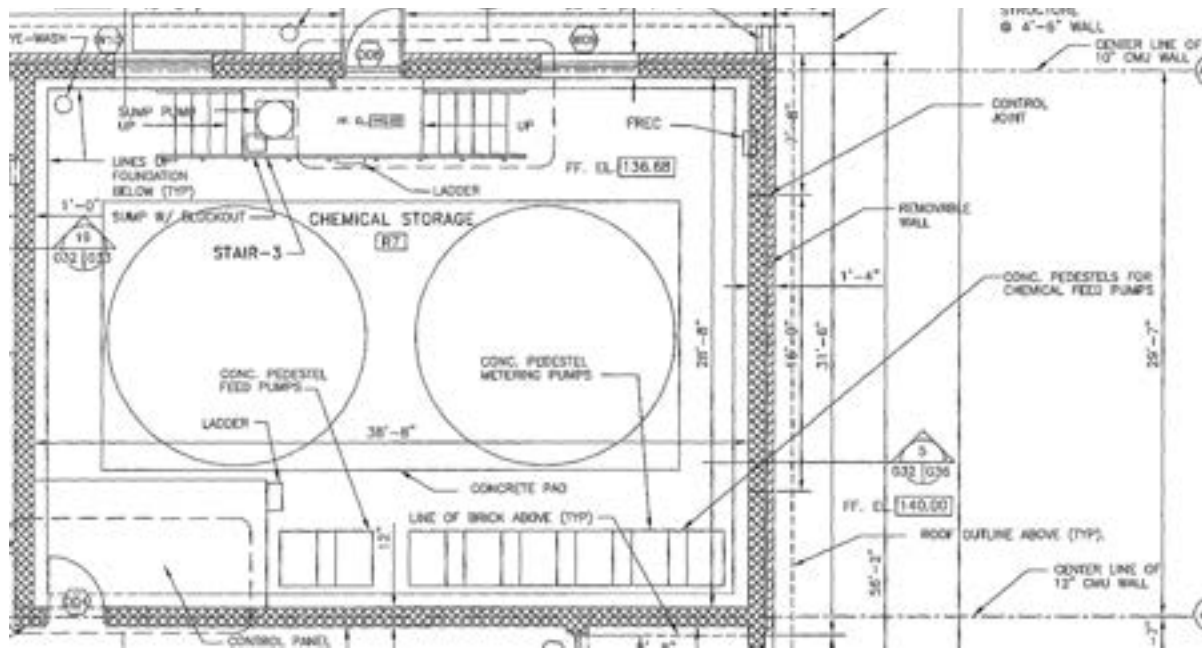


Figure 4-6
Existing Chemical Storage Room at Leib Plan View

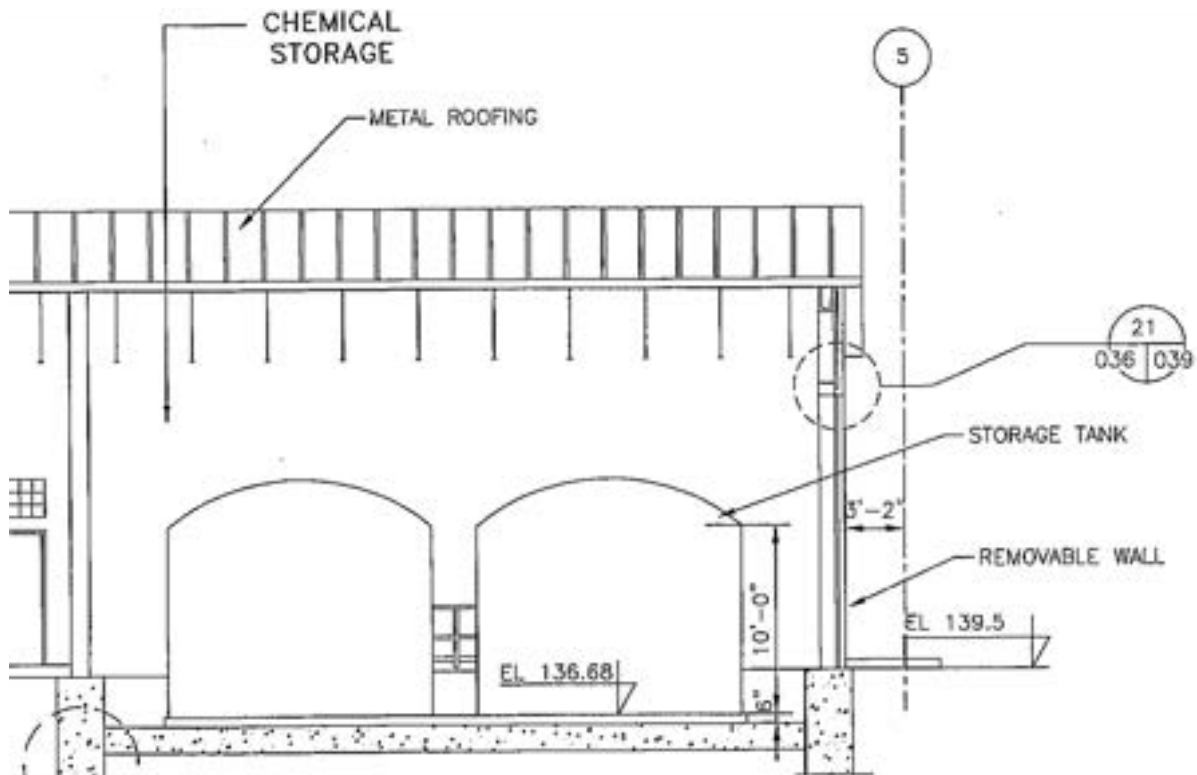


Figure 4-7
Existing Chemical Storage Room at Leib Section View

The proposed 12,600-gallon storage tanks are shown conceptually in **Figure 4-8**. The height of the tanks would need to increase approximately 3-feet to provide the required storage (working volume increase) as discussed in Section 3. Cursory field investigations and review of record drawings indicate the existing chemical storage room can accommodate the taller tanks; however, a more detailed field investigation is warranted to confirm field conditions and further evaluate construction constraints. A preliminary structural evaluation of the existing concrete tank pads was conducted, and the existing pads can accommodate the additional loads associated with the proposed larger sodium hypochlorite storage tanks. A more robust analysis should be completed as the design advances and the chemical storage sizing is further refined.

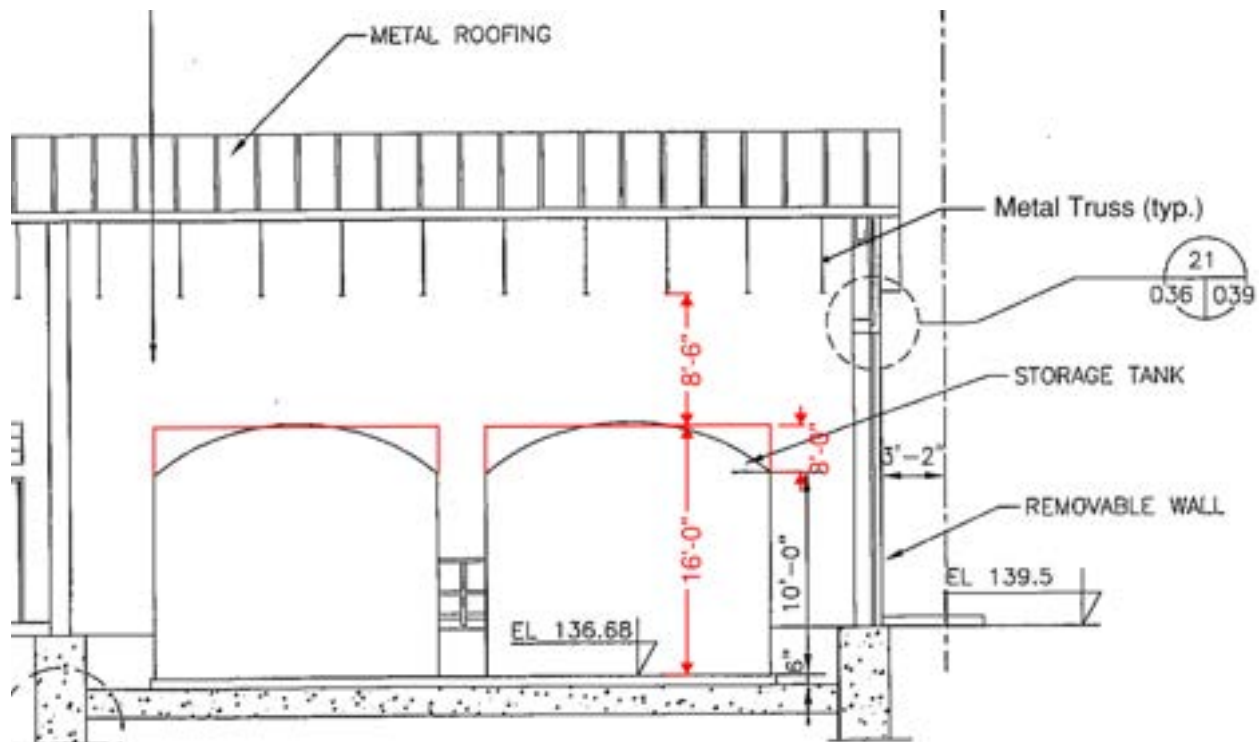


Figure 4-8
Proposed Larger Chemical Storage Tanks at Leib

The existing vent, overflow, water, and fill lines shown in **Figure 4-9** would need to be modified to accommodate the taller tanks. It appears there is sufficient clearance between the existing metal trusses and the top connections for the proposed taller tanks to allow for these piping modifications. There does not appear to be any conflicts with structural members, lighting, HVAC ducts, conduit, etc. It appears there is adequate secondary and chemical spill containment volume to accommodate the proposed larger capacity tanks. A more detailed evaluation should be completed in subsequent design phases to verify the existing chemical storage volume based on field conditions.

During the CSO Facilities Improvements Workshop GWLA requested that the access to the top of the tanks be interconnected with a catwalk or similar access platform to allow someone to access the top of the tanks from a single ladder climb. CDM Smith will explore opportunities to incorporate this access feature into the design during the basis of design phase.



Figure 4-9
Existing Sodium Hypochlorite Storage Tank at Leib

Installation of the proposed new sodium hypochlorite tanks will generally include:

- Temporarily disconnect and protect chemical sump pump and suction and discharge piping, particularly the portion of discharge piping that runs along the removable wall system.
- Removing CMU knockout wall section
- Verifying there is a relatively dry weather outlook
- Providing temporary wall system and temperature controls to prevent freezing temperatures, reduce degradation of sodium hypochlorite at high temperatures, and keep facility secure during replacement.
- Relocating tank closest to the CMU knockout wall outside the facility and installing temporary connections from the tank to the existing chemical feed system to serve as backup sodium hypochlorite storage in the event the facility activates during storage tank replacement work.
- Removing second tank (furthest from knockout wall)
- Installing new tanks, piping, instruments, and appurtenances
- Test and commission tanks
- Disconnecting temporary connections to existing tank located outside and connect new storage tanks to chemical feed system.

5.0 Alternatives Analysis

The following subsections (Sections 5.1 and 5.2) discuss the recommended chemical feed alternative for Oakwood and Leib: recirculation loop with centrifugal pumps and FCVs. Section 5.3 discusses the chemical storage alternatives for replacing the existing storage tanks with larger tanks.

5.1 Oakwood Chemical Feed Analysis

5.1.1 Recirculation Loop with Centrifugal Pumps and Flow Control Valves

Recirculation Pumps. The sodium hypochlorite recirculation pumps are designed to recirculate sodium hypochlorite from the bulk storage tanks, through one of two redundant discharge headers and back to the storage tanks in a continuous recirculation loop. It is assumed that the recirculation loop requires four times the peak design capacity to maintain adequate flow and pressure in the discharge header under all design conditions. This assumption will be verified with detailed hydraulic modeling in subsequent design phases. Therefore, the hypochlorite recirculation pumps will be designed to deliver a nearly constant flow of around four times higher than the maximum total facility dose requirement using constant-speed motors.

Due to the corrosive nature of sodium hypochlorite solutions, corrosion-resistant centrifugal pumps with seal-less magnetic drives will be used for the recirculation pumps. All wetted parts of the pump will be made of Teflon or a proprietary plastic material (BPO-DMA) manufactured by

Dow chemical specifically for sodium hypochlorite applications. **Figure 5-1** shows a typical corrosion-resistant pump manufactured by FYBROC. Two duty and two standby pumps are provided to ensure continuous operation in the event that two pumps are out of service. **Table 5-1** presents the basis of design for the sodium hypochlorite recirculation pumps.



Photo Credit: CECO Environmental Corporation

<https://www.cecoenviro.com/products/series-2530-magnetic-drive-close-coupled-pump/>

Figure 5-1
Corrosion-Resistant Centrifugal Pump Series 2530 Manufactured by FYBROC.

Table 5-1 Sodium Hypochlorite Recirculation Pumps Design Criteria

Parameters	Criteria
Type	Plastic Centrifugal
Total No. of Pumps	4
No. of Duty Pumps	2 (duplex configuration)
No. of Standby Pumps	2
Suction Pipe Size	6-inch flanged
Discharge Pipe Size	4-inch flanged
Pump Materials of Construction	FRP w/ BPO-DMA cure system
Pump Drive	Constant-speed motor with seal less mag drive

Hypochlorite Flow Control Valve Station. The sodium hypochlorite valve stations are designed to provide accurate dosing of sodium hypochlorite at the six application points located on each storm discharge pipe. Each station includes a magnetic flowmeter, globe or v-port ball valve FCVs, with manual bypass connection. The existing potable water connection and in-line static mixer assembly would be retained and continue be used to blend the sodium hypochlorite and water supply flow streams. The globe valves are designed to deliver precision dosing control over a relatively large

range in flows (e.g., 50:1 turndown capacity). The motor-operated duty FCV modulates in response to a flow signal produced by the magmeter to meet the setpoint dose for each chemical.

Two motor operated FCVs would be provided to meet the flow range requirements. The valves will likely operate in a duty/standby mode under low to moderate flows and split the flow and operate in parallel when transitioning from moderate to high flows. A third manually operated FCV will be provided as a backup standby. Opportunities to reduce the number of motor operated FCVs and reduce the associated operation and maintenance needs will be further evaluated with design progression.

A valved drain will be provided upstream of each FCV for backflushing the valve station with potable water to remove any scale deposits that accumulate in the FCV over time. Due to the corrosive nature of sodium hypochlorite, all wetted parts of the FCV will be made of titanium or Hastelloy C. An example of an FCV is shown in **Figure 5-2**. **Table 5-2** presents the basis of design for the chemical FCVs.



Photo Credit: Flowserve Corporation

<https://www.flowserve.com/en/products/products-catalog/valves/linear-control-valves/linear-globe-angle-control-valves-mark-one/>

Figure 5-2
Example of Flow Control Valve (Mark One Valtek by Flowserve).

Table 5-2 Flow Control Valve Design Criteria at Oakwood

Parameters	Criteria
Type	Globe, V-Port Ball Valve
Total No. of Valves	24
Total No. of Valve Stations	8
No. of Valves Per Valve Station	3
No. of Motor-Operated Valves Per Valve Station	2
No. of Manual Standby Valves Per Valve Station	1
Flow Control Valves	
Maximum Turndown Ratio	50:1
Materials of Construction	Titanium or Hastelloy C
Type of Valve Actuator	Electric
Actuator Power	110/60 VAC
Control Signal	4-20 mA

A process flow diagram and conceptual layout for the proposed recirculation loop and FCV system are shown in **Figure 5-3** and **Figure 5-4**. The valve size, type, materials of construction, valve station configuration, operational flow capacity, and other design criteria will be further evaluated during the basis of design phase in collaboration with GLWA.

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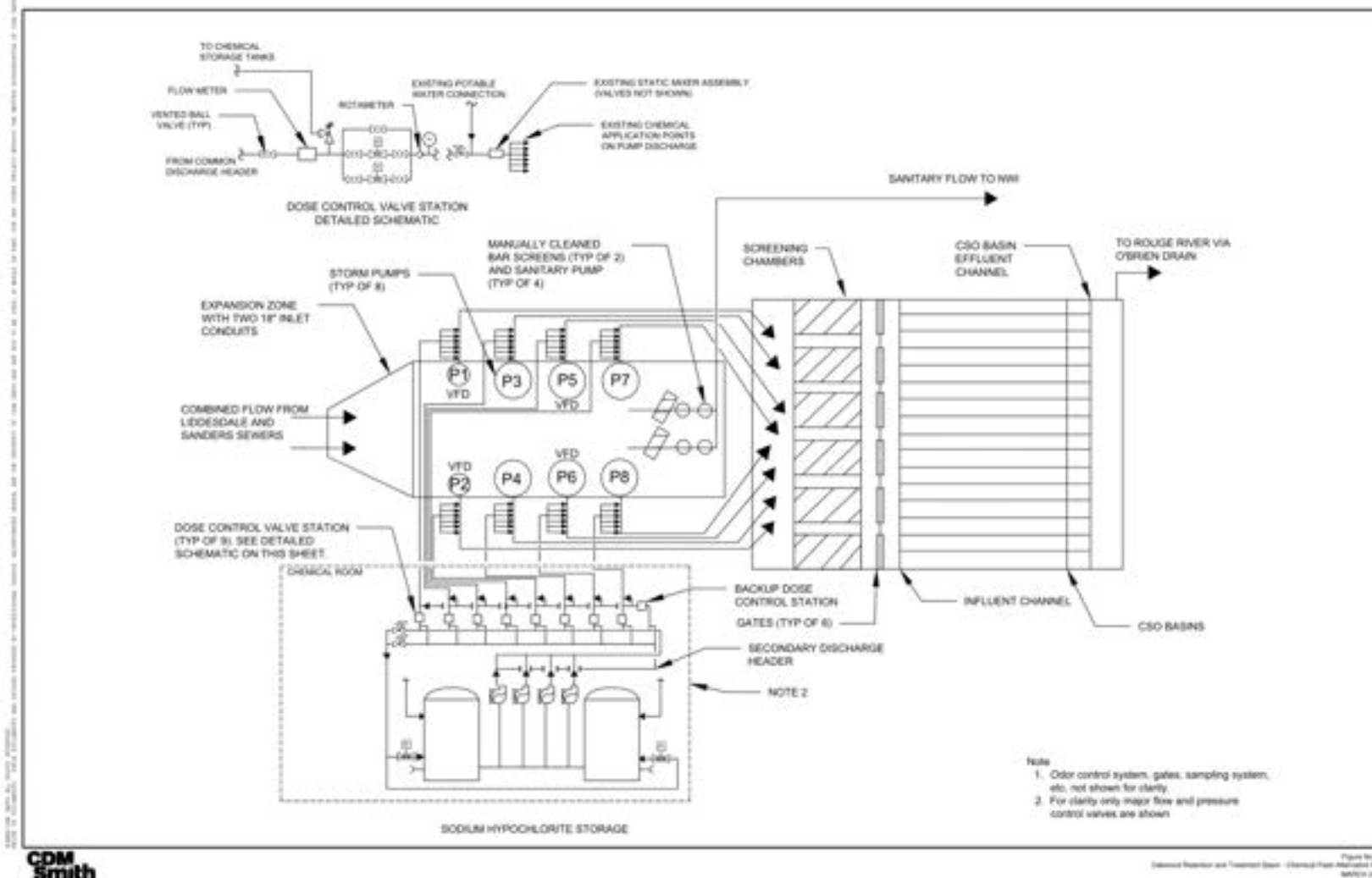


Figure 5-3
Oakwood Retention and Treatment Basin Chemical Feed Alternative Process Flow Diagram

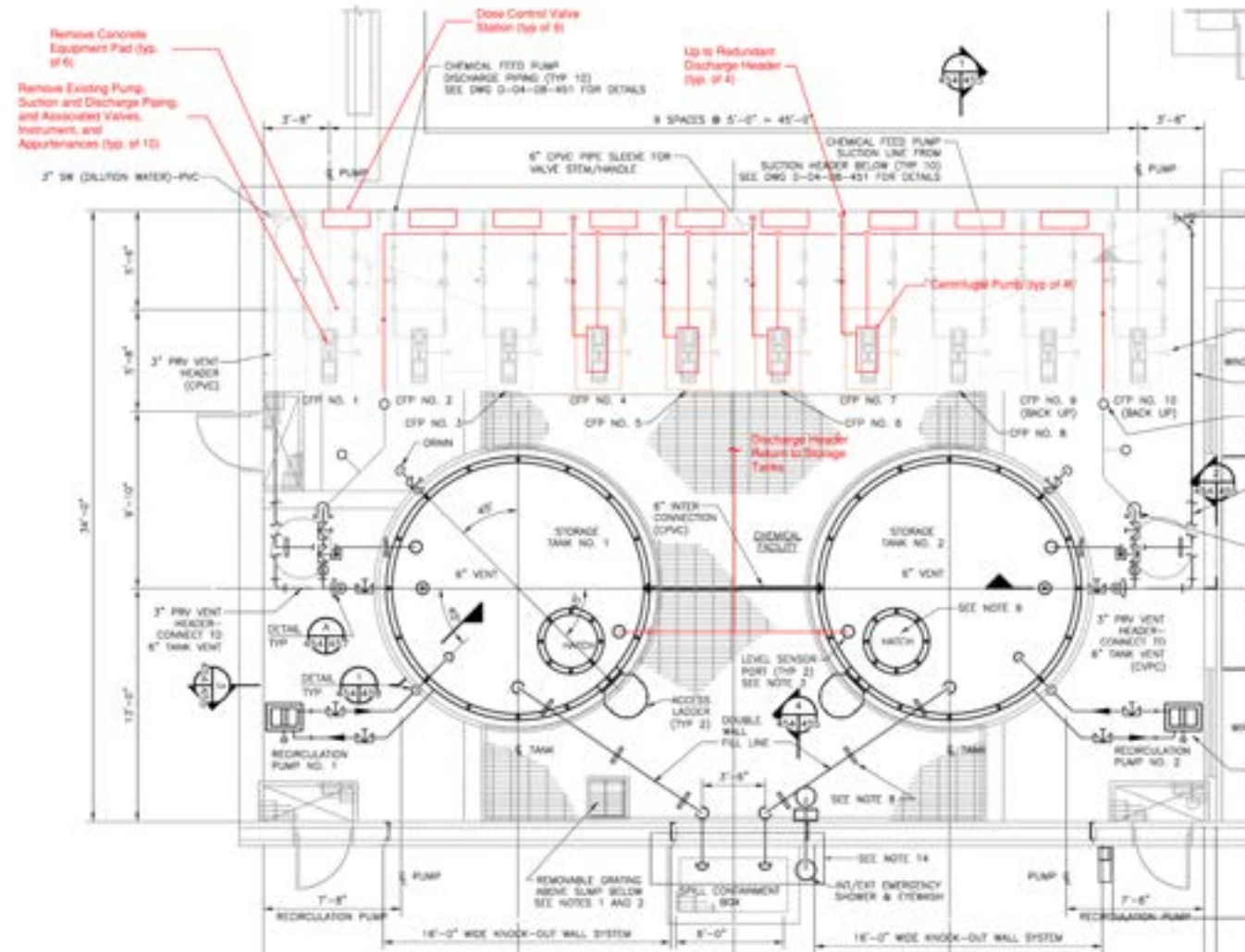


Figure 5-4
Oakwood Conceptual Layout of Recirculation Loop and Flow Control Valve.

5.2 Leib Chemical Feed Analysis

5.2.1 Recirculation Loop with Centrifugal Pump and Flow Control Valves

The recirculation loop and FCV system configuration at Leib would be similar to Oakwood; however, there would likely be two centrifugal pumps (1 duty and 1 standby). The maximum flow at Leib (950 cfs/613 mgd) is about 30% lower than the maximum flow at Oakwood (1,231 cfs/794 mgd), which likely avoids needing a duplex pump configuration at Leib.

Table 5-3 Sodium Hypochlorite Recirculation Pumps Design Criteria

Parameters	Criteria
Type	Plastic Centrifugal
Total No. of Pumps	2
No. of Duty Pumps	1
No. of Standby Pumps	1
Suction Pipe Size	6-inch flanged
Discharge Pipe Size	4-inch flanged
Pump Materials of Construction	FRP w/ BPO-DMA cure system
Pump Drive	Constant-speed motor with seal less mag drive

The FCV stations at Leib would be similar to Oakwood; however, the FCVs may be slightly smaller at Leib than Oakwood as the maximum total facility flows (52.2 gpm current collection system, 74.0 gpm future collection system) is lower than Oakwood (113.1 gpm current collection system, 126.0 gpm future collection system).

The existing disinfection equipment control panels are located in the existing chemical room, which is a corrosive environment and has limited room for staff access around process equipment and tanks. To improve equipment access in alignment with the guiding principles (i.e., provide equipment which is accessible and easy to maintain) and to protect the control panels from the corrosive environment, the new control panels for disinfection equipment will be located outside of the existing chemical room. Locations will be determined once the size and number of panels needed is determined.

Table 5-4 Flow Control Valve Design Criteria

Parameters	Criteria
Type	Globe, V-Port Ball Valve
Total No. of Valves	14
Total No. of Valve Stations	7
No. of Valves Per Valve Station	3
No. of Motor-Operated Valves Per Valve Station	2
No. of Manual Standby Valves Per Valve Station	1
Maximum Turndown Ratio	50:1
Materials of Construction	Titanium or Hastelloy C
Type of Valve Actuator	Electric
Actuator Power	110/60 VAC
Control Signal	4-20 mA

The existing chemical mixers (co-current prechlorination and counter-current mixing chamber mixers) control panels are not explosion proof and will need to be replaced with NEMA 7 explosion proof enclosures to meet area classification requirements. The mixers have submersible enclosures which satisfies the area classification requirements. It is recommended that the enclosures be replaced as part of the disinfection system upgrades.

A process flow diagram and conceptual layout for the proposed recirculation loop and FCV system are shown in **Figure 5-5** and **Figure 5-6**. The valve size, type, materials of construction, valve station configuration, operational flow capacity, and other design criteria will be further evaluated during the basis of design phase in collaboration with GLWA.

TM-20 Chlorine System Alternatives

June 1, 2023

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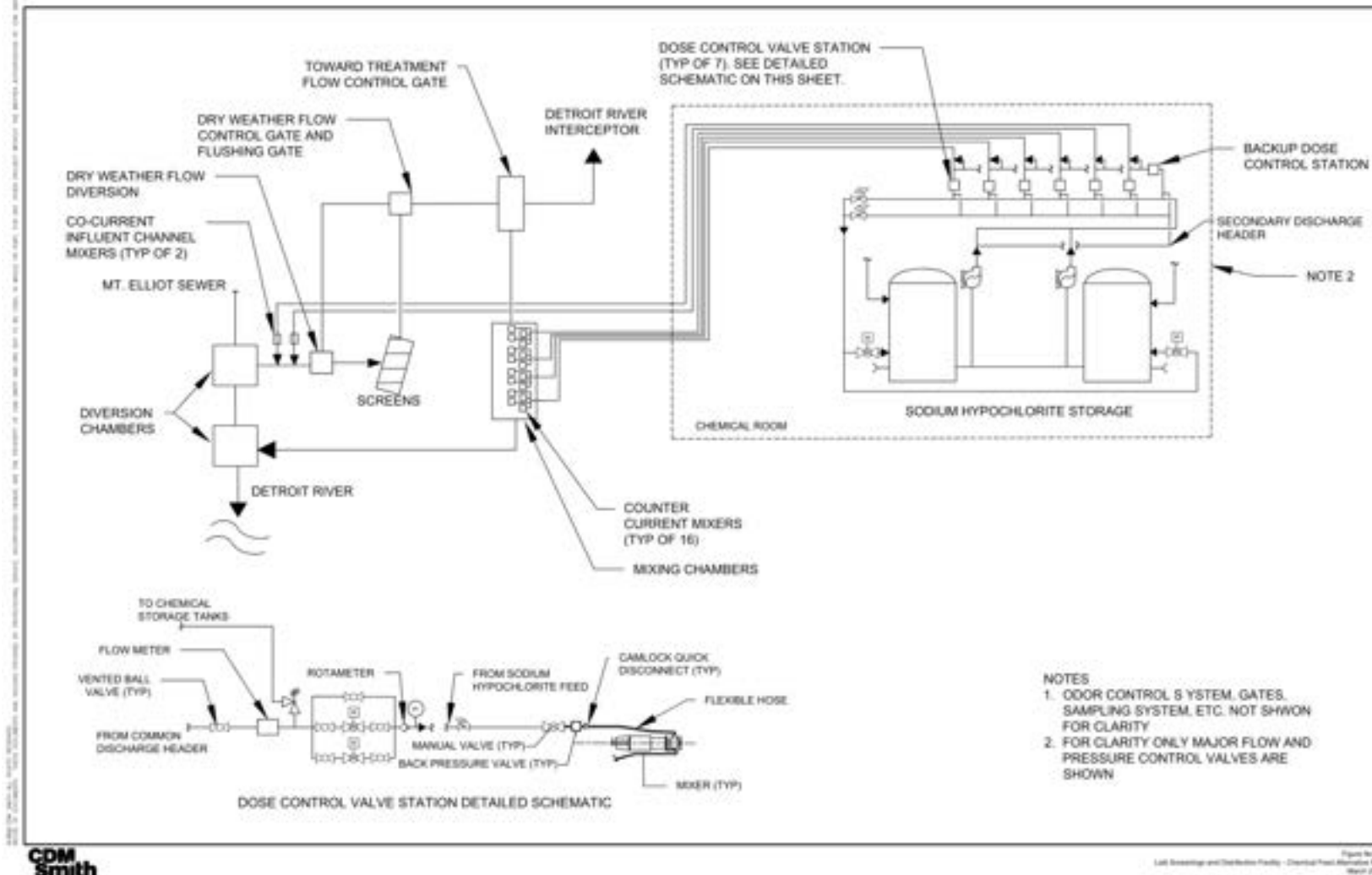


Figure 5-5
Leib Screenings and Disinfection Facility Chemical Feed Alternative Process Flow Diagram

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A life cycle cost analysis was not performed because only one alternative (recirculation loop with centrifugal pumps and FCVs) was identified as technically feasible and capable of meeting project goals.

5.3 Chemical Storage Analysis

The new larger sodium hypochlorite storage tanks would generally match the existing storage tank design given the existing size constraints, specifically:

- Existing removable wall system dimensions
- Limited space to expand existing concrete tank pads – particularly at Leib
- Height restrictions – although less constrictive than diameter limitations, there is limited overhead space in the existing chemical storage rooms and there needs to be enough clearance to stand the new taller tanks up in the existing chemical storage rooms

However, there are alternative tank materials that offer different anticipated useful life with varying capital and maintenance costs that can be considered for this application. For bulk sodium hypochlorite 15% trade percent by weight, there are three primary tank construction options: crosslinked polyethylene (XLPE), lined carbon steel, and reinforced fiberglass (FRP). The existing tanks at Oakwood and Leib are FRP and designed to store sodium hypochlorite up to 15% (trade percent by weight) with a specific gravity of 1.25. The anticipated useful life and cost comparison of the different tank materials are shown in **Table 5-5**.

Table 5-5 Sodium Hypochlorite Storage Tank Material Comparison

Tank Material	Capital Cost	Maintenance Cost	Anticipated Useful Life
XLPE	\$	\$	4 – 7 years
Lined Carbon Steel	\$\$	\$\$	3 – 6 years for liner
FRP	\$\$	\$	10 – 15 years

Table adapted from Protank Sodium Hypochlorite Storage Tanks and Specifications article.

<https://www.protank.com/sodium-hypochlorite#:~:text=Sodium%20Hypochlorite%20Storage%20Tanks%20are,from%2035%20to%20100%2C000%20gallons.>

The advantage and disadvantages associated with each tank material are shown in **Table 5-6** through **Table 5-8**.

Table 5-6 Advantages and Disadvantages for XLPE Tanks

Advantages	Disadvantages
Relatively low capital cost in comparison to lined carbon steel and FRP tanks	Tendency to leak at penetrations for fittings
Little to no maintenance (i.e., no liner to replace)	Does not last as long as FRP tanks
No seams, which can be weak points in the tank	

Table 5-7 Advantages and Disadvantages for Lined Carbon Steel Tanks

Advantages	Disadvantages
Steel tanks can last for 15+ years if liners are replaced routinely	Higher maintenance cost than XLPE and FRP tanks because liner must be replaced every 3 to 6 years, which requires draining and taking tank offline
	Relatively high capital cost in comparison to XLPE and FRP tanks
	Liner replacement often requires third-party to replace, which adds to maintenance cost

Table 5-8 Advantages and Disadvantages for FRP Tanks

Advantages	Disadvantages
Longest expected useful life in comparison to lined carbon steel tanks and XLPE	Comparable capital cost to lined steel tanks, more costly than XLPE tanks

It is recommended that the existing FRP tanks be replaced with new, larger FRP tanks, which offer the longest anticipated service life of the materials considered in this analysis without needing to periodically replace a liner system. The additional capital cost compared to XLPE is counteracted by the superior durability and lower tendency to leak (i.e., no need to penetrate tank shell to attached fittings).

6.0 Summary and Recommendations

The following recommendations are provided for the disinfection systems at Oakwood.

- Conduct additional bacteria and chlorine dose response testing to further validate sample results and refine ICT values.
 - Continue testing through the implementation phase to further refine and validate ICT results particularly to examine seasonal variability.
 - Conduct additional testing for high flow events, especially once the proposed ODIRS is constructed to validate the ICT values and opportunities to reduce the TRC required.
- Replace the existing sodium hypochlorite feed system with a recirculation loop and control valve system.

- Update the SOP to maintain a sodium hypochlorite concentration of 10.5% (median historic concentration) to help meet future chemical storage requirements and reduce the maximum sodium hypochlorite feed rate.
- Plan to replace the two existing 11,500-gallon chemical storage tanks with two new 15,000-gallon tanks in coordination with the construction of the ODIRS and associated increase in future storm volumes.
- Installing baffles in the existing CSO basins could reduce the TRC required at the end of the CSO basins, which in turn could reduce the chemical storage and feed requirements.
 - Chemical storage requirements would be reduced by approximately 3,000 gallons, which would decrease the required storage tank size from two 15,000-gallon tanks to two 13,500-gallon tanks (~11% decrease).
 - The maximum feed requirement could be reduced by approximately 15%, which could reduce the horsepower for the proposed centrifugal pumps.
 - While the reduction in chemical storage and feed is appreciable, it does not mitigate the need to replace the existing chemical storage tanks or considerably change the pump selection or number of feed pumps. Therefore, it is not recommended that baffles be installed in the CSO basins at Oakwood. If quenching is required in the future at the end of the CSO basins to counteract the high TRC requirements during high flows, installing baffles in the CSO basins may be beneficial.

The following recommendations are provided for the disinfection systems at Leib.

- Conduct additional bacteria and chlorine dose response testing to further validate sample results and refine ICT values.
 - Continue testing through the implementation phase to further refine and validate ICT values particularly to examine seasonal variability.
- Replace the existing sodium hypochlorite feed system with a recirculation loop and control valve system.
- Update the SOP to maintain a sodium hypochlorite concentration of 10.0% to help meet future chemical storage requirements.
- Replace existing mixer enclosures with NEMA 7 explosion proof enclosures to meet area classification requirements.
- Plan to replace the two existing 10,450-gallon chemical storage tanks with two new 12,600-gallon tanks in coordination with the construction of the Meldrum Sewer and associated increase in future storm volumes.

7.0 Next Steps

The following are next steps required to advance the disinfection system improvements at Oakwood and Leib.

- Field Investigations
 - Collect field measurements to verify the existing secondary chemical containment volume is adequate for the proposed new chemical storage tanks.
 - Investigate construction sequencing elements and identify any additional components that would need to be temporarily relocated to facilitate the replacement of the existing chemical storage tanks.
- Vendor Coordination
 - Further develop chemical feed pump selection based on detailed hydraulic model of recirculation loop system. Verify recirculation flow requirements to refine flow estimate (i.e., four times the required total facility sodium hypochlorite flow). Verify materials of construction for wetted components and request detailed dimensional drawings for selected pumps to develop more detailed chemical feed system layouts. Verify constant speed pumps are appropriate and VFDs are not required for this application.
 - *Coordinate with vendors to establish typical lead time for selected chemical feed pumps and coordinate with GLWA to determine if an installed spare pump (N+1 redundancy) is desirable.*
 - Coordinate proposed tank sizing with vendors to verify dimensions including manways, pipe and instrument connections, and anchor locations, and associated construction sequencing requirements.
 - Further develop FCV and actuator selection (establish FCV configuration, select FCV type, determine application point feed requirements under various operational conditions, minimum and maximum feed capacity of proposed FCV using low, average, and high ICT values to represent the full range of anticipated chlorine dose and feed requirements, etc.). Examine vendors experience with sodium hypochlorite applications. Further evaluate materials of construction available from each vendor. Request detailed dimensional drawings to develop detailed dose control valve station layouts.
 - Establish minimum and maximum operational capacity (initial and future) of feed system to account for uncertainties in basis of design such as NWI and Meldrum sewer connection impact on chlorine demand.
- GLWA Coordination

- Review proposed chemical storage and feed improvements and obtain consensus on proposed improvements and timeline relative to the construction of the ODIRS and Meldrum Sewer.
- Investigate existing storm pump flowmeter issues and discuss topic with GLWA staff to determine if this issue was addressed or needs to be addressed as it impacts the automatic disinfection system control.
- Collaborate on chemical feed system layout to ensure there is adequate space for operation and maintenance activities. Identify preferences (equipment types, materials, colors, configurations, etc.) that should be integrated into the design. Consider how equipment, pipes, valves, tanks, etc. will be removed and replaced in the future to avoid additional work necessary to replace such items.
- Consider opportunities to reconfigure existing stairs and sump to allow access around all sides of the tanks.
- Conduct sampling program to further refine ICT values.
- Design Progression
 - Further develop layouts for the proposed dose control valve station, chemical feed pump, and associated piping, valves, and instruments. Verify location of dose control valve stations and coordinate power requirements with electrical team.
 - Develop preliminary piping and instrumentation diagrams (P&IDs) for the chemical storage and feed systems.
 - Develop baseline schedule and opinion of probable construction cost for the proposed disinfection system improvements.
 - Conduct detailed hydraulic model of proposed recirculation loop to determine flow requirements for maintaining adequate pressure and flow through the recirculation loop, pressure control setpoints, and design conditions for the FCVs.
 - *Evaluate whether a single backup dose control station can serve the small and large storm pumps (i.e., turndown capacity) or if two backup dose control stations are required – one for small storm pumps and one for large storm pumps.*
 - *Evaluate location of the recirculation loop discharge outlet on the storage tanks to reduce potential to degrade sodium hypochlorite through aeration, particularly during low flow and low demand storm events when recirculation flow would be relatively high.*

- Further develop proposed new sodium hypochlorite storage tank layouts with access platforms, instrument ports, and pipe connections. Consider whether access platforms can be interconnected between the storage tanks.
- Develop provisions to assist with draw fill operations at Oakwood where operators have to use relatively high chlorine doses during the draw period to account for the loss of chlorine residual in the basins between draw/fill events.
- Develop method for disposing dilute sodium hypochlorite through the sewer system when the solution degrades and needs to be replenished. Consider method for diluting solution further.
- GLWA noted during the CSO Facilities Improvements Workshop that, to the extent feasible it is desirable to have Oakwood and Leib disinfection system be similar to the St. Aubin system (designed by others) so operators would be familiar with the operation of both facilities. CDM Smith will coordinate with the St. Aubin design team to identify opportunities to coordinate the designs.

Appendices

Appendix A Disinfection Storage Design Criteria

Appendix B Oakwood CSO RTB CFD Modeling Report

Appendix C Chlorine Contact Chamber Design Flow Evaluation Worksheet v1.04

Appendix A

Disinfection Storage Design Criteria

GLWA CSO Facilities Improvements Project
Proposed Disinfection Storage Design Criteria Approach for OKW and Leib
December 14, 2022
December 21, 2022 (comment responses)

Background

The design team is seeking feedback from GLWA on the basis of design for sizing the sodium hypochlorite tanks at both OKW and Leib. At continuously operated water and wastewater treatment facilities sodium hypochlorite (hypo) tanks are typically sized based upon:

- number of days of storage,
- stored hypo concentration,
- plant flow,
- chlorine dose.

Values for the above parameters can vary based upon regulatory and utility requirements, but many in the industry will use 15 days of storage, at the “as-delivered” hypo concentration, at max. month flow, and at average chlorine dose. While this approach works well for continuously operating facilities, other factors need to be considered when sizing hypo storage tanks at intermittently used facilities that are “event based” type facilities (i.e. activated during wet weather or snow melt events).

Proposed Design Criteria Approach

Because OKW and Leib are event based facilities rather than continuous flow based, it is recommended that the sodium hypochlorite tanks be sized based upon:

- number of design storm events
- Dilute hypo concentration (if stored dilute) or hypo concentration before being discarded (if stored at “as delivered” concentration)
- total volume per design storm event
- average chlorine dose

The original BOD for the Leib disinfection process utilized collection system modeling to identify the peak volume discharged through Leib during the simulation period. That volume was determined to be 225 MG, which was used to size the Leib hypo storage tanks.

At OKW the storage approach used, as summarized in the BOD, aligns with the recommended approach above. The 10 year, 1 hour design storm was used (48.5 MG) and then a safety factor of 2 (or 2 design storm events) was applied at a chlorine dose that was slightly higher than the design dose. The tanks were sized based upon 5% hypo concentration.

Recommendation

CDM Smith recommends the same approach used for the original sizing of the storage tanks at OKW be utilized during this project for sizing the hypo storage tanks at Leib and OKW. The table below summarizes the storm events CDM Smith recommends be utilized for the sizing of the storage tanks. These storm events come from the Design Event Memo dated 12/6/2022. The detailed basis of design criteria for the sizing of the storage tanks will be determined after the wet weather chlorine dose response testing results have been analyzed and the preliminary integrated CT value is determined at each facility to meet the permitted bacteria limit.

	Leib	Oakwood
Average Condition	6 month, 24 hr storm	6 month, 24 hr storm
Peak Condition	10 year, 24 hr storm	10 year, 24 hr storm

GLWA Input Request

We are seeking for GLWA's concurrence in using these storm events for the conditions above, and for the approach for sizing the sodium hypochlorite storage tanks.

GLWA Comments and CDM Smith Responses

1. A design event includes what, a typical first flush? I would look at this, and then a back to back event with similar bleach, but no real first flush since it would have been part of the previous event.

Response:

The design storm event includes the entire event, including first flush. To size the storage tanks we are looking at the total volume of flow that will entire the facility, and need to be disinfected, during that event. CDM Smith recommends sizing the hypochlorite storage system to handle, at minimum, back to back design storm events. The hypochlorite required for treating a single peak event will then be checked to confirm that the tanks are sized to handle that event, should the volume required be larger than the back to back average storm events.

2. I think we should define as a part of this really what is the minimum concentration of bleach necessary, and what size of events it would apply to.

Response:

The tanks are recommended to be sized based upon the lowest hypochlorite concentration before the chemical is discarded. GLWA staff have stated this concentration is 5%. CDM Smith is also in the process of evaluating the historic data GLWA has provided to determine what the lowest sodium hypochlorite concentration has been in the storage tanks to assess if the 5% value is suitable for the design criteria.

3. Average over how long? I'd be curious how this plays out for a longer event which would white wash the dose at the beginning of the event. How has CDM Smith sized previous clients, and how has that worked out over the long run? How was the original volume for Oakwood determined?

Response:

Because the project is looking to optimize the chlorine disinfection process, the average dose will first be calculated from the integrated CT (ICT) value determined from the Oakwood and Leib dose response testing. This average dose will be checked against a few historic storm events to determine if the average amount of chlorine (pounds of chlorine/MG treated in an event) seem reasonable compared to the values determined from the ICT approach.

The average dose is for calculating the storage volume. The feed rate is determined using the peak flow event. This approach has been utilized on other projects in the recent past. Since utilizing ICT to size storage and feed systems is relatively new approach, CDM Smith doesn't have any installations in operation. The Beaver Creek Satellite Treatment Facility in Albany, NY was sized based upon this approach. It will be operational in 2023.

The description of how the storage volume at Oakwood is described in the original text above.

Appendix B

Oakwood CSO RTB CFD Modeling Report



DRAFT Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Carrie Knatz, CDMS
Nigel Beaton, CDMS*

Reviewed by: Mark Allen, CDMS

Date: April 10, 2023 (Draft)

*Subject: Oakwood CSO RTB CFD Modeling Report
Contract No. 2101475 - CSO Facilities Improvements Project*

1.0 Introduction and Purpose

The Oakwood Combined Sewer Overflow (CSO) Retention Treatment Basin (RTB), owned and operated by the Great Lakes Water Authority (GLWA) and constructed in 2012, is designed to capture, treat, and discharge combined sewage in the Oakwood combined sewage interceptor. The Facility can store up to 9 million gallons (MG) of combined sewage and a hydraulic capacity of 1,660 cubic feet per second (cfs). Treatment consists of screening and sodium hypochlorite disinfection.

GLWA plans to increase utilization of the Oakwood (OKW) CSO facility by diverting flow from the Northwest Interceptor (NWI) to the facility and is interested in increasing the hydraulic efficiency of the RTB. Increasing the hydraulic efficiency of the RTB would reduce the overall disinfection chemical usage, thereby reducing the overall cost of operations. Increased hydraulic efficiency could be achieved by creating a more serpentine flow path to improve the plug flow characteristics of the basin. Computational fluid dynamics (CFD) modeling was used as a tool to evaluate the existing RTB and a proposed serpentine baffling configuration to achieve the desired increase in hydraulic efficiency.

The purpose of this technical memorandum (TM) is to summarize the CFD modeling work performed to evaluate and compare the hydraulic efficiency of the existing Oakwood CSO RTB to a serpentine-baffled configuration designed to encourage plug flow characteristics.

2.0 System Description

Combined sewage is conveyed to the RTB via eight storm pumps. Sodium hypochlorite is added to the combined sewage at the discharge of the storm pumps in the screening facility where the sewage is subsequently screened through six channels containing Andritz porous-plate step screens. Flow exits the screening facility and enters two parallel contact chambers, each with three

influent gates. Each contact chamber contains a long, straight influent weir and when the water level exceeds the elevation of the influent weir, the disinfection contact chambers begin to fill. When the water level reaches the elevation of the effluent finger weirs, the storage capacity of the RTBs is reached, and additional flow is discharged to the CSO outfall. The RTB contact chambers include multiple low “training walls” and flushing gates that guide flow used for flushing solids that settled after a CSO event has ended, and scum baffles designed to capture and prevent floatables from discharging over the effluent weirs.

3.0 Analysis Methodology

Disinfection efficacy has been shown to have a strong correlation with the disinfection dosage requirement, which is based on contact time (CT), the product of the disinfectant residual concentration and the CT. The CT component is dependent on the hydraulic efficiency of the contact tank where the ideal condition is uniform (plug) flow through the tank. When flow through the tank is not uniform, a portion of the water will not have sufficient contact time. The hydraulic efficiency through a disinfection basin is evaluated with CFD to optimize disinfection dosage requirements.

CFD is the science of predicting fluid flow by solving the governing equations that represent the three fundamental principles of fluid flow (conservation of mass, momentum, and energy). Under specified conditions, the CFD model simulates flow fields and particle transport within the model domain, solving the Reynolds-averaged Navier-Stokes equations that describe the flux of mass and momentum within a fixed domain subject to specified boundary conditions. A finite volume formulation is used where the computational model domain is generated representing the geometry to be simulated, and the domain is divided into discrete volumes called cells (the mesh) where the fundamental fluid flow equations are solved on each of these discrete cells. Integrating these cells over a volume yields the flow field for the computational domain.

The Oakwood CSO RTB CFD model was developed using *Ansys 2022*. This platform includes *SpaceClaim* to develop the model geometry, *Fluent Meshing* for meshing, *Ansys Fluent* for model processing and post-processing, and *CFD-Post* for additional post-processing.

A single-phase (water only), steady-state model was developed for each modeled simulation. The models used the shear stress transport (SST) k - ω viscous model for turbulence where k and ω refer to the turbulent kinetic energy and dissipation rate, respectively. The SST k - ω viscous model contains two transport equations for k and ω with two hybrid equations developed by combining the k - ϵ and k - ω models.

A residence time distribution (RTD) analysis was performed to simulate a tracer test and predict the hydraulic efficiency of the RTB. The Discrete Phase Model (DPM) was used for the RTD analysis where an injection of water particles (tracer) is released at the inlet boundaries and tracked through the fluid domain. The contact time of the tracer is reported at the outlet boundaries to determine the residence time distribution. Industry standard defines the contact time as T_{10} , for drinking water applications and is used for this CSO application as a conservative approach considering public health exposure to the outfall. T_{10} refers to the time at which 10% of the

particles reach the outlet. The hydraulic retention time (HRT) is the theoretical contact time defined as the volume of the contact zone divided by the flow rate. The hydraulic efficiency, or baffle factor, is defined as T_{10} divided by HRT. A higher hydraulic efficiency corresponds to more plug-flow characteristics, which are desirable in a chlorine contact tank to minimize chemical requirements. **Table 3-1** presents guidance on baffle factors provided by the USEPA for various baffling conditions and basins. Using this guideline, a baffle factor of 0.5 could be used for the Oakwood CSO RTB. However, retrofitting the RTB with baffle walls suggests a baffle factor closer to 0.7 could be achieved, which could lead to significantly less chemical usage.

Table 3-1 Baffle Factor Guidelines

Baffling Condition	Baffle Factor	Baffling Description
Unbaffled (mixed flow)	0.1	None, agitated basin, very low length to width ratio, high inlet and outlet flow velocities.
Poor	0.3	Single or multiple unbaffled inlets and outlets, no intra-basin baffles.
Average	0.5	Baffled inlet or outlet with some intra-basin baffles.
Superior	0.7	Perforated inlet baffle, serpentine or perforated intra-basin baffles, outlet weir, or perforated launders.
Perfect (plug flow)	1.0	Very high length to width ratio (pipeline flow), perforated inlet, outlet and intra-basin baffles.

Source: USEPA, March 1991. *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water*. Washington, D.C.

Sodium hypochlorite is added to the system downstream of the storm pumps; therefore, the contact time through the RTB starts at the pump discharge in the screening facility, continues through the contact chamber(s) and ends at the effluent finger weirs. Separate models of the screening facility and the contact chamber were developed to evaluate the overall contact time through the RTB. The combined hydraulic efficiency of the screening facility and the contact chamber was defined as:

$$\text{Hydraulic Efficiency} = \text{Baffle Factor} = \frac{T_{10 \text{ screening facility}} + T_{10 \text{ contact chamber}}}{HRT_{\text{screening facility}} + HRT_{\text{contact chamber}}}$$

The screens were modeled as porous zones with a specified pressure drop based on the screen manufacturer's information. The pressure drop modeled assumes 20% blinding since the screens are constantly running and rotating at full speed during operation.

Although the hydraulic capacity of the RTB is 1,660 cfs, the treatment capacity is defined as the 10-year, 24-hour storm predicted to be 1,231 cfs based on the SWMM model as reported in the "Design Storm Event and Facility Flow Rate Summary" memorandum¹; note that at the time of the CFD analysis, the flow rate summary memorandum was considered draft pending GLWA review and will be updated as additional pertinent design criteria are developed. The CFD analysis evaluated the

¹ Appendix A of Draft TM-1 dated February 14, 2023

treatment capacity of 1,231 cfs operating with one screen channel and one contact chamber out of service.

The model geometry (fluid domain) was developed from *Matterport* laser scans of the facility, converted into a *Revit* model, and then imported into the *SpaceClaim* software. A polyhedral hybrid mesh was generated for each model and **Table 3-2** presents the total mesh count for each model.

Table 3-2 Model Mesh Count

Model	Mesh Count
Existing Screening Facility	4.6 million
Existing Contact Chamber Configuration	19.6 million
Proposed Contact Chamber Configuration	14.2 million

4.0 Model Domains and Boundary Conditions

The model domain of the screening facility is shown in **Figure 4-1**. The screen channel and storm pumps assumed to be out of service were located furthest from the contact chamber in operation to present the worst-case scenario for the shortest contact time. Each storm pump in operation was defined as a mass flow inlet with the specified flow rate shown in **Table 4-1**. The three effluent gates to the single contact chamber in operation were defined as pressure outlets. The five screens operating were specified as porous zones with resistance parameters corresponding to a headloss of 14.8 inches (1.2 feet) based on the manufacturer's information. The single-phase (water only) simulation requires an assumed water surface defined as a symmetry boundary, which is an unconstrained boundary that does not impact the flow characteristics below the water surface. The storm pumps discharge above the water surface in the screening facility, therefore, the nappe profile of the pump discharge was assumed based on theoretical calculations of weir flow from a vertical pipe.

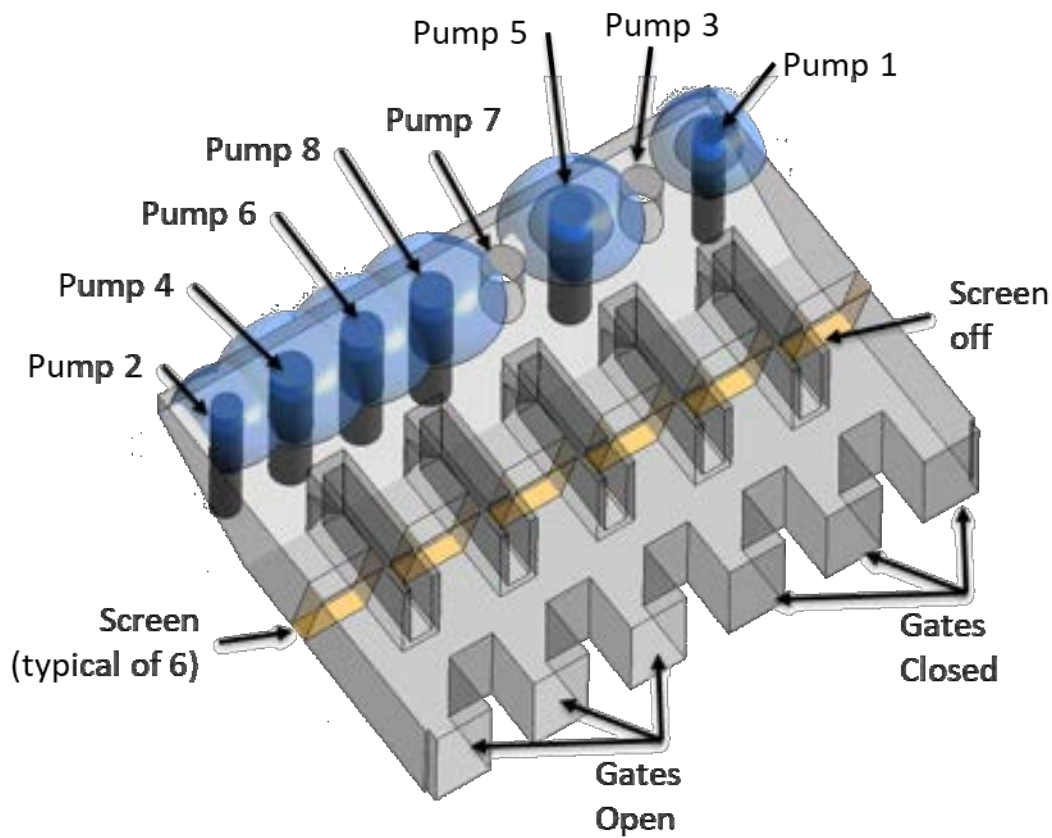


Figure 4-1
CFD Model Domain of Existing Oakwood CSO Screening Facility

Table 4-1 Pump Discharge Flow Assumptions

Pump	Flow (cfs)
1	122
2	122
3	Off
4	258
5	235
6	235
7	Off
8	258

The model domain of the existing contact chamber is presented in **Figure 4-2**, which extends from the three inlet gates at the upstream end, through the chamber and the effluent finger weirs to the effluent channel. The influent and effluent weir walls, as well as features such as the intermediate

training walls, the flushing gate walls, floor slopes, structural columns, and scum baffles were included in the model geometry. The model inlet was specified at the three influent gates and defined as a uniform mass flow inlet with equal flow split between the gates. This assumption was validated with the results of the screening facility model.

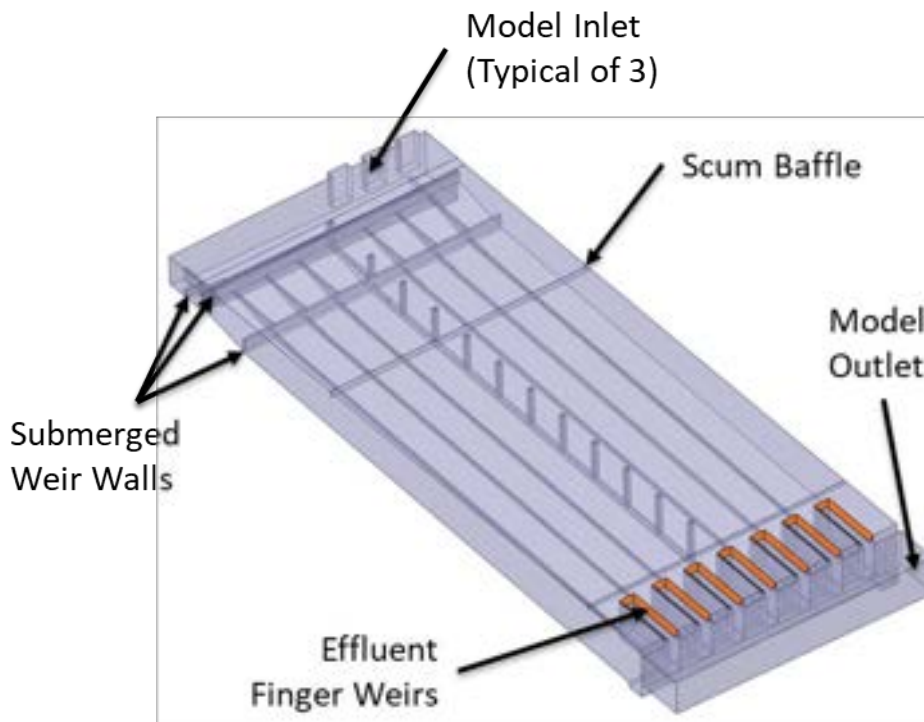


Figure 4-2
CFD Model Domain of Existing Oakwood CSO RTB Contact Chamber

The proposed baffling configuration for the contact chamber is shown in **Figure 4-3**. This configuration was designed to add minimal headloss compared to the existing configuration and create a serpentine flow path that encourages plug flow. The baffle walls were located in alignment with the existing flushing training walls and support columns to simplify the retrofit construction effort.

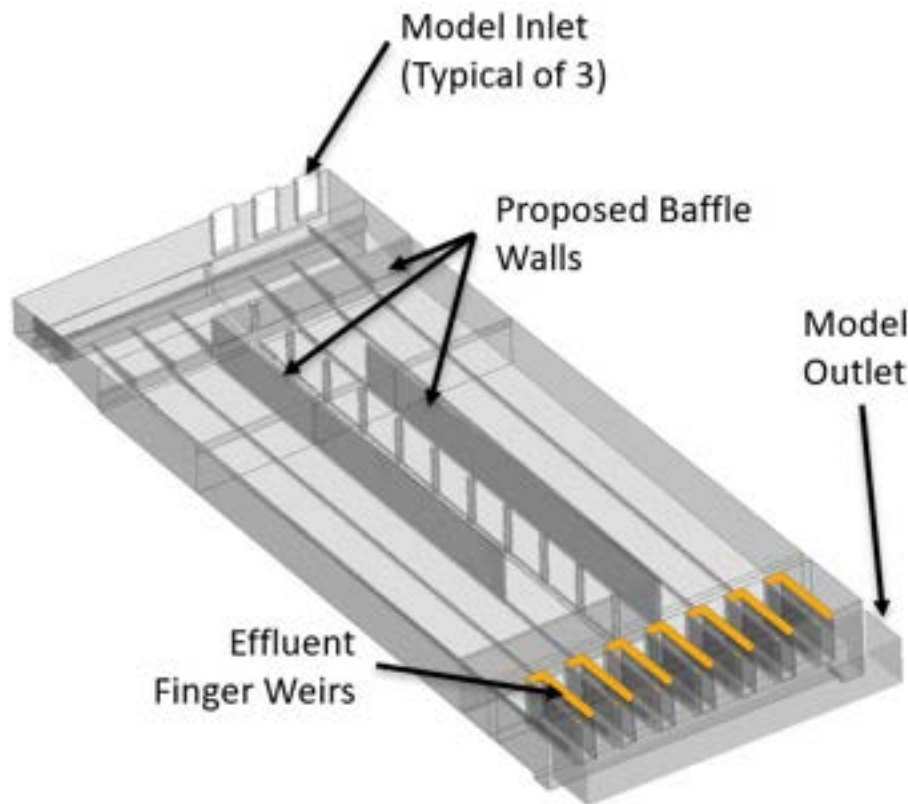


Figure 4-3
CFD Model Domain of Proposed Oakwood CSO RTB Contact Chamber Baffling Configuration

5.0 Model Results

Velocity contour and direction vector graphics were plotted to demonstrate the flow pattern through each model. High velocity is represented in red and zero velocity is represented in dark blue. The arrows present the direction vector parallel to the cross-section shown and the length of the arrow represents the velocity magnitude. In general, regions of low velocity indicate dead zones, and regions of high velocity suggest where short-circuiting may be occurring. The direction vectors can be used to identify recirculation zones that effectively act as dead zones. All these phenomena (dead zones, recirculation zones, and short-circuiting) are indicative of reduced hydraulic efficiency.

Velocity contours and direction vectors through the screening facility in plan view at mid-depth (Detroit Datum Elevation 107.5) are shown in **Figure 5-1** where the flow path is from bottom to top of the figure. The figure clearly illustrates dead zones in the offline screen channel (left-most screen channel), the overflow channels between the screens, and the contact chamber influent gates that are closed (left-most gates) that reduce the overall hydraulic efficiency. The highest velocities downstream of the screens are the result of the combined flow from two screen channels that is conveyed to the open gates.

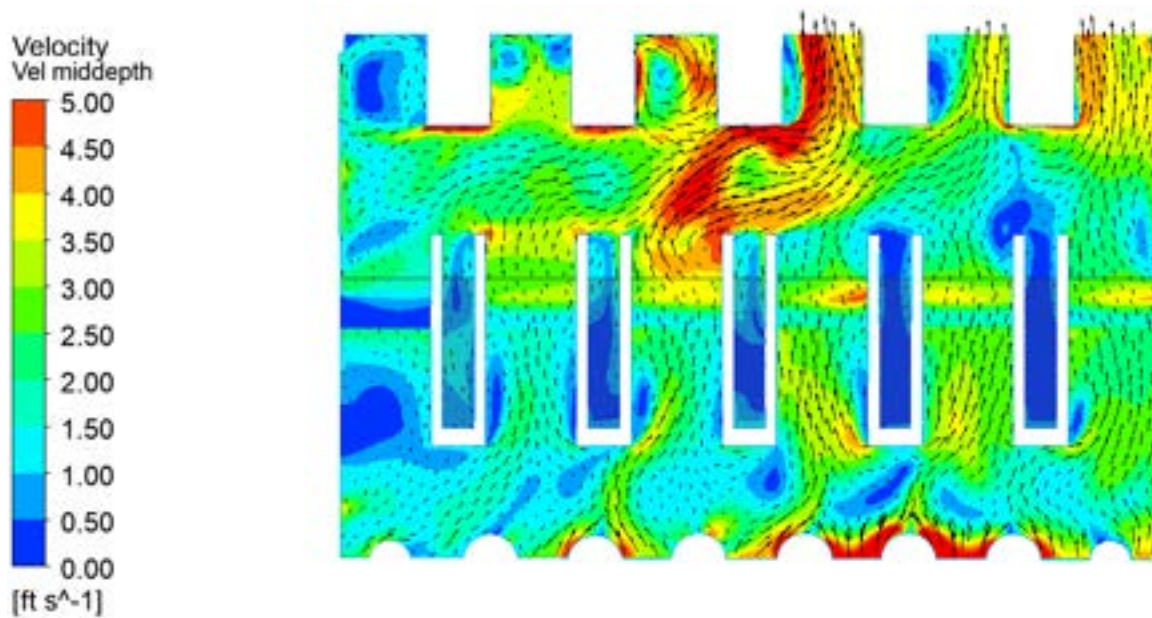


Figure 5-1
Screening Facility Velocity Contours and Vectors at Mid-depth

Figure 5-2 presents the velocity contours at the screening facility effluent gates (contact chamber influent gates). Flow split between the gates was predicted to be within +3%/-2% maldistribution validating the assumption of equal flow split between the gates for the existing and proposed contact chamber models.

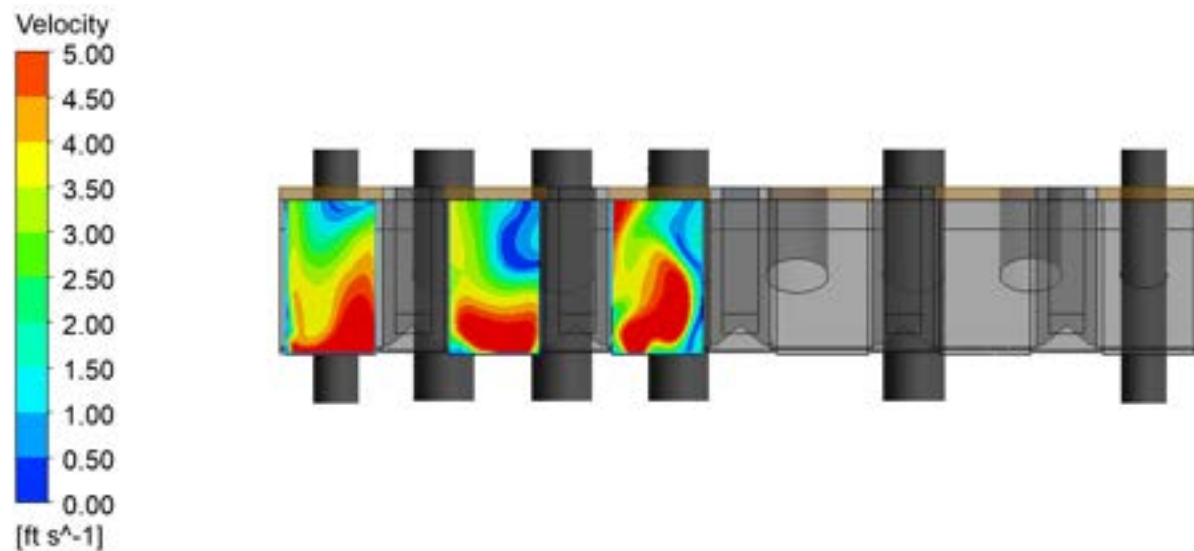


Figure 5-2
Screening Facility Velocity Contours at the Effluent Gates

The velocity contours and direction vectors for the existing contact chamber are shown in **Figure 5-3** (plan view section at mid-depth, Detroit Datum Elevation 107.5) and **Figure 5-4** (vertical sections through centerline of each influent gate).

As shown in **Figure 5-3**, one large dead zone occurs in the lower-left corner of the basin, likely resulting from the influent gates jetting into the upper-left corner of the basin and causing short-circuiting. **Figure 5-4** shows the highest velocities in the upstream portion of the contact chamber and some short-circuiting over the influent weir wall to the scum baffle. It is apparent that velocities are relatively low through the majority of the contact chamber beyond the influent weir wall. The figures show that flow is relatively uniform beyond the scum baffle approaching the effluent finger weirs.

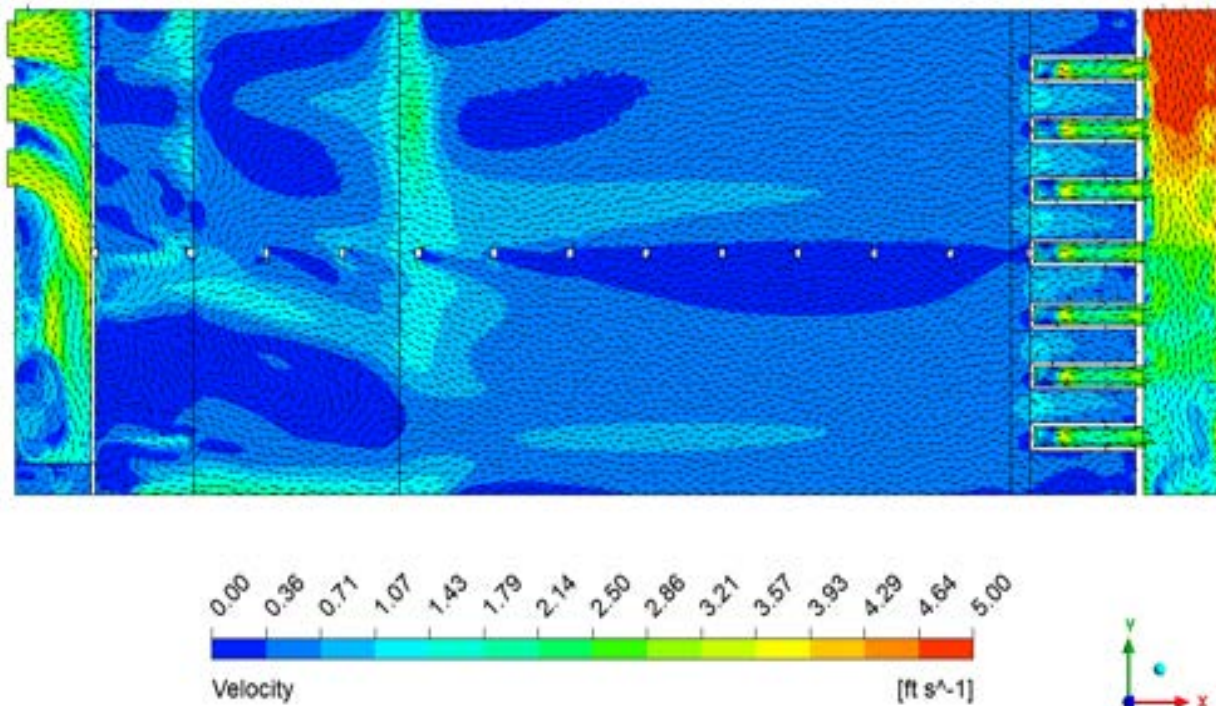


Figure 5-3
Existing Contact Chamber Velocity Contours and Vectors at Mid-depth

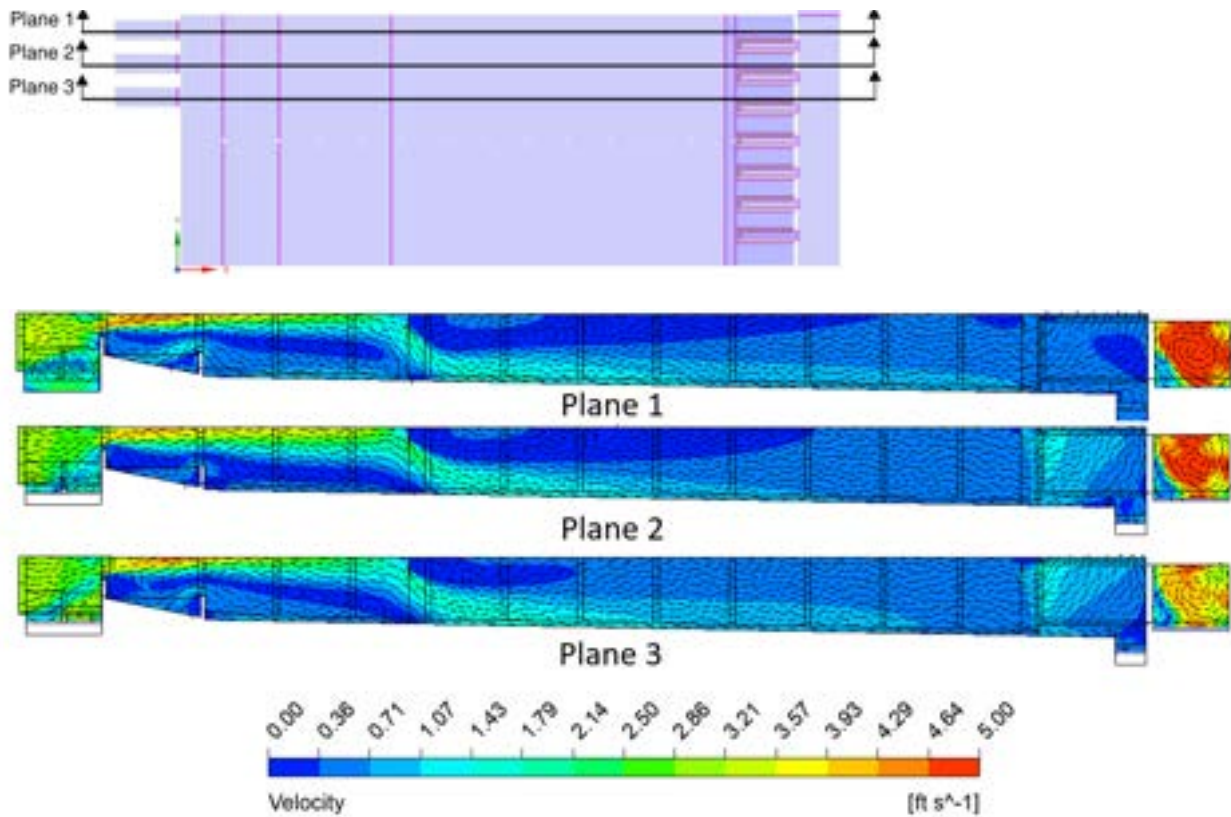


Figure 5-4
Existing Contact Chamber Velocity Contours and Vectors at Vertical Sections

Velocity contours and direction vectors for the proposed baffling modifications are presented in **Figure 5-5** (plan view section at mid-depth, Detroit Datum Elevation 107.5) and **Figure 5-6** (vertical sections through centerline of each influent gate). These figures reveal that the baffling has increased the overall velocity of flow through the basins and created several new dead zones and recirculation regions. These zones occur on the downstream edges of where flow turns around baffle walls, as well as in the corners of the baffle walls upstream of those flow turns. Additionally, the change in the approach conditions at the effluent weirs creates regions of low velocity immediately adjacent to the downstream-most weirs.

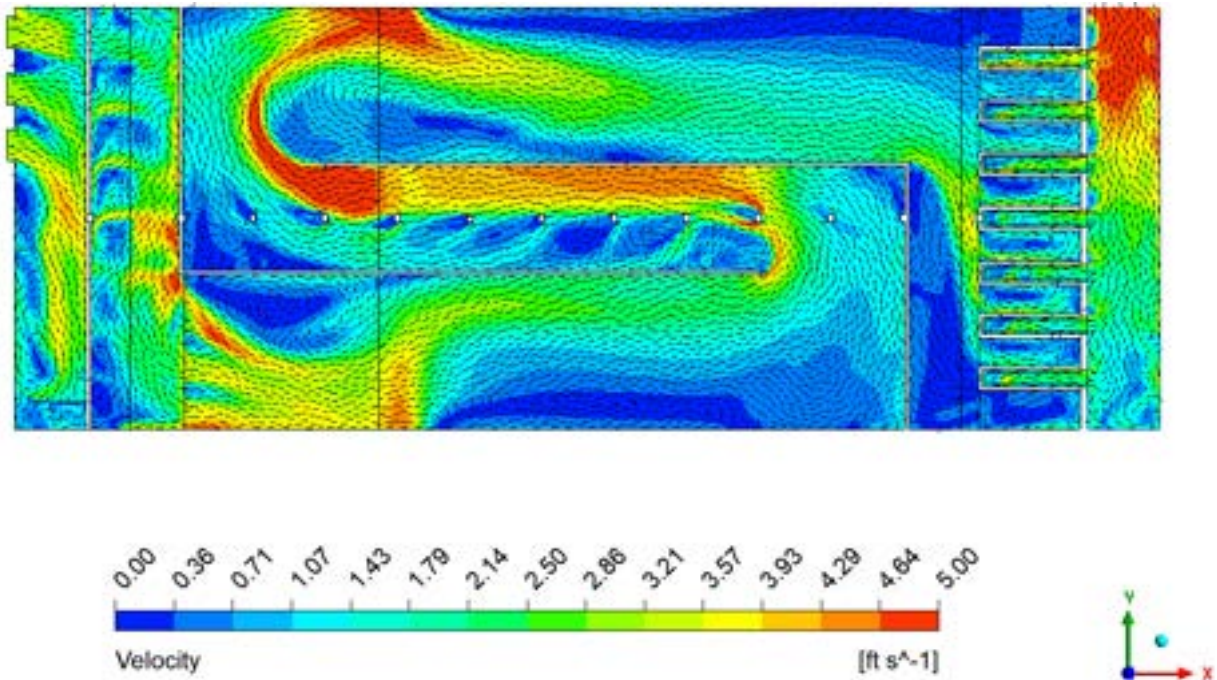


Figure 5-5
Proposed Baffled Contact Chamber Velocity Contours and Vectors at Mid-depth

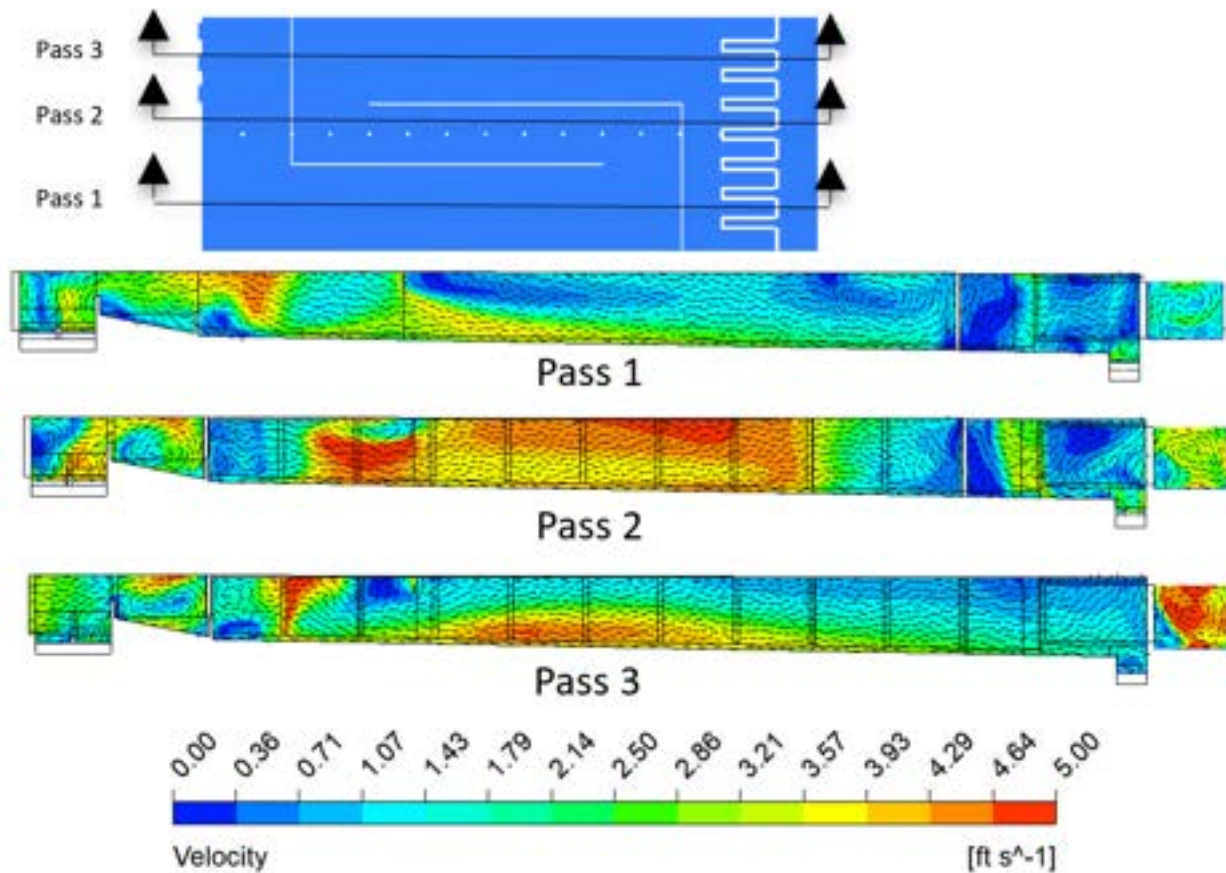


Figure 5-6
Proposed Baffled Contact Chamber Velocity Contours and Vectors at Vertical Sections

Figure 5-7 and **Table 5-1** present the residence time distribution (RTD) results for the existing and proposed baffling configurations. The results predict a modest improvement in hydraulic efficiency for the proposed baffling configuration.

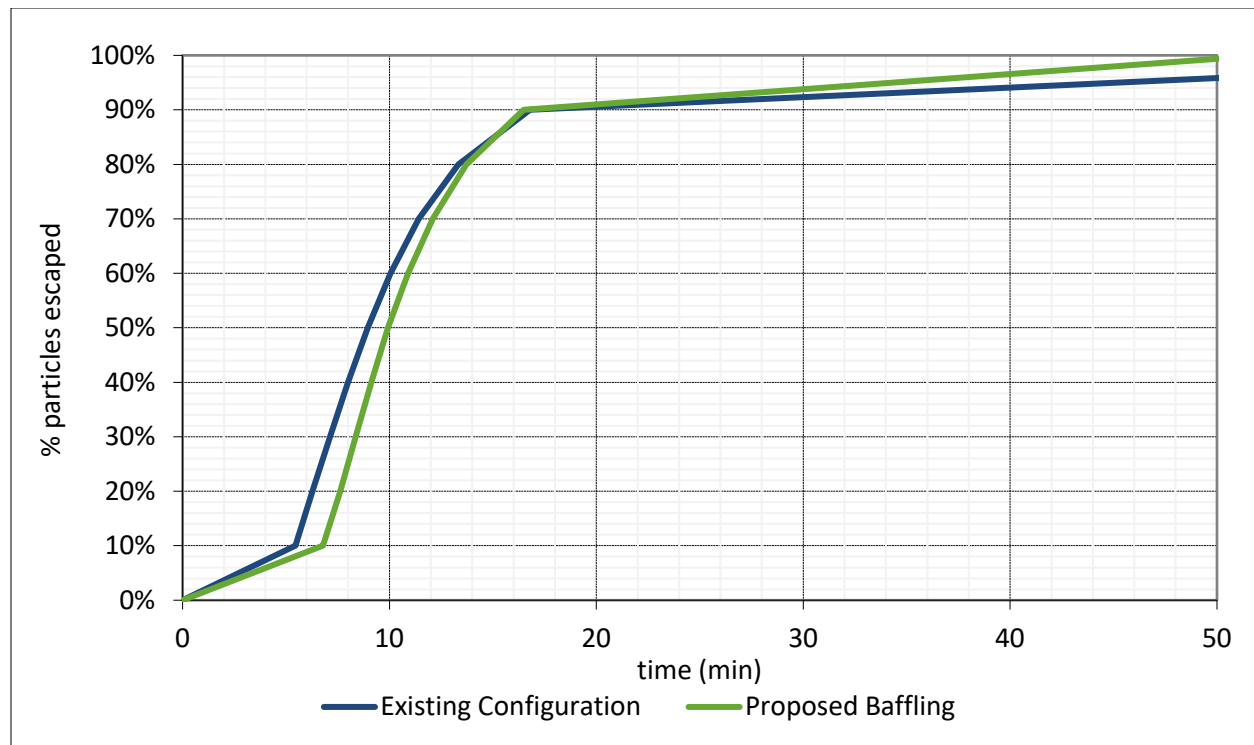


Figure 5-7
Residence Time Distribution

Table 5-1 Residence Time Distribution Results Summary

	HRT	T ₁₀	Baffle Factor
Existing Configuration	9.3 min	5.4 min	0.6
Proposed Configuration	9.3 min	6.8 min	0.7

6.0 Conclusions and Recommendations

The baffle factor of 0.6 for the existing configuration is better than expected and likely attributed to the uniform flow approaching the effluent finger weirs. The baffled configuration demonstrates a modest improvement in hydraulic efficiency with a baffle factor of 0.7. The inefficiencies for the baffled configuration are mainly due to the flow separation around each baffle wall and the short-circuiting to the effluent finger weirs closest to the last pass of the serpentine channel.

A cost to benefit analysis should be completed to evaluate the cost of the retrofit construction for the baffled configuration and the potential chemical savings as a result of the increased hydraulic efficiency.

Appendix C

Chlorine Contact Chamber Design Flow Evaluation Worksheet v1.04

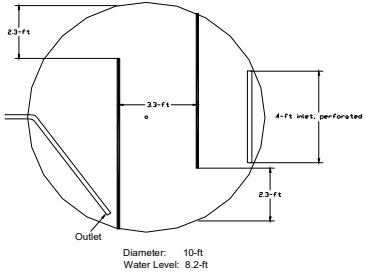
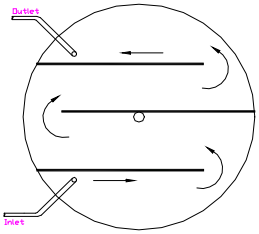
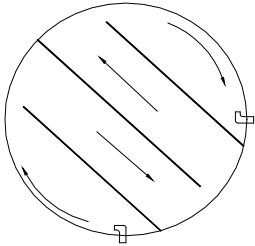
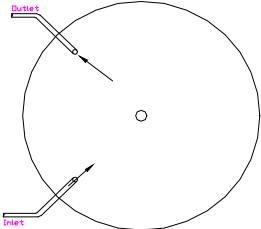
Main Menu

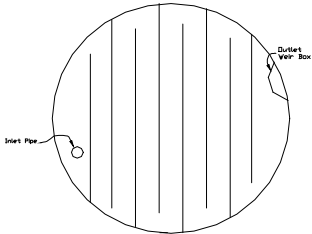
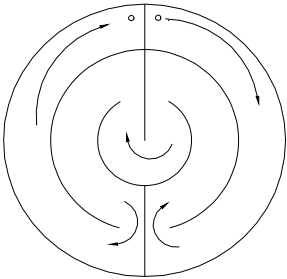
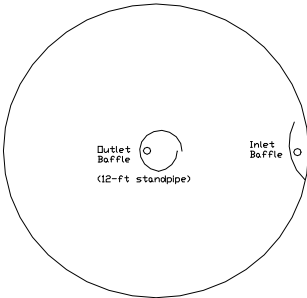
Contact Tank Summary.xls ***Chlorine Contact Chamber Design and Flow Evaluation*** **Version 1.04**

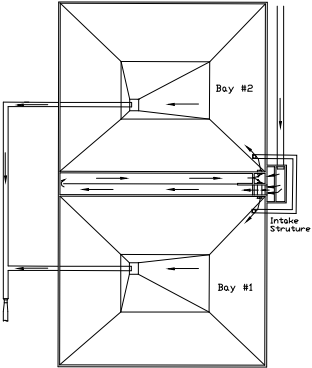
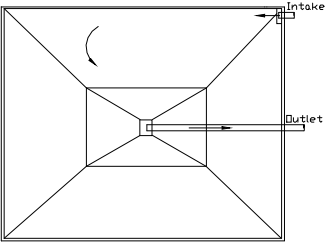
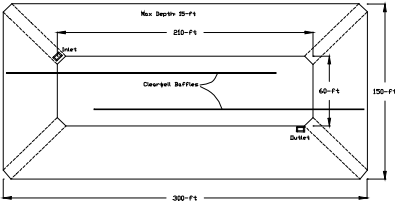
Contact Tanks	Displays different contact tanks with and without baffles and related flow parameters.
Length-Width Graph	Graph that plots Length-to-Width (L:W) ratio vs. t_{10}/T . Individual data points are associated to the person or company that conducted the test. It may be used to predict t_{10}/T based on L:W ratio and to develop a best-fit curve for individual data points.
Length-Width Graph2	Graph that plots Length-to-Width ratio vs. t_{10}/T . Individual data points are not associated to the person or company that conducted the test. This graph may be used to develop the best-fit curve.
Length-Width Graph3	Graph that plots Length-to-Width ratio vs. t_{10}/T for all data points excluding Marske and Boyle results. This graph may be used to develop the best-fit curve. Graph that plots Length-to-Width ratio vs. t_{10}/T for under-and-over flow configurations.
Predicted t_{10}/T	The short-circuiting index t_{10}/T is calculated for different L:W ratios based on data points as a whole and data points from test conducted by individual person(s) or Company.
Definition	Defines performance parameters commonly used in conventional analysis of contact basins
Reference	List the references of person(s) or company that conducted the tracer studies listed in this data base.
For questions and comments, you may contact:	Guy Schott, P.E. Associate Sanitary Engineer Mendocino District 50 D Street, Suite 200 Santa Rosa, CA 95404 707-576-2732, email: gschott@dhs.ca.gov

Type No.	Configuration - Plan View	Brief Description	Plant Flow (MGD)	Date of Test	L/W	T min	t_{10}/T	t_{50}/T	Morril Index t_{90}/t_{10}	Dispersion Index d	Type of Inlet	Type of Outlet	Tracer	Reference
1		Cross Baffled Serpentine Basin	0.7	3/21/70	24.4:1	44	0.61	0.91	2.15	0.072	Unbaffled Pipe Entrance	90° V-Notch Weirs	Rhodamine B Dye	1
			1.1	4/21/71	21.7:1	50	0.55	0.82	2.19	0.065	Unbaffled Pipe Entrance	Sharpcrested Weir	Rhodamine B Dye	1
			0.5	5/27/70	12.5:1	28	0.51	0.82	2.7	0.118	Unbaffled Pipe Entrance	90° V-Notch Weirs	Rhodamine B Dye	1
2		Baffled Serpentine Basin	2.0	10/29/97	9:1	69	0.31	0.78	5.1	0.2039	Baffled pipe entrance	Unbaffled pipe outlet	Fluoride	7
3		Single Baffle Basin Water depth 15 ft	16		6.9:1		0.27	?	5.59	0.29	Unbaffled Pipe Entrance 90° vertical bend upward near top	Unbaffled pipe outlet about midway of basin	Fluoride	2
4		Baffled Serpentine Basin	3.5	9/15/01	16.5:1	28	0.39	0.71	3.8	0.09482	Unbaffled pipe entrance	Unbaffled pipe outlet	Zinc	14
5		Longitudinal Baffled Serpentine Basin	1.5	5/15/70	70:1	83	0.63	0.76	1.43	0.019	Unbaffled pipe entrance	Sharpcrested Weir	Rhodamine B Dye	1
			1.5	5/16/70	70:1	83	0.57	0.71	1.52	0.024	Unbaffled pipe entrance	Sharpcrested Weir	Rhodamine B Dye	1
6		Baffled Serpentine Basin	?	1997	56:1	?	0.73	?	?	?	Unbaffled Pipe Entrance 3-inches off floor	Unbaffled pipe outlet 6-inches off floor	NaCl	8

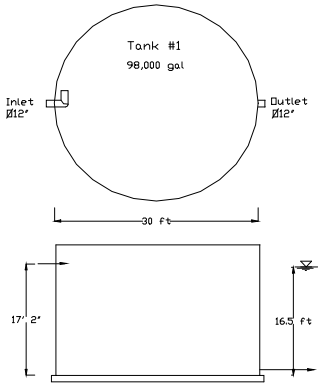
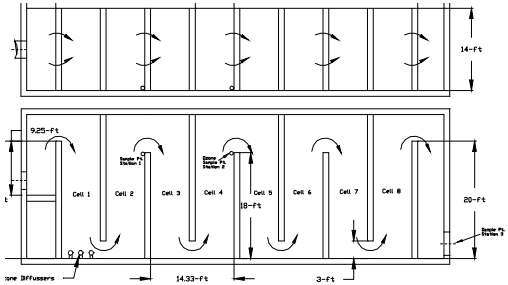
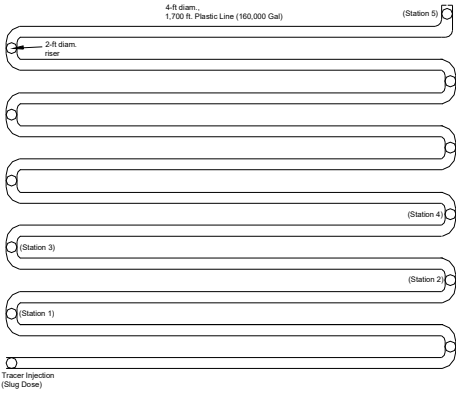
Type No.	Configuration - Plan View	Brief Description	Plant Flow (MGD)	Date of Test	L/W	T min	t_{10}/T	t_{50}/T	Morril Index t_{90}/t_{10}	Dispersion Index d	Type of Inlet	Type of Outlet	Tracer	Reference
7		Baffled Serpentine Basin Water depth: 8.5 ft	24	3/20/98	27:1	240	0.53	1.05	4.4	0.2161			Lithium	12
8		Rectangular Secondary Clarifier	30.2	3/7/70	7.5:1	37	0.67	0.95	2.25	0.081	Unbaffled ports Across face of inlet	V-Notch Weirs	Rhodamine B Dye	1
9		Rectangular Flocculation/Sedimentation Basin	18.6	7/8/99	-	105	0.64	0.95	-	-	Unbaffled ports for each Flocculator	V-Notch Weirs	Lithium	13
10		Flocculation Basins	18.6	7/8/99	-	22.7	0.46	1.08	-	-	Unbaffled ports for each Flocculator	Unbaffled ports	Lithium	13
11		Rectangular Concrete Basin	1.9	5/2/70	3:1	63	0.39	0.72	3.68	0.254	Target baffled Ports Across Face of Inlet	Cipolletti Weir	Rhodamine B Dye	1
			1.9	5/9/70	3:1	68	0.49	0.81	2.97	0.147	Target baffled Ports Across Face of Inlet	Sharpcrested Weir	Rhodamine B Dye	1
			3.6	4/24/71	3:1	35	0.39	0.63	3.21	0.149	Target baffled Ports Across Face of Inlet	Sharpcrested Weir	Rhodamine B Dye	1
			0.3	4/20/71	9:1	107	0.31	0.58	3.83	0.252	Target baffled Pipe Entrance	Sharpcrested Weir	Rhodamine B Dye	1
12		Long, Narrow and Shallow Gunite Lined Channel 3-ft deep; 16-ft wide; 335-ft long	3.5	2/21/70	21:1	49	0.59	0.85	2.14	0.077	Unbaffled pipe entrance	Sharpcrested Weir	Rhodamine B Dye	1
			3.4	3/20/70	21:1	50	0.62	0.78	2.07	0.084	Unbaffled pipe entrance	Sharpcrested Weir	Rhodamine B Dye	1
13		Serpentine - long rectangular channel; 16.8 ft deep; 7.5 ft wide channel; 272 ft long	18.6	7/8/99	36:1	22.3	0.8	1.18	2.0	0.07	Baffled pipe entrance	Baffled Outlet	Fluoride	13

Type No.	Configuration - Plan View	Brief Description	Plant Flow (MGD)	Date of Test	L/W	T min	t_{10}/T	t_{50}/T	Morril Index t_{90}/t_{10}	Dispersion Index d	Type of Inlet	Type of Outlet	Tracer	Reference
14	 Diameter: 10-ft Water Level: 8.2-ft	Baffled Serpentine Basin constant tank level 4,800 gallon storage	0.0288 20 GPM	9/11/2003	10.4	240	0.39	0.94	5.43	0.23701	4-ft length perforated PVC located at bottom of tank	PVC pipe located at top of tank	Fluoride	16
15		Baffled Serpentine Basin	1.44	11/20/97	23.5:1	132.6	0.5	1.16	4.77	0.1562	Unbaffled pipe entrance 3-inches off floor	Unbaffled pipe outlet 6-inches off floor	Fluoride	9
16		Baffled Serpentine Basin Inlet/Outlet located at bottom Diam: 137-ft Ht: 22.7 ft to overflow	14.3	4/7/2005	16.6		0.45	0.92	2.0	-	Unbaffled pipe entrance	Unbaffled pipe outlet	Fluoride	19
17		Unbaffled Basin	1.44	11/20/97	-	?	0.19	?	?	?	Unbaffled pipe entrance 3-inches off floor	Unbaffled pipe outlet 6-inches off floor	Fluoride	4

Type No.	Configuration - Plan View	Brief Description	Plant Flow (MGD)	Date of Test	L/W	T min	t_{10}/T	t_{50}/T	Morril Index t_{90}/t_{10}	Dispersion Index d	Type of Inlet	Type of Outlet	Tracer	Reference
18		Baffled Serpentine Basin	1.4	8/9/96	81:1	47.4	0.78	1.03	1.73	0.07719	Unbaffled pipe entrance 5 feet off floor	Outlet Weir Box 10 feet off floor	Fluoride	5
19		Circular Baffled Basin	111.9	9/24/97	37.7	174	0.52	0.79	2.2	0.00712	Unbaffled pipe entrance	Unbaffled pipe outlet	Lithium	10
20		50-ft diameter Inlet/Outlet Baffles 13.5-ft Height 14-inch inlet/outlet Outlet pipe is 12-ft standpipe. Operated at 12-ft during tracer test.	2.016 0.9677 0.7128	3/8/05 6/8/05 6/9/05	-	126 262 356	0.29 0.14 0.20	0.78 0.36 0.65	9.2 8.5 8.4	-	Baffle pipe entrance	Baffle pipe outlet	Fluoride	18

Type No.	Configuration - Plan View	Brief Description	Plant Flow (MGD)	Date of Test	L/W	T min	t_{10}/T	t_{50}/T	Morril Index t_{90}/t_{10}	Dispersion Index d	Type of Inlet	Type of Outlet	Tracer	Reference
21		Serpentine long rectangular channel followed by two unbaffled bay tanks operated in parallel	16.8	7/8/99	-	337	0.16	0.68	5.5	1.26	Unbaffled pipe entrance top corner of basin	Unbaffled pipe outlet on bottom	Fluoride	13
22		Unbaffled concrete underground tank; inlet top corner; outlet bottom center	35 40 45	10/9/97 9/18/97 9/4/97	- - -	235 209 184	0.39 0.31 0.34	0.88 0.74 0.81	4.5 5.0 5.2	0.1657 0.1799 0.1823	Unbaffled pipe entrance	Unbaffled pipe outlet	Lithium	6 6 6
23		Baffled Tank 30-ft between baffles Note: Width in the L:W ratio was decreased to account for tank slope. Operated at 60% full during test. Water L:W was 262:111 ft Baffle Length: 210 Approximately 100,000 gallon of inlet/out pipeline included in study. Total Tank + Pipe Vol. = 1.5 MG	20 41.5	3/17/04 7/21/04	37.6 37.6	108 52	0.59 0.67	0.86 1.0	2.2 2.8	- -	Unbaffled pipe entrance	Unbaffled pipe outlet	Fluoride	17

Type No.	Configuration - Plan View	Brief Description	Plant Flow (MGD)	Date of Test	L/W	T min	t_{10}/T	t_{50}/T	Morril Index t_{90}/t_{10}	Dispersion Index d	Type of Inlet	Type of Outlet	Tracer	Reference
24		Old clarifier converted to clearwell; circular v-notch weir left in.	0.216	10/10/98	-	179	0.09	0.55	20.3	1.72	Circular weir entrance submerge	Perforated piping on bottom of tank	Fluoride	11
25		Tanks in series	2.52	2/9/96	-	128	0.34	0.92	5.4	-	Tank1: 90 degree bend top of tank. Tank2: 90 degree bend top of tank.	Tank 1: Bottom of tank Tank 2: Bottom of tank.	Zinc	3

Type No.	Configuration - Plan View	Brief Description	Plant Flow (MGD)	Date of Test	L/W	T min	t_{10}/T	t_{50}/T	Morril Index t_{90}/t_{10}	Dispersion Index d	Type of Inlet	Type of Outlet	Tracer	Reference
26		Unbaﬄed Basin	2.52	2/9/96	-	50	0.22	0.74	9.4	-	90 degree bend top of Tank	Bottom of tank 180° from inlet	Zinc	3
27	Over and under configuration 	Station 1 Station 3 Station 2 Station 1 Station 3	13.5 13.5 13.5 10.6 10.6	10/20/05 10/20/05 10/21/05 10/21/05 10/21/05	4.4 16.8 8.0 4.4 16.8	3.46 14.06 6.58 4.39 17.8	0.62 0.82 0.63 0.56 0.75	1.1 1.2 1.0 1.0 1.1	2.1 3.4 2.65 3.3 2.2	0.29525 0.15422 0.1119 0.0238 0.1569	Baffle pipe entrance	Unbaﬄed pipe outlet	Fluoride	20
28	Serpentine Pipeline 	Station 1 Station 2 Station 3 Station 4 Station 5	0.513 0.513 0.513 0.513 0.513	1/30/03 1/30/03 1/30/03 1/30/03 1/30/03	76 114 153 192 422	79.8 121 162 202 446	0.82 0.84 0.85 0.82 0.96	0.96 0.93 0.93 0.89 1.0	1.5 1.3 1.2 1.2 1.2	-	Unbaﬄed pipe entrance	Unbaﬄed pipe outlet	Fluoride	15

**Performance parameters commonly used in conventional
conventional analysis of contact basins.**

Parameter	Definition
T	Theoretical detention time.
t_{10} , t_{50} , t_{90}	Time for 10, 50, and 90 percent of the tracer to pass through the reactor.
t_{10}/T	Index of short-circuiting
t_{50}/T	Index of mean detention time
t_{90}/t_{10}	Morril dispersion index, indicates degree of mixing, as t_{90}/t_{10} increases the degree of mixing increases. Likewise, as t_{90}/t_{10} approaches 1.0 plug flow conditions are observed.
d	Dispersion index, indicates degree of tracer dispersion. Under ideal plug flow conditions, the value of d should approach zero. The dispersion index calculation includes all points of the dispersion curve.
L/W	Length to width ratio of flow. Length is the total flow travel in the baffled channel divided by the width of the channel.

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2.7 Electrical, TM-6

Oakwood RTB

- Sample pumps
- TRC analyzers
- Replacement of Sodium Hypochlorite FRP storage tanks
- Replace all metering pumps with recirculation pumps, common discharge header and motorized flow control valves
- Replace chemical feed/transfer piping
- Temporary chemical feed system during construction
- Chemical mixer enclosures replacement



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

From: Megan Czach, CDM Smith, Inc.

Date: June 1, 2023

*Subject: TM-6 Electrical Improvements (LEIB-ELEC-1)
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

This technical memorandum (TM) has been developed to analyze adding reset buttons for each mixer motor on the face of the motor control centers (MCC) and via the SCADA system at the Leib CSO Screening and Disinfection Facility (SFD). Based on the Design Team's evaluations discussed in this TM, the Design Team is recommending the following for adding a physical reset on the face of each MCC bucket and via the SCADA system.

- There are newer soft starters that can be installed to allow for manual and virtual resetting of the starter when it trips. It is recommended to replace the existing soft starters with a new soft starter. This design work will be coordinated with TM-12 Leib CFD Model which is analyzing different mixer technologies and options.

1.0 Introduction and Purpose

The Leib CSO SFD electrical system consists of one DTE utility feed from a 480V, 3-phase, outdoor transformer and one diesel generator feed from a 350kW, 480V, 3-phase stationary generator. The utility feed is connected to a 600-A motor control center, MCC-B, with a 600A sub-feed connection to a 600A automatic transfer switch (ATS). The ATS then feeds a distribution panel with 2 600A breakers, which feeds 2 MCCs, MCC-A and MCC-C. The MCCs feed the various pumps, valves, motors, transformers, and panels at the facility. The facility includes 18 mixers that are powered from all three MCCs.

Presently, when a trip occurs for one of the existing mixer motors, the operators need to call an electrician to reset the mixer units, which is time consuming. There is presently no reset button on the front of the MCC buckets nor is there an option to reset via SCADA.

The purpose of this TM is to summarize the options to address the reset issue. It will look into how to add a physical reset on the face of each MCC bucket for each mixer motor and via the SCADA system.

2.0 Existing System Description and Evaluation

There are presently two Prechlorination Influent Mixers located in the influent channel. Each mixer is 15HP at 460V. There are an additional 16 Disinfection Chamber Mixers which are located in the mixing chambers. There are four mixing chambers with four mixers each. Three mixers can run at a time with one standby in each mixing chamber. Each of these mixers are 15HP at 460V.

The original power configuration for the mixers had across the line starters for each mixer motor. This configuration was updated to the present configuration which has Allen-Bradley soft starters, model type SMC-3, installed in each mixer MCC bucket. The SMC-3 soft starter has a reset button installed on it for resetting, but this requires the operator to call an electrician to come to the building to open the MCC bucket and physically reset the soft starter. The existing soft starter configuration inside the MCC bucket can be seen in **Figure 2-1**.



Figure 2-1
Existing soft starter configuration inside MCC bucket

3.0 System Evaluation

The existing MCCs were installed in 2003 and are in good condition with no visual signs of corrosion or damage. The existing MCCs are Cutler-Hammer, which is now Eaton. Eaton has indicated new buckets would need to be installed into the MCCs with new soft starters for each mixer.

The existing soft starter cannot be connected to a reset button on the front of the MCC even though there is room on the front of the MCC buckets to install one. The existing soft starter also does not have communication capabilities, either hardwired or ethernet/modbus signal, to be reset via SCADA.

4.0 Descriptions of Alternatives

There are newer technology soft starters that can be installed to meet the requirements of physically resetting at the MCC and via the SCADA system.

Each of the existing soft starters can be replaced with a newer version that has both the capability to be reset manually at the MCC and virtually via the SCADA system. The Design Team spoke with both Eaton, the manufacturer of the MCC, and Allen-Bradley, the existing soft starter manufacturer, about their newer products that can be installed to solve the reset issue.

Eaton has a soft starter, model S811+, that can be reset via a keypad installed on the MCC bucket cover and can be reset by the SCADA system via an ethernet/modbus communication cable. A physical reset pushbutton cannot be installed to reset this soft starter. This soft starter will fit in the existing bucket size (18 inches). Eaton recommends ordering new buckets to be installed in the existing MCCs instead of modifying the existing bucket. The face of the keypad for the S811+ soft starter can be seen in **Figure 3-1**.



Figure 3-1
Eaton S811+ Soft Starter Keypad

Allen-Bradley has the SMC Flex soft starter. The SMC Flex can have a manual reset pushbutton or a keypad installed on the front of the MCC, and it has the communication capabilities to be reset via the SCADA system via an ethernet/modbus cable. Allen-Bradley has indicated that this soft starter would need to be mounted in a 24-inch bucket. TM-12 Leib CFD Model is analyzing different technologies and number of mixers. If the option to reduce the number of mixers is the design moving forward, then this soft starter would be an option. The face of the keypad for the SMC Flex soft starter can be seen in **Figure 3-2**.



Figure 3-2
Allen Bradley SMC Flex Soft Starter Keypad

5.0 Alternatives Analysis

Not used.

6.0 Life Cycle Cost Analysis

Not used.

7.0 Summary and Recommendations

The existing starter configuration will not support a manual reset pushbutton on the face of each MCC bucket nor via the SCADA system. There are newer soft starters that can be installed to allow for manual and virtual resetting of the starter when it trips. It is recommended to replace the existing soft starters with a new soft starter.

Different technologies are being investigated as options for an upgrade mixing system in TM-12 Leib CFD Model. The information in this technical memorandum presents a solution if replacement of the mixers is in kind. If a different technology is chosen for design, the electrical group will work with the process mechanical engineers to make sure any starter will have the capabilities to be reset manually at the MCC and virtually on the SCADA system.

2.8 Instrumentation and Control Improvements, TM-7 and TM-21

Oakwood RTB

- Controls/monitoring associate with new loads listed above in electrical
- Float based alarm added on storm pump station intermediate level
- Revise operational strategy (control of storm and sanitary pumps in Ovation) as determined in process evaluation
- Signals to/from new grease lube systems
- Flow meter on each storm pump discharge
- Ovation remote I/O cabinet(s) may needed for integration of additional I/O signals (TBD)
- Replace level sensors for wet well monitoring (total of 8)
- Calibration and scaling of level sensors per City of Detroit Datum and NAVD88
- Addition of process cameras

Leib SDF

- Field instrument calibrations
- Addition of Ovation I/O modules as required
- Ovation programming
- Possible addition of more process cameras
- Replacement of field instruments for disinfection system
- Signals for new equipment



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Michael S. Watkins, CDM Smith
Hassan Ajami, PCI Vetrix, LLC
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Date: June 1, 2023

*Subject: TM-7 I&C Improvements
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

This technical memorandum (TM) has been developed to address the Instrumentation & Controls (I&C) related improvements at the Oakwood and Leib Combined Sewer Overflow (CSO) facilities identified by the Great Lakes Water Authority (GLWA) and the CS-299 report – OKW-I&C-1A and LEIB-I&C-1A. The memo reviews the existing conditions found at each facility and alternatives to be investigated for instrumentation and control focused items. The three main I&C focused items on this project are the replacement of the level sensors, integration of new Input/Output (I/O) signals into the existing process control systems at each facility, and the addition of process cameras for monitoring process areas at each facility. The following recommendations were generated from this TM:

- Further review the implementation of radar level sensors for wet well monitoring at the Oakwood facility. Further review will include investigation into the ease of maintenance for each type of sensor, installation locations available, and accuracy of the technologies at these locations. GLWA operations has eliminated utilizing submersible pressure transducers due to maintenance concerns. Laser sensors have been eliminated due to classification rating of the sensor not meeting the requirements for the Leib and Oakwood facilities. Review will include sensor redundancy, sensor selection by the operator or the control system, and how the level readings are displayed on the process graphics.
- Integrate new I/O signals into the existing Ovation Distributed Control System (DCS) at Oakwood by utilizing spare I/O points presently available on the existing process controller and extended I/O racks. If spare capacity is not available, identify a location within the electrical room for a new Ovation remote I/O cabinet to be installed.

- Integrate new I/O signals into the future Ovation DCS at Leib by utilizing spare I/O points that will be available within the process controller cabinet. The control system upgrade at Leib is presently under design under a GLWA Contract 2004538.
- Integration of OEM panels equipped with PLC hardware and electrical devices with network communication capability will be through Ethernet utilizing FDI / 3rd party network switches.
- Implement process cameras at Oakwood to aide operations personnel in monitoring the remote facilities. Process cameras hardware and implementation shall be based on GLWA standards provided to the Design Team. Locations for cameras will be reviewed with GLWA during the preliminary and detailed design development.
- Coordinate upgrades to process camera system at Leib with on-going control system upgrade occurring under GLWA Contract 2004538. Additionally, coordinate with GLWA on the need for additional process cameras at the facility. Process cameras hardware and implementation shall be based on GLWA standards provided to the Design Team. Locations for cameras will be reviewed with GLWA during the preliminary and detailed design development.

1.0 Introduction and Purpose

GLWA operates several CSO facilities as part of the overall sewerage conveyance and collection system. GLWA identified improvements to be implemented at the Oakwood CSO Retention Treatment Basin (RTB) and Pump Station and the Leib CSO Screening and Disinfection Facility (SDF). The improvements are intended to improve facility reliability, flexibility, operation, maintenance and safety to support increases in utilization for the two facilities. Future projects will divert flow from the Northwest Interceptor (NWI) to the Oakwood CSO facility, and divert flow from the Meldrum sewer to the Leib SDF.

The focus of this TM is on the I & C related improvements at each facility. The main I&C improvements are related to the influent flow metering and wet well level measurement at Oakwood, the Detroit River Interceptor (DRI) level measurement at Leib, and the integration of process cameras. There are additional process or system improvements that will require I&C modifications such as chemical disinfection, mechanical screen replacements, and overall facility sequence of operations (control narrative) modifications. The purpose of this TM is to summarize the I&C improvements, identify existing field conditions, and to recommend alternatives where appropriate.

2.0 Existing System Description and Conditions

2.1 Oakwood CSO RTB and Pump Station

2.1.1 Level Instrumentation

The Oakwood CSO has two wet wells for incoming sewage flow – East and West. When the new facility was built, each wet well had redundant bubbler systems for level monitoring on the

upstream and downstream sides of the screen (**Figure 2-1 and 2-2**). Each level was monitored by dual pressure sensors located in the Sanitary Pump Station (SPS) basement.

East Wet well

Upstream – LT804017A/B

Downstream – LT804018A/B



West Wet well

Upstream – LT804015A/B

Downstream – LT804016A/B



Figure 2-1

Oakwood CSO Redundant Bubbler Systems for Wet Well Level Monitoring

Components of the bubbler systems have failed over time and the location of the air piping within the wet well has made access for repair difficult. GLWA has installed alternate level sensors over time, with the present setup using ultrasonic and radar level transmitters to measure the levels in the wet wells. Due to the enclosed nature of the wet well, and the sanitary pumps, there have been issues with the ultrasonic sensors giving false readings. Radar units were added to provide backup level measurements and are now used as the main signal by operators and the control system.



Figure 2-2
Wet Well Level Sensors at Oakwood SPS

There are additional level sensors in the RTB side of the Oakwood facility for monitoring levels at the screens, inside the basins, surge chamber, and NWI connection. These sensors were calibrated and survey elevations were taken to provide level readings in true elevation in the control system.

Most of the instrumentation signals at Oakwood connect to the Ovation control system, except for the gas detection equipment which connects to the master gas system panel. The Ovation system is divided between the main panel at the SPS located in the front of the facility and a remote I/O panel in the RTB located by the screening equipment.

2.1.2 Control System Architecture

The existing Oakwood process control system utilizes an Emerson Ovation DCS platform with process controllers, database server, and operator workstations. A redundant process controller cabinet with redundant OCR1100 controllers is installed in the Instrumentation and Communication Room, along with an extended I/O cabinet (**Figure 2-3**). An Ovation remote I/O cabinet, located in the Electrical Room of the Screening Facility (**Figure 2-4**), integrates I/O from the screening process and CSO basins into the DCS. A control room located in the pump station is equipped with an Ovation database server, an operator workstation, and a large wall-mounted display for viewing the Human-machine interface (HMI) graphics (**Figure 2-5**).



Figure 2-3
Ovation Controller Cabinet, Extended I/O Cabinet, and UPS Cabinet in the Instrumentation and Communication Room



Figure 2-4
Ovation Remote I/O Cabinet in Screening Facility Electrical Room



Figure 2-5
Control Room for Oakwood CSO Facility

2.1.3 Process Cameras

There are no process cameras installed at the Oakwood CSO facility presently.

2.2 Leib SDF

2.2.1 Level Instrumentation

The Leib SDF influent is from two sewer lines under Mt. Elliot Street. There are existing level and Accusonic flow sensors inside the sewers upstream of the facility, as well as ultrasonic level sensors in the influent channel and disinfection chamber within the facility. Additional level and flow sensors are located at remote monitoring points on the “Toward Treatment Sewer to DRI” and on the Mt. Elliot sewer towards the outfall at the Detroit River. These remote sensors presently communicate with the Leib facility via radio links.

GLWA has an active design-build project to upgrade the Control Systems at the Leib, St. Aubin and Seven Mile facilities. This project is slated to replace the PLC and HMI equipment at the Leib facility, in addition to control panel modifications and instrument replacement. The remote I&C panels located outside of the Leib facility (CP-2, CP-3, CP-4) are also being replaced under the project and their radio communication back to the Leib facility is to be replaced with a secure cellular connection. This project is anticipated to begin construction towards then end of the year and all equipment slated for replacement will be in place by the time the design is complete.

The DRI Level sensor (LIT-3) located at the CP-3 remote panel on Jefferson Avenue is listed to be replaced under the Control Systems Upgrade project. The sensor is being replaced by the Control Systems Upgrade project (GLWA Contract # 2004538). Based on the CDM Team’s review of the 60% design submittal documents, the CDM Team’s work does not include evaluation of the level sensor. The CDM Team will use the associated signal as-is as an input to the operational strategy and associated facility control. LIT-3 will not be .

2.2.2 Control System Architecture

A process control system upgrade is presently being designed under a separate capital improvement project (CIP) to replace the existing Allen-Bradley PLC / HMI based control system presently being utilized (**Figure 2-6**). The existing Allen-Bradley platform utilizes obsolete Allen-Bradley PLC hardware installed, along with Rockwell HMI software for viewing HMI graphics (**Figure 2-7**). Under this separate CIP, the process control system will be migrated to a distributed control system (DCS) architecture utilizing Emerson Ovation hardware. A new Ovation controller cabinet is planned for installation into the existing Electrical Room. The existing PLC panel, Panel CP-1A (**Figure 2-8**), will be converted to a Marshalling Panel at an intermediate termination location between field devices and the Ovation I/O modules. The Ovation controller will contain redundant process controllers communicating with redundant Ethernet Root Switches. A new database server and two operation workstations will be provided with dual monitors to enable local monitoring through HMI graphics.



Figure 2-6
Existing Rockwell HMI System in Office



Figure2-7
Existing Allen-Bradley PLC Processor Racks in Office



Figure 2-8
Existing Control Panel CP-1A housing Allen-Bradley PLC hardware. CP-1A will be converted to a Marshalling Cabinet under separate CIP.

2.2.3 Process Cameras

The Leib SDF facility has existing process cameras that overlook the screening channels. Coordination with GLWA Contract 2004538 to identify improvements to the network infrastructure and existing process cameras will be performed at the design documents are developed further on the control system upgrade project.

3.0 System Evaluation

3.1 Oakwood CSO RTB & SPS Level Sensors

The physical design and orientation of the wet well at the Oakwood facility provides some challenges for level measurement. Due to past experience with contact type technologies (bubbler) and the difficulty of maintaining them inside the wet well, alternative non-contact solutions need to be investigated. Based on the critical nature of the wet well level measurements and their impact on the operation of the SPS and RTB, redundant solutions are recommended.

GLWA's pilot testing of different non-contact technologies in the wet well showed that radar sensors provided better reliability and accuracy over a wide range of elevations. Similar results were gained with ultrasonic sensors after they were tuned and adjusted for the shape and configuration of the wet wells. Contact-type sensors such as hydrostatic were initially considered but are not being pursued due to maintenance concerns with equipment located inside the wet well. Investigation of alternative technologies such as laser-based level sensors was performed. Laser level sensors provide accuracy and immunity from noise but are susceptible to fog/mist. The main reason they were not considered was the lack of certification for use in classified environments.

Another consideration for the wet well monitoring is the location of the sensors, keeping in mind future maintenance needs. Due to the location of the opening above the wet well, the present downstream sensors are located below the wet well ceiling slab and are difficult to access. One alternative is to locate the sensor below the access hatches for the sanitary pumps (**Figure 2-9**). The use of a "swing-arm" type mounting system, similar to the one installed at the Puritan Fenkell facility (**Figure 2-10**), would be part of the installation design. This configuration allows for the sensor to be moved out of the wet well for maintenance or for access to the hatch.

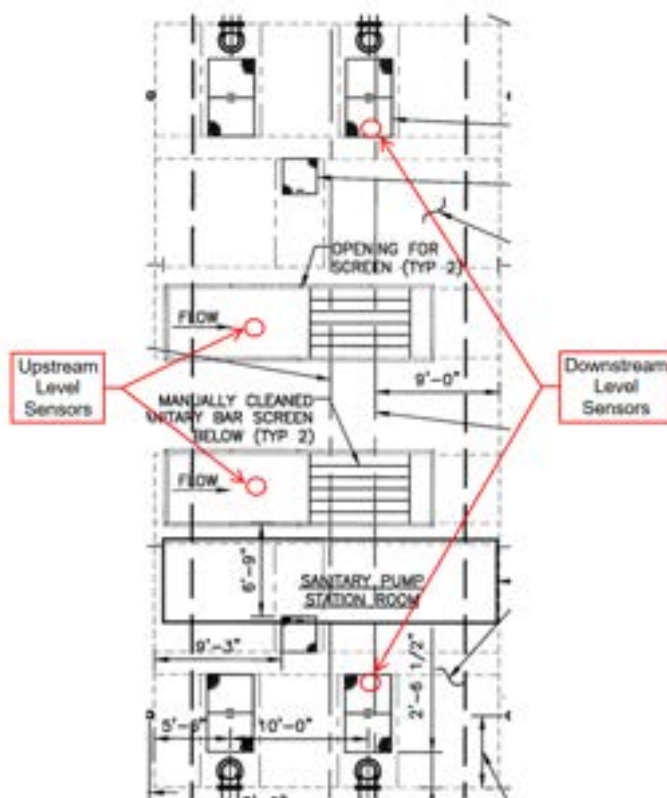


Figure 2-9
Oakwood SPS Wet Well Level Sensor Locations



Figure 2-10
Level Sensor Swing-arm Mounting Assembly

3.2 Leib SDF

The level sensors at the Leib facility are planned to be replaced under the Control System Upgrade project. The remote sites tied to Leib are also planned for upgrade under that project. Level measurement will be coordinated with that project to identify the proper instrument to be used.

4.0 Description of Alternatives

4.1 Level Sensors Alternatives

The two main categories of level sensing technologies are contact and non-contact. Contact type sensors are in direct contact with the process fluid. Sensors can be located inside a vessel (submersible/hydrostatic), or connected via a diaphragm close to the bottom of a vessel (pressure sensor). Non-contact sensors are not in direct contact with the process fluid – radar, ultrasonic, and laser are most common types. These are located at the top of a vessel, outside of any flow path. Newer model can also be mounted on the outside of an enclosed vessel, which is advantageous for chemical level monitoring.

The advantages to non-contact technologies are longer sensor life since they are out of any corrosive/harsh environments, and easier maintenance with sensors normally located close to access hatches or on top of tanks. Replacement of a failed sensors is made easier without confined space access. Disadvantages include higher costs than contact type sensors, and susceptibility to interference (fog, mist, etc.).

4.2 Integration of New I/O Signals

For the integration of new I/O signals into the existing Ovation DCS system at Oakwood and future Ovation DCS system at Leib, there are two options:

- Option 1 - Utilize spare I/O points and install additional Ovation Cabinets if necessary to incorporate the I/O signals from new field instrumentation and process equipment.
- Option 2 - Utilize Rockwell PLC hardware for interfacing with new I/O signals and digitally communicate the signals into the Ovation DCS systems at each facility.

Rockwell hardware would utilize the ControlLogix or CompactLogix platform that have been adopted by GLWA as alternatives to Emerson Ovation. A PLC panel equipped with power supplies, I/O modules, control processor, and communication module would provide the interface to hardwired I/O signals from field instrumentation and process equipment. Communication to the Emerson Ovation DCS would be implemented through the one of two methods:

- Ethernet communication from PLC rack to third-party network switch provided on Ovation system to communicate to 3rd party (PLC) devices. The Ethernet/IP driver within the Ovation process controller would be utilized to communicate to the PLC through the 3rd party network switch and router.

- Install dedicated Ethernet Link Controller (ELC) module in the Ovation Controller or I/O panel to communicate with the PLC over Ethernet.

4.3 Process Cameras

GLWA provided standard guidelines and design drawings for the process camera system. No alternatives were reviewed.

5.0 Alternative Analysis

5.1 Level Sensors

GLWA uses various types of level sensor throughout their facilities and system. Selection of contact vs. non-contact is on a case-by-case basis per the application. For the wet wells at Oakwood, past experience with the bubbler system and ultrasonic sensors initially steered the decision for new sensors towards radar and laser units. Maintenance of any type of submerged sensor is difficult, requiring draining the wet well and confined space. Discussions with GLWA operations and maintenance staff confirmed that contact type sensors were not preferred.

Ultrasonic sensors were installed in the wet wells at one point as replacements for the failed bubblers, but those exhibited spikes in level readings making them unreliable. Tuning and adjustment of the ultrasonic sensors has improved their performance, making them a suitable alternative for the backup level sensor role. The radar sensors piloted by GLWA have been more reliable over time and are the main alternative for new sensor technology. Laser level sensors have not been used at GLWA and their lack of certification for the environment has dropped them out of consideration.

5.2 Integration of I/O Signals

Option 1, utilizing Ovation spare I/O points and if necessary installing an additional remote I/O cabinet provides the most cost effective and efficient option for these facilities. Both facilities will utilize the Ovation hardware and offer spare points to integrate future I/O points. All new I/O points at Leib are anticipated to be wired to spare I/O channels and new I/O modules installed in the Ovation Controller Cabinet to be installed under the separate GLWA Contract # 2004538. At Oakwood, limited spare points are available for new I/O signals. A new Ovation remote I/O cabinet may be needed to integrate the new signals from the anticipated field instrumentation and process equipment for disinfection. This cabinet would be located in the Electrical Room of the Pump Station due to the lack of space to install a new I/O cabinet in the Instrumentation and Communications Room.

Utilization of Rockwell hardware at these facilities as Option 2 was eliminated due to both facilities utilizing Ovation DCS hardware, along with eliminating the need for a PLC system integrator to provide PLC logic development and I/O mapping to the Ovation DCS. If PLC hardware were utilized, testing and commissioning of the system would include verification and checkout of the PLC logic and additional verification of data mapping between the PLC and Ovation DCS.

5.3 Process Cameras

No alternatives were developed or analyzed; design will be based on GLWA standards.

6.0 Summary, Recommendations and Key Decisions

6.1 Level Sensors

Non-contact level sensors will be utilized for the level measurement of the wet wells at Oakwood. Due to the crucial nature of the wet well level measurement in the overall facility's operation, the recommendation is to utilize redundant level sensors on the upstream and downstream sides of the wet well screens. Control logic will be updated for locations where multiple level sensors are utilized to enable GLWA to select a preferred sensor, highest level from multiple sensors, or an average value for the control variable. Refer to TM-15 for details on the control strategy to be implemented with the level sensors.

6.2 Integration of I/O Signals

New instrumentation and process equipment for both Leib and Oakwood will be integrated into the Ovation DCS Platform by utilizing spare I/O points and installation of additional Ovation I/O modules. For Oakwood, if the new I/O signals exceed the limited number of spare channels available, a new Ovation remote I/O cabinet will be installed. This remote I/O cabinet will most likely be located in the Electrical Room, due to a lack of space in the Instrumentation and Communication Room. For Leib, new instrumentation and equipment I/O signals will be integrated into the future Ovation Controller Cabinet to be installed under a GLWA Contract 2004538. Spare capacity is anticipated to cover all new I/O signals for the site. This includes utilization of spare channels on installed I/O modules, along with the installation of new I/O modules within the existing cabinet.

For OEM and 3rd party equipment equipped with PLC or network communications, including packaged screening systems and soft starters for pumps, an Ethernet connection will be provided to connect to the existing Foreign Device Interface (FDI) or 3rd party network switches. The Emerson process controllers communicate to the FDI network switches through the Root Switches and routers.

6.3 Process Camera System

Per GLWA's request in the RFP, new process cameras will be installed at each facility to monitor process area equipment operation. The process camera system will be based upon GLWA standards provided to the Design Team. In compliance with GLWA standard, the following key design items are noted:

- Specified hardware will be Avigilon for cameras and Razberi EndpointDefender for network endpoint appliance with no substitutions permitted.
- Design drawing package for process camera system will include the following:

- Plan view of the camera, cone of view, network device, and server locations. Conduit, wiring, grounding, and viewing PC/monitor information will be provided with design documents and referenced to plan view if not included on plan view drawing.
- Camera panel and installation mounting details based on GLWA standard details.
- Riser diagram for process camera system hardware with port numbers identified.
- Schedules for cameras, conduits, devices, and power circuits with tag information.
- Coordination meeting with GLWA IT for determination and identification of all server, IP, and camera, and switch addresses.
- Coordination with GLWA's security system provider, D/A Central, for integration into the existing system.

6.4 Key Decisions

- Contact type level sensors will not be considered for installation at Oakwood.
- Upstream and Downstream wet well channels will both have redundant level sensors at Oakwood.
- Leib DRI Level sensor (LIT3) is being replaced by GLWA Contract 2004538.
- Emerson Ovation hardware will be utilized for the interface to hardwired I/O signals by utilizing existing spare I/O points on installed modules, adding I/O modules to existing Ovation cabinets, or adding additional Ovation I/O cabinets.

7.0 Next Steps

There are several areas that require additional investigation and selection of alternatives for other TMs to progress the process control system design.

- Redundancy for wet well level sensors
 - Level measurement criticality for facility operation
 - Sensor redundancy & failover strategies
 - Long-term maintenance costs
 - Ease of maintenance (sensor mounting locations / clearances)
- Integration of I/O Signals into Ovation DCS Platform
 - Finalize selection of disinfection equipment and develop P&IDs.

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- Finalize selection of screen systems and develop P&IDs.
- Identify I/O signals available (spare points / equipment to be removed / etc.).
- Identify need for new remote I/O cabinet based on point count.
- Identify OEM and 3rd party devices to be connected via Ethernet to the Ovation DCS.
- Coordination I/O requirements with control system upgrade at Leib.
- Process Control Functionality
 - Develop automatic control strategies once final disinfection equipment and methods for operation are finalized in TMs.
- Process Camera System
 - Identify process areas and locations GLWA operations wants to visually monitor through process cameras.
 - Identify locations for local hardware (switches / server / cabinet) associated with process cameras as Oakwood and Leib.
 - Engage DA Central to discuss the system design, integration, and establish an allowance to be included in the bid package.



Technical Memorandum

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Date: June 1, 2023

*Subject: TM-21 Basin Influent Flow Metering
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

The existing Teledyne ISCO Pro20 hot tap insertion pulse Doppler acoustic flow meters (Existing Meters) at the Oakwood Combined Sewer Overflow (CSO) Retention Treatment Basin (RTB) and Pump Station have reached the end of their expected life cycle. The Great Lakes Water Authority (GLWA) has appointed the Design Team to evaluate alternatives and design a solution to provide reliable Oakwood CSO RTB and Pump Station influent flow metering. The design is to include a primary means of metering the influent flow as well as a backup flow measurement. This technical memorandum (TM) reviews the existing flow metering system conditions at the Oakwood CSO RTB and Pump Station facility and analyzes potential alternatives to fulfill the Oakwood CSO RTB influent flow rate metering needs.

Review of the recorded influent flow rate data found that the Existing Meters no longer produce usable flow rate data and need to be replaced. The following improvements are recommended to provide reliable influent flow metering and a backup flow measurement at the Oakwood CSO RTB and Pump Station.

- An advanced Doppler insertion meter is to be installed as a replacement for each of eight Existing Meters to measure the Oakwood CSO RTB influent flow rate through metering along the storm pump discharge piping.
- A method of estimating the Oakwood CSO RTB influent flow rate using storm wet well level data from Ovation, variable frequency drive (VFD) data from Ovation, storm pump curves, and pump run time to be programmed as a backup to the new insertion meters. This method of estimating the Oakwood CSO RTB influent flow rate could be used to check the accuracy of

the flow meters over time and will be available if the flow meters go out-of-service during a wet weather event.

- Future consideration for installing a flow meter in the influent sewer upstream of the storm wet well to measure the Oakwood CSO RTB influent flow rate.

1.0 Introduction and Purpose

The existing flow meters at the Oakwood CSO RTB have reached the end of their expected life cycle and need rehabilitation or replacement. Analysis of the data produced by these flow meters has shown that they no longer provide accurate or reliable measurements of the flow through the storm pump discharge piping (Section 3.1).

Accurate measurement of flow through the storm pump discharge piping is important for several reasons:

- Determination of the chlorine feed rate to each pump
- Determination of the Oakwood CSO RTB influent flow rate for use in chlorine contact time (CT) calculation
- Analysis of storm pump behavior and performance
- Accurate Oakwood CSO RTB influent flow rate reporting

The Design Team investigated flow meter alternatives that provide accuracy and reliability in measuring Oakwood CSO RTB influent flow rate (Section 4.0). A brief overview of the alternatives considered includes:

- Rehabilitate the existing flow meters
- Replace the existing flow meters with latest version of the same make and model flow meter
- Replace the existing flow meters with an alternative metering technology
 - At the same locations as the existing flow meters
 - Insertion flow meters
 - Spool piece / In-line magmeters
 - At a different location along the storm pump discharge piping
 - Level sensors
 - Ultrasonic meters
 - Spool piece / In-line magmeters

- At a different location upstream of the Oakwood CSO RTB and Pump Station Storm Wet Wells
 - Ultrasonic meter

2.0 Existing System Description

As described in the 2012 CS-1364 Oakwood CSO Control Facility and Pump Station Operations and Maintenance Overview Manual, the Oakwood CSO RTB and Pump Station utilizes eight storm pumps to pump combined stormwater/wastewater up from the facility's storm wet wells to its Screen Facility and CSO Basins. Storm pump Nos. 1 and 2 are controlled by VFDs to allow pumping rates that vary from approximately 97 MGD down to 40 MGD at minimum speed. Storm pump Nos. 5 and 6 are also controlled by VFDs to vary their pumping rates from 178 MGD down to 72 MGD. The VFD equipped pumps are intended to allow the facility to match the incoming flow rates and maintain storm wet well levels. The remaining Storm Pumps, Nos. 3, 4, 7, and 8 are fixed speed pumps equipped with soft starters. These four storm pumps are intended for use during large wet weather events and have fixed pumping capacities of 178 MGD each.

Flow rates through all eight storm pumps are measured via the Existing Meters. The Existing Meters are placed within the storm pump discharge piping. **Figure 2-1** shows the associated pump number and the manhole (MH) yard vault of all eight Existing Meters, with color coding to show analogous MH yard vault locations. Existing Meters for storm pump nos. 3 & 5 and nos. 4 & 6 share common MH yard vaults. Existing Meters for Storm Pump nos. 1 through 6 are all located on the longest section of straight pipe in the discharge piping. Existing Meters for storm pump nos. 7 and 8 are located on the downstream horizontal run of the discharge pipes.

The Existing Meters are connected to their respective process through two-inch hot tap connections on the storm pump discharge piping through a two-inch flange and ball valve mounted on the pump discharge piping.

The electronics for each of these units are contained in NEMA 4X type enclosures. The Existing Meters operate using $115 \pm 10\%$ VAC, 60 Hz power. The signal input for the electronics is from a hot tap insertion transducer, with a 4-20 mADC input signal. The electronic units have a four line by 16-character display operating off an internal alkaline battery providing 24VDC, 13Ah @ 75 °F.

The Existing Meters are pulse Doppler acoustic flow meters with range gating signal processing. The Existing Meters use a transducer assembly with four individual velocity transducers using piezoelectric ceramics for emitting and receiving 1.23 MHz acoustic signals to measure velocity throughout the depth of flow. Each transducer has an operating temperature of 23 to 95 °F and is housed in a plastic transducer assembly on a corrosion resistant stainless-steel stem that can withstand a static pressure of 250 psi.

Each Existing Meter has a manufacturer stated accuracy of $\pm 2.5\%$ of reading and ± 0.01 ft/s times the area.

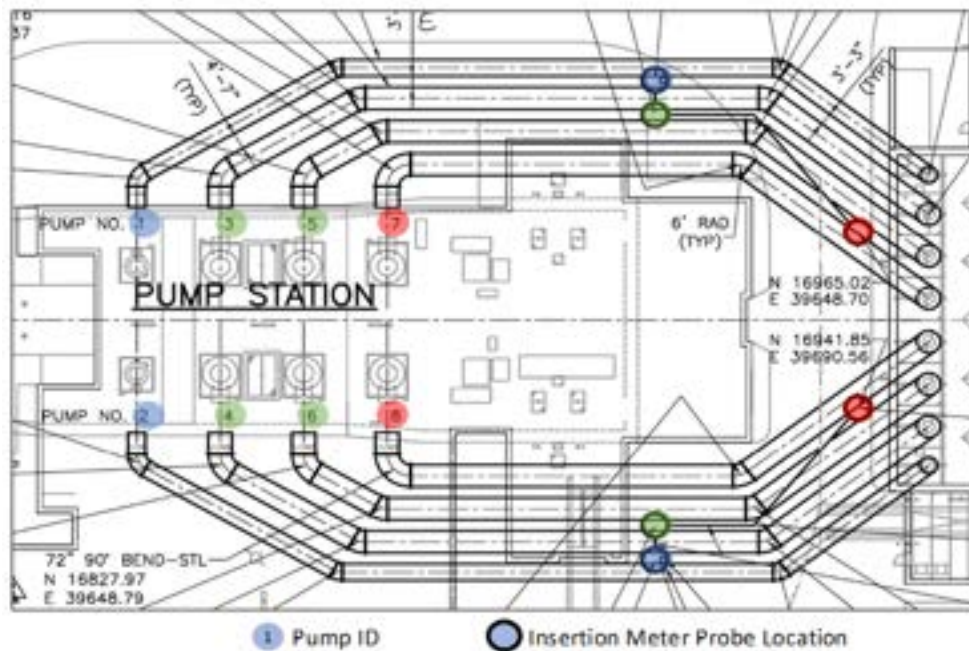


Figure 2-1
Oakwood Storm Pump Meter Pit Location

3.0 System Evaluation

Recorded flow meter data was collected and reviewed to evaluate the accuracy of the Existing Meters. Pump run time data was also collected and reviewed to supplement the evaluation. The analysis is described in detail in the following section.

3.1 Ovation Data Review

Recorded Ovation data from the eight storm pumps and the Existing Meters spanning from September 1, 2019 to November 15, 2022 was collected and reviewed. **Table 3-1** shows the point names and a description of the data gathered from Ovation for this analysis.

Table 3-1 Oakwood Ovation Data Gathered

Ovation Point Name	Point Description
N804001R.UNIT0@OKW	Oakwood Storm Pump 1 Running
N804002R.UNIT0@OKW	Oakwood Storm Pump 2 Running
N804003R.UNIT0@OKW	Oakwood Storm Pump 3 Running
N804004R.UNIT0@OKW	Oakwood Storm Pump 4 Running
N804005R.UNIT0@OKW	Oakwood Storm Pump 5 Running
N804006R.UNIT0@OKW	Oakwood Storm Pump 6 Running
N804007R.UNIT0@OKW	Oakwood Storm Pump 7 Running
N804008R.UNIT0@OKW	Oakwood Storm Pump 8 Running
OKW-ST1-FLOWRT.UNIT0@OKW	Oakwood Storm Pump 1 Flow Rate
OKW-ST2-FLOWRT.UNIT0@OKW	Oakwood Storm Pump 2 Flow Rate
OKW-ST3-FLOWRT.UNIT0@OKW	Oakwood Storm Pump 3 Flow Rate
OKW-ST4-FLOWRT.UNIT0@OKW	Oakwood Storm Pump 4 Flow Rate
OKW-ST5-FLOWRT.UNIT0@OKW	Oakwood Storm Pump 5 Flow Rate
OKW-ST6-FLOWRT.UNIT0@OKW	Oakwood Storm Pump 6 Flow Rate
OKW-ST7-FLOWRT.UNIT0@OKW	Oakwood Storm Pump 7 Flow Rate
OKW-ST8-FLOWRT.UNIT0@OKW	Oakwood Storm Pump 8 Flow Rate
OKW-TOT-INFFLOW.UNIT0@OKW	Oakwood Total Influent Flow
OKW-EFFLUENT-FLOW.UNIT0@OKW	Oakwood Effluent Flow

Flow rate data were reviewed to identify missing or erroneously low flow rates (dropouts) and peak recorded flow rates. The peak flow rate data was compared to the nominal pump capacity tributary to each meter. Data were reviewed to answer the following questions shown in **Table 3-2**.

Table 3-2 Data Review Questions

Question	Rationale
Did the meter record flow rate data when the pump was ON?	It is expected that the meter records flow rate any time the respective storm pump is running.
Was there any significant flow recorded when the pump was ON?	The storm pumps have capacities of 40 to 178 MGD. The metered flow rate must be of the appropriate order of magnitude to be reasonable.
Was the flow rate data ever reasonable?	A meter that never recorded a reasonable magnitude flow rate showed clear issues.
Did the meter consistently provide reasonable flow rates?	A meter that did not consistently record a reasonable magnitude flow rate showed clear issues.

Table 3-3 provides a summary of the data and responses to the data review questions. The pump color coding matches what is shown in **Figure 2-1** to indicate which Existing Meters share similar MH yard vault locations.

A detailed review of seven storm events was included in this analysis. These storm events were chosen to show storm pump performance for events that differ in size, number of pumps operating, and date of the event. The complete analysis and inclusion of these seven storm events as examples show the overall unreliability of the Existing Meters.

Table 3-3 Oakwood Flow Meter Analysis Summary

Parameter	Oakwood Facility		Small VFD		Large VFD		Constant Speed			
	Influent	Effluent	Pump 1	Pump 2	Pump 5	Pump 6	Pump 3	Pump 4	Pump 7	Pump 8
Nominal Pump Capacity (MGD)	-	-	97	97	178	178	178	178	178	178
Nominal Pump Minimum (MGD)	-	-	40	40	72	72	-	-	-	-
Peak Recorded Flow Rate (MGD)	-	-	100	< 1	< 1	68	100	< 1	100	100
Did Flow Meter Always Record Data When Pump Ran?	-	-	NO	NO	YES	YES	YES	YES	YES	NO
Was Any Significant Flow Recorded When Pump On?	-	-	YES	NO	NO	YES	YES	NO	YES	YES
Was Metered Flow Rate Ever Reasonable?	-	-	YES	NO	NO	NO	NO	NO	NO	NO
Storm Events (Peak Flow Rates in MGD):										
September 12, 2019	168	213	0	N/A	N/A	42	100	< 1	10	N/A
August 2, 2020	259	582	89	< 1	N/A	68	N/A	< 1	100	N/A
March 26, 2021	155	187	0	N/A	N/A	28	100	< 1	100	84
June 25, 2021	162	265	0	< 1	N/A	29	100	< 1	100	96
July 25, 2021	226	394	0	< 1	N/A	29	100	< 1	100	100
September 2, 2022	5	0	0	N/A	< 1	N/A	1.5	N/A	5	N/A
October 31, 2022	23	0	23	N/A	< 1	N/A	N/A	N/A	N/A	N/A
Did Meter Consistently Provide Reasonable Flow Rates?	-	-	NO	NO	NO	NO	NO	NO	NO	NO

Notes for storm event peak flow rate data:
0 MGD = Pump On, but No Flow Recorded
< 1 MGD = Pump On, and Less than 1 MGD Recorded
N/A = Pump Did Not Turn On

Existing Meter for Storm Pump No. 1 did record a reasonable peak (100 MGD compared to the nominal pump capacity of 97 MGD) during the period reviewed and for one of the seven storm events reviewed in detail (August 2, 2020). However, this flow meter did not record any flow on multiple occasions when the pump was indicated to be 'Running,' including six of the seven storm events reviewed in detail. This flow meter also recorded a peak flow rate outside of its operating range on at least one occasion (October 31, 2022).

Existing Meter for Storm Pump no. 2 never recorded any significant flow over the period reviewed. The metered flow rate from this flow meter was never reasonable as the peak recorded flow rate was less than 1 MGD. There were also instances when this flow meter did not record any flow while the pump was indicated as 'Running.'

Existing Meter for Storm Pump no. 3 always recorded flow while the pump was 'Running'. However, the recorded flow from this flow meter was never considered reasonable as the peak flow was well below the nominal pump capacity for this constant speed pump.

Existing Meter for Storm Pump no. 4 did not record a flow rate greater than 1 MGD, which is not considered reasonable given its nominal pump capacity.

Existing Meter for Storm Pump no. 5 did not record a flow rate greater than 1 MGD, which is not considered reasonable given its nominal pump capacity.

Existing Meter for Storm Pump no. 6 always recorded flow rate data when the storm pump was 'Running', and always recorded a significant flow rate (i.e., greater than 1 MGD). However, the peak recorded flow rate at this meter was 68 MGD which is only slightly lower than what would be

expected for the minimum flow rate through this pump. However, the recorded data shows multiple storm events where this flow meter is considered unreasonable.

Existing Meter for Storm Pump no. 7 always recorded a significant flow rate when the pump was 'Running'. This meter had a peak of 100 MGD, which is significantly lower than the expected nominal pump capacity of 178 MGD for this constant speed pump. This meter also recorded a peak flow rate much lower than 100 MGD for two of the seven storm events reviewed in detail (September 12, 2019 and September 2, 2022).

Existing Meter for Storm Pump no. 8 did not record any flow on multiple occasions when the pump was indicated to be 'Running'. This flow meter also did not ever record a peak flow rate that was considered reasonable for this constant speed pump.

In summary, the data analysis indicates that all eight Existing Meters failed at least one of the tests developed to check the recorded data and are unfit to record good and useful data for the Oakwood CSO RTB and Pump Station.

There was some concern that the meter location along the storm pump discharge piping was a factor in the performance of the Existing Meters. The meter location appears to play no role in the performance of the flow meters. Storm pump flow meter no. 1 through no. 6, which are at analogous locations along the discharge piping, do not appear to provide data that is any better or worse than Storm Pump meters no. 7 and no. 8.

The analysis also looked at select storm events to notice any patterns in how the Storm Pumps operated or how the flow rate data gathered may have changed over time. Observing the data across the storm events, it appears that there is no correlation temporally or based on storm size to the quality of the data that the storm pump meters produce.

3.2 Meter Maintenance/Inspection

A site visit to the Oakwood CSO RTB and Pump Station was completed to assess the condition of the Existing Meters. The goal of the visit was to determine if the erroneous flow rate readings were due to the condition of the Existing Meters or an issue with the metering technology.

The site visit was conducted on December 21, 2022 in conjunction with routine meter maintenance being performed by PCI, under a separate contract with GLWA. During this site visit, the hot tap insertion probes were pulled from the MH yard vaults, inspected, and cleaned. The Design Team was able to observe this process and collect qualitative data about the condition of the insertion probes.

No solids build-up was observed on any of the meter probes. The PCI technician had noted that these hot tap insertion probes typically come out dry and clean when inspected at this installation location during dry weather when the storm pumps were not in service. The meter probes have not been previously observed with any material caked on that would adversely affect the meter's ability to function as intended.

Table 3-4 provides images of the meter probe tips as observed before cleaning on the day of the site visit. Meter probes 1 and 2 appeared to be in the best condition. Meter probes 1 and 2 service the small, 97 MGD, storm pumps so may have received less wear. Meter probes 3, 5, 6, 7, and 8 all appeared to have varying levels of fading and/or signs of abrasion across the surface of the probe. The wear on these probes could have a negative effect on the meter performance. Meter probe 4 was missing from the MH yard vault and could not be observed.

PCI had noted during the site visit that meter probe 2 was not working properly as the meter was not displaying flow data. The absence of meter readings was said to most likely be attributed to a disconnection in the meter electronics.

Table 3-4 Images of the Hot Tap Meter Insertion Probes for All Eight Storm Discharge Pipes

	
Meter Probe 1	Meter Probe 2
	N/A Probe Missing from MH Yard Vault
Meter Probe 3	Meter Probe 4

Table 3-4 Images of the Hot Tap Meter Insertion Probes for All Eight Storm Discharge Pipes cont.

	
Meter Probe 5	Meter Probe 6
	
Meter Probe 7	Meter Probe 8

A field report written by PCI in 2018 summarized a series of site visits in which troubleshooting was performed for all eight flow meters. The report summary noted that the Existing Meters for Storm Pump nos. 1, 7, and 8 were tested and found to be operational with no changes necessary. Existing Meters for Storm Pump nos. 2 and 3 were operational after the transmitter was reconfigured. The Existing Meter for Storm Pump no. 6 was operational after the transmitter was reconfigured and the probe was adjusted. The Existing Meter for Storm Pump no. 5 could not be tested as the pump was being repaired at the time of the visit, however the transmitter was tested and operational. The Existing Meter for Storm Pump no. 4 was not operational, and the transmitter was removed and sent back to Teledyne ISCO to be diagnosed and repaired. This evaluation by PCI was submitted before the period of data that was analyzed in the following section. The field report summary shows that several flow meters were not operational in 2018 but were returned to an operation status. However, the PCI procedures are completed during dry weather and “operational” is an indication that the meter provides a signal, not that the signal is accurate.

Since the 2018 report, PCI has performed semi-annual to quarterly preventative maintenance and calibration on the Existing Meters. The preventative maintenance has shown issues with the meter

probes and transmitters. As these meters are no longer supported by the manufacturer, it is difficult to restore these meters to a fully-functioning condition.

4.0 Description of Alternatives

The Design Team explored various alternatives to address the Oakwood CSO RTB influent flow rate metering issues. Based on the Ovation data analysis and the condition assessment of the meter it was determined that the Existing Meters needed to be replaced with new meters.

Rehabilitation or replacement in-kind of the Existing Meters were considered as alternatives. These options were discarded as the existing metering technology, the Pro20 ADFM Velocity Profiling Insertion Flowmeter manufactured by Teledyne ISCO, is a discontinued product and is no longer supported. As such, rehabilitation and replacement in-kind are not viable options. Additionally, the GLWA CSO Improvements Project Guiding Principles advises against replacing equipment in-kind, but seeking solutions that improve performance and reduce maintenance.

The Design Team explored multiple alternatives to improve Oakwood CSO RTB influent flow rate metering. The Design Team explored options that used a variety of technologies and techniques to measure or estimate the flow through the discharge piping, at the Storm Pumps, and in the influent sewer. The methodologies discussed include the following:

- New insertion meters placed in the Existing Meter pits (Section 4.1)
- Level sensors located at the storm discharge pipes in the Screen Facility (Section 4.2)
- External and internal ultrasonic flow meters on the vertical discharge piping in the Screen Facility (Section 4.3 and 4.4)
- Spool piece / in-line magmeters installed in either the vertical discharge piping in the Screen Chambers or the horizontal discharge piping between the storm pumps and the Screen Facility (Section 4.5)
- Calculation of storm pump flow using monitored pump activity and measured storm wet well levels (Section 4.6)
- Metering of flow upstream of the storm wet wells to measure incoming flow (Section 4.7)

4.1 Insertion Meter

For this alternative eight new insertion meters would re-use the existing MH yard vaults and hot tap sleeves, currently occupied by the Existing Meter probes, to measure the flow rate in all eight storm discharge pipes. Implementing new insertion meters would have minimal construction implications, and there would also be minimal change in procedure to the current meter servicing process.

An insertion meter would function similarly to the existing flow meters. Insertion magmeters and an ultrasonic cross correlation meters were evaluated.

4.1.1 Insertion Magmeter

An insertion magmeter works to measure flow rate by utilizing Faraday's law of induction. Magmeters operate based on the principle that a voltage is induced in an electrical conductor moving through a magnetic field, where the conductor is the flowing water being measured. The magnitude of the induced voltage is proportional to the velocity of the conductor. Electrodes measure the induced voltage on opposite sides of the sensor. The voltage readings are averaged to obtain a velocity which is then converted to a flow rate by using the known cross-sectional area of the pipe. In the case of an insertion magmeter, the electrodes are housed in a probe that is inserted into the pipe.

4.1.2 Advanced Doppler Insertion Meter

An advanced Doppler insertion meter calculates the flow rate through a measurement of the flow velocity. The flow velocity determination method is based on the ultrasonic reflection principle. The reflecting particles contained within the medium (e.g., debris or gas bubbles) are scanned using an ultrasonic impulse transmitted in a defined angle and are saved as an image. The positions of the reflecting particles are determined by correlating saved signals. The particles can be found in different positions in sequential images since they move with the medium. Considering the beam angle, it is possible to directly convert the shift of the particles into their velocity which is equal to the flow velocity of the medium.

Figure 4-1 shows a diagram of an ultrasonic cross correlation flow measurement insertion meter probe.

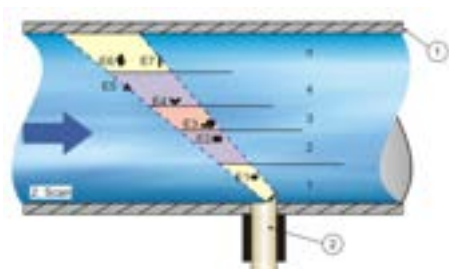


Figure 4-1
Ultrasonic Cross Correlation Flow Measurement Insertion Meter Probe

4.2 Level Sensor

This alternative would implement eight level sensors that would obtain a level measurement over the rim of each discharge pipe. The level sensor alternative includes a down looker level sensor and a pressure sensor.

A level sensor would be used in conjunction with a hydraulic calculation to estimate the effluent flow rate out of each discharge pipe. While a level sensor would only measure a depth, an equation, such as the weir equation, would be used to convert the depth into a flow rate. A specific formula would need to be developed for both the 54-inch and 72-inch discharge pipe sizes.

4.2.1 Down Looker Level Sensor

The down looker level sensors would be mounted to the ceiling of the Screen Facility and out of the way of any flow. The location of these level sensors would make them relatively easy to install and maintain. Down looker level sensors are available with electronics using ultrasonic signals, radar signals, and lasers.

A level sensor would be placed over the rim of the vertical discharge piping in the Screen Facility to read the water level over the rim.

4.2.2 Pressure Sensor

The pressure sensors would be installed to the pipe wall within the vertical discharge piping in the Screen Facility. The pressure sensor would sit in the flow of the discharge pipe during storm pump use.

A pressure sensor measures the water pressure above the sensor and translates this measurement into a depth. A comparison of the depth of the water read by the pressure sensor and the known distance from the sensor to the rim of the pipe can be used to calculate the depth of the water over the rim of the pipe.

4.3 External Ultrasonic Flow Meter

A pair of externally mounted ultrasonic flow meters would be placed on the outside wall of all eight storm discharge pipes in the Screen Facility. The external ultrasonic flow meters would be non-invasive to the discharge piping, requiring no cutting or welding to install, as they are mounted using a tensioning belt fastened around the circumference of the pipe.

An external ultrasonic flow meter utilizes ultrasound to measure the velocity of a fluid via a pair of transducers on the outer pipe wall. Velocity is measured by measuring the transit time of the ultrasound to travel between the two transducers, where transit time is directly proportional to the velocity. The measured velocity is converted to a flow rate by using the known cross-sectional area of the pipe.

Figure 4-2 shows a diagram of a pair of ultrasonic transducers mounted externally on a pipe.

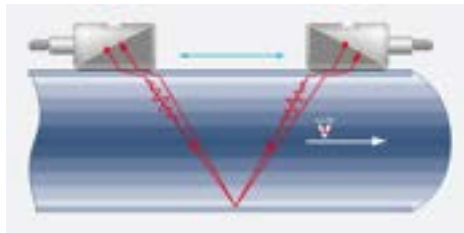


Figure 4-2
Externally Mounted Ultrasonic Flow Meter Transducers

4.4 Internal Ultrasonic Flow Meter

A pair of internally mounted ultrasonic transducers would be placed within all eight storm discharge pipes in the Screen Facility. The ultrasonic transducers would be invasive to the discharge piping and could require cutting of the pipe to install the transducers and ancillary equipment.

An internal ultrasonic flow meter utilizes ultrasound to measure the velocity of a fluid via a pair of transducers on the inner pipe wall. Velocity is measured by measuring the transit time of the ultrasound to travel between the two transducers, where transit time is directly proportional to the velocity. The measured velocity is converted to a flow rate by using the known cross-sectional area of the pipe.

4.5 Spool Piece / In-Line Magmeter

A spool piece magmeter would be installed into each storm discharge pipe for this alternative. This process would require cutting out a section of pipe and installing new flanges to bolt the magmeter in place of the removed pipe. Two 54-inch and six 72-inch inner diameter magmeters would be needed for this alternative. There are two possible locations for the installation of a spool piece magmeter and are identified in Sections 4.5.1 and 4.5.2.

A spool piece or in-line magmeter works to measure flow rate by utilizing Faraday's law of induction. Magmeters operate based on the principle that a voltage is induced in an electrical conductor moving through a magnetic field, where the conductor is the flowing water being measured. The magnitude of the induced voltage is proportional to the velocity of the conductor. Electrodes on each side of the pipe sense the flow-induced voltage created by magnetic coils. The measured velocity is converted to a flow rate by using the known cross-sectional area of the pipe. In the case of a spool piece or in-line magmeter the electronics are integrated into the spool piece.

4.5.1 Spool Piece Magmeter in Vertical Piping in Screen Facility

One variation of this alternative is to install the spool piece magmeter into the vertical section of each storm discharge pipe in the Screen Facility. As stated above, this would require cutting out a section of the vertical discharge pipe and installing a flange to bolt the magmeter in place.

4.5.2 Spool Piece Magmeter in Horizontal Discharge Piping

The other variation of this alternative is to install the spool piece magmeter into the horizontal run of each storm discharge pipe between the storm pumps and the Screen Facility. This would require cutting out a section of pipe and installing flanges to bolt the magmeter in place. This would also require excavation of the buried horizontal discharge piping and demolition of the concrete encasement surrounding the discharge piping.

Figure 4-3 shows an example of a spool piece magmeter.



Figure 4-3
A Spool Piece or In-Line Magmeter

4.6 Calculated Storm Pump Flow Using Ovation Data

The storm wet well basin level and pump activity monitored in the Ovation data can be used to perform a calculation that estimates the flow rate through each active pump based on pump curves and run time. This calculation does not provide the level of certainty that is desired for the Oakwood CSO RTB influent metering but is an alternative to add a backup method of calculating the flow rates through the storm pump discharge pipes. This calculation would take place within Ovation and the data would be readily available should measurements from the flow meters be unusable for any reason.

This is planned for development and testing later in the design phase.

4.7 Metering Flow Upstream of Storm Wet Wells

The influent sewer has several manholes that provide access to the flow and would be suitable for the installation of a flow meter such as an advanced Doppler meter or a transit-time meter including those offered by Nivus, Accusonic, and GWF. This alternative would require only one meter in the influent sewer to the storm wet wells, as shown in **Figure 4-4**, however an additional meter would be required if additional influent sewers are connected to Oakwood CSO RTB (such as the planned Oakwood District Intercommunity Relief Sewer (ODIRS)). Site work would be needed

to establish power, install a meter cabinet, and obtain a signal from any upstream metering location.

This alternative would provide a good measurement of the total influent flow rate but would not allow flow rate through any individual storm pump to be monitored. However, this alternative could be used in conjunction with Alternative 4.6 to allocate the influent measured flow rate to each individual storm pump.

Although this alternative does not provide the storm pump flow rates needed for chlorine feed rates, it has merit for future considerations related to the disinfection process as the system automation and machine learning process advances for the integrated CT method. The monitoring of collection system influent flow to the facility could be a valuable addition to understanding the flow coming to the facility.

This meter placement would provide unique data that would not be made redundant by the meter alternatives measuring and estimating the CSO Basin influent flow nor the calculated Storm Pump flow using Ovation data.

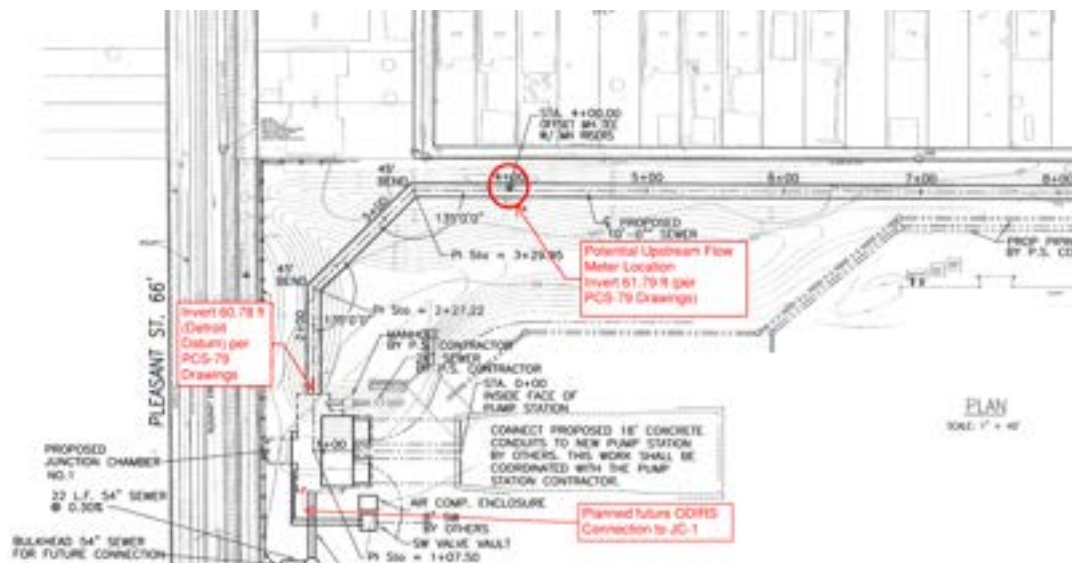


Figure 4-4 Potential Upstream Flow Meter Location (Background drawing source: PCS-79 Dated 11/13/09)

4.8 Alternatives Evaluation Criteria

Several criteria were developed to evaluate the expected performance and feasibility of the flow meter alternatives.

4.8.1 High Expected Accuracy

A suitable meter ideally needs to report within $\pm 2\%$ of the actual flow rate through the discharge piping, although up to $\pm 5\%$ may be acceptable. High accuracy is needed to reliably use the meter readings to automate the chemical feed system.

4.8.2 Ability to Measure Full Range of Expected Velocities

Based on flow velocity calculations through the discharge piping, the flow meters should be able to measure a minimum of 6.2 ft/s and a maximum of 9.8 ft/s. These velocities assume a minimum flow rate of 64 MGD and 120 MGD of the flow for the 54-inch and 72-inch discharge pipes, respectively, and a maximum flow rate of 98 MGD and 178 MGD for the 54-inch and 72-inch discharge pipes, respectively. These assumed flow rates are based upon preliminary future pump operating ranges.

Table 4-1 summarizes the minimum and maximum velocities through each size discharge pipe.

Table 4-1 Minimum and Maximum Velocity Through 54-Inch and 72-Inch Discharge Pipe

Parameter	54-Inch Pipe		72-Inch Pipe	
Pipe Diameter (inches)	54	54	72	72
Flow Rate (MGD)	64	98	120	178
Area (sq. ft.)	15.9	15.9	28.3	28.3
Velocity (ft/s)	6.23	9.53	6.57	9.74

4.8.3 Compatibility with Site Constraints

The site constraints consist of meter compatibility with 54-inch and 72-inch diameter pipes, level of disruption to the structural integrity of the facility necessary to install the meter, meter accessibility for maintenance, and meter resistance to submerged and corrosive environments.

4.8.4 GLWA CSO Improvements Project Guiding Principles

The GLWA CSO Improvements Project Guiding Principles provide general guidelines that direct the design process. Pertinent guidelines include:

- Do not replace equipment in kind – make it better
- Provide equipment which is accessible and easy to maintain
- Maintain operation of Oakwood facility throughout construction phase

5.0 Alternatives Analysis

The following subsections compare the metering technology alternatives to the alternative evaluation criteria. A summary of the meter alternative evaluation is presented in **Table 5-1**. Detailed information on the metering technology is presented in the subsequent sections of this memorandum.

Table 5-1 Evaluated Flow Meter Technology Summary

Meter Technology	Meets Evaluation Criteria (Yes/No)			Recommended (Yes/No)
	Accuracy	Velocity	Site Compatibility	
Insertion Magmeter	No	Yes	Yes	No
Insertion Advanced Doppler	Yes	Yes	Yes	Yes
Level Sensor	No	N/A	Yes	No
External Ultrasonic	Yes	Yes	No	No
Internal Ultrasonic	Yes	Yes	No	No
Spool Piece/In-line Magmeter	Yes	Yes	No	No

5.1 Insertion Meter

For all insertion meter alternatives discussed, the existing hot tap sleeves/port ball valves at the Oakwood CSO RTB MH yard vaults can be reused. All insertion meter technologies discussed also offer hot tap installation, meaning the meter can be removed and inserted into the pipe without interruption to pump service.

5.1.1 Insertion Magmeter

The Design Team evaluated the AquaProbe FEA100 manufactured by ABB. This insertion meter uses the design principles of a magmeter. The flow meter is compatible with pipe diameters ranging from 8 to 300 inches in diameter. The meter has a flow measurement uncertainty of $\pm 2\%$ of the flow rate and can measure velocities in a pipe up to 16 feet per second. The meter probe insertion length into the pipe for this meter is typically $\frac{1}{8}$ to $\frac{1}{2}$ of the pipe diameter. The insertion length for the 54- and 72-inch diameter pipes will be at least 6 inches and 9 inches, respectively. This level of insertion means that wastewater debris catching on the meter is likely, and the probes will be susceptible to wear. Because of the insertion length, the AquaProbe meter is not recommended.

5.1.2 Advanced Doppler Insertion Meter

The Design Team evaluated advanced Doppler insertion meters such as the CS2 Correlation Pipe Sensor manufactured by Nivus or the GWF Q-Eye advanced Pulse-Doppler. These insertion meters utilize digital pattern detection to measure flow velocity. The Nivus flow meter is compatible with the Oakwood CSO RTB storm pump discharge pipe configuration. The flow meter is expected to provide a high accuracy for the given pipe diameter, available straight run, and expected fluid velocities. These meters have a flow measurement uncertainty of less than $\pm 1\%$ of the flow rate for the velocities expected in the storm pump discharge pipe. The meter probe inserts into the open pipe area with minimal protrusion. The probe itself needs to be inserted less than 1 inch into the open pipe area, making the probe nearly flush with the pipe wall. These insertion meters have little concern of catching wastewater debris. These meters are also offered with materials available to coat the flow sensor to protect against possible corrosion from the chlorine disinfectants injected into the wastewater upstream of the meter location. The Nivus CS2 Correlation Pipe Sensor specifically is made up of a stainless-steel sensor body and a polyetheretherketone (PEEK) sensor

which offers very good chemical resistance. Additional information on these meters can be found in Appendix A and B. This meter technology is the recommended alternative.

5.2 Level Sensor

The Design Team evaluated level sensors that would be used to measure the level of the wastewater over the rim of the storm pump discharge piping in the Screen Facility. Along with the development of a suitable hydraulic formula, the level over the rim would be used to calculate the flow rate out of the discharge piping. This method is problematic as the relationship of depth over the rim to estimated flow rate may vary over the range of expected flow rates and due to other factors, such as water level in the RTB. The certainty of this method to properly measure the flow rate is unknown for the down looker level sensor and pressure sensor alternatives.

This method was deemed not viable by the Design Team because of the uncertainty of the methodology to adequately measure the level of the water over the rim of the discharge piping. As this uncertainty poses a risk to obtaining good flow rate data, the level sensors are not a viable alternative.

5.3 External Ultrasonic Flow Meter

An external ultrasonic flow meter evaluated by the Design Team was the NIC Clamp-On Sensor manufactured by Nivus. This meter operates as an ultrasonic time transit sensor. It is compatible with pipes ranging from 2 to 236 inches in diameter. The meter has a measurement uncertainty of $\pm 0.1\%$ of the measured velocity and can measure velocities in a pipe up to 32 feet per second. The flow meter transducers would be mounted on the vertical section of the discharge piping in the Screen Facility. A 0.5mm pipe wall thickness is required to mount the transducers. The transducers do not require any welding or cutting of the pipe to mount them, but instead are mounted using a tensioning belt fastened around the circumference of the pipe.

Although the transducers would be outside of the pipe, they would still be subjected to submersion as the Screen Facility fills during a storm event. As such, the transducers and associated mounting equipment need to be able to withstand the wetted and corrosive environment in the Screen Facility. The Nivus NIC Clamp-On Sensors cannot be submerged.

Additionally, the NIC Clamp-On Sensors require a non-turbulent flow profile to have accurate flow measurements. Due to the abrupt 90° bend in the discharge piping just upstream of where these external ultrasonic flow meters would be located, some turbulence in the pipe may be expected. For these reasons, the external ultrasonic flow meter is not a viable alternative.

5.4 Internal Ultrasonic Flow Meter

An internal ultrasonic flow meter evaluated by the Design Team was the Accusonic 8510+ flow meter and Model 7934 transducer. It is compatible with pipes ranging from four to 60 feet in diameter. The meter has a measurement uncertainty of $\pm 0.5\%$ of the flow rate.

For an internal ultrasonic flow meter application, the transducers sit inside the flow. Transducers would be mounted inside the vertical section of discharge piping in the Screen Facility.

Internal ultrasonic magmeters are typically used for buried pipes where externally mounted transducers are not possible. Internally mounted sensors either require cutting of the pipe to install or cabling ran inside the pipe, which may catch debris. These sensors would be difficult to access for maintenance purposes. The Design Team determined that an internal ultrasonic flow meter is not a viable alternative because of the difficulty of installation and maintenance.

5.5 Spool Piece / In-Line Magmeter

The Design Team evaluated the SITRANS FM MAG 3100 spool piece magmeter manufactured by Siemens as an alternative technology to replace the existing storm pump flow meters. This meter is compatible with pipes ranging from 0.5 to 78 inches in diameter. It has a measurement uncertainty of $\pm 0.2\%$ of the flow rate and a measurable velocity of up to 32 feet per second.

5.5.1 Spool Piece Magmeter in Vertical Piping in Screen Facility

A spool piece magmeter placed in the vertical section of discharge piping in the Screen Facility presents a few issues. There is bracing in place in the Screen Facility to provide stability to the discharge piping that would be difficult to work around and could potentially require removal to install a spool piece magmeter. Re-welding this bracing to the magmeter is of concern because of the possibility of damage to the magmeter due to the heat generated when welding. Further, there is concern that the integrity of the bracing may not be restored.

A spool piece magmeter would require a large amount of corrosive protection. The magmeter would be prone to submersion as the Screen Facility fills during a storm event. The existing vertical pipes in the Screen Facility have a corrosion-protection liner applied to the exterior. A similar protective lining would need to be applied to the spool piece magmeters and reapplied to the pipe and other affected steel surfaces following installation.

Due to the structural implications of installing a spool piece magmeter at all eight storm pump discharge pipes, the Design Team has deemed the spool piece magmeter not a viable option. The installation of this meter alternative would be too disruptive to the structure of the facility and is not compatible with the Screen Facility.

Figure 5-1 shows the storm pump vertical discharge piping the Screen Facility. The discharge piping is stabilized by the bracing seen on the left side and top of the image.



Figure 5-1
Existing Storm Pump Vertical Discharge Piping in Screen Facility

5.5.2 Spool Piece Magmeter in Horizontal Discharge Piping

Inserting a spool piece magmeter in the horizontal run of discharging piping (along where the Existing Meters are placed) was vetted as a possible alternative as well. This option was dismissed as the discharge piping is encased in concrete, making this option is cost-prohibitive, disruptive to the facility, and would reduce the integrity provided by the concrete encasement.

5.6 Calculated Storm Pump Flow Using Ovation Data

Calculating the storm pump flow rate using Ovation data and storm wet well levels at the Oakwood CSO RTB has the benefit of providing a backup flow rate estimate to the selected flow meter alternative. This alternative would be simple to implement and does not interfere with the current operations at the facility.

This alternative will require development and testing later in the design phase. Proper development and calibration of the relationship of pumped flow rate to the storm wet well level, pump curve, pump speed (when applicable), and storm pump on/off is needed to provide an accurate estimate of the storm pump flow rates and agrees with the primary method of metering. This is recommended to be implemented as a backup to the new flow meters.

5.7 Metering Flow Upstream of Storm Wet Wells

Metering the flow entering the facility as influent to the Pump Station storm wet well was determined to not be a feasible alternative for the purposes of the Oakwood CSO RTB influent flow rate metering. Metering the flow upstream of the pumps would lead to uncertainty in chemical feed dosing, as the flow rate entering the facility's storm wet wells is not necessarily equal to the flow rate pumped from the storm pumps.

However, metering flow upstream of the storm wet wells could be beneficial to the needs of the disinfection process. An upstream flow meter would provide influent flow rate data to help train an artificial intelligence / machine learning dosing model that is intended to optimize the disinfection system operation at the Oakwood CSO RTB and Pump Station.

Another advantage of adding a flow meter on the influent sewer is that it could allow confirmation that the meter is operating or developing any failures between wet weather events and corrective maintenance could be performed. If an advanced Doppler sensor, like those offered by Nivus or GWF, is installed on the bottom of the pipe, it will have flow present during dry weather as well as storm events in the existing influent sewer. The accuracy of the meter may be reduced at very low depths, but operating issues could be identified between storm events. If a multi-path acoustic meter, like those offered by Accusonic or GWF, is installed then this advantage would only be achieved if the lowest velocity sensor path can be placed below the dry weather flow depth in the sewer.

There are some disadvantages of also metering upstream of the Pump Station in addition to the meters needed on the storm pump discharge pipes. This will be an additional meter to maintain, however there may be some efficiency in that maintenance could be performed by the same team that is maintaining the flow meters on the discharge pipes. There is the potential for debris to catch on the sensor or cable and require corrective maintenance to clean the sensor, however the sensors are streamlined to minimize this occurring. Finally, the invert of the pipe at the location shown in **Figure 4-4** on the Oakwood CSO RTB site is 61.79 ft. This is below the typical wet well level operating range for the storm pumps; therefore the flow meter depth and velocity will be affected by backwater from the wet well. The advanced Doppler sensors or multi-path acoustic meters are generally capable of metering in backwater flow conditions, but the accuracy may decrease as the sensors may see rapidly increasing and decreasing depths and velocities as the pipe experiences the fill/draw cycles of the wet well.

This alternative should be explored more in depth under a separate contract, as the benefits of this alternative do not meet the needs of the individual chemical feed system installed on each storm pump.

Table 5-2 provides a comparison of the major advantages and disadvantages for the influent sewer and storm discharge piping flow meter alternatives.

Table 5-2 Flow Meter Location Alternative Comparison

Flow Meters Along the Storm Discharge Piping		Flow Meter in Influent Sewer Upstream of Wet Well	
Advantages	Disadvantages	Advantages	Disadvantages
Capable of high accuracy flow measurement in the expected flow rate range	More possible points of failure due to use of eight devices	Requires maintenance for a single device	Measured flow rate will not equal exactly the flow being pumped due to wet well and upstream in-system storage
Will measure the flow rate from each individual pump		Desire for future considerations related to the disinfection optimization process	Additional meter required with construction of ODIRS connection to the Oakwood Wet Well
Reuses existing infrastructure for flow meter installation		Available for dry-weather calibration	Flow meter depth and velocity may be affected by backwater from the wet well. Backwater conditions will occur periodically throughout each wet-weather event due to storm pump operations. Dry-weather calibration may not be applicable at peak flow rates

6.0 Life Cycle Cost Analysis

Based upon the previous alternative analysis discussed in Section 5, the Design Team has determined that a life cycle cost analysis is not necessary for this portion of the improvement project. Only the advanced Doppler insertion meter technology installed in the storm pump discharge pipes was deemed feasible for this application. All other technologies present limiting factors that eliminated them from further consideration for this task.

7.0 Summary, Recommendations and Key Decisions

The Existing Metering technology does not provide accurate and reliable flow readings at the Oakwood CSO RTB and Pump Station. Flow metering upstream of the Pump Station was evaluated but is not recommended at this time. An upstream flow meter would provide operators with the total facility influent flow rate but would not provide performance data of the individual pumps. Flow rate data for the individual pumps is helpful for monitoring the performance of the pumps over time and chlorination of the flow to the RTB.

The advanced Doppler insertion meter is the recommended replacement meter alternative for all eight of the storm pump discharge pipes. With proper installation and setup, this meter should provide accurate flow rate readings on the individual pump discharge lines which will allow accurate flow readings into the basin. This should also provide the flow rates needed for the disinfection process improvements at the facility. When the flow meters are installed, it is also recommended to monitor diagnostic parameters such as signal strength to improve maintenance efficiency, for example by identify when sensor cleaning is needed, and monitor meter performance

In addition, Ovation should be updated to include a flow rate estimate based on storm wet well levels and storm pump run time. This should serve as a secondary estimate for flow rate through the discharge piping and could be used to check/confirm the accuracy of the flow meters over time.

Future consideration for an advanced Doppler or acoustic flow meter installed in the influent sewer upstream of the storm wet well to measure the Oakwood CSO RTB influent flow rate, is also recommended. The monitoring of collection system influent flow to the facility, could be a reliable addition to understanding the flow coming to the facility and provide useful data for future advanced disinfection system analysis and programming with machine learning.

7.1 Key Decisions

Key decisions made during the course of review and presentation of this Technical Memorandum are as follows:

- GLWA agreed with the recommendation to meter Oakwood basin influent flow using insertion type advanced Doppler flow meters on the storm pump discharge pipes, if can demonstrate that reliable for the proposed meter type in wet/dry application.
- GLWA agreed with the recommendation for backup flow estimate to be calculated within Ovation

8.0 Next Steps

The following steps will be completed during the design phase of this project.

- Complete evaluation of GWF and Nivus as comparable manufacturers for the advanced Doppler insertion meter technology.
- Evaluate the feasibility of re-using the existing sealing equipment with recommended Nivus or GWF insertion meter.
- The Design Team will work with GLWA staff and consultants to develop the operational strategy for Ovation to include the backup flow rate calculations based on storm wet well levels and pump run time. This step is recommended as the primary flow metering methodology until the existing flow meters are replaced.
- Coordinate with I&C lead and GLWA to include monitoring diagnostic parameters such as signal strength and potentially other parameters related to meter diagnostics and performance in Ovation. The team will coordinate on how to store this information so it can be accessed and monitored, but only the flow rates will be included on a main operating screen.

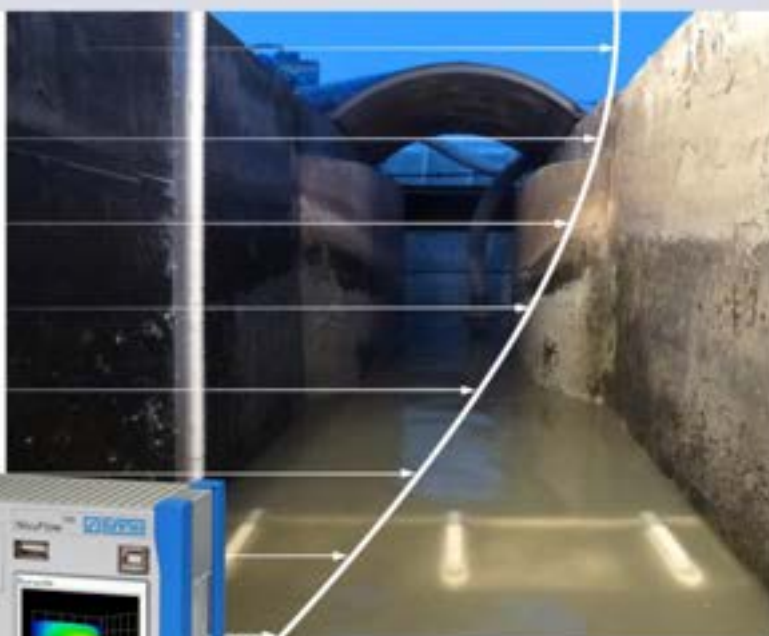
Appendices

Appendix A – Nivus CS2 Correlation Pipe Sensor Information

Appendix B – GWF Advanced Pulse-Doppler Sensor Information

Appendix A

Nivus CS2 Correlation Pipe Sensor Information



NivuFlow 750 NivuFlow 700

High accurate flow measurement for slightly polluted and dirty media in part filled and full pipes, channels and more



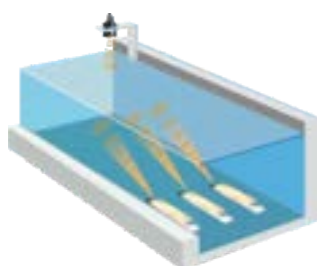
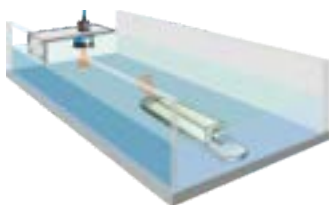
Our proven transmitter family systematically developed further

Flow measurement systems by NIVUS stand for innovation, reliability and highest accuracy.

NivuFlow 750/700 is a fixed transmitter for continuous flow measurement, flow control as well as for storage of measurement values recorded in slight to heavily polluted media featuring various consistencies.

It is designed for use in open channels, closed and part filled pipes (NivuFlow 700: full pipes) with various shapes and dimensions. The transmitter can handle up to 3 measurement spots and up to 9 flow sensors.





Flow measurement systems at the highest technical level

- Very high measurement accuracy
- Suitable even for very difficult applications
- Up to 3 measurement spots and up to 9 flow sensors (M9 version)
- Real-time measurement of real flow velocity profiles
- Intuitive, modern operating concept for quick and easy initial start-up
- Integrated numeric flow models
- Measurement in channels, part filled and full pipes as well as flumes
- Weatherproof version for outdoor use
- Ex approval Zone 1
- High-resolution graphic daylight display
- Extensive diagnostic functions for reliable initial start-up and quick maintenance
- Compact construction for narrow switching cabinets
- Quick wiring thanks to easily accessible connection points
- Universal, standardised interfaces for easy integration
- Online connection/data transmission and remote maintenance via Internet
- MCERTS certified



Typical Applications

WWTPs, channel networks, discharge constructions, industrial wastewater networks, measurement places for billing, intakes, drainage lines, return sludge lines, recirculation lines and many more



The right sensor for each application

The complete flow measurement system consists of the NivuFlow 750/700 transmitter and the appropriate sensors.

For flow velocity measurement starting at flow levels as low as 3 cm up to several meters in pipes, flumes and channels of various shapes and dimensions there is a wide selection of sensors available: flow velocity sensors with and without integrated flow level measurement as well as air-ultrasonic flow level sensors.

Your benefits

- Absolutely zero point stable and drift-free sensors
- Low installation expenses through perfectly matched mounting accessories
- Installation under process conditions
- Various sensor constructions guarantee the best solution for each application
- Digital signal transmission for error-free connections over long distances
- Ex approval Zone 1



Air-ultrasonic sensor
for level measurement,
installed in flume crown



Flow velocity sensors
for installation on channel bottom
or channel walls



Flow velocity sensors
for installation in pipes and in the
NIVUS Pipe Profiler



Nivu Flow 750 / 700 - Universal transmitter

The intuitive one-hand operation and the bright high-resolution colour display allow quick, easy and cost-efficient commissioning on site. Additional input devices or software are not required.

The latest integrated numeric discharge models enable more accurate, more stable and more reliable determination of flow rates even under very difficult measurement conditions.

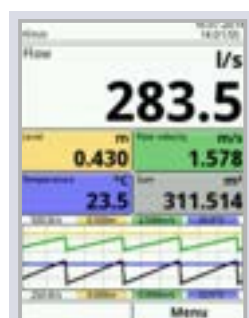
The 3D flow profile is calculated in real time and is reproducibly and verifiably indicated on the transmitter display.

Factors influencing the calculation results such as channel shapes, discharge behaviour and wall roughness are considered during flow calculation.

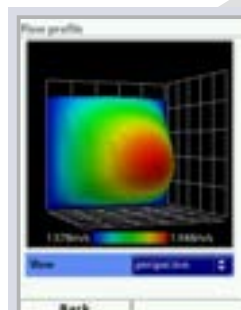
In addition to the compact DIN rail version there is a weatherproof field unit available featuring appropriate connection space for outdoor installation



Screen display menu



Screen display main screen



Screen display 3-D flow profile



Screen display measuring place

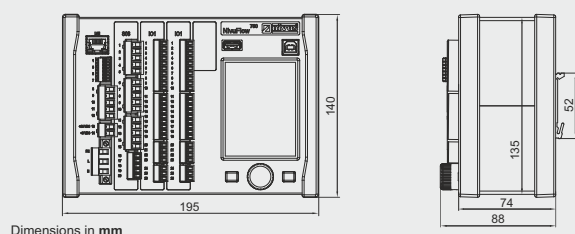


Screen display Level sensors

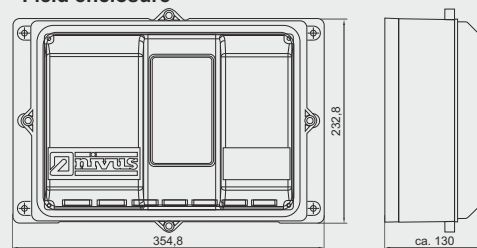


Technical Information NivuFlow 750/700

DIN rail enclosure for easy installation in switching cabinet



Field enclosure

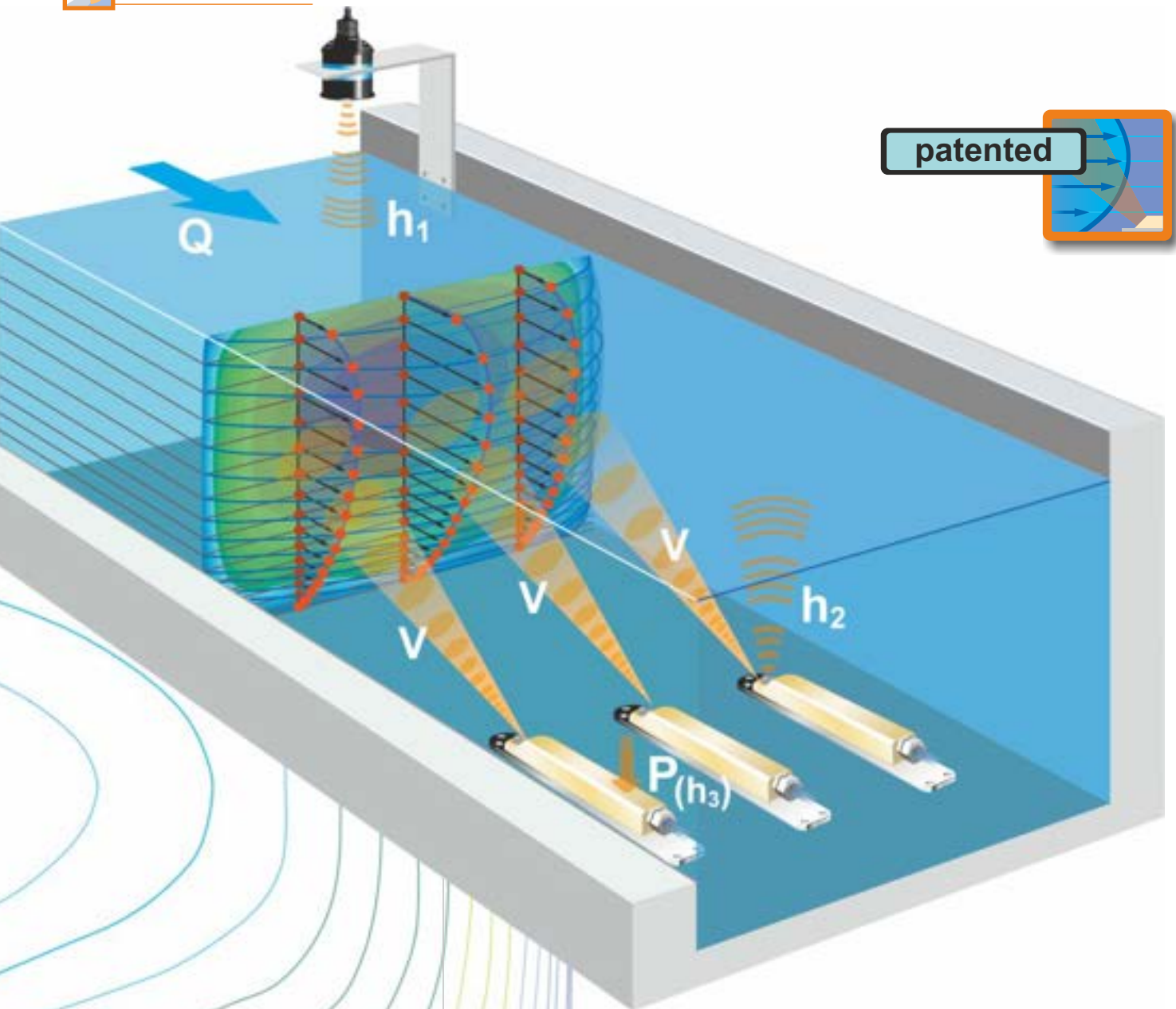


Power supply	85 to 240 V AC, +10 % / -15 %, 47 to 63 Hz or 9-36 V DC
Power consumption	typical 14 VA
Enclosure	Aluminium, plastic (installation in switching cabinet), plastic (field enclosure)
Protection	IP 20 (installation in switching cabinet), IP 68 (field enclosure)
Operating temperature	-20°C to +70°C
Storage temperature	-30°C to +75°C
Max. humidity	80%, non-condensing
Display	240 x 360 pixel, 65536 colours
Operation	rotary pushbutton, 2 function keys, menus in German, English, French, Swedish and other languages
Connection	plug with cage clamp terminals
Inputs	up to 7 x 4 - 20 mA, up to 4 x RS 485 for connection of up to 9 flow velocity sensors (via multiplexer)
Outputs	up to 4 x 0/4 - 20 mA, up to 5 x relays (SPDT)
Controller	3-step controller, quick close control, adjustable valve position in case of error
Data memory	1.0 GB internal memory, readout on faceplate via USB stick
Communication	Modbus, HART

You can find the complete specifications in the instruction manual or on www.nivus.com

NivuFlow is available as unit for installation in control cabinet or with a robust field enclosure





How the NivuFlow 750/700 measures



The flow measurement principle as video under: www.nivus.com

Flow cannot be measured directly. Multiple factors are required to detect the flow Q: average flow velocity and the flow cross section which leads to the general formula:

$$Q = v_{(average)} \cdot A$$

The flow cross section A is investigated by continuously measuring the filling level considering the channel shape.

The flow velocity is detected by using the particles' velocity. Most media contain a certain load of dirt particles or gas bubbles which move in the same velocity as the liquid itself.

Level measurement (h)

Accurate flow measurements require precise and reliable level detection under all hydraulic conditions. The development of a level measurement system with multiple redundancy is a result of our many years of experience. Combining hydrostatic measurement, water-ultrasound and air-ultrasound provides solutions for all measurement tasks.

External 4- 20 mA level sensors such as "i-Series" sensors or NivuBar Plus can be connected additionally.

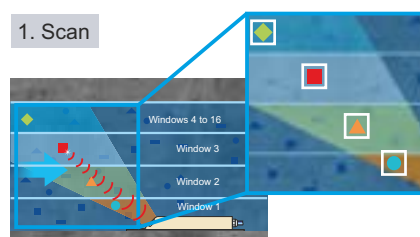


Flow velocity measurement (v) using cross correlation

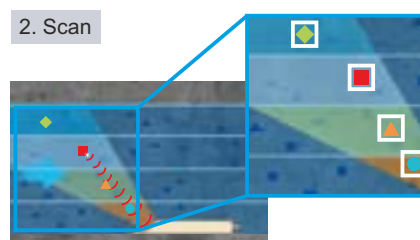
The measurement method used for flow velocity determination is based on the principle of ultrasonic reflection. One of the most modern and most efficient measurement methods for flow velocity detection is the NIVUS cross correlation method.

Existing reflectors within the medium (particles, minerals or gas bubbles) are scanned using an ultrasonic impulse with a defined angle.

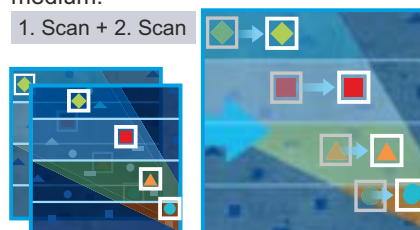
The resulting echoes are saved subsequently as images or echo patterns.



A few milliseconds later a second scan follows. The resulting echo patterns are saved as well.



By correlating/comparing the saved signals, the positions of unambiguously identifiable reflectors can be identified. The reflectors can be identified at varying positions within the images since they have moved with the medium.

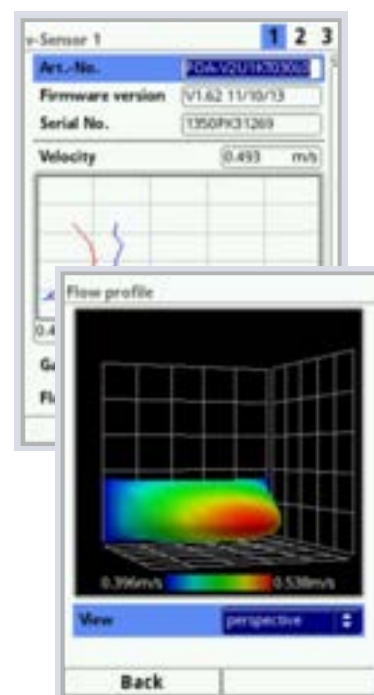


Overlay of image patterns

Considering the beam angle it is possible to directly compute the particle velocity and hence the medium flow velocity from the temporal shift of the reflectors.

This allows to obtain highly accurate readings without the need to perform additional calibration measurements.

Gates			
	Position	v average	v raw
1	0.065 m	0.392 m/s	0.423 m/s
2	0.074	0.403	0.421
3	0.080	0.399	0.379
4	0.088	0.410	0.393
5	0.096	0.436	0.441
6	0.106	0.481	0.507
7	0.117	0.499	0.490
8	0.129	0.522	0.504
9	0.144	0.532	0.512
10	0.160	0.542	0.522
11	0.179	0.560	0.526
12	0.201	0.546	0.512
13	0.226	0.555	0.510
14	0.257	0.547	0.502
15	0.292	0.540	0.500
16	0.333	0.531	0.503



The NivuFlow 750/700 uses up to 9 x 16 gates for flow measurement. A flow profile can be directly indicated on the display.

Your benefits

- Highest measurement accuracy
- Stable readings
- No calibration required
- Determination and indication of flow profiles



On site from anywhere

- Integrated data logger for high data security
- Saved data can be recalled at any time
- Online operation and online setting of parameters (remote control)
- Quick and comprehensive remote diagnostics of entire measurement sites

Latest Technologies

Based on the latest hydraulic models, the NIVUS-COSP system computes a dense measurement network covering the entire flow cross section from the individual measurement spots.

NivuFlow 750/700 provides options for remote maintenance, remote diagnostics and the flexible integration into process conducting systems and telecontrol networks.

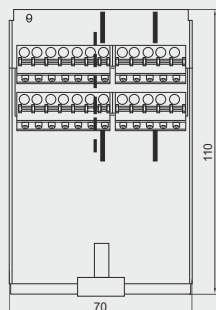
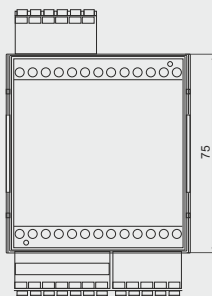
- Scientifically tested, channel-specific mathematical real-time flow models
- Calculation of flow velocity distributions in proximity to walls and horizontal velocity profiles
- Velocity integration covering the entire cross section
- Ideal to investigate average flow velocities in flumes with hydraulic disturbances

EX Separation Module iXT / Multiplexer MPX

The Ex separation module iXT is a Multiplexer used for sensor connection in Ex zone 1.

The Multiplexer Type MPX allows the electronic combination of up to 3 flow velocity sensors and 3 level sensors on site.

Technical Information



Dimensions in mm

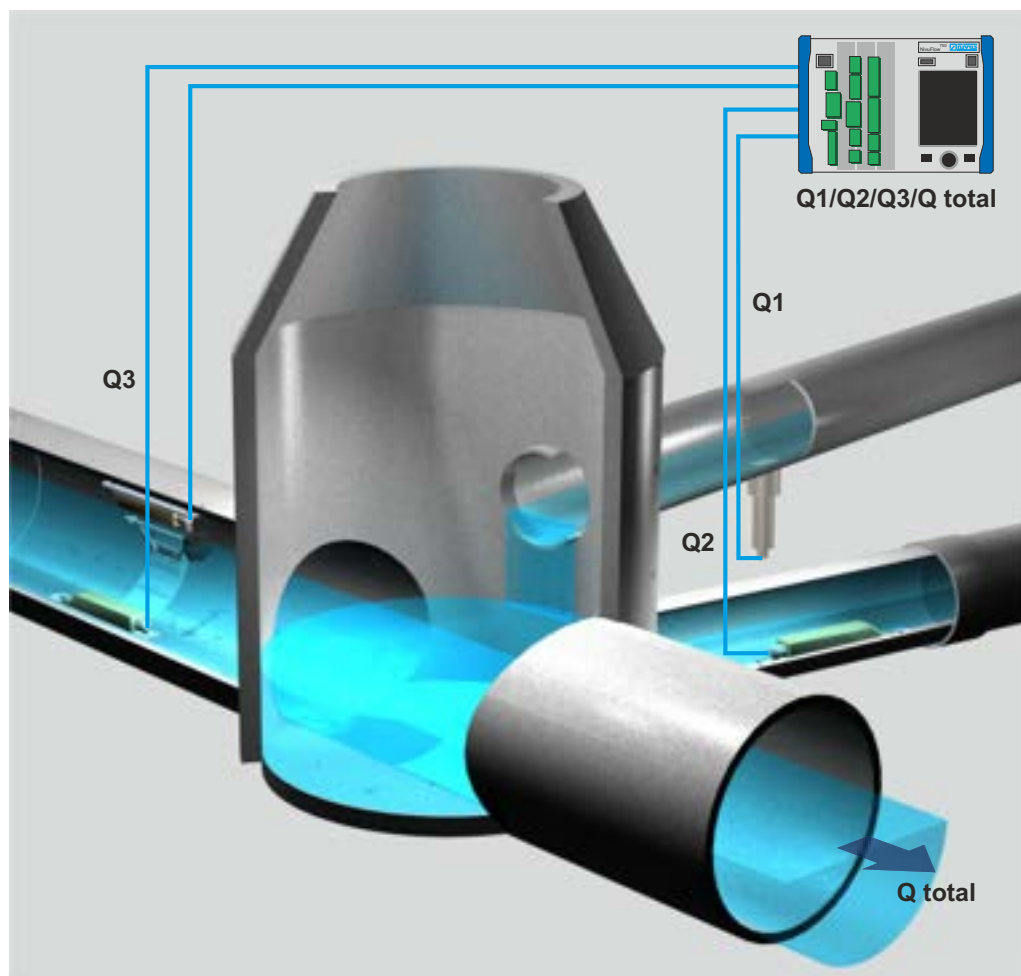
Power supply	12 V DC, max. power consumption 9 W (typ. 7 W), supplied by transmitter
Protection	IP20
Ex approval iXT	ATEX and IECEx, ATEX: TÜV14ATEX142076, IECEx: TUN14.0014
Inputs	1 (optional 2) x analog 4-20 mA loop-powered sensor connection Ex ib Gb IIB, one of them HART compatible
Outputs	2 (optional 4) x sensor connection Ex ib Gb IIB with RS485 interface
	RS 485 to transmitter

You can find the complete specifications in the instruction manual or on www.nivus.com

Perfect solutions even under difficult conditions

Your benefits

- Accurate and reliable measurement results
- Perfectly dimensioned measurement systems
- Saves costs thanks to quick and easy installation and commissioning procedures
- Low personnel expenses through integrated systems
- One competent contact person for all components



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Appendix B

GWF Advanced Pulse-Doppler Sensor Information



Water



GWF



Q-Eye PSC

Stationary area velocity flow meter for partially filled or pressurized pipes and open channels

Your benefits

- Best-in-class Doppler profiling technology:
Excellent long-time measurement stability, no need for costly on-site calibration
- Velocity profiling with logarithmic interpolation:
No blanking zone at bottom of channel or pipe. Highest accuracy in flow measurement for optimized process control
- Smallest area velocity sensor worldwide:
No disturbance of the flow profile, velocity measurement starts at 2 cm (< 1") water level
- Platform-independent web interface for configuration, operation and maintenance:
Easy and fast setup with multi-language graphical user interface. Parametrization with any mobile device, no software needed
- Integrated Wi-Fi access point and LAN interface, optional mobile connection:
Efficient system integration, real-time remote access anytime and anywhere
- Passive sensor, no electronics inside:
Maximum sensor robustness and lifetime, minimized total cost of ownership

Application

- Full or partially full pipes 100-2000 mm (4-80") in diameter or open channels with flow depths of 40-2000 mm (1.5-80")
- Ideal for sites with non-uniform or rapidly changing flow behavior. Suitable for applications with low and high water levels
- Continuous flow monitoring in slightly to heavily polluted media:
 - Wastewater treatment plants
 - Wastewater collection systems
 - Urban drainage
 - Industry

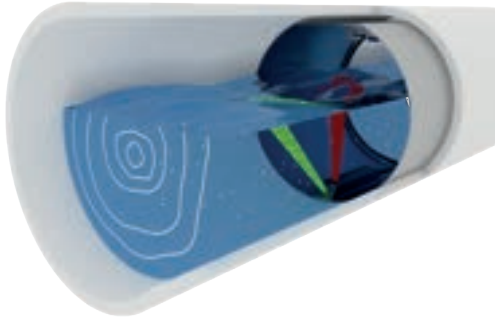
Features

- Compact aluminum housing, IP66 (NEMA 4)
- Smallest area velocity sensor worldwide, IP68
- Insertion sensor which does not protrude into the flow, IP68
- Pulse-Doppler Spectral Correlation technology
- Scanning of the entire velocity profile in up to 18 measuring cells
- Measurement of low velocities down to 0.04 m/s
- Bi-directional measurement over the entire flow range
- Typical accuracy: $\pm 2\%$ of reading for flow
- Integrated Wi-Fi access point
- Graphical user interface in multiple languages
- All units for display and data storage can be customized by the user
- Preselection of typical cross sections or user-definable irregular shapes
- Analog inputs for external sensors (2-wire loop-powered)
- Multiple analog and digital outputs, user programmable
- Communication: Ethernet, Modbus RTU/TCP, optional 4G/3G/2G modem
- Power supply: 100-240 V AC or 9-36 V DC
- ATEX for area velocity sensor available

Application

- Area velocity sensor to be mounted on pipe or channel bottom (up-looking) or wall (side-looking)
- Several velocity sensors in one cross section (up to 3)
- Insertion sensor for pipes only accessible from the outside
- Additional external level sensors (pressure, non-contact ultrasonic or radar)
- Well-established sensor mounting systems for diverse applications

Product description



Q-Eye PSC area velocity sensor

WebUI (Wi-Fi)

The Q-Eye PSC is equipped with an integrated web server running a WebUI. You can display and manage the WebUI using the standard web browser of your smartphone, tablet PC or notebook. There is no need for any additional software or App. Parameter setting and data visualization has never been so easy.



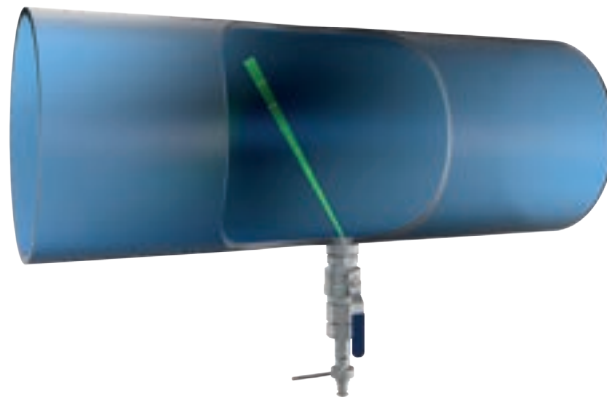
Data storage and transmission

Combine the Q-Eye PSC with a 4G/3G/2G cellular modem for automatic data transmission. The logged data can be sent to any host computer (FTP server) or to the GWF web-based cloud solution at a user-selectable interval (e.g. 4 times a day, once a day or once a week). Alternatively, wireless LAN and Ethernet connections are available.

Information on level, velocity, flow and signal strength can be taken at regular intervals between 1 minute and 60 minutes. In case of a flood event, the logging can be set automatically to one minute (event mode). The Q-Eye PSC is equipped with internal storage capacity (16 GB) and will store data for up to 18 months.

The Q-Eye PSC area velocity flow meter is designed for stationary flow monitoring of slightly to heavily polluted media in full or partially full pipes or open channels.

It uses advanced Pulsed-Doppler technology to directly evaluate velocity profiles, making it the best choice for sites with non-uniform or rapidly changing flow conditions. Additionally, the Q-Eye PSC measures bi-directional flow over the entire measurement range and near zero flow velocities down to 0.04 m/s. This profiling capacity eliminates the need for on-site calibration, thereby significantly reducing the cost of installation.



Q-Eye PSC insertion velocity sensor

Measuring principle

The Q-Eye PSC is a major improvement in open channel flow measurement. It's the latest entry in the GWF family of high-accuracy metering products. In contrast to the older Continuous Wave Doppler method, the Q-Eye PSC transmits acoustic pulses into the flow. These sound pulses are echoed back from particles in the medium. By time-gating the returned signals, velocity is measured in multiple cells, enabling a stepwise scanning of the entire velocity profile. Detailed velocity data in relation to the sensor location is used to calculate a highly accurate flow profile.

When compared to the Cross-Correlation method (evaluation of specific patterns in the flow), the Spectral-Correlation technology (PSC) allows for measurements in considerably more cells with a cell size of only a few millimeters. Thus the velocity profile can be measured with a much higher resolution.

By means of the PSC technology, it is possible to measure flow velocity profiles very close to the sensor as well as in greater distances. This makes the Q-Eye PSC suitable for both shallow and high water level applications.

Component description

The Q-Eye PSC system can be composed of a wall-mounted transmitter and several sensor options. The submersible area velocity sensor offers combined velocity and water level measurement for direct flow calculation with one sensor. The insertion velocity sensor can be used directly for pressurized pipes or combined with any additional level sensor for partially filled pipes.

Transmitter



Wall-mounted transmitter

The Q-Eye PSC transmitter incorporates all the required algorithms and software to ensure measurement accuracy and repeatability. The IP66 (NEMA 4X) compact housing features a 4 x 20 alphanumeric LCD display and a 4 button keypad.

All configuration data as well as measured and calculated data are stored inside a 16 GB Micro-SD card. The transmitter controls the measurements, calculates the flow rate and provides freely programmable current outputs, status alarms, frequency outputs and totalizer readings.

Sensors



Insertion velocity sensor



Low-profile area velocity sensor

The submersible area velocity sensor measures only 15 x 25 x 108 mm, making it the smallest sensor of this type currently available. Its low profile means less interference, which results in more accurate velocity measurements, especially in low-flow situations.

The insertion sensor is used when the pipe is accessible from the outside only. This sensor is for use in full pipes or partially full pipes in combination with an external level sensor (e.g. pressure or ultrasonic). These sensors can be installed into existing pipework through a 5 cm / 2" ball valve.

Mounting systems



Mounting plate, spring ring and scissors rings

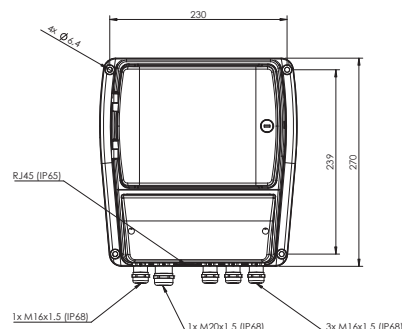
Standardized accessories including mounting plates, spring and scissors rings are available. Thus, the sensors can be installed within minutes, reducing time in the manhole. The sensor is first attached to a carrier and can then be fixed onto any of the compatible mounting systems. To install the sensors in rectangular, trapezoidal or earthen channels, we recommend the sensor mounting plate. Stainless steel spring rings simplify sensor installation in cylindrical pipes. 8 standard diameters from 100 mm (4") to 600 mm (24") are available.

You can install the sensor and fix the cable to a mounting ring before entering the manhole. In this way, the time spent in the sewer is significantly reduced. The rings can be expanded with a screw mechanism against the wall of the sewer. The expanding pressure makes undesired shifting of the ring impossible.

The adjustable scissors ring is installed in large pipes from 500 mm (20") to 1450 mm (57") in diameter. It consists of a base element with a scissors mechanism and one or more pairs of extensions to fit the size of the pipe.

Technical data

Transmitter



Q-Eye PSC

Display	4 lines, 20 characters
Keyboard	4 keys
Datalogger	16 GB Micro SD card
Communication	RS-485, Modbus (RS-232 or RS-485), Wireless LAN, 4G (LTE) / 3G (HSPA+) / 2G, Ethernet 10/100 Mbps
Inputs	max. 4 x 4-20 mA, 2 x digital
Outputs	max. 4 x 4-20 mA, 4 x relay, 2 x digital
Power supply	9-36 V DC or 100-240 V AC (50/60 Hz)
Approval	IP66 (NEMA 4)
Enclosure	Aluminum
Operating temperature	-20 °C to +60 °C
Storage temperature	-20 °C to +70 °C
Dimensions	270 x 256 x 139 mm (L x W x H)

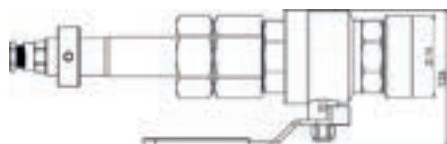
Sensor



Area velocity sensor

Sensor	1 x velocity 1 x water level
Frequency	1 MHz
Range	Velocity ± 5.3 m/s Water level 0.04 - 1.3 m expandable with external 4-20 mA level sensor
Accuracy	Velocity: ± 0.03 m/s from -1.5 m/s to +1.5 m/s ± 1 % of reading from -5.2 to -1.5 m/s and +1.5 to +5.2 m/s Level: ± 0.5 % FS (1.5 m) Flow: typically ± 2 %, depending on site conditions
Cable length	10 m incl. (max. 80 m)
Particle concentration	> 50 ppm
Material	Epoxy
Protection class	IP68 (48 h at 50 kPa, NEMA 6P)
Approval	ATEX (option)
Dimensions	108 x 25 x 15 mm (L x W x H)

Sensor



Insertion sensor

Sensor	1D velocity sensor for partially and fully filled pipes incl. 50 mm (2") ball valve
Frequency	1 MHz
Range	± 5.3 m/s (velocity)
Accuracy Velocity	± 0.03 m/s from -1.5 m/s to +1.5 m/s ± 1 % of reading from -5.2 to -1.5 m/s and +1.5 to +5.2 m/s
Cable length	10 m incl. (max. 80 m)
Material	Stainless steel 1.4301 (AISI 304)
Dimensions	Diameter: 50 mm (2")

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2.9 Facility Hydraulic Models, TM-1



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Andrew Wood, Applied Science, Inc.
Keaton LeFevre, Applied Science, Inc.
John Michalski, Applied Science, Inc.*

Date: June 1, 2023

*Subject: TM-1 Facility Hydraulic Models
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

Hydraulic models were created of the Leib Combined Sewer Overflow (CSO) Screening and Disinfection Facility (SDF) and the basin component of the Oakwood CSO Retention Treatment Basin (RTB) and Pump Station to develop updated hydraulic profiles. The hydraulic profiles were provided to the Great Lakes Water Authority (GLWA) CSO Facilities Improvements (2101475) Project Design Team to assist in the design and evaluation of facility improvement projects.

Profiles were developed for existing and proposed conditions through the Leib CSO SDF and existing conditions through the Oakwood CSO RTB. The energy grade lines (EGLs) showed levels that met the acceptable surcharging criteria for the conditions that were analyzed.

1.0 Introduction and Purpose

The purpose of this memorandum is to summarize the development and calibration of the hydraulic models that were used to create hydraulic profiles through the Leib CSO SDF and the Oakwood CSO RTB and Pump Station. The hydraulic profiles were used to evaluate existing conditions in the facilities and aid in the design of proposed facility upgrades that are discussed in more detail in a separate technical memorandum. (TM).

The hydraulic models were created using the Transient Analysis Program (TAP) software. TAP is a one-dimensional program that can accurately calculate head loss through model elements by dividing the elements into small uniform cells. The head loss calculations are completed for each cell instead of each element which ends up providing more detail through the facilities. Record drawings of the Leib CSO SDF and the Oakwood RTB were used to develop model geometry. Manufacturer head loss calculations were used to calibrate the losses through the screens at both facilities. The model development and calibration are discussed in more detail in subsequent sections of this technical memorandum.

2.0 Existing Systems Description and Conditions

The focus of the modeling effort was on the Leib CSO SDF and the RTB component of the Oakwood CSO RTB and Pump Station. Details of both facilities are provided in the following sections.

2.1 Leib CSO Screening and Disinfection Facility

The Leib CSO SDF was constructed in 2002 to screen and disinfect wet weather flows in the Conant-Mt. Elliot Sewer. Dry weather flows are directed through the facility to the Toward Treatment (TT) sewer which conveys the wastewater flow to the Detroit River Interceptor (DRI). Flows that exceed the facility's dry weather capacity will pass through screens and receive treatment in a disinfection chamber before being sent through a nearly 1-mile-long effluent conduit before discharging into the Detroit River.

The facility was intended to be a full-scale pilot facility and employs two types of screening technologies.

1. Raked horizontal bar screen (originally manufactured by Copa)
2. Raked vertical bar screen (manufactured by Romag)

There are four screening channels in the facility, with a total of eight Copa screens and a total of four Romag screens. The focus of the modeling effort on this project was through the treatment stream of the Leib CSO SDF which included flow through the screens. A plan view of the facility is presented in **Figure 2-1**.

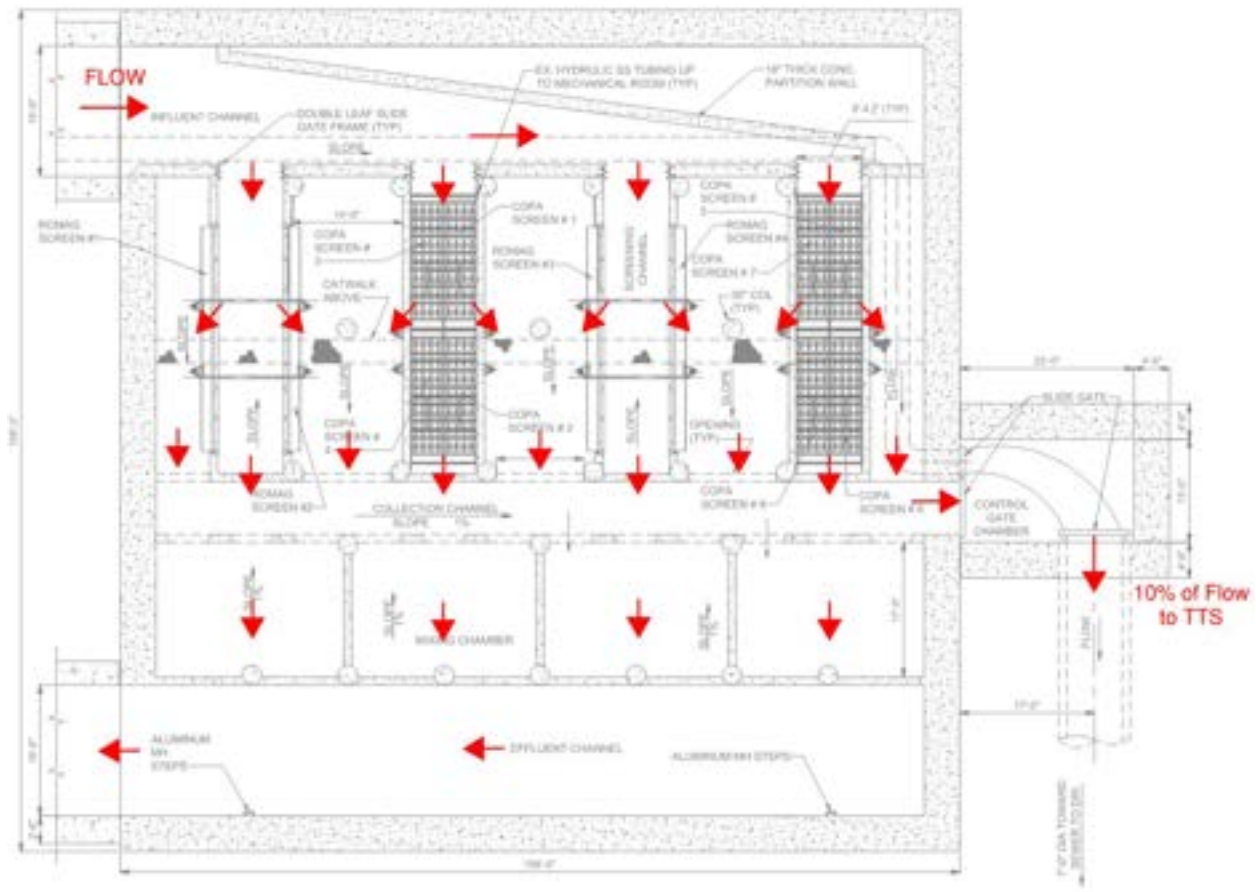


Figure 2-1
Plan View of Leib Facility

2.2 Oakwood CSO RTB and Pump Station

The Oakwood CSO RTB and Pump Station services the Oakwood Sewer District in the City of Detroit. This facility was completed in 2012 and replaced an older pump station facility servicing the same area. The Oakwood CSO RTB and Pump Station provides the pumping and CSO treatment capacity needed to meet NPDES permit requirements as well as provides the upstream customers with a higher level of service.

The Oakwood Pump Station has a firm capacity of 1,660 cfs and a total capacity of 1,950 cfs. There are a total of eight storm pumps at the Oakwood Pump Station. These pumps discharge to the RTB. Pumps 1, 2, 5 and 6 have variable frequency drive (VFD). Pumps 3, 4, 7, and 8 are constant speed pumps. Pumps 1 and 2 each have a rated capacity of 150 cfs. Pumps 3 through 8 each have a rated capacity of 275 cfs. Once the RTB is full, treated overflow discharges from the RTB to the O'Brien Drain and then runs to the Rouge River.

The stormwater pumps convey flow to the RTB. The RTB consists of two basin compartments which provide a total of 9 MG of storage. Six screens upstream of the basin compartments remove large debris from the flow stream. Excess volume is discharged through the effluent conduits to the O'Brien Drain and out to the Rouge River.

The focus of the modeling effort on this project was through the retention treatment basin. Hydraulic grade lines were developed through the facility from the stormwater pump discharge piping to the effluent channel. A plan view of the facility is presented in **Figure 2-2**.

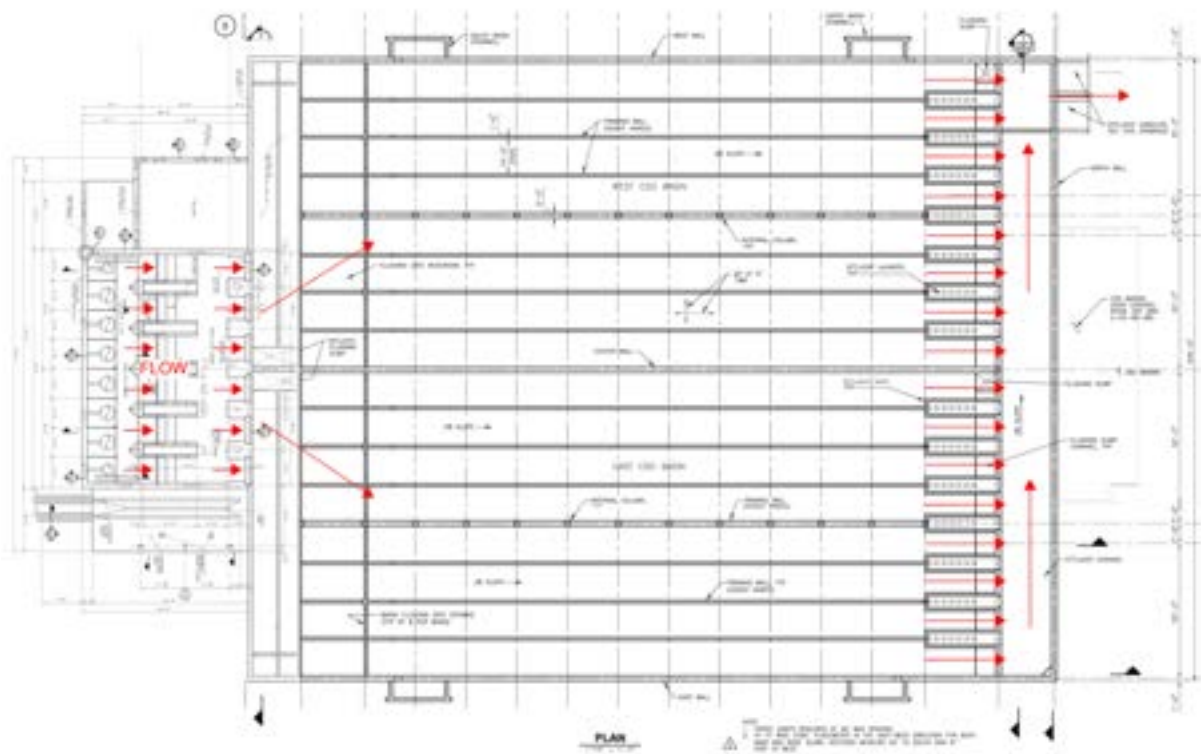


Figure 2-2
Plan View of the Oakwood CSO Facility Screen Chamber and CSO Basins

3.0 System Evaluation

The energy grade line through the Leib CSO SDF and the Oakwood RTB were calculated in TAP. TAP is a computational hydraulics program developed by Applied Science, Inc. (ASI) that can simulate steady-state, gradual time-varying, and rapidly-varying flow conditions for both open and closed conduit systems. TAP was selected for this modeling effort due to its ability to accurately model head losses in a system or facility. TAP divides conduits into uniformly-spaced small cells to determine the energy grade line and hydraulic grade line through the element. For each cell and each timestep, the fully dynamic equations are solved, and cell averaged quantities of depth, area, velocity, and flow rates are provided.

TAP models were created for the Leib CSO SDF and Oakwood RTB. The TAP models were run for steady-state conditions for a series of design flow rates and operational conditions.

3.1 Model Development

The TAP models were developed using a combination of as-built drawings provided by GLWA and head loss curves provided by the screen manufacturers. The TAP models contain the major components in the facilities which include the influent and effluent channels, weirs, gates and screens. The major facility components that were modeled in TAP are presented on schematics shown in **Figures 3-1** and **3-2**.

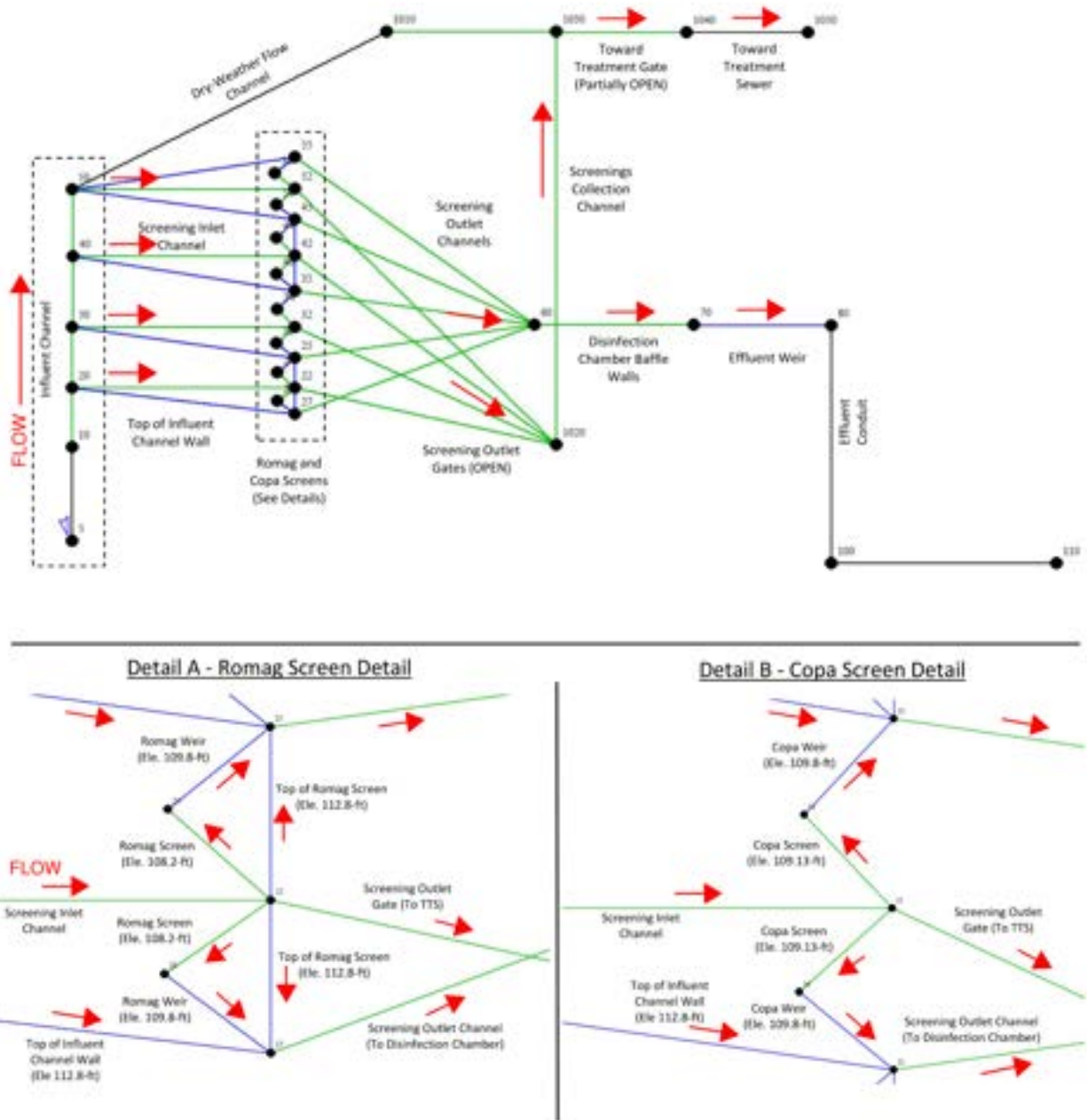


Figure 3-1
 Leib CSO SDF TAP Schematic

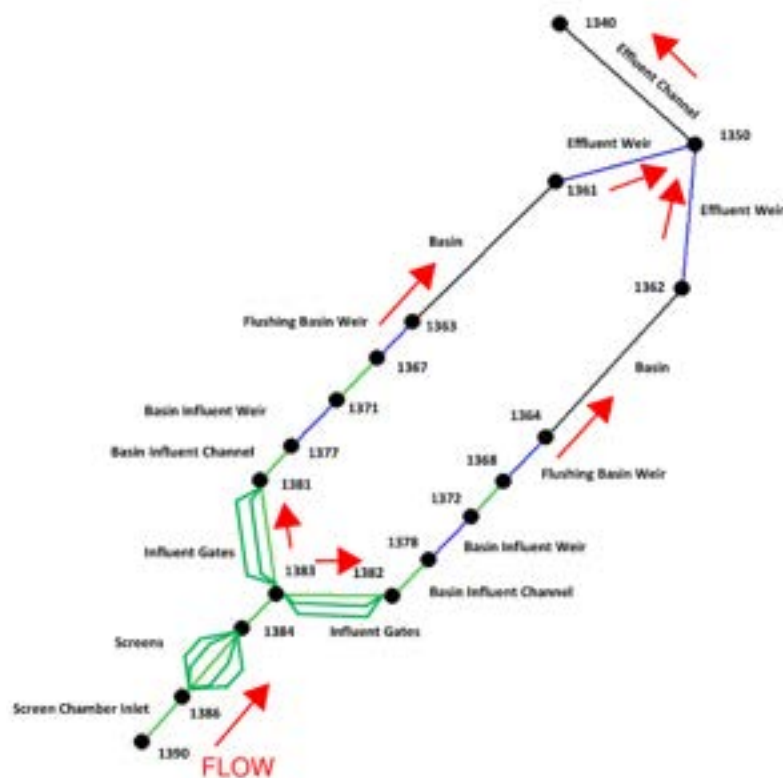


Figure 3-2
Oakwood CSO RTB TAP Schematic

3.1.1 Model Head loss

As-built drawings were reviewed and used to develop the TAP models. The minor loss coefficients used in the TAP model were based on the facility geometry. Entrance and exit head loss coefficients for the influent channels, gates, weirs, and effluent channels were taken from established literature. The head loss coefficients typically ranged as given in **Table 3-1**.

Table 3-1 Hydraulic Structure Head Loss Coefficients

Head loss Component	Minimum Coefficient (K)	Maximum Coefficient (K)
Abrupt Contractions	0.10	0.50
Abrupt Expansions	0.20	1.00
Gradual Expansions	0.00	0.02
Gradual Contractions	0.00	0.04
Entrance	0.10	0.50
Exit	0.30	1.00

The screen losses for the Leib CSO SDF and the Oakwood RTB were calibrated to match the head loss information provided by the screen manufacturer. Each screen manufacturer provided head loss information for a series of flow rate and downstream boundary conditions. This information was used to develop head loss curves for the screens since the losses vary based on both flow rate and downstream level.

TAP mini-models were created to calibrate the screen head losses. The entrance and exit losses for the screen elements were calibrated to produce head loss that matched the developed head loss curves. This was an iterative process that required the element entrance and exit losses to be adjusted for a range of flow rates provided on the head loss curves. The screen model representation from the calibrated mini models was then incorporated into the overall facility TAP models.

The modeling effort assumed some level of screen blinding. The screen manufacturers provided recommendations for the percentage blinding that should be assumed during peak flow conditions. The screen design team adopted these blinding percentages for the hydraulic analyses. The percentage blinding varies by each screen manufacturer and screen technology and is summarized below.

- Leib CSO SDF Copa Screens: 50% blinding
- Leib CSO SDF Romag Screens: 25% blinding
- Leib CSO SDF Duperon Multi-Rake Screens (Proposed Pilot): 30% blinding
- Oakwood RTB Perforated Plate Screens: 20% blinding

Calibration head loss curves can be found in Appendix B of this memorandum.

3.1.2 Model Flow Rates

Steady-state flow rates used in this analysis were taken from an existing SWMM5 model of the regional collection system. The Regional Wastewater Collection System (RWCS) SWMM5 model was developed under the Wastewater Master Plan (WWMP) and has been used for collection system project planning and decision-making purposes. The RWCS model includes representation of the Leib Facility and the Oakwood CSO RTB and Pump Station and was used to generate the steady-state flow rates used in the TAP modeling effort.

Future collection system projects are proposed upstream of both the Leib CSO SDF and the Oakwood CSO RTB and Pump Station that would increase the wet weather flows to the facilities. A connection from the Meldrum Sewer to the Leib CSO SDF is being considered that would send all dry weather and wet weather flows from the Meldrum Sewer to the Leib CSO SDF. The Oakwood District Intercommunity Relief Sewer (ODIRS) Project has been designed to send excess wet weather flow from the Northwest Interceptor (NWI) to the Oakwood CSO RTB and Pump Station. This project is designed to send wet weather flow to the Oakwood Pump Station to control

surcharging along the NWI. The RWCS design event model assumed both projects were built and are in-service.

The RWCS model was run for the 6-month, 24-hour design storm event and the 10-year, 24-hour design storm event for this analysis. The peak flow rates that were generated for these events were selected as the steady-state flow rates. A summary of the design event analysis can be found in Appendix A of this memorandum. The steady-state flow rates used in this analysis are presented in **Table 3-2**.

Table 3-2 Steady-State Flow Rates

Location	Design Event	Collection System Conditions	Steady-State Flow Rate (cfs)
Leib CSO SDF	6-month, 24-hour	Future (Meldrum Sewer Connection)	380
	10-year, 24-hour	Future (Meldrum Sewer Connection)	950
Oakwood RTB	6-month, 24-hour	Future (ODIRS)	531
	10-year, 24-hour	Future (ODIRS)	1231

3.1.3 Model Boundary Conditions

The TAP models of the Leib CSO SDF and the Oakwood RTB used fixed elevations as downstream boundary conditions. These elevations were taken from the RWCS model and are relative to the timing of the selected peak flow rate. For both models the downstream boundary elevation was the predicted level in the junction downstream of the effluent weir. The downstream boundary elevations are presented in **Table 3-3**.

Table 3-3 Downstream Boundary Elevation

Location	Design Event	Effluent Weir Elevation (ft – Detroit Datum)	Downstream Boundary Elevation (ft – Detroit Datum)
Leib CSO SDF	6-month, 24-hour	105.00	95.77
	10-year, 24-hour	105.00	103.66
Oakwood RTB	6-month, 24-hour	114.00	106.52
	10-year, 24-hour	114.00	106.52

4.0 Description of Alternatives

The Leib CSO SDF and Oakwood RTB were modeled under existing conditions. Additional modeling was completed at the Leib CSO SDF to evaluate alternative screening concepts. The modeled alternatives are described in more detail in the following sections.

4.1 Existing Conditions

The existing condition model setup for both facilities was based on a review of as-built drawings and Operations and Maintenance (O&M) manuals. Direction on operational assumptions for the modeling effort was provided by the screening and disinfection design team members.

The following assumptions were made for the existing conditions scenarios at the Leib CSO SDF.

- The Screening Outlet Gates were assumed to be in a fully OPEN position.
- The Toward Treatment gate was assumed to be partially open. The gate was opened enough to allow 10% of the total influent flow rate to be conveyed to the Toward Treatment Sewer.

The number of Screening Inlet Channels in-service varied among the existing conditions scenarios. Most of the existing condition scenarios assumed all Screening Inlet Channels were in-service to align with the original facility design assumptions. However, one existing conditions scenario was developed to evaluate the facility's firm capacity. This scenario assumed the Romag screens in the western-most Screening Inlet Channel were out-of-service.

The Oakwood RTB was analyzed for two operating scenarios under existing conditions. All scenarios assumed that one of the six perforated plate screens were out-of-service. The two scenarios summarized were:

- Five screens and both basin compartments in-service
- Five screens and one basin compartment in-service

4.2 Proposed Conditions

Proposed conditions scenarios were evaluated at the Leib CSO SDF to assess screening and operational alternatives. The following proposed condition scenarios were evaluated at the Leib CSO SDF.

- Screening Pilot Scenario – Replacement of one Copa/horizontal screen with a Duperon/multi-rake screen in the 4th (eastern-most) Screening Inlet Channel. A plan view of the proposed pilot is presented in **Figure 4-1**. The following assumptions were made for the pilot scenarios at the Leib CSO SDF.
 - This alternative was evaluated for the total facility capacity and the firm capacity of the facility. The firm capacity assumed the Romag screens in the western-most Screening Inlet Channel were out-of-service.
 - The Screening Outlet Gates were assumed to be in a fully OPEN position.

- The Toward Treatment gate was assumed to be partially open. The gate was opened enough to allow 10% of the total influent flow rate to be conveyed to the Toward Treatment Sewer.

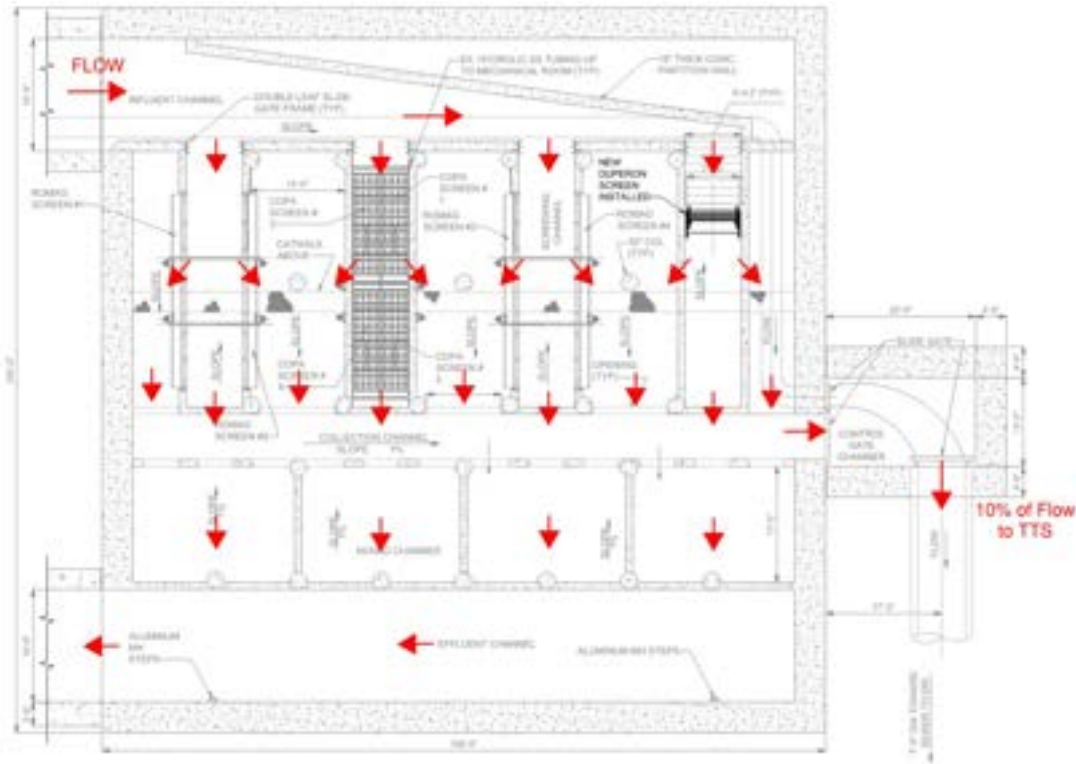


Figure 4-1
Multi-Rake Pilot Screening Alternative

- All Romag Screening Alternative – Replacement of both Copa/horizontal screens with Romag/vertical bar screens in the 2nd and 4th Screening Inlet Channels. This concept is presented in **Figure 4-2**. This proposed scenario was modeled for one operational scenarios.
 - The Romag screens in the western-most Screening Inlet Channel are out-of-service.
 - The Screening Outlet Gates were assumed to be in a fully OPEN position.
 - The Toward Treatment gate was assumed to be partially open. The gate was opened enough to allow 10% of the total influent flow rate to be conveyed to the Toward Treatment Sewer.

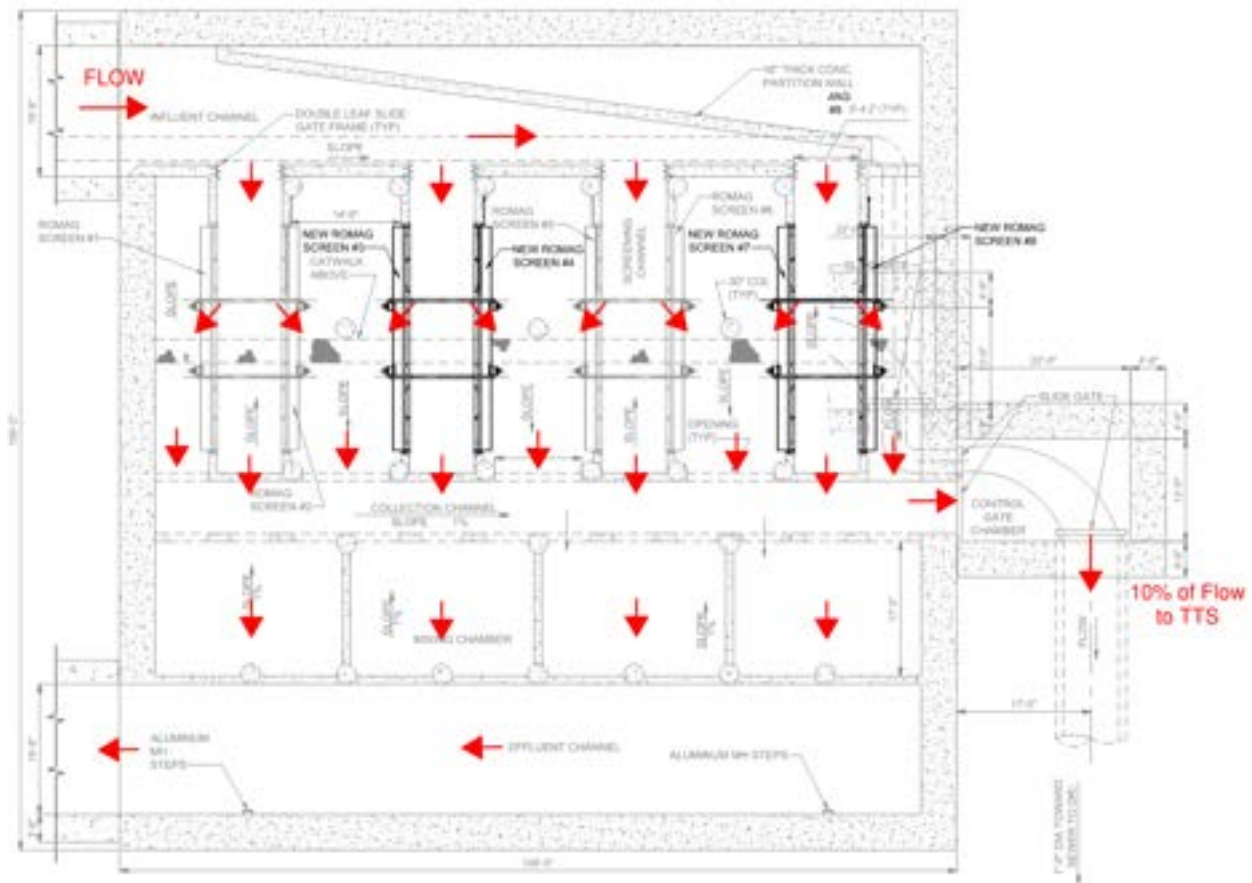


Figure 4-2
Proposed All Romag Screening Alternative

Additional screening alternatives may be evaluated throughout the design phase as other screening technologies are vetted.

There were no proposed conditions scenarios evaluated for the Oakwood RTB for this hydraulic analysis. A CFD modeling effort has been completed to evaluate proposed mixing alternatives in the basin compartments for the process team. The CFD modeling effort is covered in a separate technical memorandum.

4.3 Acceptable Surcharging

Acceptable surcharging levels were established under the original design at both facilities. The performance of the concepts evaluated in this phase of the project is based on a comparison of modeled existing EGLs and proposed EGLs. The upstream HGLs were checked against acceptable surcharge levels to identify or prevent potential operational or upstream collection system issues.

4.3.1 Leib CSO SDF

For the purposes of conceptual screen design and overall hydraulic acceptability, the existing conditions steady-state EGL at the upstream end of the facility was determined to be the acceptable surcharge elevation. Based on the modeling effort outlined in this memorandum, that elevation was determined to be 111.59-ft assuming all screen inlet channels were in-service. The upstream EGL increased to 112.31-ft when one Romag screen inlet channel was taken out-of-service to represent the firm capacity of the facility.

Proposed conditions grade lines were compared to the existing conditions grade lines at the upstream end of the facility. Elevations that were less than or equal to existing conditions were determined to be acceptable.

4.3.2 Oakwood RTB

The acceptable surcharge elevation for the Oakwood RTB is 120.00-feet (Detroit Datum) or 599.25-feet (NAVD88 datum). This elevation corresponds to the storm pump discharge standpipe elevation which is shown in **Figure 4-3**. Elevations below 120.00-feet allow for free discharge conditions at the standpipe and will not impact the performance of the storm pumps.

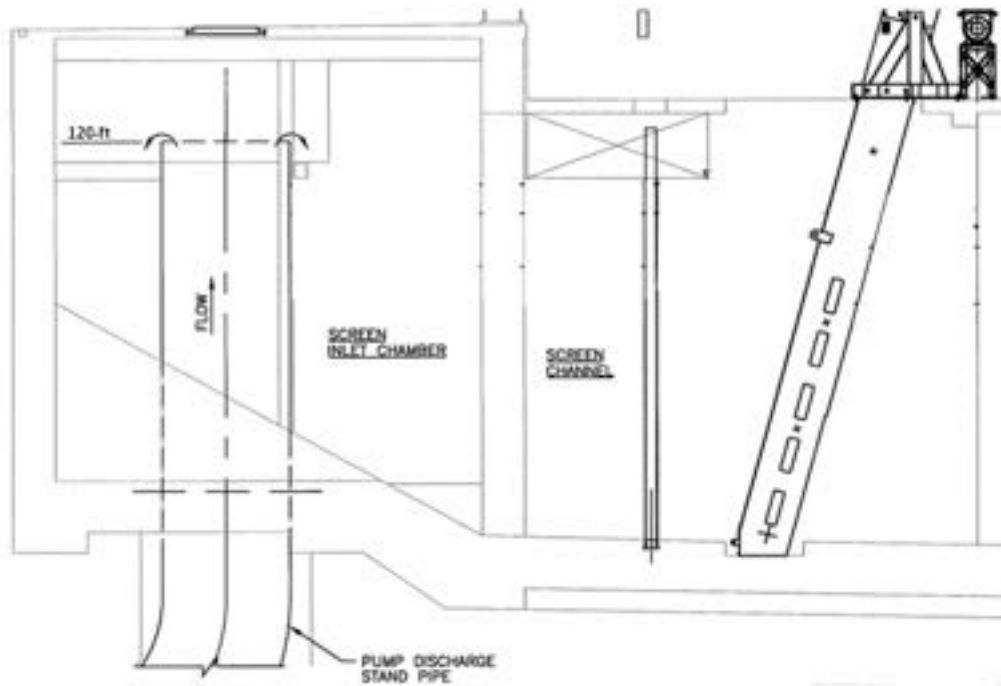


Figure 4-3
Oakwood Storm Pump Discharge Standpipe

5.0 Alternatives Analysis

The Leib CSO SDF and Oakwood RTB TAP models were run for the 6-month, 24-hour and 10-year, 24-hour design event peak flow rates. Each model was run until steady-state conditions were reached.

The hydraulic grade line at each model node was tabulated to create the hydraulic profiles through the facilities. The profiles can be found in Appendix C of this document. The hydraulic profiles were provided to the various team disciplines for use in the evaluation of existing conditions and proposed facility modifications.

The model results are also tabulated below for the Leib CSO SDF and the Oakwood RTB in **Tables 5-1** and **5-2**, respectively.

Table 5-1 Steady-State Model Results at the Leib CSO SDF

Scenario	Description	Flow Rate (CFS)	Steady-State Energy Grade Lines (feet- Detroit Datum)				
			Upstream End of Facility	Upstream of Screens	Downstream of Screens	Over Effluent Weir	Downstream Effluent Channel
1	Existing Conditions	380	110.61	110.57	110.48	106.27	100.99
2	Existing Conditions	950	111.59	111.40	111.10	107.35	104.18
3	Existing Conditions, One Screening Inlet Channel Out-of-Service	950	112.31	111.87	110.51	107.35	104.18
4	Proposed Multi-Rake Pilot	950	111.60	111.39	110.97	107.35	104.18
5	Proposed Multi-Rake Pilot, One Screening Inlet Channel Out-of-Service	950	112.29	111.92	111.41	107.35	104.18
6	Proposed All Romag Concept, One Screening Inlet Channel Out-of-Service	950	111.81	111.52	111.16	107.35	104.18

Table 5-2 Steady-State Model Results at the Oakwood RTB

Scenario	Condition	Flow Rate (CFS)	Steady-State Energy Grade Lines (feet- Detroit Datum)				
			Upstream of Screens	Downstream of Screens	Over Influent Channel	Over Effluent Weir	Downstream Effluent Channel
1	Existing Conditions, One CSO Basin In-Service	531	114.82	114.53	114.51	114.49	110.70
2	Existing Conditions, One CSO Basin In-Service	1231	116.39	115.05	114.96	114.85	110.70
3	Existing Conditions, Two CSO Basins In-Service	1231	116.01	114.59	114.57	114.54	110.70

6.0 Life Cycle Cost Analysis

Not used.

7.0 Summary, Recommendations and Key Decisions

Hydraulic profiles were prepared for existing and proposed conditions through the Leib CSO SDF and existing conditions through the Oakwood RTB. The modeling effort showed levels that met the acceptable surcharging criteria for the conditions that were analyzed. Profiles can be found in Appendix C of this technical memorandum.

7.1 Key Decisions

Key decisions made during the course of review and presentation of this Technical Memorandum are as follows:

- As addressed in the design event memo in Appendix A, GLWA and EGLE agreed that the basis of design flow rates will be based on the peak 6-month, 24-hour and 10-year, 24-hour flow rates from the RWCS model.

8.0 Next Steps

The hydraulic profiles have been circulated to the GLWA CSO Facilities Improvements (2101475) team discipline leads to assist in the evaluation of existing equipment and any proposed modifications at the Leib CSO SDF and the Oakwood RTB.

At the time of the publication of this memorandum, the Romag alternative has been found to be hydraulically acceptable and is the preferred alternative for future modifications at the Leib CSO SDF. The hydraulic analysis for both the Leib CSO SDF and the Oakwood RTB will be revisited at major project milestones throughout the design phase to confirm that any proposed modifications will be hydraulically acceptable.

Appendices

Appendix A – Design Event Memo

Appendix B – Screen Head Loss Data

Appendix C – Hydraulic Grade Line Profiles

Appendix A

Design Event Memo



MEMORANDUM

To: Scott Worth, PMA Consultants, LLC
Chris Nastally, Great Lakes Water Authority (GLWA)
David McCord, Great Lakes Water Authority (GLWA)
Steve Fehniger, CDM Smith
Ali Khraizat, CDM Smith

From: Andrew Wood, Applied Science, Inc.
John Michalski, Applied Science, Inc.

Project: GLWA CSO Facilities Improvements (2101475)

Subject: Design Storm Event and Facility Flow Rate Summary

Date: February 14, 2023

Introduction

The purpose of this memorandum is to document the selected design storm events and peak flow rates that will be used in the evaluation of the existing GLWA CSO facilities under the GLWA CSO Facilities Improvements (2101475) Project. Hydrographs through these facilities were generated using the Regional Wastewater Collection System (RWCS) SWMM model and will be used by the various team disciplines to evaluate the performance of existing equipment and any proposed modifications at the GLWA facilities.

This memorandum will summarize the peak flow rate at each facility for the selected design events and compare them to the facility design flow rates. The goal of this write-up is to get consensus from the discipline leads and the client on the direction of the project as it pertains to design criteria.

ASI intends for this to be a living document through the development of the BOD, and additional flow conditions will be simulated or analyzed by ASI, as requested, as the BOD progresses. It is understood that the CDM Smith process design team is evaluating what flows are applicable for each of the following design elements:

1. Optimization of the Chlorination Process
2. Screen Design
3. Distinguishing Between Treatment Capacity and Hydraulic Conveyance Capacity
4. Dry Weather Emergency at WRRF that prompts the Emergency Use of CSO Facilities
5. Wet Weather Worst Case – Extreme Storm Event

RWCS Model Background

The RWCS model was developed under the Wastewater Master Plan (WWMP) Project for planning and decision-making purposes. The RWCS model provides a detailed representation of the wastewater collection system as it is today and supersedes earlier collection system models including the GDRSS model which was used in the design of the CSO facilities. The RWCS model contains a detailed representation of all major GLWA assets including the four CSO Facilities that are the focus of this project: Baby Creek CSO Screening and Disinfection Facility (SDF), Conner Creek CSO Retention Treatment Basin (RTB), Leib CSO SDF and Oakwood CSO RTB and Pump Station.

The RWCS model was used for this project to provide design flow rates and hydraulic gradelines (HGLs) at the four CSO facilities. Three design events selected for this analysis are the 6-month, 24-hour, 10-year, 1-hour and 10-year, 24-hour storm events. An aerial reduction factor (ARF) was applied to the NOAA Atlas 14 rainfall totals for the two 24-hour duration storm events. The modeled rainfall totals are as follows:

- 6-month, 24-hour event: 1.10 inches (1.15 inches total with 0.96 ARF)
- 10-year, 1-hour event: 1.71 inches
- 10-year, 24-hour event: 3.18 inches (3.31 inches total with 0.96 ARF)

The 6-month, 24-hour design storm event was selected to represent the collection system response for an average wet weather event. Events smaller than the 6-month storm event had the likelihood of not producing a wet weather response at some of the CSO facilities included in this project.

The 10-year, 1-hour and 10-year, 24-hour design storm events were selected for this project because they were used in the original design of the CSO facilities with GDRSS model. The 10-year, 1-hour storm event was used to generate the design flow rates for the Baby Creek CSO SDF, Leib CSO SDF and Oakwood CSO RTB and Pump Station. The Conner Creek CSO RTB was designed around peak flow rates generated by the 10-year, 24-hour design storm event.

RWCS Model Results

The RWCS model was run for the design storm events for current and future conditions. Model predicted influent peak flow rates to each facility are summarized below in Table 1 for current conditions at all four facilities and future conditions at Leib and Oakwood based on present planning. Current conditions represents the wastewater collection system as it is today. Future conditions assumes the Meldrum connection to the Leib CSO SDF and the Oakwood District Intercommunity Relief Sewer (ODIRS) connection to the Oakwood CSO RTB and Pump Station have been constructed and are in-service. The original facility design flow rates are also included in Table 1 for comparison purposes.

The predicted peak flow rates presented in Table 1 are based on 5-minute model output. The reporting time step of 5-minutes was selected under the Wastewater Master Plan Project to match meter time stamp data. The modeling effort for this project retained these parameters.

Table 1 – Flow Rate Comparison

Facility	Facility Design Flow Rate (cfs)	Collection System Conditions (Current or Future)	Predicted 5-minute Peak Flow Rate (cfs)		
			6-month, 24-hour Design Event	10-year, 1-hour Design Event	10-year, 24-hour Design Event
Baby Creek CSO SDF ¹	5,100	Current	1,123	3,606	3,855
Conner Creek CSO RTB ²	13,252 (Treatment Capacity) 13,963 (Hydraulic Capacity)	Current	3,709	8,719	9,910
Leib CSO SDF ³	1,550 (Peak Design Flow) 2,000 (Hydraulic Capacity)	Current	118	394	520
		Future	380	510	950
Oakwood CSO RTB and PS ⁴	1,660 (Firm Capacity)	Current	135	712	765
		Future	531	1,176	1,231

Notes:

- 1) The Baby Creek CSO SDF was designed to a 10-year, 1-hour storm event with a river elevation of 92.0-feet (Detroit Datum).
- 2) The Conner Creek CSO RTB was designed to a 10-year, 24-hour design storm event with a 25-year flood level on the Detroit River (97.5-feet Detroit Datum). Treatment capacity was designed using a 10-year, 1-hour design event.
- 3) The Leib CSO SDF was designed to a 10-year, 1-hour storm event.
- 4) The Oakwood CSO RTB and Pump Station was designed to a 10-year, 1-hour storm event.

Conclusions

The RWCS model flow rates for the 6-month, 24-hour and 10-year, 24-hour design storm events presented in Table 1 will be used in this analysis. The predicted flow rates from the RWCS model are significantly lower than the design flow rates from the GDRSS model at all four CSO facilities, however the RWCS model provides a more accurate representation of the flow conveyed in the collection system to the facilities as it is today. The individual designers are to confirm the ultimate design condition for the work being proposed and use those rates for complete assessment of the performance over the range of conditions potentially experienced over the lifespan of the work.

Appendix B

Screen Head Loss Data

Head Loss Calculations for Andritz Perforated Plate Screen (20% Blinding)

Manufacturer Stated Head Loss For One (1) Perforated Plate Screen

	Flow Rate and Downstream Depth Condition ¹		
	Condition 1	Condition 2	Condition 3
Flow Rate (MGD)	214.6	159.1	214.6
DS Depth (in)	175.2	182.4	184.8
Blinding	20%	20%	20%
US Depth (in)	201.10	197.20	208.80
Head Loss (in)	25.90	14.80	24.00
² TAP, Screen K_{ent}	1.6	2.0	1.7
² TAP, Head Loss (in)	26.52	14.64	24.72

¹Conditions 1 - 3 in Table are Unique Flow Rate and DS Depth Scenarios Provided by the Manufacturer.

²Modeling Team Recreated Scenarios in the TAP Modeling Program as a Proof of Concept for Screen Headloss Calibration.

Andritz Screen Head Loss Formula

$$Q = C_0 A_0 \sqrt{\frac{2\Delta P / \rho}{(1 - (A_0 / A)^2)}}$$

Andritz Head Loss Data Source

The screen head loss calculator was developed using a formula and data provided by the screen manufacturer. The provided data can be found in the following document:

Andritz Screen Data (Oakwood WWTP, MI ASC Calc 1-5-23).pdf

Andritz Screen Head Loss Calculator

	Parameter	Value	Units
Pressure	Pressure Drop (ΔP)	2800.18	lb-m/(ft*s ²)
	Pressure Drop	87.04	lb-f/ft ²
	Pressure Drop	0.604	psi
Head	Head Loss	1.40	ft
	Head Loss	16.76	in
	DS Depth	14.08	ft
Input	# of Screens	5	
	Blinding	20%	
	Total Flow Rate	1231	cfs
	US Depth	15.48	ft
Intermediate	Flow per Screen (Q)	246.2	cfs
	Total Wetted Area (A)	124.12	ft ²
	Open Area (A_0)	39.72	ft ²
Constant	Water Density (ρ)	62.42	lb-m/ft ³
	Discharge Coeff. (C_0)	0.62	

TAP Model Calibrated Screen Head Loss

Calibration Runs	Min Flow	Avg Flow - Existing	Avg Flow - Future	Peak Flow - Existing	Peak Flow - Future	Peak Flow - Future	Design Peak Flow
Flow Rate (cfs)	99	135	531	765	1231	1231	1660
# of Basins Open	1	1	1	1	1	2	2
# of Screens Operating	5	5	5	5	5	5	5
Blinding	20%	20%	20%	20%	20%	20%	20%
DS Depth (ft)	13.66	13.70	14.03	14.20	14.53	14.08	14.22
US Depth (ft)	13.67	13.72	14.33	14.79	15.86	15.48	16.46
Calc'd, Head Loss (in)	0.12	0.24	3.60	7.08	15.96	16.80	26.88
Calc'd, Head Loss (ft)	0.01	0.02	0.30	0.59	1.33	1.40	2.24
TAP, Screen K_{ent}	2.1	2.1	2.1	2.1	1.80	1.75	1.38
TAP, Head Loss (in)	0.12	0.24	3.48	7.2	16.2	16.92	27.24
TAP, Head Loss (ft)	0.01	0.02	0.29	0.6	1.35	1.41	2.27

Note on Calibration:

DS Depth obtained by sending design flow rate through Oakwood Facility model. Use flow and DS Depth to calculate head loss / US Depth in this spreadsheet. In Isolated Screen model, set flow rate and DS Depth. Tweak screen entrance loss to achieve calculated head loss. Plug calibrated entrance loss into Oakwood Facility model to obtain full hydraulic grade line through facility.

Head Loss Calculations for ROMAG Vertical Screens (25% Blinding)

ROMAG Screen Head Loss Data Sheet Sample

Dimension of the screen		RSW 12x84
effective surface	4.20 m ²	45.20 sq ft
length emergency discharge	5.84 m	20.00 ft
height emergency discharge	0.52 m	3.51 ft
height additional weir	no additional weir	
degree of straining	25 %	
velocity through the screen	1.18 m/s	3.88 ft/s
flow rate (m ³ /s)	2.73 m ³ /s	62.4 MGID
flow rate emergency discharge	14.16 m ³ /s	323.2 MGID

Dimension for several screens		4
effective surface total	16.80 m ²	180.81 sq ft
flow rate (m ³ /s) total	10.91 m ³ /s	249.6 MGID
Emergency discharge total	56.64 m ³ /s	1292.8 MGID

Levels		
height emergency discharge	height (feet)	110.85
top of screen	height (feet)	112.84
waterlevel in front of screen	height (feet)	111.21
waterlevel behind the screen	height (feet)	110.85
height of weir	height (feet)	109.80
height of threshold	height (feet)	108.21

Remarks:

Leib Detroit blinding rate 25% date 18.11.22

ROMAG high performance screen RSW 12x84 drawn Bu

Hydraulic calculation

AB43183-T10

ROMAG Head Loss Data Source

The plotted curve seen below was developed using data provided by the screen manufacturer. The provided data can be found in the following documents:

2022-11-18 hydraulic Saveco.pdf

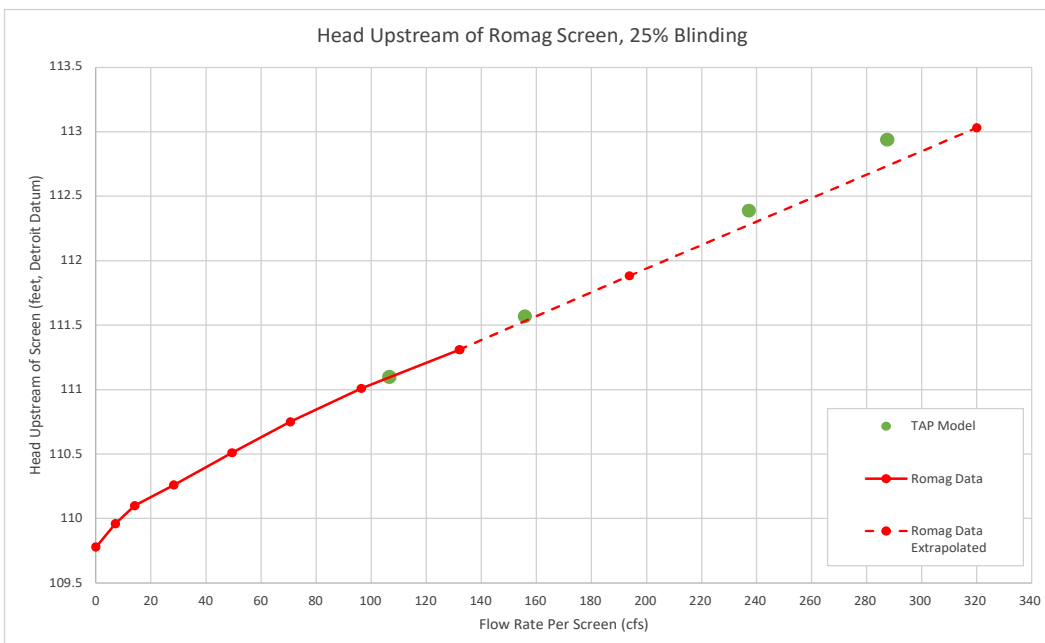
2022-11-18 hydraulic Waterlink original calcs.pdf

ROMAG Head Loss Curve Data

Flow Rate (cfs)		Upstream Head (feet, Detroit Datum)	
Facility	Per Screen	ROMAG Data	ROMAG Extrapolated ¹
0	0	109.78	
56.48	7.06	109.96	
113.04	14.13	110.10	
226	28.25	110.26	
395.52	49.44	110.51	
565.04	70.63	110.75	
771.28	96.41	111.01	
1056.8	132.1	111.31	111.31
1550	193.75		111.88
2000	320		113.03

¹Extrapolated Data Calculated Using a Linear Trendline of the Last Three Data Points.
Trendline Equation: $y = 0.0091x + 110.12$

ROMAG Screen Head Loss Curve and TAP Calibration Plot



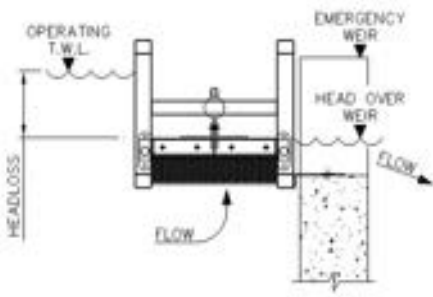
TAP Model Calibration Head Loss

Flow Rate (cfs)		Upstream Head (feet, Detroit Datum)
Facility	Per Screen	TAP Model Calibration
771	106.52	111.1
1057	155.73	111.57
1550	237.11	112.39
2000	287.38	112.94

Screen $K_{Ent} = 1.0$

Head Loss Calculations for COPA Horizontal Screens (50% Blinding)

COPA Screen Head Loss Formula



Total Head loss = Head loss over weir + Head loss through screen

$$\text{Head loss over weir} = \left(\frac{Q}{1.76 \times W} \right)^2 \times 0.333$$

$$\text{Head loss through screen} = \frac{1}{2 \times g} \left(\frac{Q}{A} \right)^2$$

Where Q = Flow (m³/sec)
W = Weir length (m)
CD = 0.6
g = 9.81 m/s²
C = Screen discharge co-efficient (use 0.6)
A = Screen open area (m²)

TECHNICAL INFORMATION SHEET		SHEET	OF
		1	1
HEADLOSS CALCULATIONS FOR HORIZONTAL RAKED BAR -STORM OVERFLOW SCREENS		DATE	18/05/09
		NO	TI 642

jacopa
CORROSION PROTECTANTS

COPA Head Loss Data Source

The screen head loss curve was developed using a formula provided by the screen manufacturer. The provided data can be found in the following document:

642- Headloss calculations for horizontal raked storm overflow screens.pdf

Head Loss Formula Constants

Discharge Coeff, C	0.6
Gravitational Constant, g	9.81 m/s ²
Weir Length	10.36 m
Weir Length	34 ft
Screen Open Area	5.24 m ²
Screen Open Area	56.4 ft ²
Blinding	50%
Blinded Area, A	2.62 m ²
Blinded Area, A	28.20 ft ²

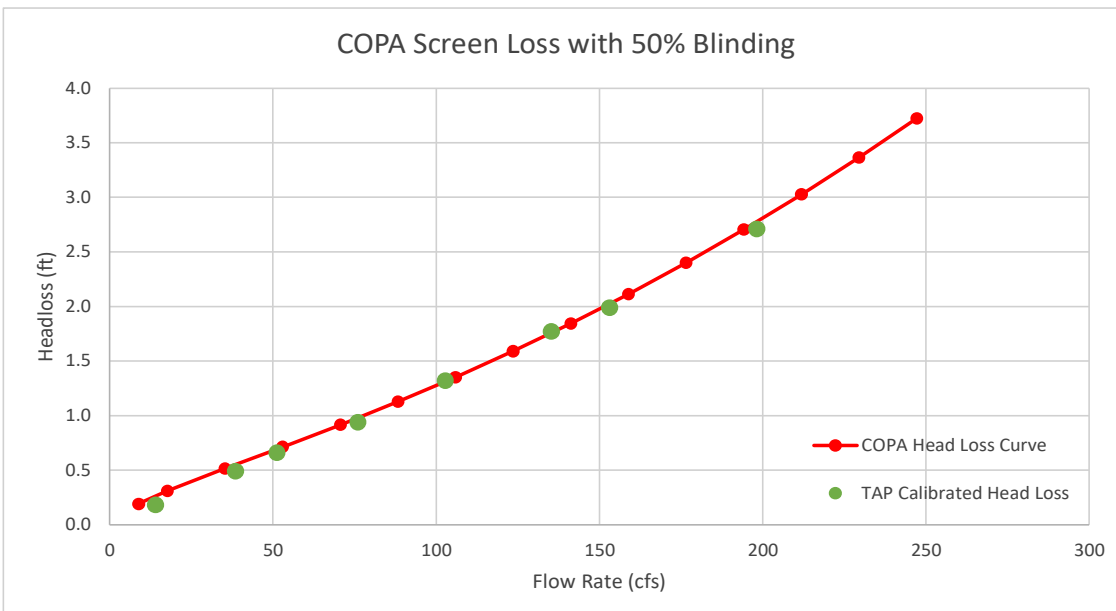
COPA Screen Head Loss Curve

Flow Rate	Weir Loss	Screen Loss	Total Loss
cfs	feet	feet	feet
35.31	0.47	0.04	0.52
52.97	0.62	0.09	0.71
70.63	0.75	0.16	0.92
88.29	0.87	0.25	1.13
105.94	0.99	0.37	1.35
123.60	1.09	0.50	1.59
141.26	1.19	0.65	1.84
158.92	1.29	0.82	2.11
176.57	1.39	1.02	2.40
194.23	1.48	1.23	2.70
211.89	1.56	1.46	3.03
229.55	1.65	1.72	3.37
247.20	1.73	1.99	3.72

Tap Calibration Results

Facility Flow Rate (cfs)	Flow Thru COPA Channel (cfs)	Screen K _{ent}	Head Loss (ft)	Expected Head Loss (ft)
118	14.08	20.00	0.18	0.26
380	38.5	10.00	0.49	0.55
520	51.2	8.00	0.66	0.69
771	76	5.50	0.94	0.98
1057	102.8	4.50	1.32	1.31
950	135.23	3.65	1.77	1.76
1550	153.16	3.25	1.99	2.02
2000	198.25	2.75	2.71	2.78

COPA Screen Head Loss Curve and TAP Calibration Plot



Head Loss Calculations for Duperon Bar Screens (30% Blinding)

Manufacturer Stated Head Loss for Bar Screen

US Depth	Flow Rate		Head Loss
	MGD	cfs	Inches
15.4	110	170	2.95
15.4	120	186	3.51
15.4	125	193	3.81
15.4	135	209	4.45
15.4	145.42	225	5.16
15.4	160	248	6.24
15.4	175	271	7.47
15.4	200	309	9.76

Black Text Denotes Data Provided by Manufacturer

Red Text Denotes Calculated Value

Duperon Head Loss Data Source

The plotted curve was developed using data provided by the screen manufacturer. The provided data can be found in the following document:

P12737 GLWA Leib CSO, MI - Hydraulics.pdf

Duperon Screen Head Loss Formula

$$Head\ Loss = \frac{\left(\frac{1}{C^2}\right) * (V^2 - v^2)}{2g}$$

Where:

Flow Coefficient, $1/C^2 = 0.99$

Velocity Upstream of Screen, V

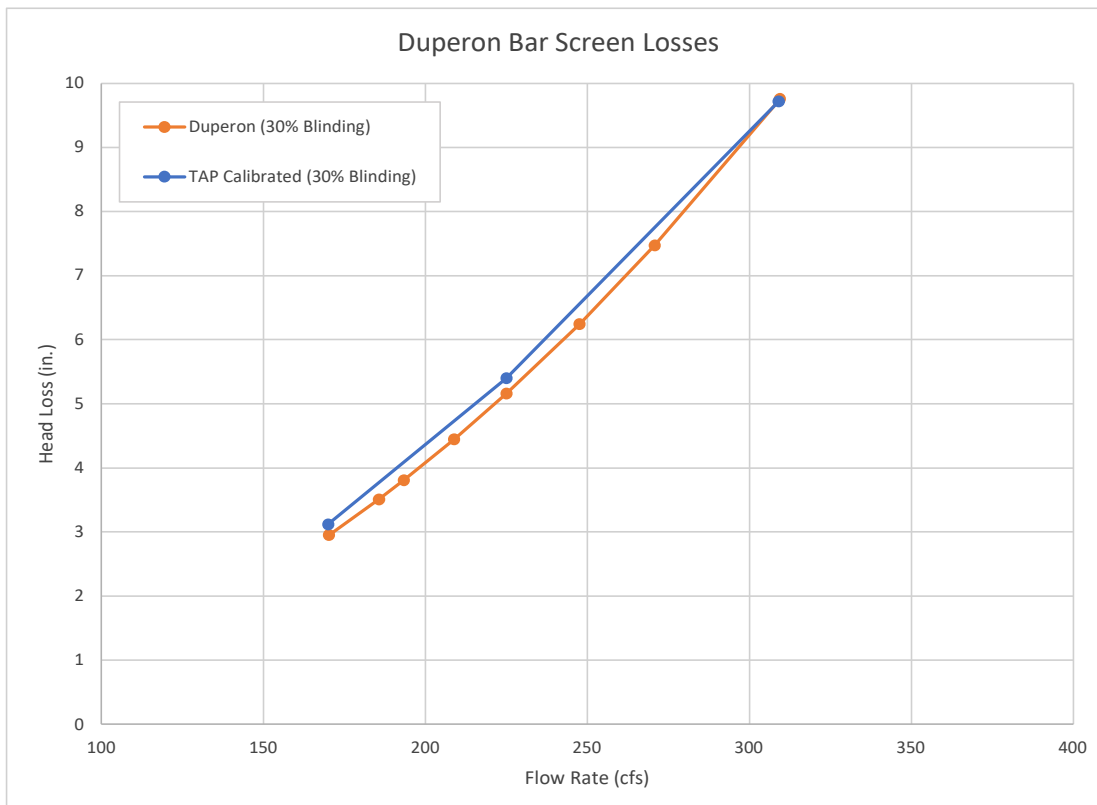
Velocity Through Screen, v

Gravitational Acceleration, $g = 32.2\text{ ft/s}^2$

TAP Model Calibrated Screen Head Loss

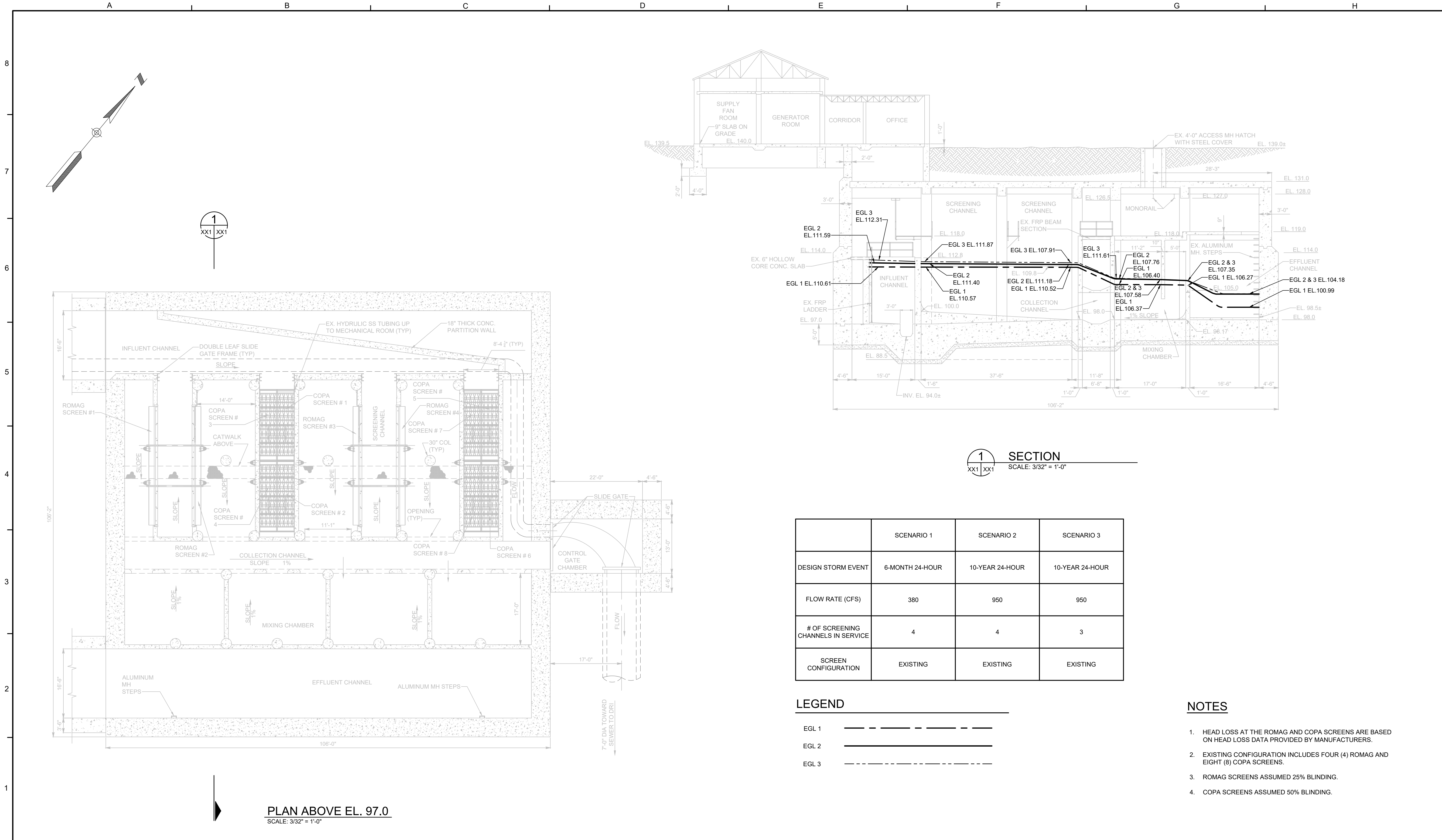
US Depth (ft)	Flow (cfs)	TAP Model Loss (in)	Calculated Loss (in)	Screen K_{Ent}
15.4	170.03	3.12	2.98	0.25
15.4	225.00	5.40	5.21	0.4
15.4	309.07	9.72	9.87	0.45

Duperon Screen Head Loss Curve and TAP Calibration Plot

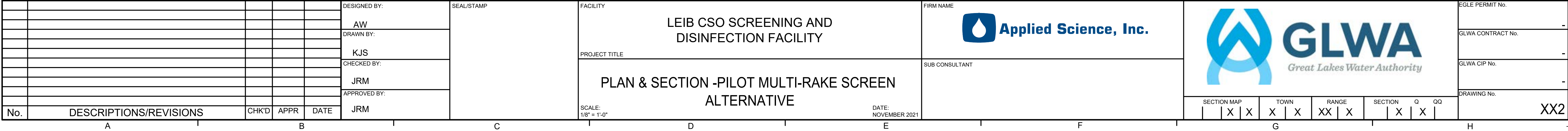


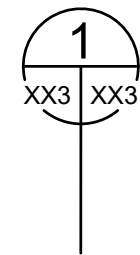
Appendix C

Hydraulic Grade Line Profiles



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SCALE: 3/32" = 1'-0"



LEGEND

1. HEAD LOSS AT THE ROMAG SCREENS ARE BASED ON HEAD LOSS DATA PROVIDED BY MANUFACTURERS.
2. PROPOSED CONFIGURATION INCLUDES EIGHT (8) ROMAG.
3. ROMAG SCREENS ASSUMED 25% BLINDING.

XX3

2.10 Permitting and Regulatory Requirements, TM-28



Technical Memorandum

*To: Chris Nastally, GLWA
Scott Worth, PMA*

*From: Dustin Ford, CDM Smith
Ali Khraizat, CDM Smith*

Date: June 1, 2023

*Subject: TM-28 Permitting and Regulatory Requirements
Contract No. 2101475 - CSO Facilities Improvements Project*

Executive Summary

As a part of the scope of work, the Design Team has been assigned the task of identifying and obtaining necessary permits and regulatory requirements associated with the design and construction modifications to meet the project needs. Here within is a list of the identified permitting and regulatory requirements. The Design Team will continue to evaluate these requirements and monitor their progress to help limit the impact they will have on the overall project schedule.

1.0 Introduction and Purpose

The purpose of this technical memorandum (TM) is to assist the Design Team in meeting the regulatory compliance requirements associated with the design and construction of the Oakwood and Leib Combined Sewer Overflow (CSO) Improvements. Under contract no. 2101475 the Great Lakes Water Authority (GLWA) intends to improve the Oakwood Combined Sewer Overflow Retention Treatment Basin (RTB) and Pump Station facility and the Leib CSO Screening and Disinfection Facility (SDF). These improvements are intended to improve facility reliability, flexibility, operation, maintenance and safety to support planned increases in utilization in the Oakwood CSO RTB and Leib SDF facilities. These planned increases will follow other projects planned under the Great Lakes Water Authority (GLWA) Wastewater Master Plan; these projects will divert flow from the Northwest Interceptor to the Oakwood CSO RTB, and from the Meldrum Sewer to the Leib SDF.

This TM will also assist the Design Team in identifying necessary approvals that may be incidental to the Michigan Department of Environmental, Great Lakes, and Energy (EGLE) approval process under Part 31 and Part 41 of Public Act 451 of 1994, as amended and are in the jurisdiction of agencies other than EGLE. These requirements may include approvals from various Departments in the City of Detroit, Wayne County, and EGLE.

2.0 NPDES Permit

2.1 Present Authorization to Discharge

GLWA operates the Water Resource Recovery Facility (WRRF) in accordance with effluent limitations, monitoring requirements and other conditions set forth by National Pollutant Discharge Elimination System (NPDES) Permit# MI0022802 issued on July 18, 2019. The NPDES Permit# MI0022802 authorizes discharge from the combined sewer overflow facilities to specific receiving waters including the Detroit River, the Rouge River, Conner Creek, Fox Creek, and O'Brien Drain.

Part I Section A.6 specifically identifies the outfall location, receiving stream, and conditions of authorization for the combined sewer overflow retention treatment basin located within the City of Detroit. The discharge point from the existing Oakwood CSO RTB is identified as Outfall 108 in the Permit.

Part I Section A.7 specifically identifies the outfall location, receiving stream, and conditions of authorization for the combined sewer overflow screening and disinfection facilities located within the collection system. The discharge point from the existing Leib CSO SDF is identified as Outfall 105 in the Permit.

No modification to the NPDES permit will be made as part of this project. The facility will continue to discharge to the receiving stream under the effluent limits and discharge conditions described in the present Permit. Conditions for discharge from these outfalls are outlined in the permit document and are summarized in the following section.

2.2 Facility Effluent Limits and Monitoring Requirements for Outfall 108

The following sections describe the expected effluent limits and monitoring requirements for Outfall 108 at the Oakwood CSO and RTB facility.

2.2.1 Effluent Limits

The authorized Effluent Limits for Oakwood CSO RTB - Outfall 108 are presented in **Table 2-1**.

Table 2-1 Effluent Discharge Limits for Oakwood CSO RTB

Influent Characteristics	Maximum Limits for Quantity or Loading		Maximum Limits for Quality or Concentration			Monitoring Sample	
	Monthly	Daily	Monthly	Daily	Event	Monitoring Frequency	Sample Type
Flow	(report)	(report)	---	---	---	Daily	Report Total Daily Flow
Effluent Characteristics							
Flow	(report)	(report)	---	---	---	Daily	Report Total Daily Flow
CBOD₅	---	---	(report)	(report)	---	Event	Composite
TSS	---	---	(report)	(report)	---	Event	Composite
Ammonia Nitrogen (as N)	---	---	(report)	(report)	---	Event	Composite
Total Phosphorus (as P)	---	---	(report)	(report)	---	Event	Composite
Fecal Coliform Bacteria (May 1 – October 31)	---	---	---	---	400 cfs / 100 ml	Event	Grab
Fecal Coliform Bacteria (November 1 – April 30)	---	---	---	---	400 cfs / 100 ml	Event	Grab
Event Average				Event Maximum			
TRC	---	---	(report)	---	(report)	Event	Grab
Oil & Grease	---	---	(report)	---	(report)	Event	Grab
Event Minimum				Event Maximum			
pH	---	---	(report)	---	(report)	Event	Grab
Dissolved Oxygen	---	---	(report)	---	(report)	Event	Grab

The discharge is limited as specified in the following section:

2.2.2 Retention Basin Monitoring and Reporting

EGLE requires GLWA to monitor retention basin performance and report the monitoring to the District Supervisor of the Southeast Michigan District of the Water Resources Division. Sampling and monitoring requirements are as follows:

- Total daily influent flow must be measured and reported. No influent sampling is required.
- Effluent flow must be measured and reported for each event.

- Effluent sampling for CBOD5, TSS, Ammonia Nitrogen (as N) and Total Phosphorus is required to be by effluent flow-weighted composite sampling over the entire event. For events that occur over multiple days, the composite pollutant concentrations for the event are required to be reported on the day that the event ends.
- For Fecal Coliform Bacteria, grab samples are required to be collected every 2 hours for the first 6 hours of the event, and every 4 hours thereafter until discharge ceases. The “event maximum” is required to be reported as the geometric mean of all samples taken during an event, provided that three or more samples are collected. The goal of the effluent sampling program is to collect at least three samples during each discharge event. Samples shall be collected at shorter intervals at the onset of the event, if the permittee estimates that the event duration may be less than 6 hours.
- For Total Residual Chlorine, grab samples are required to be collected every two hours for the first 6 hours of the event, and every 4 hours thereafter until discharge ceases. The goal of the effluent sampling program is to collect at least three samples during each discharge event. Samples shall be collected at shorter intervals at the onset of the event, if the permittee estimates that the event duration may be less than 6 hours. The average of all sample taken during the event is to be reported as the “event average.” The maximum individual sample collected in the event is to be reported as the “event maximum”
- For effluent pH, the lowest value of any individual sample must be reported as the minimum. The highest value of any individual sample must be reported as the maximum. Individual values taken for each sample must be reported on the daily Discharge Monitoring Report (DMR).
- For dissolved oxygen, the lowest concentration of any individual sample must be reported as the minimum. Individual values taken for each sample must be reported on the daily DMR.

2.2.3 Retention/Treatment Basin Dewatering

The RTB is required to be promptly dewatered as soon as possible following the need to divert flow to the basin and must be maintained in readiness for use. The discharge of sludge or residual accumulations from the basin to the surface waters is prohibited. This sludge shall be promptly removed and disposed in accordance with procedures approved by the EGLE.

The CSO basin may be dewatered under the condition that up to 930 MGD (including recycle) is being processed with secondary treatment at the WRRF and no primary flow is being discharged.

2.2.4 Narrative Standard

The receiving water may contain no unnatural turbidity, color, oil films, floating solids, foams, settleable solids, suspended solids, or deposits as a result of this discharge in quantities which are or may become injurious to any designated use.

2.2.5 Operations and Maintenance Plan

Discharges may only occur in response to rainfall (or snowmelt) events and cease soon thereafter. Rehabilitation and maintenance needs must be addressed to ensure adequate sewer capacity and functionality. This is to be accomplished through the ongoing implementation of the Operation and Maintenance plan.

The following sections describe the expected effluent limits and monitoring requirements for Outfall 108 at the Oakwood CSO and RTB facility.

2.3 Facility Effluent Limits and Monitoring Requirements for Outfall 105

The following sections describe the expected effluent limits and monitoring requirements for Outfall 105 at the Leib CSO SDF.

2.3.1 Effluent Limits

The authorized Effluent Limits for the Leib CSO SDF - Outfall 105 are presented in **Table 2-2**.

Table 2-2 Effluent Discharge Limits for Leib SDF

Effluent Characteristics	Maximum Limits for Quantity or Loading		Maximum Limits for Quality or Concentration			Monitoring Sample	
	Monthly	Daily	Monthly	Daily	Event	Monitoring Frequency	Sample Type
Flow	(report)	(report)	---	---	---	Daily	Report Total Daily Flow
CBOD ₅	---	---	(report)	(report)	---	Event	Composite
TSS	---	---	(report)	(report)	---	Event	Composite
Ammonia Nitrogen (as N)	---	---	(report)	(report)	---	Event	Composite
Total Phosphorus (as P)	---	---	(report)	(report)	---	Event	Composite
Fecal Coliform Bacteria (May 1 – October 31)	---	---	---	---	400 cfs / 100 ml	Event	Grab
Fecal Coliform Bacteria (November 1 – April 30)	---	---	---	---	400 cfs / 100 ml	Event	Grab
			Event Average		Event Maximum		
TRC	---	---	(report)	---	(report)	Event	Grab
Oil & Grease	---	---	(report)	---	(report)	Event	Grab
			Event Minimum		Event Maximum		
pH	---	---	(report)	---	(report)	Event	Grab
Dissolved Oxygen	---	---	(report)	---	(report)	Event	Grab

The discharge is limited as specified in the following section:

2.3.2 Monitoring and Reporting

EGLE requires GLWA to monitor facility performance and report the monitoring to the District Supervisor of the Southeast Michigan District of the Water Resources Division. Sampling and monitoring requirements are as follows:

- Effluent flow must be measured and reported for each event.
- Effluent sampling for CBOD₅, TSS, Ammonia Nitrogen (as N) and Total Phosphorus is required to be by effluent flow-weighted composite sampling over the entire event. For events that occur over multiple days, the composite pollutant concentrations for the event are required to be reported on the day that the event ends.

- For Fecal Coliform Bacteria, grab samples are required to be collected every 2 hours for the first 6 hours of the event, and every 4 hours thereafter until discharge ceases. The “event maximum” is required to be reported as the geometric mean of all samples taken during an event, provided that three or more samples are collected. The goal of the effluent sampling program is to collect at least three samples during each discharge event. Samples shall be collected at shorter intervals at the onset of the event, if the permittee estimates that the event duration may be less than 6 hours.
- For Total Residual Chlorine, grab samples are required to be collected every 2 hours for the first 6 hours of the event, and every 4 hours thereafter until discharge ceases. The goal of the effluent sampling program is to collect at least three samples during each discharge event. Samples shall be collected at shorter intervals at the onset of the event, if the permittee estimates that the event duration may be less than 6 hours. The average of all sample taken during the event is to be reported as the “event average.” The maximum individual sample collected in the event is to be reported as the “event maximum”
- For effluent pH, the lowest value of any individual sample must be reported as the minimum. The highest value of any individual sample must be reported as the maximum. Individual values taken for each sample must be reported on the daily DMR.
- For dissolved oxygen, the lowest concentration of any individual sample must be reported as the minimum. Individual values taken for each sample must be reported on the daily DMR.

2.3.3 Narrative Standard

The receiving water may contain no unnatural turbidity, color, oil films, floating solids, foams, settleable solids, suspended solids, or deposits as a result of this discharge in quantities which are or may become injurious to any designated use.

2.3.4 Sampling Locations

Sampling locations for the pollutants listed in **Table 2-2** must be representative of the effluent and consistent with the locations approved by the department.

2.3.5 Operations and Maintenance Plan

Discharges may only occur in response to rainfall (or snowmelt) events and cease soon thereafter. Rehabilitation and maintenance needs must be addressed to ensure adequate sewer capacity and functionality. This is to be accomplished through the ongoing implementation of the Operation and Maintenance plan.

2.3.6 Treatment Facility Dewatering

The facility is required to be promptly dewatered as soon as possible following the need to divert flow to the facility and must be maintained in readiness for use. The discharge of sludge or residual accumulations from the basin to the surface waters is prohibited. The facility may be dewatered

under the condition that up to 930 MGD (including recycle) is being processed with secondary treatment at the WRRF and no primary flow is being discharged.

2.3.7 Quarterly Monitoring

Quarterly samples must be taken during the months of January, April, July and October. If the facility does not discharge during these months, the facility must be sampled during the next discharge that occurs during the period in question. If the facility does not discharge during the period in question, a sample is not required for that period.

3.0 Other EGLE Permits

3.1 Wastewater Collection and Treatment Facilities Construction Permit

The Water Resources Division within EGLE has responsibility for processing Wastewater Construction Permit Applications under the authority of Part 41, Sewerage Systems, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. The purpose of this permit is to ensure that plans and specifications for wastewater facilities are complete with regard to the minimum requirements and that the proposed construction is acceptable with regard to accepted design standards for wastewater facilities to protect the public health and the environment.

A Part 41 permit for facility construction is required for any modification of the Oakwood and Leib facilities. The permit application must be completed via the EGLE MiEnviro System. The permit application form and project documents must be submitted via the MiEnviro System. Payment of fees may be made via the MiEnviro system or check made payable to the State of Michigan. Checks may be delivered by mail or in person at the following addresses:

Mail Delivery

EGLE

Cashier's Office

WB-IC

P.O. Box 30657

Lansing, Michigan 48909-8157

Office Delivery (e.g., UPS, Fed Ex, by hand)

State Transportation Building

Accounting Services Center - Cashier's Office

425 West Ottawa Street

Lansing, Mi 48933

3.2 Soil Erosion and Sedimentation Control Permit

Part 91, Soil Erosion and Sedimentation Control (SESC), of the Natural Resources and Environmental Protection Act (NREPA) (Part 91) provides for the control of soil erosion and protects adjacent properties and the waters of the state from sedimentation. A permit is generally required for any earth change activity which disturbs one or more acres of land or which is within

500 feet of a lake or stream. A permit will be required at one or both sites if site improvements work at the site meets those conditions.

Part 91 is administered and enforced by various state, county, and local governmental agencies. In this project, Wayne County is the delegated authority to regulate the work. Refer to the following section on permits required by Wayne County for information on applying for the Wayne County SESC permit.

3.3 Great Lakes Bottomlands Permit

The Water Resources Division (WRD) within EGLE, is responsible for issuing Great Lakes bottomlands permits under the authority of Part 325, Great Lakes Submerged Lands (formerly Public Act 247 of 1955, as amended), of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). The purpose of this permit is to protect the waters of the Great Lakes and the Great Lakes bottomlands (the land lying below the ordinary high-water mark (OHWM)). This permit may be required for a project that includes outfall construction, construction in the floodplain, wetland impacts and drain crossings.

The present scope of contract includes only work within the existing project sites. Therefore, the only permits that may be required are a Flood Plain Permit, if any of the proposed construction is within the flood plain, and a Wetlands Permit, if any of the proposed construction impacts existing regulated wetlands. Based on the Flood Insurance Maps included in Appendix A, the project sites at both the Oakwood CSO RTB facility and the Leib SDF do not appear to lie within the 100-year flood plain. At this time there is no information about the presence of any regulated wetlands on the proposed site or on the proposed route for the connection to the existing discharge conduit.

3.4 Air Quality Permit to Install and Renewable Operating Permit

The Air Quality Division (AQD) within EGLE supports efforts to maintain clean air and minimize adverse impacts on public health and the environment. This division is responsible for issuing permits to install ensuring that all new or modified sources of air pollution will not have a detrimental impact on human health, human welfare, or the environment, and will comply with all applicable state and federal requirements. The Renewable Operating Permits are issued to ensure that all applicable air pollution control requirements for a major source are consolidated and clarified in a single comprehensive document.

Construction of the Oakwood CSO RTB facility required an Air Quality Permit, but not a Renewable Operating Permit. No modifications to the odor control system at Oakwood are included in the scope of this project, so an Air Quality permit should not be required. Likewise, no Air Quality permit was required for construction of the Leib facility, and no Renewable Operating permit.

4.0 City of Detroit Permits, Reviews or Approvals

4.1 Building Permit(s)

The Building, Safety Engineering, and Environmental Department (BSEED) enforces construction, property maintenance, environmental compliance and zoning codes, for the City of Detroit. Plans and specifications must be submitted to this department for review to ensure that the project complies with City of Detroit adopted ordinances and codes. This department is responsible for issuing the building permit approving modifications performed at the Oakwood and Leib facilities.

The process for applying for a BSEED building permit is completed through City of Detroit eLAPS system. For each permit application, the applicant must complete the permit application and submit the permit review fee via the eLaps system. submit the following required information as part of the permitting process. Plans must be submitted for review via a separate system called ProjectDox (ePLANS) after the application has been submitted. A ProjectDox account is automatically created for a user if that applicant does not already have one registered with their email address. For users with an existing account under the same email address, the submitted permit application will be linked to their existing account automatically. Additional information regarding plan submission is transmitted to the applicant automatically after the permit application is submitted. After plans are submitted, the documents are automatically transmitted to the appropriate internal reviewing agencies and departments based on the content of the application and the selections made on the application forms.

Each facility will require its own building permit, and an individual permit application should be submitted for both the Oakwood CSO RTB facility and the Leib CSO SDF. Required documents for each submittal may include plans, specifications, and calculations, depending on the scope of the alterations at each facility.

GLWA will obtain the building permit, however, the sub-contractors responsible for the various trades may be required to obtain the trade permits for electrical, mechanical, plumbing and heating.

4.2 Right-of-Way / Encroachment Permit

The scope of work at the Leib CSO SDF includes expanding the site footprint to encompass multiple adjacent empty lots and an adjoining alley. This work will require an approved request to change the status of the right of way for the alley.

The request must include the following required information:

- **Completed application form.** The application form must be submitted via the City of Detroit Right of War Management Account.
- **Letter of Intent.** A letter must be submitted addressed to the City of Detroit that includes the name/contact info of the applicant and a detailed summary of the proposal.

- **Letter of support.** Any vacation of the right of way requires proper community engagement with all adjacent landowners. The applicant must obtain a letter of support from all adjacent landowners before the application can be accepted. Blocks that are residential only, may obtain signatures of 2/3 or 66% of adjacent residential owners. A standard petition form is available for collecting signatures from residential owners. If the proposal for vacation results in the creation of a dead-end right-of-way or alley the application will be rejected.
- **Site plan.** A site plan is typically required, but this requirement is waived for residential alleys.
- **Utility Plan.** If the right-of-way will be vacated and not converted to an easement, any public utilities located in the right of way must be abandoned or relocated. The applicant must provide a utility plan showing how assets located in the street/alley will be changed (abandoned, relocated, or new easements to access utility assets).

The City of Detroit Department of public works (DPW) is tasked with conducting a review for all requests to change the status of a right-of-way. During the review, a notice will be sent out to various utility companies and City Departments. Completion of the review process takes approximately 6 to 10 weeks. Upon completion of the review, a recommendation will be made to City Council and a hearing will be scheduled.

5.0 Wayne County Requirements, Reviews or Approvals

5.1 Traffic Control

Construction activity related to this project may impact traffic in the area, and some of the traffic planning may impact the way the traffic in Wayne County is rerouted. Therefore, it may be necessary to inform the Wayne County Road Commission of construction activities with the potential to impact traffic. Their approval may not be required, but a plan should be submitted to them for informational purposes. The Traffic Operation Office can be contacted at the following number:

Traffic Operation Office:

Tel: 1-888-762-3273

5.2 Soil Erosion and Sedimentation Control Permit

The Wayne County Department of Public Services (DPS) requires a permit for the following activities under Wayne County DPS jurisdiction:

1. Crossing, modifying or discharging storm water to a County Drain
2. Connecting into or otherwise altering a County sanitary interceptor sewer
3. Design and construction of wastewater facilities such as a sanitary sewer, pumping station, with a direct connection to a Wayne County sewer.

TM-28 Permitting and Regulatory Requirements

June 1, 2023

Page 12

4. Any earth change/disturbance over 1 acre in size and/or within 500 feet of a water of the state. (Soil Erosion Permit)

Work at the Oakwood CSO RTB facility and the Leib SDF will not require work on any stormwater drains or sewers that would require permits as described in bullets 1-3. However, site improvements at one or both sites may trigger requirements for a soil erosion permit. If it is determined that a SESC permit is required for this project, the application must include the following information:

1. Completed application form.
2. Three sets of plans and specifications for the Soil Erosion and Sedimentation Control plans.
3. Payment of application fee. and performance deposit.
4. Performance deposit for maintenance of the finished project up to and beyond project completion

The application packaged must be submitted 1 month prior to the project startup. The information must be submitted to:

Land Resource Management Division of the Department of Public Services
3600 Commerce Court
Building E
Wayne, Michigan 48184
Ph: 734-595-6504 x2008

5.3 Special Hauling and Transportation Permits

Wayne County DPS, Roads Division is responsible for issuing special hauling and transportation permits and enforcement of oversize and overweight vehicles. The general contractor will need to obtain special hauling and transportation permits if any are required for construction of this project.

Permits are issued by:

Wayne County Department of Public Services
Roads Division - Weighmaster Office
Central Maintenance Yard
29900 Goddard Extension
Romulus, MI 48242
Ph: 734-955-2363

Appendices

Appendix A – FEMA 100 Year Flood Plain Maps

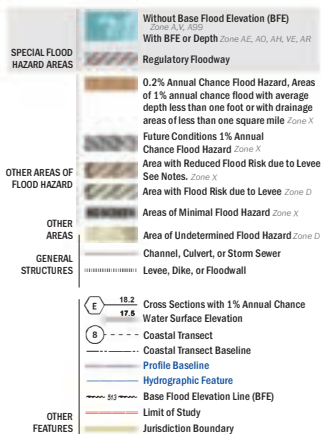
Appendix A

FEMA 100 Year Flood Plain Maps



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING
DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT
[HTTPS://MSC.FEMA.GOV](https://msc.fema.gov)



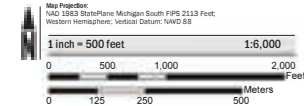
NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with the FIRM, including historic editions, the current map data for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information Exchange at 1-877-FEMA-MAP (1-877-362-6271) or use the FEMA Flood Map Service Center website at <https://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

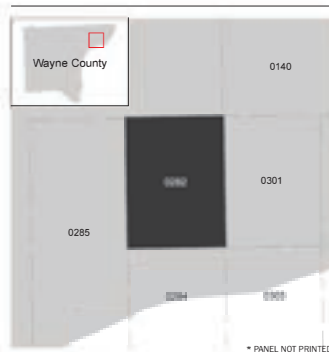
For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction. To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-368-5620.

Base map information shown on this FIRM was provided in digital format by the United States Department of Agriculture Farm Service Agency (USDA-FSA). This information was derived from digital orthorectified photography at a 1-meter resolution from photography dated 2012.

SCALE



PANEL LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM FLOOD INSURANCE RATE MAP

WAYNE COUNTY, MICHIGAN
PANEL 282 of 575



Panel Contains:
COMMUNITY NUMBER PANEL SUFFIX
DETROIT, CITY OF 260222 0282 F

VERSION NUMBER
2.4.3.5
MAP NUMBER
26163C0282F
MAP REVISED
OCTOBER 21, 2021

APPENDICES

Appendix A

Conceptual Opinion of Probable Construction Cost

Appendix A1

2023-06 Oakwood CSO Treatment Facility Improvements

GLWA, MI
Oakwood CSO Facility Improvements
Opinion of Probable Construction Cost, June 2023, Study

Estimator	Matthew Giacobbe
Labor rate table	MI23 Detroit
Equipment rate table	2023 \$6EquipRate BOF
ENR CCI	JUNE 2023: 13,345.00
ENR BCI	JUNE 2023: 8,095.33
ENR MCI	JUNE 2023: 5,881.65
AACEi Class	5
Estimate Type	OPCC
Design Level	Conceptual
CDM Smith DB Ver.	S1.0
Reviewed by	Paul Damon
Review Date	6/13/2023
Delivered Date	6/13/2023
Notes	This is an Opinion of Probable Construction Cost only, as defined by the documents provided at the level of design indicated above. CDM Smith has no control over the cost of labor, materials, equipment, or services furnished, over schedules, over contractor's methods of determining prices, competitive bidding (at least 3 each - both prime bidders and major subcontractors), market conditions or negotiating terms. CDM Smith does not guarantee that this opinion will not vary from actual cost, or contractor's bids. There are not any costs provided for: Change Orders, Design Engineering, Construction Oversight, Client Costs, Finance or Funding Costs, Legal Fees, Land Acquisition or temporary/permanent Easements, Operations, or any other costs associated with this project that are not specifically part of the bidding contractor's proposed scope. This OPCC shall remain valid for 30 days. Beyond this date, CDM Constructors should be notified of design changes. The estimate will also be reviewed to reflect current market conditions. Assumptions: No rock excavation is required. Only nominal dewatering is needed. No consideration for contaminated soils or hazardous materials is included (i.e. asbestos, lead, etc).
Report format	Sorted by 'Area/16CSI Sctn/Element'



'Detail' summary
Allocate addons
Combine items
Paginate



GLWA, MI
Oakwood CSO Facility Improvements
(INDIRECT COSTS UNALLOCATED)

6/14/2023 12:01 AM

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
005 Sitework								
09-96-00 High-Performance Coatings								
005.099600.68.005 Concrete Pavement Sealant								
Concrete Sealer- Water Based	56,300.00 sf	10,773	7,438				0.32 /sf	18,211
005.099600.68.005 Concrete Pavement Sealant	56,300.00 sf	10,773	7,438				0.32 /sf	18,211
09-96-00 High-Performance Coatings		10,773	7,438					18,211
31-00-00 Earthwork								
005.312300.68.005 Replace Bioswale Soil								
----- EXCAVATION (Summary) -----	361.11 CY	-	-	-	-		/CY	
Excav- Excavator C325- 33MT-186HP/1.5cy	361.11 cy	1,708	-	3,268	-	-	13.78 /cy	4,976
BACKFILL from STOCKPILE (Summary)	361.11 cy	-	-	-	-		/cy	
Place Backfill from Stockpile- Excavator C325- 33MT- 186hp-1.50cy/CP323 Compactor/4k gallon Water Truck	361.11 cy	4,602	-	7,049	-	-	32.27 /cy	11,651
----- IMPORT MATERIAL (Summary) -----	361.11 cy	-	-	-	-		/cy	
Import Sandy-Loam Fill	361.11 cy	-	30,263	-	6,917	-	102.96 /cy	37,180
EXCAVATION SPOILS-SOURCES of FILL (Summary)	361.11 cy	-	-	-	-		/cy	
Structure Excavation Spoils (Summary)	361.11 cy	-	-	-	-		/cy	
Load Spoils from Stockpile Cat 325 Excavator-32MT- 180hp	361.11 cy	643	-	1,230	-	-	5.18 /cy	1,872
Haul Spoils/Off Site 18cy Rear Dump 1 Load/Hour	361.11 cy	1,958	-	3,409	-	-	14.86 /cy	5,367
005.312300.68.005 Replace Bioswale Soil	361.00 cy	8,911	30,263	14,956	6,917		169.11 /cy	61,047
31-00-00 Earthwork		8,911	30,263	14,956	6,917			61,047
31-11-00 Clearing and Grubbing								
005.311100.68.005 Clear Vegetation from Surge Basin								
Clear & Grub Light Trees	45,000.00 sf	10,682	-	9,750	-	-	0.45 /sf	20,432
005.311100.68.005 Clear Vegetation from Surge Basin	45,000.00 sf	10,682		9,750			0.45 /sf	20,432
31-11-00 Clearing and Grubbing		10,682		9,750				20,432
32-00-00 EXTERIOR IMPROVEMENTS								
005.320000.68.005 Misc Site Restoration								
Sitework Restoration Allowance	1.00 ls	-	-	-	57,558	-	57,558.19 /ls	57,558
005.320000.68.005 Misc Site Restoration	1.00 ls				57,558		57,558.19 /ls	57,558
32-00-00 EXTERIOR IMPROVEMENTS					57,558			57,558
32-11-23 Aggregate Base Courses								
005.320116.68.005 Remove Existing Gravel Road								
Haul Demo/Off Site 18cy Rear Dump 1 Load/Hour	27.00 load	2,458	-	4,313	-	-	250.78 /load	6,771
Mobilize/Demobilize Equipment (2 hrs each way)	1.00 ea	364	-	732	-	-	1,095.76 /ea	1,096
Remove Existing Gravel Drive	1,803.89 sy	13,360	-	30,576	-	-	24.36 /sy	43,936
005.320116.68.005 Remove Existing Gravel Road	1,804.00 sy	16,182		35,621			28.72 /sy	51,803
32-11-23 Aggregate Base Courses		16,182		35,621				51,803
32-13-13 Concrete Paving								
005.321313.68.005 Concrete Pavement								
--- Total Aggregate Base Area ---	16,235.00 sf	-	-	-	-		/sf	
Aggregate Base-Parking Lots	400.86 cy	5,238	-	8,263	-	-	33.68 /cy	13,502
ASTM D448 # 57 Stone (1.00- No. 4)	400.86 cy	-	29,207	-	7,679	-	92.02 /cy	36,886
Concrete Pavement- 9"	1,803.89 sy	24,928	130,800	9,298	-	-	91.48 /sy	165,026
Reinforcing Steel for Rigid Paving	1,803.89 sy	36,507	34,754	-	-	-	39.50 /sy	71,261
005.321313.68.005 Concrete Pavement	1,804.00 sy	66,673	194,761	17,562	7,679		158.91 /sy	286,675
005.321313.68.010 Existing Pavement and Sidewalk Repair Allowance								
Concrete Repair Allowance	1.00 ls	-	-	-	28,779	-	28,779.09 /ls	28,779
005.321313.68.010 Existing Pavement and Sidewalk Repair Allowance	1.00 ls				28,779		28,779.09 /ls	28,779



GLWA, MI
Oakwood CSO Facility Improvements
(INDIRECT COSTS UNALLOCATED)

6/14/2023 12:01 AM

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
32-13-13 Concrete Paving		66,673	194,761	17,562	36,458			315,454
33-42-00 Stormwater Conveyance								
005.334200.68.005 Splash Blocks								
Total Formwork (Summary)	190.00 csf	-	-	-	-		/csf	
Slab-on-Grade Form Oil & Hardware	190.00 csf	-	414	-	-	-	2.18 /csf	414
Slab-on-Grade Form Hoisting	190.00 sf	-	-	198	-	-	1.04 /sf	198
Layout Slab-on-Grade	600.00 sf	66	-	-	-	4	0.12 /sf	70
Hand Fine Grade SOG	600.00 sf	402	-	-	-	-	0.67 /sf	402
Slab-on-Grade < 6" 3 Form Uses	190.00 sf	5,194	358	-	-	-	29.22 /sf	5,552
Rebar Accessories/Unload & Store	0.83 tn	34	12	28	-	-	88.14 /tn	73
Reinforcing Hoisting - Crane	0.83 tn	109	-	255	-	-	436.20 /tn	363
SOG Rebar	0.83 TN	1,480	2,268	-	-	-	4,499.20 /TN	3,748
Rebar Support - bricks	40.00 ea	9	38	-	-	-	1.16 /ea	47
Total SOG Concrete (Summary)	11.11 cy	-	-	-	-		/cy	
Truck Place Slab on Grade	11.11 cy	1,063	-	-	-	-	95.68 /cy	1,063
Trowel Finish @ SOG	600.00 sf	861	-	-	-	-	1.44 /sf	861
Water Base Non-Residual Cure	600.00 sf	131	250	-	-	-	0.63 /sf	381
Total Redi-Mix Concrete (Summary)	11.11 cy	-	-	-	-		/cy	
4,500 psi Concrete- Central Region	11.11 CY	-	3,024	-	-	-	272.19 /CY	3,024
005.334200.68.005 Splash Blocks	10.00 ea	9,348	6,363	481		4	1,619.66 /ea	16,197
33-42-00 Stormwater Conveyance		9,348	6,363	481		4		16,197
005 Sitework		122,570	238,825	78,369	100,933	4		540,701
010 Screening Facility								
03-00-00 Concrete								
010.308100.68.005 Core Drill Floor								
Mobilize Core Drill Crew-Minimum	1.00 ea	-	-	-	576	-	575.59 /ea	576
Core Drill - Slab, 12.0" diameter hole, 8" deep	3.00 ea	1,009	210	143	-	-	454.18 /ea	1,363
010.308100.68.005 Core Drill Floor	3.00 ea	1,009	210	143	576		646.04 /ea	1,938
03-00-00 Concrete		1,009	210	143	576			1,938
46-21-00 Screening Equipment								
010.462100.68.005 Modify Conveyor to include (3) drains								
Equipment Manufacturers Representative *Q	3.00 day	-	-	-	7,598	-	2,532.56 /day	7,598
Modify Conveyor for drains *Q	3.00 ea	8,988	31,081	-	-	-	13,356.39 /ea	40,069
010.462100.68.005 Modify Conveyor to include (3) drains	3.00 ea	8,988	31,081		7,598		15,888.95 /ea	47,667
46-21-00 Screening Equipment		8,988	31,081		7,598			47,667
010 Screening Facility		9,997	31,292	143	8,173			49,605
015 Storm Pump Station								
02-41-00 Demolition								
015.024100.68.005 Demo Trench Covers								
Demo 6" Trench Covers	320.00 sf	5,547	-	1,817	-	-	23.01 /sf	7,363
Haul Demo/Off Site 18cy Rear Dump 1 Load/Hour	1.00 load	75	-	131	-	-	206.59 /load	207
Demolition - Tipping Fees- Concrete/Masonry	5.93 cy	-	-	-	-	437	73.67 /cy	437
015.024100.68.005 Demo Trench Covers	320.00 sf	5,622		1,948		437	25.02 /sf	8,007
02-41-00 Demolition		5,622		1,948		437		8,007
03-01-30.10 Concrete Cleaning								
015.030130.68.005 Clean Storm Wet Well								
Surface Blasting & Cleaning	13,405.00 sf	47,149	-	2,114	-	-	3.67 /sf	49,262
015.030130.68.005 Clean Storm Wet Well	13,405.00 sf	47,149		2,114			3.67 /sf	49,262
03-01-30.10 Concrete Cleaning		47,149		2,114				49,262



GLWA, MI
Oakwood CSO Facility Improvements
(INDIRECT COSTS UNALLOCATED)

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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
05-50-00 Metal Fabrications								
015.055000.68.005 Grating Modifications								
Grating Modifications Allowance	8.00 ea	7,455	2,802	3,341	-	-	1,699.82 /ea	13,599
015.055000.68.005 Grating Modifications	8.00 ea	7,455	2,802	3,341			1,699.82 /ea	13,599
05-50-00 Metal Fabrications								
		7,455	2,802	3,341				13,599
33-05-10.100 DUCTILE IRON PIPE								
015.330510.68.005 8" Flushing System								
Pipe Painting Preparation/Small Tools & Consumables	104.72 sf	31	35	-	-	-	0.62 /sf	65
Paint 8" Pipe- Brush 1 Primer/2 Finish	50.00 lf	291	180	-	-	-	9.41 /lf	471
Pipe Test	50.00 lf	151	130	86	-	-	7.34 /lf	367
Spray Nozzles-Split Eyelet for 2" Pipe	21.00 ea	970	604	-	-	-	74.98 /ea	1,575
Class 150, 316 SS Bolt Sets, 8"	10.00 ea	-	602	-	-	-	60.21 /ea	602
1/8" Full Faced EPDM Gasket, 8"	10.00 ea	-	197	-	-	-	19.74 /ea	197
Total Weight (Zero Cost Item)	2,065.00 lbs	-	-	-	-		/lbs	
Weight of Pipe (Zero Cost Item)	2,065.00 lbs	-	-	-	-		/lbs	
Unload Care & Protect Flanged/PE DIP & Fittings	2,065.00 lbs	48	-	39	-	-	0.04 /lbs	87
Weight of Flanged/PE Pipe (Zero Cost Item)	2,065.00 lbs	-	-	-	-		/lbs	
Layout Flanged/PE DIP & Fitting	50.00 lf	46	-	-	-	-	0.92 /lf	46
DIP Equipment- All-Terrain Crane 100MT	1.80 ch	204	-	1,390	-	-	885.09 /ch	1,593
DI Pipe, FLxFL, CL53, CML, 8" x 5'-0"	10.00 ea	5,230	17,562	-	-	-	2,279.24 /ea	22,792
015.330510.68.005 8" Flushing System	1.00 ls	6,971	19,310	1,515			27,795.77 lls	27,796
33-05-10.100 DUCTILE IRON PIPE		6,971	19,310	1,515				27,796
43-23-00 Dry Location Liquid Pumps								
015.432300.68.005 Remove, Rehab, and Reinstall Storm Pumps								
Disassembly, Removal and Ship Pumps *Q	8.00 ea		-		644,652	-	80,581.46 /ea	644,652
Small Storm Pump Rebuild *Q	2.00 ea		-	-	858,768	-	429,384.05 /ea	858,768
Large Storm Pump Rebuild *Q	6.00 ea	-	-	-	2,769,700	-	461,616.64 /ea	2,769,700
Factory Witness Test *Q	8.00 ea		-	-	368,372	-	46,046.55 /ea	368,372
Ship, Installation and Start Pumps *Q	8.00 ea		-	-	755,163	-	94,395.42 /ea	755,163
015.432300.68.005 Remove, Rehab, and Reinstall Storm Pumps	8.00 ea				5,396,655		674,581.92 /ea	5,396,655
015.432300.68.010 Cooling System for Storm Pumps								
Strainer Bronze Wye Threaded, 1/2"	8.00 ea	754	370	-	-	-	140.48 /ea	1,124
Copper "Hard" Pipe, Type K, 1/2"	320.00 lf	23,657	3,055	-	-	-	83.48 /lf	26,712
Copper 90deg Bend, 1/2"	48.00 ea	1,819	7	-	-	-	38.04 /ea	1,826
Copper Tee, 1/2"	32.00 ea	1,745	142	-	-	-	58.95 /ea	1,886
Copper Reducer, 1/2" x1/4"	8.00 ea	266	1	-	-	-	33.41 /ea	267
Gate Valve, Bronze, Threaded, 0.50"	32.00 ea	1,538	2,460	571	-	-	142.78 /ea	4,569
015.432300.68.010 Cooling System for Storm Pumps	8.00 ea	29,778	6,036	571			4,548.07 /ea	36,385
43-23-00 Dry Location Liquid Pumps		29,778	6,036	571	5,396,655			5,433,040
43-25-00 Submersible/Immersible Liquid Pumps								
015.432500.68.005 Install and Replace Sump Pumps								
Pump Manufacturers Representative	1.00 day	-	-	-	-	2,878	2,877.91 /day	2,878
Unload/Protect Equip - Medium Equip	2.00 ea	648	-	415	-	-	531.39 /ea	1,063
Submersible Centrifugal Sump Pump	2.00 ea	3,696	8,634		-	-	6,165.06 /ea	12,330
Test & Check	2.00 ea	1,498	-	-	-	-	748.98 /ea	1,498
015.432500.68.005 Install and Replace Sump Pumps	2.00 ea	5,842	8,634	415		2,878	8,884.38 /ea	17,769
43-25-00 Submersible/Immersible Liquid Pumps		5,842	8,634	415		2,878		17,769
015 Storm Pump Station		102,817	36,782	9,903	5,396,655	3,315		5,549,472
020 Sewer Pump Station								



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Oakwood CSO Facility Improvements
(INDIRECT COSTS UNALLOCATED)

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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
02-41-00 Demolition								
020.024100.68.005 Demo Stair C								
Demo Stairs	12.00 sf	693	-	242	-	-	77.94 /sf	935
Haul Demo/Off Site 18cy Rear Dump 1 Load/Hour	1.00 load	75	-	131	-	-	206.60 /load	207
Demolition - Tipping Fees- Other	0.02 tn	-	-	-	-	1	69.00 /tn	1
020.024100.68.005 Demo Stair C	12.00 sf	769		373		1	95.26 /sf	1,143
02-41-00 Demolition		769		373		1		1,143
03-00-00 Concrete								
020.030000.68.005 Concrete Fillet								
Total Formwork (Summary)	3.67 csf	-	-	-	-		/csf	
Slab-on-Grade Form Oil & Hardware	3.67 csf	-	8	-	-	-	2.18 /csf	8
Slab-on-Grade Form Hoisting	3.67 sf	-	-	4	-	-	1.05 /sf	4
Layout Slab-on-Grade	18.00 sf	2	-	-	-	0	0.12 /sf	2
Hand Fine Grade SOG	18.00 sf	168	-	-	-	-	9.31 /sf	168
Slab-on-Grade < 4" 3 Form Uses	3.67 sf	100	4	-	-	-	28.53 /sf	105
Total SOG Concrete (Summary)	0.11 cy	-	-	-	-		/cy	
Buggy Place Slab on Grade	0.11 cy	574	-	-	-	-	5,172.25 /cy	574
Trowel Finish @ SOG	18.00 sf	191	-	-	-	-	10.63 /sf	191
Water Base Non-Residual Cure	18.00 sf	4	7	-	-	-	0.63 /sf	11
Concrete Power Buggy Ride-On 16cf	0.11 cy	2	-	1	-	-	21.35 /cy	2
Total Redi-Mix Concrete (Summary)	0.11 cy	-	-	-	-		/cy	
4,500 psi Concrete- Central Region	0.11 CY	-	30	-	-	-	273.40 /CY	30
020.030000.68.005 Concrete Fillet	0.12 cy	1,041	50	5		0	9,130.30 /cy	1,096
03-00-00 Concrete		1,041	50	5		0		1,096
03-01-30.10 Concrete Cleaning								
020.030130.68.005 Clean Sewer Wet Wells								
Surface Blasting & Cleaning	13,280.00 sf	47,148	-	2,114	-	-	3.71 /sf	49,262
020.030130.68.005 Clean Sewer Wet Wells	13,280.00 sf	47,148		2,114			3.71 /sf	49,262
03-01-30.10 Concrete Cleaning		47,148		2,114				49,262
020 Sewer Pump Station		48,958	50	2,491		1		51,501
025 Chemical Building								
03-00-00 Concrete								
025.030000.68.005 Hypo Pump Pads								
Total Formwork (Summary)	140.00 csf	-	-	-	-		/csf	
Equipment Pad/Curb Form Oil & Hardware	140.00 csf	-	305	-	-	-	2.18 /csf	305
Equipment Pad/Curb Form Hoisting	140.00 sf	-	-	29	-	-	0.21 /sf	29
Equipment Pad/Curb < 6" 3 Form Uses	140.00 lf	7,655	264	-	-	-	56.56 /lf	7,918
Bonding Agent @ Curb/Pad/Fill Concrete	84.00 sf	276	59	-	-	-	3.98 /sf	334
Blast Clean Construction Joints	84.00 sf	176	49	8	-	-	2.78 /sf	233
Chamfer Strip	168.00 lf	294	65	-	-	-	2.13 /lf	359
Rebar Accessories/Unload & Store	0.12 tn	5	2	4	-	-	88.00 /tn	10
Equipment Pad/Curb Rebar	0.12 TN	1,554	319	-	-	-	16,009.91 /TN	1,873
Rebar Support - Continuous Slab Bolster	28.00 lf	6	16	-	-	-	0.81 /lf	23
Drill & Epoxy Grout #5 Bars	168.00 ea	6,528	3,090				57.25 /ea	9,618
Total Pad/Curb/Misc Concrete	1.56 cy	-	-	-	-		/cy	
Buggy Place Equipment Pad/Support	1.56 cy	1,339	-	-	-	-	860.84 /cy	1,339
Trowel Finish @ Equipment Pad/Curb	84.00 sf	121	-	-	-	-	1.44 /sf	121
Water Base Non-Residual Cure	224.00 sf	49	93	-	-	-	0.63 /sf	142
Concrete Power Buggy Ride-On 16cf	1.56 cy	1,177	-	594	-	-	1,138.18 /cy	1,771
Total Redi-Mix Concrete (Summary)	1.56 cy	-	-	-	-		/cy	



GLWA, MI
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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
025.030000.68.005 Hypo Pump Pads								
4,500 psi Concrete- Central Region	1.56 CY	-	424	-	-	-	272.21 /CY	424
025.030000.68.005 Hypo Pump Pads	2.00 cy	19,180	4,685	635			12,249.66 /cy	24,499
03-00-00 Concrete		19,180	4,685	635				24,499
40-05-31.23 CPVC Pipe and Fittings								
025.400531.68.005 Replace Chemcial Pipe Allowance								
Replace Chemical Piping Allowance	1.00 ls	23,102	28,779	-	-		51,881.37 /ls	51,881
025.400531.68.005 Replace Chemcial Pipe Allowance	1.00 ls	23,102	28,779				51,881.37 /ls	51,881
40-05-31.23 CPVC Pipe and Fittings		23,102	28,779					51,881
40-05-66 Globe Valves								
025.400566.68.005 Replace 2" Flow Control Valves								
Valve Painting Preparation/Small Tools & Consumables	3.00 sf	1	1	-	-	-	0.62 /sf	2
Paint 2" Valve Brush 1 Primer/2 Finish	18.00 ea	186	27	-	-	-	11.85 /ea	213
Angle Globe Valve Count	18.00 ea	-	-	-	-		/ea	
Unload Care & Protect Valves	18.00 ea	379	-	309	-	414	61.24 /ea	1,102
Globe Valve, 2.00" *Q	18.00 ea	16,634	1,036,047	6,177	-	-	58,825.42 /ea	1,058,858
Valve Tag, Plastic, 1-1/2" Diameter	18.00 ea	333	73	-	-	-	22.51 /ea	405
025.400566.68.005 Replace 2" Flow Control Valves	18.00 ea	17,532	1,036,148	6,485		414	58,921.13 /ea	1,060,580
40-05-66 Globe Valves		17,532	1,036,148	6,485		414		1,060,580
43-23-00 Dry Location Liquid Pumps								
025.432300.68.005 Sample Pumps								
Sample Pump Spares *Q	3.00 ea		39,024	-	-	-	13,008.15 /ea	39,024
Pump Manufacturers Representative	1.00 day	-	-	-	-	2,878	2,877.91 /day	2,878
Unload/Protect Equip - Medium Equip	7.00 ea	2,267	-	1,452	-	-	531.39 /ea	3,720
Sample Pumps *Q	7.00 ea	10,486	91,057	-	-	-	14,506.11 /ea	101,543
Grout Equipment Base- Non Shrink, Non Metallic	2.33 cf	277	591	-	-	-	372.02 /cf	868
Test & Check Sample Pumps	7.00 ea	1,049	-	-	-	-	149.80 /ea	1,049
025.432300.68.005 Sample Pumps	7.00 ea	14,079	130,672	1,452		2,878	21,297.33 /ea	149,081
025.432300.68.010 Remove Metering and New Recirculation Pumps								
Remove Existing Feed Pumps	10.00 ea	7,490	-	-	-	-	748.98 /ea	7,490
Pump Manufacturers Representative	1.00 day	-	-	-	-	2,878	2,877.91 /day	2,878
Unload/Protect Equip - Medium Equip	4.00 ea	1,296	-	830	-	-	531.39 /ea	2,126
Chemical Recirculation Pumps *Q	4.00 ea	5,992	184,186	-	-	-	47,544.50 /ea	190,178
Grout Equipment Base- Non Shrink, Non Metallic	1.33 cf	158	338	-	-	-	372.00 /cf	496
Test & Check Chemical Transfer Pumps	4.00 ea	599	-	-	-	-	149.80 /ea	599
025.432300.68.010 Remove Metering and New Recirculation Pumps	4.00 ea	15,535	184,524	830		2,878	50,941.58 /ea	203,766
43-23-00 Dry Location Liquid Pumps		29,613	315,196	2,282		5,756		352,848
43-41-45 Fiberglass Reinforced Plastic Tanks								
025.434145.68.005 Remove and Replace Hypo FRP Tanks								
Unload & Protect Fiberglass Tanks	2.00 ea	2,301	-	2,007	-	-	2,153.81 /ea	4,308
15250 Remove and Replace Gallon Flat Bottom FRP Storage Tank *Q	2.00 ea	23,006	148,500	20,071	-	-	95,788.13 /ea	191,576
Hydro Test FRP Tanks	2.00 ea	1,479	-	-	-	-	739.27 /ea	1,479
025.434145.68.005 Remove and Replace Hypo FRP Tanks	2.00 ea	26,785	148,500	22,078			98,681.21 /ea	197,362
43-41-45 Fiberglass Reinforced Plastic Tanks		26,785	148,500	22,078				197,362
025 Chemical Building		116,212	1,533,308	31,480		6,170		1,687,171
030 CSO Basin								
03-01-30.30 Structural Concrete Rehabilitation								
030.030130.68.005 Concrete Repair								
Concrete Core Drill and Repair	1.00 ls	-	-	-	11,512	-	11,511.63 /ls	11,512



GLWA, MI
Oakwood CSO Facility Improvements
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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
030.030130.68.005 Concrete Repair	1.00 ls				11,512		11,511.63 /ls	11,512
03-01-30.30 Structural Concrete Rehabilitation					11,512			11,512
05-50-00 Metal Fabrications								
030.055000.68.005 Access Hatch @ sample pumps								
36"x 36" Aluminum Bilco Floor Door (Drainage), 300pst, Type J-4AL	7.00 ea	2,700	12,651	1,009	-	-	2,337.09 /ea	16,360
030.055000.68.005 Access Hatch @ sample pumps	7.00 ea	2,700	12,651	1,009			2,337.09 /ea	16,360
05-50-00 Metal Fabrications		2,700	12,651	1,009				16,360
40-05-73 Special Valves								
030.400573.68.005 Relocate Flushing Valves								
Valve Painting Preparation/Small Tools & Consumables	12.00 sf	4	4	-	-	-	0.63 /sf	8
Paint 12" Valve Brush 1 Primer/2 Finish	2.00 ea	87	18	-	-	-	52.38 /ea	105
Class 150, 316 SS Bolt Sets, 12"	4.00 ea	-	468	-	-	-	117.02 /ea	468
1/8" Full Faced EPDM Gasket, 12"	4.00 ea	-	144	-	-	-	35.91 /ea	144
Flow Control Valve Count	2.00 ea	-	-	-	-		/ea	
Unload Care & Protect Valves	2.00 ea	42	-	34	-	46	61.25 /ea	122
Flushing Valve, Flanged, 12"	2.00 ea	3,327	-	-	-	-	1,663.37 /ea	3,327
Valve Tag, Plastic, 1-1/2" Diameter	2.00 ea	37	8	-	-	-	22.51 /ea	45
030.400573.68.005 Relocate Flushing Valves	2.00 ea	3,496	642	34		46	2,109.09 /ea	4,218
40-05-73 Special Valves		3,496	642	34		46		4,218
43-25-00 Submersible/Immersible Liquid Pumps								
030.432500.68.005 Conditioning Pumps								
Pump Manufacturers Representative	1.00 day	-	-	-	-	2,878	2,877.91 /day	2,878
Unload/Protect Equip - Medium Equip	2.00 ea	648	-	415	-	-	531.38 /ea	1,063
Submersible Centrifugal Sump Pump, 15 HP	2.00 ea	3,696	25,901	1,373	-	-	15,485.07 /ea	30,970
Install Guide Rails	2.00 ea	374	-	-	-	-	187.25 /ea	374
Install Base Elbow	2.00 ea	374	-	-	-	-	187.25 /ea	374
Test & Check	2.00 ea	1,498	-	-	-	-	748.98 /ea	1,498
030.432500.68.005 Conditioning Pumps	2.00 ea	6,591	25,901	1,788		2,878	18,578.87 /ea	37,158
43-25-00 Submersible/Immersible Liquid Pumps		6,591	25,901	1,788		2,878		37,158
030 CSO Basin		12,787	39,194	2,831	11,512	2,924		69,247
040 Electrical and I&C								
26-00-00 ELECTRICAL								
040.260000.01.0100 Feeds to Replaced Disinfection System Equipment & Instruments								
Connect & Feed Disinfection System Process Equipment & Instruments	1.00 ls	0		-	287,791	-	287,790.93 /ls	287,791
040.260000.01.0100 Feeds to Replaced Disinfection System Equipment & Instruments	1.00 ls	0			287,791		287,790.93 /ls	287,791
040.260000.01.0101 Connect & Feed Central Grease Lube System Storm Pump								
Connect & Feed Storm Pump	8.00 ls	0		-	368,372	-	46,046.54 /ls	368,372
040.260000.01.0101 Connect & Feed Central Grease Lube System Storm Pump	1.00 ls	0			368,372		368,372.36 /ls	368,372
040.260000.01.0102 Connect & TRC Analyzers								
Connect & Feed TRC Analyzers	4.00 ls	0		-	57,558	-	14,389.58 /ls	57,558
040.260000.01.0102 Connect & TRC Analyzers	1.00 ls	0			57,558		57,558.33 /ls	57,558
040.260000.01.0103 Connect & Feed Sample Pumps								
Connect & Feed Sample Pumps	10.00 ls	0		-	287,791	-	28,779.10 /ls	287,791
040.260000.01.0103 Connect & Feed Sample Pumps	1.00 ls	0			287,791		287,791.05 /ls	287,791
040.260000.01.0104 Connect & Feed Basin Conditioning Pumps								
Connect & Feed Conditioning Pumps	2.00 ls	0		-	57,558	-	28,779.10 /ls	57,558
040.260000.01.0104 Connect & Feed Basin Conditioning Pumps	1.00 ls	0			57,558		57,558.20 /ls	57,558
040.260000.01.0105 Relocate & Reconnect Flushing Valve Actuators								
Relocate & Re-connect Flushing Valve Actuators	2.00 ls	0		-	23,023	-	11,511.66 /ls	23,023



GLWA, MI
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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
040.260000.01.0105 Relocate & Reconnect Flushing Valve Actuators	1.00 ls	0			23,023		23,023.31 /ls	23,023
040.260000.01.0106 Connect & Feed Replaced & New Sump Pumps								
Connect & Feed Sump Pumps	2.00 ls	0		-	57,558	-	28,779.10 /ls	57,558
040.260000.01.0106 Connect & Feed Replaced & New Sump Pumps	1.00 ls	0			57,558		57,558.21 /ls	57,558
040.260000.01.0107 Connect & Feed Motorized CWS Isolation Valves								
Connect & Feed cws motorized isolation valves	8.00 ls			-	184,186	-	23,023.27 /ls	184,186
040.260000.01.0107 Connect & Feed Motorized CWS Isolation Valves	1.00 ls				184,186		184,186.18 /ls	184,186
040.260000.01.0108 Process Camera System								
Process Camera System	1.00 ls	0		-	287,791	-	287,790.94 /ls	287,791
040.260000.01.0108 Process Camera System	1.00 ls	0			287,791		287,790.94 /ls	287,791
26-00-00 ELECTRICAL			0		1,611,629			1,611,630
40-70-00 Instrumentation for Process Systems								
040.407000.01.0100 I&C								
I&C	1.00 ls	0		-	1,151,164	-	1,151,163.70 /ls	1,151,164
040.407000.01.0100 I&C	1.00 ls	0			1,151,164		1,151,163.70 /ls	1,151,164
40-70-00 Instrumentation for Process Systems			0		1,151,164			1,151,164
040 Electrical and I&C			1		2,762,793			2,762,793



GLWA, MI
Oakwood CSO Facility Improvements
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Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	413,341		4,696.943 hrs	
Material	1,879,451			
Subcontract	8,280,066			
Equipment	125,218		1,116.249 hrs	
Other	12,414			
Subtotal Allowances	10,710,490	10,710,490		
<u>General Conditions</u>				
GC General Conditions	1,606,573			15.000 %
Subtotal General Conditions	1,606,573	12,317,063		
<u>Indirect Costs</u>				
Building Permits(% total cost)	87,773			0.400 %
Builder's Risk Ins (% total cost)	109,716			0.500 %
Gen Liab Ins (% total cost)	219,432			1.000 %
GC Bonds (% total cost)	329,148			1.500 %
Subtotal Prior to OH&P	746,069	13,063,132		
Contractor Total OH&P	1,959,470			15.000 %
Subtotal with OH&P	1,959,470	15,022,602		
Construction Contingency	4,506,781			30.000 %
Total Cost in Today's Dollars	4,506,781	19,529,383		
Escalation to Mid Point Constr	2,413,832			12.360 %
Based on 6% per Year				
June 2023 to June 2025				
	2,413,832	21,943,215		
Total		21,943,215		

"This Opinion of Probable Construction Cost is produced in accordance with CDM Smith's Firmwide Quality policies and best practices as described in CDM Smith's Estimating Manual Dated 01/03/12 Section 10 titled Quality Control. I hereby acknowledge that the Cost Estimating policies and procedures were followed in preparation of the Opinion of Probable Cost".

Lead Estimator initials - Paul Damon 6/13/2023

Appendix A2

2023-06 Leib CSO Facility Improvements

Great Lakes Water Authority
Leib CSO Facility Improvements
Opinion of Probable Construction Cost, June 2023, Study

Estimator	Matthew Giacobbe
Labor rate table	MI23 Detroit
Equipment rate table	2023 \$6EquipRate BOF
ENR CCI	JUNE 2023: 13,345.00
ENR BCI	JUNE 2023: 8,095.33
ENR MCI	JUNE 2023: 5,881.65
AACEi Class	5
Estimate Type	OPCC
Design Level	Study
CDM Smith DB Ver.	S1.0
Reviewed by	Paul Damon
Review Date	6/13/2023
Delivered Date	6/13/2023
Notes	This is an Opinion of Probable Construction Cost only, as defined by the documents provided at the level of design indicated above. CDM Smith has no control over the cost of labor, materials, equipment, or services furnished, over schedules, over contractor's methods of determining prices, competitive bidding (at least 3 each - both prime bidders and major subcontractors), market conditions or negotiating terms. CDM Smith does not guarantee that this opinion will not vary from actual cost, or contractor's bids. There are not any costs provided for: Change Orders, Design Engineering, Construction Oversight, Client Costs, Finance or Funding Costs, Legal Fees, Land Acquisition or temporary/permanent Easements, Operations, or any other costs associated with this project that are not specifically part of the bidding contractor's proposed scope. This OPCC shall remain valid for 30 days. Beyond this date, CDM Constructors should be notified of design changes. The estimate will also be reviewed to reflect current market conditions. Assumptions: No rock excavation is required. Only nominal dewatering is needed. No consideration for contaminated soils or hazardous materials is included (i.e. asbestos, lead, etc).
Report format	Sorted by 'Area/16CSI Sctn/Element'



'Detail' summary
Allocate addons
Combine items
Paginate



Great Lakes Water Authority
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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
005 Sitework								
03-00-00 Concrete								
005.030000.68.005 Gate Slab								
Total Formwork (Summary)	30.00 csf	-	-	-	-		/csf	
Slab-on-Grade Form Oil & Hardware	30.00 csf	-	65	-	-	-	2.18 /csf	65
Slab-on-Grade Form Hoisting	30.00 sf	-	-	31	-	-	1.04 /sf	31
Layout Slab-on-Grade	125.00 sf	14	-	-	-	1	0.12 /sf	15
Hand Fine Grade SOG	125.00 sf	84	-	-	-	-	0.67 /sf	84
Slab-on-Grade < 6" 3 Form Uses	30.00 sf	820	57	-	-	-	29.23 /sf	877
Rebar Accessories/Unload & Store	0.17 tn	7	2	6	-	-	88.20 /tn	15
Reinforcing Hoisting - Crane	0.17 tn	23	-	53	-	-	436.26 /tn	76
SOG Rebar	0.17 TN	309	474	-	-	-	4,503.68 /TN	784
Rebar Support - bricks	8.00 ea	2	8	-	-	-	1.16 /ea	9
Total SOG Concrete (Summary)	2.32 cy	-	-	-	-		/cy	
Truck Place Slab on Grade	2.32 cy	100	-	-	-	-	43.07 /cy	100
Trowel Finish @ SOG	125.00 sf	179	-	-	-	-	1.44 /sf	179
Water Base Non-Residual Cure	125.00 sf	27	52	-	-	-	0.64 /sf	79
Total Redi-Mix Concrete (Summary)	2.32 cy	-	-	-	-		/cy	
4,500 psi Concrete- Central Region	2.32 CY	-	630	-	-	-	272.28 /CY	630
ASTM D448 # 57 Stone (1.00- No. 4)	2.32 cy	-	169	-	44	-	92.06 /cy	213
005.030000.68.005 Gate Slab	2.00 cy	1,565	1,457	90	44	1	1,579.02 /cy	3,158
03-00-00 Concrete		1,565	1,457	90	44	1		3,158
32-13-13 Concrete Paving								
005.321313.68.005 Concrete Paving								
--- Total Aggregate Base Area ---	4,790.00 sf	-	-	-	-		/sf	
Aggregate Base-Parking Lots	118.27 cy	1,310	-	2,066	-	-	28.55 /cy	3,376
ASTM D448 # 57 Stone (1.00- No. 4)	118.27 cy	-	8,619	-	2,266	-	92.04 /cy	10,886
Concrete Pavement- 9"	532.22 sy	8,311	38,601	3,100	-	-	93.97 /sy	50,012
Reinforcing Steel for Rigid Paving	532.22 sy	9,130	10,256	-	-	-	36.42 /sy	19,386
005.321313.68.005 Concrete Paving	532.00 sy	18,751	57,477	5,167	2,266		157.26 /sy	83,660
32-13-13 Concrete Paving		18,751	57,477	5,167	2,266			83,660
32-31-00 Fences and Gates								
005.323100.68.005 Chainlink Fence and Vehicle Gate								
8" Chain Link Fence	200.00 lf	-	-	-	17,100	-	85.50 /lf	17,100
8" Chain Link Fence Man Gate	2.00 ea	-	-	-	2,067	-	1,033.60 /ea	2,067
8" Chain Link Fence Vehicle Gate 24' Wide	1.00 ea	-	-	-	17,273	-	17,272.62 /ea	17,273
Add- Vinyl Coating- 8'	200.00 lf	-	-	-	3,464	-	17.32 /lf	3,464
3 Strand Barb Wire @ Top Add	200.00 lf	-	-	-	1,191	-	5.95 /lf	1,191
005.323100.68.005 Chainlink Fence and Vehicle Gate	200.00 lf				41,094		205.47 /lf	41,094
32-31-00 Fences and Gates					41,094			41,094
33-00-00 UTILITIES								
005.330000.68.005 Catch Basins								
Excav- Excavator C325- 30MT-186HP/1.50cy	5.93 cy	214	-	409	-	-	105.04 /cy	622
----- IMPORT MATERIAL (Summary) -----	0.59 CY	-	-	-	-		/CY	
ASTM D448 # 57 Stone (1.00- No. 4)	0.59 cy	-	36	-	11	-	79.06 /cy	47
EXCAVATION SPOILS-SOURCES of FILL (Summary)	7.11 cy	-	-	-	-		/cy	
Foundation Excavation Spoils (Summary)	7.11 cy	-	-	-	-		/cy	
Load Spoils from Stockpile Cat 325 Excavator-32MT- 180hp	7.11 cy	13	-	24	-	-	5.19 /cy	37
Haul Spoils/Off Site 18cy Rear Dump 1 Load/Hour	7.11 cy	39	-	67	-	-	14.87 /cy	106
Unload Care & Protect Catch Basins	2.00 ea	211	-	172	-	-	191.15 /ea	382



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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
005.330000.68.005 Catch Basins								
Catch Basin 36" x 36" x 5'-0" Deep	2.00 ea	1,509	5,838	817	-	-	4,082.11 /ea	8,164
005.330000.68.005 Catch Basins	2.00 ea	1,984	5,874	1,489	11		4,679.23 /ea	9,358
33-00-00 UTILITIES		1,984	5,874	1,489	11			9,358
33-05-10.400 PLASTIC PIPE								
005.330510.68.005 8" Drain Pipe								
Layout & Stake Pipe Excavation	75.00 lf	173	22	-	-	-	2.60 /lf	195
Trenching- Backhoe/Loader 95HP Average Exc.	33.60 cy	221	-	387	-	-	18.07 /cy	607
Trench Bedding-Backhoe/Loader C446 95HP	3.73 cy	58	-	53	-	-	29.91 /cy	111
Trench Pipe Zone Backfill- Backhoe/Loader 95HP	11.53 cy	348	-	261	-	-	52.82 /cy	609
Trench Native Backfill- Backhoe/Loader 95HP	17.33 cy	226	-	186	-	-	23.77 /cy	412
3/8 Stone Bedding/Zone/Engineered Fill Material	15.26 cy	-	856	-	274	-	74.10 /cy	1,130
Trench Box/Shield- 8' x 20", (9,500 lb)	0.04 u/mo	-	-	-	-	115	2,881.80 /u/mo	115
Pipe Detectable/Non-Detectable Tape	75.00 lf	26	19	-	-	-	0.60 /lf	45
EXCAVATION SPOILS-SOURCES of FILL (Summary)	16.27 cy	-	-	-	-		/cy	
Trenching Spoils (Summary)	16.27 cy	-	-	-	-		/cy	
Load Spoils from Stockpile Cat 325 Excavator-32MT- 180hp	16.27 cy	29	-	55	-	-	5.19 /cy	84
Haul Spoils/Off Site 18cy Rear Dump 1 Load/Hour	16.27 cy	88	-	154	-	-	14.87 /cy	242
Unload Care & Protect Pipe/Fittings	75.00 lf	16	-	13	-	-	0.38 /lf	29
Layout Pipe & Fitting	75.00 lf	69	-	-	-	-	0.92 /lf	69
PVC SDR35 Gravity Sewer Pipe, 8"	75.00 lf	2,958	1,219	-	-	-	55.69 /lf	4,177
PVC SDR35 45 Bend, 8"	2.00 ea	287	388	-	-	-	337.44 /ea	675
PVC SDR35 Tee, 8"	1.00 ea	214	263	-	-	-	476.79 /ea	477
005.330510.68.005 8" Drain Pipe	75.00 lf	4,712	2,767	1,109	274	115	119.71 /lf	8,978
33-05-10.400 PLASTIC PIPE		4,712	2,767	1,109	274	115		8,978
34-71-13.19 Vehicle Traffic Barriers								
005.347113.68.005 Bollards								
Bollard Post Sleeve	4.00 ea	-	-	-	-	622	155.46 /ea	622
Total Foundation Concrete	1.29 cy	-	-	-	-		/cy	
Place & Finish Pipe Bollard Concrete	4.00 ea	766	-	-	-	-	191.40 /ea	766
Total Redi-Mix Concrete (Summary)	1.29 cy	-	-	-	-		/cy	
4,500 psi Concrete- Central Region	1.29 CY	-	352	-	-	-	272.31 /CY	352
FOB Pipe, 6", Sch 40	24.00 lf	-	2,552	-	-	-	106.35 /lf	2,552
Pipe Painting Preparation/Small Tools & Consumables	37.70 sf	13	15	-	-	-	0.76 /sf	29
Paint 6" Pipe- Brush 1 Primer/2 Finish	24.00 lf	129	80	-	-	-	8.71 /lf	209
Excavate for Pipe Bollards	4.00 ea	783	-	505	-	-	322.01 /ea	1,288
005.347113.68.005 Bollards	4.00 ea	1,691	3,000	505		622	1,454.35 /ea	5,817
34-71-13.19 Vehicle Traffic Barriers		1,691	3,000	505		622		5,817
005 Sitework		28,703	70,575	8,360	43,690	738		152,066
010 Screenings Channel								
03-00-00 Concrete								
010.030000.68.005 Slope Screen Channel Concrete								
Total Formwork (Summary)	376.00 csf	-	-	-	-		/csf	
Equipment Pad/Curb Form Oil & Hardware	376.00 csf	-	819	-	-	-	2.18 /csf	819
Equipment Pad/Curb Form Hoisting	376.00 sf	-	-	79	-	-	0.21 /sf	79
Misc. Edges/Fill Forms < 6" 3 Form Uses	376.00 lf	20,563	708	-	-	-	56.57 /lf	21,271
Total Pad/Curb/Misc Concrete	8.03 cy	-	-	-	-		/cy	
Pump Place Miscellaneous Fill	8.03 cy	3,062	-	-	-	-	381.60 /cy	3,062
Concrete Pump- 92' Boom (28m)	8.03 cy	-	-	-	342	56	49.61 /cy	398
Total Concrete Pumping (Summary)	8.03 cy	-	-	-	-		/cy	



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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
010.030000.68.005 Slope Screen Channel Concrete								
Concrete Pump - Mob/Washout/Demob	4.00 ls	-	-	-	1,152	-	287.88 /ls	1,152
Total Redi-Mix Concrete (Summary)	8.03 cy	-	-	-	-		/cy	
Flowable Fill- Concrete Central Region	8.03 CY	-	1,687	-	-	-	210.23 /CY	1,687
010.030000.68.005 Slope Screen Channel Concrete	8.00 cy	23,625	3,214	79	1,493	56	3,558.48 /cy	28,468
010.030000.68.010 Modify Romag Walls for New Screens								
Modify Romag Walls For New Screens Allowance	1.00 ls	18,375	3,504	5,013		-	26,892.10 /ls	26,892
010.030000.68.010 Modify Romag Walls for New Screens	1.00 ls	18,375	3,504	5,013			26,892.10 /ls	26,892
010.030000.68.015 Modify COPA Walls for New Screens								
Modify COPA Walls for new screens Allowance	1.00 ls	24,501	7,008	6,684		-	38,192.25 /ls	38,192
010.030000.68.015 Modify COPA Walls for New Screens	1.00 ls	24,501	7,008	6,684			38,192.25 /ls	38,192
03-00-00 Concrete		66,501	13,726	11,776	1,493	56		93,552
40-05-19 Ductile Iron Pipe								
010.400519.68.005 Flushing Water System								
Pipe Test	300.00 lf	908	777	518	-	-	7.34 /lf	2,203
Spray Nozzles-Split Eyelet for 2" Pipe	32.00 ea	592	921	-	-	-	47.27 /ea	1,513
Pipe Marker/Label, Snap Around, 6" Pipe	30.00 ea	369	485	-	-	-	28.46 /ea	854
Class 150, 316 SS Bolt Sets, 6"	38.50 ea	-	2,190	-	-	-	56.88 /ea	2,190
1/8" Full Faced EPDM Gasket, 6"	38.50 ea	-	537	-	-	-	13.95 /ea	537
Total Weight (Zero Cost Item)	7,832.00 lbs	-	-	-	-		/lbs	
Weight of Pipe (Zero Cost Item)	7,192.00 lbs	-	-	-	-		/lbs	
Weight of Fittings (Zero Cost Item)	640.00 lbs	-	-	-	-		/lbs	
Unload Care & Protect Flanged/PE DIP & Fittings	7,832.00 lbs	181	-	148	-	-	0.04 /lbs	329
Weight of Flanged/PE Pipe (Zero Cost Item)	7,192.00 lbs	-	-	-	-		/lbs	
Weight of Flanged Fittings (Zero Cost Item)	640.00 lbs	-	-	-	-		/lbs	
Layout Flanged/PE DIP & Fitting	300.00 lf	277	-	-	-	-	0.92 /lf	277
DI Pipe, FLxFL, CL53, CML, 6" x 10'-0"	29.00 ea	16,030	55,404	-	-	-	2,463.25 /ea	71,434
DI, CML, 90 Short Radius Bend, FL, 6"	5.00 ea	1,354	2,442	-	-	-	759.22 /ea	3,796
DI, CML, Tee, FL, 6"x 6"	3.00 ea	1,137	2,151	-	-	-	1,096.06 /ea	3,288
010.400519.68.005 Flushing Water System	300.00 lf	20,848	64,908	666			288.07 /lf	86,422
40-05-19 Ductile Iron Pipe		20,848	64,908	666				86,422
40-05-23 Stainless Steel Pipe								
010.400523.68.005 3/4" Hydraulic Lines for screens								
Pipe Marker/Label, Snap Around, 3/4" Pipe	400.00 ea	3,697	3,146	-	-	-	17.11 /ea	6,843
Weld 1.00" 316 Sch 40s Stainless Pipe	528.00 ea	17,461	1,094	1,034	-	-	37.10 /ea	19,590
Unload Care & Protect Pipe/Fittings	4,782.40 lbs	1,007	-	821	-	-	0.38 /lbs	1,828
Weight of Pipe (Zero Cost Item)	4,752.00 lbs	-	-	-	-		/lbs	
Weight of Fittings (Zero Cost Item)	30.40 lbs	-	-	-	-		/lbs	
Layout Pipe & Fitting	4,000.00 lf	3,697	-	-	-	-	0.92 /lf	3,697
316 Sch 40s Stainless Pipe BW, 0- 3/4"	3,960.00 lf	94,654	38,304	-	-	-	33.58 /lf	132,958
316 Sch 40s Stainless 90 Ell BW, 0- 3/4"	160.00 ea	34,608	9,452	-	-	-	275.37 /ea	44,059
Inert Gas Purge, 0- 3/4"	368.00 ea	7,143	4	-	-	-	19.42 /ea	7,148
010.400523.68.005 3/4" Hydraulic Lines for screens	4,000.00 lf	162,269	52,000	1,855			54.03 /lf	216,124
40-05-23 Stainless Steel Pipe		162,269	52,000	1,855				216,124
46-21-00 Screening Equipment								
010.462100.68.005 Remove, Rehab, and Reinstall Romag Screens								
Remove, Rehab, and Reinstall Romag Screens *Q	4.00 ea	36,922	-	32,122	549,845	-	154,722.39 /ea	618,890
010.462100.68.005 Remove, Rehab, and Reinstall Romag Screens	4.00 ea	36,922		32,122	549,845		154,722.39 /ea	618,890
010.462100.68.010 Remove COPA Screens and Replace with Romag								
Equipment Manufacturers Representative	5.00 day	-	-	-	-	14,394	2,878.77 /day	14,394



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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
010.462100.68.010 Remove COPA Screens and Replace with Romag								
Unload/Protect Equip - Medium Equip	4.00 ea	2,592	-	1,660	-	-	1,063.09 /ea	4,252
Remove COPA and Install Romag Screens *Q	4.00 ea	46,153	2,565,444	40,153	-	-	662,937.54 /ea	2,651,750
010.462100.68.010 Remove COPA Screens and Replace with Romag	4.00 ea	48,745	2,565,444	41,813		14,394	667,599.08 /ea	2,670,396
46-21-00 Screening Equipment		85,667	2,565,444	73,936	549,845	14,394		3,289,286
010 Screenings Channel		335,285	2,696,078	88,233	551,338	14,450		3,685,384
020 Chemical/OC Building								
01-50-60 Temporary Process Equipment								
020.015060.68.005 Temporary Chemical System								
Temporary Chemical System Allowance	1.00 ls	-	-	-	57,575	-	57,575.39 /ls	57,575
020.015060.68.005 Temporary Chemical System	1.00 ls				57,575		57,575.39 /ls	57,575
01-50-60 Temporary Process Equipment					57,575			57,575
02-41-00 Demolition								
020.024100.68.005 Demo Courtyard Entrance								
Demo Courtyard Entrance	65.00 sf	1,387	-	454	-	-	28.33 /sf	1,841
Disposal Fee (Tipping)	0.40 tn	-	-	-	-	23	57.56 /tn	23
020.024100.68.005 Demo Courtyard Entrance	1.00 ls	1,387		454		23	1,864.47 /ls	1,864
020.024100.68.010 Demo OC Concrete Stub								
Demo Concrete	1.00 ea	1,387	-	454	-	-	1,841.40 /ea	1,841
Haul Demo/Off Site 18cy Rear Dump 1 Load/Hour	1.00 load	75	-	131	-	-	206.64 /load	207
Demolition - Tipping Fees- Concrete/Masonry	1.00 cy	-	-	-	-	74	73.70 /cy	74
020.024100.68.010 Demo OC Concrete Stub	1.00 ea	1,463		586		74	2,121.74 /ea	2,122
020.024100.68.015 Demo SF Wall								
Demo Masonry Wall	212.00 sf	1,633	-	494	-	-	10.03 /sf	2,127
Haul Demo/Off Site 18cy Rear Dump 1 Load/Hour	2.00 load	151	-	263	-	-	206.65 /load	413
020.024100.68.015 Demo SF Wall	212.00 sf	1,784		756			11.98 /sf	2,541
02-41-00 Demolition		4,634		1,796		97		6,527
03-00-00 Concrete								
020.030000.68.005 Concrete Opening Fill (Slab)								
Total Formwork (Summary)	53.42 csf	-	-	-	-		/csf	
Elevated Slab Form Oil & Hardware	26.00 csf	-	57	-	-	-	2.18 /csf	57
Elevated Slab Form Hoisting	26.00 sf	107	-	104	-	-	8.09 /sf	210
Slab Edge < 10" 3 Form Uses	13.00 sf	355	53	-	-	-	31.39 /sf	408
Floor Slab x10" 3 Form Uses	13.00 sf	219	32	-	-	-	19.29 /sf	251
Slab Shore Hoisting	27.42 sf	10	-	10	-	-	0.74 /sf	20
Slab Shoring Hardware	54.84 sfmo	-	50	-	-	-	0.91 /sfmo	50
Shore 10" Slab Perimeter x20 Ft AFF 1- Form Use	14.42 sf	189	585	-	-	-	53.70 /sf	775
Shoring 10" Slab Soffit x20 Ft AFF 1- Form Use	13.00 sf	171	227	-	-	-	30.59 /sf	398
Rebar Accessories/Unload & Store	0.03 tn	1	0	1	-	-	88.52 /tn	2
Reinforcing Hoisting - Crane	0.03 tn	4	-	8	-	-	436.30 /tn	12
Elevated Slab Rebar	0.03 TN	444	73	-	-	-	19,140.00 /TN	517
Rebar Support - Continuous Slab Bolster	5.20 lf	1	3	-	-	-	0.81 /lf	4
Drill & Epoxy Grout #5 Bars	13.00 ea	505	239	-	-	-	57.26 /ea	744
Total Elevated Slab Concrete	0.36 cy	-	-	-	-		/cy	
Buggy Place Suspended Slab	0.36 cy	191	-	-	-	-	530.17 /cy	191
Trowel Finish @ Slab	13.00 sf	19	-	-	-	-	1.44 /sf	19
Water Base Non-Residual Cure	13.00 sf	3	5	-	-	-	0.63 /sf	8
Concrete Power Buggy Ride-On 16cf	0.36 cy	84	-	42	-	-	350.53 /cy	127
Total Redi-Mix Concrete (Summary)	0.36 cy	-	-	-	-		/cy	



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020.030000.68.005 Concrete Opening Fill (Slab)								
4,500 psi Concrete- Central Region	0.36 CY	-	98	-	-	-	272.22 /CY	98
020.030000.68.005 Concrete Opening Fill (Slab)	0.40 cy	2,304	1,422	165			9,727.90 /cy	3,891
020.030000.68.010 Concrete Opening Fill (Wall)								
Total Formwork (Summary)	25.92 csf	-	-	-	-		/csf	
Lumber Wall Form Oil & Hardware	25.92 csf	-	56	-	-	-	2.18 /csf	56
Lumber Wall Form Hoisting	25.92 sf	15	-	15	-	-	1.17 /sf	30
Wall-Lumber Formed 4 Ft- 3 Form Uses	25.92 sf	656	137	-	-	-	30.61 /sf	794
Rebar Accessories/Unload & Store	0.05 tn	2	1	2	-	-	88.10 /tn	5
Reinforcing Hoisting - Crane	0.05 tn	7	-	17	-	-	436.00 /tn	24
Wall Rebar	0.05 TN	444	148	-	-	-	10,962.00 /TN	592
Rebar Support - Continuous Wall/Column/Beam Bolster	2.59 lf	1	2	-	-	-	0.82 /lf	2
# 5 Loose Dowel Bars	13.00 lf	-	31	-	-	-	2.42 /lf	31
Total Wall Concrete	0.72 cy	-	-	-	-		/cy	
Pump Place Walls	0.72 cy	191	-	-	-	-	265.85 /cy	191
Trowel Finish @ Wall Top	5.40 sf	8	-	-	-	-	1.44 /sf	8
Point & Patch Walls	25.92 sf	50	1	-	-	-	1.95 /sf	51
Water Base Non-Residual Cure	31.32 sf	7	13	-	-	-	0.64 /sf	20
Concrete Pump- 92' Boom (28m)	0.72 cy	-	-	-	26	5	42.51 /cy	31
Total Concrete Pumping (Summary)	0.72 cy	-	-	-	-		/cy	
Concrete Pump - Mob/Washout/Demob	1.00 ls	-	-	-	288	-	287.88 /ls	288
Total Redi-Mix Concrete (Summary)	0.72 cy	-	-	-	-		/cy	
4,500 psi Concrete- Central Region	0.72 CY	-	196	-	-	-	272.24 /CY	196
020.030000.68.010 Concrete Opening Fill (Wall)	0.80 cy	1,381	585	33	313	5	2,897.53 /cy	2,318
020.030000.68.015 Hypo Pump Pads								
Total Formwork (Summary)	40.00 csf	-	-	-	-		/csf	
Equipment Pad/Curb Form Oil & Hardware	40.00 csf	-	87	-	-	-	2.18 /csf	87
Equipment Pad/Curb Form Hoisting	40.00 sf	-	-	8	-	-	0.21 /sf	8
Equipment Pad/Curb < 6" 3 Form Uses	40.00 lf	2,188	75	-	-	-	56.57 /lf	2,263
Bonding Agent @ Curb/Pad/Fill Concrete	24.00 sf	79	17	-	-	-	3.98 /sf	96
Blast Clean Construction Joints	24.00 sf	50	14	2	-	-	2.78 /sf	67
Chamfer Strip	48.00 lf	84	19	-	-	-	2.14 /lf	103
Rebar Accessories/Unload & Store	0.03 tn	1	0	1	-	-	88.50 /tn	3
Equipment Pad/Curb Rebar	0.03 TN	888	91	-	-	-	29,670.30 /TN	979
Rebar Support - Continuous Slab Bolster	8.00 lf	2	5	-	-	-	0.81 /lf	6
Drill & Epoxy Grout #5 Bars	40.00 ea	1,555	736				57.26 /ea	2,290
Total Pad/Curb/Misc Concrete	0.44 cy	-	-	-	-		/cy	
Buggy Place Equipment Pad/Support	0.44 cy	766	-	-	-	-	1,724.32 /cy	766
Trowel Finish @ Equipment Pad/Curb	24.00 sf	34	-	-	-	-	1.44 /sf	34
Water Base Non-Residual Cure	64.00 sf	14	27	-	-	-	0.64 /sf	41
Concrete Power Buggy Ride-On 16cf	0.44 cy	336	-	170	-	-	1,139.90 /cy	506
Total Redi-Mix Concrete (Summary)	0.44 cy	-	-	-	-		/cy	
4,500 psi Concrete- Central Region	0.44 CY	-	121	-	-	-	272.12 /CY	121
020.030000.68.015 Hypo Pump Pads	0.50 cy	5,997	1,191	181			14,739.44 /cy	7,370
03-00-00 Concrete		9,682	3,199	380	313	5		13,579
04-00-00 Masonry								
020.040000.68.005 Remove and Install Knockout Wall								
Remove and Reinstall Knockout Wall	192.00 sf	11,405	-	-	-	-	59.40 /sf	11,405
020.040000.68.005 Remove and Install Knockout Wall	192.00 sf	11,405					59.40 /sf	11,405
020.040000.68.010 New SF Wall								



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(INDIRECT COSTS UNALLOCATED)

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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
020.040000.68.010 New SF Wall								
Interior Smooth Face CMU Wall, 8" Complete	216.00 sf	-	-	-	7,959	-	36.85 /sf	7,959
Painting Preparation & Consumables- Total SF	432.00 sf	192	151	-	-	-	0.79 /sf	343
CMU Block Filler- 2 Coat	432.00 sf	575	279	-	-	-	1.97 /sf	853
--- Interior Walls ---	216.00 type	-	-	-	-		/type	
Paint Interior Walls- Oil Base (Prime & 2 Coats)	432.00 sf	575	1,055	-	-	-	3.77 /sf	1,630
020.040000.68.010 New SF Wall	216.00 sf	1,341	1,485		7,959		49.93 /sf	10,785
04-00-00 Masonry		12,746	1,485		7,959			22,190
05-12-00 STRUCTURAL STEEL								
020.051200.68.005 New Supporting Beam								
Total Structural Steel Weight (No Cost Item)	0.16 tn	-	-	-	-		/tn	
Total Beam Steel Weight (No Cost Item)	0.16 tn	-	-	-	-		/tn	
W 8x24 Beam	13.00 lf	3,728	1,749	1,671	-	-	549.89 /lf	7,149
Galvanize by Fabrication Weight	312.00 lbs	-	306	-	-	-	0.98 /lbs	306
020.051200.68.005 New Supporting Beam	13.00 lf	3,728	2,055	1,671			573.44 /lf	7,455
05-12-00 STRUCTURAL STEEL		3,728	2,055	1,671				7,455
07-26-00 Vapor Retarders								
020.071100.68.005 Waterproofing								
6 Mil. Poly Vapor Barrier	26.00 sf	335	3				13.01 /sf	338
020.071100.68.005 Waterproofing	26.00 sf	335	3				13.01 /sf	338
07-26-00 Vapor Retarders		335	3					338
07-41-00 Roofing								
020.074100.68.005 Overhead Canopy								
Overhead Canopy	20.00 sf		-	-	3,455	-	172.73 /sf	3,455
020.074100.68.005 Overhead Canopy	20.00 sf				3,455		172.73 /sf	3,455
07-41-00 Roofing					3,455			3,455
08-10-00 DOORS AND FRAMES								
020.081000.68.005 SF Double Door								
Grout Hollow Metal Frame	1.00 ea	64	841	-	-	4	909.19 /ea	909
Polyurethane Joint Sealant 3/8" x 3/8"	40.00 lf	98	23	-	-	-	3.01 /lf	120
Hollow Metal Door Pair /Frame & Hardware 6'-0" x 7'-0"	1.00 ea	1,697	7,708	-	-	-	9,404.86 /ea	9,405
020.081000.68.005 SF Double Door	1.00 ea	1,858	8,572			4	10,434.28 /ea	10,434
08-10-00 DOORS AND FRAMES		1,858	8,572			4		10,434
09-96-00 High-Performance Coatings								
020.099600.68.005 Repair Floor Coating								
Coating Preparation & Consumables- Total SF	25.00 sf	11	9	-	-	-	0.79 /sf	20
SSPC- SP- 3 Power Tool Cleaning	25.00 sf	443	-	-	-	-	17.74 /sf	443
Concrete Floor Coating	25.00 sf	-	-	-	1,439	-	57.58 /sf	1,439
020.099600.68.005 Repair Floor Coating	25.00 sf	454	9		1,439		76.11 /sf	1,903
09-96-00 High-Performance Coatings		454	9		1,439			1,903
13-00-00 SPECIAL CONSTRUCTION								
020.130000.68.005 Additional Building Modifications Allowance								
Additional Building Modifications Allowance	1.00 ls	-	-	-	11,515	-	11,515.08 /ls	11,515
020.130000.68.005 Additional Building Modifications Allowance	1.00 ls				11,515		11,515.08 /ls	11,515
13-00-00 SPECIAL CONSTRUCTION					11,515			11,515
22-00-00 Plumbing								
020.220000.68.005 Floor Drain Modifications								
Floor Drain Modifications	1.00 ls	1,530	420	-	-	-	1,950.61 /ls	1,951
020.220000.68.005 Floor Drain Modifications	1.00 ls	1,530	420				1,950.61 /ls	1,951



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(INDIRECT COSTS UNALLOCATED)

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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
22-00-00 Plumbing		1,530	420					1,951
23-00-00 Heating, Ventilating, and Air Conditioning (HVAC)								
020.230000.60.005 Replace Thermostat								
Thermostat	1.00 ea	526	210	-	-	-	736.06 /ea	736
020.230000.60.005 Replace Thermostat	1.00 ea	526	210				736.06 /ea	736
23-00-00 Heating, Ventilating, and Air Conditioning (HVAC)		526	210					736
31-23-00 Excavation and Fill								
020.312300.68.005 OC Pipe Fill (Sand)								
Mobilize/Demobilize Earthwork Equipment (8 hr each way)	1.00 ea	151	-	301	-	-	451.37 /ea	451
----- FILL from IMPORT (Summary) -----	50.00 CY	-	-	-	-		/CY	
Place Fill from Import- Excavator C325-30MT- 186HP/1.50cy/CP323 Compactor/4k gallon Water Truck	50.00 cy	2,302	-	3,527	-	-	116.58 /cy	5,829
----- IMPORT MATERIAL (Summary) -----	50.00 CY	-	-	-	-		/CY	
Import Sand Fill	50.00 cy	-	4,191	-	958	-	102.99 /cy	5,150
020.312300.68.005 OC Pipe Fill (Sand)	50.00 cy	2,453	4,191	3,827	958		228.60 /cy	11,430
31-23-00 Excavation and Fill		2,453	4,191	3,827	958			11,430
32-31-19 Decorative Metal Fences and Gates								
020.323119.68.005 Security Fence and Bird Screen								
Bird Screen	5.00 lf	-	-	-	534	-	106.88 /lf	534
Layout Fencing	5.00 lf	5	-	-	-	-	1.06 /lf	5
Industrial Security Fencing x 96" tall	5.00 lf	673	648	297	-	-	323.63 /lf	1,618
Industrial Security Fence Gate 3' wide x 96" tall	1.00 ea	673	1,163	297	-	-	2,133.88 /ea	2,134
020.323119.68.005 Security Fence and Bird Screen	1.00 ls	1,352	1,811	594	534		4,291.73 /ls	4,292
32-31-19 Decorative Metal Fences and Gates		1,352	1,811	594	534			4,292
40-05-00 PROCESS PIPING								
020.400500.68.005 Chemical Feed Pipe Allowance								
Chemical Feed Pipe Replacement Allowance	1.00 ls	18,487	11,515	-	-	-	30,002.29 /ls	30,002
020.400500.68.005 Chemical Feed Pipe Allowance	1.00 ls	18,487	11,515				30,002.29 /ls	30,002
40-05-00 PROCESS PIPING		18,487	11,515					30,002
40-05-66 Globe Valves								
020.400566.68.005 Flow Control Vavles								
Valve Painting Preparation/Small Tools & Consumables	1.31 sf	0	0	-	-	-	0.63 /sf	1
Paint 1-1/2" Valve Brush 1 Primer/2 Finish	14.00 ea	145	21	-	-	-	11.86 /ea	166
Angle Globe Valve Count	14.00 ea	-	-	-	-		/ea	
Unload Care & Protect Valves	14.00 ea	295	-	240	-	322	61.26 /ea	858
Globe Valve, 1.50" *Q	14.00 ea	12,941	773,813	4,805	-	-	56,539.98 /ea	791,560
Valve Tag, Plastic, 1-1/2" Diameter	14.00 ea	259	56	-	-	-	22.52 /ea	315
020.400566.68.005 Flow Control Vavles	14.00 ea	13,640	773,891	5,046		322	56,635.67 /ea	792,899
40-05-66 Globe Valves		13,640	773,891	5,046		322		792,899
43-23-00 Dry Location Liquid Pumps								
020.432300.68.005 Sample Pumps								
Sample Pump Spare *Q	2.00 ea		26,024	-	-	-	13,012.04 /ea	26,024
Pump Manufacturers Representative	1.00 day	-	-	-	-	2,879	2,878.77 /day	2,879
Unload/Protect Equip - Medium Equip	4.00 ea	1,296	-	830	-	-	531.54 /ea	2,126
Sample Pump *Q	2.00 ea	2,997	26,024	-	-	-	14,510.43 /ea	29,021
Test & Check Sample Pumps	2.00 ea	300	-	-	-	-	149.84 /ea	300
020.432300.68.005 Sample Pumps	4.00 ea	4,592	52,048	830		2,879	15,087.39 /ea	60,350
020.432300.68.010 Recirculation Pumps								
Chemical Transfer Pump Spare Parts	1.00 lot	94	2,879	-	-	-	2,972.42 /lot	2,972
Pump Manufacturers Representative	1.00 day	-	-	-	-	2,879	2,878.77 /day	2,879



Great Lakes Water Authority
Leib CSO Facility Improvements
(INDIRECT COSTS UNALLOCATED)

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Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Equip Amount	Sub Amount	Other Amount	Total Cost/Unit	Total Amount
020.432300.68.010 Recirculation Pumps								
Unload/Protect Equip - Medium Equip	2.00 ea	648	-	415	-	-	531.54 /ea	1,063
Chemical Recirculation Pump *Q	2.00 ea	2,997	92,121	-	-	-	47,558.71 /ea	95,117
Test & Check Chemical Transfer Pumps	2.00 ea	300	-	-	-	-	149.84 /ea	300
020.432300.68.010 Recirculation Pumps	2.00 ea	4,038	94,999	415		2,879	51,165.68 /ea	102,331
43-23-00 Dry Location Liquid Pumps		8,631	147,048	1,245		5,758		162,681
43-41-45 Fiberglass Reinforced Plastic Tanks								
020.434145.68.005 Remove and Replace Hypo Tanks								
Unload & Protect Fiberglass Tanks	2.00 ea	2,301	-	2,008	-	-	2,154.44 /ea	4,309
Remove and Replace 12,800 gal FRP Tank *Q	2.00 ea	23,012	134,496	20,077	-	-	88,792.43 /ea	177,585
Hydro Test FRP Tanks	2.00 ea	1,479	-	-	-	-	739.49 /ea	1,479
020.434145.68.005 Remove and Replace Hypo Tanks	2.00 ea	26,792	134,496	22,084			91,686.35 /ea	183,373
43-41-45 Fiberglass Reinforced Plastic Tanks		26,792	134,496	22,084				183,373
46-41-00 Mixing Equipment								
020.464100.68.005 New Mixer Enclosures								
Mixer Enclosures	2.00 ea	7,492	5,758	-	-	-	6,624.72 /ea	13,249
020.464100.68.005 New Mixer Enclosures	2.00 ea	7,492	5,758				6,624.72 /ea	13,249
46-41-00 Mixing Equipment		7,492	5,758					13,249
020 Chemical/OC Building		114,341	1,094,663	36,644	83,750	6,186		1,335,583
025 Electrical and I&C								
26-00-00 ELECTRICAL								
040.260000.01.0100 Feeds to Replaced Disinfection System Equipment & Instruments								
Connect & Feed Disinfection System Process Equipment & Instruments	1.00 ls	0		-	287,877	-	287,876.99 /ls	287,877
040.260000.01.0100 Feeds to Replaced Disinfection System Equipment & Instruments	1.00 ls	0			287,877		287,876.99 /ls	287,877
040.260000.01.0101 Chemical Mixer MCC Starter Replacement / Modification								
Demo MCC Starter	16.00 ea	2,947	-	-	-	-	184.20 /ea	2,947
Comb Motor Starter (field-mounted in MCC) [Eaton S811+N37P3S]	16.00 ea	5,894	63,673	-	-	-	4,347.97 /ea	69,568
040.260000.01.0101 Chemical Mixer MCC Starter Replacement / Modification	1.00 ls	8,842	63,673				72,514.73 /ls	72,515
040.260000.01.0102 Refeed Screen Hydraulic Power Packs								
Refeed Screen Hydraulic Power Packs	4.00 ls			-	69,090	-	17,272.62 /ls	69,090
040.260000.01.0102 Refeed Screen Hydraulic Power Packs	1.00 ls				69,090		69,090.46 /ls	69,090
040.260000.01.0103 Camera & Badge Reader Wiring for New Access								
Electronic Safety & Security: Camera & Badge Reader for New Access	1.00 ls	0		-	17,273	-	17,272.63 /ls	17,273
040.260000.01.0103 Camera & Badge Reader Wiring for New Access	1.00 ls	0			17,273		17,272.63 /ls	17,273
040.260000.01.0104 Lighting -Arch Mod Impacts at Vestibules								
Lighting -Arch Mod Impacts at Vestibules	1.00 ls	0		-	57,575	-	57,575.42 /ls	57,575
040.260000.01.0104 Lighting -Arch Mod Impacts at Vestibules	1.00 ls	0			57,575		57,575.42 /ls	57,575
26-00-00 ELECTRICAL		8,842	63,673		431,815			504,330
40-70-00 Instrumentation for Process Systems								
040.407000.01.0100 I&C								
I&C	1.00 ls	0		-	575,754	-	575,753.96 /ls	575,754
040.407000.01.0100 I&C	1.00 ls	0			575,754		575,753.96 /ls	575,754
40-70-00 Instrumentation for Process Systems		0			575,754			575,754
025 Electrical and I&C		8,842	63,673		1,007,569			1,080,084



Great Lakes Water Authority
Leib CSO Facility Improvements
(INDIRECT COSTS UNALLOCATED)

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Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	487,170		5,076.462 hrs	
Material	3,924,989			
Subcontract	1,686,347			
Equipment	133,237		544.015 hrs	
Other	21,374			
Subtotal Allowances	6,253,117	6,253,117		
<u>General Conditions</u>				
GC General Conditions	937,968			15.000 %
Subtotal General Conditions	937,968	7,191,085		
<u>Indirect Costs</u>				
Building Permits(% total cost)	51,245			0.400 %
Builder's Risk Ins (% total cost)	64,056			0.500 %
Gen Liab Ins (% total cost)	128,111			1.000 %
GC Bonds (% total cost)	192,167			1.500 %
Subtotal Prior to OH&P	435,579	7,626,664		
Contractor Total OH&P	1,144,000			15.000 %
Subtotal with OH&P	1,144,000	8,770,664		
Construction Contingency	2,631,199			30.000 %
Total Cost in Today's Dollars	2,631,199	11,401,863		
Escalation to Mid Point Constr	1,409,270			12.360 %
Based on 6% per Year				
June 2023 to June 2025				
	1,409,270	12,811,133		
Total		12,811,133		

"This Opinion of Probable Construction Cost is produced in accordance with CDM Smith's Firmwide Quality policies and best practices as described in CDM Smith's Estimating Manual Dated 01/03/12 Section 10 titled Quality Control. I hereby acknowledge that the Cost Estimating policies and procedures were followed in preparation of the Opinion of Probable Cost".

Lead Estimator initials - Paul Damon 6/13/2023

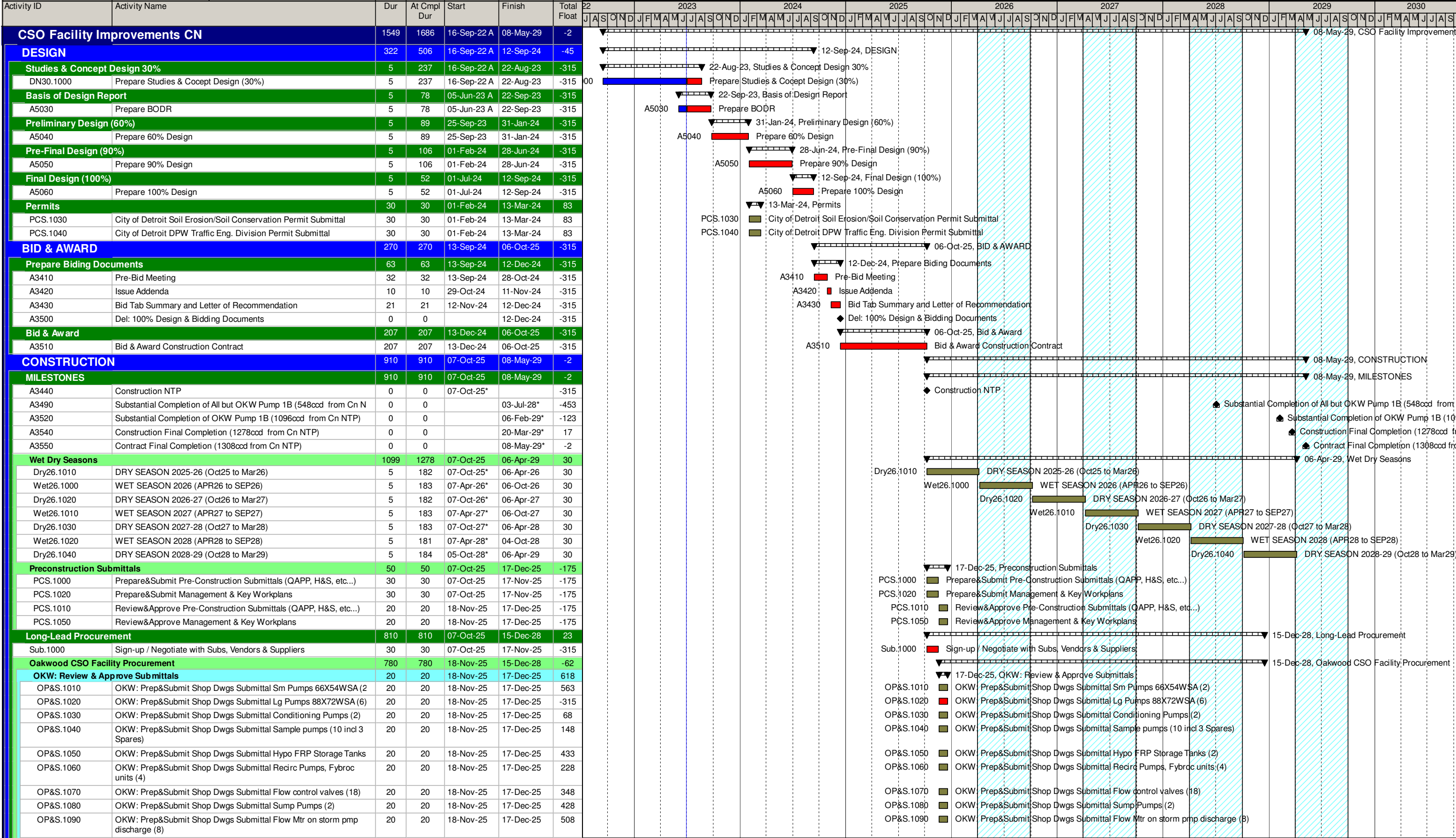
Appendix B

Conceptual Construction Schedule



Great Lakes Water Authority, A Michigan Muniapal Authority
CSO FACILITIES IMPROVEMENTS - Project ID CS-299

Data Date: 01-Jul-23
Run Date: 19-Jul-23 Time: 01:53



Level of Effort Remaining Work Finish Constraint Summary
Actual Work Critical Remaining Work Milestone

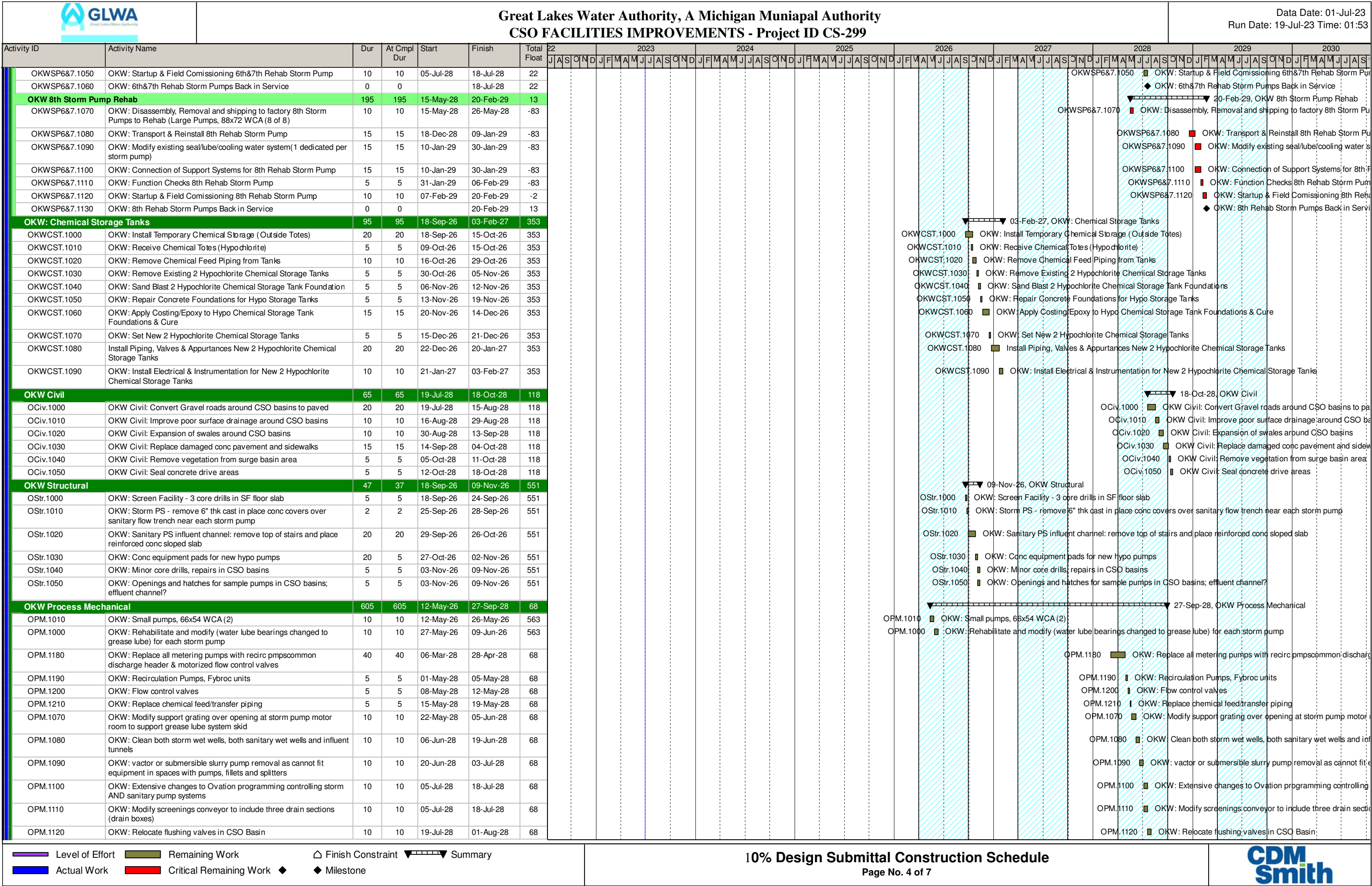




Data Date: 01-Jul-23
Run Date: 19-Jul-23 Time: 01:53

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Level of Effort Remaining Work Finish Constraint Summary	10% Design Submittal Construction Schedule Page No. 3 of 7	
 Actual Work  Critical Remaining Work ◆ Milestone		





Data Date: 01-Jul-23
Run Date: 19-Jul-23 Time: 01:53

 Level of Effort
  Remaining Work
  Finish Constraint
  Summary

 Actual Work
  Critical Remaining Work
  Milestone



Level of Effort  Actual Work	Remaining Work  Critical Remaining Work	Finish Constraint  Milestone	Summary	10% Design Submittal Construction Schedule Page No. 6 of 7	
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Level of Effort Remaining Work Finish Constraint Summary	10% Design Submittal Construction Schedule Page No. 7 of 7	
 Actual Work  Critical Remaining Work  Milestone		

Appendix C

List of Technical Memoranda

List of Technical Memoranda

- TM-1 Facility Hydraulic Models
- TM-2 Storm Pump Rehab and Wet Well Cleaning (OKW-Pump-1B)
- TM-3 Sanitary PS Concrete Stair Modification Evaluation (OKW-Pump-2)
- TM-4 Oakwood Screw Conveyor & Grinder System Modifications (OKW-2)
- TM-5 LEIB-SCR1 Screening Improvements and Pilot Screen
- TM-6 Electrical Improvements (Leib-Elec-1)
- TM-7 I & C Improvements
- TM-8 Leib HVAC Improvements
- TM-9 Leib NFPA 820 Analysis
- TM-11 Survey and Site Constraints
- TM-15 Storm and Sanitary Pump Operational Strategies Improvement Evaluation (OKW-Pump-1A)
- TM-17 Influent WQ Sampling Program
- TM-18 Chlorine Dose Response Results and ICT Model
- TM-19 Chlorine System Automation Evaluation
- TM-20 Chlorine System Alternatives
- TM-21 Basin Influent Flow Metering
- TM-22 Flushing Systems (Leib-FD-1, OKW-FD-2, and OKW-Pump-1B)
- TM-24 Site Civil Design
- TM-28 Permitting and Regulatory Requirements

Appendix D

CFD Model Reports

Appendix E

CS-299 Report



CS-299 CSO Facilities Assessment
Volume 2 – Multi-Disciplinary Facilities Assessment

FINAL

April 9, 2021

Great Lakes Water Authority



CS-299 CSO Facilities Assessment

Project No: C6A13300
Document Title: Volume 2 - Multi-Disciplinary Facilities Assessment
Revision: Final
Date: April 9, 2021
Client Name: Great Lakes Water Authority
Project Manager: Bruce Allman / Allen Gelderloos

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Document history and status

Version	Date	Description
Draft	August 21, 2020	Draft Multi-Disciplinary Needs Assessment
Final	April 9, 2021	Final Multi-Disciplinary Facilities Assessment

Contents

Overall CS-299 Facilities Assessment Organization

Volume 1 – Project Introduction and Capital Improvement and Outlay Plans

Volume 2 – Multi-Disciplinary Facilities Assessment

Volume 3 – Asset Audit, Condition Assessment, FMEAs, and Schedule Replacement Plan

Volume 4 – Reporting

Volume 5 – CSO System 5-Year SRF Project Plan

Volume 6 – Appendices

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Acronyms and Abbreviations

A	amperes
AACE	Association for the Advancement of Cost Engineering
ACH	air changes per hour
AHU	air handling unit
ATS	automatic transfer switch
BC	Baby Creek
BCE	Business Case Evaluation
BLI	Belle Isle
BTU	British thermal unit(s)
CCTV	closed-circuit television
CFD	computational fluid dynamics
cfm	cubic feet per minute
cfm/ft ²	cubic feet per minute per square feet
cfs	cubic feet per second
CIP	Capital Improvement Plan
Cl ₂	chlorine
CON	Conner Creek
CSO	combined sewer overflow
ct	counts
DDC	direct digital controller
DRI	Detroit River Interceptor
DTE	DTE Energy
EGLE	Environment, Great Lakes, and Energy
FRP	fiber-reinforced plastic
FSP	flushed solids pump
ft	feet
ft ²	square feet
gal	gallon(s)
GIS	geographic information system
GLWA	Great Lakes Water Authority
gpm	gallon(s) per minute
GPS	Global Positioning System
H ₂ S	hydrogen sulfide
HDPE	high-density polyethylene

HGL	hydraulic grade line
HIM	human interface module
HMI	human-machine interface
hp	horsepower
HS	Hubbell Southfield
HVAC	heating, ventilation, and air conditioning
HVU	heating ventilation unit
I&C	Instrumentation and Controls
I&I	infiltration and inflow
in.	inch
Jacobs	Jacobs Consultants, Inc
JOC	Job Order Contract
kV	kilovolt(s)
kVA	kilovolt-ampere(s)
kW	kilowatt(s)
LED	light-emitting diode
LEIB	Leib
mA	milliampere(s)
MAU	make-up air unit
MBH	1000 British thermal unit(s) per hour
MBtu	million British thermal unit(s)
MCC	motor control center
MG	million gallon
mg/L	milligram(s) per liter
MGD	million gallons per day
mL	milliliter(s)
mm	millimeter(s)
N/A	not applicable
NaOCl	sodium hypochlorite
NaOH	sodium hydroxide
NFPA	National Fire Protection Association
No.	Number
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
NPW	non-potable water

NWI	Northwest Interceptor
O&M	operation and maintenance
OEM	original equipment manufacturer
OIT	Operator Interface Terminal
OKW	Oakwood
PF	Puritan-Fenkell
PLC	programmable logic controller
pph	pound(s) per hour
ppmv	part(s) per million volume
PS	pumping station
psi	pound(s) per square inch
psig	pound(s) per square inch gauge
PTZ	point, tilt, zoom (camera)
PVC	polyvinyl chloride
RFP	request for proposal
rpm	revolutions per minute
RTB	retention treatment basin
RWCS	Regional Wastewater Collection System
SCADA	supervisory control and data acquisition
SDF	Screening and Disinfection Facility
SM	Seven Mile
SRP	Scheduled Replacement Plan
STA	St. Aubin
TDH	total dynamic head
TOES	Task Order Engineering Services
TRC	total residual chlorine
UV	ultraviolet
VFD	variable frequency drive
WAM	Work and Asset Management
WO	work order
WRRF	Water Resource Recovery Facility
WWMP	Wastewater Master Plan

4. Process Overview

4.1 General Combined Sewer Overflow Facility Descriptions

The Great Lakes Water Authority (GLWA) operates and maintains nine combined sewer overflow (CSO) facilities. The primary function of the CSO facilities is to screen, settle, skim, and disinfect combined sewer/storm water during rain events before discharge to the receiving water body or return captured water to the Wastewater Resource Recovery Facility (WRRF) for further treatment. These CSO facilities play a vital role in keeping combined sewer water out of residents of the City of Detroit's basements and protecting public health and the environment. All facilities must meet discharge requirements contained in GLWA's National Pollutant Discharge Elimination System (NPDES) permit. Detailed facility descriptions are provided in the following sections.

There are two types of CSO facilities: Retention Treatment Basins (RTBs) and Screening and Disinfection Facilities (SDFs). Both facilities provide screening and disinfection. The RTB provides dedicated settling within a retention basin. The SDFs provide contact time for disinfection within effluent conduits prior to discharge to the river. The effluent conduits are up to 1 mile long.

Table 4-1 presents key design criteria and general information for each facility.

4.2 Project Overview

This project consists of three main activities, which consist of the following:

- Asset Management Planning (Scheduled Replacement Plan)
- Performance Based Planning (Facilities Assessment)
- 20-Year Capital Improvement and Capital Outlay Planning

The three main activities and their relationship is demonstrated in Figure 4-1 and described in Sections 4.2.1 through 4.2.3.

Table 4-1. Key Design Criteria and General Information for GLWA’s CSO Facilities

	Baby Creek	Belle Isle	Conner Creek	Hubbell Southfield	Leib	Oakwood	Puritan-Fenkell	Seven Mile	St. Aubin
Facility Abbreviation	BC	BLI	CON	HS	LEIB	OKW	PF	SM	STA
Facility Type	SDF	RTB	RTB	RTB	SDF	RTB	RTB	RTB	SDF
Year of Startup	2005	2007	2005	1996	2002	2012	1996	1997	2002
Hydraulic Capacity (cfs)	5,100	33	13,963	3,200	2,000	1,660	845	655	310
River Level Basis for Hydraulic Capacity (Detroit Datum)	92.0	Not influenced by river elevation	97.5	102.0	Not influenced by river elevation	N/A	129.0	135.2	Documentation not found
Treatment Capacity ^a (cfs)	5,100	33	13,963/ 13,262 ^b	3,200/ 2,200 ^c	1,550	1,660	845	655	250
Storage Volume (MG)	3.0	0.3	30	22	9.9	9	2.8	2.2	2.4
Screen Type (size of slot or opening)	Perforated Plate (6-mm)	Perforated Plate (6-mm)	Bar Screen (1.5-inch)	Bar Screen (1.5-inch)	Raked Vertical and Horizontal Bar Screens (4-mm)	Perforated Plate (6-mm)	Bar Screen (0.5-inch)	Bar Screen (0.5-inch)	Raked Vertical Bar Screens (4-mm)
Disinfectant Type	Liquid Sodium Hypochlorite (NaOCl)								
Receiving Water Body	Rouge River	Detroit River	Detroit River	Rouge River	Detroit River	Rouge River	Rouge River	Rouge River	Detroit River

^a Treatment capacity refers to the design capacity of the screening and disinfection systems.
^b Based on Conner Creek Basis of Design report, the screening capacity is 13,963 cfs and disinfection capacity is 13,262 cfs.
^c Based on Hubbell Southfield O&M Manual, the disinfection capacity is 2,200 cfs. The screening capacity is not specifically listed and is assumed to be equal to the hydraulic capacity.

Notes:
cfs = cubic feet per second
MG = million gallon(s)
mm = millimeter(s)
N/A = not applicable
NaOCl = sodium hypochlorite
O&M = operation and maintenance

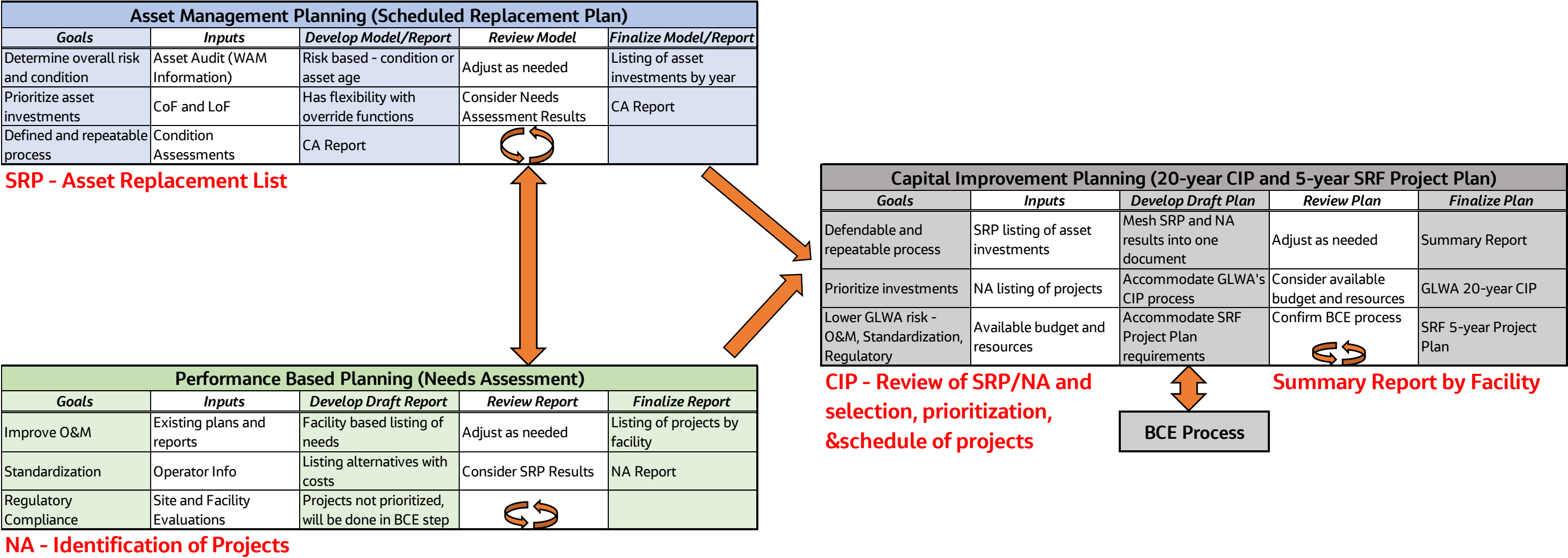


Figure 4-1. Relationship of Main Project Activities

4.2.1 Asset Management Planning (Scheduled Replacement Plan)

The Asset Management Planning (Scheduled Replacement Plan) is further described and the work was completed in Volume 3 – Asset Audit, Condition Assessment, FMEAs, and Scheduled Replacement Plan. This portion of the work focused on the existing GLWA CSO assets, populated asset information into GLWA's Computerized Maintenance Management System (CMMS) Oracle Work and Asset Management (WAM), gathered asset condition and depreciation information, and then utilized a mathematical model to determine when an asset should be replaced.

The Scheduled Replacement Plan (SRP) is an output of the SRP Model and is a listing of asset replacements and their costs over a 20-year planning period. The SRP utilizes the condition assessment results and asset information to calculate a scheduled replacement plan for each asset. The SRP information is then compared to the Facilities Assessment information to help make decisions on selection of Facilities Assessment alternatives, selected alternative implementation date, and possible bundling of alternatives into larger projects.

The SRP is strictly identifying when an asset should be replaced. This replacement is in-kind or with the current version, often the case of control systems. The SRP does not take into account future conditions such as regulatory change or increased/decreased flows. As shown in Figure 4-1, the SRP information is then coordinated with the Facilities Assessment to avoid duplication of budgets and to optimize bundling and scheduling of replacements and/or projects, while considering both existing and future asset needs.

The work completed in Volume 3 - Asset Audit, Condition Assessment, FMEAs, and Schedule Replacement Plan, specifically the SRP, is the first work completed within the overall CSO CS-299 project. This is the foundation of the condition and replacement of existing assets. This information will be pulled into Volume 2 – Facilities Assessment and used to optimize the overall delivery of existing asset replacement and Facilities Assessment projects. In this process, information in Volume 3 may become out of date if Volume 2 optimizes timing of the scheduled replacement of existing assets due to the Facilities Assessment. Therefore, Volume 3 information may not match the final information found in Volume 2.

4.2.2 Performance Based Planning (Facilities Assessment)

The Performance Based Planning (Facilities Assessment) is further described in this Volume 2 – Facilities Assessment. This portion of the work focuses on the current and future needs of the GLWA CSO Facilities such as improving Operations & Maintenance (O&M), increasing safety, standardizing equipment, anticipated flow requirements, and anticipated regulatory requirements.

Within the Facilities Assessment, site reviews of assets, interviews of O&M staff, and evaluation of current and reasonably anticipated future requirements of the CSO Facilities occurred. This resulted in a list of Facility Needs which should be addressed. Alternatives were developed to address these needs and generally include a Do Nothing alternative and one or more implementation alternatives. Each alternative was scored with non-economic benefit rankings and those benefits were compared to the Net Present Value (NPV) of the alternative. The NPV consists of the alternative's capital cost and annual operations and maintenance cost. The best value alternative consisted of the alternative with the lowest NPV/benefit ratio, which indicates the least amount of money required for the largest benefit.

Generally, the best value alternative was the selected alternative which moved on to Capital Improvement Plan (CIP) consideration. However, occasionally some alternatives had very similar NPV/benefit ratios or had external non-quantified benefits and therefore the best value alternative may not have been selected.

Once the Facilities Assessment alternatives were selected and a project identified, consideration of the accompanying assets from the SRP was completed. Some Facilities Assessment alternatives offered enhancements to existing assets or new assets and some alternatives offered replacement of existing assets. Therefore, consideration of the SRP was critical to avoid double budgeting of assets (replacement and needs) and to develop optimal bundling and scheduling of alternatives and projects to maximize the value of the existing assets. For example, the enhancement of a disinfection system should consider the condition of the existing disinfection system and, if appropriate, the enhancement implementation schedule should coincide with maximizing the life of the existing disinfection system.

The work completed in Volume 2 – Facilities Assessment, is the second phase of work completed with the overall CSO CS-299 project. This is the foundation of the facility performance needs and is impacted by the existing condition of assets and the scheduled replacement plan. Volume 2 – Facilities Assessment will optimize the facility needs and scheduled replacement plan and develop the 20-year CIP and 20-year Capital Outlay Plan on a Facility by Facility basis. This information will ultimately proceed to the Volume 1 – Project Information and Capital Improvement and Capital Outlay Plan.

4.2.3 20-Year Capital Improvement and Capital Outlay Planning

Following the development of the Facilities Assessment and SRP, individual CSO Facility 20-year CIPs and 20-year Capital Outlay Plans were created. This process is further described in this Volume 2 – Facilities Assessment report.

Projects for individual CSO Facilities were bundled and scheduled, and a 20-year CIP was developed. These nine 20-year CIPs are contained in this report in the following sections below. The intent of this report is to develop the nine individual CIPs.

Within the Facilities Assessment, a Capital Outlay Plan is developed for each CSO Facility. This plan was developed following the development of the specific CSO Facility CIP. Assets identified in the SRP, that are not being replaced in the Facilities Assessment selected alternatives, make it into the Capital Outlay Plan. Occasionally, a Facilities Assessment selected alternative may be of low complexity, low capital cost, and/or impacted with asset replacements and, therefore, may be included in the Capital Outlay Plan and not the CIP.

4.3 Purpose of Multi-Disciplinary Facilities Assessment

The purpose of this Multi-Disciplinary Facilities Assessment report is to document the identified improvements or needs at GLWA's nine CSO Control Facilities. A facility need is a required or desired improvement to meet current or anticipated changes to the CSO system such as regulatory requirements, hydraulic changes, health and safety, equipment standardization, and/or ease operation and maintenance (O&M).

Jacobs, in collaboration with GLWA staff, identified and evaluated these needs, developed total project capital costs, and provided information for needs prioritization through GLWA's business case evaluation process. The Facilities Assessment projects, along with projects from the Scheduled Replacement Plan (SRP), described further in the following section, will be incorporated into the CIP or Capital Outlay Plan.

4.4 Approach for Multi-Disciplinary Facilities Assessment

Jacobs Consultants, Inc (Jacobs) assembled a team of discipline-specific engineers to help identify and evaluate improvements at each CSO facility. The disciplines for this assessment included:

- Screening

- Disinfection
- Odor Control
- Flushing and Dewatering
- Heating, Ventilation, and Air Conditioning (HVAC) and Plumbing
- Electrical
- Instrumentation and Control (I&C)
- Site
- Architectural
- Safety
- Supporting Infrastructure
- Sanitary and Storm Pumping, if applicable

The needs were identified through the following activities:

- Review of the Wastewater Master Plan (WWMP) for any planned increased/decreased flows at each facility and the potential need for increased facility capacity or modified operation (i.e., RTBs converted to capture-only basins). The WWMP was completed by CDM Smith Inc. in 2020.
- Discipline-specific meetings with GLWA CSO O&M staff to obtain input on needs and issues within the facilities
- Observations during site visits by Jacobs team staff members
- Review of maintenance work orders from WAM
- Review of supervisory control and data acquisition (SCADA) data
- Review of original equipment manufacturer (OEM) condition assessments conducted under CS-299
- Projects to address the identified needs and issues were developed with two or more alternatives. The approach for alternatives evaluation is described in Section 4.7.

4.5 Organization of Multi-Disciplinary Facilities Assessment

The Multidisciplinary Facilities Assessment is organized by facility (in alphabetical order of facility name). The Facilities Assessment starts at Section 4. Section 4 provides the process overview for the Facilities Assessment and how the work was performed. Section 5 provides the evaluation of issues that are common to multiple facilities, such as standardized chemical feed system replacement. In an effort to reduce repetition, these issues are described once in this section and referred to in the facility-by-facility assessments, where applicable.

Sections 6 through 14 include the facility-by-facility assessment of needs. For each facility assessment, the needs are addressed by discipline in the order presented in Section 4.4.

4.6 Coordination with Scheduled Replacement Plan

In conjunction with the Multi-Disciplinary Facilities Assessment, Jacobs reviewed existing WAM data, as-built record drawings, O&M manuals, and met with GLWA O&M staff to identify assets, develop an asset hierarchy, and populate WAM with updated or new asset information. With current asset information established, GLWA and Jacobs collaboratively identified how condition assessments would be performed, either visually or detailed. The visual condition assessment was performed whether the asset was operating or not. Therefore, this was a less intensive condition assessment and a method commonly employed on lower risk assets. The detailed condition assessment was performed on operating assets and, depending on asset type, included such items as vibration, temperature, voltage, and amperage.

Jacobs performed onsite visual and detailed condition assessments of approximately 3,200 assets. This resulted in an asset condition score of 1 through 5, with 1 being nearly new and 5 being extremely poor or not operating. Utilizing the asset condition score, along with additional asset information such as useful life, install date, and replacement cost, Jacobs was able to calculate the asset's scheduled replacement.

The SRP consists of all the CSO assets and their calculated individual replacement date and costs. While a robust SRP following Asset Management best practices is highly important to balance asset risk and expenditures, the SRP process has a very limited ability to address future needs, such as those mentioned above and consisting of regulatory requirements, hydraulic changes, health and safety, equipment standardization, and/or ease O&M.

The SRP process and the Multi-Disciplinary Facilities Assessment report need to be coordinated to avoid excessive expenditures as well as balancing the upgrading of good condition assets. Once the Multi-Disciplinary Facilities Assessment projects are identified, projects that are directly impacting existing assets will be noted and linked to the asset. This will pull all information together so that GLWA staff and Jacobs can develop the prioritized projects for the CIP. For example, see Table 4-2, which demonstrates how decisions might be made based on the Facilities Assessment and SRP information.

Table 4-2. Example of Facilities Assessment and SRP Interaction

Facilities Assessment		Scheduled Replacement Plan		Recommendation
Description	Need Date	Condition	Replacement Date	
Project No. 1	2021	2	2035	Implement Facilities Assessment Project
Project No. 2	2025	5	2021	Implement SRP Project
Project No. 3	None Identified	3	2024	Implement SRP Project

The prioritization of the Facilities Assessment and SRP projects into the CIP may result in some assets in good condition being replaced early as in Project No. 1 above or some Facilities Assessment projects being implemented sooner based on corresponding poor condition assets such as in Project No. 2. The Facilities Assessment and SRP coordination process will be a manual and iterative process, however it is benefited by the work being completed concurrently.

Finally, Project No. 3 illustrates a project or asset that is not included in the Facilities Assessment and will ultimately be replaced as part of the SRP. As such, the intent of the Facilities Assessment is not to evaluate the replacement of every asset, especially those that will be replaced in-kind. Rather, the Facilities Assessment focuses on those needs associated with new regulatory requirements, hydraulic changes, health and safety, equipment standardization, and/or ease O&M.

4.7 Alternatives Evaluation Approach

Once needs were identified, projects were developed, and each project consisted of several types of alternatives for consideration:

- Do Nothing Alternative – replace existing assets in-kind or do not add enhancement assets
- Improvement Alternative – replace/improve existing assets with new technology or approach (includes standardization). This alternative is benefited by a comparison to the Do Nothing alternative which includes existing asset information.

- Improvement Alternative – enhance existing facility performance by adding new assets. This alternative is not benefited by a comparison to the Do Nothing alternative.

4.7.1 NPV/Benefit Ratio

To evaluate alternatives, a best value approach was established. This approach considers the non-economic benefit scoring of each alternative along with the economic Net Present Value (NPV) of each alternative. Then the ratio of NPV to benefit can be determined and an alternative with the lowest NPV/benefit ratio, is the best value alternative.

The non-economic benefits that were considered include:

- Benefit #1 – Health and Safety
- Benefit #2 - Water Quality and Compliance
- Benefit #3 – Capacity Enhancement
- Benefit #4 - Component Performance
- Benefit #5 - O&M Ease

These non-economic benefits were ranked on a scale of 1 to 5 for each benefit and each alternative, with the least benefit being 1 and greatest benefit being 5. When considering the benefit score, the actual number is not as important as the relationship of the scores between alternatives. For example, an alternative that has a significantly greater benefit should be scored accordingly with regards to other alternatives.

The NPV is determined by understanding the alternatives immediate capital cost along with the projected annual O&M cost. For several projects, the differential in O&M costs between alternatives is negligible so for simplicity, the alternatives did not include O&M costs in the NPV, as it would not change the results of the best value alternative.

This best value alternative works very well to defend and justify project alternative selections. However, occasionally additional external factors or the scale of the NPV versus the scale of the non-economic benefits do not align which results in the NPV/benefit ratio not being the best method of selecting an alternative. In those cases, engineering judgement and knowledge of the CSO facility and needs were utilized to select an alternative.

4.7.2 Do Nothing Alternative

Alternatives generally consisted of improvements to the facility but also considered a Do Nothing alternative. The Do Nothing alternative typically consists of pulling the SRP information for the existing assets associated with the Facilities Assessment project. This information contains total replacement costs of the associated assets. The Do Nothing alternative was then given benefit and NPV scores, and an NPV/benefit ratio was developed and considered against improvement alternatives.

Comparing the NPV/benefit ratios of the Do Nothing alternative against the improvement alternatives helped guide the selection of the best value alternative. In some cases, the improvement alternative was selected and, in some cases, the Do Nothing alternative.

Occasionally the Do Nothing alternative did not relate to existing assets as the project was based strictly on adding new assets. In these cases, the Do Nothing alternative did not have costs or an NPV/benefit ratio and, therefore, a best value alternative was not determined. However, the improvement alternative may have been selected when comparing its NPV/benefit ratio to other alternatives throughout this process and when considering external factors.

The SRP also pulls the information listed below (this information is pulled by assigning the Facilities Assessment project number, for example "BC-DIS-1", to the appropriate assets in the SRP):

- Total number of assets selected
- Maximum Consequence of Failure score of the selected assets
- Average Consequence of Failure score of the selected assets
- Maximum Condition Score of the selected assets
- Average Condition Score of the selected assets
- Maximum Risk Score of the selected assets
- Average Risk Score of the selected assets
- Average Life Expectancy of the selected assets
- Average Replacement Date (based on the condition score) of the selected assets
- Total Replacement Cost of the selected assets

The information listed above for the Do Nothing alternative is extremely helpful in determining the scheduling of projects. For example, when considering the standardization of a chemical feed system, the improvement alternative selected may suggest standardizing the chemical feed system. Then, when considering the asset information of the existing chemical feed system, it may be determined that the existing chemical feed system is projected to reach the end of its useful life in a few years and that time may be the optimal time for chemical feed system standardization.

4.7.3 Improvement Alternative

The improvement alternative typically consists of 1) replacing/improving existing assets with a new technology/ approach or 2) enhancement of the existing facility performance through the addition of new assets.

4.8 Capital Improvement Plan and Capital Outlay Plan Approach

The 20-year CIP and 20-year Capital Outlay Plan approach consists of projects for all nine CSO facilities that are to be debt financed (CIP) or revenue/cash financed (Capital Outlay). The CIP projects generally consists of improvements identified in the Facilities Assessment while the Capital Outlay Plan generally consists of the SRP assets.

4.8.1 Capital Improvement Plan Process Overview

The development of the 20-year CIP is based on the results of the Asset Audit, Asset Condition Assessments, SRP, and the Facilities Assessments. While all of this information influenced the development of the CIP, the greatest influencer is the Facilities Assessments and selected implementation alternatives.

Within the Facilities Assessment, site reviews of assets, interviews of O&M staff, and evaluation of current and reasonably anticipated future requirements of the CSO Facilities occurred. This resulted in a list of Facility Needs which should be addressed. Alternatives were developed to address these needs and generally include a Do Nothing alternative and one or more implementation alternatives. Each alternative was scored with non-economic benefit rankings and those benefits were compared to the Net Present Value (NPV) of the alternative. The NPV consists of the alternative's capital cost and annual O&M cost. The best value alternative consisted of the alternative with the lowest NPV/benefit ratio, which indicates the least amount of money required for the largest benefit.

Generally, the best value alternative was the selected alternative which moved on to CIP consideration. However, occasionally some alternatives had very similar NPV/benefit ratios or had external non-quantified benefits and therefore the best value alternative may not have been selected.

Once the Facilities Assessment alternatives were selected and a project identified, consideration of the accompanying assets from the SRP was completed. Some Facilities Assessment alternatives offered enhancements to existing assets or new assets and some alternatives offered replacement of existing assets. Therefore, consideration of the SRP was critical to avoid double budgeting of assets (replacement and needs) and to develop optimal bundling and scheduling of alternatives and projects to maximize the value of the existing assets. For example, the enhancement of a disinfection system should consider the condition of the existing disinfection system and, if appropriate, the enhancement implementation schedule should coincide with maximizing the life of the existing disinfection system.

4.8.2 Capital Outlay Plan Process Overview

The development of the 20-year Capital Outlay Plan is based on the results of the Asset Audit, Asset Condition Assessments, SRP, and the Facilities Assessments. While all of this information influenced the development of the Capital Outlay Plan, the greatest influencer is the SRP.

Within the Facilities Assessment, a Capital Outlay Plan was developed for each CSO Facility. This plan was developed following the development of the specific CSO Facility CIP. Assets identified in the SRP, that are not being replaced in the Facilities Assessment selected alternatives, make it into the Capital Outlay Plan. Occasionally, a Facilities Assessment selected alternative may be of low complexity, low capital cost, and/or impacted with asset replacements and therefore may be included in the Capital Outlay Plan and not the CIP.

4.9 Capital Cost Estimating Approach

Capital cost estimates were developed for capital improvement projects presented in this Facilities Assessment and for SRP projects (i.e., replace in-kind).

4.9.1 Capital Improvement Project Costs

Capital improvement projects represent those projects that would likely require design and construction assistance by a Professional Engineer and installation/construction by a Contractor. Capital cost estimates (included in Volume 6 – Appendices, Appendix C for all Facilities Assessment projects) used a uniform template with individual construction costs for major components of the project and then typical percentages for planning, design services, services during construction, additional project costs for the contractor, and design and construction contingencies. The total cost presented for each project represents a Total Project Cost. A summary of the cost categories and the associated source of costs is included in Table 4-3.

Table 4-3. Cost Categories for Capital Cost Estimating

Cost Category	Description	Method for Cost Generation
Project Definition, Planning and Preliminary Design	Represents costs for professional services to develop the project definition, planning and preliminary design concepts. Typically, this information would be used in development of the Design Services procurement documents. Budget for this scope is provided for every project, however GLWA staff may choose to complete this scope internally at minimal cost.	5% of Total Construction Cost

Cost Category	Description	Method for Cost Generation
Design Services	Represents costs for professional design services to produce contract documents that can be bid by a Contractor.	The cost of this service is based on a percentage inversely proportional to the total construction cost, with a higher percentage for lower cost projects and a lower percentage for higher cost projects.
Non-Construction Contingency	Contingency for the design phase to include unforeseen issues that need to be included in the design or be evaluated during design.	15% of Total Construction Cost for most projects.
Services During Construction	Represents costs for professional services that are not covered by GLWA staff to provide construction administration services, including submittal reviews, Requests for Information (RFIs), field inspection, material testing, etc.	Similar to Design Services, the cost of this service is based on a percentage inversely proportional to the total construction cost with a higher percentage for lower cost projects and a lower percentage for higher cost projects.
Total Construction Cost	Represents the cost for a Contractor to perform the work, assuming a Design/Bid/Build type of project delivery.	Sum of Project Cost of Work and Additional Project Cost for Construction.
Project Cost of Work	This cost represents the costs for the material, labor, and equipment to construct the scope of work.	Based on vendor quotes, Jacobs construction cost estimating software, and experience.
Additional Project Cost for Construction	Represents the additional costs of the Contractor to manage and deliver the scope of work. Also includes Construction Contingency based on Final Design.	- Contractor Overhead – 8% (of Project Cost of Work, typical for all costs in this category) - Contractor Profit – 5% - General Conditions – 10% - Mobilization/Demobilization – 5% - Insurance – 2% - Performance Bond General – 1% - Performance Bond Electrical – 1%
Construction Contingency Based on Final Design	Contingency (30% for most projects) to cover ancillary items not included in the line item costs and unforeseen conditions that are not known in the project planning phase.	30% of Project Cost of Work for most projects
Total Project Cost		Sum of the Project Definition, Planning & Preliminary Design, Design Services, Services During Construction and the Total Construction Costs

The Total Project Costs represent Class 4 estimates, as defined by the Association for the Advancement of Cost Engineering (AACE) International. The expected range of costs is -30% and +50% from the median value. It should be noted that in providing opinions of cost for projects, Jacobs has no control over performance of third party engineers/contractors; cost or price of labor and materials; unknown or latent conditions of existing equipment or structures that may affect operation or maintenance costs; competitive bidding procedures and market conditions; time or quality of performance by operating personnel or third parties; and other economic and operational factors that may materially affect the ultimate project cost or schedule. Therefore, Jacobs makes no warranty that the actual project costs will not vary from Jacobs opinions or estimates of cost.

4.9.2 Scheduled Replacement Plan Asset Replacement Costs

Replacement costs are provided for every asset in the CSO WAM database. These costs are used to provide capital costs in the SRP. The costs are intended to represent installed costs for the in-kind (or latest version) replacement of each asset. To populate these costs, Jacobs used previously generated costs from the 2013 SRP project (inflated to 2021 dollars), which included costs from Schedule of Values from the original construction project for the CSO basins. Where costs were not available, Jacobs obtained costs from construction cost estimating software or vendor quotes. Table 4-4 provides the mark-ups applied to the unit costs to generate the total replacement cost for each asset.

Table 4-4. Cost Categories for SRP Replacement Costs

Cost Category	Method of Cost Generation
Replacement Cost (including installation)	Previous SRP Replacement costs (inflated to 2021 dollars), construction cost estimating software, and vendor quotes
Engineering and Contingency	30% of replacement cost
Contractor Overhead and Profit	15% of replacement cost

5. Common Needs Among Multiple Facilities

5.1 Introduction

This section provides the evaluation of needs that are common or similar among multiple or all facilities. Disciplines with common needs include Disinfection, Electrical, Instrumentation and Controls (I&C), Structural, and Safety. To reduce repetition, these issues are described once in this section and referred to in the facility-by-facility assessments, where applicable. The review of past Maintenance Work Orders for all assets is included at the end of this section.

5.2 Disinfection

5.2.1 Overview and Review of Current Disinfection Performance

This section describes needs related to disinfection that are common among multiple facilities. Common needs for the disinfection systems at each facility include:

- 1) Replacement of Chemical Feed Systems
- 2) Provide Flow-Paced and Total Residual Chlorine (TRC)-Paced Automatic Chemical Feed
- 3) Reduce Costs Associated with Large Quantity of Chemical Induction Mixers

Table 5-1 provides a summary of the disinfection system at each CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G. Table 5-2 provides a summary of the sodium hypochlorite pumps and capacities at each facility.

Table 5-1. Overview of Disinfection Systems

Facility	Type	Install Date	Disinfection System Design Storm Flow (cfs)	Disinfectant Used	Design Feed Strength (% Hypo.)	Max. Dosage at Design Flow (mg/L Cl ₂)	No. of Storage Tanks	Total Vol. of Storage Tanks (gal)	Storage Tank Material	Type of Mixing at Feed Point	Contact Time (min)	No. of Mixers	Model Number/ hp	Manufacturer
Baby Creek	SDF	2006	5,100	Sodium hypochlorite	5	20	4	144,000	Rubber-lined steel	Chemical induction mixers	10	32	SWC15XPL 15 hp	Water Champ
Belle Isle	RTB	2007	33	Sodium hypochlorite	6-8	25	2	2,668	FRP	Chemical induction mixers	10	4	SWC15XP 15 hp	Water Champ
Conner Creek	RTB	2005	13,262	Sodium hypochlorite	10	25	4	380,000	Rubber-lined steel	Chemical induction mixers	5	60	SWC20XP 20 hp	Water Champ
Hubbell-Southfield	RTB	1996	2,200	Sodium hypochlorite	5	10	2	30,000	FRP	Chemical induction mixers	20	3	Series 32 25 hp	Gas Mastrrr
Leib	SDF	2002	1,550	Sodium hypochlorite	7.5	38	2	20,900	FRP	Chemical induction mixers	10	18	SWC15FX 15 hp	Water Champ
Oakwood	RTB	2012	1,660	Sodium hypochlorite	7.5	12	2	23,000	FRP	Diffuser ring	6 w/ 1 basin, 12 w/ 2 basins in service	Hypo added to pump discharge	N/A	N/A
Puritan-Fenkell	RTB	1996	845	Sodium hypochlorite	5	10 @ 845 cfs	2	8,000	FRP	Chemical induction mixers	20	2	SWC5R 5 hp	Water Champ
Seven Mile	RTB	1996	655	Sodium hypochlorite	5	10 @ 655 cfs	2	4,800	FRP	Chemical induction mixers	30	1	Series 32 10 hp	Gas Mastrrr
St. Aubin	SDF	2002	250	Sodium hypochlorite	10	38	2	10,400	FRP	Chemical induction mixers	10	7	SWC7.5FX 7.5 hp	Water Champ

Notes:
% = percent
Cl₂ = chlorine
FRP = fiber-reinforced plastic
hp = horsepower
mg/L = milligram(s) per liter

Table 5-2. Hypochlorite Pump Summary

Facility	Disinfection System Design Storm Flow (cfs)	No. of Pumps	Type of Pump	Capacity of Pump (gpm)	Manufacturer	Drive Type
Baby Creek	5,100	8 Total 2 low-rate 3 mid-rate 3 high-rate	Centrifugal	Low-rate: 0-50 Mid-rate: 0-150 High-rate: 0-400	Corcoran	VFD
Belle Isle	33	3	Diaphragm	10.4	Milton Roy	Adjustable stroke length and speed
Conner Creek	13,262	10	Centrifugal, magnetic drive	197	ITT Goulds Company	Constant speed
Hubbell-Southfield	2,200	5	Gear	10-55	Pulsafeeder (w/ standard coupler/drive)	VFD
Leib	1,550	8 Total 6 low-rate 2 high-rate	Low-rate: Diaphragm High-rate: Centrifugal	Low-rate: 7.6 High-rate: 112	Low-rate: Pulsa Series High-rate: Goulds	VFD
Oakwood	1,660	10 (3 low-rate, 7 high-rate)	Gear	Low-rate: 0-26 High-rate: 1.0-51	Pulsafeeder (with magnetic coupler/drive)	VFD
Puritan-Fenkell	845	4	Gear	20	Liquiflo	VFD
Seven Mile	655	4	Gear	20	Pulsafeeder (w/ standard coupler/drive)	VFD
St. Aubin	250	5 (2 low-rate, 3 high-rate)	Hydraulic diaphragm	Low-rate: 7.6 High-rate: 22.8	Pulsafeeder	VFD

Notes:
gpm = gallon(s) per minute
VFD = variable-frequency drive

NPDES Permit Requirements: The NPDES Permit No. M10022802 contains limits for fecal coliform and goals for TRC for all the CSO facility discharges. The permit specifies event maximum limits for fecal coliform bacteria of 400 counts (cts)/100 milliliter (mL) during the summer and 1000 cts/100 mL during the winter. The event maximum is reported as the geometric mean of all samples taken during an event, provided that three or more samples are collected.

The goals for TRC minimization are to "...operate the CSO retention treatment basins and CSO screening and disinfection facilities in a manner which will provide consistent, effective disinfection while minimizing the discharge of TRC...". The permit specifies operation goals for effluent TRC concentrations of 1.5 mg/L as an event average value and 2.0 mg/L (November 1 – April 30 or "winter") or 3.0 mg/L (May 1 – October 31 or "summer") as event instantaneous maximum values.

The permit defines that an "event" starts when combined sewage is discharged into a facility and ends when effluent flow ceases and does not resume within 24 hours. During an event, grab samples for effluent fecal coliform and TRC are collected every two hours for the first six hours of the discharge and every four hours thereafter for the duration of the discharge. For TRC, the average of all samples in an event is the "Event Average" and the maximum individual sample in an event is the "Event Maximum". On multiday events, the pollutant concentrations for the event are reported on the day the discharge event ends.

Historical Facility Disinfection Performance: Historical facility performance related to disinfection performance from 2016 through 2018 is presented in Volume 6 – Appendices, Appendix D. There are two graphs for each facility:

- 1) Daily Maximum Effluent TRC concentrations
- 2) Effluent Fecal Coliform and Average TRC concentrations

Effluent performance was assessed by comparing the reported event geometric mean fecal coliform concentrations to permit limits and the reported maximum and average TRC measurements to the permit operation goals. Upon review of the TRC data, it was apparent that the measurements were *daily* average and maximum measurements, rather than *event* average and maximum values. Additionally, there were several instances when the recorded maximum TRC value was less than the recorded average TRC value. In such cases, the dataset provided was checked against the Daily Monitoring Reports submitted to Environment, Great Lakes, and Energy (EGLE), and it was determined that the recorded values were simply switched. These errors were corrected by listing the greater value as the daily maximum measurement and the lesser value as the daily average measurement.

A summary of the findings and observations from this evaluation are provided in the following list:

- 1) The fecal coliform limit is typically met for every event, with a few exceptions. The facilities exceeding the limits and the corresponding number of times were as follows: Conner Creek (1), Leib (1), St. Aubin (2), and Baby Creek (2).
- 2) The summer and winter maximum effluent TRC goals of 2 and 3 mg/L are typically met. The SDFs appear to have slightly higher maximum values than the RTBs.
- 3) The operational goal for average TRC of 1.5 mg/L is typically exceeded for all facilities that discharge. This is likely due to the variable nature of CSO influent water quality, the fact that the operators first priority is to achieve permit compliance for fecal coliform, and the lack of automated chemical feed pacing.
- 4) There was no discharge from Puritan-Fenkell or Seven Mile during this period, therefore, the figures indicate "No Data Collected."

5.2.2 Replace Chemical Feed System

5.2.2.1 Introduction

Based on GLWA personnel input and observations during the site visits, the chemical feed systems at most of the facilities are in need of replacement to address one or more of the following:

- Replace aging, unreliable, and/or expensive to maintain chemical feed pumps and mixers
- Address inaccessible valves and appurtenances due to overly complex flow distribution schemes, and poorly laid out piping
- Increase turndown to not overdose during the more typical storm events while providing capacity for the infrequent peak instantaneous design storm flows
- Simplify the chemical feed system to improve manual operations should automated components be unavailable
- Ensure appropriate flow splitting to multiple mixers and diffusers in a given mixing zone including:
 - Replace old and unreliable back pressure valves to each mixer and diffuser
 - Provide a means of measuring pressure to verify back pressure valves are functioning properly and set equally
 - Provide flow indication for visual verification that flow is occurring to each location.

Additional facility specific needs are discussed in the facility-by-facility evaluation in the following sections. The evaluation and identification of chemical feed system alternatives for each facility are presented here and referenced in the facility-by-facility section because this section applies to most facilities.

5.2.2.2 Chemical Feed System Sizing

Based on GLWA observations and historical storm events, the chemical feed systems are generally oversized. The conservative sizing of chemical feed pump capacities is a result of the original facility design storm flows being greater than what has been observed as well as conservative assumptions on the required chlorine dose to meet permit fecal coliform requirements. Turndown of the oversized chemical feed system is exacerbated at Conner Creek where reliability issues with isolation gates results in flow being distributed across all bays regardless of how small the wet weather event is. The lack of isolation gates into the mixing zones results in a similar situation at Leib. Oversized chemical feed systems make it difficult to control dosing during smaller events. This increases the risk of exceeding the operational goals for TRC. Relevant information from past CSO facility studies was considered for sizing the chemical feed pumps for purposes of developing a capital cost budget.

The CSO facilities were originally designed based on modeled peak flow for a 10-year recurrence, 1-hour rainfall. Although continuous flow measurement records are not available, the design capacity at most or all of the facilities has never been reached based on available flow data and observations by GLWA personnel. Collection system modeling tools have improved since the modeling used for the design of these facilities. The most recent design storm results were obtained from the December 2019 Existing Conditions version of the Regional Wastewater Collection System model developed for the 2019 GLWA WWMP. The current predicted 10-year, 1-hour storm flows and the ratio of those flows as a percent of the original design flows are presented in Table 5-3.

Table 5-3. Comparison of Original and Current Predicted CSO Facility Design Storm Peak Flow Rates (10-Year, 1-Hour Flow Rates)

Facility	BC	BLI	CON	HS	Leib	OKW	PF	SM	STA
Original Predicted Facility Design Storm Peak Flow (cfs)	5,100	33	13,262	3,000 ^a	1,550	1,660	655 ^a	493 ^a	250
Current Predicted Facility Design Storm Peak Flow (cfs)	1,661	37	2,569	1,501	194	475	136	82	235
Ratio of Current to Originally Predicted Storm Flows (%)	33%	111%	19%	Not a comparable storm comparison	13%	29%	Not a comparable storm comparison	Not a comparable storm comparison	94%

^a The O&M manual provides the "10-year" Design Flow for 3.5 inch storm. It is assumed this is the 10-year, 24-hour storm event, since the 10-year, 1-hour storm is about 1.8 inches.

For the larger facilities with comparable design storms (i.e., Baby Creek, Conner Creek, Leib, and Oakwood) the predicted flows are less than half what was predicted for the same storm event when the facilities were designed. The generally lower flow predictions are partially explainable by:

- Recently modeled flows are in terms of peak hour while the original modeled flows were a shorter time increment
- The percent imperviousness of many of the service areas has decreased, thus contributing to less runoff
- More conservative assumptions in the original model

However, two concerns prevent revising the chemical feed system sizing based on the recent 10-year 1-hour modeling as follows:

- 1) There have been issues calibrating the model predicted flows to actual measured flows from storm events
- 2) The model predicted flows are less than past observed peak hour flows

At Conner Creek, which is the largest facility, the recently modeled 10-year 1-hour flow is only 19 percent of the original modeled flow. This would indicate that the facility is significantly oversized. However, the WWMP evaluated the flow distribution of 78 storms, 25 from 2005 to January of 2008 from the "Conner Creek CSO Basin Final Evaluation Report", and 53 from 2010 to 2014 discharge records, and found the peak flow at Conner Creek was 8,600 cfs and the average peak flow was 2,600 cfs. Thus, the modeled peak 10-year 1-hour event of 2,569 cfs was essentially equal to the average peak flow and significantly less than the historical peak from the 78 storms analyzed. The 8,600 cfs peak flow identified in the WWMP corresponds to 65 percent of the facility's design capacity. Based on the years analyzed, it would appear that the original design capacity of Conner Creek is overly conservative. However, the more recent modeled peak 10-year 1-hour flow does not appear to be conservative enough. Unfortunately, complete flow data is not available for the last 10 years at the CSO facilities to allow evaluation of the peak 10-year flow. Due to the absence of historical data and the fact that the recently modeled 10-year 1-hour event does not appear sufficiently conservative for design of disinfection facilities, the original facility design capacities will be used for sizing the chemical feed systems for capital budgeting. As additional flow data

becomes available with upgrades to flow measurement and recording, more modeling calibrated to actual flows could be considered during design to avoid oversizing the chemical feed system.

The selected design dose is also important to chemical feed system sizing. The original design doses vary from 10 mg/L as Cl_2 to 38 mg/L between CSO facilities. Experience at other CSO facilities indicates that the high doses assumed at some facilities are overly conservative considering both the improbability of needing the peak dose concurrent with peak flow when fecal coliform concentrations are likely diluted, and test data that would indicate diminishing disinfection benefits above certain doses.

For this evaluation under CS-299, a dose of 20 mg/L was assumed for all facilities except St. Aubin. A dose of 25 mg/L was assumed for St. Aubin because this facility had the highest average dose for the four largest storms evaluated from 2016 through 2018 and because a relatively recent report by another consultant assumed 24 mg/L. However, it is suspected that the higher dosing at St. Aubin was a result of turndown issues and lack of an automated control system and thus conservative. In addition, planning and budgeting for St. Aubin's disinfection system is not required because there is an ongoing design by another consultant at St. Aubin. Therefore, dosing requirements at St. Aubin are not further evaluated in this Facilities Assessment. The dose assumptions are believed to be sufficiently conservative for sizing the chemical feed systems for capital budgeting, especially when used in conjunction with the design peak flow rate. It may be appropriate to assume less conservative doses during design because oversizing the chemical feed system can lead to turndown issues for typical storm events.

The third most significant factor affecting chemical feed system sizing is the sodium hypochlorite strength. The sodium hypochlorite strength can vary either due to degradation or intentional dilution of a new delivery of sodium hypochlorite done to slow the degradation of sodium hypochlorite. The degradation of sodium hypochlorite is unique compared to most other chemicals used in wastewater treatment. The lower the sodium hypochlorite strength the larger the chemical feed system needs to be. The sodium hypochlorite strength is important because twice the feed rate is required for the same TRC if the sodium hypochlorite has degraded from 10 percent to 5 percent. An evaluation of sodium hypochlorite strength reported in recent years for the CSO facilities indicates that the strength has dropped to as low as 2 to 3 percent for all facilities that data was available, except Conner Creek. At Conner Creek the lowest reported strength was 5 percent. The hypochlorite strength has such a significant impact on sizing the chemical feed system that it is important to develop and abide by a policy of replacing the hypochlorite when the strength drops below a certain value. Depending on the quantity stored, this may be achieved by ordering a new delivery and mixing the low strength hypochlorite with the new full strength (e.g., typically on the order of 12.5 percent) hypochlorite. However, if the volume stored will excessively reduce the strength of a new delivery it would be necessary to dispose of the excess hypochlorite. Careful management of hypochlorite can be practiced to minimize the latter. For this evaluation under CS-299, a value of 5 percent was assumed as the minimum strength that sodium hypochlorite would be managed to for sizing the chemical feed pumps for purposes of developing a capital cost budget.

The assumed pump sizing is dependent on the sodium hypochlorite distribution approach and is thus presented in Section 5.2.2.4.

5.2.2.3 Chemical Feed System Pump Type

It is recommended that the existing pumps be replaced with either hose pumps (referred to as peristaltic pumps for smaller sizes) or magnetic drive centrifugal pumps. The advantages and disadvantages of these two types of pumps are noted in the following paragraphs. The final decision between the recommended types of pumps shall be determined during design. The preferred type of pump may also depend on what alternative is selected for flow distribution of sodium hypochlorite.

Hose Pumps: The advantages of hose pumps are listed in the following bullets:

- High turndown: With a totally enclosed non-ventilated motor and 60:1 variable-frequency drive (VFD), the hose pump maximum and minimum acceptable revolutions per minute (rpms) become the limiting factor. Higher than 20:1 turn down can be achieved by designing around atypically high rpms for the design peak flow storm events if this condition is expected to be rare. Turndowns on the order of the 60:1 VFD turndown may be possible by this approach.
- Positive displacement for accurate and repeatable metering
- Self-priming and suction lift capability of up to 30 ft thereby allowing full tank drawdown and allowing the pumps to be elevated on pads for spill protection
- Can pump air during priming, and sodium hypochlorite off-gassing will not bind the pump
- Hoses readily available for sodium hypochlorite (common application)
- No seals, diaphragms, glands, or exposed components to leak, corrode, or replace
- Eliminates need for check valves, seal water flush systems, and run-dry protection
- Standard parts (hose, bearings) for rehab

The disadvantages of hose pumps are listed in the following bullets:

- Higher initial cost than some other pumps
- Requires hose replacement
- Requires pulsation dampener which GLWA has had O&M issues with elsewhere
- If a hose wears through or bursts before replacement, then components of the pump will be exposed to the corrosive sodium hypochlorite
- Requires bumping the pumps per manufacturer's suggested schedule when idle (i.e., during dry weather and spare pumps) because the rollers compressing a fixed point of the hose for an extended period of time reduces hose life

The largest hose pump offered by Bredel is rated for 317 gallons per minute (gpm) continuous duty.

Magnetic Drive Centrifugal Pumps: The advantages of magnetic drive centrifugal pumps are listed in the following bullets:

- Generally lower initial cost than most pumps suitable for sodium hypochlorite
- Smaller footprint for the capacity than most pumps suitable for sodium hypochlorite
- Magnetic drive eliminates seals and leaks from drive shaft
- Centrifugal pumps are generally low maintenance
- GLWA has favorable experience using this type of pump at Conner Creek
- Eliminates need for pulsation dampeners
- Depending on the flow and head condition, higher capacities generally available compared to hose pumps

The disadvantages of magnetic drive centrifugal pumps are listed in the following bullets:

- Significantly less turndown than a positive displacement pump. This can result in the need for more pumps and potentially pumps of different sizes to cover the required range of flows.

- Not self-priming and less suction lift capability than a positive displacement pump. Therefore, these pumps cannot be elevated above the bottom of the tank as much as self-priming pumps for spill protection, and these pumps may not be able to draw a tank down to empty without supplemental priming provisions. The latter issue adds components and complexity and may decrease reliability. Although there are some self-priming models available, there are far fewer offerings than the standard non-self-priming sizes to cover the required range of flow and head conditions.
- Requires some appurtenances not required with a hose pump (e.g., check valves).
- Cannot run dry.
- Possibility of cavitation.

5.2.2.4 Sodium Hypochlorite Distribution Approach

In conjunction with pump replacement, it is recommended that the piping be replaced, and that the new piping be simplified compared to the current arrangement. Reasons for piping replacement include overly complex piping layouts, inaccessible valves and appurtenances, and failing joints in some facilities (e.g., Baby Creek). It is recommended that piping to and from the pumps be as simple as possible while maintaining necessary flexibility. Adding additional flexibility that is unlikely to be used adds complexity including additional valves to be exercised, the need for additional pressure relief valves wherever sodium hypochlorite off-gas could be trapped and can result in inaccessibility of components which is a common problem at the GLWA facilities. It is recommended that these points be carefully considered as the details of the piping are determined during design. A standardized pump per mixing zone or a standardized manifold approach is recommended for all GLWA CSO facilities. The final decision between the recommended options for sodium hypochlorite distribution should be determined during design considering the advantages and disadvantages. Two recommended options and piping arrangements are presented in the following paragraphs.

Option 1—Standardized Pump Distribution

This option would consist of utilizing a positive displacement pump for each mixing zone. The recommended type of positive displacement pump for this option is a hose pump (or peristaltic pump for smaller capacities) because of the advantages noted in Section 5.2.2.3. Each pump would require a VFD to adjust the dose in response to varying storm flows and chlorine demands. Each pump would pump to one mixing zone. One spare pump, or more if desired, is recommended with a tie-in to each primary pump to provide redundancy to each mixing zone without significantly increasing the complexity of the piping. The proposed configuration is illustrated in Figure 5-1.

Flow to each mixing zone would be split between mixers using back pressure valves. New back pressure valves are recommended to split the flow between injection points (e.g., mixers and or diffusers). A setting of 15 pounds per square inch gauge (psig) is recommended by Evoqua for Water Champ induction mixers. A pressure tap is recommended upstream of each back pressure valve to allow a calibrated pressure gauge to be moved between these taps to allow verification that each back pressure valve is set equally and to adjust the back pressure valve setting if not. A flow meter is also recommended to further verify equal flow splitting and to allow calculation of total flow rate to that mixing zone. Minimization of mixers and feed points is recommended as discussed herein to reduce the number of flow splits with back pressure valves, flow meters, and pressure gauge taps.

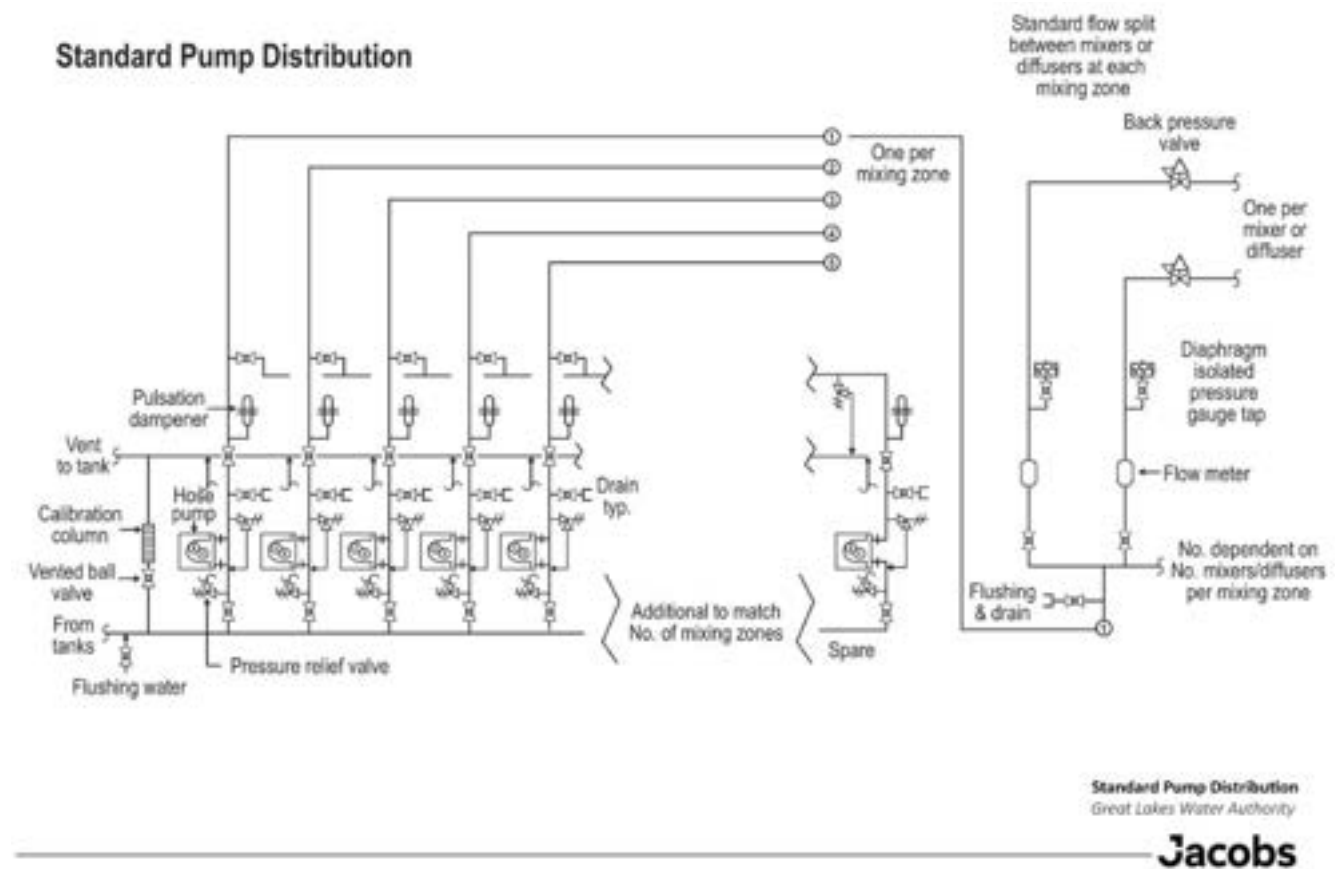


Figure 5-1. Standardized Pump Distribution

The advantages and disadvantages of this option are as follows:

Advantages:

- Simple and reliable control strategy with linear relationship between the pump speed and pump output (not reliant on flow meters due to the predictable speed vs. output relationship).
- Proven common approach for chemical dosing that will meet the permit requirements at each facility.
- Higher turndown ability than manifold option. Turndown ability is based on pump capabilities and not limited by instrumentation.
- If automated mode is not functional then manual mode would consist of manual pump speed adjustment for each pump in response to changing storm flow and TRC measurement.

Disadvantages:

- Higher number of pumps
 - Higher capital cost
 - Greater floor space required
 - More maintenance because pumps are higher maintenance than actuators in the manifold option
 - More equipment that could fail
 - More operations of equipment

Option 2 - Standardized Manifold Distribution

This option would be expected to allow a reduced number of pumps at facilities with a large number of mixing zones and would consist of the following: One or more pumps would pump to a manifold. Each pump would be controlled by a VFD. The pumps could be magnetic drive centrifugal or hose pumps. There would be one branch from the manifold for each mixing zone plus a spare connected to each to provide the same redundancy as the spare pump in Option 1. Every mixing zone would have its own flow meter and flow control valve. There would be a modulating pressure control valve on a recycle loop downstream of the manifold that is controlled to a pressure setpoint to ensure sufficient pressure to split flow in the manifold. The pumping rate is set sufficiently in excess of the desired sum of the feed rates to all feed points. Flow in excess of that distributed through the manifold is recycled to the feed pump suction header. The proposed configuration is illustrated in Figure 5-2.

Standard Manifold Distribution

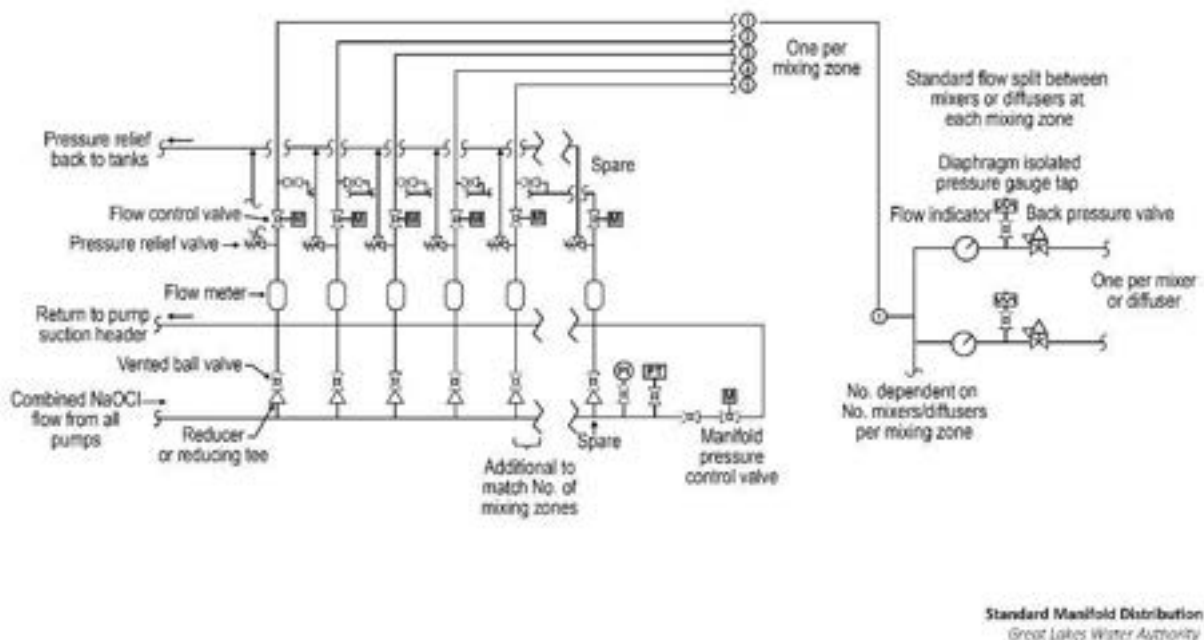


Figure 5-2. Standardized Manifold Distribution

Flow to each mixing zone would be split the same as Option 1, except given there will be a magnetic meter to each mixing zone the flow meters to each mixer or diffuser need not be sophisticated nor connected to SCADA. Therefore, a rudimentary visual flow indicator is recommended upstream of each back pressure valve. The flow indicators will allow a visual confirmation that hypochlorite is being provided to each location and an indication of equal flow splitting. Minimization of mixers and feed points is recommended as discussed herein to reduce the number of flow splits with back pressure valves, flow meters, and pressure gauge taps.

The advantages and disadvantages of this option are as follows:

Advantages:

- Minimizes number of pumps
- Proven approach to flow splitting.
 - Similar design by author has been in operation since the early 1990s at a WRRF.
 - There are many large WRRFs using a large number of flow control valve (FCV)/flow meter combinations to split air between aeration grids and multiple parallel aeration basins based on dissolved oxygen monitoring.
- A low number of pumps, and a flow control valve and flow meter combination per mixing zone, typically will have a lower capital and maintenance cost than a dedicated pump per mixing zone.
- Similar redundancy to a spare pump can be achieved with a spare branch from the manifold that ties into the discharge to each mixing zone from the manifold.

Disadvantages:

- Will require utilization of the number of mixing zones to match the storm flows. For example, a small storm event needs to be contained in one mixing zone while the peak storm event can utilize all mixing zones. This will ease the turndown requirements of the control instrumentation and the overall system.
- Lower turndown than possible with a dedicated peristaltic/hose pump approach. Minimum turndown of at least 16:1 and possibly as high as 26:1 per mixing zone.
 - The estimated maximum achievable turndown is based on a maximum allowable velocity of 8 ft/sec through a pipe and magnetic meter. Above this, noise and potential for cavitation in the flow control valve can become problematic.
 - The estimated maximum achievable turndown is based on a minimum velocity of 0.3 to 0.5 ft/sec. Below this, flow measurement can drop off to zero in magnetic meters and thus not be reliable.
 - Accommodating the required turndown from the infrequent design peak storm capacity to the more typical storm events could be problematic. The acceptability of the maximum achievable turndowns with this approach should be compared to ratios of peak design storm capacity to historical flows for each facility considering this approach.
- Must properly tune actuators at startup for steady valve operation.
- Even with well-tuned actuators, the valves must adjust frequently during a storm event to rapidly changing flows and chlorine demands, and to the influence of adjacent valves that are changing position.
- The pipe sizes required will result in small valves with large and heavy actuators that must be independently supported (i.e., pipe supports for the actuators).
- Must maintain multiple modulating actuators.
- If automated mode is not functional then manual mode would consist of manually adjusting the position of each of the flow control valves in response to changing storm flow and chlorine residual measurement, verifying adequacy and changing as necessary the pumping rate (but fewer pumps than the dedicated pump per mixing zone option), and verifying adequacy and changing as necessary the pressure control valve position to maintain sufficient pressure in the distribution manifold.

- Failure of the pressure control valve actuator would require manual valve adjustment that must be monitored and adjusted as necessary as the storm flow varies.
- Although not a high likelihood of failure, there is more length of common header piping than the dedicated pump option. This is because the hypochlorite is in a common header not only to the pumps but from the pumps to the manifold and on the return loop downstream of the pressure control valve. This common header length can be minimized by locating the manifold in the pump room. A failure in a common header would disrupt disinfection everywhere.

5.2.2.5 Pump Sizing for Capital Budgeting

As discussed herein, the original facility's design peak flow, an assumed dose of 20 mg/L chlorine for all but St. Aubin, and an assumed minimum sodium hypochlorite solution strength of 5 percent was assumed to size chemical feed pumps at each facility for soliciting budgetary pricing from the leading manufacturer of hose pumps for the two recommended options for feed distribution, as shown in Table 5-4 and Table 5-5.

Table 5-4. Option 1 – Pump Sizing for Standardized Pump Distribution

Facility	BC	BLI	CON	HS	Leib	OKW	PF	STA
Number of Prechlorination Pumps	0	0	0	0	1	0	2	1
Size of Each Prechlorination Pumps (gpm)	N/A	N/A	N/A	N/A	100	N/A	24	30
Number of Mixing Zone Pumps (includes one spare)	9	3	11	5	5	9	3	3
Size of Each Mixing Zone Pumps (gpm)	95	2	197	70	58	31	24	23

Table 5-5. Option 2- Pump Sizing for Standardized Manifold Distribution Using Hose Pumps

Facility	BC	BLI	CON	HS	Leib	OKW	PF	STA
Total Number of Pumps (includes one spare)	4	2	8	3	3	3	2	2
Size of Pumps (gpm)	253	5	282	164	115	124	48	47

The lack of turndown and resulting higher number of required pumps prevents the magnetic drive centrifugal pumps from being a recommended type of pump for Option 1. However, magnetic drive centrifugal pumps are a viable alternative for Option 2. Larger magnetic drive centrifugal pumps are available than with hose pumps. Therefore, budgetary pricing with fewer larger magnetic drive centrifugal pumps was solicited for Option 2 as shown in Table 5-6.

Table 5-6. Option 2- Pump Sizing for Standardized Manifold Distribution Using Magnetic Drive Centrifugal Pumps

Facility	BC	BLI	CON	HS	Leib	OKW	PF	STA
Total Number of Pumps (includes one spare)	3	2	6	2	2	2	2	2
Size of Pumps (gpm)	378	5	394	326	230	246	47	46

5.2.2.6 Chemical Feed System Alternative Costs for Identified Alternatives

The capital costs for the identified chemical feed system alternatives, including the replace in-kind alternative, are summarized in Table 5-7. Detailed cost estimates for each facility are provided in Volume 6 – Appendices, Appendix C under each facility.

Table 5-7. Capital Costs for the Pump Distribution and Pump Type Options

Identified Alternatives	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Facility	Replace In-Kind	Standardized Pump Distribution (Option 1) with Hose Pumps	Standardized Manifold Distribution (Option 2) with Magnetic Drive Centrifugal Pumps	Standardized Manifold Distribution (Option 2) with Hose Pumps
Baby Creek	\$1,657,000	\$3,325,000	\$1,237,000	\$2,388,000
Belle Isle	\$235,000	\$382,000	\$274,000	\$264,000
Conner Creek	\$2,919,000	\$5,409,000	\$2,300,000	\$4,369,000
Hubbell-Southfield	\$970,000	\$1,130,000	\$534,000	\$843,000
Leib	\$1,262,000	\$1,724,000	\$901,000	\$1,178,000
Oakwood	\$1,964,000	\$1,332,000	\$443,000	\$886,000
Puritan-Fenkell	\$340,000	\$687,000	\$383,000	\$545,000
Seven Mile	Not evaluated since facility will be converted to a Capture-Only			
St. Aubin	Evaluated under Sodium Hypochlorite Feed and Storage System Improvements. See Section 14.2.2.2.			
Total Capital Costs for All Facilities	\$9,348,000	\$13,989,000	\$6,072,000	\$10,473,000

It should be noted that Alternative 4 is not further included in the evaluation as it is nearly double the cost of Alternate 3 with no additional benefits or performance enhancements.

The following additional improvements to the sizing of the disinfection systems should be addressed for either Alternative 2 or 3, but are especially important if implementing the manifold alternative due to the lower turndown:

- Refine the maximum design flow once sufficient influent flow data is available from improved influent flow monitoring. While 10 years of reliable historical data will not be available in time for replacing the chemical feed systems, reliable influent flow data in conjunction with precipitation data should be used to better calibrate the collection system model. The model can then be used to determine an appropriate design flow once the model accurately predicts flow to a facility for a given precipitation event.
- Consider a lower design dose at peak flow. Monitoring influent bacterial counts versus flow and evaluating the probability of the peak dose being required concurrent with peak flow could further reduce the required pump sizing. A lower dose may be required at the design peak flow if bacterial counts decrease due to dilution with increasing flow. For example, if the required dose at the design peak flow was determined to be only 10 mg/L rather than 20 mg/L, this would allow the hypochlorite pump sizing to be half that assumed. This in turn would allow dosing at a much lower rate during small wet weather events and thereby help address the turndown limitation of the manifold compared to the pump distribution alternative.

5.2.3 Flow-Paced and TRC-Paced Automatic Chemical Feed

5.2.3.1 Introduction

Based on GLWA personnel input and observations during the site visits, the chemical feed systems do not operate in automatic as intended at any of the facilities. GLWA desires a simple, automated chemical feed system that will improve GLWA's ability to meet both fecal coliform criteria and TRC goals. Manual control is undesirable for the following reasons:

- Operation in manual requires frequent manual adjustments in response to varying storm flow.
- Operation in manual requires frequent sampling and analysis of TRC which is time consuming. This reduces available time for monitoring the facility and attending to other O&M needs.
- Except for extreme storm events at the facilities designed for 5 to 10 minutes contact time, the effluent sample points represent too long of a time delay between the hypochlorite dosing point and measuring point. Thus, adjustments in response to the TRC sampling and analyses at the effluent permit compliance point inherently results in poor control.

The considerations for automating chemical feed pacing are presented here and referenced in the facility-by-facility section because this section applies to most facilities.

5.2.3.2 Automated Sodium Hypochlorite Feed Approach

Consistent dosing in response to rapid changes in flow requires flow pacing, and refinement of the dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The control strategy would be as follows: The operator inputs a starting chlorine dose in terms of mg/L as Cl_2 . The chemical feed rate to that mixing zone would be controlled automatically to achieve that dose based on total facility flow and number of mixing zones in service. Flow splitting between mixers and or diffusers in a given mixing zone would be by non-automated means as described in Section 5.2.2.4 and thus would not be included in the control loop.

The operator will also input a target TRC. A new TRC analyzer sampling slightly downstream of the dose point (e.g., a certain number of minutes downstream at average flow) will be required for this control. The TRC setpoint would be what is desired after complete mixing and the initial rapid chlorine demand. If the measured TRC is less than the setpoint, then the operator entered target dose, still controlled by flow, would be automatically increased to eliminate the difference between the measured TRC and setpoint TRC (i.e., the primary control parameter will be flow pacing to maintain a target dose and the TRC analyzer will be used to adjust the target dose to account for CSO variability). Operator adjustable time delays would also be provided to allow for the adjusted dose to reach the TRC probe before the measurement is used to make the next adjustment to the dose. This approach is anticipated to control both effluent coliform and effluent TRC to a tighter range than possible based on the current manual approach to chemical dosing.

A second TRC analyzer is recommended at each CSO facility for the final discharge point. This will facilitate tweaking the setpoint for the upstream TRC analyzer discussed above and thereby improve compliance with the TRC goal at the discharge. The effluent TRC analyzer results can either be manually considered in tweaking the upstream TRC set point, or if GLWA prefers, it could be used automatically to adjust the upstream TRC setpoint. For example, if it is desired to target a 1 mg/L effluent TRC and the measured effluent TRC is 2 mg/L, and the upstream TRC setpoint was 5 mg/L, the upstream TRC setpoint could be automatically decreased by this 1 mg/L differential to 4 mg/L. And if the measured effluent TRC is 0 mg/L

the upstream TRC setpoint could be increased in increments (e.g., 0.5 or 1 mg/L) with adequate time delays between adjustments, until the effluent TRC reaches 1 mg/L.

Having online TRC analyzers will not only allow effluent coliform and effluent TRC to be controlled to a tighter range than is possible through manual measurements and feed rate adjustments but it will also free up time spent chemically analyzing TRC during a storm so that operators are able to spend their time attending to other needs and monitoring the facility.

Automated control systems require that the flow measurement and TRC analyzers be well maintained and calibrated. With eight active (i.e., excluding Seven Mile) CSO facilities and the recommendation for two TRC analyzers per facility, it is recommended that a single entity, whether internal or contracted, be responsible for maintaining the TRC analyzers to ensure these instruments are operating properly.

Operator training will be critical for successful transition to automated dosing. It is important that the training convey, and operators implement the following:

- The concept of dose being in terms of a concentration (i.e., mg/L) because of the correlation between dose and residual chlorine.
- Regular measurement and entry of sodium hypochlorite strength into the control system. This is important because twice the feed rate is required for the same TRC if the sodium hypochlorite has degraded from 10 percent to 5 percent. The degradation of sodium hypochlorite is unique compared to most other chemicals used in wastewater treatment.

Good operator training will also facilitate operation in manual mode should the TRC analyzer and or flow measurement be out of service. If the TRC analyzer is out of service, the automation system should be designed to allow the flow pacing control to continue. Manual adjustments of the dose should primarily be based on sampling at the upstream TRC sample point with the effluent TRC sample point being a secondary consideration due to the time delay issue discussed above.

5.2.3.3 Review of TRC Analyzer Manufacturers

There are multiple manufacturers with successfully operating TRC analyzers in wastewater applications. The primary types are colorimetric and amperometric. Some require reagents and some are reagent-less. The decision of which analyzer to choose should be based on consideration of some of the attributes of one analyzer versus another and discussions with personnel at other WRRFs or CSO facilities regarding their satisfaction with the equipment. The following are examples of manufacturers that GLWA may want to consider:

- Swan
- Evoqua Wallace & Tiernan
- Chemsan
- Hach
- Rosemount

GLWA may wish to pilot several to identify a preferred analyzer. Once an analyzer is proven at one facility, it is recommended that all the facilities standardize on this TRC analyzer to simplify calibration and maintenance, and to facilitate operators rotating between CSO facilities.

5.2.3.4 Identified Alternatives

Based on the discussion above, the identified alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

5.2.4 Reduce Cost Associated with Large Quantity of Chemical Induction Mixers

5.2.4.1 Introduction

Based on GLWA personnel input and observations during the site visits, reducing the quantity of induction mixers, especially at the facilities with a large number of induction mixers, is desired for the following reasons:

- The mixers are expensive to maintain and due to the sealed nature of submersible mixers they must be sent back to the manufacturer for maintenance
 - Manufacturer maintenance costs are higher than equipment that can be maintained in house
 - Shipping adds costs
 - Turnaround of the Evoqua induction mixers utilized at the majority of GLWA's CSO facilities takes months before the mixer is returned to service.
- Splitting chemical feed to multiple mixers complicates the chemical feed system (e.g., additional back pressure valves, flow metering, pressure monitoring, and piping)

For these reasons, a mixer evaluation was conducted under CS-299 that is applicable to multiple facilities. The importance is greatest at the facilities with the most mixers as follows:

- Conner Creek: 60 induction mixers
- Baby Creek: 32 induction mixers
- Leib: 18 induction mixers

The next largest number of mixers is St. Aubin with seven induction mixers. After that there are only two to four induction mixers per facility and thus the number of mixers at these facilities is not as significant.

The recommendations for facilities requiring a mixer evaluation are presented here and referenced in the facility-by-facility section because this section applies to multiple facilities.

The following alternatives for reducing costs of mixers at Conner Creek, Baby Creek and Leib are provided in the following list and described in the following sections:

- 1) Use an equivalent, less costly induction mixer (potentially Gas Mastrrr induction mixers) for all facilities
- 2) Reduce quantity of induction mixers
- 3) Use a different type of mixer (i.e., vertical shaft)

5.2.4.2 Comparison of Water Champ and Gas Mastrrr Induction Mixers

There are two manufacturers of induction mixers at the CSO facilities, Evoqua Water Champs and Mastrrr Company Gas Mastrrr induction mixers. There are 123 Water Champs at six CSO facilities compared to

only four Gas Mastrrr mixers at two CSO facilities, therefore the majority of GLWA's experience is with Water Champs. The Water Champs have had a higher purchase price, and it is desired to determine if the two manufacturers can be competitively bid when replacing mixers. Therefore, it was requested that the mixing intensity, as defined by the G-value, be compared for the Gas Mastrrr units versus the Water Champs for a given horsepower (hp) unit.

G-Value: Information was gathered on the cone of influence and corresponding mixing energy (referred to as "G-value") for both manufacturers and it was confirmed that Gas Mastrrr induction mixers provide similar G values to Water Champs for a given hp model.

Modifications for Installation of Gas Mastrrr Mixers: The local Gas Mastrrr representative visited a couple of the GLWA facilities where Water Champs are used and concluded the guide rails and controls would be reusable but new attachment brackets may be required.

Comparison of Maintenance Work Order History: Currently, GLWA has Gas Mastrrr induction mixers at Hubbell-Southfield (3) and Seven Mile (1). However, given the hydraulic issues limiting discharge from Seven Mile, the three Gas Mastrrr induction mixers at Hubbell-Southfield are the primary basis for forming opinions on relative reliability. For comparison there are a combined 123 Water Champ induction mixers at six of the CSO facilities. An evaluation of the number of maintenance work orders for the chemical induction mixers over the past five years is presented in Table 5-8 (as presented in the Maintenance Work Order Review for Facilities Assessment Task report). Although there is a large majority of Water Champ mixers, the annual average number of work orders per mixer is similar.

Table 5-8. Review of Chemical Induction Mixer Work Orders by CSO Facility

CSO Facility	Mixer Manufacturer and Model	Number of Installed Mixers	Total Number of WOs for Chemical Induction Mixers	Average Number of WOs per Mixer Over a 5-Year Period
Baby Creek	Evoqua (Water Champ)	32	38	1.2
Belle Isle	Evoqua (Water Champ)	4	0	0
Conner Creek	Evoqua (Water Champ)	60	51	0.9
Hubbell Southfield	Gas Mastrrr	3	5	1.7
Leib	Evoqua (Water Champ)	18	41	2.2
Puritan-Fenkell	Evoqua (Water Champ)	2	0	0
Seven Mile	Gas Mastrrr	1	0	0
St. Aubin	Evoqua (Water Champ)	7	15	2.1
Total		127	150	1.2

Repair Center: Another consideration for the mixers is the location of the repair center and the associated shipping costs. Gas Mastrrr indicated a local repair shop in Detroit area would be used, whereas Evoqua's repair center was historically located in Louisiana. As of late 2020, however, a repair facility is reportedly located in Belleville, Michigan.

Cost Comparison: Pricing was received from both manufacturers that varied with the number of units purchased, whether existing units were exchanged, and with and without explosion-proof motors. Table 5-9 provides a cost comparison of the two sizes for which explosion-proof motors were quoted by both manufacturers, assuming no existing units are exchanged, and using their bulk pricing discount assuming ten mixers are purchased at a time. The Gas Mastrrr mixers were quoted at 70 percent to 72 percent of the

Water Champ mixers. It is possible that Evoqua will improve their Water Champ pricing in a true competitive bid situation.

Table 5-9. Cost Comparison Between Water Champ and Gas Masterrr Induction Mixers

Motor hp	Water Champ (\$/mixer)	Gas Masterrr (\$/mixer)
15	\$37,000	\$26,300
20	\$40,000	\$29,300

Based on the G factor, the apparent interchangeable use of the existing guiderails and controls, work order history on reliability, and a comparison of quotes, GLWA can competitively bid Gas Masterrr mixers and Water Champ mixers when replacing mixers going forward. The attachment brackets, and any other appurtenances as required to utilize the alternative manufacturer at a given location, can be specified to be included in the bid by that company to ensure all cost for switching to an alternative manufacturer are accounted for.

5.2.4.3 Reduce Quantity of Existing Mixers

This section evaluates the feasibility of reducing the number of mixers at each facility, now that many years of various storm events and operating experience has been obtained.

To understand the basis for the current number of mixers at each facility, it is helpful to review design documents. The basis of design for Conner Creek states:

"The number and size of the mixers was based on data collected during a mixing test conducted by Alden Research Laboratory, Inc in July 1999. The purpose of the test was to define the volume of water affected by the mixer at the design flow...

Mixing effectiveness was determined by measuring the concentration of a fluorescent tracer at two vertical planes, 10 feet (ft) and 58 ft downstream from the impeller of the mixers. The velocity and tracer concentration data were normalized by dividing the measured values by the theoretical average value. The theoretical channel velocity was 3 fps...

At the 10-ft vertical plane, a "uniform mix" was observed to occur within a cross-sectional area of approximately 24 square ft, which was equivalent to 33% of the total cross-sectional area. At the 58-ft vertical plane, the fluorescent tracer dye was observed throughout the 10-ft x 8.5-ft cross sectional flow path. Additionally, at the 58-ft vertical plane, there was an obvious gradation of tracer concentration, the highest concentration being at the water surface. The cross-sectional area of the test channel was approximately 1/6 of the full-scale channel, therefore, it is recommended to equip each of the screening/mixing channels with six, 20-hp induction-type mixers."

In summary, the mixer achieved non-uniform tracer dispersion across the entire cross-sectional area of the test channel at 58 ft and uniform dispersion across 33 percent of the cross-sectional area at 10 ft, the only two vertical planes tested. The basis, and significance if any, of the 58 ft vertical plane sampled is not explained. If one were to extrapolate the dispersion being across 33 percent of the cross-sectional area at 10 ft, then it is possible that dispersion occurred across the whole cross-sectional area at 30 ft. It is not apparent from the basis of design report that interpretation of the dispersion results was used in choosing the number of mixers for full-scale design. Instead, it appears that the determination of how many mixers to incorporate into the full-scale design at Conner Creek was simply a multiplication of the test channel cross-sectional area to the full-scale facility cross-sectional area. This raises the question that if they had instead chosen a pilot facility that was 1/4th the size of the full-scale facility, would they have designed four mixers rather than six mixers per mixing zone?

Computational Fluid Dynamics (CFD) is a powerful hydraulic analysis and design tool that was not available when the CSO facilities were designed. A primary issue with the physical model approach previously taken is how to interpret and apply the test results to design. With CFD modeling, the dispersion of chemical can be determined with relatively high certainty for any given number of mixers and mixer locations. Thus, the required number of mixers can be determined. A required input of CFD modeling is the mixing characteristics of each mixer to be modeled. Therefore, this information would be required from the mixer manufacturers.

CFD modeling is recommended for Baby Creek, Conner, Creek, and Leib, and if desired St. Aubin as well although only a two-mixer reduction would be anticipated there. The small number of mixers at the remaining facilities minimizes potential mixer reductions at those facilities, especially considering the benefit of some redundancy should a mixer become non-operational and not be available during a CSO event. For example, at a facility with only two, three, and four mixers, one mixer out of service represents a 50 percent, 33 percent, and 25 percent reduction in overall facility mixing capacity, respectively. The implications of one or two mixers being out of service at the three facilities with the largest number of mixers are much smaller.

Consultation with the CFD modeler should occur during scoping of the CFD modeling project to decide on the best modeling approach. It should also be determined whether the peak design capacity of the facility is the only condition to be modeled or whether any lower flow rates should also be modeled. The following is a preliminary list for consideration:

- Modeling of the existing number and size of mixers to develop a baseline.
- Modeling with fewer of the existing mixers in existing locations to determine what mixers if any could be eliminated.
- Modeling with fewer of the existing mixers but in optimized locations. Utilization of existing floor openings should be given first preference. If significant benefits are anticipated with alternative mixer locations then interferences and cost implications of a new floor penetration, hatch, and mixer removal infrastructure should be considered when selecting alternative locations to model.
- Modeling of larger (e.g., higher hp) induction mixers. This could be done in conjunction with one or both of the previous two bullets.

Although not recommended because it would rely more on trial and error and extensive sampling, an alternative to CFD modeling would be to remove mixers in one mixing zone and sample at enough points at the discharge end of the mixing zone to analyze the adequacy of chlorine dispersion. This could be accomplished by installing submersible sample pumps or sample pipes connected to self-priming sample pumps located on the operating level. A significant number of sample pumps or sample pipes would be required to adequately cover the cross section leaving the mixing zone. Initial testing could be conducted with the currently installed number of mixers to develop a baseline. Then testing could be conducted with one or more mixers removed. The intermittent and highly variable nature of CSOs make full-scale testing much more challenging than would be the case at a continuously operating wastewater treatment plant. Drawbacks of this approach compared to CFD modeling include:

- The design capacity of the facilities corresponds to a very infrequent event with a flow far in excess of typical peak storms. Therefore, testing at lower flows is unlikely to be fully indicative of the adequacy of mixing at peak design flow.
- The optimum positioning of mixers would be by trial and error and would be limited to positions on existing rails.
- Testing of each configuration would likely need to occur during multiple events, with an emphasis on capturing data during large events. This could require testing in one configuration (e.g., number of

mixers and mixer positioning) for a year or more depending on how soon a peak event occurs after setting a given configuration.

- The lack of access favors installing a matrix of sample points to provide adequate sampling. The associated piping would likely accumulate debris passing through screening and require periodic cleaning.

Without CFD modeling there is not a real basis for estimating whether the number of mixers can be reduced and by how much. Therefore, assumptions are required for estimating the costs of this alternative. Table 5-10 summarizes the assumptions for cost estimating this alternative.

Table 5-10. Reduced Number of Induction Mixers Alternative Summary

Facility	No. of Mixing Channels	Existing Number of Mixers Per Mixing Zone	Existing Total Number of Mixers	Assumed Number of Mixers Per Mixing Zone	Assumed Total Number of Mixers	Cost Per Mixer ^a	Cost Savings per Facility Using Reduced No. of Mixers
Baby Creek	8	4	32	2	16	\$50,000	\$800,000
Conner Creek	10	6	60	4	40	\$50,000	\$1,000,000
Leib	4	4	16 ^b	2	8 ^b	\$50,000	\$400,000

^a Based on existing Water Champ induction mixers with explosion-proof motors (Table 5-9), with a contingency and installation cost.

^b The two prechlorination mixers are not included in this evaluation and would remain.

5.2.4.4 Alternative Mixer Technology – Vertical Shaft Mixer

Vertical shaft mixers are a more common type of mechanical mixer at wastewater and water treatment plants than induction mixers. Vertical shaft mixers are typically very low maintenance and highly reliable. Figure 5-3 shows a vertical shaft mixer potentially applicable to Conner Creek.

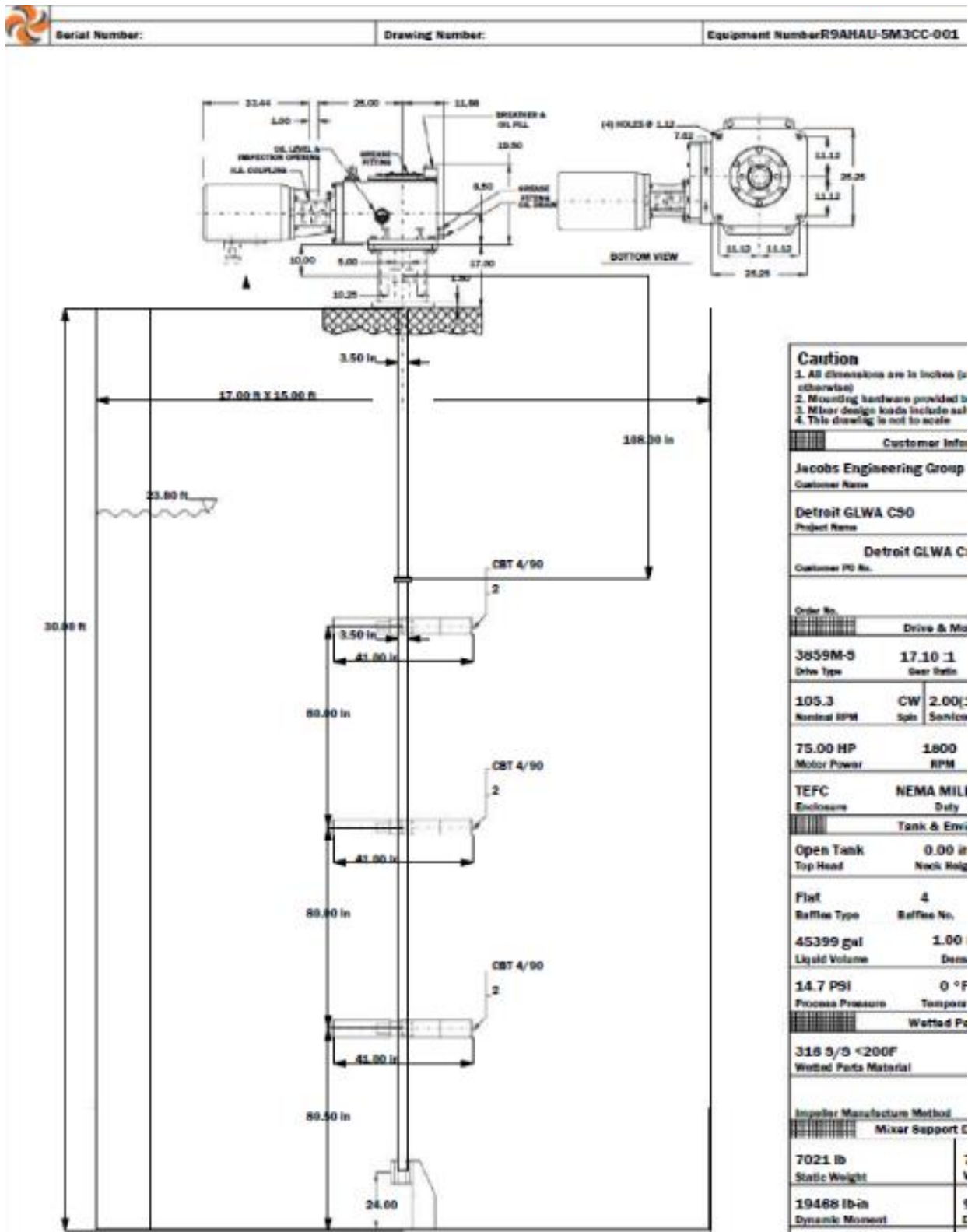
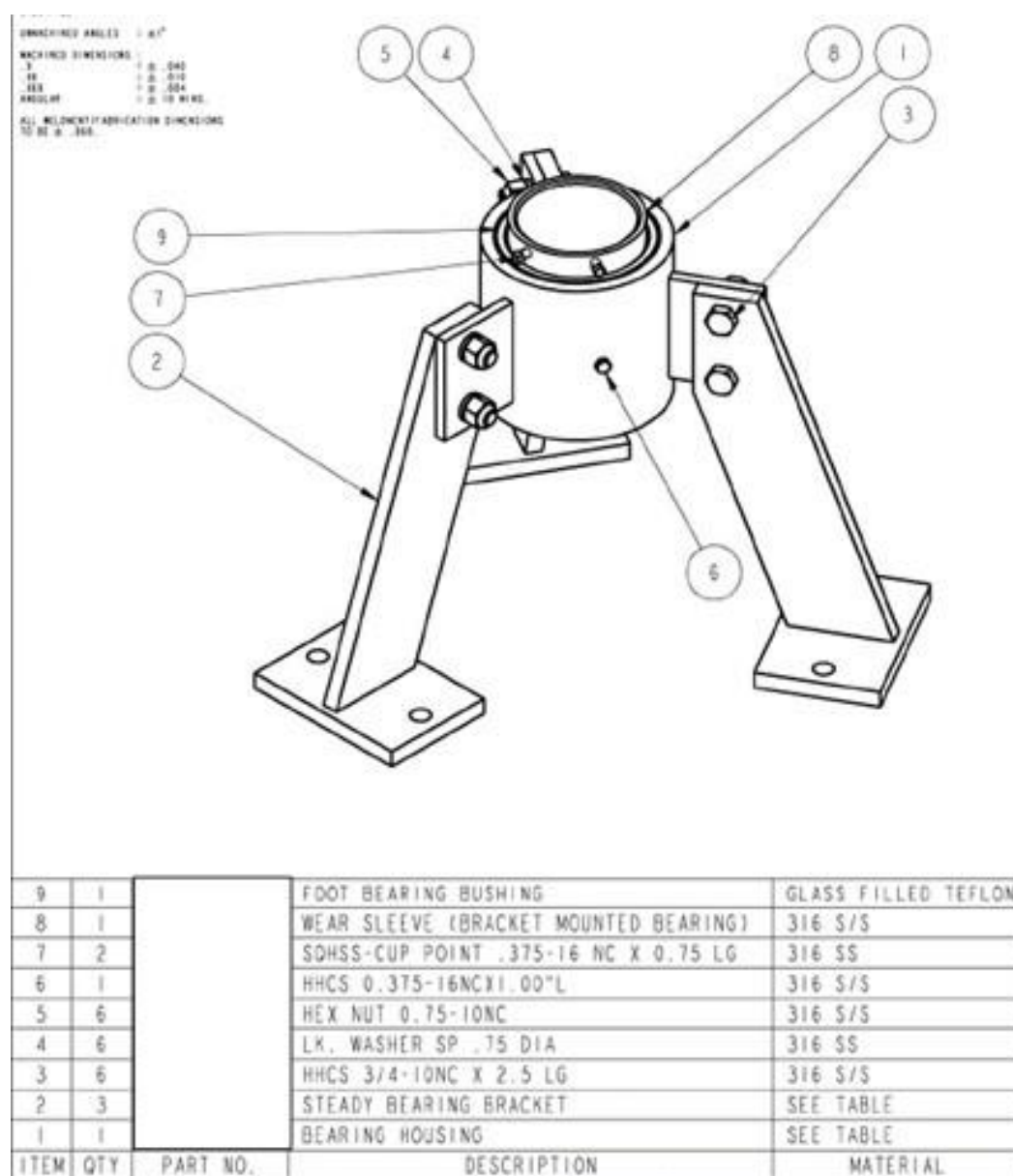


Figure 5-3. Vertical Shaft Mixer

The primary concern with this proven mixing technology if applied to a CSO facility is the potential for ragging and questions regarding whether that would cause damage to the mixer or result in significantly greater maintenance. Maintenance on vertical shaft mixers for this application would consist of:

- Change oil every 6 months to a year (potentially less frequent if the oil is sampled and analyzed).
- Grease bearings at the same time as oil changes. There is an upper and a lower bearing in the gearbox.
- Removal of rags from the shaft and impellers periodically. The amount of ragging will vary with CSO facility due to differences in screen openings and the quantity of screenings present in the CSO.
- Service the steady bearing every two years. This is a floor mounted bearing. Steady bearings are custom made for the application and their design will vary. An example of steady bearing is shown in Figure 5-4. Given the presence of solids, this application may involve a water flush to the lower bearing similar to pump seal water in order to maximize bearing life.



For the Leib facility, the belowground location of the mixer chamber and limited headspace would require significant structural modifications above the mixing chambers to allow the vertical shaft mixer to be installed and removed. Based on these constraints, the vertical shaft mixer is not further considered at the Leib facility and only induction mixer alternatives will be considered at Leib.

In addition to vertical shaft mixers typically being very low maintenance and highly reliable, another advantage of vertical shaft mixers over submersible mixers are the first two maintenance tasks noted above are on components located on the operations floor.

Drawings, facility design flows, and other relevant information were provided to Philadelphia Mixing Solutions and recommendations and budgetary pricing requested for the three facilities with the largest number of induction mixers. The three facilities were Conner Creek, Baby Creek, and Leib. The next largest number of mixers is St. Aubin with seven induction mixers. If successfully implemented at the facilities with the largest number of induction mixers, then replacement of six induction mixers with vertical shaft mixers downstream of screening could be considered at St. Aubin in the future. The seventh induction mixer at St. Aubin is a prechlorination mixer upstream of screening and would be assumed to remain. There are only one to four induction mixers per facility at the remaining facilities with induction mixers and thus the number of mixers at these facilities is not significant enough to warrant replacement with vertical shaft mixers.

- Philadelphia Mixing Solutions selected mixer sizes to rapid mix sodium hypochlorite based on the mixing zone size and configuration and the design peak flow of the facility. The proposed vertical shaft motor hp per mixing zone exceeds that of the existing induction mixers. The fact that the energy demand is concentrated in fewer larger motors will require changes to the power distribution thereby affecting capital cost. However, the intermittent nature of the CSO facilities is expected to minimize the life-cycle energy cost differences between the two technologies. Two features were proposed by Philadelphia Mixing Solutions to address the concerns about ragging:
 - 1) Steady bearing. This is provided to prevent shaft deflection from rag accumulation on the shaft and impeller and resulting stress on the upper bearings.
 - 2) Curved-blade turbine impeller intended to minimize ragging. The impeller is illustrated in Figure 5-5.

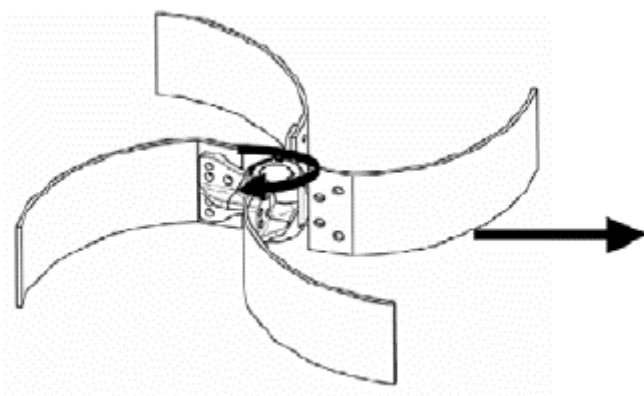


Figure 5-5. Curved-blade Turbine Impeller

- The mixers are designed to run during fill/drain operations, i.e., as the water level rises, or drops back down, through the level of the impeller(s). Although the mixer could run dry for short periods of time, the manufacturer does not recommend running them dry for any extended period of the time because

if solids are present in the steady bearing, the wear sleeve could be damaged. The mixers at Conner Creek and Baby Creek would have three impellers per shaft to provide rapid mixing at multiple depths. The mixers could run with any combination of impellers being above or below the water level due to water level variation during an event. Two mixers were proposed at each existing mixing zone for all three facilities. Table 5-11 summarizes the vertical shaft mixer concept for the two feasible facilities.

Table 5-11. Vertical Shaft Mixer Alternative

Facility	No. of Mixing Channels	Mixers Proposed Per Channel	Total Mixers Required	Cost Per Mixer	Mixer Equipment Cost Per Facility	Per Mixer Motor hp	Total Mixer Motor hp
Baby Creek	8	2	16	\$70,000	\$1,122,000	50	800
Conner Creek	10	2	20	\$79,000	\$1,578,000	75	1,500

- This alternative would cut the number of mixers from 60 to 20 at Conner Creek and from 32 to 16 at Baby Creek. Vertical baffling was recommended by the mixer manufacturer at each mixer location to facilitate turbulence rather than bulk laminar liquid rotation. Mixer locations (red) and proposed baffles (green) for each facility are illustrated in Figure 5-6, Figure 5-7 and Figure 5-8.

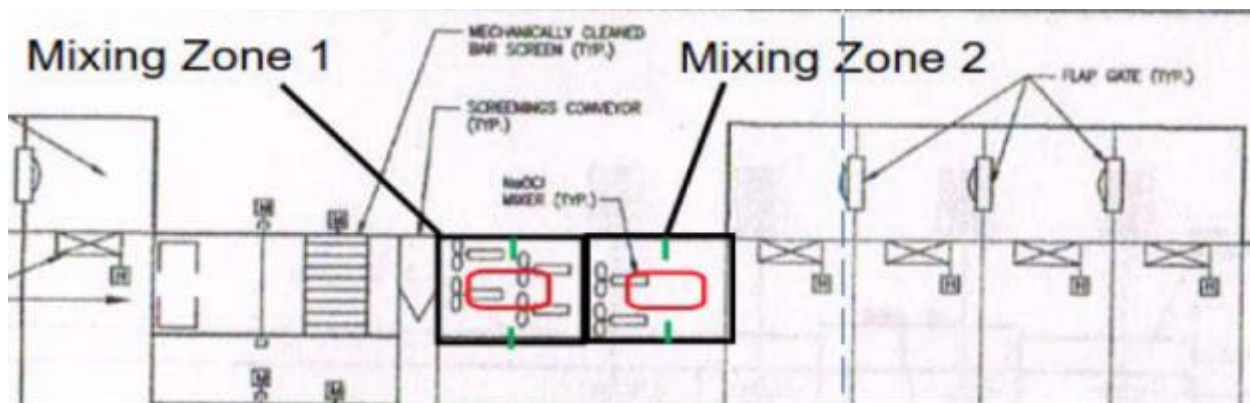


Figure 5-6. Vertical Shaft Mixers (Profile) Conceptual Implementation - Conner Creek

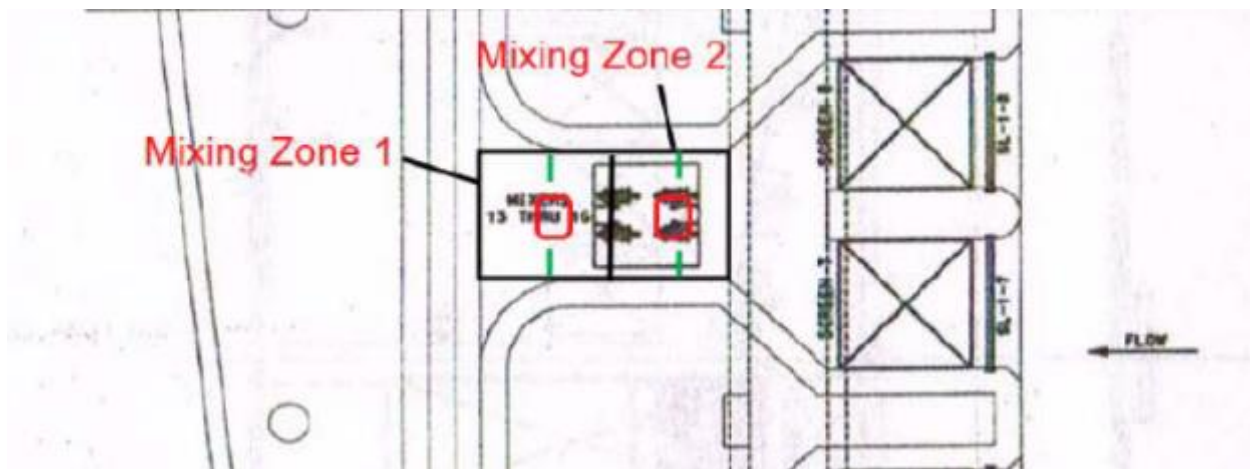


Figure 5-7. Vertical Shaft Mixers (Plan) Conceptual Implementation - Baby Creek

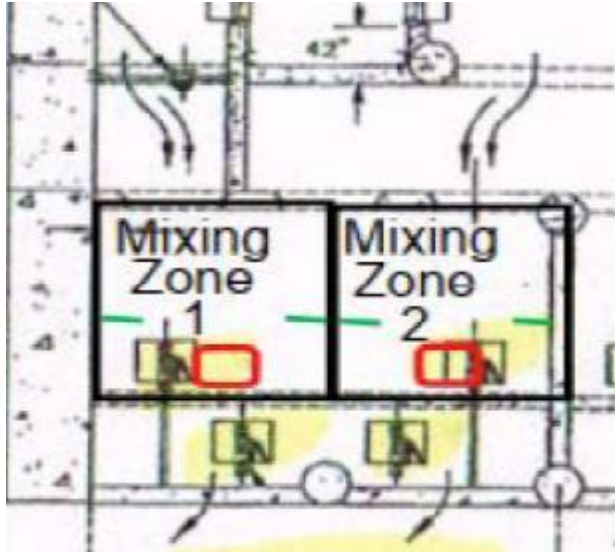


Figure 5-8. Vertical Shaft Mixers (Plan) Conceptual Implementation – Leib (Shown for reference only)

The in-series orientation at Conner Creek and Baby Creek would have the added advantage of providing partial redundancy because rapid mixing, at half the normal energy input, would continue to occur if there was a problem preventing operation of one mixer in that pair.

The advantages and disadvantages of the vertical shaft mixer is as follows:

Advantages:

- Typically very low maintenance
- Typically highly reliable
- Components requiring routine maintenance are located on the operations floor
- Cuts the number of mixers from 60 to 20 at Conner Creek and from 32 to 16 at Baby Creek
- Motor and gear drive are serviceable thereby minimizing the need to ship components to the manufacturer's maintenance facility
- Mixer can be run over the range of water levels during an event. This compares to the need to start and stop induction mixers installed at different elevations depending on water level.
- The in-series orientation at Conner Creek and Baby Creek would provide partial redundancy if one mixer were out of service (i.e., 50 percent mixing intensity)

Disadvantages:

- Requires steady bearing on the floor of the mixing zone due to the application. This is less typical for vertical shaft mixers and the associated maintenance requirements are site-specific and difficult to predict. Maintenance on these requires
- Steady bearing may require seal water to flush debris which could shorten the life of the bearing.
- Requires periodic removal of rags and debris from the shaft and impeller. CSO is not a typical application for vertical shaft mixers and the associated maintenance requirements are site-specific and difficult to predict.

- Requires some baffling additions. The head loss associated with these is anticipated to be insignificant but this should be verified during design.
- Higher total hp than the existing induction mixers. However, the intermittent nature of the CSO facilities is expected to minimize the life-cycle energy cost differences between the two technologies.

5.2.4.5 Alternative Evaluation

The 20-year life-cycle costs are presented in the alternatives evaluations contained in the Disinfection sections of the Baby Creek (Section 6.2.2) and Conner Creek (Section 8.2.2). These are the only two facilities where the vertical shaft mixer is considered feasible. The alternatives evaluation also includes the anticipated annual maintenance costs associated with each mixer.

It is recommended that CFD modeling be conducted as described herein to determine by how much the number of induction mixers can be reduced.

5.2.5 Total Chlorine Residual Reduction

TRC reduction (i.e., dechlorination) is currently not required for CSO discharges at any of the existing CSO facilities. However, the WWMP evaluated the size and location of dechlorination facilities in the section on potential future regulations. The capital cost estimates from the WWMP are presented in Table 5-12. GLWA does not anticipate a TRC requirement in the next 20 years while the Long Term CSO Control Plan is being executed because of finite resources to support other capital expenditures.

Table 5-12. TRC Reduction Capital Cost Estimates From the WWMP

CSO Facility	Estimated Capital Cost ^a (ENR CCI 11500 2019)
Baby Creek SDF	\$ 22.5 million
Conner Creek RTB	\$ 46.2 million
Hubbell Southfield RTB	\$ 16.5 million
Leib SDF	\$ 10.8 million
Puritan-Fenkell RTB	\$ 7.7 million
Oakwood RTB	\$ 10.6 million
Puritan-Fenkell RTB	\$ 7.7 million
Seven Mile RTB	\$ 7.3 million
St Aubin SDF	\$ 5.2 million

^a WWMP estimated TRC reduction capital costs, however these capital costs are not anticipated in the 20 year planning period of this report.

5.3 Electrical

5.3.1 CSO-Wide Lighting Replacement Project

A light-emitting diode (LED) Lighting Replacement project, conducted under Job Order Contract (JOC) No. 9, was completed in late 2020. The project consisted of replacing the originally installed fluorescent and sodium vapor light fixtures with new energy-efficient LED lighting fixtures at all CSO facilities. This project included a 7-year warranty on the new fixtures. Because of this recent project, the existing lighting at the facilities was not evaluated under CS-299.

New and additional lighting locations were discussed with O&M staff at each facility where lighting improvements are desired to better perform maintenance and daily operations activities. If applicable, the locations for additional lighting are presented in the Electrical section of each facility.

5.3.2 Power Quality Monitoring

GLWA currently has an ongoing power monitoring project for all CSO facilities. The project consists of installing a Schneider power monitoring system, which will enable GLWA to monitor the power quality of the electrical systems at each facility. The system will detect abnormal conditions, locate circuit insulation faults, and monitor the electrical equipment. It will allow GLWA to efficiently identify and track power event causes, patterns and system capacity to avoid overloads and failures. The power monitoring system has the ability to capture and record power monitoring data which can be used to troubleshoot and address current and future power issues at the facility.

5.4 Instrumentation and Control

5.4.1 Introduction

There are a number of I&C-related common improvements that could be made at the CSO facilities to standardize their operation, reduce maintenance costs and improve operations. The needs are described in this section and referenced, as appropriate, in the facility-by-facility assessments in the following bullets. The common needs include:

- Control System Improvements
- Evaluation of Level Measurement Technology – Ultrasonic vs Radar Instruments
- Chemical Fill Station Level Indicators
- Evaluation of Valve Control Philosophy – Valve Network (PakScan) vs Hardwired
- Fire Alarm System and Gas Monitoring Minimization
- Open Channel Flowmeter Alternatives
- Process Monitoring Cameras
- Additional Local Control
- Generator Run Status Signals to Historian
- Study for Disabled Motor Moisture Detection Capabilities

SCADA Data Review: In order to better understand the condition of level and flow signals generated from the numerous level sensors and flow meters throughout the nine CSO facilities, Jacobs conducted a detailed SCADA Data Review. This evaluation obtained and reviewed SCADA data from a recent 6-month period (August 2019 to February 2020). This evaluation was used to help determine whether some of the redundant instrumentation could be minimized (for example, see I&C sections of Baby Creek and Conner Creek). Furthermore, this evaluation was used to populate information in the CS-299 Condition Assessment related to whether the instrument “Performed Its Intended Function.”

5.4.2 Control System Improvements

Because the CSO facilities were constructed at various times over the last 25 years, the control systems vary. Table 5-13 provides a summary of the existing control systems at each facility. The table also provides the proposed and recommended upgrades for the control systems at all the facilities to standardize the systems and make operating these facilities more similar from one facility to another.

Table 5-13. Existing and Proposed SCADA Control Systems at Each CSO Facility

Facility	Existing Control System (Version)	Proposed and Recommended Upgrades
Baby Creek	Emerson Ovation (O.V.3.5.0)	Ovation System Upgrade to O.V.3.7 Replace local control panel at Sampling Building and provide control from Sample Building
Belle Isle	Emerson Ovation (O.V.3.5.0)	Ovation System Upgrade to O.V.3.7 Add root switch for network redundancy
Conner Creek	Emerson Ovation (O.V.3.5.0)	Ovation System Upgrade to O.V.3.7
Hubbell Southfield	Rockwell ControlLogix PLC's with Factory Talk software	Replace entire control system (proposed project under CS-299)
Leib	Rockwell PLC 5 with RSView software	Upgrade is ongoing through "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" project
Oakwood	Emerson Ovation (O.V.3.5.0)	Ovation System Upgrade to O.V.3.7
Puritan-Fenkell	Rockwell PLC 5 with RSView software	Replace entire control system (proposed project under CS-299)
Seven Mile	Rockwell PLC 5 with RSView software	Upgrade is ongoing through "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" project
St. Aubin	Rockwell PLC 5 with RSView software	Upgrade is ongoing through "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" project

Note:

PLC = programmable logic controller

During CS-299 Facilities Assessment meetings, GLWA personnel requested that the control systems and screen graphics be standardized across facilities so that staff could more easily understand the controls and operation from one facility to another. GLWA SCADA Governance Standards require that all CSO facilities use Ovation workstations with new high-performance graphics. Version 3.7 of Ovation should be used. The recommendations in the following paragraphs address these issues.

"Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" is a project that is intended to replace the control systems at the three facilities mentioned. The request for proposals (RFP) for this design/build project should be issued within the next few months (as of August 2020). A Jacobs team member was involved in the development of the RFP documents for this project and was able to convey the GLWA CSO team's desire for standardization. For this project, the workstations with high-performance graphics will be Ovation. The RFP will allow for either Ovation or Rockwell control system to be bid, so that it can be more competitively priced.

Replace Entire Control System: Hubbell Southfield and Puritan-Fenkell control systems and workstations are Allen Bradley programmable logic controller (PLC)-based systems that are obsolete and do not meet GLWA's Governance Standards. These systems should be replaced. The Facility assessments for Hubbell Southfield and Puritan-Fenkell provide project descriptions and recommendations for the replacement project.

Ovation Control System Upgrade: The Ovation Control System at the existing four facilities (Baby Creek, Belle Isle, Conner Creek and Oakwood) will provide GLWA reliable operation for many years. With the advances in technology and new operating systems, it is logical to upgrade the Ovation system to take

advantage of new capabilities to improve performance and ensure reliability of the system. For the Ovation system to have high-performance graphics and elements, the system needs to be upgraded to version O.V.3.7. Once upgraded, the system will be able to utilize the latest graphic elements in Ovation that GLWA is currently pursuing.

The potential control system upgrades are listed in the following paragraphs (and are subject to change during design phase):

- High-Performance Graphics: Provide use of new screen graphic macros to maximize the experience with high-performance graphics.
- Remote Node Interface: Ability to expand the system with Ethernet based remote nodes that have the capability to handle smart modules such as ELC, Profibus, or Fieldbus in remote locations.
- Machinery Health monitor: Vibration sensors to collect raw data and software to analyze and predict failures.
- Updated OCR1100 Controller: Updates to controller software and interfaces to handle high speed applications along with an enhanced set of control algorithms.
- Windows Server 2016 and Windows 10: Operating system obsolescence will no longer be an issue along with security patch availability.
- Trusted Domain capabilities: Allow all GLWA system credentials to be available for authentication at all sites and systems.
- HART capabilities enhancements: Allows the system to communicate to 254 HART variables via the wireless HART device.
- Enhance system viewer/analyzer: Provide the ability to troubleshoot by including the option to filter by message type or time. Additionally, the level of criticality can be selected to ensure only the most important items are viewed.
- Gigabit network communication capability and up to 500,000 tags.
- Upgrade Fiber Network to OM3 fiber to support greater distances with gigabit capabilities.

5.4.3 Evaluation of Level Measurement Technology – Ultrasonic vs Radar Instruments

Many different technologies exist for level measurement. The predominant methods for measuring liquid level in the water industry are through ultrasonic level measurement and radar level measurement. Both methods rely on transmitting a wave and tracking the time it takes to receive an echo from the reflected wave. With ultrasonic, the wave is acoustical and with radar, the wave is electromagnetic. When the CSO Facilities were originally designed and constructed, ultrasonic was the dominant technology for level measurement. Radar level instruments were just beginning to come to market and were much more expensive and not as accurate as ultrasonic level instruments. It was common to have the ultrasonic technology be the primary level instrument and the radar technology to be the secondary level instrument.

Today, the opposite is true. Radar level measurement has improved, and for many applications is superior to ultrasonic level measurement. The frequency of the electromagnetic wave has increased with each new version introduced which provides for a narrower beam spread with less chances of error introduced from waves reflecting off of different surfaces. In addition, the higher frequency allows for more accurate level measurement in water containing small particles of debris and/or foam. Radar level instruments are a 2-wire, loop powered device and do not require a separate 120-volt (V) power feed, unlike ultrasonic level instruments. This saves on installation costs by eliminating additional conduit and wire.

In the future, Jacobs recommends that new level instruments would be radar as the primary level and ultrasonic as the secondary (if secondary is required). Since the radar instruments are loop powered, an additional source of 120V power and the associated conduit and wire is not required. The radar level instruments tend to have a lower unit cost and slightly more accurate and reliable than ultrasonic. For existing installations where ultrasonic level instruments are successfully being used and it is time for replacement, the recommendation would be to re-install an ultrasonic level instrument, since 120V power and the associated conduit and wire is already present, and the mounting location is already set for ultrasonic.

5.4.4 Evaluation of Open Channel Flowmeter Technologies

At the CSO Facilities, Accusonic open channel flowmeters are commonly used to measure flow. The meters are expensive to purchase, expensive to maintain, and frequently have issues accurately measuring flow.

Two alternatives are available for flow measurement besides the Accusonic units. The alternatives are described in the following paragraphs.

Alternative 1 - Laser-Doppler Velocity Flow Measurement: The non-contact laser-doppler velocity sensor measures flow by using a combination of a laser beam to measure velocity in a pipe or channel and an ultrasonic level sensor to measure the level of the liquid in the pipe or channel. Once the level of the channel is known, the laser beam is focused on a specific point and the frequency shift is measured on the returned light. The flow is then calculated from the cross-sectional area of the pipe or channel (accounting for level) multiplied by the velocity. An example of this type of flowmeter is the TieNet 360 Laser Flowmeter.

Advantages:

- Non-contact with the liquid in the pipe or channel. This provides for better accuracy by not disturbing the flow of liquid and will also remain cleaner by not being exposed to debris in the liquid.
- Ability to be submerged and still measure flow (requires optional surcharge sensors).
- Less expensive than Accusonic.

Disadvantages:

- The 45-degree angle of the laser beam requires special mounting considerations. This involves using an opening in the pipe or channel to accommodate the geometry of the 45-degree beam along with the downward facing ultrasonic level sensor. An alternative is to use a remote mounted ultrasonic meter and use one opening where the 45-degree beam enters the channel, or use two smaller openings; one above the ultrasonic meter on the main unit, and one for the 45 degree beam.
- Generally, requires a larger structure to account for the special mounting.
- Distance limitations between the flow sensor and flow transmitter. The manufacturer supplied cable is limited to a maximum 150 ft. In order to increase this distance, an additional extender module is required, and larger cables are required to counteract the voltage drop in the cable.

Alternative 2 - Radar Velocity Flow Measurement: Similar to the laser-doppler velocity flowmeter, the non-contact radar velocity sensor measures flow by using a combination of a radar beam to measure velocity and an ultrasonic level sensor to measure the level of the liquid in the pipe or channel. The radar is pointed to the center of the flow stream to measure surface velocity by calculating the frequency shift of the returned radar beam (doppler effect). The flow is then calculated from the cross-sectional area of the pipe or channel (accounting for level) multiplied by the velocity. An example of this type of flowmeter is the Hach Flo-Dar.

Advantages:

- Non-contact with the liquid in the pipe or channel. This provides for better accuracy by not disturbing the flow of liquid and will also remain cleaner by not being exposed to debris in the liquid.
- Ability to be submerged and still measure flow.
- Less expensive than Accusonic.

Disadvantages:

- The mounting design of the radar velocity flow measurement is meant to be installed on a bracket located in the bottom of a manhole directly above the channel or pipe opening. Access to the meter would be limited unless a large manhole was used above the pipe or channel.
- Would require a larger structure similar to the laser-doppler velocity meter to provide access to the meter.

It is recognized that GLWA has recently replaced all of the Accusonic influent flow meters at the large CSO facilities (i.e., Baby Creek, Conner Creek, Hubbell Southfield, Leib and St. Aubin). These facilities have a contract for bi-annual maintenance of these meters. Given this current situation, it is recommended that the Accusonics continue to be used. As these units age and as technology continues to advance, alternative flow meters could be evaluated in the future.

Jacobs recommends one location (Conner Dewatering) where a new Laser-Doppler Velocity Flow Meter should be installed. This is further discussed in Section 8.2.7.3.

5.4.5 Chemical Fill Station Level Indicators

Level sensor indicators are necessary at the fill stations of all chemical storage tanks. This allows contractors to monitor tank level from outside the building while delivering sodium hypochlorite. GLWA staff are replacing level sensor indicators at St. Aubin and Leib, but replacement is required at Belle Isle. All other facilities require installation of new level sensor indicators.

For the CSO Facilities which require new level indication, it is recommended for the design to include a NEMA 4X enclosure, digital process display with large, red characters which are easy to read, panel heater, and an alarm horn or strobe to indicate when the tank is approaching a high level. The 4-20 milliamperes (mA) level signal used for the process display indication should be part of the 4-20 mA instrument loop between the level sensor and PLC analog input and should indicate how full the tank is and how close it is to overflow. The alarm horn or strobe should be powered through a relay from the process display and based on an adjustable setpoint through the process display setup. A reasonable level should be chosen for the setpoint, which might be 12 inches (in.) to 24 in. below the top level of the tank. If a horn is used for the level indication panel, a "test" and "alarm silence" pushbutton should be incorporated to the front of the panel.

5.4.6 Evaluation of Valve Control Philosophy – Valve Network (PakScan) vs Hardwired

The PakScan valve network is a proprietary networking system for use with Rotork electric actuators. The valve network utilizes a serial communication protocol to carry all valve actuator status and control signals over a two-wire system. Valve networks have advantages and disadvantages. For PakScan, the network can accommodate hundreds of individual valve actuators spanning over many miles apart. The valve network is capable of transmitting a multitude of status and control signals nearly instantaneously across the entire network. Some of the disadvantages of the PakScan valve network include losing status and control

of all valve actuators in the event of a cable malfunction and associated networking difficulties during power cycles (such as valve actuators losing IP addresses while the network is coming back online).

For the CSO Facilities which utilize PakScan valve networks (i.e., Baby Creek, Conner Creek, Puritan-Fenkell, and Seven Mile), Jacobs considered an alternative of maintaining the existing valve network for status monitoring, but converting to hardwired control for critical status and control functions. The addition of hardwired control would involve the addition of conduit and wire between the valve actuators and the nearest PLC panel. Any discrete status and control would be through No. 14 AWG wire. Additional I/O would likely be required in the PLC panels. If the PLC panel would not have space or capacity for additional valve actuator I/O, remote I/O panels would be required to collect the status and control signals and be tied into the local PLC panel. The major benefit of this alternative is that, in the event the valve network experiences issues or outages, the hardwired control would still remain as a backup to keep the CSO Facility in operation.

Construction costs (without Contractor overhead and profit or Engineering design) for this concept for all the actuators at the four CSO facilities was found to be fairly expensive, as follows:

- Baby Creek (60 actuators): \$204,000
- Conner Creek (107 actuators): \$355,000
- Puritan Fenkell (19 actuators): 68,000
- Seven Mile (15 actuators): 54,000

Based on this information and discussion with GLWA, the cost/benefit of this alternative was not considered to be favorable. The exception is the 16 effluent relief gates at Conner Creek, which could cause major flooding damage in the collection system if they do not open as programmed during a large storm event. As such, this alternative is not considered further, except for the Conner Creek effluent relief gates.

5.4.7 Fire Alarm System and Gas Monitoring Minimization

Minimization of Fire Alarm Systems: GLWA requested that Jacobs investigate potential locations where fire alarm and sprinkler systems could be eliminated. As part of this investigation, Jacobs recognizes that each facility was designed by professionals to meet current fire and safety requirements and codes. Furthermore, the designs and final installations were reviewed and approved by the City Fire Marshall. For these reasons, we do not recommend that the current fire safety systems be modified, unless further evaluated under a separate study.

Removal of Gas Monitors from Various Basins: GLWA also requested that Jacobs investigate the potential removal of gas monitors in the basins for Belle Isle and Oakwood CSO Facilities. When originally installed, the gas monitoring in the basin was the primary method to determine if dangerous gas levels were present and if it was safe for personnel to enter. Since then, the standard operating procedures have been updated to make personal meters worn by personnel the primary means for checking for dangerous gas levels. Per NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities, Table 4.2.2, Row 32, Fire Protection measure, which include combustible gas detection, is not required in wastewater holding basins.

For the gas monitoring equipment in the basins at Belle Isle and Oakwood, the recommendation is to remove the existing gas monitors to avoid the effort required to maintain the sensors. This recommendation is also based on the fact that entry into basin (confined space) requires individuals to have their own gas monitor, along with fans on. The existing conduit and wire should remain as spare and left for future use.

Gas monitors in the Headworks should remain for the same reasons as the fire alarm systems mentioned above.

5.4.8 Process Monitoring Cameras

During Facilities Assessment meetings with O&M staff, GLWA requested that Jacobs evaluate locations in which additional cameras would be beneficial to monitoring operations. With GLWA input, the locations of existing cameras and the number of new cameras required at the CSO facilities were identified. A summary of desired camera locations is presented in Table 5-14. For this report, the costs associated with cameras are included in the individual facility I&C Improvements project.

Table 5-14. Process Monitoring Camera Needs at Each CSO Facility

Facility	Location	Number of new cameras required	Notes
Baby Creek	Headworks	4	One camera for a group of four screens
	Influent Area	1	Focused on area upstream of the weir wall
	Chemical Room	2	PTZ ^a
Belle Isle	Headworks	1	Existing camera in the headworks needs updating
	Chemical Room	1	
Conner Creek	Headworks	3	
	Chemical Room	2	One camera inside and one camera outside. PTZ
	Outfall	0	Camera will be installed as part of ongoing security project
Hubbell-Southfield	Headworks	3	PTZ
	Chemical Room	1	PTZ
	Outfall	1	
Leib	Headworks	0	There is an existing camera in the headworks area
	Chemical Room	1	PTZ
Oakwood	Headworks	3	PTZ
	Chemical Room	2	PTZ
	Pump Room	2	PTZ
Puritan-Fenkell	Headworks	2	
	Chemical Room	1	PTZ
	Outfall	1	PTZ
Seven Mile	Headworks	No	
	Chemical Room	No	
St. Aubin	Headworks	1	Existing camera in headworks area needs updating
	Chemical Room	1	PTZ

^a PTZ is a point, tilt, zoom camera

5.4.9 Install Local Control Near Process Equipment

GLWA staff requested local control capability for some equipment to improve operability, for example submersible dewatering pumps and mixers at some locations. For areas where local control would provide a benefit, a standard approach would be taken for all CSO Facilities.

- In classified areas, local control stations should be added next to the equipment in NEMA 7 explosion-proof enclosures. Start and stop pushbuttons, local-off-remote selector switches and push-to-test indicating lights would be specified for the local control station. For applications involving VFDs, speed indication and speed control potentiometers should be included on the local control station.
- For non-classified areas, local control stations should be added next to the equipment in NEMA 4X stainless steel enclosures. Start and stop pushbuttons, local-off-remote selector switches and push-to-test indicating lights would be specified for the local control station. For applications involving VFDs, speed indication and speed control potentiometers should be included on the local control station.

The local control stations would require new conduit and wire back to the motor starters, typically located within MCC. The internal control circuits would need to be modified and updated to include the additional local control stations.

For typical applications, the multi-conductor exposed cables would route up through the wet-well to either quick-disconnect devices, or permanent terminal boxes. Seal-off fittings would be incorporated where required by code between the local control stations and terminal boxes/quick-disconnect devices.

The Instrumentation and Control sections of each facility provide the locations where remote control of equipment was recommended by O&M staff. These include:

- Baby Creek screens (see Section 6.2.7.3)
- Hubbell Southfield dewatering pumps (see Section 9.2.7.3)
- Leib fine screens (see Section 8.2.1.3)
- St. Aubin dewatering pumps (see Section 14.2.7.3)

5.4.10 Automatic Transfer Switch and Generators Controls Upgrade

Seven CSO facilities have standby generators (i.e., Belle Isle, Conner Creek, Hubbell-Southfield, Leib, Puritan-Fenkell, Seven Mile, and St. Aubin). The reliability of these generators and automatic transfer switches (ATS) has declined over recent years. During utility power outages when the standby generators are necessary, either the generators do not start automatically, or the ATSs do not transfer. In addition, the generator control panels and the ATSs do not report status or alarm signals to the operators through the SCADA Ovation control system.

The “Automatic Transfer Switch and Generators Controls Upgrade” project is an ongoing project that will address these issues. Under this project, the CSO facilities with standby generator systems will be upgraded to have a standardized, dedicated automatic transfer control system. In addition, the project will include the following:

- 1) The PLCs or other controller styles will be replaced with modern, standardized, microprocessor-based automatic transfer controllers.
- 2) The front panel of ATS panels not being fully replaced will be reconfigured to be standardized across all CSO facilities. A remote human-machine interface (HMI) screen dedicated for the automatic transfer system will be provided.
- 3) Local generator panels will be evaluated for compatibility and reliability.

- 4) Ovation displays will be standardized and useful inputs (alarms, configuration, status) will be included.

5.4.11 Study for Disabled Motor Moisture Detection Capabilities

Throughout many of the CSO Facilities, motor moisture detection used for mixers and dewatering pumps has been disabled using wire jumpers to bypass the shutdown control circuits. While this practice could be considered acceptable during emergency situations, the problem comes from not removing the wire jumpers after the CSO event and correcting the underlying moisture problem in the motors. As time goes on, these jumpers are forgotten about, as well as additional, new jumpers being added for other motors. Jacobs recommends a study of all facilities to identify the location of all existing jumpers used on the motor moisture detection circuits and then develop a plan to remove the jumpers and correct the motor moisture detection issues.

5.5 Structural

A Structural Rehabilitation Needs Assessment, dated August 2018, was conducted by NTH Consultants for all nine CSO facilities under a separate project. In this assessment, NTH assessed structural defects in aboveground buildings and belowground structures. The purpose of this assessment was to provide bridging documents for an upcoming CSO Structural Rehabilitation design/build project, which is scheduled to begin in early 2021. As such, it is not considered a complete list of all the structural defects. The selected design-build firm will be generating an updated, more complete list of defects at the start of their project. Because the structural assessment will be completed soon, structural rehabilitation capital costs are not presented in this report.

5.6 Building Roofs

A Roof Asset Condition Assessment, dated July 19, 2018, was conducted by NTH Consultants under a separate project for eight of the nine CSO facilities. (Puritan-Fenkell was not included in the assessment because a planned roof replacement was out for bid at the time of the inspections). The purpose of this assessment was "to visually examine the facility roofs, determine needs and priorities, and recommend optimal remedial roofing work strategies that will ensure a maximum return on investment and optimize the use of facility maintenance funds." The assessment included the size (in square ft) of each roof, roof membrane type or composition, slope, year installed, roofing contractor, roof system manufacturer, and roof condition/service projection. Each roof was rated good, fair, or poor. The results of the 2018 roof assessment are included in Volume 6 – Appendices, Appendix H.

The results of the roof condition assessments were used by the CS-299 team to populate the condition of the roofs for each facility in CS-299 Condition Assessment. In some cases, the roof has been replaced since the assessment; these scores have been adjusted accordingly.

5.7 Safety

5.7.1 CSO Facility Safety Inspection

Under CS-299, Jacobs conducted a safety inspection of all the CSO facilities in January 2020. The purpose of the safety inspection was to identify safety-related issues. The report identified whether the issue should be addressed through a future capital improvement or non-capital projects. The findings of the safety inspections were presented in the CSO Facility Safety Inspection Report, dated March 30, 2020, included in Volume 6 – Appendices, Appendix E.

5.7.2 Safety-Related Capital Improvement Projects for Each Facility

Safety-related capital improvement projects at the CSO facilities generally fall into one of the following categories:

- 1) Fall Protection Improvements – the approach for fall protection and recommended improvements are discussed in Section 5.7.3.
- 2) Eyewash and Emergency Shower Improvements – to be included in each facility Safety cost estimate.
- 3) Exit Sign Improvements – see discussion in the following paragraphs for proposed project to address these issues.
- 4) Conner Creek Conveyor Improvement – See Conner Creek Screening section (Section 8.2.1.2) for project that is addressing this issue.

Emergency Lighting: Emergency lighting issues identified in the Safety Inspection Report are not included in the capital improvement projects since it is understood by Jacobs that these issues will be addressed in the recently completed LED Lighting Project.

Exit Sign Improvement Project: Illuminated exit signs and emergency lighting were not functioning or not present at many locations. Emergency lighting is being addressed in the ongoing LED Lighting Project. The emergency lighting project may provide illumination of exits in various locations, thus affecting the exit locations that need to be addressed in this project. Also, some of the exit sign bulbs may simply need to be replaced. As such, it is recommended that Exit Sign Improvement projects include an exit route survey at each facility meeting NFPA 101 (Life Safety Code) requirements, Michigan Building Code requirements (2015 ver.) and MIOSHA regulations. This task is being addressed in a separate project under Task Order Engineering Services (TOES). As such, capital costs are not included in this section.

Safety-related capital improvement projects are recommended for each individual facility. The detailed cost estimates in Volume 6 – Appendices, Appendix C provide the safety-related items included for each facility.

5.7.3 Fall Protection Improvements

Using the information presented in the Safety Inspection Report, preliminary recommendations for improvements at each hatch opening were generated. These are included in Table E-1 in Volume 6 – Appendices, Appendix E. The purpose of this table is to provide a basis for the project cost associated with fall protection. Design of some of the safety recommendations will be required, and, therefore, the costs may change in the future.

The following general approach was used for the preliminary recommendation at each hatch opening:

- 1) In general, permanent railings are preferred since they provide the most reliable protection. This includes most roof access hatch locations. It also includes other locations where there are no traffic or access issues. However, permanent railing are not practical at all locations due to the need to maintain traffic or access. These locations need to consider some other form of fall protection.
- 2) For hatch openings for equipment removal, where permanent railings are not practical, GLWA O&M staff has requested that nets be provided.
 - For equipment openings with double leaves where each side is at least 3.5 ft high (42-in.) when opened, chains could be added to the existing leaves at the top and middle. This would provide fall protection for these hatch openings.

- For equipment openings where the hatch leaves are not 3.5 ft high, Jacobs recommends temporary/portable railings be provided to protect other staff at locations where the hatch could be left open and the net pulled back for equipment removal for an extended period of time. The temporary railings can be either custom-made railings from a local fabricator that slide into cored holes in the floor (for inside locations only), or they could be standard portable railings purchased from a handrail manufacturer.
 - If temporary railings are not acceptable for these equipment openings, Jacobs recommends that D-rings be used in conjunction with staff in a safety harness to provide fall protection for the worker while removing/installing equipment.
- 3) For hatch locations for ladder access into confined spaces (i.e., basins or vaults), a portable davit in conjunction with a worker safety harness is recommended, as the davit provides both fall protection and aids in personnel rescue, if needed. A ladder ratchet system could also be used for fall protection; however, it is not as effective for retrieval.
 - 4) All ladders should have retractable safety posts at the top of the ladder for improved safety when entering or exiting the opening.
 - 5) At Conner Creek at the time of the Jacobs safety walk-through, it was noted that many small (2 ft by 2 ft) hatches for lighting in the basin were left open. Netting is recommended at these locations as a permanent safety measure, as well as D-rings to provide fall protection during light bulb replacement.

In addition to fall protection, other modifications or enhancements are needed at some hatches to address various deficiencies. These issues are included in the “Additional Items” column of the spreadsheet and should be more thoroughly evaluated during the detailed design for modifications to the hatches at each facility. The most notable modifications include:

- 1) Replacing the 16 plates over the mixers at Leib with hatches.
- 2) Re-orienting the basin access hatches, as necessary, to make closing the hatch safer. See Figure 5-9 for an example at Belle Isle basin where staff must reach across opening to actuate the red handle to close the hatch.



Figure 5-9. Example of Need for Re-orienting the Basin Access Hatches

- 3) Replacement of the cylinders to aid hatch opening and closing should be evaluated at the time of replacement of all hatches.
- 4) Installation of a ladder safety system or personal fall arrest system for existing fixed ladders over 24 ft in height by November 18, 2036, for any section of the fixed ladder/cage/well that is replaced, or for any new fixed ladder exceeding 24 ft in height, per revised OSHA standard 1910.28(b)(9). Existing cages on ladders will require replacement with an alternate fall arrest system or ladder safety system to meet the revised standards.
- 5) A preliminary list of ladders with cages are presented in Table E-1 in Volume 6 – Appendices, Appendix E. It is recommended that the replacement of existing ladder cages be included in future capital improvement projects between now and 2036, and as such, cost estimates are not included in this assessment.

Other fall and trip hazards were present at several locations. These are listed in Table E-1 in Volume 6 – Appendices, Appendix E. Many of these hazards can be addressed with the addition of fall protection features such as temporary railings and are generally included in the cost estimates for each facility. Note, that since the safety inspection report was issued in March 2020, Jacobs was notified by GLWA that swing gates are current practice – chains are not acceptable fall protection. The project costs for fall protection for each individual facility are presented in the facility-by-facility Safety sections.

5.8 Maintenance Work Order Review

The CS-299 CSO Facilities Assessment scope of work required Jacobs to review historical maintenance work orders (WOs) as one component of the Facilities Assessment. The purpose of this review was to determine whether useful information can be obtained from the WOs to aid in the identification of future improvements to the assets, specifically related to capital improvements. For example, if there is evidence within an asset's work order history that pointed to recurring problems, this evaluation could potentially identify that asset to be a candidate for capital improvement to address the issue.

The WO review, included in Volume 6 – Appendices, Appendix F, presents the findings from the review of historical maintenance work orders from 2013-2018. As indicated in the summary, this review did not provide significant information that is useful to determine the need for capital improvements to assets. While there are several WOs that address asset repairs, these generally appear to be normal wear items and do not indicate an installation or performance concern. Information from this review was used to compare reliability of chemical induction mixers.

6. Baby Creek CSO Control Facility

6.1 Facility Description and Future Capacity Considerations

6.1.1 General Facility Description

The Baby Creek CSO facility is a SDF with 3 million gallons (MG) of storage, and a treatment capacity of 5,100 cfs. It was constructed in 2006. The facility has a nearly 1-mile long effluent conduit used for disinfection contact time before discharge into the Rouge River. The facility consists of one main building with a large Headworks, Chemical Room, utility support (two Electrical Rooms and a Mechanical Room), control room and other miscellaneous rooms. The facility also includes a small, off-site effluent sample building near the end of the effluent conduit and outfall access at the Rouge River (Miller Road Gates).

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

6.1.2 Future Capacity Considerations

Based on a review of the WWMP and discussions with GLWA, there were no future increased capacity considerations identified at this facility.

The high water levels in the Great Lakes and Lower Rouge River, however, have created the need for using the bypass gates during peak flows of larger wet weather events, before the design-rated capacity of the screens is reached. This issue is further discussed in the Screening and I&C in the following sections.

6.2 Facility Assessment

6.2.1 Screening

6.2.1.1 Description of Existing System

The Baby Creek CSO facility has 16 perforated panel screens that were installed in 2006. The influent weir to the first four screens is set one foot lower than the remaining 12 screens so that only the first four screens are used during smaller storm events and lower flow periods. This means flows are preferentially sent through the Elmer Ternes barrel of the Outfall.

Soon after startup of the facility, the screens significantly blinded during a large wet weather event due to heavy leaf load in the influent wastewater. Water backed up in the sewer system causing flooding issues in the community upstream of the facility. Modifications were made to the screens to address this issue including running the units at high speed (VFDs were provided for the original system and are still installed, but now they are only run at high speed) and eliminating the start/stop control of the screens based on differential level. Currently, the screens are operated when the water level spills over the influent weir wall. Furthermore, a bypass channel was constructed around the screening and disinfection portion of the facility. This bypass channel can be and has been used when there was reported blinding of the screens during high flow events or when levels in the influent sewer are high.

The operators report that they have used the bypass about four to five times during the past two years, which is more frequent than in the past due to the unprecedentedly higher water levels in the Great Lakes over the past year. When the bypass gates are opened, the bypassed flow does not receive screening or

disinfection, making this a significant issue. Bypasses are considered a violation of the NPDES permit by EGLE.

Screenings from the screens discharge into a sluice channel. The screens are equipped with a rotating brush and spray water to aid in the removal of the screenings from the screen. Flushing pumps pump raw wastewater to the sluice channel to convey the screenings to the Toward Treatment Sewer.

Table 6-1 provides an overview of the existing screening system at Baby Creek CSO facility.

Table 6-1. Overview of Existing Screening System at Baby Creek CSO facility

Parameter	Value
Treatment Capacity (cfs)	5,100
No. of Screens	16
Manufacturer	US Filter – John Meunier (now Veolia)
Screen Type	Perforated Panel Screen
Opening Size	6-mm perforation
Depth or Length / Width	26 ft 6 in / 10 ft 0 in
Screen Cleaning	Brush and high-pressure spray
Screening Removal	Conveyed through sluice trough to Toward Treatment Sewer and to WRRF

6.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Improve existing screens for blinding and reliability. Note that the evaluation of screen blinding is presented in the next section. It was determined that blinding was not a major issue and does not require a capital improvement. During the investigation, however, a potential improvement to the screen brushes was proposed and is evaluated under Replace Existing Screen Brushes (Project BC-SCR-1).
- Evaluate maintenance access to Screen 5. Unlike the other 15 screens, Screen 5 is unable to tilt up to Headworks floor due to interference by a large tipping bucket. Jacobs contacted Veolia to obtain input on maintenance procedures for this screen, given this constraint. They indicate that this screen needs to be only slightly pivoted to make the lateral doors near the bottom of the screen accessible and work on the bottom elements (i.e., sprockets, stub shafts, bushing, etc.) needs to be performed in the channel. Based on this input, this issue is not evaluated further.

6.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with a recommended alternative.

Improve existing screens for blinding and reliability. Operations staff reported that the screens blind about twice per year, once in the spring and once in the fall. If blinding is occurring, it may be increasing upstream water levels such that bypassing of the screens is required, which is a permit violation.

An assessment of screen blinding was conducted under CS-299. SCADA data was collected for seven storms between July 2017 through January 2020 for water levels upstream and downstream of the

screens. This information was used to evaluate the level differential (i.e., upstream level minus downstream level) through the screen during the entire storm event. If the screens blind, the level differential through the screen will increase significantly compared to the rest of the event.

Table 6-2 provides a summary of the storms and the level differentials.

Table 6-2. Peak Total Influent Flow and Screen Level Differential During Storm Events

Storm Date	Peak Total Influent Flow (cfs)	Level Differential Throughout Storm (inches)
11/18/17	952	5 – 8
4/15/18	614	5 – 8
5/12/18	878	5 – 9
10/2/18	405	5 – 8
7/7/19	872	19 – 31
10/27/19	1149	6 – 7
1/11/20	1444	6

Figure 6-1 and Figure 6-2 show water levels upstream and downstream of the screens as well as the river elevation and flow for the two storm events in October 2019 and January 2020, respectively. The upstream water level is shown in light and dark green and the downstream water level is shown in red and magenta. The screen differential levels in Figure 6-1 and Figure 6-2 are representative of all of the storms except for the July 7, 2019, storm as discussed below.

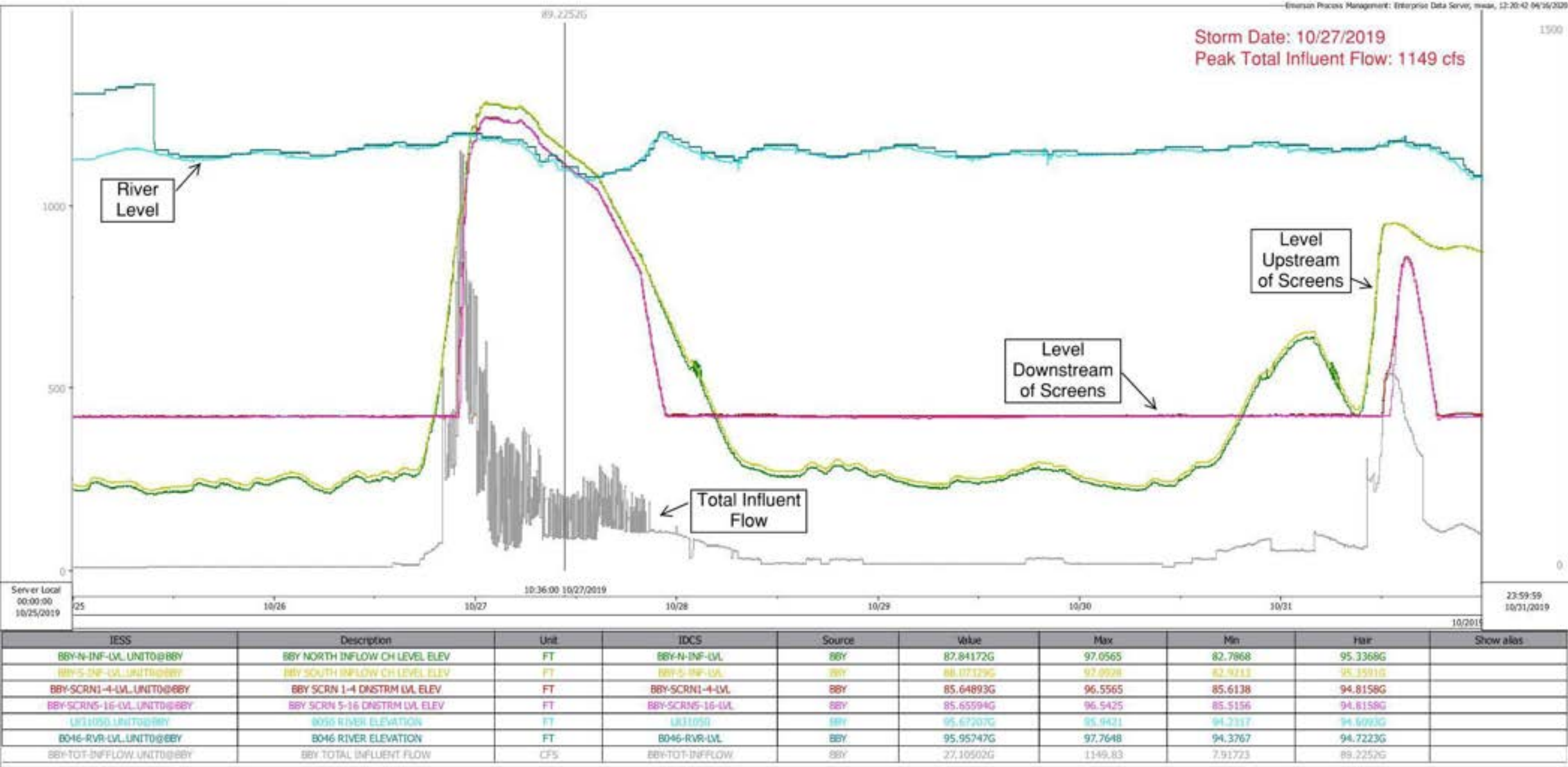


Figure 6-1. Screen Differential Level during October 27, 2019 Storm

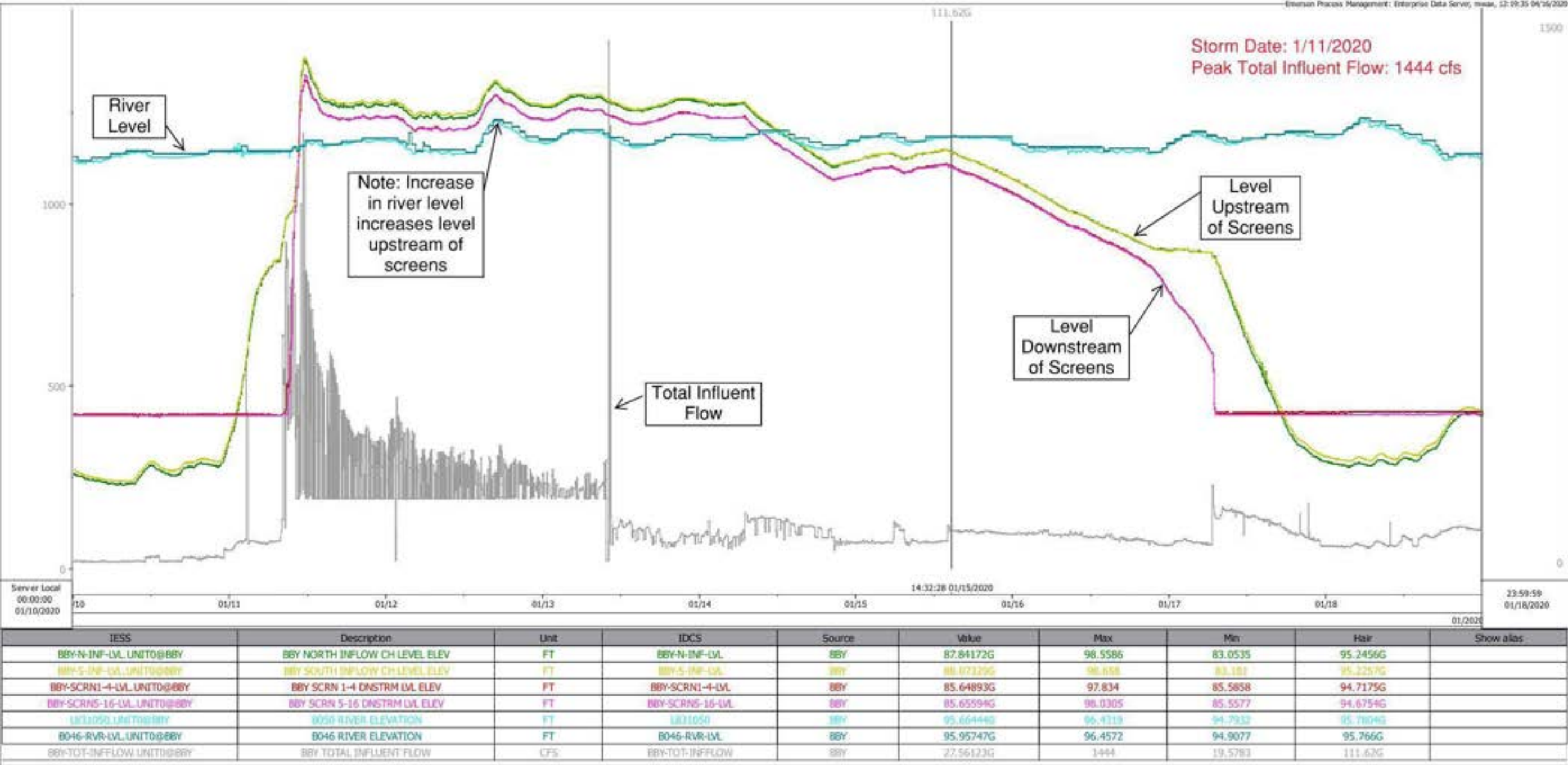


Figure 6-2. Screen Differential Level during January 11, 2020 Storm

Below are findings from analyzing the level differential data for all of the events.

- All events show a relatively constant differential across the screen during the entire storm event, regardless of flow rate throughout the storm. It should be noted that the differential through the screens should be greater during high flows and smaller during lower flows. The sensors should be checked for calibration as an annual recurring preventative maintenance (PM) activity.
- The differential varies from storm event to storm event; however, the value is nearly constant through an individual storm event. For example, differential was 6 in. for the entire January 11, 2020 storm and 6 to 7 in. for the October 27, 2019 storm. One storm (July 7, 2019), however, had differential of 19-31 in. throughout the storm event. This range was due to the fact that the influent level sensors had a 12- in. difference between the two readings for the entire event, which is not considered accurate.
- There are spikes in the level at the beginning of two events (May 11, 2018 [not shown] and January 11, 2020). These could be considered blinding caused by a first flush since the level rapidly increases, then decreases. In fact, for the January 11, 2020 storm, the bypass gates had to be opened at the beginning of the event. However, the downstream level shows the same spike. This indicates that blinding is not the cause of the spike in level. Rather, it is likely caused by the rapid increase in flow to the facility.
- The January 11, 2020 demonstrates that the river level affects the upstream levels. As noted on the figure (Figure 6-2) on January 12, 2020, an increase in the river level increases the downstream and the upstream screen levels.

Based on the constant level differential across the screens during large storm events, the screens do not show evidence of blinding. This issue was reviewed with GLWA on April 16, 2020. It was concluded that blinding was not occurring. As such, capital improvements intended to specifically reduce screen blinding will not be beneficial.

Replace Existing Screen Brushes (Project BC-SCR-1). During the investigation of the blinding issue and previous Veolia site visits, Veolia indicated that there is a new type of brush mechanism for the screens. The current mechanism is stationary, and a newer, current version of the mechanism is self-adjusting. All new screens of this type from Veolia have self-adjusting brush mechanisms. Reportedly, the self-adjusting brush maintains better contact with the screen panels at a constant pressure as the panels pass by the brush improving removal of screenings and extending brush life. The existing screen could be retrofitted with the new mechanism to potentially improve screenings removal and extend the life of the brush.

Due to the lack of supporting data related to the benefits of the newer brushes, GLWA could consider piloting the self-adjusting brush mechanism on two of the more frequently used screens (i.e., Screens 1 to 4) to compare its performance and the impact on brush life. Based on these results, GLWA would be able to determine whether to replace the brush mechanisms on the remaining screens. As such, there are two alternatives with this option:

- 1) **Alternative 1: Replace Existing Brushes In-Kind.** Replace with stationary brushes for two screens.
- 2) **Alternative 2: Pilot Self-Adjusting Brushes.** Replace with self-adjusting brushes for two screens.

The alternative evaluation is presented in Table 6-3. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 is based on brush costs from Veolia from a recent brush replacement order in 2019. Cost is for two brushes, installed by GLWA maintenance.

- The capital cost for Alternative 2 are included in Volume 6 – Appendices, Appendix C, under this project title, and are based on a quote for two brushes. Installation of the brushes is assumed to be performed by a contractor.

This analysis does not account for a potentially longer life of the brush, which would be determined through the pilot evaluation. Review of the NPV/Benefit costs, however, shows that the self-adjusting brushes would need a longevity of approximately four times longer than the existing brushes to be considered the Best Value Alternative. It is not anticipated that the self-adjusting brushes would have a longevity long enough to be considered the Best Value Alternative. As such, **Alternative 1: Replace Existing Brushes In-Kind is the recommended alternative.** Because this should be considered a wear item, it is not included in the capital improvement projects; rather, brush replacement should be included in a Capital Outlay for these screens.

Table 6-3. Alternative Evaluation for Replace Existing Screen Brushes (Project BC-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Screen Brushes In-Kind	Health and Safety	3	2.40	\$ 36,000	\$ -	\$ 36,000	\$ 15,000	Best Value Alternative
	<i>Definition:</i>	Replace existing screen brushes in-kind when they have worn	Water Quality & Compliance	2						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Shorter brush useful life due to higher wear rate. Not as effective at cleaning the screen.	Component Performance	2						
	<i>Comments:</i>	Brush costs from Veolia. Assumes GLWA labor for installation.	O&M Ease	2						
2	<i>Alt. Name:</i>	Pilot Self-Adjusting Brushes (Two Screen Pilot)	Health and Safety	3	3.00	\$ 173,000	\$ -	\$ 173,000	\$ 57,667	
	<i>Definition:</i>	Install higher performance self-adjusting brushes.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher cleaning performance. Longer life due to less wearing.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	Although new brushes may last longer than existing bushes, this evaluation assumes the new brushes have the same useful life.	O&M Ease	3						

6.2.2 Disinfection

6.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of four rubber-lined steel tanks, eight self-priming centrifugal pumps with VFD speed control, eight disinfectant rapid mix zones, and 32 induction mixers. There are 16 screens and the flow from each pair of screens is funneled into a disinfectant rapid mix zone. There are four induction mixers per disinfectant rapid mix zone consisting of two low level mixers and two high level mixers. The sodium hypochlorite pumps discharge to two headers, one smaller than the other, which run the length of the Headworks and each connect to the manifold feeding the four induction mixers at each rapid mix zone. Flow splitting between the four induction mixers is not metered and is dependent on functioning back pressure valves with equal upstream pressure settings.

Table 6-4 provides an overview of the existing disinfection system at Baby Creek CSO facility and the disinfection process flow diagram is included in Volume 6 – Appendices, Appendix G.

Table 6-4. Overview of Existing Disinfection System at Baby Creek CSO facility

Parameter	Value
Treatment Capacity (cfs)	5,100
Design Feed Strength (% hypochlorite)	5
Max. Dosage at Design Flow (mg/L as Cl ₂)	20
Disinfection Contact Time (min)	10
Storage Tanks	
Number	4
Volume of Each Tank (gal)	36,000
Type	Rubber-lined steel
Pumps	
Number	8 Total; 2 low-rate, 3 mid-rate, 3 high-rate
Capacity (gpm)	Low-rate: 0-50, Mid-rate: 0-150, High-rate: 0-400
Type	Centrifugal
Mixers	
Number / Type	32 / Chemical induction mixers
Model Number/ hp / Manufacturer	SWC15XPL/ 15 hp / Water Champ

6.2.2.2 Identified Needs and Issues

The needs and issues for Baby Creek were identified from meetings with O&M staff and Jacobs team site visit and investigations. The identified needs and issues are listed in the following bullets:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Baby Creek chemical feed system has the following issues:
 - The pumps and pipe supports in the vicinity of the pumps are corroding as a result of exposure to sodium hypochlorite.
 - A glued polyvinyl chloride (PVC) joint fails at an approximate rate of one every three months in the Chemical Room.

- The pumps have traditional drives requiring seal water, are reaching the end of their useful life, and include self-priming accessories adding to their complexity and increasing their footprint.
- The chemical piping is complex and congested.
- The back pressure valves controlling the chemical feed split between the four induction mixers at each disinfectant rapid mix zone are suspected of not functioning properly.

These issues are addressed in Replace Chemical Feed System (Project BC-DIS-1) in the next section.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Project BC-DIS-2) in the following bullet.
- There are 32 chemical induction mixers that require relatively frequent and costly maintenance. This issue is addressed in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project BC-DIS-3).
- Inefficient mixer removal system – includes evaluation of monorail vs. gantry cranes with electric hoist and electric trolley to replace existing hand chain hoist. This issue is addressed in Improve Mixer Removal System (Project BC-SUPP-1) at the end of this facility section.
- Modify floor slope in Chemical Room to drain to sump – This issue is addressed in the Architectural section (Section 6.2.9.3).
- Reline chemical storage tanks – Based on an inspection in 2020, the tanks are in need of relining to provide extended life. The repair/replacement of the liner is an ongoing project, so it is not included in the capital improvement projects for CS-299. The SRP model was manually adjusted to recognize the improvement of this ongoing project.
- Related to the relining of the storage tanks, GLWA requested that Jacobs review the historical and expected chemical usage compared to tank storage capacity to determine whether to reline all four tanks or only two or three tanks. Sodium hypochlorite usage for the four largest storms from 2016 through early 2019 was evaluated. The volume used was based on tank levels rather than flow meters because of suspicious flow meter data. The analysis indicated that the maximum used as a percent of total tank volume was 49 percent. This would indicate that the minimum number of tanks to be relined would be two. Had a larger storm occurred than the period analyzed then more than two tanks would be required assuming all other things equal (i.e., assuming the same dose and hypochlorite strength). Using more conservative assumptions of a 15 mg/L average dose and an assumed 5 percent hypochlorite strength, a volume in excess of the total four tank volume would be required. At an assumed dose of 15 mg/L and 9 percent hypochlorite strength three tanks would be fully consumed. Given the possibilities of a larger storm, hypochlorite degradation down to 5 percent, or the need for a higher dose, it is recommended that all four tanks be relined to retain the original design capacity at Baby Creek.
- Sump pump replacement in Chemical Room – This is an ongoing project. As such, it is not included in the capital improvement projects for CS-299.
- Chemical make-up water actuator replacement in Chemical Room – This is an ongoing project. As such, it is not included in the capital improvement projects for CS-299.

6.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project BC-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, BC-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

The alternative evaluation for these alternatives is presented in Table 6-5. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP and include pump replacement at Year 10.
- The capital costs for Alternative 2 and 3 are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 was developed based on GLWA experience of two pump rebuilds per year at a cost of \$13,000.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 6-5 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 6-5. Alternative Evaluation for Replace Chemical Feed System (Project BC-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System In-Kind	Health and Safety	3	2.08	\$ 1,657,301	\$ 26,000	\$ 2,205,631	\$ 1,058,703	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with feeding too much chemical. System is unique to Baby Creek.	Component Performance	1						
	<i>Comments:</i>	Capital costs include pump replacement at Year 10	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 3,325,000	\$ 44,550	\$ 4,264,543	\$ 1,184,595	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per disinfection channel. Utilize hose pumps.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual switchover.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 1,237,000	\$ 4,000	\$ 1,321,359	\$ 367,044	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps connected to all disinfection channels. Utilize centrifugal pumps.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily utilized.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each disinfection channel.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Project BC-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Operation in manual at Baby Creek is noted by operations as being extremely difficult. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

The sample point should be located approximately 15 minutes travel time downstream of the dosing point at average flow but peak flow travel time must also be considered. The exact location would be determined during design. Based on the evaluation of a few years of recent data, the average flow rate during storms at Baby Creek is about 108 cfs. This is a very small percent of the design storm and 15 minutes contact time at average flow will be only a short distance downstream of the dose point (approximately 500 ft). The sampling location needs to be upstream of storm sewer flows which would dilute the measurement. If there is an existing access point that meets the criteria, then this should be explored during design. However, the cost of a new manhole will be assumed to access the sampling pump.

The automatic chemical feed system should require less operator input during an event; however, this cost difference is not included in this analysis because GLWA O&M staff believe that manual sampling to confirm the auto sample result will still be necessary. There will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 6-6. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains ready for service.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be consistently met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 6-6. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project BC-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less efficient chemical feed and possible overdosing of chemical.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 201,000	\$ 4,860	\$ 303,496	\$ 87,970	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more efficient use of chemical.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult with infrequent CSO facility use.	Component Performance	4						
	<i>Comments:</i>	O&M to maintain analyzers based on 3 hrs/month.	O&M Ease	2						

Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project BC-DIS-3). Plant personnel reported that the mixers are expensive to maintain and due to the sealed nature of submersible mixers they must be sent back to the manufacturer for maintenance which adds shipping cost and takes months before the mixer is returned to service. These issues are exacerbated by having 32 mixers at Baby Creek, which is the second-highest of the nine CSO facilities. A reduction in the number of mixers would reduce maintenance and the associated expenses proportionate to the reduction. It would also reduce the complexity of equal flow splitting between mixers.

The alternatives to address this issue were identified previously in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Section 5.2.4). The alternatives include:

- 1) **Alternative 1. Replace Existing Chemical Induction Mixers In-Kind.** This alternative assumes replacement of the mixers in-kind.
- 2) **Alternative 2. Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers.** CFD modeling is assumed to be required to demonstrate to EGLE the adequacy of a lesser number of mixers. For illustration purposes, it is assumed that the number of mixers can be reduced by half (i.e., from four to two per channel) based on the fact that the latest model shows design flows are about half of the original design flows.
- 3) **Alternative 3. Install Vertical Shaft Mixers.** This alternative would replace the existing chemical induction mixers with new vertical shaft mixers. For Baby Creek, two mixers would be provided per channel.

The alternative evaluation is presented in Table 6-7. The sources of costs used in this evaluation are listed in the following bullet:

- The capital cost for Alternatives 1 and 2 includes mixer replacement in-kind at the number of mixers shown. Capital costs are based on the SRP replacement cost of \$50,000 per mixer and a 10-year life. Because the life-cycle period is 20 years, the capital costs assume replacement of the mixers twice during the 20-year period.
- For Alternative 2, the cost of the CFD model is assumed to be \$50,000.
- The O&M costs for mixer replacement in Alternatives 1 and 2 is based on current costs for repairing a chemical induction mixer. It is assumed the mixer needs to be repaired every 2.5 years at a cost of \$18,000 per mixer.
- The capital cost for Alternative 3 (vertical shaft mixers) is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 3 (vertical shaft mixers) are based on expected maintenance costs, including changing oil, greasing bearings, periodic rag removal from the shaft and servicing the steady bearing.

As shown in Table 6-7, Alternative 2 has a Total Benefit score about 0.4 higher than Alternative 1 because of the improved ease of maintaining fewer mixers. Alternative 3 has a Total Benefit score about 0.3 higher than Alternative 2 based on the anticipated improved performance of the vertical mixers and improved ease of maintenance, since the mechanical portion of above the water surface. **Alternative 2, however, has the lowest NPV/Benefit cost and therefore, is the recommended alternative.**

It should be noted that the cost of the reduced mixers is not a new capital cost for GLWA. Rather, it was used in this evaluation to compare alternatives. The cost for the CFD modeling would likely be included in a capital outlay, not a capital improvement project. If the CFD modeling does not prove that disinfection performance can be achieved, the vertical mixer alternative should be further explored, possibly through the pilot testing of this technology in one of the channels at Baby Creek or Conner Creek.

Table 6-7. Alternative Evaluation for Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project BC-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Induction Mixers In-Kind	Health and Safety	3	2.57	\$ 3,200,000	\$ 230,400	\$ 8,059,052	\$ 3,139,890	
	<i>Definition:</i>	Replace existing mixers as required.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, lots of redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Expensive and impacts operations and maintenance. Equipment installed in channels. Possible ragging issues.	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement 2 times during 20-year period.	O&M Ease	1						
2	<i>Alt. Name:</i>	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	Health and Safety	3	3.00	\$ 1,650,000	\$ 115,200	\$ 4,079,526	\$ 1,359,842	Best Value Alternative
	<i>Definition:</i>	Perform CFD modeling to simulate performance with fewer mixers (assumed 50% of existing).	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less expensive and less impacts to operations and maintenance. Equipment installed in channels. Possible ragging issues.	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement 2 times during 20-year period & CFD Modeling of \$50,000.	O&M Ease	3						
3	<i>Alt. Name:</i>	Install Vertical Shaft Mixers	Health and Safety	3	3.32	\$ 7,033,000	\$ 56,000	\$ 8,214,020	\$ 2,476,589	
	<i>Definition:</i>	Replace existing mixers with vertical shaft mixers.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less equipment to operate and maintain. Overall less install horsepower. Equipment is above the basin and accessible in a non-confined space environment. Maintains redundancy requirements.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Bearing in bottom of channel. Possible ragging issues.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

6.2.3 Odor Control

6.2.3.1 Description of Existing System

The Baby Creek odor control system is a Calgon Carbon PHOENIX automatic regeneration system, which utilizes radial flow canisters filled with Centaur HP carbon. Several years ago, Calgon Carbon sold its odor control equipment division to Continental Carbon along with the Centaur HP carbon. The unit consists of 26 compartments of five canisters each for a total of 130 canisters. Foul air is delivered from the Screening Building by the odor control fan and is uniformly distributed through the carbon canisters, bringing the air in direct contact with the carbon. Centaur HP carbon contains a catalyst that oxidizes hydrogen sulfide (H_2S) and converts it to sulfuric acid. As a result, the carbon can be restored for H_2S uptake by water washing. The regeneration process consists of filling a single compartment of canisters with water, letting the water sit for a period of time, and then draining and drying the carbon. The system was installed in 2006. The carbon has not been replaced since installation.

This odor control system operates under air permit requirements (Permit to Install No. 69-90). The emission limit is 0.04 pounds per hour of H_2S . At a design air flow of 26,000 cubic feet per minute (cfm), this equates to approximately 0.3 parts per million volume concentration of H_2S . The permit does not require sampling of emissions of carbon media unless the Michigan Department of EGLE specifically requests it.

Per GLWA, no odor complaints have been received for at least the past three years.

6.2.3.2 Identified Needs and Issues

During meetings with O&M staff related to the odor control system, no needs were identified. The recommendations in this section are based on the Jacobs team evaluation of the existing system.

Future Carbon Replacement Considerations. Carbon eventually needs to be replaced when the capacity to remove H_2S diminishes to the point that the discharge does not meet permit limits. Carbon replacement can be expensive, and the frequency and type of carbon should be carefully considered. This section presents considerations for carbon replacement.

The Centaur HP carbon loses capacity over time for several reasons. The main mechanism is loss of adsorption sites due to compounds other than H_2S . Other odorous compounds like organic sulfide compounds remain adsorbed to the carbon and are not removed during the regeneration process. Chlorine and other compounds that may be present in the regeneration water will adsorb to the carbon and remain. Another mechanism is residual sulfuric acid that does not get rinsed during the regeneration cycle and remains on the carbon occupying sites. Finally, carbon fines (i.e., tiny pieces of the carbon media) are lost over time as a result of the repeated washing process. The loss of fines reduces the carbon volume, which, correspondingly, reduces the carbon's overall capacity. One typically determines the need for carbon regeneration by measuring the H_2S concentration in the discharged air. When H_2S is still detected in the discharged air after a regeneration cycle, the carbon is spent and should be replaced. Centaur HP replacement is about every two years under typical municipal wastewater applications. GLWA facilities are not typical applications as the odor control systems are operated infrequently and are likely under low loads from H_2S and odorous compounds meaning the carbon will last a lot longer. According to O&M staff, the Baby Creek system is regenerated twice per year based on the recommended PM in the manufacturer's O&M manual. If this frequency has occurred since startup, the system has been washed about 24 times. Under extremely low odor loads, the carbon can be depleted faster due to compounds in the regeneration water like chlorine. Laboratory analysis of the carbon for H_2S capacity is likely the best

way to determine the remaining carbon life for the Baby Creek system. Sampling the discharged air for H₂S breakthrough likely will not be effective due to the likely low H₂S load.

Although the current carbon capacity may be significantly less than the original capacity, the lack of any odor complaints from the community means that any odors being discharged are either not noticeable, not objectionable or are masked by other odor sources in the area. It is recommended that GLWA sample the influent and discharge of the odor control system during at least two storm events in the summer months (i.e., the period with the highest odor potential) to better understand the magnitude of odors generated from the CSO facility and the performance of the current system relative to the existing air permit limits.

If the influent H₂S levels are below discharge permit limits, replacement of the carbon would not be needed. Further testing could then be performed to determine if the carbon could be removed and not replaced. If influent and discharge H₂S levels are greater than permit limits, carbon replacement should be performed in the near future. The following bullets provides considerations for the carbon replacement.

- The existing Centaur HP carbon in the PHOENIX system has an H₂S capacity of 0.09 g H₂S/cubic centimeter of carbon (15 percent by weight). The cost for replacement of the carbon is about \$88,400 (130 canisters at \$680 per canister). The cost includes a new canister, sealing and loading the canister with Centaur HP carbon, and delivery.
- ECS Environmental Solutions (ECS) manufactures a direct equivalent to Centaur HP carbon at a lower cost. ECS reuses the existing canisters. The cost for ECS's water regenerable catalytic carbon is about \$55,250 (130 canisters at \$425 per canister). The cost includes shipping the full canisters to ECS, disposal of the spent carbon, cleaning the canisters, charging the canisters with ECS water regenerable catalytic carbon, and delivery.

As noted above, an evaluation of influent and discharge H₂S concentrations is recommended prior to carbon replacement. When it is time to replace the Centaur HP carbon, GLWA should evaluate replacing it with either Centaur HP or ECS water regenerable catalytic carbon.

6.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement "needs".

6.2.4 Flushing and Dewatering

6.2.4.1 Description of Existing System

Dewatering System: After an overflow event, the effluent conduits and headworks area are dewatered by gravity by opening the sluice gates S-6-1 and S-6-2 to the Oakwood Interceptor. A 3,000 gpm dewatering pump is provided in the flushing pump area to fully dewater the Headworks area.

An alternate mode of dewatering is to allow the screening flushing pumps to continue to operate following an overflow event. This method of dewatering will allow dewatering flow into the Oakwood Interceptor even when the hydraulic grade line is relatively high.

Flushing System: A flushing system for the area in the Headworks upstream of the screens consists of two tipping buckets. There is one tipping bucket upstream of Screens 1-4 and one tipping bucket upstream of Screens 5-16.

It is noted that a flushing system is not currently provided for the effluent conduits. The nearly 1-mile long effluent conduits have an issue with significant quantities of solids accumulating in the channels (i.e., up to 5 ft deep in some locations). GLWA televised these conduits in 2019. GLWA plans to issue an RFP to address this issue in the near future. As such, this issue is not further addressed in this report.

Table 6-8 provides an overview of the existing flushing and dewatering system at Baby Creek CSO facility.

Table 6-8. Overview of Existing Flushing and Dewatering System at Baby Creek CSO facility

Parameter	Value
Headworks Dewatering and Flushing System	- One 3,000 gpm submersible pump for station dewatering (in Dewatering Sump) - Four 16,000 gpm submersible pumps - typically for screenings conveyance, but can be used to dewater area upstream of screens 2 tipping buckets for the area upstream of screens. Buckets flush toward Dewatering Sump, which pumps to Toward Treatment sewer
Effluent Conduit Dimensions	Three 17.5 ft × 14.5 ft barrel conduits
Effluent Conduit Dewatering and Flushing System	- Sluice gates at end of conduit are used to dewater effluent conduit to the Oakwood Interceptor after storm event. - There is no flushing system in the effluent conduit. <i>Project for a flushing system anticipated in the near future</i>

6.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- A significant amount of solids can accumulate in the influent channel area, immediately upstream of the weir wall at the Headworks. Significant solids buildup can cause hydraulic restrictions and impede inspection of influent flow meters. There is no flushing system at this location and solids removal must be performed periodically by a contractor. A contractor recently cleaned the influent channel area in 2019.
- S-2-1 sluice gate opening does not extend to the bottom of the influent channel to allow for complete dewatering (or solids flushing) of the influent area.
- Address sediment buildup in effluent disinfection conduits. Significant sediment occurs over time in the effluent conduits. An RFP for professional engineering services to minimize the buildup of sediments is planned in the near future to address this issue. As such, it is not included as a capital improvement project for CS-299.

6.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Flushing System in Influent Area (Project BC-FD-1). There are two alternatives for addressing the solids buildup in the influent area and the S-2-1 sluice gate opening. These alternatives include:

- Alternative 1: Do Nothing/ Contractor Clean-Out.**
- Alternative 2: Flushing System in Influent Area.** An identified alternative includes mounting a 6- in. high-density polyethylene (HDPE) flushing header along the backwall of the influent area

approximately 8 ft above the adjacent lower concrete surface. See Volume 6 – Appendices, Appendix B for figures (Figure BC-FD-1-ALT-2) showing conceptual layouts of this header. HDPE pipe is recommended for this application due to its corrosion resistance and its flexibility that imparts resistance to damage from impacts by heavy debris suspended in wet weather flows. The flushing header should be specified with an adequate wall thickness to allow for directionally drilled holes (up to 3/4- in. diameter) that create a water jet aimed in a specific direction toward the opening of Gate S-2-1. This gate is normally closed during dry-weather operation. A subsequent project to lower the invert of this opening is included in this set of recommendations.

The proposed hole spacing along the header is approximately 18 to 24 in. A total flow rate of at least 900 gpm is estimated to adequately remove sediment from the concrete shelf above the dry-weather flow channel and maintain adequate volume and velocity to carry the sediment into the dry-weather flow channel post event.

A second HDPE header mounted approximately 5 ft above the dry-weather flow channel with a similar spray hole distribution is recommended to provide additional flow and increase velocity during flushing. This will encourage faster removal and migration of sediment to the reconfigured Gate S-2-1 opening for pumping with the existing dewatering pump and discharge toward the WRRF with its better capacity for solids removal and disposal. A total flow rate of 1,200 gpm is estimated for initial sizing of this header. The benefit of the drilled hole approach to directing a jet of water is that no fittings are mounted on the exterior, and the pipe wall provides enough apparent length such that the hole directs the flow toward the intended surface.

Non-potable water (NPW) will be required. A 6-in. NPW line exists within the Headworks facility and is currently used for screen spray water and for chemical line flushing. The proposed flushing system connection could be made to this existing line within the facility. Flushing of the influent channel should occur after facility flows have significantly receded. As such, the influent flushing water use will not conflict with these other uses.

Following a CSO event, a motor operated solenoid/gate/ball control valve at the NPW pipe connection to the flushing water system will be opened to charge the flushing header. The control strategy assumes that solenoid is activated for a set duration (minimum of 15 minutes) after the level sensors in the influent channel record a water level rise above a pre-determined wet weather elevation and then a subsequent water level drop. A small valve is also recommended at the terminus end of each spray header with a rising stem and automated actuator mounted outside of the chamber. At the start of the cleaning cycle, these valves will automatically open for several minutes, allowing the potable water to flush any materials that have entered the header through openings out the open end. These terminus valves would close, and the header would pressurize and start spraying. Weekly automated cleaning during dry weather periods using this system will help reduce buildup of materials on the shelf and in the dry-weather flow channel.

During initial operation, onsite staff should visually inspect the shelf area to confirm sediment has been adequately removed and then adjust the control system timer to increase/decrease the flushing duration as needed until the system has been optimized. Integration with the facility's SCADA and PLC systems is necessary to achieve this functionality. A new electrical connection to the control valve is also required (110 V) and would be routed from the nearest internal junction box.

The opening for the S-2-1 gate does not extend to the floor of the influent channel. Making the bottom of this gate opening at a lower elevation would allow for flushed solids to enter the dewatering well and staff to be able to dewater the area without using sump pumps. The opening of sluice gate S-2-1 could be modified by removing the existing gate and frame, cutting approximately 2 ft of concrete from the bottom of the opening and remounting a new larger sluice gate.

The existing dry-weather flow channel will require addition of concrete topping to form a positive slope toward the expanded Gate S-2-1 opening, as shown in the drawings. The final designer should

collect and characterize site-specific sediment samples for grain size and density, and use a sediment fate/transport, CFD or scale model to finalize the performance criteria. This will be critical in evaluating and sizing this system to determine the required flow rate to direct sediment and the dry-weather base flow (20-30 cfs) toward the opening of Gate S-2-1.

The opening for the S-2-1 gate does not extend to the floor of the influent channel. Making the bottom of this gate opening at a lower elevation would allow for flushed solids to enter the dewatering well and staff to be able to dewater the area without using sump pumps. The opening of sluice gate S-2-1 could be modified by removing the existing gate and frame, cutting approximately 2 ft of concrete from the bottom of the opening and remounting a new larger sluice gate. Subsequent to the draft Facilities Assessment Report, another consultant (AECOM) analyzed this proposed flushing arrangement using CFD modeling and found that the proposed flow rate in the trough did not significantly suspend sediment within the influent trough. Based on this input, GLWA elected to postpone this project further into the future (at least 10 years out) and re-evaluate again after another round of manual cleaning.

For reference, the alternative evaluation for these alternatives is presented in Table 6-9. The sources of costs used in this evaluation are listed in the following bullets:

- Contractor clean-out of this area is estimated to be \$250,000 every 5 years, based on the cost and amount of solids buildup from the recent cleaning project at this location. This O&M cost is annualized to \$50,000.
- The capital cost for the flushing system (Alternative 2) is included in Volume 6 – Appendices, Appendix C under this project title. It should be noted that the capital cost includes an allowance of \$90,000 for cleaning the influent channel prior to installing the flushing system. The \$90,000 equates to about \$250,000 after contingencies, and standard markups for design, construction assistance and contractor overhead and profit have been applied.
- The O&M costs for the flushing system (Alternative 2) is based on water usage of 2,100 gpm for 15 min every week, for a total of about 1.6 MG per year and a unit cost of \$4,000 per MG.

Based on the results of recent CFD modeling of the flushing system by others showing that the sediment is not significantly suspended, **Alternative 1 – Contractor Clean Out is the recommended alternative.** Although Alternative 2 is not recommended at this time, it is included in the CIP to be reconsidered in about 10-15 years based on experienced gained from contracted cleaning the influent channel.

Table 6-9. Alternative Evaluation for Flushing System in Influent Area (Project BC-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Contractor Clean-Out	Health and Safety	2	2.50	\$ -	\$ 50,000	\$ 1,054,482	\$ 421,793	
	<i>Definition:</i>	Allow solids to build up and have a Contractor clean out the channel, as needed	Water Quality & Compliance	3						
	<i>Adv.:</i>	No system to maintain	Capacity Enhancement	3						
	<i>Disadv.:</i>	Significant build-ups can impact facility hydraulic capacity. Cleaning influent area is a high-risk activity. Requires a great deal of GLWA coordination.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Flushing System in Influent Area	Health and Safety	5	3.78	\$ 787,000	\$ 6,400	\$ 921,974	\$ 243,693	Best Value Alternative
	<i>Definition:</i>	Mount a flushing header along the backwall of the influent area and second flushing header above the dry weather flow channel	Water Quality & Compliance	3						
	<i>Adv.:</i>	Allows flushing after every event.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance of equipment and increased water usage.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

6.2.5 HVAC

6.2.5.1 Description of Existing System

The Baby Creek CSO facility was constructed in 2006. The facility consists of one main building with a large Headworks, Chemical Room, utility support (two Electrical Rooms and a Mechanical Room), control room and other miscellaneous rooms. The facility also includes a small, off-site effluent sample building about a mile from the main building. Table 6-10 provides a summary of the major HVAC equipment at this facility.

Plumbing services for the facility consist of city water service, sanitary system, natural gas-fired water heater, electric water cooler, emergency shower/eye wash, emergency eye wash, and bathrooms with lockers and shower. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 6.2.10.

Table 6-10. Major HVAC Equipment at Baby Creek CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	HV-1 & 2	2 × Heating and Ventilating Units	31,000 cfm and 1,760 MBH
	SF-1, 2, & 3	3 × Supply Fans	45,000 cfm
	EUH-1A to H	8 × Electric Unit Heaters	2,450 cfm and 51.2 MBH
Chemical Room	GUH-5A to 5E	5 × Gas Unit Heaters	1,100 cfm and 60 MBH
	IF-1	Exhaust Fan	2,110 cfm
	IF-2	Exhaust Fan	10,551 cfm
Electrical Room 1	WF-1	Wall Fan (Exhaust)	6,320 cfm
	EUH-2	Electric Unit Heater	700 cfm and 25.6 MBH
Electrical Room 2	WF-2	Wall Fan (Exhaust)	1,000 cfm
	EUH-3	Electric Unit Heater	400 cfm and 17.1 MBH
Control Room	HVAC-1	AHU with Split DX Cooling Coil and Natural Gas Furnace	1,610 cfm 74 MBH Heating 43.5 MBH Cooling
Office	HVAC-2	AHU with Split DX Cooling Coil and Natural Gas Furnace	1,480 cfm 74 MBH Heating 43.5 MBH Cooling

Notes:

AHU = air handling unit(s)

BTU = British thermal units

MBH = thousand British thermal units per hour

Table 6-11 provides a summary of the basis of design performance criteria for HVAC systems at Baby Creek and Table 6-12 provides the outdoor Basis of Design conditions.

Table 6-11. Baby Creek Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Headworks	Class I, Div 1, Group D	60	N/A	12 ACH (Occupied)
Chemical Room	Unclassified	60	100	6 ACH (Cooling Mode) 1 ACH (Continuous)
Electrical Room	Unclassified	70	100	Heat Relief
Control Room	Unclassified	72	72	5 cfm per person & 0.06 cfm/ft ²
Office	Unclassified	72 (Occupied) 50 (Unoccupied)	75	5 cfm per person & 0.06 cfm/ft ²

Notes:

ACH = air changes per hour

cfm/ft² = cubic feet per minute per square feet

Table 6-12. Baby Creek Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

6.2.5.2 Identified Needs and Issues

During discussions with GLWA O&M staff and GLWA's HVAC Contractor, the following HVAC issues were noted:

- Inadequate heating in Control Building: O&M staff noted that when outdoor air conditions are under 20 °F, the furnaces (HVAC-1 and HVAC-2) serving the main Control Building struggle to maintain a setpoint of 70 °F indoors.
- Abnormally short life for Electric Unit Heaters in Headworks Area: Per GLWA's HVAC Contractor, the Electric Unit Heaters in the Headworks Area have a life of 2 to 3 years. The typical expected life of unit heaters which are properly selected for their environment is about 15 years.
- Corrosion issues with Gas Unit Heaters in Chemical Room: GLWA's HVAC Contractor has observed corrosion issues with the gas unit heaters in the Chemical Room. Additionally, the location of one unit over the pump area was noted as making access for maintenance a major issue.

During site investigations (June 2020) the following observations were noted:

- The Chemical Room unit heaters are difficult to access. See Figure 6-3.



Figure 6-3. Chemical Room Unit Heater Located in Inaccessible Area

- Corrosion was visible on unit heaters in the Chemical Room.
- The Transformer Room supplied outside air for ventilation cooling high in the space and exhausted at a low level.
- The large overhead doors were open in the Headworks Area, the relief dampers were closed, and the make-up air unit (MAU) was not running.
- The thermostat on EUH-1 in the Headworks Area was out of calibration.
- Unit heater EUH-2 was turned on in the Headworks Area and it was about 75 degrees outside.
- Corrosion was visible on Trane unit heaters in the Headworks Area.
- Several of the motorized outside air intake dampers for SF-1, SF-2, and SF-3 were not functional. The fans showed signs of significant corrosion.

Improvements are currently ongoing under existing projects including:

- The installation of a new intake louver with integral motorized damper and exhaust fan in the Electrical Room
- Damper motor actuator replacements in the Chemical Room
- Damper and actuator replacements in the Headworks Area
- Various monitoring and control upgrades including control and monitoring of electric unit heaters, fans, dampers and HVAC units.

6.2.5.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Control Building HVAC Investigation and Improvements Study (Air Balance Study). Given that the winter outdoor design condition for the units was 3 °F and that they were designed to heat to 72 °F, the furnaces are not functioning as intended.

If the ongoing controls upgrade does not improve heating at the facility, Jacobs recommends an air balance of HVAC-1 and HVAC-2 to assess whether poor air distribution is the cause of the observed underheating.

If the air balance does not improve heating in the under-heated areas, electric duct heaters can be added to branches of the system requiring additional heat.

Chemical Room Unit Heaters and Ventilation System (Project BC-HVAC-1). The Trane GAND model unit heaters in the Chemical Room have aluminized steel heat exchangers. Sodium hypochlorite is known to have a severe corrosive effect on aluminum. The use of natural gas unit heaters in a sodium hypochlorite environment is generally not recommended due to the potential for corrosion of the unit heaters and subsequent natural gas leakage. There are two alternatives to address this issue:

- 1) **Alternative 1: Replace Chemical Room Unit Heaters and Ventilation System In-Kind.** This alternative assumes the units will be replaced in-kind. Because of the corrosive environment of this room, the units will be assumed to be replaced more frequently than typical unit heaters, as discussed further in the alternative evaluation in the following paragraph.
- 2) **Alternative 2: Replace Chemical Room Unit Heaters and Ventilation System with Air Handling Unit.** This alternative involves removing the gas unit heaters and installing an air handling unit (AHU) with a modulating gas heating section at ground level adjacent to the Chemical Room. The unit would be provided with a VFD to allow the AHU to work in conjunction with IF-1 to maintain a set differential pressure between the Chemical Room and ambient conditions. The AHU would run in conjunction with IF-1 and IF-2 in the summer to provide ventilation for cooling the Chemical Room. The AHU would run continuously at the minimum ventilation rate but would also be provided with a low leakage motorized damper which would close when the unit is not running (when the unit requires maintenance) to prevent backflow of air from the Chemical Room to the inside of the AHU potentially leading to corrosion issues. Locating the heating section in an AHU on the ground level has the added benefit of both reducing the number of pieces of equipment which need to be maintained and providing easier access to the equipment for maintenance personnel.

Figure BC-HVAC-1-ALT-2 in Volume 6 – Appendices, Appendix B, shows a potential location for the AHU. It also shows that the road next to the Chemical Room would need to be slightly relocated to allow adequate room for the AHU. Road modifications are included in the capital cost for this alternative.

The alternative evaluation is presented in Table 6-13. The sources of costs used in this evaluation are listed in the following bullets:

- Capital costs for the unit heaters and ventilation units in Alternative 1 were obtained from the SRP. The costs for the six unit heaters were multiplied by 2, assuming the units would need to be replaced twice during the life cycle of the AHU in Alternative 2.
- The annual O&M cost recognizes that there is less maintenance on the one AHU (Alternative 2) as opposed to the six unit heaters (Alternative 1).
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 is the Best Value Alternative. **As such, Alternative 2 Replace Chemical Room Unit Heaters and Ventilation System with Air Handling Unit is the recommended alternative.** Since Alternative 1 consists of in-kind replacement of the unit heaters and ventilation equipment, these units will be included in the SRP, not a CIP project.

Table 6-13. Alternative Evaluation for Replace Chemical Room Unit Heaters and Ventilation System (Project BC-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Chemical Room Unit Heaters and Ventilation System In-Kind	Health and Safety	3	2.78	\$ 73,400	\$ 5,760	\$ 194,876	\$ 70,015	Best Value Alternative
	<i>Definition:</i>	Replace unit heaters in Chemical Room in-kind, with material compatible with corrosive atmosphere	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Multiple units require increased maintenance	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement of unit heaters 2 times during 20-year period. O&M assumes annual maintenance of 6 hrs per unit.	O&M Ease	2						
2	<i>Alt. Name:</i>	Replace Chemical Room Unit Heaters and Ventilation System with Air Handling Unit	Health and Safety	4	3.60	\$ 236,000	\$ 2,400	\$ 286,615	\$ 79,615	
	<i>Definition:</i>	Replace unit heaters in Chemical Room with a make-up air unit outside Room at ground level	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier access for maintenance, fewer units to maintain, protected from corrosive atmosphere	Capacity Enhancement	3						
	<i>Disadv.:</i>	Tight site constraints for MAU	Component Performance	4						
	<i>Comments:</i>	O&M assumes annual maintenance of 20 hrs for AHU.	O&M Ease	4						

Headworks Building Electric Unit Heaters. The Trane UHXA unit heaters in the Headworks Building have an aluminum-finned tubular steel heat exchanger which is directly exposed to the air stream in the Headworks Building when the heaters are running. Steel has very poor H₂S resistance and is a poor choice of materials for the environment the unit heaters are in. It is recommended that as the unit heaters fail they are replaced by properly rated units that have a 316 stainless steel heat exchanger and cabinet body, aluminum or 316 stainless steel fins, fan blade, and control enclosure and a motor with a corrosion-resistant protective coating which has passed the ASTM B117 salt-spray test. Indeeco makes such a unit, which has been installed in other CSO facilities. Based on the information presented here, new unit heaters will not be a capital improvement project; rather they will be replaced as part of the SRP.

6.2.6 Electrical

6.2.6.1 Description of Existing System

The Baby Creek facility's electrical system consists of a double-ended unit substation with dual (redundant) utility feeds, primary metering and DTE Energy indoor dry type transformers. The substation has a tie-breaker and automatic source transfer controls. Circuit breakers in the substation then feed four motor control centers (MCCs). The MCCs then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Because of the redundant electrical feed, this facility does not have an emergency generator. Table 6-14 provides a summary of the major electrical equipment for this facility.

Table 6-14. Major Electrical Equipment at Baby Creek

Location	Major Electrical Equipment	Description
Electrical Room 1	Double-ended unit substation	2,000 kVA, 24 kV-480/277 V, 3 Phase
Electrical Room 1	MCC-1	1,200 A, 480/277 V, 3 Phase
Electrical Room 1	MCC-2	1,200 A, 480/277 V, 3 Phase
Electrical Room 2	MCC-3	800 A, 480/277 V, 3 Phase
Electrical Room 2	MCC-4	800 A, 480/277 V, 3 Phase

Note:

kVA= kilovolt-ampere(s)

6.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for less safe working conditions. These lighting needs are in addition to the recent LED lighting project. This issue is further described in the next section.

6.2.6.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project BC-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles, however it will be less safe when operating bypass gates at night and when accessing area downstream of screens.

2) **Alternative 2: Electrical Improvements.** Add Lighting and Exterior Power Receptacles at the following locations (and shown on the electrical drawings - Figure BC-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):

- Downstream of mixers – Add the required amount of ceiling and wall mounted LED lighting fixtures to provide sufficient lighting for O&M activities.
- Light pole by bypass gates - Add light pole and associated LED lighting fixture at the facility's bypass gates.
- Exterior power receptacles are needed about every 75 ft on the front and back wall of the facility to assist in the maintenance and operations of the facility. Receptacles should be accessible from ground level.

The alternative evaluation is presented in Table 6-15. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$38,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 6-15. Alternative Evaluation for Electrical Improvements (Project BC-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe when operating bypass gates at night and when accessing area downstream of screens.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 133,000	\$ -	\$ 133,000	\$ 38,000	Not Applicable
	<i>Definition:</i>	Add additional lighting and receptacles at identified locations	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Minor increased maintenance and energy usage with increased number of lights.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

6.2.7 I&C

6.2.7.1 Description of Existing System

Control System: The original Ovation control system was installed in 2005 under PC-748. The Ovation system was designed having two separate control systems – one for the CSO Facility and one for the Sampling Building. The CSO Facility's control system has the capability to control and monitor both systems; whereas the Sampling Building control system only monitors the outfall and controls the Miller gates. In 2015 under Job Order JB -173 the CSO Ovation system controllers and software were upgraded to O.V.3.5.0.

The existing CSO Facility Ovation system is composed of a typical Ovation control network with primary and backup network switches. The switches are connected to the GLWA AT&T wide area network via the system's router. It has three operator workstation stations, plus a database server. A redundant pair of Ovation controllers provides the station with controls and I/O capabilities. A 10 kilovolt-amperes (kVA) Liebert uninterruptible power supply is used to provide constant power to the network equipment and workstations. The network connections inside the facility are via copper Ethernet cables. The controller's connections are dual-homed, which means each controller has one connection to each of the network switches. Should one network fail, the backup, redundant network is available to provide station monitoring and control. The current system is equipped with a backup radio system to communicate critical monitoring points back to the System Control Center on wide area network failure.

The Sample Building's Ovation system consists of Ovation local I/O points, a controller, and a HMI that can only perform local control. Communications are via telephone line with radio backup to the CSO Facility. The local control panel is in poor condition and should be replaced in the near future due to reoccurring maintenance issues. The Sampling Building local control system was not updated in 2015 and is still operating on the old O.V.3.1. platform.

Flow and Level Sensors: Table 6-16 summarizes the level sensors and flow meters at the Baby Creek CSO facility used to monitor flows through the treatment system, chemical feed, and chemical storage.

Table 6-16. Summary of Flow Meters and Level Sensors at Baby Creek CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent (Elmer Ternes, East Barrel, West Barrel)	3	Transit-Time (AccuSonic)
CSO Level Sensors		
Influent (Elmer Ternes)	1	Ultrasonic
	1	Radar (Backup)
Influent (East Channel)	1	Ultrasonic
	1	Radar (Backup)
Influent (West Channel)	1	Ultrasonic
	1	Radar (Backup)
Screening Area (Upstream and downstream of screens)	6	Ultrasonic
	6	Radar (Backup)
Effluent Channel	1	Ultrasonic
	1	Radar (Backup)

Area	Quantity	Instrument Type
<i>Chemical System Flow Meters</i>		
Chemical Feed	2	Magnetic
Carrier Water	1	Magnetic
Service Water	1	Magnetic
<i>Chemical Storage Level Sensors</i>		
Chemical Storage Tanks	4	Ultrasonic

6.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- Address influent screen VFD failures
- Evaluate level sensors to determine redundancy and identify level sensors that could potentially be removed
- Need for additional flow meters and level sensors to improve monitoring and control of facility flows during wet weather and dewatering phases and level monitoring of tank levels at the Chemical Fill Station
- Need for process cameras at select locations to improve monitoring of facility during wet weather operation
- Replacement options for valve control network for the chemical feed system is discussed in detail in Section 5.4.6. The cost/benefit of the hardwired control was not favorable and therefore was not considered further.
- Update Ovation control system to the latest version and increased monitoring capabilities
- There is a lack of full monitoring and control of CSO facility from the Effluent Sample Building
- The facility bypass gates require manual operation. During large storm events, this takes on operator away from other activities. Providing remote control of these gates is an ongoing project. As such, it is not included in the capital improvement projects for CS-299.

6.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project BC-I&C-1). Due to the relatively small nature of some of the I&C-related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation control system upgrade and the full monitoring and control capability of the entire facility from the Effluent Sample Building, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. There are two alternatives for this project:

1) Alternative 1: Do Nothing/Replace In-Kind.

- Replace screen VFDs in-kind or leave VFDs in bypass mode
- Leave redundant level sensors in place

2) **Alternative 2: I&C Improvements** including,

- Address influent screen VFD failures
- Remove redundant level sensors
- Provide additional flow meters and level sensor
- Provide process cameras at select locations
- Provide local remote control for screens

Each of the I&C-related improvements listed above is described further in the following paragraphs:

Address influent screen VFD failures. Operations staff indicated the VFDs running the influent screens are subject to regular failures. The failures occur intermittently and cannot always be reset from the VFD. Operators have the option of bypassing the VFD to operate the screens, but without the ability to control the speed. It should be noted that, the screens operate at 100 percent speed constantly.

A short-term, temporary solution to bypass the VFDs after a fault is available. Each of the influent screens is equipped with a bypass contactor separate from the VFD. A selector switch on the front of the influent screen control panel is used to select the “bypass” mode. While operating in bypass mode, the influent screens will run in the forward direction at full speed. The reverse jog pushbutton located in a control station on the process floor near each influent screen, which is intended to momentarily reverse the screens in the event of a jam, will not function while the screens are in bypass mode. The VFD is used to provide the reversing feature and is not available while being bypassed. Operations has indicated the reverse jog feature is never used, so operating the influent screens in bypass mode is an acceptable, temporary option.

For a long-term solution, the influent screen manufacturer should be consulted to determine the path forward and if VFDs are necessary. If the influent screens do not require VFDs to operate, the VFDs should be removed and replaced with constant speed starters, similar to operation while in bypass mode. A second, reversing contactor should be included and interfaced with the reverse jog pushbutton located at the influent screens. Internal wiring modifications and as-built record drawings should be included. If the VFDs are necessary for long-term operation, the VFDs should be replaced with modern units to avoid the intermittent VFD failures.

Remove redundant level sensors. During the January 2020 Facilities Assessment meetings with O&M staff, GLWA requested that Jacobs investigate existing level sensors at all facilities to determine where there was redundancy and identify level sensors that could potentially be removed to minimize the number of instruments. The main focus of this investigation was the level sensors throughout the CSO treatment process.

There are two sets of level sensors in the influent channel at Baby Creek. Each set contains a primary ultrasonic and backup radar level sensor. One set is for the southern end of the channel (near Screen 2) where the influent weir is at El. 91 ft and the other is at the northern end (near Screen 11) where the influent channel is at El. 92 ft. Figure 6-4 shows the locations of these sensors. Review of the historical Ovation data for a recent six-month period shows that these two sets of level sensors have nearly identical readings, and as such, one set could potentially be removed. If removed, this would provide one ultrasonic level sensor as the primary sensor and one radar sensor as the backup for the influent channel.

There are also several redundant level sensors immediately upstream and downstream of the screens. Figure 6-4 highlights the locations of these level sensors in the Headworks. The original intent of these sensors, as depicted in the piping and instrumentation diagrams, was to provide the differential level readings for banks of screens to indicate when the screen should turn on and the speed of the screen. GLWA (and previously Detroit Water and Sewerage Department) have not used this feature since the major screen blinding/failure issues shortly after facility startup. Currently, the screens are

turned on at high speed when needed and then turned off after the wet weather event. Also, the jog feature is reportedly not used by operations staff. The removal of these differential level sensors (in accordance with Figure 6-4) would prevent the jogging feature of the screen and the speed adjustment, both of which are not used.

Provide additional flow meters and level sensors. Operations staff requested additional flow or level monitoring at the following locations:

- **Outfall Level Sensor:** GLWA requested a level sensor at the outfall. Consistent with the level measurement technology in Section 5.4.3, a radar level instrument is recommended.
- **Effluent Conduit Flowmeter:** The flowmeter should not be an Accusonic model but should be a laser-based flowmeter such as a TieNet 360 LaserFlow Velocity meter.
- **Bypass Conduit Flowmeter:** It should be noted that Jacobs performed a more detailed assessment of a laser-based flowmeter (TieNiet360 LaserFlow Velocity meter) for this location. Although the cost of the flow meter itself is significantly less than that of an Accusonic meter, the total project cost was greater than expected due to the significant cost for the structure above the conduit to provide adequate room for proper flow measurement. This flow meter is not included in the cost estimate.
- **Chemical Fill Station:** Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

Provide local remote control for screens. Provide local control for the screens in accordance with Section 5.4.9.

The alternative evaluation is presented in Table 6-17. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 includes VFD replacement for all screens and level sensors.
- The capital cost for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 1 include estimated annual maintenance of the valve control network. The O&M costs for Alternative 2 include estimated annual maintenance costs for the additional instrumentation provided.

This evaluation shows that Alternative 1, Do Nothing/Replace In-Kind, is the Best Value Alternative because the NPV/Benefit cost of Alternative 1 is approximately \$148,000 lower than that of Alternative 2. The total benefit score for Alternative 2, however, is 0.5 higher than Alternative 1 due to improved component performance and ease of O&M. **Since Alternative 2 provides increased performance and ease of O&M, it is the recommended alternative.** Due to the high NPV/benefit cost, however, it is not necessarily a high priority project if there are budget constraints.

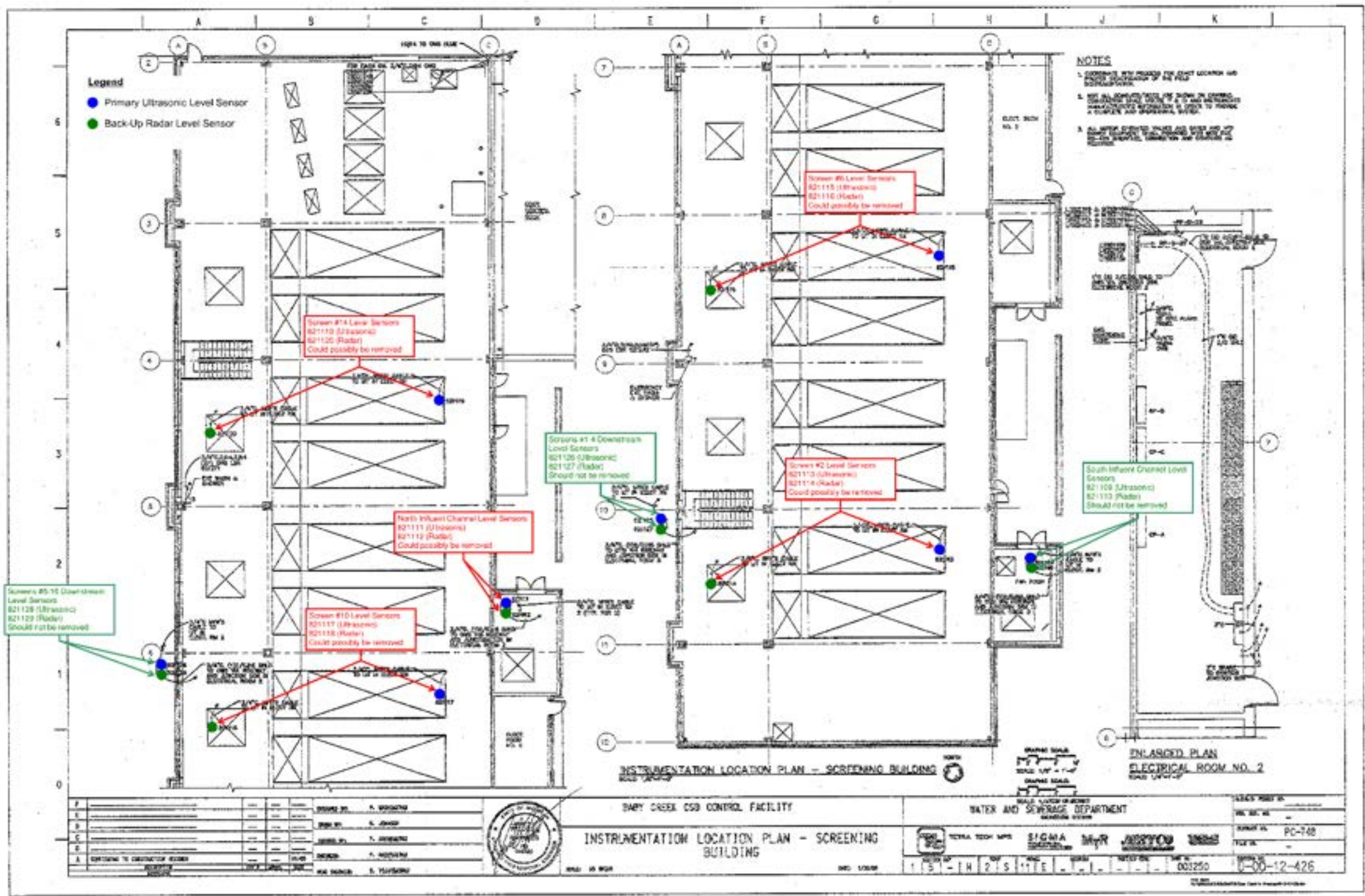


Figure 6-4. Baby Creek CSO Facility Level Sensor Identification

Table 6-17. Alternative Evaluation for I&C Improvements (Project BC-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	3	2.78	\$ 347,600	\$ 4,500	\$ 442,503	\$ 158,983	Best Value Alternative
	<i>Definition:</i>	Replace screen VFDs and level sensors in-kind.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	3						
	<i>Comments:</i>	O&M assumes annual maintenance of 5 hrs for level sensors; \$10,000 per year for valve network maintenance.	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 766,000	\$ 12,000	\$ 1,019,076	\$ 307,259	
	<i>Definition:</i>	Address VFD screen failures; removal of redundant level sensors; provide additional flow meters & sensors; provide process cameras; provide local control for screens	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	O&M assumes annual maintenance of 5 hrs for level sensors; 20 hrs for flow meter; 10 hrs for cameras.	O&M Ease	4						

Control System Upgrade (Project BC-I&C-2). This project updates the Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2. A full list of control system upgrades at the Baby Creek CSO facility is included in the following bullets:

- Update Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2.
- Replace the Sampling Building local control panel
- Update the Sample Building Ovation system to provide full control of the facility from the Sampling Building

Because the Ovation system is the only alternative for the control system upgrade, it is the only alternative considered. Table 6-18 provides the summary of the Control System Upgrade, which is the recommended alternative. Capital costs are included in Volume 6 – Appendices, Appendix C under this project title.

Table 6-18. Alternative Evaluation for Control System Upgrade (Project BC-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 1,337,000	\$ -	\$ 1,337,000	\$ 445,667	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Replace Sample Building local control panel. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Updates the control system to allow for enhanced performance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

6.2.8 Site

6.2.8.1 Description of Existing Site

The Baby Creek Control/Headworks Building site includes a 20-ft wide concrete paved access road off of Dix Rd on the west side of the facility. A concrete paved parking area is located on the northwest side of the Control Building. Site pavement on both sides of the building consists of 10- in. concrete and 6- in. aggregate base. Site runoff is collected by a storm sewer network in the parking areas and in grassy areas on the perimeter of the site. Then the flow is conveyed to the combined sewers onsite. Site security around the perimeter of the facility is provided by 8-foot-high ornamental fencing. Access to the facility is controlled by a sliding security gate located at the northwest corner of the Control Building.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's geographic information system (GIS). Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, Global Positioning System (GPS) date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this section.

6.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following sections.

- The fence is damaged in some locations due to lawn mower strikes.
- The existing access hatch to the Baby Creek sewer requires a crane to remove concrete planks. This is being addressed in an ongoing "Baby Creek Outfall Improvements" project (CIP 277001).
- An additional access point is needed downstream of the Screens 1-4.
- The stop logs are currently stored out-of-doors at the facility. The stop logs rubber seals are damaged by sunlight and, subsequently, are not effective when needed for flow isolation.
- The existing entrance gate is a 24-foot-wide cantilever sliding ornamental gate. The gate has experienced frequent electrical issues and has remained out of service for extended periods of time awaiting repair. During periods when the gate is out of service, it remains in an open position, which is a security concern particularly during hours of the day when there are fewer staff at the site. This was addressed in late 2020 under the GLWA-Contract No. 2001372 – Task 25 "Baby Creek Entrance Gate Repairs & Improvement" project.
- The following needs are generally PM items intended to ensure that the site features and utilities are serviceable throughout their expected service lives. These needs are listed in the following bullets and are not included in the capital improvement projects for CS-299. It is recommended that these issues be addressed by a GLWA-wide facilities maintenance contract. If not addressed.
 - Seal concrete pavement joints to prevent water infiltration

- Caulk expansion joint at the base of Control and Headworks Buildings between the walls/sidewalks along the north, south and west sides of the buildings
- Repair cracks in access drive and sidewalks

6.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Repair Security Fencing and Add Concrete Maintenance Strip (Project BC-SITE-1). The existing security fencing consists of 8-foot- tall powder coated aluminum fencing with 1- in. square fencing pickets. The total length of fencing is approximately 1,920 ft. The bottom of the fencing panels have experienced damage at several locations due to lawn mower strikes (example of damaged fencing shown in Figure 6-5). The impacts have left the bottom 6 to 8 in. of the pickets and posts severely bent or broken off. The fence is about 14 years old and, aside from the damaged pickets, remains in good condition. The damage sustained by the fencing does not currently impact security; however, because several fence posts have been damaged the fencing integrity in those areas has been compromised. There are two alternatives for addressing this issue. These alternatives include:

- 1) **Alternative 1: Do Nothing.** Repair bottom of fence, as necessary.
- 2) **Alternative 2: Repair Security Fencing and Add Concrete Maintenance Strip.** this alternative replaces the damaged fencing panels and posts. To avoid future damage by lawn mowing equipment, it is recommended that a maintenance strip be established 2 ft from each side of the fence line to avoid future strikes. The concrete maintenance strips beneath the fencing appear to have worked well at other sites.



Figure 6-5. Example of Damaged Fencing at Baby Creek CSO Facility

The alternative evaluation for these alternatives is presented in Table 6-19. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

Due to the limited extent of damage to the fence (i.e., only at the bottom), it is recommended that the fence be repaired, as necessary, and replaced when it has reached the end of its useful life. **As such, Alternative 1 is the recommended alternative.**

Table 6-19. Alternative Evaluation for Security Fencing (Project BC-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	3.00	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Replace fence in-kind at the end of useful life	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lowest cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Minor security concern	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Repair Fencing and Add Concrete Maintenance Strip	Health and Safety	3	3.20	\$ 226,000	\$ -	\$ 226,000	\$ 70,625	Not Applicable
	<i>Definition:</i>	Repair damaged fence and provide a concrete maintenance strip under fence to prevent future damage.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Addresses minor security concern	Capacity Enhancement	3						
	<i>Disadv.:</i>	Capital expenditure	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	3						

Stop Log Storage Shelter (Project BC-SITE-2). The stop logs are currently stored out-of-doors onsite at the Baby Creek CSO facility. The stop logs are equipped with compressible rubber seals that are susceptible to damage as a result of prolonged exposure to ultraviolet (UV) light. This results in their premature aging, impacting their ability to effectively prevent leakage when installed in the sewer stop log guides. The stop logs are currently stored in an area located between the Woodmere Pumping Station and the Baby Creek Headworks building, which has a footprint of approximately 60 ft by 20-ft. The stop logs are stored on grade and stacked next to each other. The stop logs rubber seals are damaged by sunlight and, subsequently are not effective and leak. There are two alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing.** Continue to store stop logs outside.
- 2) **Alternative 2: New Stop Log Storage Shelter and Racks.** The purpose of a new storage shelter is to provide protection for existing isolation stop logs. The storage shelter must provide protection from UV light and exposure to the elements, but its design must also remain open enough to allow equipment to access and move the stop logs in and out of the shelter. Per discussions with GLWA, the new shelter is to be located in the same general area as the existing storage area.

There are two potential styles of structure that could be used for a stop log shelter: a pavilion style pitched roofed structure or a semi-permanent canopy style structure. The pavilion style structure is generally a steel truss and post framed structure with a steel panel roof but generally without permanent sidewalls. The canopy structure can be a steel or aluminum framed structure with a heavy-duty PVC or polyethylene fabric cover that covers the entire framing structure to ground level. Either structure can be designed to meet Michigan Building Code requirements for snow and wind loads. The canopy style structure would provide additional UV protection with covered sidewalls extending to grade and is recommended for the storage of the stop logs. In addition, this option is less permanent than a pavilion structure, in the event that this structure might need to be moved around within the property. See Figure BC-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B, for the location of the proposed stop logs storage shelter. The figure also shows conceptual photos of what this type of semi-permanent low-tech structure would look like.

To avoid storage of stop logs directly on grade, it is also recommended that the shelter be placed on a concrete pad and the stop logs be stored in racks. These items are included in the cost estimate in BC-SITE-2 in Volume 6 – Appendices, Appendix C under this project title.

In addition, GLWA also requested that a new access hatch be provided to allow access for the area downstream of Screens 1 to 4. This hatch will be located outside of the facility near the existing concrete pavement above the channel (Figure BC-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B), provides the approximate location. Soils will be excavated above the existing roof near the outer channel wall to allow installation of a new 4-foot by 4-foot accessway and fall-restraint type ladder. The roof slab will be sawcut, and a precast utility vault section set and affixed. This opening size is required to accommodate the ladder assembly to the surface, clear space for personnel entering/exiting the lower facility and adequate space for personnel extraction connections to move freely between the lower facility and surface. A locking traffic-rated hatch (HS-20) is recommended. The existing pavement section will be extended to this new hatch location to provide a clean, paved working surface for topside activities while manned-entry into the lower area is underway.

The alternative evaluation for these alternatives is presented in Table 6-20. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – New Stop Log Storage Shelter and Racks has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and improved O&M provided by protecting the rubber seals on the stop logs. The NPV/Benefit cost for Alternative 2 is \$145,000, which is a relatively high cost compared to other projects

recommended in this assessment. Based on this information, **Alternative 2 - New Stop Log Storage Shelter and Racks** is recommended; however, it should be a relatively lower priority than other projects.

Table 6-20. Alternative Evaluation for Stop Log Storage (Project BC-SITE-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to store stop logs outside	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lowest cost.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Rubber seals may not properly hold back water when needed for projects.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	New Stop Log Storage Shelter and Racks	Health and Safety	3	3.42	\$ 497,000	\$ -	\$ 497,000	\$ 145,463	Not Applicable
	<i>Definition:</i>	New storage shelter will provide protection from UV light exposure.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Rubber seals should last longer.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost.	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	4						

6.2.9 Architectural

6.2.9.1 Description of Existing Facilities

The Baby Creek CSO facility consists of one main building with rooms for the process systems (screening and chemical feed/storage), odor control, utility support (electrical and mechanical), control room and other miscellaneous rooms. The facility also includes a small, off-site effluent sample building about a mile from the main building.

6.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a roof replacement evaluation and a detailed assessment of architectural issues, as described in the following paragraphs.

Evaluation of Type of Future Roof Replacement. The facility has a shingled roof. About one-third of the roof surface was replaced in 2017. A recent (2020) assessment by a roofing contractor (Schreiber) indicated that the remaining two-thirds was in “poor” condition and there have been leaks into the Electrical Room during recent rain events. GLWA requested that Jacobs perform a cost comparison of replacing the shingled roof with a metal roof.

Jacobs reviewed the results of the roof assessment and prepared a 60-year life-cycle cost analysis between shingled roof and metal roof. Based on the results of this evaluation, which shows a lower life-cycle cost for shingled roof, Jacobs recommended replacement of two-thirds of the roof with shingles. The analysis is presented in Table 6-21. Subsequently, GLWA requested that drawings and a roof replacement specification be developed to use in contracting for roof replacement. This project should be completed in 2021. As such, it is not included in this report as a future capital project. The SRP model was manually adjusted to recognize the improvement of this ongoing project.

Table 6-21. 60-Year Life-Cycle Cost Evaluation of Shingled vs. Metal Roof for Baby Creek Facility

	Shingle Roof	Metal Roof
Replacement Cost ^a	\$649,000	\$2,163,000
Replacement Interval	20 years	60 years
Number of Roof Replacements During 60 Years	3	1
Total Life-Cycle Cost (NPV) Discounted at 2.4%	\$1,762,000	\$2,163,000

^a Based on 43,250 ft² roof area; \$15/ ft² for shingle roof and \$50/ ft² for metal roof.

Note:

ft² = square feet

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities under CS-299. Jacobs used the architectural-related information in NTH’s Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the aboveground buildings as a starting point and included additional items, as observed during the assessments conducted under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff indicated that the floor coating in the Chemical Room had been consumed by sodium hypochlorite spills and the floor was flat and did not slope toward the sump.

6.2.9.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (BC-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessment. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove and replace isolation/ cove joint sealant and around building perimeter
 - Repair and replace cracked guardrail member; make unstable base connections for FRP guardrail more rigid
 - Address door and door frame corrosion issues, and door hardware issues for various doors
 - Clean localized rusted areas of structural steel surface and recoat localized steel areas in Headworks
 - Clean rusted areas of steel bollards and recoat all exterior bollards
 - Remove and replace, in kind, disbonded tile and underlayment from concrete floor
 - Repair/ patch finish material and repaint ceiling of entryway exterior canopy
 - Clean corrosion in steel base/ steel column supporting the entryway exterior canopy and repaint

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings (Figure BC-ARCH-1-ALT-2) in Volume 6 – Appendices, Appendix B. Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 6-22. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the need to prevent more costly damage in the future from not addressing these issues, **Alternative 2 - Architectural Rehabilitation is the recommended alternative.**

Table 6-22. Alternative Evaluation for Architectural Rehabilitation (Project BC-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 596,000	\$ -	\$ 596,000	\$ 192,258	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

Slope Chemical Room Floors and Add Coating (Project BC-ARCH-2). GLWA requested Jacobs evaluate modifying the floor slope in the Chemical Room to drain to the sump. There are three alternatives evaluated:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Provide Corrosion-Resistant Floor Coating in Chemical Room** (on existing flat floor). This alternative only provides a floor coating which is currently being considered to address an immediate need for floor protection. Jacobs has successfully used the following highly chemical-resistant coating systems in sodium hypochlorite containment areas:
 - Surface Preparation: Meet requirements of Society for Protective Coating SP 13 and coating manufacturer's instructions.
 - Primer: 1 coat of the manufacturer's recommended concrete primer.
 - Filler/Surfacer: 1 coat as required to fill voids of trowel grade filler and surfacer designed for vinyl ester coating.
 - Finish: 2 coats of vinyl ester coating resistant to containment service of 12.5 percent sodium hypochlorite solution. Provide slip resistant surface on floors.
- 3) **Alternative 3: Provide Corrosion-Resistant Floor Coating and Slope Floor in Chemical Room.** This alternative includes sloping the floor before adding the coating described in Alternative 2. Sloping the floor would be accomplished by grouting over the existing floor. Grouting should be coordinated with the chemical feed system replacement project, if possible. Coating of the floor should be done after increasing the floor slope.

The alternative evaluation is presented in Table 6-23. The capital costs for Alternative 2 and 3 are included in Volume 6 – Appendices, Appendix C under this project title.

As shown in Table 6-23, Alternative 2 has a Total Benefit score about 1.0 higher than Alternative 1 because of the chemical resistant coating protecting the concrete floor. Alternative 3 has a Total Benefit score about 1.2 higher than Alternative 2 based on the improved health and safety, component performance, and ease of O&M with the chemical resistant coating and the sloped floor. Coating the floor is necessary to protect the concrete floor over the life of the facility. Examination of the NPV/benefit costs for the alternatives that provide a coating (Alternatives 2 and 3) shows that Alternative 3 has the lowest cost. **As such, Alternative 3 - Provide Corrosion-Resistant Floor Coating and Slope Floor in Chemical Room is the recommended alternative.**

This project should be scheduled with future improvements to the chemical feed system. If these improvements do not occur within the next two to three years, consideration should be given to coating the existing floor to preserve the condition of the concrete.

Table 6-23. Alternative Evaluation for Slope Chemical Room Floors and Add Coating (Project BC-ARCH-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	1	2.02	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Concrete floor continues to deteriorate.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Corrosion Resistant Floor Coating (on existing flat floor) in Chemical Room	Health and Safety	2	3.03	\$ 283,000	\$ -	\$ 283,000	\$ 93,297	Not Applicable
	<i>Definition:</i>	Provide corrosion resistant floor coating on existing floor	Water Quality & Compliance	3						
	<i>Adv.:</i>	Protects concrete floor from damage due to aggressive chemical	Capacity Enhancement	3						
	<i>Disadv.:</i>	Chemical still stays on the floor for extended period.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Provide Corrosion Resistant Floor Coating and Slope Floor in Chemical Room	Health and Safety	5	4.20	\$ 338,000	\$ -	\$ 338,000	\$ 80,476	Not Applicable
	<i>Definition:</i>	Slope floor toward sump and coat floor	Water Quality & Compliance	3						
	<i>Adv.:</i>	Spills will be conveyed to sump	Capacity Enhancement	3						
	<i>Disadv.:</i>	Highest cost	Component Performance	5						
	<i>Comments:</i>	Project should be combined with major disinfection project	O&M Ease	5						

6.2.10 Safety

6.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

6.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 6-24. The capital improvement project to address these issues is included in the table.

Table 6-24. Identification of Capital Improvements for Safety Issues

Location	Description	Proposed Corrective Action	Capital Improvement Project
Sample Room	Door needs illuminated exit sign	Add exit sign	Exit Sign Improvements ^a
Mechanical Room	No illuminated exit sign on exterior door	Add exit sign	Exit Sign Improvements ^a
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project BC-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

6.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section.

Safety Improvements (Project BC-SAFE-1). This project should address the safety issues identified above. These issues include:

- Fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 6-25 shows the one alternative.

Table 6-25. Alternative Evaluation for Safety Improvements (Project BC-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 236,000	\$ -	\$ 236,000	\$ 78,667	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection and eye washes.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

6.2.11 Supporting Infrastructure

6.2.11.1 Description of Existing System

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above.

6.2.11.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- Inefficient mixer removal system – includes evaluation of monorail vs. gantry cranes with electric hoist and electric trolley to replace existing hand chain hoist.
- Address inability of overhead crane to access dewatering pump.
- Address high iron sediment concentration in potable water lines. GLWA has experienced high iron concentrations in incoming potable water to the facility. In August 2020, flushing of the incoming 8-in. water mains servicing the facility conducted under CS-299 in an effort to remove the cause of the rust colored water within the facility. A few weeks after the flushing exercise, the operators reported rust colored water again. Based on the results of the flushing samples and the return of the rust color, the following recommendation were made to minimize the iron in these lines:
 - For the eye wash in the Chemical Room, it is recommended to install an automatic solenoid valve on a timer to routinely flush this line for a set period of time each day. The operators could do this over a few consecutive days to find out how long it takes to flush the line before the iron dissipates. If it takes a long time and there is a large amount water on the floor, there should be consideration to providing a permanent drain to the sump. However, the results seem to indicate the iron color may dissipate quickly, especially if it is flushed routinely.
 - For the kitchen, a point of use device could be installed specifically designed for iron removal.

These projects could be done by GLWA maintenance and are not included in the capital improvements.

6.2.11.3 Discussion and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Improve Mixer Removal System (Project BC-SUPP-1). The overhead bridge crane was not designed with adequate side-to-side reach for removal and installation of the induction mixers. Currently, portable A-frame gantry cranes with hand chain hoists are used for this purpose. An improved mechanism for removing and installing the induction mixers is desired.

Three alternatives are identified in the following list:

- 1) **Alternative 1: Do Nothing.** Continue to use gantry cranes with hand chain hoists.
- 2) **Alternative 2: Monorail System.** Provide two parallel monorails centered over the two pairs of induction mixers in each mixing zone. The monorails would run the length of the building (or shorter monorails could be provided serving one or more of the mixing zones). Two continuous monorails the

length of the building were assumed for estimating cost. One ¼ ton electric hoist with manual trolley on each of the two parallel monorails was assumed for estimating cost.

- 3) **Alternative 3: A-Frame Portable Gantry Cranes with Electric Hoists.** Provide two new portable A-frame gantry cranes with a ¼ ton electric hoist and trolley on each.

The alternative evaluation is presented in Table 6-26. Capital costs for each alternative are presented in Volume 6 – Appendices, Appendix C under this project title. The table shows that Alternative 3: A-Frame Portable Gantry Cranes with Electric Hoists provides a Total Benefit score of 1.0 higher than the Do Nothing alternative because of improvement safety and ease of O&M. The table also shows that the NPV/Benefit cost is more reasonable than the Alternative 2 – Monorail System. **As such, Alternative 3 is the recommended alternative.**

Table 6-26. Alternative Evaluation for Improve Mixer Removal System (Project BC-SUPP-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use gantry cranes with hand chain hoists	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Raising mixer out of channel for inspection is more difficult and less safe.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Monorail System	Health and Safety	5	4.00	\$ 998,000	\$ -	\$ 998,000	\$ 249,500	Not Applicable
	<i>Definition:</i>	Provide two parallel monorails centered over the two pairs of induction mixers in each mixing zone. One ¼ ton electric hoist with manual trolley on each of the two parallel monorails.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Raising mixer out of channel is easier and safer.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Highest cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						
3	<i>Alt. Name:</i>	A-Frame Portable Gantry Cranes with Electric Hoists	Health and Safety	4	3.50	\$ 266,000	\$ -	\$ 266,000	\$ 76,000	Not Applicable
	<i>Definition:</i>	Provide two new portable A-frame gantry cranes with a ¼ ton electric hoist and trolley on each.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Raising mixer out of channel is easier and safer than existing operation	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not as easy as monorail system.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

Overhead Crane Access for Dewatering Pump (Project BC-SUPP-2). O&M staff indicate that the existing building's overhead crane is unable to remove the dewatering pump. This is because the overhead crane travel does not reach the mid-point of the rails for the submersible dewatering pump. In order to use the overhead crane, the hook must be able to pull the dewatering pump straight up the rails, or the pump will not be able to be removed. Figure 6-6 illustrates this issue.

Two alternatives are identified in the following list:

- 1) **Alternative 1: Do Nothing.** Continue to use gantry crane. The gantry crane does not fit well into the space, making it difficult to remove the pump.
- 2) **Alternative 2: Add Trolley to Overhead Crane:** Jacobs contacted Crane Technologies, the original crane supplier for solutions to this issue. They recommended a 2-ton capacity electric chain hoist with motorized trolley. The hoist would be powered from a festoon track system that would have to be installed on the crane bridge. The hoist would be controlled from either a dedicated hard wire pendent, (which would have the concern for that pendent hanging down when the crane bridge is traveling down the runway), or from a dedicated radio control device, which would eliminate the corded pendent. The radio control system is recommended. The system would be explosion-proof rated.

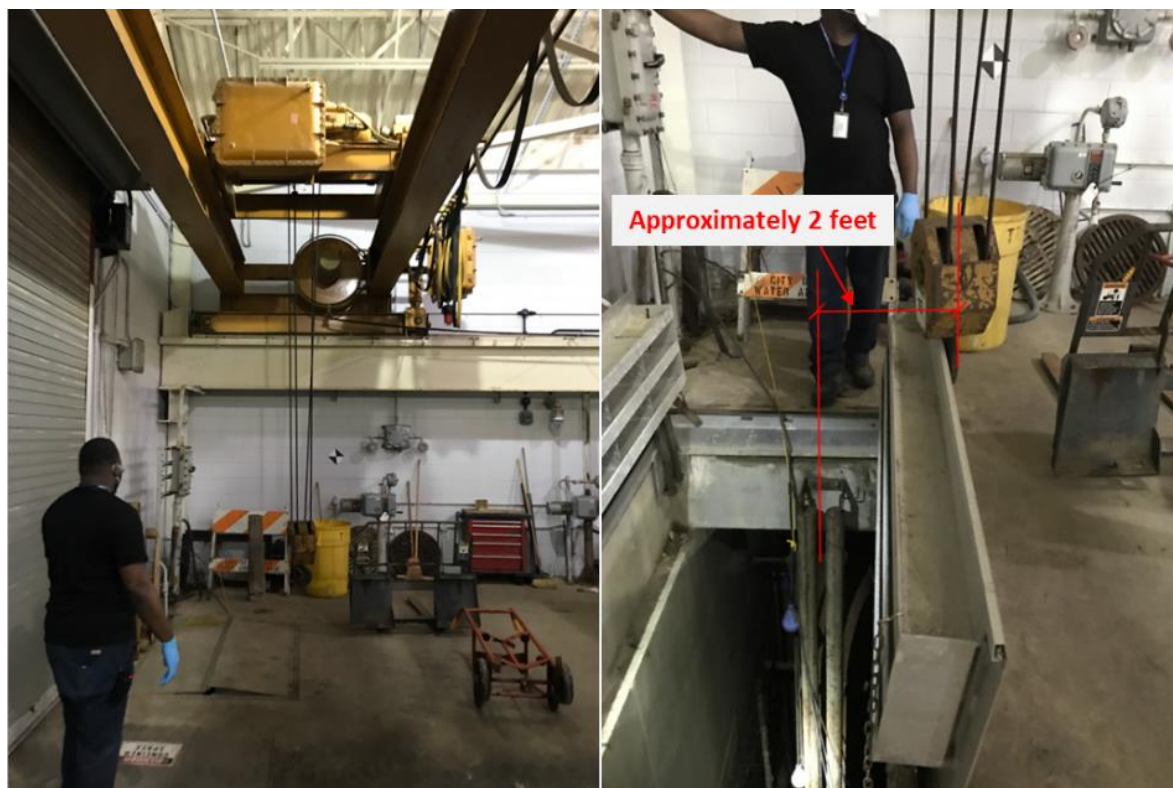


Figure 6-6. Overhead Crane Issue

The alternative evaluation is presented in Table 6-27. Capital costs for each alternative are presented in Volume 6 – Appendices, Appendix C under this project title. The table shows Alternative 2 has a Total Benefit score of 1.5 higher than the Do Nothing Alternative because of improved safety and ease of O&M. The NPV/Benefit cost for Alternative 2 is about \$22,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety and O&M with this alternative, Alternative 2 – Add Trolley to Overhead Crane is the recommended alternative.**

Table 6-27. Alternative Evaluation for Overhead Crane Access for Dewatering Pump (Project BC-SUPP- 2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to utilize gantry crane to remove dewatering pump	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Extremely tight site conditions make positioning the gantry crane difficult, and potentially unsafe.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Add Trolley to Overhead Crane	Health and Safety	5	4.00	\$ 90,000	\$ -	\$ 90,000	\$ 22,500	Not Applicable
	<i>Definition:</i>	Add a 2-ton capacity electric chain hoist with motorized trolley	Water Quality & Compliance	3						
	<i>Adv.:</i>	Simplified pump removal and install	Capacity Enhancement	3						
	<i>Disadv.:</i>		Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

6.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Baby Creek CSO facility, Table 6-28 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 6-28, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 6-28. Listing of Asset Condition Assessments for Baby Creek Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	40	40	0	100%
AHU	4	0	4	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	4	4	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	9	6	3	100%
BUILDING	2	1	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	0	0	0	N/A
COND-AIR	2	2	0	100%
CONVEYOR	0	0	0	N/A
CRANE	1	1	0	100%
CTRLPANEL	1	1	0	100%
DAM	0	0	0	N/A
DAMPER	16	16	0	100%
DISCONNECT	4	4	0	100%
DOOR	3	3	0	100%
DRIVE-ELEC	24	8	16	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
EYEWASHSTA	6	6	0	100%
FAN	1	0	1	100%
FANVENT	17	9	3	71% ^b
FENCE	2	2	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	1	0	100%
GASMONITOR	2	2	0	100%
GATE	10	10	0	100%
GEARBOX	48	0	48	100%
GENERATOR	0	0	0	N/A
GRINDER	0	0	0	N/A
GROUND	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	2	0	0	0% ^c
MCC	4	0	4	100%
METER	8	8	0	100%
MIXER	32	32	0	100%
MOTOR	34	0	34	100%
PANEL	6	6	0	100%
PIPING	4	4	0	100%
PUMP	18	11	5	89% ^d
ROOF	1	1	0	100%
SAMPLER	1	1	0	100%
SCADA	2	2	0	100%
SCREEN	16	0	16	100%
SCRUBBER	1	0	1	100%
SENSOR	24	24	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	5	0	5	100%
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
TANK-STOR	4	4	0	100%
TIPBUCKET	2	2	0	100%
TRANSFRMR	3	0	3	100%
UNITHEATER	23	23	0	100%
UPS	3	3	0	100%
VALVE	56	56	0	100%
WATERHTR	2	2	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The five Roof Ventilators (non-motorized) on the roof were not accessible

^c The two Make Air Units are duplicates of the HV-1 and HV-2 Air Handling Units. These MAUs should be deleted in the future.

^d The two post-screening pumps are not in service and were not assessed.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Baby Creek Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

6.3 Capital Planning for Baby Creek CSO Facility

6.3.1 Summary of Capital Improvement Plan Projects

Table 6-29 provides a summary of the recommended CIP projects and associated capital costs for the Baby Creek CSO facility based on the alternative evaluations conducted for this facility.

Table 6-29. Summary of Recommended Projects at Baby Creek CSO Facility

Project No.	Alternative	Description	Total Project Cost
BC-DIS-1	3	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	\$ 1,237,000
BC-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 201,000
BC-DIS-3	2	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000
BC-FD-1 ^a	2	Flushing System in Influent Area	\$ 787,000
BC-ELEC-1	2	Electrical Improvements	\$ 133,000
BC-I&C-1	2	I&C Improvements	\$ 766,000
BC-I&C-2	1	Control System Upgrade	\$ 1,337,000
BC-SITE-2	2	New Stop Log Storage Shelter and Racks	\$ 497,000
BC-ARCH-1	2	Architectural Rehabilitation	\$ 596,000
BC-ARCH-2	3	Provide Corrosion-Resistant Floor Coating and Slope Floor in Chemical Room	\$ 338,000
BC-SAFE-1	1	Safety Improvements	\$ 236,000
BC-SUPP-1	3	A-Frame Portable Gantry Cranes with Electric Hoists	\$ 266,000
BC-SUPP-2	2	Add Trolley to Overhead Crane	\$ 90,000

Note:

^a Although this project is not recommended at this time, it is included in the CIP to be reconsidered based on experience gained from contractor cleaning of the influent channel.

6.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 6-30. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 6-30. Capital Improvement Plan Projects for Baby Creek CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
BC-1 Disinfection System Improvements	\$1,785,000	2033 <i>Timing based on existing asset condition</i>	BC-DIS-1	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	\$ 1,246,000
			BC-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 201,000
			BC-ARCH-2	Provide Corrosion-Resistant Floor Coating and Slope Floor in Chemical Room	\$ 338,000
BC-2 Influent Flushing System^a	\$ 787,000	2036 <i>Project to be re-evaluated after another cleaning cycle of the influent area</i>	BC-FD-1	Flushing System in Influent Area	\$ 787,000
BC-3 Facility-Wide Electrical and I&C Improvements	\$ 2,723,000	2025 <i>Timing based on asset condition</i>	BC-I&C-1	I&C Improvements	\$ 766,000
			BC-I&C-2	Control System Upgrade	\$ 1,337,000
			BC-ELEC-1	Electrical Improvements	\$ 133,000
BC-4 Facility-Wide Safety and Architectural Improvements	\$ 829,000	2023 <i>Project should be initiated as soon as possible</i>	BC-SAFE-1	Safety Improvements	\$ 229,000
			BC-ARCH-1	Architectural Improvements	\$ 600,000
BC-5 New Stop Log Storage Shelter	\$ 497,000	2030 <i>Timing based on best judgement</i>	BC-SITE-2	New Stop Log Storage Shelter and Racks	\$ 497,000
BC-10 Model Disinfection Performance	\$ 50,000	2021 <i>Timing based on potential for major maintenance cost reduction</i>	BC-DIS-3	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000

Note:

^a Although this project is not recommended at this time, it is included in the CIP to be reconsidered based on experience gained from contractor cleaning of the influent channel.

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 6-31 and Table 6-32 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 6-32 indicates that BC-DIS-1 project has two assets that need to be replaced immediately due to condition score of "5". These assets, however, have already been replaced/rebuilt since the Condition Assessment was conducted in Summer 2020. The remaining 40 assets that are included in this project have an average condition score of 1.55 and an average replacement date of 2034 (See Table 6-31). This information was used to propose a scheduled construction completion date of 2033.

Table 6-31. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
BC-DIS-1	40	1.35	1.55	2.43	21	2034	\$ 1,065,500
BC-DIS-3	29	1.29	1.24	2.08	10	2030	\$ 1,450,000
BC-HVAC-1	7	1.14	1.59	2.05	16	2032	\$ 39,801
BC-I&C-1	24	1.38	1.46	2.37	11	2031	\$ 329,307
BC-I&C-2	3	1.57	1.38	2.70	10	2030	\$ 803,097
BC-SAFE-1	2	1.71	1.29	2.82	10	2030	\$ 25,336
BC-SITE-1	1	1.29	1.33	2.14	20	2039	\$ 391,500

Table 6-32. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
BC-DIS-1	2	1.29	5.00	4.50	10	2021	\$ 102,000
BC-DIS-3	3	1.29	5.00	4.50	10	2021	\$ 150,000
BC-HVAC-1	1	1.14	5.00	4.00	15	2023	\$ 4,800
BC-I&C-1	1	1.43	5.00	5.00	10	2021	\$ 18,300
BC-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -
BC-SAFE-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
BC-SITE-1	0	0.00	0.00	0.00	N/A	N/A	\$ -

There are a number of recommended capital improvement projects presented in Table 6-29 that could be better delivered under capital outlay projects. These projects are listed in the following bullets:

- A-Frame Portable Gantry Cranes with Electric Hoists (BC-SUPP-1)
- Add Trolley to Overhead Crane (BC-SUPP-2)

For the CFD Modeling of Mixers (BC-DIS-3), it is ultimately recommended to include this project with similar modeling projects at the Conner Creek and Leib CSO Facilities. See Section 2 (Volume 1 – Project Introduction and Capital Improvement and Outlay Plans) for proposed bundling of this project.

6.3.3 20-Year Capital Outlay Plan

Table 6-33 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 6-33. 20-Year Capital Outlay Plan for Baby Creek CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 501,900	\$ 25,000	\$ -	\$ -	\$ 252,000	\$ -	\$ -	\$ 224,900	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 293,574	\$ -	\$ 293,574	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ 4,469	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2,546	\$ 1,923	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ 20,562	\$ -	\$ 20,562	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 3,033,298	\$ -	\$ -	\$ 3,004,620	\$ -	\$ -	\$ -	\$ 5,565	\$ 23,113	\$ -	\$ -	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 197,626	\$ 2,568	\$ -	\$ -	\$ 188,171	\$ -	\$ -	\$ 6,887	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,194,379	\$ -	\$ 131,141	\$ -	\$ 30,857	\$ -	\$ 38,003	\$ -	\$ -	\$ 994,379	\$ -	\$ -	\$ -
2030	\$ 2,353,820	\$ 19,572	\$ -	\$ -	\$ 2,235,076	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 99,172	\$ -	\$ -
2031	\$ 518,214	\$ 6,988	\$ -	\$ -	\$ 503,431	\$ -	\$ -	\$ 7,795	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 1,384	\$ -	\$ -	\$ -	\$ 1,384	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 256,028	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 256,028	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 4,789,716	\$ 986,965	\$ -	\$ 2,432,093	\$ 566,616	\$ -	\$ -	\$ 361,509	\$ -	\$ -	\$ 415,117	\$ -	\$ 27,416
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 2,567,530	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2,567,530	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 3,877,602	\$ 165,549	\$ -	\$ -	\$ -	\$ 2,619,091	\$ 40,007	\$ 386,452	\$ -	\$ -	\$ -	\$ 666,503	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 19,610,103	\$ 1,206,641	\$ 445,276	\$ 5,436,713	\$ 3,777,535	\$ 2,619,091	\$ 78,010	\$ 1,251,682	\$ 2,592,566	\$ 994,379	\$ 514,290	\$ 666,503	\$ 27,416

Notes:

Explanation of large capital outlays in first two years:

- Screening System: Screen No. 1 was out of service at the time of the Condition Assessment for major repair and received a score of 5. It has since been put back into service and could be reassessed.
- Disinfection System: Three mixers (\$50,000 each; \$ 150,000 total) were missing/out of service at the time of the Condition Assessment. Also, two chemical feed pumps (\$51,000 each; \$102,000 total) were missing.
- HVAC System: The Air Handling Unit (HV-2) was not operational two different times during the Condition Assessment. Unit was new in early 2020. It has since been fixed. Also, there was one unit heater in the Chemical Room that was out of service.

7. Belle Isle CSO Control Facility

7.1 Existing Facility Description and Future Capacity Considerations

7.1.1 General Facility Description

The Belle Isle CSO Facility is an RTB with 300,000 gallons of storage and a treatment capacity of 33 cfs. It was constructed in 2007. The facility consists of a headworks, chemical room, odor control room, electrical room, mechanical room, control room, sample room, and restrooms. The facility also includes an adjoining Belle Isle Pump Station, which is not included in this facility assessment.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

7.1.2 Future Capacity Considerations

Jacobs recommends an evaluation of sewer separation on Belle Isle be conducted in an effort to reduce or eliminate treatment of wet weather flows.

A review of the Belle Isle Basis of Design shows that sewer separation was considered as an alternative to constructing a regional treatment basin (RTB). In 1998, there was a concern that stormwater treatment at a single location may be required. As such, 8,100 ft of storm sewer piping was included in the cost comparison for the sewer separation alternative. Given the current movement toward green infrastructure, stormwater treatment does not appear to be a concern, particularly for a natural location such as Belle Isle.

A study of current wet weather flows and inflow and infiltration for the Belle Isle sewer system should be conducted to determine whether sewer separation and infiltration and inflow (I&I) control could reduce wet weather flows sufficiently to completely eliminate the need for the RTB (i.e., screening, disinfection, storage, and odor control). If I&I cannot be reduced enough to eliminate the need for the RTB, flows should be reduced enough so that the facility could operate as a complete capture facility. This would eliminate the need for disinfection, screening (potentially), and operator involvement during storm events.

7.2 Facility Assessment

7.2.1 Screening

7.2.1.1 Description of Existing System

The Belle Isle CSO Facility has two perforated horizontal band screens that were installed in 2007. Screenings that are captured by the screens are pumped by the Screenings Recirculation Pumps back to the Belle Isle Pump Station, where they are conveyed by the sanitary pumps to the Detroit River Interceptor (DRI), and ultimately to the WRRF.

Table 7-1 provides an overview of the existing screening system at Belle Isle CSO facility.

Table 7-1. Overview of Existing Screening System at Belle Isle CSO Facility

Parameter	Value
Treatment Capacity (cfs)	33
Number of Screens	2

Parameter	Value
Manufacturer	JWC Environmental
Screen Type	Horizontal Band Screen
Opening Size	6-mm perforation
Depth or Length / Width	7 ft 8 in. / 2 ft 8 in.
Screen Cleaning	Brush and high-pressure spray
Screening Removal	Screenings pumped to Pumping Station and conveyed to DRI and to WRRF

Note:

in. = inch(es)

7.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issue was identified related to the screens:

- Existing band screens are difficult to maintain due to tight site conditions

7.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Screen Replacement (Project BLI-SCR-1). The existing band screens perform well but maintenance is difficult due to their location under the grating and tight site conditions. The existing JWC Environmental horizontal band screens have 6-millimeter (mm) perforations. There are two alternatives:

- Alternative 1: Replace Existing Band Screens In-Kind.** This alternative would generally replace the existing band screens in-kind.
- Alternative 2: Replace Existing Screens with Fine Bar Screens.** A vertical fine bar screen was evaluated as a replacement. A vertical screen will provide adequate screening while being much more accessible for maintenance. Duperon's FlexRake FPFS-F fine bar screen was used as a representative screen and has 0.25- in. (approximately 6 mm) spacing. While a 6-mm perforation is finer than a 0.25-in. bar screen gap, both screens should provide equivalent screening. Michigan EGLE approval would be necessary for the 0.25-in. bar screen.

A vertical bar screen will require modifications to the existing channel. Currently, water enters the channel and flows up through the screen and over a weir as shown by the flow direction arrows on Figure 7-1. The existing screens extend approximately halfway across the channel. The vertical bar screen will extend across the full channel. Figure 7-2 shows the plan view of two vertical screening options. Option 1 positions the screen approximately halfway down the channel length while Option 2 positions the screen at the end of the channel where it leans up against the existing fiberglass screening retention baffle wall. A steel beam is needed to support the screen with both options. Duperon's screen may be completely vertical or at an angle of up to 45 degrees. The existing weir must be removed and filled in with concrete to prevent bypassing at high flows due to the long length of the existing weir. An opening downstream of the screen and cut into the concrete is necessary to convey the discharged flow. Option 2 requires an angled screen position and flow must discharge through a triangular opening.

Figure 7-2 also shows a 6-in. to 1-foot concrete bump out from the west wall extending the full channel depth for screen maintenance access. Positioning the screen at the end of the channel (Option 2) allows for screenings to discharge over the existing screening retention baffle wall into the screening wet well. Option 1 will require a screening sluice to convey screenings from the screens to the screening wet well. Figure 7-3 shows the sluice option. Headloss through the screen at the design flow of 16.5 cfs with 25 percent blinding is 0.04 in. Headloss through the existing JWC Environmental screen is unknown.

The alternative evaluation is presented in Table 7-2. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 1 were obtained from the screen replacement costs of the Scheduled Replacement Plan (SRP).
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C, under this project title.

This evaluation shows that Alternative 1 is the Best Value Alternative. Although maintenance would be easier for the proposed screen in Alternative 2, the difference in O&M costs were not calculated because the difference in capital costs is nearly \$1,000,000. Annualized over 30 years, this represents about \$51,000 (at 3 percent interest rate). It is unlikely the annual maintenance savings would be this high.

Because of the large difference in capital costs between the two alternatives, **Alternative 1 - Replace Existing Band Screens In-Kind is the recommended alternative**. As such, the replacement of these screens is not included in the CIP projects; rather it is included in the SRP.

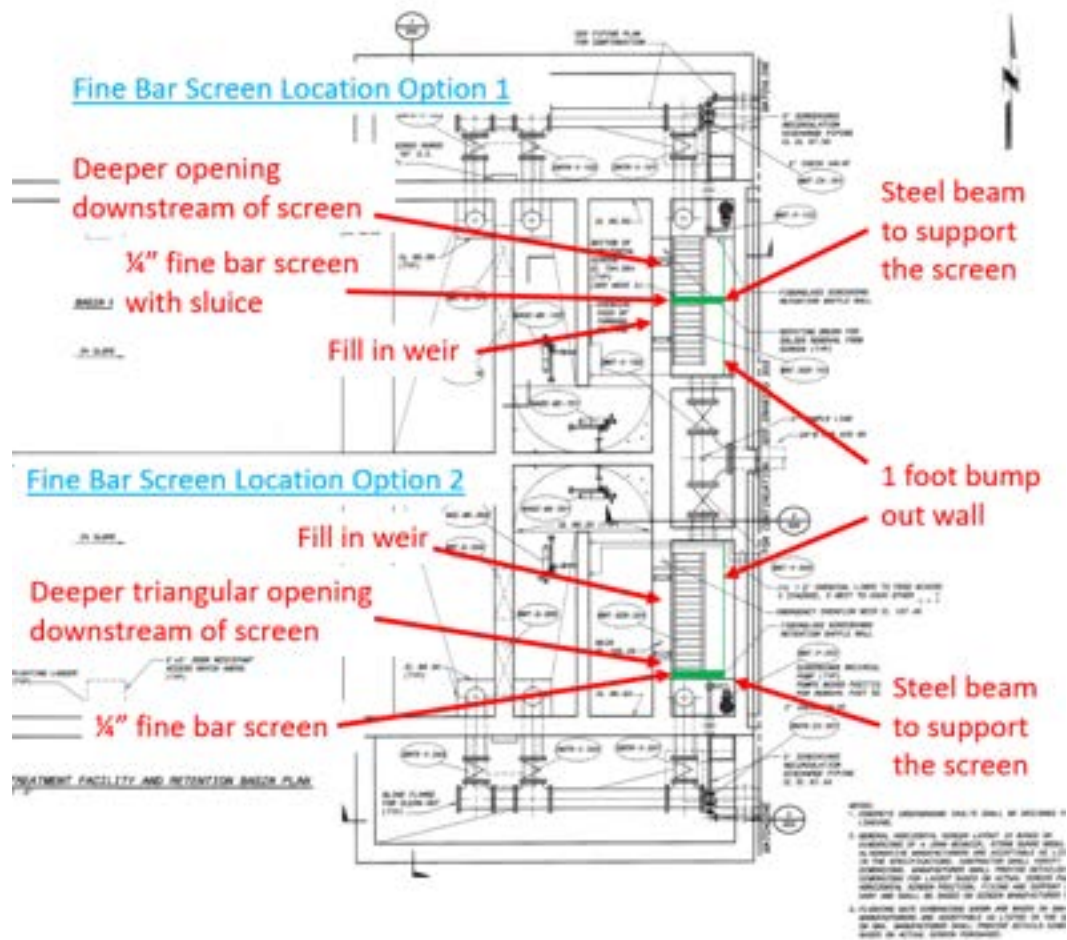


Figure 7-2. Belle Isle Screening Channel Modifications

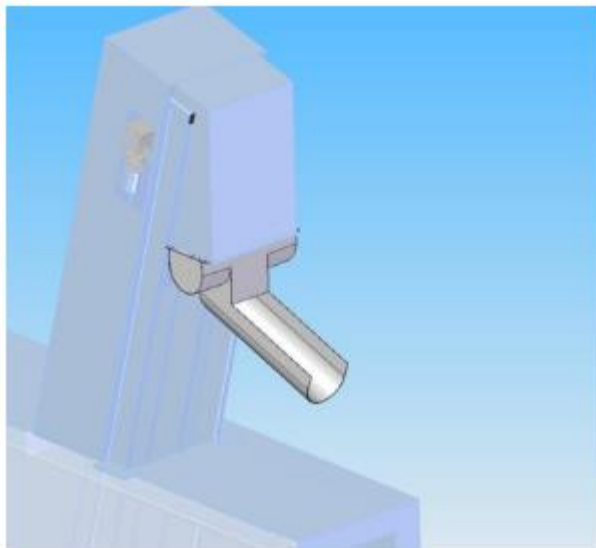


Figure 7-3. Illustration of a Screening Sluice for Belle Isle

Table 7-2. Alternative Evaluation for Screen Replacement (Project BLI-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Band Screens In-Kind	Health and Safety	3	2.78	\$ 978,000	\$ -	\$ 978,000	\$ 351,377	Best Value Alternative
	<i>Definition:</i>	Replace band screen in-kind	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system; has met permit	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance is difficult due to tight site conditions.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Replace Existing Screens with Fine Bar Screens	Health and Safety	3	3.43	\$ 1,960,000	\$ -	\$ 1,960,000	\$ 570,874	
	<i>Definition:</i>	Modify screen channel to allow for different type of screen that will allow better access for maintenance	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier maintenance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Retrofit of facility	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

7.2.2 Disinfection

7.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two fiber-reinforced plastic (FRP) tanks, three diaphragm pumps, two disinfectant rapid mix zones, and four induction mixers. There are two screens and each discharge into two disinfectant rapid mix zones in series. There are two induction mixers, one per disinfectant rapid mix zone in series, consisting of one low level mixer and one high level mixer. The sodium hypochlorite pumps discharge to a common header that splits to the two mixing zones and splits again to each induction mixer in that zone. The Basis of Design Report does not discuss sodium hypochlorite flow splitting. Flow splitting is not metered and there does not appear to be any basis for throttling the valves to individual induction mixers to achieve equal flow splitting. Table 7-3 provides an overview of the existing disinfection system at Belle Isle CSO facility.

Table 7-3. Overview of Existing Disinfection System at Belle Isle CSO Facility

Parameter	Value
Treatment Capacity (cfs)	33
Design Feed Strength (% hypochlorite)	6-8
Max. Dosage at Design Flow (mg/L Cl ₂)	25
Disinfection Contact Time (min)	10
Storage Tanks	
Number	2
Volume of Each Tank (gal)	1,334
Type	FRP
Pumps	
Number	3
Capacity (gpm)	10.43
Type	Diaphragm
Mixers	
Number / Type	4 / Chemical induction mixers
Model Number/ hp / Manufacturer	SWC15XP / 15 hp / Water Champ

7.2.2.2 Identified Needs and Issues

The needs and issues identified for Belle Isle were identified from meetings with O&M staff and Jacobs team site visit and investigations. These needs and issues are listed in the following bullets:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Belle Isle chemical feed system has the following issues:
 - The chemical piping is complex and congested. This is due to the available space being small for the three diaphragm-style pumps installed in a manufacturer's skid containing some potentially unnecessary pipe branches and components. Smaller footprint pumps and simplified piping could reduce complexity and congestion.
 - Chemical feed pumps are on large skids and removal of the skid would require significant pipe disassembly. A means of removing assemblies weighing more than 100 pounds is desired.

These issues are addressed in Replace Chemical Feed System (Project BLI-DIS-1) in the following bullets.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project BLI-DIS-2) in the following section.
- Complex recirculation pumps piping which makes it difficult to access pumps. This issue is addressed in Replace Chemical Recirculation System with Simplified System (Project BLI-DIS-3) below.

7.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project BLI-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities are included in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, BLI-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

The alternative evaluation for these alternatives is presented in Table 7-4. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 was obtained from the replacement costs of the SRP.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 1 were estimated based on manufacturer pump rebuilds at an average cost of \$20,000 per year and GLWA onsite rebuilds at an average cost of \$12,000 per year.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10 and routine maintenance. This frequency is based on GLWA's experience at Conner Creek.

Table 7-4 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 7-4. Alternative Evaluation for Replace Chemical Feed System (Project BLI-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System In-Kind	Health and Safety	3	2.08	\$ 234,619	\$ 32,000	\$ 909,487	\$ 436,554	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 382,000	\$ 2,340	\$ 431,350	\$ 119,819	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Small no. of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 274,000	\$ 3,000	\$ 337,269	\$ 93,686	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Project BLI-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue included in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-Paced and TRC-Paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

The automatic chemical feed system should require less operator input during an event; however, this cost difference is not included in this analysis because GLWA O&M staff believe that manual sampling to confirm the auto sample result will still be necessary. There will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation for these alternatives is presented in Table 7-5. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains ready for service.
- As noted above, this evaluation did not account for any reduction in operations labor using the automatic control system.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be consistently met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 7-5. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project BLI-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Replace existing chemical feed control system utilizing current level of controls and	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 220,000	\$ 4,860	\$ 322,496	\$ 93,477	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

Replace Chemical Recirculation System (Project BLI-DIS-3). The recirculation pumps' piping is unusually complex, which is readily apparent when compared to that at the Oakwood CSO facility. The area available for recirculation on the opposite side of the tanks from the feed pipes is small and the unnecessary complexity results in poor access to the pumps. The two alternatives are:

- 1) **Alternative 1: Do Nothing.** Maintain existing system.
- 2) **Alternative 2: Replace Chemical Recirculation System with Simplified System.** It is recommended that the complex recirculation pump and piping layout be replaced with a single pump per tank recirculation patterned after Oakwood (Figure 7-4).



Figure 7-4. Comparison of Complex Piping at Belle Isle (left) and Simplified Chemical Piping at Oakwood CSO Facility (right)

The alternative evaluation is presented in Table 7-6. Capital costs for each alternative are presented in Volume 6 – Appendices, Appendix C under this project title. This evaluation shows that Alternative 2 has a total benefit score about 0.4 higher than Alternative 1 based on the improved O&M provided by simplified piping. The NPV/Benefit cost for Alternative 2 is \$67,500, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the ease of O&M with this alternative, Alternative 2 – Replace Chemical Recirculation System with Simplified System, is the recommended alternative.**

Table 7-6. Alternative Evaluation for Replace Chemical Recirculation System (Project BLI-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Maintain existing system	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Poor access to pumps.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Replace Chemical Recirculation System with Simplified System	Health and Safety	3	3.22	\$ 217,000	\$ -	\$ 217,000	\$ 67,461	Not Applicable
	<i>Definition:</i>	Replace existing piping with straight-forward piping.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less pipe to maintain.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.3 Odor Control

7.2.3.1 Description of Existing System

The Belle Isle odor control system is a vertical flow, single dual-bed vertical carbon adsorber. The odor control fan pulls foul air from the screenings chamber, mixing chamber, and retention basin when liquid is detected in any of these areas. Carbon is replaced through the top and side access hatches on the vessel.

The system was installed in 2007. Overall, the system is in good condition. For a detailed condition assessment of individual odor control assets, see CS-299 Condition Assessment.

This odor control system operates under air permit requirements (Permit to Install No. 333-07). The emission limit is 0.0107 pounds per hour of hydrogen sulfide. At a design air flow of 8,800 cfm, this equates to approximately 0.23 ppm concentration of hydrogen sulfide. The carbon is tested for remaining bed life on a quarterly basis as required by the permit. Carbon was replaced in February 2019, which was the first time it was replaced since it was put into service.

Per GLWA, no odor complaints have been received for at least the past 3 years.

7.2.3.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified:

- The odor control vessel has a dome top which increases the risk of slipping during carbon replacement.
- Accessing the top bed of the media for sampling is not easily performed. Jacobs investigated this issue further for this evaluation and the findings and recommendations are presented in the following paragraphs.

Quarterly carbon samples are taken from the top bed so that the final layer of carbon media can be analyzed to test for breakthrough. The final layer of carbon media is not accessible in the bottom bed. Accessing the top bed requires two operations staff to safely hold the ladder against the cylindrical vessel while a third staff members scales the ladder and opens the top hatch to collect the sample.

During meetings with O&M staff, Jacobs suggested that the discharged air from the vessel could be sampled and analyzed for breakthrough of H₂S. Sampling of discharged air is safer and less labor intensive than carbon media sampling. However, air sampling also requires the facility to be in operation during a wet weather event. Due to the multiple other duties of O&M staff during a wet weather event, GLWA decided to continue sampling the carbon media, which can be done during dry weather periods.

As an alternative to sampling carbon through the top access hatch, carbon may be sampled from one of the six sample ports on the side of the carbon vessel. Three ports are provided for each carbon bed. Carbon should be sampled from one of the two ports shown on Figure 7-5. These ports are located near the discharge end of each carbon bed. The lower port may be sampled from ground level. A grain thief is necessary to obtain a sample from the ports. A grain thief (see Figure 7-5, <https://www.globalgilson.com/sampling-probes>) is a device used for obtaining a grain sample from a silo and can be constructed from PVC or purchased from agricultural supply stores and other online sources. Carbon analysis is a common service provided by most activated carbon suppliers or can also be performed by many analytical laboratories.

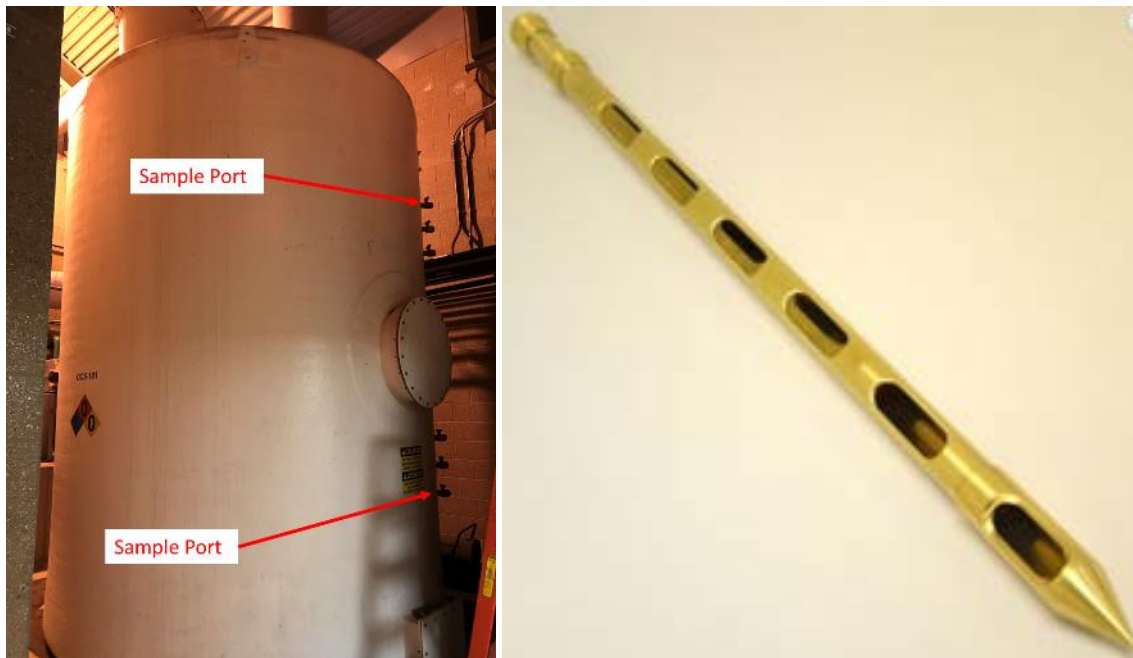


Figure 7-5. Carbon Sample Ports (left) and Grain Thief (right)

7.2.3.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative

Access to Odor Control Vessel (Project BLI-OC-1). Staff indicated that the recent carbon replacement at the facility required constructing scaffolding to safely access the top of the carbon vessel for replacing the top carbon bed. The vessel has a dome top increasing the risk of slipping.

Jacobs evaluated two alternatives that would make accessing the top of the carbon vessel safer for both sampling and carbon replacement and compared it to the current approach. Alternatives include:

- 1) **Alternative 1: Erect scaffolding for Carbon Replacement.** The O&M staff currently erects a scaffolding when replacing the carbon. The carbon needs to be replaced about every 10 years.
- 2) **Alternative 2: Ladder and Railing System.** Figure 7-6. shows a ladder and railing alternative. A contractor would field install fiberglass clips and receptacles to the existing fiberglass tank to secure the ladder and railing. The existing bolted hatch cover on the top of the vessel will be replaced with a hatch that has quick-opening clamps. The figure does not show a 6-in. toe rail, which is recommended, that should be installed at the bottom of the railing to help prevent a person's foot from slipping off the domed top along with tools and equipment.

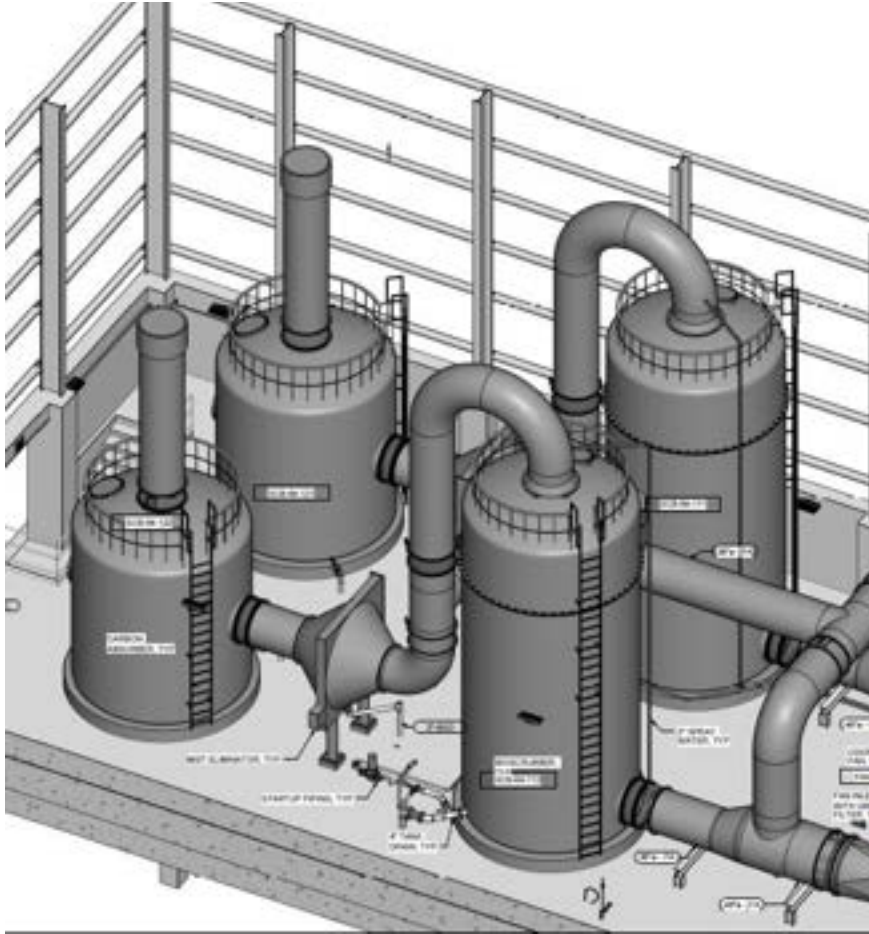


Figure 7-6. Example of Ladder and Railing (figure is not Belle Isle's odor control system)

- 3) **Alternative 3 - Ladder, Platform and Railing System:** Figure 7-7 shows an example of a ladder, platform, and railing on a horizontal tank. The platform provides a more stable working surface than the domed top. The option is a safer option because the platform provides a flat surface on which to stand. A contractor would field install fiberglass clips and receptacles to the existing fiberglass tank to secure the ladder, platform, and railing. Installation of the platform and rail option is more expensive than the railing only option (Option 1) as a crane is necessary to remove the metal roof and lower the platform from above. The existing bolted hatch cover on the top of the vessel will be replaced with a hatch that has quick-opening clamps.



Figure 7-7. Example of Ladder, Platform and Railing (figure is not Belle Isle's odor control system)

The alternative evaluation for these alternatives is presented in Table 7-7. The sources of costs used in this evaluation are listed below:

- The O&M cost for Alternative 1 is based on \$15,000 for erecting scaffolding. Because the carbon is replaced once every 10 years, the annual O&M cost is assumed to be \$1,500.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – Ladder and Railing System has a Total Benefit score 1.0 higher than Alternative 1 – Erecting Scaffolding due to the improved safety and the ease of O&M. Alternative 2 also has the lowest NPV/Benefit cost. **As such, Alternative 2 – Ladder and Railing System, is the recommended alternative.**

Table 7-7. Alternative Evaluation for Access to Odor Control Vessel (Project BLI-OC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Erect Scaffolding for Carbon Replacement	Health and Safety	2	2.50	\$ -	\$ 1,500	\$ 31,634	\$ 12,654	
	<i>Definition:</i>	Continue to use scaffolding when replacing carbon.	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Must be set up every time carbon is replaced.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Ladder and Railing System	Health and Safety	4	3.50	\$ 41,000	\$ -	\$ 41,000	\$ 11,714	Best Value Alternative
	<i>Definition:</i>	Provide a ladder on side of vessel and railing around top of vessel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Ladder provides improved access and railing provides safety during carbon change-out.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Surface of dome is still sloped and not as safe as a flat surface.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Ladder, Platform, and Railing System	Health and Safety	5	4.00	\$ 162,000	\$ -	\$ 162,000	\$ 40,500	
	<i>Definition:</i>	Provide a ladder on side of vessel and a platform and railing system on top of vessel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Platform provides more stable working surface of top of vessel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

7.2.4 Flushing and Dewatering

7.2.4.1 Description of Existing System

Dewatering System: After a wet weather event that fills the basin, the basin, screen channel, and mixing channels are dewatered by gravity back to the Belle Isle Pump Station, and subsequently pumped to the DRI and then to the WRRF.

Flushing System: Each basin contains a single flushing gate. After the basin is dewatered, the water in the flushing reservoirs (or NPW, if necessary) is used to flush the solids from the floor of the basins. The flushed solids flow by gravity to the Belle Isle Pump Station.

Table 7-8 provides an overview of the existing flushing and dewatering system at Belle Isle CSO facility.

Table 7-8. Overview of Existing Flushing and Dewatering System at Belle Isle CSO Facility

Parameter	Value
Total Basin Volume (MG)	0.3
Headworks and Basin Dewatering and Flushing System	- Each basin has one flushing gate - Flushed solids are routed by gravity to Belle Isle Pump Station

7.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- A significant amount of solids can accumulate in the corners of the mixing channels
- Local control of the valves in the two basin dewatering valve vaults requires confined space entry into the vaults. This issue is addressed in the I&C section (Section 7.2.7).

7.2.4.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Flushing System in Mixing Channel (Project BLI-FD-1). Review of the 3-D scanning results for CS-299 showed that there was a build-up of solids in the corners of the mixing channels. A means to spray these locations is needed. There are two alternatives for addressing the solids buildup in the corners of the mixing channels. These alternatives include:

- Alternative 1: Do Nothing/ Manual Flushing Build-Up Solids.** Allow solids to build-up and manually flush once every 3 months. One of the disadvantages of this alternative is that the solids in the mixing channels that are not removed after draining the basin may affect subsequent disinfection.
- Alternative 2: Flushing System in Mixing Channel.** The recommended improvement includes mounting a 4-in. HDPE header along the perimeter of the mixing channel approximately 3 ft above adjacent lower concrete surface. See Volume 6 – Appendices, Appendix B, for figures (Figure BLI-FD-1-ALT-2) showing conceptual layouts. The HDPE header should be specified with an adequate wall thickness to allow for directionally drilled holes (up to 0.75-in.-diameter) that create a water jet. The proposed hole spacing along the header is 18 to 24 in. A total flow rate of 250 gpm is required to adequately remove settled materials from the concrete shelf above the dry weather flow channel and

maintain adequate volume and velocity to carry materials into the dry weather flow channel following a CSO event.

Onsite NPW will be required. The final designer should confirm that the pressure in the existing water line is adequate (15 to 20 psi at the drilled hole) to meet the flushing requirements. The intent will be to use existing water pressure and not a booster pump. The 4-in. HDPE header should be connected to the interior NPW system piping. Following a wet-weather event, a motor operated solenoid/gate/ball control valve will be opened to charge the flushing header. The control strategy assumes that solenoid is activated for a set duration (minimum of 15 minutes) after the level sensors in the mixing channel record a water level rise above elevation 95.0 ft and subsequent water level drop.

A small valve is also recommended at the terminus end of each spray header with a rising stem and automated actuator mounted outside of the chamber. At the start of the cleaning cycle, these valves will automatically open for several minutes, allowing the potable water to flush any materials that have entered the header through openings out the open end. These terminus valves would close, and the header would pressurize and start spraying.

During initial operation, onsite staff should visually inspect the mixing channel area to confirm settled materials have been adequately removed and then adjust the control system timer to increase/decrease the flushing duration as needed until the system has been optimized. Provisions to flush the header pipe could be provided by adding another automatically operated valve at the terminal end of the header to open at the start of the flush event and flush any accumulated debris from the pipe. Integration with the facility's SCADA and LC) system is required to achieve this functionality. New electrical connections to the new control valve are also required (110 V).

The alternative evaluation for these alternatives is presented in Table 7-9. The sources of costs used in this evaluation are listed in the following bullets:

- The O&M cost for Alternative 1 assumes two personnel for 4 hours each day for manually flushing the mixing channels every 3 months.
- The O&M cost for water usage is assumed to be the same for the two alternatives, and therefore, not included in the O&M costs.
- The capital cost for the flushing system (Alternative 2) is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 1 – Do Nothing/ Manual Flushing Build-Up Solids, has the lowest NPV/Benefit cost and is considered the Best Value Alternative. **As such, Alternative 1 – Do Nothing/ Manual Flushing Build-Up Solids is the recommended alternative.**

Table 7-9. Alternative Evaluation for Flushing System in Mixing Channel (Project BLI-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Manual Flushing Solids Build-Up	Health and Safety	2	2.22	\$ -	\$ 3,200	\$ 67,487	\$ 30,445	Best Value Alternative
	<i>Definition:</i>	Allow solids to build-up and manually flush.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Known system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Solids in the mixing channels that are not removed after draining the basin may affect subsequent event water quality.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Flushing System in Mixing Channel	Health and Safety	4	3.50	\$ 151,000	\$ -	\$ 151,000	\$ 43,143	
	<i>Definition:</i>	Install a spray flushing system in each mixing channel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Solids are removed from the mixing channel after every storm.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased assets to maintain.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.5 HVAC

7.2.5.1 Description of Existing System

The Belle Isle facility consists of a headworks, chemical room, odor control room, electrical room, mechanical room, control room, sample room, and restrooms. The facility also includes an adjoining retention basin. Table 7-10 provides summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, sanitary system, electric water heater, electric water cooler and emergency shower/eye washes. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 7.2.10.

Table 7-10. Major HVAC Equipment at Belle Isle CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	WEF-2 and 3	Wall Exhaust Fans	3,350 cfm
	MAU-1	Make-up Air Unit	6,700 cfm
Basin	REF-1 and 2	2 × Roof Exhaust Fans	6,500 cfm
Chemical Room	WSF-1	Wall Supply Fan	1,600 cfm
	IEF-1	Inline Exhaust Fan	1,600 cfm
	EUH-1 and 2	Electric Unit Heater	2,450 cfm 25 kW
Electrical Room	IEF-2	Exhaust Fan	1,000 cfm
	IEF-3	Exhaust Fan	3,700 cfm
	EUH-5	Electric Unit Heater	580 cfm 5 kW
	EUH-6	Electric Unit Heater	5 kW

Notes:

kW = kilowatt(s)

Table 7-11 provides a summary of the basis of design performance criteria for HVAC systems at Belle Isle and Table 7-12 provides the outdoor Basis of Design conditions.

Table 7-11. Belle Isle Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (°F)	Summer (°F)	
Headworks Area	Class I, Div 2, Group D (Per As-Built Drawings)	60	N/A	12 ACH (Occupied)
Mechanical Room, Electrical Room	Unclassified	60	104	1 ACH (Mechanical Room) 1 ACH (Electrical Room)
Odor Control Area	Class I, Div 2, Group D (Per Basis of Design)	72	75	6 ACH (Occupied) 2 ACH (Unoccupied)

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (°F)	Summer (°F)	
Sample Room, Men's and Women's Washrooms, Control Room	Unclassified	72 (Occupied), 60 (Unoccupied)	75 F Dry Bulb, 50% Relative Humidity	1 ACH (Office) 6 ACH (Other Areas)
Chemical Room	Class I, Div 2, Group D (Per Basis of Design)	60	100	6 ACH (Occupied) 2 ACH (Unoccupied)

Table 7-12. Belle Isle Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb °F)	Summer (Wet Bulb °F)
3	91	73

7.2.5.2 Identified Needs and Issues

During discussions with GLWA O&M staff and GLWA's HVAC contractor, the following HVAC issues were noted:

- MAU-1 provides inadequate heat for Headworks Area: It was noted by O&M staff that this unit does not provide enough heat in the winter. However, no frozen pipe issues were noted in this area.
- Corrosion of Unit Heaters (UH-1 to UH-6). It was noted that half of Trane UHXA unit heaters at the facility have been recently replaced by GLWA's HVAC contractor due to corroding of copper soldering in the unit.
- Frequent failures of DX cooling coil in AHU-1. It was reported in the meetings that the Trane AC unit fails every year.
- Chemical room unit heater and exhaust fan are difficult to access due to the tight conditions in the room and the poor accessibility.
- The backflow preventer occasionally sprays water in the sample room.
- Occasional low water pressure at the facility: See Site Section 7.2.8.2 for discussion of this issue.
- Difficultly accessing chemical room HVAC equipment for maintenance: GLWA's HVAC contractor confirmed that accessing exhaust fan and unit heater in the chemical room for maintenance is very difficult. Routine maintenance has required the erection of scaffolding.

During site investigations (June 2020) the following observations were noted:

- Both Trane UHXA unit heaters in the chemical room had been replaced by Indeeco Ultra-Safe EXP unit heaters.
- The door between the electrical room and the adjacent Corridor was held open with a rope.
- Explosion proof unit heaters were provided throughout the facility including in spaces without explosion proof electrical equipment and lighting fixtures such as the electrical room and chemical room.
- The Trane UHXA unit heater in the electrical room had been replaced with an Indeeco Ultra-Safe EXP unit heater.

- The supply and exhaust fans in the odor control area were observed to be not running.
- The supply and exhaust fans in the chemical room are very difficult to access for maintenance due to their locations. See Figure 7-8. below.



Figure 7-8. Chemical Room Supply and Exhaust Fans Located in Inaccessible Area

- The exhaust fans were observed to not be running in the Headworks Area.
- Opening the Basin access hatches did not start either of the Basin exhaust fans. The fans should start when the hatch is opened.

7.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

HVAC Improvements (Project BLI-HVAC-1). Due to the relatively small nature of some of the HVAC related projects identified as improvements, all of the identified HVAC improvements are proposed to be in one project – HVAC Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) Alternative 1: Do Nothing/ Replace In-Kind.

- Replace MAU-1 in kind.

2) Alternative 2: HVAC Improvements including,

- Odor Control Area ventilation improvements
- Odor Control Area fan maintenance access
- Headworks ventilation

- Unit heater replacement
- Improved cooling for control room and sample room
- Improved access for chemical room HVAC equipment
- Water spray from backflow preventer

Each of the HVAC related improvements listed above are described further below:

Odor Control Area Ventilation Improvements. The 2003 Basis of Design report indicates that both the Chemical Room and the Odor Control Room were classified as Class I, Division 2 per NFPA 820; however, all other spaces aside from the Headworks Area and Basin were indicated as unclassified. Jacobs notes that chemical rooms are not Class I, Division 2 spaces. Rather, they are unclassified spaces, provided they are physically separated from classified spaces. The Chemical Room therefore does not require explosion-proof equipment such as the explosion-proof unit heaters currently installed in this space.

Per NFPA 820-2003, which was in effect when the facility was designed, the Odor Control Room is considered a Class I, Division 2 space if it is not continuously ventilated at 6 air changes per hour (ACH). However, the exhaust and supply fans in the odor control area were sized based on 6 ACH, which would make the area unclassified. Jacobs notes that the fans must run continuously and ventilation monitoring on both the supply and exhaust fan is required to detect no airflow. Ventilation failure and combustible gas in excess of 10 percent of the Lower Explosive Limit needs to be alarmed with visual and audible alarms at the entrance to the odor control area as well as inside the space.

It is recommended that the Odor Control Room be made unclassified by meeting the requirements noted above. Continuous ventilation of the odor control area and providing slight negative pressurization with respect to the atmosphere should have the added benefit of reducing H₂S levels in the electrical room, which was likely the cause of the need to replace the Trane UHXA unit heaters.

It should be noted that although it is not a code requirement, current best practice is to physically separate electrical rooms from spaces with corrosive conditions (e.g., the Odor Control Room) and to positively pressurize the space with respect to these areas. If the Odor Control Room is provided with negative pressurization with respect to adjacent spaces this most likely will not be necessary but if corrosion of the equipment in the electrical room becomes an issue it should be considered.

Odor Control Area Fan Maintenance Access. It is difficult to access WSF-2 and WEF-1 for maintenance purposes due to their locations high in the space and the proximity of conduit and piping restricting ladder access from below (Figure 7-9).



Figure 7-9. Odor Control Room Exhaust (left) and Supply (right) Fan Poorly Accessible

Access to WEF-1 could be provided by installing a platform which would be accessed from the landing outside of mechanical room on the second floor. This would effectively be an extension of the existing landing. WSF-1 could be provided with a platform with ladder access. This project should be coordinated with the Improved Access to Odor Control Vessel (Project BLI-OC-1) project.

Headworks Ventilation. Per the electrical record drawings, the Headworks area is electrically a Class I, Division 2 space which requires ventilation at a continuous rate of 12 ACH. Neither the odor control unit (which exhausts air from the Basin and Headworks Area), nor the Headworks Area exhaust fans were observed to be running during the site visit. This means the space is effectively a Class I, Division 1 environment containing equipment only rated for a Class I, Division 2 environment. It was also noted that Headworks Area exhaust fan WEF-3 is located only approximately 3 ft from odor control area supply fan WSF-2 (see excerpt from HVAC drawings below). When both fans are running, air being exhausted from the Headworks Area will be introduced into the odor control area by WSF-2 (Figure 7-10). This could have contributed to the corrosion which lead to the need to replace the Trane UHXA unit heaters.

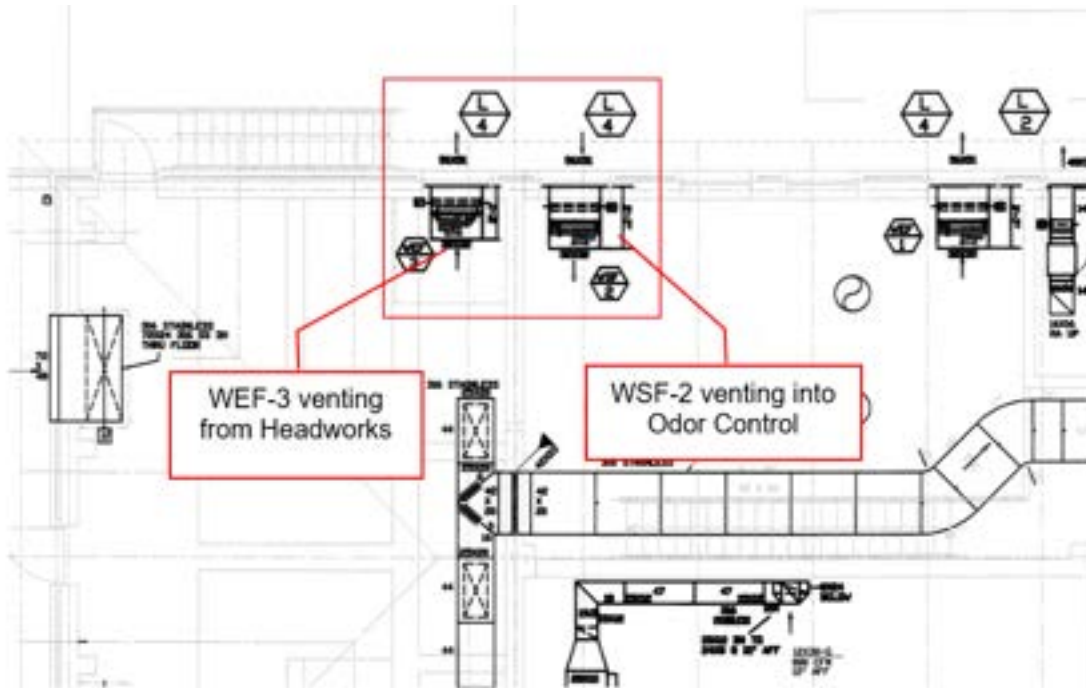


Figure 7-10. Short-Circuiting of Airstreams Between WEF-3 and WSF-2

In addition to issues with short-circuiting of the air streams between WEF-3 and WSF-2, MAU-1 has a duct which runs from the mechanical room through the odor control area to the headworks area (Figure 7-11). The ductwork between the classified Headworks Area and the unclassified mechanical room is a breach in physical separation as defined by NFPA 820 and effectively classifies the entire building with the same classification as the Headworks Area.

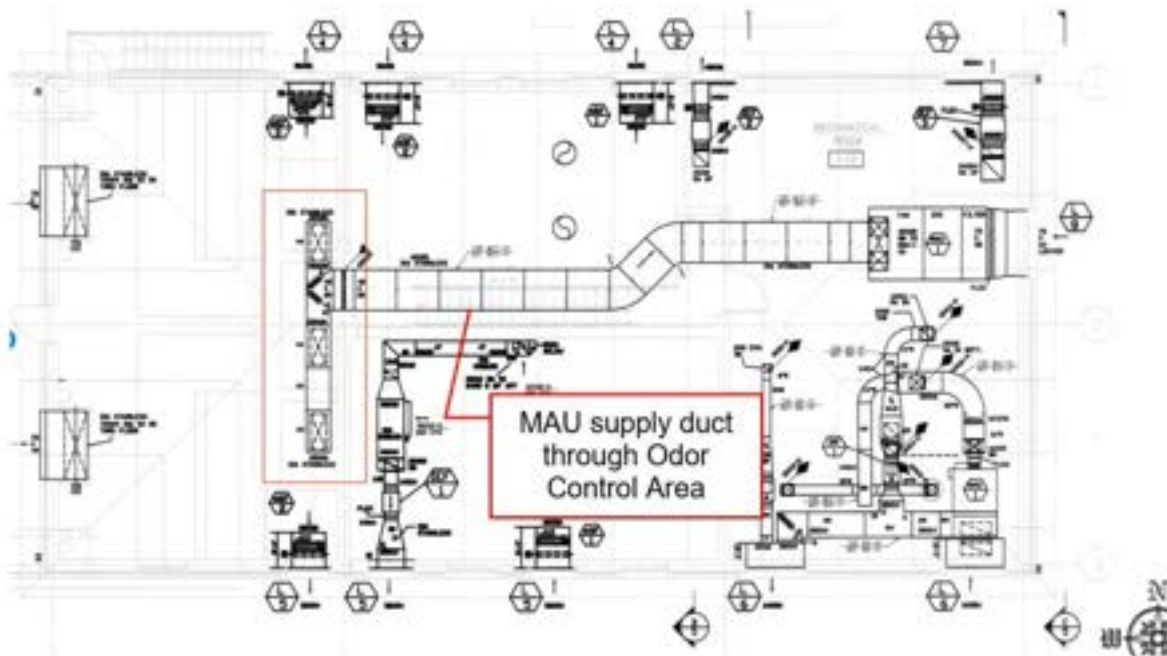


Figure 7-11. Ductwork Passing Between Classified and Unclassified Areas

It is recommended that MAU-1 be removed and replaced by either a MAU located at the ground level near the Headworks Area or a supply fan with the same capacity as MAU-1 and explosion proof unit heaters. For cost estimating purposes, a new supply fan and unit heaters are assumed. Locating the supply fans or MAU on the North side of the Headworks Area and relocating WEF-3 to the South side would have the benefit of eliminating the short-circuiting currently occurring between WEF-3 in the Headworks Area and WEF-2 in the odor control area.

Increased MAU-1 Heating Capacity (if necessary). MAU-1 serves the Headworks. It was noted by O&M staff that this unit does not provide enough heat in the winter. The basis of design dry bulb temperature for the Headworks area is 60°F, so it is possible that this area could be perceived as being cold in the winter. No pipes have frozen in the past in this area. If additional heating is desired in this space, a unit with increased heating capacity should be provided with the new MAU described in the project above.

Unit Heater Replacement. The Trane UHXA unit heaters at the facility have an aluminum-finned tubular steel heat exchanger which is directly exposed to the air stream when the heaters are running. Steel has very poor H₂S resistance and is a poor choice of materials for the environment the unit heaters are in. It is recommended that as the unit heaters fail, they are replaced by properly rated units that have a 316 stainless steel heat exchanger and cabinet body, aluminum or 316 stainless steel fins, fan blade, and control enclosure and a motor with a corrosion-resistant protective coating that has passed the ASTM International Method B117 salt-spray test. The Indeeco units are a good selection for the electrical room and odor control area. If the odor control area is unclassified, they are not required to be explosion-proof. Based on the recommendation to replace the units when they fail, their cost is not included in the capital cost estimate, rather, they are in the SRP.

The Indeeco units currently installed in the chemical room should last longer than the Trane UHXA units which they replaced; however, even 316 stainless steel is also susceptible to corrosion by sodium hypochlorite.

Improved Cooling for Control Room and Sample Room. GLWA's HVAC contractor noted that while there have been mechanical failures in AHU-1 in the past, the failures were not out of the ordinary in terms of frequency or severity and have been reportedly rectified.

It is likely that AHU-1 could appear to be under-performing in terms of cooling due to the fact that when the space is unoccupied, the setpoint is controlled to increase to 85°F. Operators visit the facility infrequently and in the short amount of time they are at the facility the temperature in the spaces served by AHU-1 (i.e., the sample room, control room, men's and women's restrooms, and corridor) may not reach the Basis of Design temperature of 72°F.

In order to improve operator comfort when the facility is occupied it is recommended that split direct expansion (DX) units be installed in the sample room and control room. The evaporator units in the split DX systems could be configured to discharge in locations where operators are likely to be located and would provide a faster response to occupancy than the current system configuration. The proposed split DX units would be provided in addition to the existing AHU-1 cooling coil and would be provided with their own thermostat.

Improved Access for Chemical Room HVAC Equipment. GLWA's HVAC contractor noted the need to erect scaffolding to perform maintenance on the unit heater and exhaust fan in the chemical room. Jacobs recommends either (1) installing a platform with ladder to allow for maintenance on the exhaust fan and relocating the unit heater to an area where ladder access is possible, or (2) evaluating and possibly repositioning the supply and exhaust fans closer to the floor when the chemical feed system is re-designed in the future (as described in the CS-299 Disinfection technical memorandum).

Water spray from backflow preventer. During the site visit water was noted on the floor near the backflow preventer with no drain near the unit (Figure 7-12). Jacobs recommends the installation of

an airgap fitting with hose attachment and running the hose to the nearest drain. This should address the water spray.



Figure 7-12. Water Spray Near Backflow Preventer

The alternative evaluation is presented in Table 7-13. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for MAU-1 in Alternative 1 was obtained from the SRP. It should be noted, however, that replacement of the MAU in its current location would likely not be code compliant.
- The O&M costs for Alternative 1 include scaffolding costs (to perform maintenance on the unit heater and exhaust fan in the chemical room).
- The capital costs for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 1 is the Best Value Alternative. However, replacement of the MAU in its current location would likely not be code compliant. In addition, Alternative 2 has a total benefit score about 1.0 higher than the Alternative 1 based on the improved health and safety and improved O&M. **As such, Alternative 2 - HVAC Improvements is the recommended alternative.**

Table 7-13. Alternative Evaluation for HVAC Improvements (Project BLI-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	2	2.50	\$ 63,500	\$ 2,000	\$ 99,591	\$ 39,836	Best Value Alternative
	<i>Definition:</i>	No improvements	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lack of code compliance, difficult, less safe, and more costly maintenance, corrosive gases entering building, and control room discomfort.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	4	3.50	\$ 293,000	\$ -	\$ 293,000	\$ 83,714	
	<i>Definition:</i>	Addition of Odor Control area ventilation monitoring to meet code requirements, replacement of MAU-1 with new system, improved fan access for maintenance, and supplemental air conditioning.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Code compliance, easier and safer maintenance, more comfortable control room conditions.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.6 Electrical

7.2.6.1 Description of Existing System

The Belle Isle electrical system consists of one DTE utility feed from a 1,000 kVA, 480 V, 3-phase outdoor transformer (primary metering) and one diesel generator feed from a 750 kilowatts (kW), 480 V, 3-phase stationary generator. The feeds are connected to a 1,200 A switchboard with electrically operated breakers and automatic source transfer controls. The switchboard then feeds a 1,200 A motor control center (MCC). The MCC then feeds the various pumps, valves, motors, transformers, panels, etc. at the facility. The Belle Isle Pump Station is fed from the CSO facility MCC; however, it is not included in this facility assessment, per the CS-299 Scope of Work. Table 7-14 provides a summary of the major electrical equipment for this facility.

Table 7-14. Major Electrical Equipment at Belle Isle

Location	Major Electrical Equipment	Description
Electrical Room	Main Switchboard/ATS	1,200 A, 480/277 V, 3-Phase
Outdoors	Generator (Diesel)	750 kW, 480 V, 3-Phase
Electrical Room	MCC	1,200 A, 480/277 V, 3-Phase

7.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the section below.

7.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project BLI-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting, however it will be less safe when operating at night and when accessing area downstream of screens.
- 2) **Alternative 2: Electrical Improvements.** Add lighting at the following location (and shown on the electrical drawings - Figure BLI-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Basin – Add additional external lighting on top and the riverside of the basin. Lighting foot-candles will meet the requirements of the local outdoor lighting ordinances.

The alternative evaluation is presented in Table 7-15. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting. The NPV/Benefit cost for Alternative 2 is \$16,500, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 7-15. Alternative Evaluation for Electrical Improvements (Project BLI-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe when operating at night.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 58,000	\$ -	\$ 58,000	\$ 16,571	Not Applicable
	<i>Definition:</i>	Add additional external lighting on top and the riverside of the basin.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.7 I&C

7.2.7.1 Description of Existing System

Control System: The original Ovation control system was installed in 2007 under PC-753. This project upgraded the existing Belle Isle Pump Station facility to include the new CSO basin facility. In 2014 under PC-773D, the Ovation system controllers and software were upgraded to version O.V.3.5.0.

The facility's Ovation network currently has only one primary network switch. The switch is connected to the GLWA AT&T wide area network via the system's router. The system has one database server and one operator workstation located in the control room. The system has a pair of Ovation controllers that provide the facility with redundant local controls and I/O capabilities. All network connections in the Belle Isle facility are via copper Ethernet cables. The controllers are connected to the network via a single-homed connection, which means each controller has only one connection to the network switch. Since there is only one network switch, the primary switch is a single point of failure for the overall system. The current system is equipped with a back-up radio system to communicate critical monitoring points back to SCC on wide area network failure.

Flow and Level Sensors: Table 7-16 summarizes the level sensors and flow meters at the Belle Isle CSO Facility used to monitor flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 7-16. Summary of Flow Meters and Level Sensors at Belle Isle CSO Facility

Area	Quantity	Instrument Type
CSO Level Sensors		
Screening Chambers	2	Ultrasonic
	2	Radar (Back-up)
Mixing Chambers	2	Ultrasonic
	2	Radar (Back-up)
Basin 1 and 2	2	Ultrasonic
	2	Radar (Back-up)
Flush Water Storage	2	Ultrasonic
	2	Radar (Back-up)
Chemical System Flow Meters		
Chemical Feed		
To upper mixers	2	Magnetic
To lower mixers	2	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Ultrasonic

7.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets:

- GLWA requested to have the ability to control the Belle Isle CSO Facility from Conner Creek to improve operational efficiency during CSO events.
- GLWA requested that Jacobs investigate the potential removal of gas monitors in the basins for Belle Isle to reduce instrumentation maintenance requirements.
- GLWA requested process cameras at select locations to improve monitoring of the facility during wet weather operation.
- Local control of the valves in the two basin dewatering valve vaults requires confined space entry into the vaults.
- Generator and ATS controls do not adequately report alarm signals into Ovation and are becoming less reliable. This issue is being addressed in an on-going project and is therefore not included in the capital improvement projects for CS-299.
- Update Ovation control system to the latest version and increased monitoring capabilities.
- Control system network lacks redundancy.

7.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project BLI-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, all of the identified I&C improvements, with the exception of the Ovation Control System Upgrade, are proposed to be in one project – I&C Improvements. This project could be split into multiple delivery projects, if needed. There are two alternatives for this project:

1) **Alternative 1: Do Nothing**

2) **Alternative 2: I&C Improvements including,**

- Provide remote operation of Belle Isle CSO Facility from Conner Creek CSO Facility
- Investigate need for gas monitoring in CSO basins
- Provide process cameras at select locations
- Provide local control capabilities of actuators in valve vaults

Each of the I&C related improvements listed above is described further below:

Provide remote operation of Belle Isle CSO Facility from Conner Creek CSO Facility. GLWA requested to have the ability to control the Belle Isle CSO Facility from Conner Creek to improve operational efficiency during CSO events. The physical infrastructure is in place to allow this to happen. It is recommended that GLWA investigate the programming through SCADA to determine if the code has already been written and activate if that is the case. If the existing programming in SCADA does not contain code for remote control of Belle Isle from Conner Creek, provide additional programming for this functionality.

Investigate need for gas monitoring in CSO basins. Eliminate gas monitoring equipment in accordance with Section 5.4.7.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

Provide local control for valves in valve vaults above ground (outside of vault). Local control of the valves requires confined space entry. Providing controls above ground, outside of the valve vault would improve safety, when local control of the valves may be needed.

The alternative evaluation is presented in Table 7-17. The sources of costs used in this evaluation are listed in the following bullets:

- The O&M costs for Alternative 1 assume that the lack of remote control of the Belle Isle facility requires additional operator time every wet weather event.
- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- O&M costs for Alternative 2 include an estimated annual cost for maintenance of the proposed cameras.

This evaluation shows that Alternative 1, Do Nothing/Replace In-Kind, is the Best Value Alternative because the NPV/Benefit cost of Alternative 1 is about \$7,000 lower than that of Alternative 2. The total benefit score for Alternative 2 is 1.3 higher than Alternative 1, due to improved health and safety, and ease of O&M. Based on the higher total benefit score and the small difference in NPV/Benefit cost, **Alternative 2 - I&C Improvements is the recommended alternative.**

Control System Upgrade (Project BLI-I&C-2). It is recommended to update the Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2. As part of this project, it is recommended to increase network switch redundancy. Adding a back-up network switch within the system will eliminate the single point of failure of the primary network switch. Once the back-up network switch is added, the connections to the network equipment and Ovation controllers will need to be converted to a dual-home configuration instead of single-home connections. This will provide full redundancy and should one of the networks fail, the second network will remain available for monitoring and control.

Capital costs are included in Volume 6 – Appendices, Appendix C under this project title. Because the Ovation system is the only alternative for the control system upgrade, it is the only alternative considered. Table 7-18 provides the summary of the **Control System Upgrade, which is the recommended alternative.**

Table 7-17. Alternative Evaluation for I&C Improvements (Project BLI-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ 4,000	\$ 84,359	\$ 33,743	Best Value Alternative
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Unexpected conditions may occur in the Headworks	Component Performance	3						
	<i>Comments:</i>	Annual O&M without remote control of basin: 10 events; 4 hrs per event; \$100/hr	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	5	3.78	\$ 112,000	\$ 2,000	\$ 154,179	\$ 40,752	
	<i>Definition:</i>	Provide local control of valves without entering valve vault, install cameras for monitoring of process areas, and eliminate gas monitoring in CSO basins.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance (with reduction of gas monitoring), and more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance (with addition of cameras)	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

Table 7-18. Alternative Evaluation for Control System Upgrade (Project BLI-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 922,000	\$ -	\$ 922,000	\$ 307,333	Best Value Alternative
	<i>Definition:</i>	Upgrade control system to latest version of Ovation.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Allows for use of high performance graphics and provides other benefits.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

7.2.8 Site

7.2.8.1 Description of Existing Site

The Belle Isle CSO Facility was constructed in 2009. The site includes the CSO facility and a sanitary pump station used to pump sanitary and retained storm flows from Belle Isle to the DRI on the west side of the Detroit River. The total area of the site is approximately 0.85 acres and includes an access road, parking area and fencing. The security fencing is 6-ft tall. There is a 24-ft wide sliding gate at the southern corner of the fenced-in area, as well as multiple smaller swing gates in other parts of the fence.

Site access/egress is by access road off of Sunset Drive. A parking area is located along the west side of the site to accommodate parking for O&M personnel and visitors. The access road and parking area consist of concrete pavement. The reinforced concrete sidewalk is 5 in. thick with 2 in. of aggregate base course. The rest of the reinforced concrete pavement on site is 10 in. thick with 9 in. of aggregate base course.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

7.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- Inadequate space or turning radius inside the site for the sodium hypochlorite tanker trucks to maneuver through the site.
- Water ponding near the entrance gates.
- GLWA Operations has experienced issues at the basin roof drain scupper outlets as they get plugged by leaves and debris resulting in ponding on the basin surface.
- Investigate occasional low water pressure. GLWA has experienced low pressure in the incoming potable water line to the Belle Isle CSO facility in the past. The watermain servicing the facility is 6-in.-diameter. Based on discussions with GLWA after the Needs Assessment meeting, GLWA staff believes the pressure issues may have been related to Detroit Water and Sewerage Department closing valves and changing flow paths during their operation of the system (now done by the State of Michigan). This may have resolved the issue. Pressure monitoring of the water pressure at the fire hydrant outside the facility could be performed over an extended period of time (i.e., a few months) to better determine the timing and magnitude of the issue, if this is still an issue in the future.
- Seal concrete pavement joints of service drive and parking area to ensure serviceability. This could be considered a preventative maintenance item; however, for this evaluation, costs have been included in the Site capital improvements to address any concrete pavement joints or other repairs.

7.2.8.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Site Improvements (Project BLI-SITE-1). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Site Improvements** including,
 - Tanker Truck Access
 - Address Ponding Near Service Drive Entrance
 - Improve Basin Surface Drainage

Each of the site related improvements listed above are described further below:

Tanker Truck Access: The sodium hypochlorite fill station is located on the south side of the facility. Tanker trucks must access this location several times a year for hypochlorite delivery. Currently, the trucks pull up on a temporary unpaved access drive next to the City's barricade storage yard outside of the fence line, and then run a hose through a manway gate to the fill station to offload the hypochlorite. There is not adequate space or road turning radius inside the site for the tanker trucks to maneuver through the site. Trucks accessing the truck fill station outside the fence is not ideal as trucks could get stuck in the soft grade while pulling up and turning on the site.

It is recommended that the concrete pavement be extended parallel to the existing drive from the entrance service drive to the truck fill location, and then extended southward with adequate paved area to provide adequate turning radii for the tanker truck to turn to the south and back up to the manway gate at the point of the truck fill (see Figure BLI-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B).

Address Ponding Near Service Drive Entrance: A low point in the existing site grading exists on the north side of the service drive near the entrance gate to the facility. This is an area where water encroaches on the service drive frequently and can be a nuisance, particularly in winter months when icing on the service drive is a concern. It is recommended that a catch basin be installed at this location and connected to the existing storm sewer near this low point.

Improve Basin Surface Drainage: The basin roof is sloped from south to north with drain scuppers located through a parapet wall that allow drainage through the wall to downspouts. GLWA Operations has experienced issues at the scupper outlets as they get plugged by leaves and debris resulting in ponding on the basin surface.

One alternative could be to remove the trees near the basin and replace them with a lower growing tree or shrub. Another alternative could be that the sizes and number of scuppers be evaluated, and appropriate modification be made to the scuppers to prevent leaves and debris from blocking the scupper outlets. Coring holes directly into the basin roof to provide additional drainage relief may also be considered as an alternative to work along with the existing scupper system.

The alternative evaluation is presented in Table 7-19. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than Alternative 1 based on the improved health and safety and improved O&M provided by the various site improvements. The NPV/Benefit cost for Alternative 2 is \$63,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Site Improvements is the recommended alternative.**

Table 7-19. Alternative Evaluation for Site Improvements (Project BLI-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Maintain current operation for hypo deliveries and do not address ponding.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Trucks could get stuck in the soft grade while accessing the site & safety issue with ponding water.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 220,000	\$ -	\$ 220,000	\$ 62,857	Not Applicable
	<i>Definition:</i>	Improved tanker truck access, address ponding near service drive entrance, and improve basin surface drainage.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved maneuverability and safety during hypo deliveries & improved safety for accessing facility.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.9 Architectural

7.2.9.1 Description of Existing Facilities

The Belle Isle CSO Facility includes the CSO facility and a sanitary pump station used to pump Belle Isle sanitary flows to DRI on the west side of the river. The treatment facility consists of a chemical room, odor control room, utility support (electrical and mechanical), control room, sampler room, screen room and other miscellaneous rooms. The facility also includes an adjoining retention basin.

7.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a roof replacement evaluation and a detailed assessment of architectural issues, as described in the following paragraphs.

Evaluation of Type of Future Roof Replacement. Jacobs reviewed the results of a roof assessment and prepared a 60-year life-cycle cost analysis between shingled roof and metal roof. Based on the results of this evaluation, which shows lower life cycle cost for shingled roof, Jacobs recommends replacement of the shingled roof with shingles when the roof is ready for replacement. The analysis is presented in Table 7-20. As such, the roof should be replaced in-kind and the costs and schedule for roof replacement will come from the SRP.

Table 7-20. 60-Year Life Cycle Cost Evaluation of Shingled vs. Metal Roof for Belle Isle Facility

	Shingle Roof	Metal Roof
Replacement Cost ^a	\$70,000	\$233,000
Replacement Interval	20 years	60 years
Number of Roof Replacements During 60 Years	3	1
Total Life Cycle Cost (NPV) Discounted at 2.4%	\$190,000	\$233,000

^a Based on 4,650 ft² roof area; \$15 ft² for shingle roof and \$50/ft² for metal roof.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because the items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

7.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (BLI-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control /expansion wall joints
 - Remove and replace isolation /cove joint sealant and around building perimeter
 - Clean concrete bollards, patch, prepare surface and coat
 - Repoint mortar joints
 - Remove damaged coating, prepare surface, patch and apply coating to coping.

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure BLI-ARCH-1-ALT-2). Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project. It should be noted that recoating of the floor in the Chemical Room was originally included in the architectural items, but moved to the Chemical Feed project (BLI-DIS-1).

The alternative evaluation is presented in Table 7-21. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, **Alternative 2 is the recommended alternative.**

Table 7-21. Alternative Evaluation for Architectural Rehabilitation (Project BLI-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 243,000	\$ -	\$ 243,000	\$ 78,387	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

7.2.10 Safety

7.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

7.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 7-22. The capital improvement project to address these issues is included in the table.

Table 7-22. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Chemical Room	Top and mid-rail fall protection needed at ladder access at top of tanks	Add swing gate (original recommendation was to add chain; however, this is no longer current GLWA practice)	Safety Improvements (Project BLI-SAFE-1)
Chemical Room	Emergency eyewash/shower is at different level from tank and pumps and it is partially obstructed by door	Relocate eyewash/shower	Safety Improvements (Project BLI-SAFE-1)
Odor Control Room	No illuminated exit signs	Add or replace exit signs	Exit Sign Improvements ^a
Odor Control Room	Concrete pad creates uneven exit access to exterior door	Remove section of concrete pad	Safety Improvements (Project BLI-SAFE-1)
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project BLI-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

7.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section.

Safety Improvements (Project BLI-SAFE-1). This project should address the safety issues identified above. These issues include:

- Add swing gate to access top of tanks in the chemical room
- Replace eyewash/shower in the chemical room
- Remove section of concrete pad in the odor control room
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 7-23 shows the one alternative.

Table 7-23. Alternative Evaluation for Safety Improvements (Project BLI-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	5	3.78	\$ 82,000	\$ -	\$ 82,000	\$ 21,674	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection, eye wash and exit signage.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at the Belle Isle CSO Facility.

7.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Belle Isle CSO facility, Table 7-24 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 7-24, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 7-24. Listing of Asset Condition Assessments for Belle Isle Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	15	15	0	100%
AHU	2	1	1	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	4	4	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	0	0	0	N/A
BUILDING	2	1	0	50% ^a
CAMERA	1	1	0	100%
COMPRESSOR	0	0	0	N/A
COND-AIR	0	0	0	N/A
CONVEYOR	0	0	0	N/A
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAMPER	15	15	0	100%
DISCONNECT	0	0	0	N/A
DOOR	2	2	0	100%
DRIVE-ELEC	3	3	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	4	4	0	100%
FAN	1	0	1	100%
FANVENT	13	13	0	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	0	0	0% ^b
GASMONITOR	8	8	0	100%
GATE	7	7	0	100%
GEARBOX	4	0	4	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	3	3	0	100%
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	1	1	0	100%
MCC	1	0	1	100%
METER	4	4	0	100%
MIXER	4	4	0	100%
MOTOR	7	3	4	100%
PANEL	8	8	0	100%
PIPING	4	4	0	100%
PUMP	8	8	0	100%
ROOF	1	1	0	100%
SAMPLER	1	1	0	100%
SCADA	0	0	0	N/A
SCREEN	2	0	2	100%
SCRUBBER	1	0	1	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SENSOR	18	18	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	1	1	0	100%
STRAINER	0	0	0	N/A
SWITCH	1	0	1	100%
SWITCHGR	1	0	1	100%
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	3	0	3	100%
UNITHEATER	6	6	0	100%
UPS	2	2	0	100%
VALVE	21	19	2	100%
WATERHTR	1	1	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is not an asset.

^b The one gas detector is a portable gas detector and was not assessed.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Belle Isle Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

7.3 Capital Planning for Belle Isle CSO Facility

7.3.1 Summary of Capital Improvement Plan Projects

Table 7-25 provides a summary of the recommended CIP projects and associated capital costs for the Belle Isle CSO facility based on the alternative evaluations conducted for this facility.

Table 7-25. Summary of Recommended Projects at Belle Isle CSO Facility

Project No.	Alternative	Description	Total Project Cost
BLI-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 274,000
BLI-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
BLI-DIS-3	2	Replace Chemical Recirculation System with Simplified System	\$ 217,000
BLI-OC-1	2	Ladder and Railing System	\$ 41,000
BLI-HVAC-1	2	HVAC Improvements	\$ 293,000
BLI-ELEC-1	2	Electrical Improvements	\$ 58,000
BLI-I&C-1	2	I&C Improvements	\$ 112,000
BLI-I&C-2	1	Control System Upgrade	\$ 922,000
BLI-SITE-1	2	Site Improvements	\$ 220,000
BLI-ARCH-1	2	Architectural Rehabilitation	\$ 243,000
BLI-SAFE-1	1	Safety Improvements	\$ 82,000

7.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 7-26. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 7-26. Capital Improvement Plan Projects for Belle Isle CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
BLI-1 Disinfection System Improvements	\$752,000	2028 <i>Timing based on asset condition</i>	BLI-DIS-1	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	\$ 274,000
			BLI-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
			BLI-DIS-3	Replace Chemical Recirculation System with Simplified System	\$ 217,000
			BLI-OC-1	Ladder and Railing System	\$ 41,000
BLI-2 HVAC Improvements	\$ 293,000	2033 <i>Timing based on asset condition</i>	BLI-HVAC-1	HVAC Improvements	\$ 293,000
BLI-3 Facility-Wide Electrical and I&C Improvements	\$ 1,092,000	2025 <i>Timing based on asset condition</i>	BLI-ELEC-1	Electrical Improvements	\$ 58,000
			BLI-I&C-1	I&C Improvements	\$ 112,000
			BLI-I&C-2	Control System Upgrade	\$ 922,000
BLI-4 Site Improvements	\$ 220,000	2030 <i>Timing based on best judgement</i>	BLI-SITE-1	Site Improvements	\$ 220,000
BLI-5 Facility-Wide Safety and Architectural Improvements	\$ 325,000	2023 <i>Project should be initiated as soon as possible</i>	BLI-ARCH-1	Architectural Rehabilitation	\$ 243,000
			BLI-SAFE-1	Safety Improvements	\$ 82,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 7-27 and Table 7-28 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 7-27 indicates that BLI-DIS-1 project has 13 assets that has an average condition score of 1.54 and an average replacement date of 2029. This information was used to propose a scheduled construction completion date of 2028.

Table 7-27. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
BLI-DIS-1	13	1.52	1.54	2.79	12	2029	\$ 234,619
BLI-HVAC-1	1	1.29	1.50	2.25	20	2034	\$ 63,500
BLI-SCR-1	1	2.00	1.70	3.70	30	2041	\$ 489,400

Table 7-28. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
BLI-DIS-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
BLI-HVAC-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
BLI-SCR-1	1	2.00	5.00	7.00	30	N/A	\$ 489,400

7.3.3 20-Year Capital Outlay Plan

Table 7-29 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 7-29. 20-Year Capital Outlay Plan for Belle Isle CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 44,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 19,500	\$ -	\$ -	\$ 14,500	\$ 10,000	\$ -
2022	\$ 504,082	\$ -	\$ 504,082	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ 8,555	\$ -	\$ -	\$ -	\$ 8,555	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 57,413	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 21,012	\$ -	\$ 36,401	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 354,204	\$ -	\$ -	\$ -	\$ 354,204	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 146,878	\$ -	\$ 61,713	\$ 61,713	\$ 23,452	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2030	\$ 171,867	\$ 37,838	\$ -	\$ -	\$ 83,138	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 50,890	\$ -	\$ -
2031	\$ 183,478	\$ -	\$ -	\$ -	\$ 159,120	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 24,358
2032	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 190,568	\$ -	\$ -	\$ 29,371	\$ -	\$ 18,603	\$ -	\$ 142,595	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 405,562	\$ 149,595	\$ -	\$ -	\$ -	\$ -	\$ 4,599	\$ 176,519	\$ -	\$ -	\$ 74,849	\$ -	\$ -
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 609,924	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 609,924	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 639,908	\$ 88,180	\$ -	\$ 291,140	\$ -	\$ 21,566	\$ 18,046	\$ 144,707	\$ -	\$ -	\$ -	\$ 76,269	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 3,316,439	\$ 275,614	\$ 565,795	\$ 382,224	\$ 628,468	\$ 40,169	\$ 22,644	\$ 483,321	\$ 630,936	\$ -	\$ 176,641	\$ 86,269	\$ 24,358

- Notes:
- Explanation of large capital outlays in first two years:
- Screening System: Screen in Basin 2 was out of service at the time of the Condition Assessment for major repair and received a score of 5. It has since been returned to service.

8. Connor Creek CSO Control Facility

8.1 Facility Description and Future Capacity Considerations

8.1.1 General Facility Description

The Connor Creek CSO Facility is an RTB with 30 MG of storage and a treatment capacity of 13,963 cfs. It was constructed in 2005. The facility consists of a headworks, chemical room, chemical storage area (outdoor), utility support (electrical, transformer and mechanical rooms), control room, sample room, hydraulic room, office space on the second floor, and other miscellaneous rooms.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

8.1.2 Future Capacity Considerations

There were no future capacity considerations identified at the time of this report.

8.2 Facility Assessment

8.2.1 Screening

8.2.1.1 Description of Existing System

The Connor Creek CSO Facility has 10 catenary bar screens that were installed in 2005. Channels 1-3 were originally designed to be always open (i.e., there are no influent slide gates upstream of these screens). Channels 4-10 have motorized double leaf slide type influent gates that were originally designed to open sequentially, first as a set of two (Numbers 4 and 6), and then as a final set of all remaining gates, based on increasing influent flow. During a large wet weather event in 2016, the gates did not open because there was no remote control, GLWA staff could not get to the basin, and the local area flooded. GLWA Operations decided to leave them open until all SCADA / controls can be restored for the facility.

Screenings are discharged onto one of two conveyor belts which transfer the screenings to a dumpster. One belt is provided for Bar Screens 1 through 5 and another belt is provided for Bar Screens 6 through 10. The screenings are disposed of in a landfill.

Table 8-1 provides an overview of the existing screening system at Connor Creek CSO facility.

Table 8-1. Overview of Existing Screening System at Connor Creek CSO Facility

Parameter	Value
Treatment Capacity (cfs)	13,963
No. of Screens	10
Manufacturer	US Filter
Screen Type	Catenary Bar Screen
Opening Size	1.5-in. slot
Depth or Length / Width	29 ft 8.5 in / 17 ft 0 in
Screen Cleaning	Mechanical Rake
Screening Removal	Conveyor belt to dumpster and landfilled

8.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Investigate conveyor belt improvements to address belt alignment issues and to address occasional buildup of screenings at start of the conveyor belt incline section.

Jacobs further investigated this issue with Custom Conveyor Corporation (the original belt manufacturer). It should be noted that Custom Conveyor will conduct a site investigation at a later date during CS-299 to assess the conveyor issues and provide recommendations.

Based on initial conversations, potential recommendations to address belt alignment issues include tightening the belt tension, installing training idlers, and replacing the belt. Tightening the belt tension by adjusting the tail pulley could prevent the belt from becoming misaligned. Installing training idlers approximately every 50-ft on the carry side of the belt can prevent the belt from walking off to the side. Over time, the belt may become stretched and exceed the ability of the tail pulley to provide further tension. The belt may also reach the end of its service life. In either case, the belt may need to be replaced.

Cleats may be recommended to prevent buildup of screenings at the start of the incline. Cleats prevent screenings from sliding down the belt. Cleats may be bolted onto existing belts. Cleats requires replacing the wiper used to clean the screens with a belt thumper. The belt thumper is slave driven off the discharge pulley.

No capital improvement costs have been provided to address this issue.

- GLWA O&M personnel requested improvements to access for screen maintenance, including for wear shoes and motor and gearbox. The motor and gearbox extend over the screenings channel and are difficult to reach from the walkway next to the screen. Currently, maintenance staff use a man-basket connected to the overhead crane to access the motor.

Jacobs further investigated this issue. One option would be to construct a walkway to provide better access; however, this will likely be a costly option. This issue has been added to the list of issues to be evaluated by E&I (original screen manufacturer) during their upcoming OEM screen assessment to determine if they have a better option. The results of E&I's evaluation will help determine the scope of any improvement.

During Jacobs safety inspection under CS-299, the following issue was identified in the Headworks Building:

- Eliminate low headspace between screenings dumpsters. During Jacobs Safety Inspection in January 2020, it was noted that the support beams for the screenings conveyor create a safety hazard for staff walking through the building due to their relatively low height. These beams support the head pulleys and discharge end of the screenings conveyors.

Jacobs contacted the original conveyor manufacturer (Custom Conveyor) to evaluate options for resolving this issue. Figure 8-1 shows a recommended modification that will eliminate the overhead safety concern. It involves providing a new drive-end conveyor support for each conveyor and relocating the drive motor. This is an on-going project being completed under a JOC.

8.2.1.3 Description and Evaluation of Alternatives

The issues above are either on-going or they do not require capital improvement at this time. As such, there are no alternatives identified as screening capital improvement "needs".

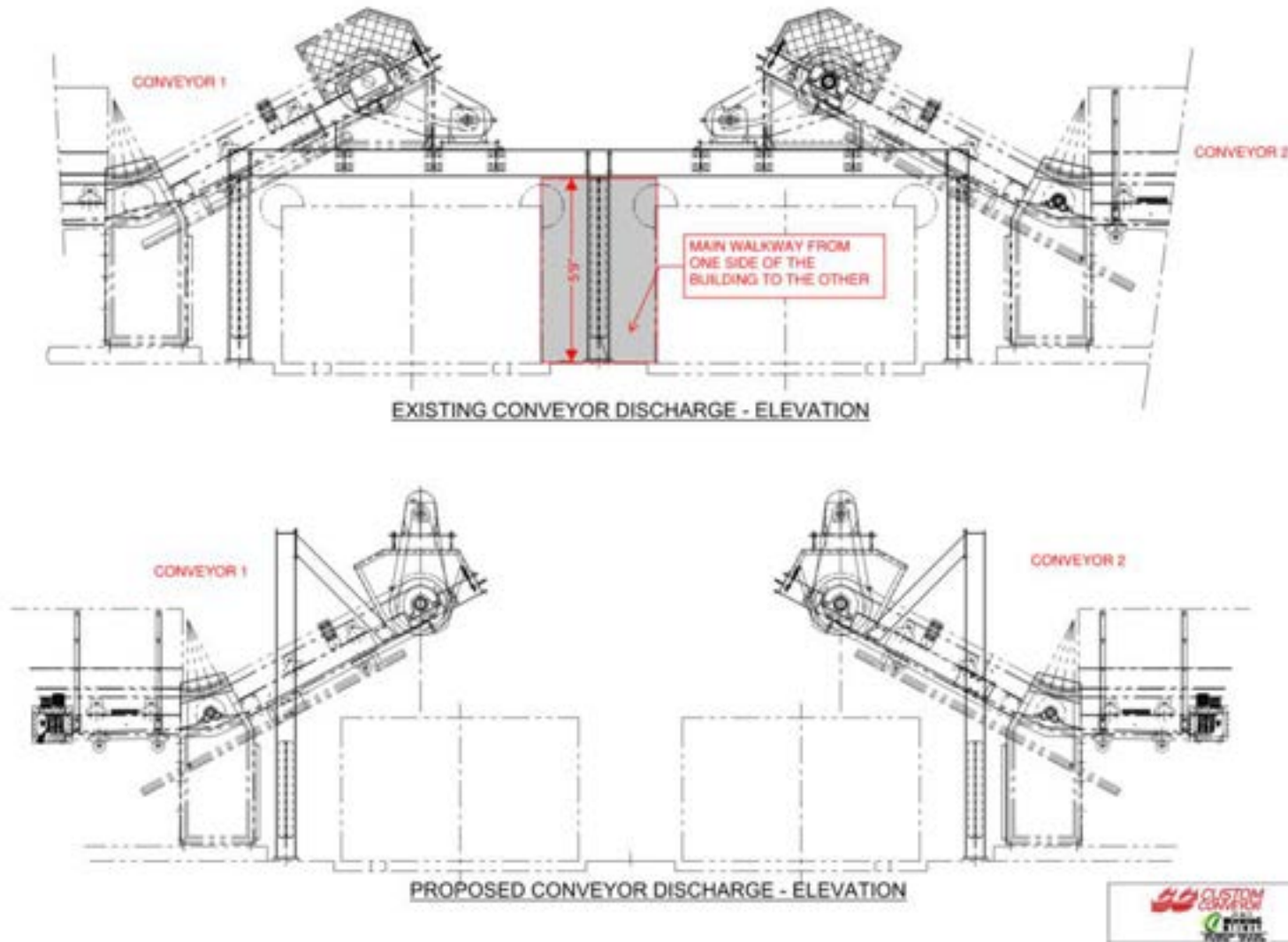


Figure 8-1. Conveyor Modifications to Improve Access through Headworks Building

8.2.2 Disinfection

8.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of four outdoor insulated rubber lined steel tanks, 10 constant speed magnetic drive centrifugal pumps, 10 disinfectant rapid mix zones, and 60 induction mixers. There are 10 screens and there is one disinfectant rapid mix zone immediately downstream of each screen. There is a diffuser at floor level immediately downstream of each screen to allow feeding sodium hypochlorite before the water level reaches the low-level induction mixers and to continue to provide disinfectant near floor level throughout an event. There are six induction mixers per disinfectant rapid mix zone consisting of two low-level mixers, two mid-level mixers, and two high-level mixers. Each sodium hypochlorite pump is paired to one disinfectant rapid mix zone. However, there is a valved crossover from each pump to one other pump. This provides less redundancy than a spare pump that could serve all disinfectant rapid mix zones. The sodium hypochlorite pumps each discharge to a manifold feeding the diffuser and 6 induction mixers at their paired rapid mix zone. There is a flow meter to the diffuser and each pair of low-level, mid-level, and high-level induction mixers. Flow splitting within each pair of mixers at a given level is assumed equal based on symmetry.

Table 8-2 provides an overview of the existing disinfection system at Connor Creek CSO facility and the disinfection process flow diagram is included in Volume 6 – Appendices, Appendix G.

Table 8-2. Overview of Existing Disinfection System at Connor Creek CSO Facility

Parameter	Value
Treatment Capacity (cfs)	13,262
Design Feed Strength (% hypochlorite)	10
Max. Dosage at Design Flow (mg/L Cl ₂)	25
Disinfection Contact Time (min)	5
Storage Tanks	
Number	4
Volume of Each Tank (gal)	95,000
Type	Rubber-lined steel
Pumps	
Number	10
Capacity (gpm)	197
Type	Centrifugal, magnetic drive
Mixers	
Number / Type	60 / Chemical Induction mixers
Model Number/ hp / Manufacturer	SWC20XP / 20 hp / Water Champ

8.2.2.2 Identified Needs and Issues

The needs and issues identified for Connor Creek were identified from meetings with O&M staff and Jacobs team site visit and investigations. The identified needs and issues are listed in the following bullets:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Connor Creek chemical feed system has the following issues:
 - The back-pressure valves controlling the chemical feed split between the three pairs of induction mixers and the diffuser at each disinfectant rapid mix zone are not functioning properly. Also, one

back pressure valve serves each pair of mixers at a given level. Therefore, flow splitting between each pair of mixers is assumed equal based on symmetry alone.

- The flow meters are in need of replacement due to age and some are showing significant signs of corrosion. Also, the vertical downflow orientation is poor as there is the potential for a non-full pipe.
- Similar to other facilities, it is desired to standardize on a flow splitting regime that considers such attributes as simplicity, reliability, and functionality.
- Currently, a hose must be moved and connected to each pump suction pipe to flush the hypochlorite solution from the feed system with NPW. A hard-piped flushing water connection is desired so that flushing could be accomplished by opening a valve to each pump.
- The pump area is located down four steps and there is no dedicated means to lower or lift the pumps and motors to or from this area. A mechanical means of getting pumps in and out of the room is desired.

These issues are addressed in Replace Chemical Feed System (Project CON-DIS-1) below.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project CON-DIS-2) below.
- There are 60 chemical induction mixers that require relatively frequent and costly maintenance. This issue is addressed in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project CON-DIS-3).
- Heat tracing on the outside chemical pipes occasionally fails putting the piping at risk of failing if it freezes. In fact, piping in this outdoor area for the eye wash / shower stations has previously frozen and ruptured. The heat tracing and insulation also hinders access to detect and replace leaking fittings and pipes. This issue is addressed in Freeze Protection for Chemical Storage Area Piping (Project CON-DIS-4).

8.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project CON-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, CON-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

Each of the alternatives above would include provisions to address the additional concerns specific to Conner Creek feed system:

- For cost estimating purposes, water piping and valving to each feed pump was assumed to allow water flushing for the entire chemical feed system from the feed pumps to the mixers.
- For cost estimating purposes, a mast type jib crane (also referred to as a base mounted jib crane – see Figure 8-2 for an example) for moving the pumps and motors up and down the flight of stairs. The base could be located approximately 4 ft from the bottom of the stairway so as to maintain sufficient egress to and from the stairway and to provide a set down area for the pump or motor. The beam would cantilever from the base over the stairway and the upper landing. An electric hoist and trolley could then be used to pick the pump or motor, raise it, convey it over the stairway, and set it down on the upper level. From there, a cart could be used to get the pump or motor out the door. This is the recommended alternative and was used for budgeting.



Figure 8-2. Example of Mast-Type Jib Crane

The alternative evaluation for these alternatives is presented in Table 8-3. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP and include pump replacement at Year 10.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 8-3 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 8-3. Alternative Evaluation for Replace Chemical Feed System (Project CON-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System in-kind	Health and Safety	3	2.08	\$ 2,919,000	\$ -	\$ 2,919,000	\$ 1,401,120	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with feeding too much chemical. System is unique to Conner Creek.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 5,409,000	\$ 109,670	\$ 7,721,900	\$ 2,144,972	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per disinfection channel. Utilize hose pumps.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	LOTS of pumps and valves, allows for an installed redundant pump but manual switchover.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 2,300,000	\$ 7,000	\$ 2,447,627	\$ 679,897	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps connected to all disinfection channels. Utilize centrifugal pumps.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily utilized.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each disinfection channel.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project CON-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the chemical dosing point to further adjust chemical feed flows.

The automatic chemical feed system should require less operator input during an event; however, this cost difference is not included in this analysis because GLWA O&M staff believe that manual sampling to confirm the auto sample result will still be necessary. There will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 8-4. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains ready for service.
- As noted above, this evaluation did not account for any reduction in operations labor using the automatic control system.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 8-4. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project CON-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 156,000	\$ 4,860	\$ 258,496	\$ 74,926	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

Reduce Cost Associated with Large Quantity of Chemical Induction Mixer (Project CON-DIS-3). Plant personnel report that the mixers are expensive to maintain and due to the sealed nature of submersible mixers they must be sent back to the manufacturer for maintenance which adds shipping cost and takes months before the mixer is returned to service. These issues are exacerbated by having 60 induction mixers at Conner Creek, which is the highest of the nine CSO facilities. A reduction in the number of mixers would reduce maintenance and the associated expense proportionate to the reduction. It would also reduce the complexity for equal flow splitting between mixers.

The alternatives to address this issue were identified previously in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Section 5.2.4). The alternatives include:

- 1) **Alternative 1. Replace Existing Chemical Induction Mixers In-Kind.** This alternative assumes replacement of the mixers in-kind.
- 2) **Alternative 2. Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers.** Computation fluid dynamic (CFD) modeling is assumed to be required to demonstrate to EGLE the adequacy of a lesser number of mixers. For illustration purposes, it is assumed that the number of mixers can be reduced by half (i.e., from six to three per channel). This needs to be confirmed by collection system modeling performed by others.
- 3) **Alternative 3. Install Vertical Shaft Mixers.** This alternative would replace the existing chemical induction mixers with new vertical shaft mixers. For Conner Creek, two mixers would be provided per channel.

The alternative evaluation is presented in Table 8-5. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternatives 1 and 2 includes mixer replacement in-kind at the number of mixers shown. Capital costs are based on the SRP replacement cost of \$50,000 per mixer and a 10-year life. Because the life-cycle period is 20 years, the capital costs assume replacement of the mixers twice during the 20-year period.
- For Alternative 2, the cost of the CFD model is assumed to be \$50,000.
- The O&M costs for mixer replacement in Alternatives 1 and 2 is based on current costs for repairing a chemical induction mixer. It is assumed the mixer needs to be repaired every 2.5 years at a cost of \$18,000 per mixer.
- The capital cost for Alternative 3 (vertical shaft mixers) is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 3 (vertical shaft mixers) are based on expected maintenance costs, including changing oil, greasing bearings, periodic rag removal from the shaft and servicing the steady bearing.

As shown in Table 8-5, Alternative 2 has a Total Benefit score about 0.4 higher than Alternative 1 because of the improved ease of maintaining fewer mixers. Alternative 3 has a Total Benefit score slightly higher than Alternative 2 based on the anticipated improved performance of the vertical mixers and improved ease of maintenance, since the mechanical portion of above the water surface. **Alternative 2, has the lowest NPV/Benefit cost and therefore, is the recommended alternative.**

It should be noted that the cost of the reduced mixers is not a new capital cost for GLWA. Rather, it was used in this evaluation to compare alternatives. The cost for the CFD modeling would likely be included in a capital outlay, not a capital improvement project. If the CFD modeling does not prove that disinfection

performance can be achieved, the vertical mixer alternative should be further explored, possibly through the pilot testing of this technology in one of the channels at Baby Creek or Conner Creek.

Table 8-5. Alternative Evaluation for Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project CON-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace Existing Mixers in-kind	Health and Safety	3	2.57	\$ 6,000,000	\$ 438,000	\$ 15,237,260	\$ 5,936,595	
	<i>Definition:</i>	Replace existing mixers as required.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, lots of redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Expensive and impacts operations and maintenance. Equipment installed in basins.	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement 2 times during 20-year period	O&M Ease	1						
2	<i>Alt. Name:</i>	Model Disinfection Performance and Replace/Utilize 2/3rds of the In-Kind Mixers	Health and Safety	3	3.00	\$ 3,050,000	\$ 219,000	\$ 7,668,630	\$ 2,556,210	Best Value Alternative
	<i>Definition:</i>	Perform computational fluid dynamics (CFD) model of basin and determine required number	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, maintains required redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less expensive and less impacts to operations and maintenance. Equipment installed in	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement 2 times during 20-year period & CFD Modeling of \$50,000.	O&M Ease	3						
3	<i>Alt. Name:</i>	Install Vertical Shaft Mixers	Health and Safety	3	3.32	\$ 9,239,000	\$ 70,000	\$ 10,715,274	\$ 3,230,736	
	<i>Definition:</i>	Install vertical shaft mixers throughout the basin.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less equipment to operate and maintain. Overall less install horsepower. Equipment is above the basin and accessible in a non-	Capacity Enhancement	3						
	<i>Disadv.:</i>	Bearing in bottom of basin. Possible ragging issues.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Freeze Protection for Chemical Storage Area Piping (Project CON-DIS-4). Conner Creek is the only facility with outdoor sodium hypochlorite storage. There are two alternatives:

- 1) **Alternative 1: Do Nothing – Continue to Use Heat Tracing and Replace at Regular Intervals.** Heat tracing with a monitoring system is currently used on chemical piping. Heat tracing, however, can fail and could cause the contents of an entire tank to spill into the containment area. This alternative assumes continued use of heat tracing with a monitoring system. Provisions for an improved system and, potentially replacement of the system before the end of its useful life should be considered to improve reliability.
- 2) **Alternative 2: Provide a New Building to Enclose Storage Area.** The existing structure surrounding the Chemical Storage Area consists of concrete masonry unit block wall with exterior brick. This wall is shorter than the tanks. While this wall could be integrated with a building to enclose the tanks, additional columns would be required to support the roof. A building would also require heating and ventilation, and possibly air conditioning, facility electrical (e.g., lighting and additional electrical outlets as needed), and fire protection (e.g., sprinklers). Air conditioning is often practiced with hypochlorite because the degradation rate is higher with higher temperature. Site glasses are also desired on the tanks.

For cost estimating purposes, a column supported roof and additional wall height necessary to enclose the tanks and integrate with the existing containment walls was the basis for the new structure. Provisions for HVAC, electrical and fire protection are included in the cost estimate.

The alternative evaluation is presented in Table 8-6. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 for heat trace system is included in Volume 6 – Appendices, Appendix C under this project title. It should be noted that the heat trace system useful life is assumed to be 10 years. To be consistent with the building life in Alternative 2 (60 years), the cost of the heat trace system is multiplied by 5.
- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title. The building life is assumed to be 60 years in this analysis.

As shown in Table 8-6, Alternative 2 has a Total Benefit score about 1.2 higher than Alternative 1 because of the improved health and safety, component performance, and ease of O&M. However, the NPV/Benefit is much larger for Alternative 2 compared to Alternative. Therefore, **Alternative 1 is the recommended alternative.**

Table 8-6. Alternative Evaluation for Freeze Protection for Chemical Storage Area Piping (Project CON-DIS-4)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing – Continue to Use Heat Tracing and Replace at Regular Intervals	Health and Safety	2	2.40	\$ 864,000	\$ -	\$ 864,000	\$ 360,000	Best Value Alternative
	<i>Definition:</i>	Replace/upgrade existing heat trace system	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Heat tracing can fail without notice or indication, causing pipe rupture	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide a New Building to Enclose Storage Area	Health and Safety	4	3.60	\$ 3,856,000	\$ -	\$ 3,856,000	\$ 1,071,111	
	<i>Definition:</i>	Enclose area around storage tanks and piping	Water Quality & Compliance	3						
	<i>Adv.:</i>	Enclosure provides temperature-controlled space, which would prevent freezing.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.3 Odor Control

8.2.3.1 Description of Existing System

The Conner Creek odor control system consists of four dual-bed vertical carbon adsorbers, one for each retention basin compartment, located near the effluent end of the retention basin. Air is pulled from the Headworks Building, down through the floor opening in the Retention Basin, and then up through the odor control vessels at the downstream end of the retention basin. Each system treats 25,000 cfm of air. Carbon is replaced through the top and side access hatches on the vessel.

The system was installed in 2005. Overall, the system was in fair condition with two systems out of service due to fan issues at the time of the Needs Assessment.

This odor control system operates under air permit requirements (Permit to Install No. 69-06). There is no H₂S emission limit but there is a six-minute average of 20 percent opacity limit. No testing of carbon for remaining bed life is required by the permit. The carbon has not been replaced since installation.

Per GLWA, no odor complaints have been received for at least the past three years.

8.2.3.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified:

- The odor control vessel has a dome top which increases the risk of slipping during carbon replacement.
- Jacobs odor control team notes that the majority of carbon systems are provided with simple differential pressure gauges for local monitoring. Regular monitoring of differential pressure gauges is not necessary as the pressure differential changes gradually over time and is not a critical operating parameter. SCADA monitoring is not necessary given the infrequency of operation. As such, remote monitoring of pressure drop across the carbon beds via SCADA is not recommended.
- During the site visit on 1/27/20, only Odor Control Unit 4 was in operation. The magnehelic pressure gauges showed no pressure loss through either vessel carbon bed in the dual bed vessel. The magnehelic pressure gauge across the grease filter indicated a pressure drop verifying air movement by the fan. Either the gauges are not operating, the magnehelic pressure gauge tubing is reversed, gauge ports are blocked, or there is no carbon in the vessel.

To address the lack of carbon bed pressure drop across Odor Control Unit 4, GLWA should inspect the vessel for carbon media. If the carbon media were removed at some point in the past and not replaced, there would be no pressure drop. If there is carbon in the vessel, check that the magnehelic pressure gauges are properly installed. If the gauges are installed properly, try an operating gauge from another vessel on Unit 4 to verify the pressure drop. Another possibility is the gauge ports are blocked by carbon or some component of the tank interior resin or coating. A pipe cleaner or compressed air can be used to check for blockage of the port connection and to remove loose obstructions.

8.2.3.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Access to Odor Control Vessel (Project CON-OC-1). Staff indicated that carbon replacement at the facility would require constructing scaffolding to safely access the top of the carbon vessel for replacing the top carbon bed. The vessel has a dome top increasing the risk of slipping.

Jacobs evaluated two alternatives that would make accessing the top of the carbon vessel safer for both sampling and carbon replacement.

- 1) **Alternative 1: Erect scaffolding for Carbon Replacement.** The O&M staff currently erects a scaffolding when replacing the carbon. The carbon needs to be replaced every 10 years.
- 2) **Alternative 2: Ladder and Railing System.** Figure 7-6. in the BLI facility section above shows a ladder and railing alternative. The figure does not show a 6-in. toe rail, which is recommended, that should be installed at the bottom of the railing to help prevent a person's foot from slipping off the domed top along with tools and equipment. A contractor would field install fiberglass clips and receptacles to the fiberglass tank to secure the ladder and railing. The existing bolted hatch cover on the top of the vessel will be replaced with a hatch that has quick-opening clamps.
- 3) **Alternative 3: Ladder, Platform and Railing System.** Figure 7-7 in the BLI facility section above shows an example of a ladder, platform, and railing on a horizontal tank. The platform provides a more stable working surface than the domed top. The option is a safer option because the platform provides a flat surface on which to stand. A contractor would field install fiberglass clips and receptacles to the fiberglass tank to secure the ladder, platform and railing. Installation of the platform and rail option is more expensive than the railing only option (Option 1) as a crane is necessary to remove the metal roof and lower the platform from above. The existing bolted hatch cover on the top of the vessel will be replaced with a hatch that has quick-opening clamps.

The alternative evaluation for these alternatives is presented in Table 8-7. The sources of costs used in this evaluation are listed below:

- The O&M cost for alternative 1 is based on \$10,000 per carbon column for erecting scaffolding. Since, the carbon is replaced once every 10 years, the annual O&M cost is assumed to be \$4,000.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C, under this project title. The standard markups for design, construction assistance and contractor overhead and profit have been applied.

This evaluation shows that Alternative 1 – Erect scaffolding for Carbon Replacement has the lowest NPV/Benefit ratio. **As such, Alternative 1 – Erect scaffolding for Carbon Replacement is the recommended alternative.**

Table 8-7. Alternative Evaluation for Access to Odor Control Vessel (Project CON-OC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Erect Scaffolding for Carbon Replacement	Health and Safety	2	2.50	\$ -	\$ 4,000	\$ 84,359	\$ 33,743	Best Value Alternative
	<i>Definition:</i>	Continue to use scaffolding when replacing carbon.	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Must be set up every time carbon is replaced.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Ladder and Railing System	Health and Safety	3	3.22	\$ 138,000	\$ -	\$ 138,000	\$ 42,902	
	<i>Definition:</i>	Provide a ladder on side of vessel and railing around top of vessel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Ladder provides improved access and railing provides safety during carbon change-out.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Surface of dome is still sloped and not as safe as a flat surface.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Ladder, Platform, and Railing System	Health and Safety	5	4.00	\$ 410,000	\$ -	\$ 410,000	\$ 102,500	
	<i>Definition:</i>	Provide a ladder on side of vessel and a platform and railing system on top of vessel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Platform provides more stable working surface of top of vessel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

8.2.4 Flushing and Dewatering

8.2.4.1 Description of Existing System

Dewatering System: The basin and upstream hydraulic structures are dewatered mostly by gravity. Four submersible dewatering pumps located in a sump area in the central portion of the CSO basin (between Compartments 2 and 3) are used when gravity flow rates decline below pumping rate. The total volume of stored CSO after an overflow event is 62 MG, with 30 MG in the basin and 32 MG in the upstream structures. The volume of 62 MG was designed to be dewatered to the DRI in a 48-hour period. The rate of dewatering is controlled based on the level in the DRI.

Each pump discharges through a dedicated pipe to a junction chamber located next to the basin. All four pumps are intended to operate simultaneously. If one of the dewatering pumps is out of service, a flushing pump can be put into service.

Flushing System: A flushing gate system is used for cleaning solids from the bottom of the basin. Flushing gates with reservoirs were constructed at the following locations: 1) at each side of the screening distribution channel (upstream of the screens); 2) at each side of the basin distribution channel (i.e., the channel downstream of the screens); and 3) at the influent and effluent ends of the four basin compartments. The flushing reservoirs fill with wastewater as the facility fills during a wet weather event. Once the facility is dewatered, water remains in the reservoir. When the flushing gates are actuated, a surge of water is discharged down the channel, scouring solids and moving them into the sump areas. Flushing solids pumps are used to pump this water and solids mixture to the DRI. See Table 8-8 for the location and capacity of the pumps. If additional flushing is needed after the initial flush, NPW can be used to re-fill the reservoir.

The facility receives a significant amount of grit and large debris from the collection system. Because of the large accumulation of grit and heavy solids in the Screening Distribution Channel (upstream of the screens), the flushing gates and flushed solids pump (FSP-1) are ineffective in this area. In fact, FSP-1 has been removed and GLWA staff must use water hoses, vactor truck hoses and portable pumps to remove the solids from this channel.

For the influent sewer area ahead of the Screening Distribution Channel, a bobcat is lowered through a hatch to aid in moving the solids to the hatch area for subsequent removal. Solids are typically loaded into a small container to be lifted out through the hatch and loaded into a larger dumpster at ground level.

Table 8-8 provides an overview of the existing flushing and dewatering system at Connor Creek CSO facility.

Table 8-8. Overview of Existing Flushing and Dewatering System at Connor Creek CSO Facility

Parameter	Value
Total Basin Volume (MG)	30
Headworks and Basin Dewatering and Flushing System	- Flushing gates are installed in 1) Screening Distribution Channel; 2) Basin Distribution Channel; 3) Each Basin Compartment (4 total) 8 flushing gates for each channel or compartment (48 total) - FSPs are used to remove flushed solids from each compartment. - FSP-1 in the area ahead of the screens has been removed due to excessively high grit levels - FSP-2 in the Basin Distribution Channel is 735 gpm at 39.8 ft TDH - FSP-3 and 4 in the middle of the basins are 1,610 gpm at 51.5 TDH - Gravity dewatering can occur down to about 84 ft via in-system storage gates. - Four dewatering pumps. Capacity varies with water level in basin from 7,600 gpm at 12.3 ft TDH (basin full) to 4,475 gpm at 45.5 ft TDH (basin empty). Flow is routed to the DRI

Note:

TDH = total dynamic head

8.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- A significant amount of solids builds up in the Screening Distribution Channel (upstream of the screens). The removal of solids is labor intensive and costly, and some areas are inaccessible to the bobcat.
- Filling the flushing reservoirs after the first flush uses a significant amount of potable water, which is costly, and is a time consuming exercise. Also, water fills a group of four reservoirs by filling one reservoir and subsequently overflowing into the next three, one at a time. If one of the first flushing gates leaks, the downstream reservoirs do not get filled.
- Accumulation of sediment within the Conner Creek channel could potentially limit the discharge capacity of the facility.
- Many flushing gates do not function properly. Based on an inspection of each flushing gate in late 2019/early 2020 by a contractor, many of the gates do not function properly, making cleaning the basin difficult, if not completely ineffective, and time-consuming. GLWA is currently addressing this issue through rehabilitation of the existing gates through a JOC. As such, this project is not included in the capital improvement projects under CS-299.

8.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Screening Distribution Channel Improvements (Project CON-FD-1). A significant amount of grit builds up in the influent conduits to the Conner Creek Basin and in the Screening Distribution Channel. The build-up of solids (typically 3 to 6 ft high over time) prevents the flushing gates in the Screening Distribution Channel from being able to flush the solids to the sump area and it has overwhelmed FSP-1. Due to the significant quantity of grit, considerations to improve or modify the existing grit removal system were quickly dismissed.

The most effective method of grit removal for this CSO facility has proven to be using a bobcat to load the grit into dumpsters. In 2017, GLWA added a large (8-ft × 12-ft) equipment hatch to the influent conduit area to lower a bobcat into this area. This opening is also used to remove the grit from influent conduit area using a small container and dumping it into a larger dumpster located at the surface.

The flushing channels cannot be cleaned out by a bobcat since the channels are not accessible. To make them accessible, the leading alternative is to remove the training walls of the flushing channels, install ramps for the bobcat to access the channel area and fill the FSP-1 area with concrete. This concept is shown in several figures (Figure CON-FD-1-ALT-2) in Volume 6 – Appendices, Appendix B, and described further below.

There are two alternatives for addressing this issue:

1) **Alternative 1: Do Nothing/ Continue to Manually Clean Area**

2) **Alternative 2: Screening Distribution Channel Improvements.** This alternative includes the following:

Demolition of existing concrete and equipment. The recommended improvement involves demolition of the existing flushing gate channel training walls, flushing gate assemblies, and the front flushing gate reservoir walls. The anticipated demolition method is jackhammering, which will remove the concrete down to below the adjacent floor system. Rebar will be cut below the floor surface as well. High-strength concrete patching materials will be applied to create an overall smooth surface on the flushing floor. By removing this concrete, O&M staff will be able to maneuver around the area freely to collect sediment

Concrete Fill. The flushing wave collection channel will be filled in with concrete to be level with the floor surface. The FSP-1 sump will be cleaned and partially filled with concrete to result in a shallower sump, approximately 2 ft below the flushing floor edge.

Drain Pump System Reconfiguration and Reinstallation. The FSP-1 sump pump was previously removed by GLWA due to consistent pump fouling by sediment. Jacobs recommends constructing a more robust screen around the FSP-1 sump and reinstalling the pump and discharge piping. The benefit of reinstalling a protected pump is the ability to consistently dewater the influent channel area after all events, and to dewater the space more effectively prior to grit removal.

The more robust sump pump screen concept consists of a static screen installed around the existing sump. Four 6-in. bollards will be set inside the FSP-1 sump prior to concrete filling. A stainless-steel perforated screen will be fabricated with 2-mm openings (similar material and opening size to screens used for dewatering sumps in construction excavations). The screen fabrication will be approximately 10 ft high and will be positioned over the bollards, with the bollards serving to maintain the screen in its location. The screen unit will be sufficiently heavy to remain in place during inundation by CSO events but can be lifted from the surface to a height necessary to clean any debris that may accumulate inside the screen.

The FSP-1 sump pump will be reconfigured such that the pump suction intake is 2 ft above the sump floor with a welded stainless steel bracket. The operational setting for this pump will be reprogrammed to start operation once the minimum pump submergence level has been detected (requires level sensor element control) and will stay in operation for the duration of the event. A provision for a secondary water jet should be provided at the intake to support the dewatering. With the perforated screen in place, and the pump in continuous operation, the sediment loading inside the screened area will be significantly minimized, allowing the influent channel to be adequately dewatered following each event. The perforated screen can be lifted from the surface if needed to access the sump area.

Access to Screening Distribution Floor. To facilitate access to the floor from the influent conduit access hatch, two concrete ramps will be poured with a 12H:1V slope (approximately 8 degrees). Concrete bollards (6-in. diameter, 4 ft tall) will be set along the edge of the upper level at 6-foot spacings and along the edge of the ramp to the cleaning floor, effectively guiding equipment operators to the ramp during sediment removal and preventing driving over the edge.

At-Surface Sediment Removal. To support a more efficient removal of sediment from the area upstream of the bar screens, a series of 8 ft × 8 ft openings will be cut into the influent channel roof. A surface mounted conveyor unit will be extended into the opening down to the floor, where the bobcat operator can deposit sediment in a hopper. See Figure 8-3 for an example of a conveyor that could be used. The conveyor will lift the sediment to the surface and deposit the material into a dumpster or directly to a dump truck for off-site disposal. As the operator systematically cleans the area, the conveyor can be rotated to different positions using a crane from the surface as needed to minimize bobcat travel. Once a general area has been cleaned, the conveyor is retracted and relocated to another opening. The sequence is repeated until the entire upper level and floor has been adequately cleaned. Additionally, the openings through the roof slab facilitate easier access to the influent channel during construction. The conveyor used as a basis of the concept can be viewed online at www.interquip.net. When not in use, the conveyor belt unit would be disassembled and stored onsite. GLWA staff will need to identify a potential location where the stored unit does not interfere with day-to-day O&M. A covered storage structure (e.g., canopy cover, prefabricated metal shelter) and paved surfacing at a preferred storage location is not included in the capital cost estimate.



Figure 8-3. Example of Surface Mounted Conveyor Unit

Flow management during construction will be a major consideration for this option. Bypass pumping is not feasible, given the potentially large flows and isolating the areas of concrete addition will not be cost effective. Constructing concrete sections for the channel infill and the two concrete ramps above-ground and lowering into place should be considered. This issue will require much further evaluation during detailed design.

New Storage Building. A new 30-ft by 60-ft prefabricated metal building with a concrete slab-on-grade will be constructed near the existing building. The building will be used to store the conveyor, stop logs, and other spare parts for the facility.

The alternative evaluation for these alternatives is presented in Table 8-9. The sources of costs used in this evaluation are listed below:

- The O&M cost for Alternative 1 includes GLWA labor cost and water usage cost. The labor cost is based on 3 staff for 80 hours per week and 4 times per year, or about \$100,000 per year. Water usage assumes a water jet is needed to break-up the solids and convey them to the sump area. Water usage based on about 1 MGD needed for 8 hours per day during the 2 week period at \$4,000/MG, or about \$56,000 per year.
- The capital cost for the flushing system (Alternative 2) is included in Volume 6 – Appendices, Appendix C under this project title. It should be noted that the capital cost includes an allowance of \$200,000 for cleaning/re-cleaning the Screening area, and another \$200,000 allowance for wet weather interruptions/delays.
- The O&M costs for Alternative 2 is based on GLWA labor cost of 2 staff for 20 hours per week and 8 times per year, or about \$16,000 per year.
- Grit disposal costs are assumed to be similar for the two alternatives and, therefore, not included.

This evaluation shows that the Total Benefit score for Alternative 2 is 2.0 higher than Alternative 1 because of improved health and safety and ease of O&M. In addition, it is the best value alternative. **As such, Alternative 2 – Screening Distribution Channel Improvements is the recommended alternative.**

Table 8-9. Alternative Evaluation for Screening Distribution Channel Solids Build-Up (Project CON-FD-1)

Alt.	Description	Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i> Do Nothing	Health and Safety	1	1.72	\$ -	\$ 156,000	\$ 3,289,983	\$ 1,916,495	
	<i>Definition:</i> Continue removing solids from portion of basin using bobcat and bucket	Water Quality & Compliance	2						
	<i>Adv.:</i> Known system	Capacity Enhancement	3						
	<i>Disadv.:</i> Labor intensive, solids typically remain due to incomplete cleaning - thus solids could be scoured out of basin in a subsequent storm.	Component Performance	3						
	<i>Comments:</i> None	O&M Ease	1						
2	<i>Alt. Name:</i> Screening Distribution Channel Improvements	Health and Safety	4	3.72	\$ 2,880,000	\$ 16,000	\$ 3,217,434	\$ 865,677	Best Value Alternative
	<i>Definition:</i> Modify floor of channel to remove training walls and add ramps for bobcat; fill flushing wave collection channel with concrete; reconfigure and reinstall Flushing Solids Pump 1; provide removable solids removal conveyor.	Water Quality & Compliance	3						
	<i>Adv.:</i> Will make solids removal less labor intensive, less costly and safer.	Capacity Enhancement	3						
	<i>Disadv.:</i> None.	Component Performance	3						
	<i>Comments:</i> None	O&M Ease	5						

Flushing Water System Improvements (Project CON-FD-2). The flushing reservoirs in the basin and influent area are naturally filled with combined sewage during storms that fill at least one-quarter of the basin. The volume of water captured in the flushing reservoirs is used to flush the settled debris from the floor of the basin. If additional flushing is needed, NPW (i.e., City water that has gone through the backflow preventer) must be used. GLWA Operations personnel have noted that it takes about 10 hours to fill all the flushing reservoirs with water using the water lines. Based on the active reservoir volume of 0.4 MG, this implies that the average flow rate is about 700 gpm. Operations personnel also note that there is a drop in water pressure for hose washdown in the basin when the flushing reservoirs are being filled. The reservoir fill lines and hose drop connections are fed from the same service water system in the basin. The header for this system is an 8-in. diameter water line. The basin flushing water is fed from the facility's service water system that originates from a 12-in. connection on Freud Avenue.

There are three alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing/ Continue Using Potable Water**
- 2) **Alternative 2: Flushing Water System Improvements Using River Water.** This alternative involves using water from Conner Creek for flushing water. The gravity-fed system would consist of two 12-in. HDPE header pipes located across the basin to service the flushing reservoirs. See figures (Figure CON-FD-2-ALT-2) in Volume 6 – Appendices, Appendix B, for a plan view and section view, respectively, of this option. Each header would originate on the east side of the basin in the canal where the pipe would penetrate the basin wall. A screen (manually cleaned) is shown at the inlet of each pipe to prevent large objects from entering the header pipe. Platforms are provided at each inlet to allow for cleaning the screen, if necessary. The installation of this system will require intake structures, along with accompanying cofferdams, to be constructed at each intake into the basin from the canal.

The screened inlet must be located at an elevation below the Detroit River low water datum, which is approximately elevation 93.0 ft (City of Detroit Datum). At this river elevation, there would be a minimum of 12 ft of static head between the river elevation and the elevation of the discharge points at the flushing reservoirs. A motorized control valve would be located on the header pipe at each set of flushing reservoirs. After each valve, GLWA has requested piping to each individual reservoir, which allows for filling each reservoir even when there is a leak (i.e., a leak at the flushing gate) in the first reservoir. It is anticipated that each header could convey approximately 2,000 gpm, or nearly 3 million gallons per day (MGD). The influent and effluent flushing reservoirs could be filled independently. This modification, along with higher flows, would significantly reduce the time to fill the reservoirs.

The advantages of this gravity system, compared to a pumping system, are:

- City water savings (see alternative evaluation for details)
- Few moving parts to be maintained
- Lower maintenance cost
- Lower capital cost
- Ability to fill influent-end and effluent-end flushing reservoirs at the same time, thus significantly reducing the time to fill the reservoirs
- Ability to fill four reservoirs at a time, instead of filling one reservoir and allowing the water to overflow into subsequent reservoirs, by using a valve to control flow to the group of four reservoirs and extending a pipe with discharge to each of the four reservoirs.

The disadvantages of the gravity system, compared to a pumping system, are:

- Valve actuator being at the deck level will have 25 to 30 ft long stem requiring several braces spaced along the height of the valve stems.

- Potential blockage of screens due to zebra mussels

The attachment of zebra mussels on the intake screen or in the intake pipe will decrease screen inlet flow area and pipe diameter reducing flushing reservoir filling rates or completely restricting flows to the individual flushing reservoirs. Allowing zebra mussels to colonize the intake pipes will also provide them with an opportunity to enter the basin where further colonization may occur. For these reasons, it is recommended that a zebra mussel control strategy be implemented at each of the intake pipe locations for the gravity-feed system. There are a variety of mussel control measures ranging from treatments with chlorine and other oxidants, mechanical removal, and special pipe coatings. Sodium hypochlorite is commonly used to control zebra mussel growth. Extension of the Conner Creek CSO hypochlorite system to the raw water inlets may be the simplest approach as hypochlorite does not need to be applied continuously. Intermittent application of 1.0 mg/L hypochlorite during the breeding season in the summer is usually sufficient. Many utilities apply hypochlorite to the front edge of water intake pipes to prevent mussel colonization and to kill any mussels that have already attached. GLWA currently applies hypochlorite at the Belle Isle intake structure to control zebra mussels on the intake screens and within the intake structure and tunnel. Such practices are therefore recommended at the respective intake areas at the Connor Creek facility.

It should be noted that an application for water withdrawal from EGLE in excess of 2 MGD is required. The need for this permit will need to be further explored during detailed design phase. Water is not being diverted from the Great Lakes basin so obtaining a permit should not be a problem.

- 3) **Alternative 3: Flushing Water System Improvements Using Potable Water.** This alternative involves continued use of City water from Conner Creek, with the addition of the valves and piping to allow the groups of four reservoirs to fill at one time, as described in Alternative 2. Instead of tying into the river water piping, this proposed system would tie into the existing potable water system.

This alternative would have the advantage of being able to fill reservoirs downstream of leaking flushing gates. It would have the disadvantage of using a significant amount of City water and would still take a long time to fill all the reservoirs with water.

The alternative evaluation for these alternatives is presented in Table 8-10. The sources of costs used in this evaluation are listed below:

- The annual O&M cost for Alternative 1 and 3 is based on water usage of 800,000 gallons per event, 25 events a year, and a unit cost of \$4,000 per MG. The annualized cost of water is about \$80,000.
- The capital cost for the proposed flushing systems (Alternatives 2 and 3) are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 2 includes \$2,000 for equipment maintenance.

This evaluation shows that Alternative 1 – Do Nothing/Continue Using Potable Water, is the best value alternative. However, this alternative does not provide an acceptable level of cleaning when there are leaking flushing gates. Alternative 2 and 3 provides a solution to this issue. The NPV/Benefit cost for Alternative 3 is greater than Alternative 2. Because Alternative 2 provides the best value alternative compared to Alternative 3, **Alternative 2 – Flushing Water System Improvements Using River Water is the recommended alternative.**

Table 8-10. Alternative Evaluation for Flushing Water System Improvements (Project CON-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Continue Using Potable Water	Health and Safety	3	2.68	\$ -	\$ 80,000	\$ 1,687,171	\$ 628,759	Best Value Alternative
	<i>Definition:</i>	Continue to use potable water to fill reservoirs	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Significant amount of City water usage; time consuming	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Flushing Water System Improvements Using River Water	Health and Safety	3	3.32	\$ 2,692,000	\$ 2,000	\$ 2,734,179	\$ 824,376	
	<i>Definition:</i>	Use river water as source of flushing water	Water Quality & Compliance	3						
	<i>Adv.:</i>	Reduced potable water usage/cost; less time to fill reservoirs; lower maintenance cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Zebra mussel control	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Flushing Water System Improvements Using Potable Water	Health and Safety	3	3.32	\$ 1,332,000	\$ 80,000	\$ 3,019,171	\$ 910,303	
	<i>Definition:</i>	Continue to use potable water to fill reservoirs; add distribution to each reservoir	Water Quality & Compliance	3						
	<i>Adv.:</i>	All reservoirs can be filled even if there is a damaged gate	Capacity Enhancement	3						
	<i>Disadv.:</i>	Significant amount of City water usage; long time to fill reservoirs	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.5 HVAC

8.2.5.1 Description of Existing System

The Conner Creek CSO Facility consists of a Headworks, chemical room, chemical storage area (outdoor), utility support (electrical, transformer and mechanical rooms), control room, sample room, hydraulic room, office space on the second floor, and other miscellaneous rooms. The facility also includes adjoining retention basin. Table 8-11 provides summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, gas-heater water heater, electric water coolers, emergency shower/eye wash, and washroom shower. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 8.2.10.

Table 8-11. Major HVAC Equipment at Connor Creek CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	MAU-1 and 2	2 × Make-Up Air Units	44,000 CFM
Basin	ICEF-1 to 6	6 × Exhaust Fan (Influent Area)	50,200 CFM
	SF-1 to 24	24 × Supply Fan (Basin Deck)	45,000 CFM
Control Building	AHU-1	Air Handler	21,000 CFM
Chemical Room	EF-3	Exhaust Fan	4,140 CFM
	AHU-2	Air Handler	4,080 CFM
Electrical Room	EF-5	Exhaust Fan	2,893 CFM
	EUH-2	Electric Unit Heater	10.2 MBtu
Transformer Room	EF-4	Exhaust Fan	3,130 CFM

Note:

MBtu = million British thermal unit(s)

Table 8-12 provides a summary of the basis of design performance criteria for HVAC systems at Connor Creek and Table 8-13 provides the outdoor Basis of Design conditions.

Table 8-12. Connor Creek Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Headworks Building	Class I, Div 1, Group D (Per Basis of Design Report)	60	N/A	12 ACH (Occupied) 6 ACH (Unoccupied)
Mechanical and Electrical Rooms, Transformer Room, and Maintenance Shop	Unclassified	60	104	Heat Relief
Control Room	Unclassified	72 F Dry Bulb, 50% Relative Humidity	72 F Dry Bulb, 50% Relative Humidity	20 cfm per occupant
Office, Sample Room, Toilet Rooms and Hydraulic Room	Unclassified	72 (Occupied), 60 (Unoccupied)	75 F Dry Bulb, 50% Relative Humidity	50 cfm per flushing fixture (restrooms)

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
				20 cfm per occupant (Other Spaces)
Chemical Room	Unclassified	60	N/A	12 ACH (Occupied) 3 ACH (Unoccupied)

Table 8-13. Connor Creek Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

8.2.5.2 Identified Needs and Issues

During discussions with GLWA O&M staff and GLWA's HVAC contractor, the following HVAC issues were noted:

- Inadequate heating in maintenance shop and electrical room: O&M staff noted that the Maintenance Shop gets cold in winter months and electrical room to a lesser degree.
- Uneven heating was reported in the Control Building
- High temperatures in transformer room: Based on investigation by Jacobs, the basis of design summer dry bulb temperature for transformer room is 104°F. It is therefore not unusual that relatively high temperatures are observed in this space. During the site visit by Jacobs, exceedingly high temperatures were not noted in the transformer room; however, the door to the transformer room was open and the exhaust fan was observed to run at a low rpms, likely indicating a reduced airflow capacity. Additionally, the thermostat did not appear to be functional based on the fact that the exhaust fan remained on and the supply air damper remained open when the thermostat was adjusted to a setpoint above the space temperature. This is not considered a capital need.
- GLWA staff reported malfunctioning dampers in chemical room, maintenance room, electrical room, and transformer room. During the Jacobs site visit, the Maintenance Shop and electrical room motorized dampers were tested for functionality. The dampers responded to changes in the thermostat setpoint; however, there was a delay in the response. This delay is normal and does not require any corrective actions. The transformer room damper was observed to be open and the exhaust fan running; however, the damper and fan did not respond to changes in the thermostat setpoint. This issue should be investigated and corrected by maintenance staff and is not considered a capital need.
- Chemical room AHU-2 is difficult to replace due to limited size of door openings to the chemical room.
- O&M staff would like a shower in the upstairs men's and women's restrooms.

During the discussions with Dunbar Mechanical, GLWA's HVAC contractor, the following historical issues were noted:

- Heating Improvements in Control Building: GLWA's HVAC contractor noted that on/off control from the duct heaters in the Control Building was replaced with a controller that modulates the gas valves to maintain a minimum supply air temperature.
- Replacement of Duct Heater: GLWA's HVAC contractor noted that one of the three gas duct heaters had been recently replaced.

- Humidity Issues in exterior rooms: GLWA's HVAC contractor noted that major humidity issues had occurred in the North and East exterior room in the Control Building. Jacobs notes that several factors could be contributing to the humidity issues noted by GLWA's HVAC contractor. Major contributors include:
 - Insufficient cooling capacity of AHU-1's cooling coil. As noted below, the McQuay condensing unit appears to have a refrigerant leak which would result in a decrease in the ability of AHU-1 to remove humidity from the incoming outside air and return air streams. The recommended replacement of the condensing unit should eliminate cooling capacity as a contributing factor to high humidity levels.
 - Air infiltration into the space. During the site walkthrough it was noted that windows were left open in the Conference Area on the 2nd floor. Major sources of infiltration such as open windows would seriously contribute to the potential for condensation in air-conditioned spaces, particularly in the summer when the outside air dewpoint temperature is likely to be above the dewpoint temperature of interior surfaces.
 - Insufficient ventilation/poor air distribution (which would allow for the buildup of humidity in occupied spaces). The uneven heating noted by GLWA O&M staff could be an indicator of poor air distribution/ventilation. The recommended air balance should eliminate this as a potential contributing factor.

If the humidity issues persist after the recommended air balance study and replacement of the condensing unit, monitoring of the doors and windows using the direct digital controller (DDC) could be considered to determine if there is a correlation between open windows/doors and humidity issues.

During site investigations (June 2020) the following observations were noted:

- A new split DX system had recently been installed in the control room server area.
- The windows were open in the control building second floor conference room.
- The exhaust fan was off in the chemical room.
- Both roll-up doors were open in the headworks area.
- Oil was observed on the McQuay air-cooled condensing unit's (ACCU-1) condensing coil and the compressors were observed to be hissing (see Figure 8-4 below). This observation most likely indicates a refrigerant leak. The unit is 17-years old and a refrigerant leak would result in reduced cooling capacity, which could be contributing to the humidity issues in the control room noted by GLWA's HVAC contractor. Given that the unit is near the end of its useful life and a refrigerant leak is likely, it is recommended that the unit be replaced with a unit of the same capacity and added to the DDC system for monitoring and control. This replacement is included in the SRP.



Figure 8-4. Oil on McQuay Unit Condensing Coil

- The door to the transformer room was open.
- The transformer room exhaust fan appeared to be operating at low RPM.
- The actuator on the transformer room motorized damper appeared to have been recently installed.
- The electrical room overhead door was open.
- The electrical room exhaust fan intake is located very close to the air intake louver with motorized damper.
- The Maintenance Shop exhaust air ductwork is located close to its air intake louver.
- The duct for Basin supply fan SF-22 (located in the Maintenance Shop) is not enclosed in fire-rated walls as indicated on the design drawings (see Figure 8-5 and Figure 8-6).



Figure 8-5. Supply Duct for SF-22 Not Enclosed in Fire-Rated Wall

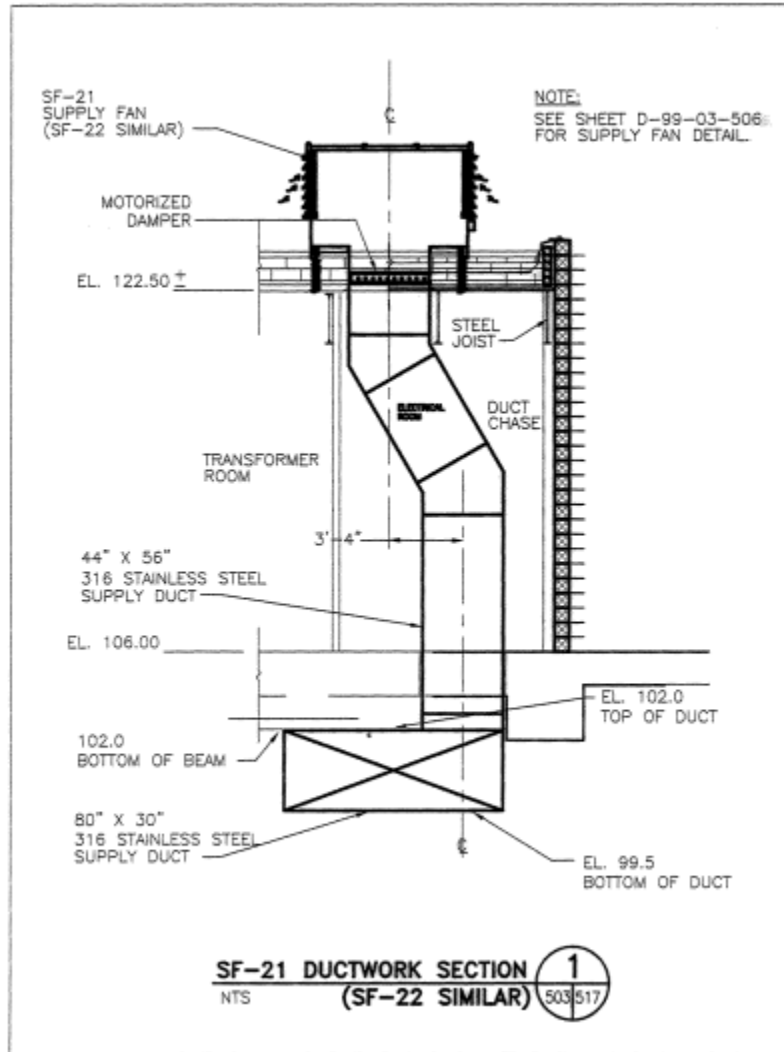


Figure 8-6. SF-22 Chase Detail (Per 02/06 Project Record Drawings)

8.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Control Building Air Balance Study. As noted in Section 8.2.5.2, the duct heaters in the Control Building have recently had a control upgrade to modulate the gas valves and maintain a minimum discharge temperature instead of being on-off and controlled by wall-mounted thermostats. If this change has not resolved the uneven heating experienced in the Control Building, an air balance study is recommended to determine if heated air is properly being distributed to spaces in the Control Building. If this does not resolve the issues, additional measures can be considered, such as additional duct heaters in spaces which are receiving inadequate heat. Jacobs recently prepared a scope to coordinate air balance study with a Testing and Air Balancing contractor.

HVAC Improvements (Project CON-HVAC-1). Due to the relatively small nature of some of the HVAC related projects identified as improvements, all of the identified HVAC improvements are proposed to be in one project – HVAC Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: HVAC Improvements** including,

- Maintenance Shop and Electrical Room Heating Improvements
- Chemical Room AHU Access Improvements
- Control Room Wall Extension
- Chase for SF-22 Basin Supply Air Duct
- Shower in Second Floor Men's and Women's Restrooms

Each of the HVAC related improvements listed above are described further below:

Maintenance Shop and Electrical Room Heating Improvements. The basis of design winter dry bulb temperature for the Maintenance Shop and electrical room is 60°F so it is possible that these areas could be perceived as being cold in the winter. Both the Maintenance Shop and electrical room are served by a single 3 kW electric unit heater. Jacobs noted that the unit heater in the Maintenance Shop and electrical room are located on the opposite side of the room from the outside doors, which likely makes for a big difference in temperature across the room during the winter months. It is recommended that an additional unit heater be added to each room.

Chemical Room AHU Access Improvements. To improve ability to remove this unit in the future, the single door to the hallway should be replaced with a double door.

Control Room Wall Extension. A new split DX system was recently added to the control room server area. This space is provided with conditioned air from AHU-1 and is not completely enclosed with a floor to ceiling partition (Figure 8-7). Thermal comfort in the occupied portion of the control room would be improved by extending the existing partition between the two spaces to the ceiling and extending the existing return air duct to the server room area in an appropriate location.



Figure 8-7. Low Wall in Control Room

Chase for SF-22 Basin Supply Air Duct. Per the design drawings, the supply air duct for SF-22 which runs through the Maintenance Shop to the Basin below was designed to be enclosed in a chase, which would create a physical separation between the Maintenance Shop and the supply air duct. A similar chase was constructed in the transformer room for SF-21's supply air ductwork. NFPA 820 requires a gas tight partition between classified spaces (such as the Basin, which is Class I, Division 1) and unclassified spaces, which was the reason the original design included the chase. Without the enclosure for the supply air duct, the Maintenance Shop, and by extension all spaces connected to it, are technically Class I, Division 1 spaces. It is recommended that a

chase be constructed in the Maintenance Shop per the original design drawings to create the required physical separation between the Basin and Maintenance Shop. See Figure 8-6 herein.

Shower in 2nd Floor Men's and Women's Restrooms. Space exists for the installation of showers in the 2nd Floor Washrooms. Although a complete design would require further assessment it seems likely that the drains, vents, and hot and cold water supplies could be connected to the existing plumbing system fairly easily.

During the evaluation of the existing plumbing assets it was discovered that the existing hot water tank only has a 100-gallon capacity. ANSI Z358.1 requires 20 gpm of tepid water for a period of 15 minutes for emergency showers. At the design mixed water temperature of 80°F, design storage temperature of 120°F, and recommended 47°F cold water design inlet temperature, the existing tank would only provide tepid water for 11 minutes. Jacobs recommends that the hot water tank should be replaced with one with a storage capacity of at least 150 gallons regardless of whether the shower upgrades are pursued.

The alternative evaluation is presented in Table 8-14. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- There is no measurable difference in O&M costs between the two alternatives.

This evaluation shows that Alternative 1 is the Best Value Alternative. Under Alternative 2, the chase for SF-22 air duct is a code compliance issue, so it should be implemented during a major project at the facility. Based on this need, **Alternative 2 is the recommended alternative.** However, it is noted that the remaining tasks are not high priority and could be performed at a later date.

Table 8-14. Alternative Evaluation for HVAC Improvements (Project CON-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do not address issues	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Worker discomfort	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	4	3.50	\$ 116,000	\$ -	\$ 116,000	\$ 33,143	Not Applicable
	<i>Definition:</i>	Maintenance Shop and Electrical Room heating improvements; Chemical Room AHU access improvements; Control Room wall extension; chase for SF-22 basin supply air duct; shower in 2nd floor men's and women's restrooms	Water Quality & Compliance	3						
	<i>Adv.:</i>	Code compliance and worker comfort	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.6 Electrical

8.2.6.1 Description of Existing System

The Conner Creek facility's electrical system consists of dual (redundant) 24 kV utility feeds for two unit substations with primary metering and DTE 3,000 kVA indoor dry type transformers. The facility also has one diesel generator feed from a 2 MW, 480/277 V, 3-phase stationary generator. The substations and generator feed into the double ended switchboard main distribution panel (MDP), which has a tie-breaker and automatic source transfer controls. Circuit breakers in the MDP then feed six MCCs and one power distribution panel (PDP). The MCCs and PDP then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 8-15 provides a summary of the major electrical equipment for this facility.

Table 8-15. Major Electrical Equipment at Connor Creek

Location	Major Electrical Equipment	Description
Transformers Room	Transformers T1 and T2 Substations	3,000 kVA, 24 kV-480/277 V, 3-Phase
Outdoors	Generator (Diesel)	2 MW, 480/277 V, 3-Phase
Electrical Room	Double ended switchboard main distribution panel (MDP)	3,200 A, 480/277 V, 3-Phase
Electrical Room	MCC-1	1,600 A, 480/277 V, 3-Phase
Electrical Room	MCC-2	1,600 A, 480/277 V, 3-Phase
Electrical Room	MCC-3	1,600 A, 480/277 V, 3-Phase
Electrical Room	MCC-4	1,600 A, 480/277 V, 3-Phase
Electrical Room	MCC-5	1,600 A, 480/277 V, 3-Phase
Chemical Room	MCC-6	1,600 A, 480/277 V, 3-Phase

8.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the section below.

8.2.6.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project CON-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles, however it will be less safe when operating at night and select locations within the basin.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure CON-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - FSP-2 access stairway – Relocate the existing LED wall mounted light fixtures to provide the required foot-candles and code requirements.

- Influent area ahead of Screens – Add LED lighting fixtures to meet the required foot-candles and code requirements for the area.
- Interior effluent end of Basin – Add interior LED wall mounted lighting fixtures to the area to address the required foot-candles and code requirement.
- Exterior effluent end of Basin – Add additional exterior LED lighting fixtures to supplement the current lighting within the area to address the required foot-candles and code requirements.
- Add power receptacles to assist in the maintenance and operations of the facility near the FSP-1 opening.

The alternative evaluation is presented in Table 8-16. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting. The NPV/Benefit cost for Alternative 2 is \$37,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 8-16. Alternative Evaluation for Electrical Improvements (Project CON-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe when operating at night and select locations within the basin	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 129,000	\$ -	\$ 129,000	\$ 36,857	Not Applicable
	<i>Definition:</i>	Add additional lighting in the at select locations in the basin and near the effluent.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.7 I&C

8.2.7.1 Description of Existing System

Control System: The original Ovation control system was installed in 2005 under GLWA project PC-739. During the same time period, stand-alone Ovation systems were being installed in the Freud Pump Station and Conner Creek Pump Station under PC-713. The Conner Creek CSO facility was designed to house the main control system for the region. In 2014 under PC-773D, the three facilities were combined into one overall Ovation control system. While the systems were being combined, the system controllers and software were upgraded to version O.V.3.5.0 for all three facilities.

The Conner Creek control system is comprised of primary and back-up network switches to provide the system complete network redundancy. The switches are connected to the GLWA AT&T wide area network via the system's router. These primary and back-up network switches are interfaced to three redundant networks, with one at the Freud Pump Station, one at the Conner Creek CSO facility, and one at the Conner Pump Station. The redundant network switches in the Conner CSO facility are connected to one database server and two operator workstations. All workstations are connected redundantly to the network switches via copper Ethernet cables. Additionally, it has two redundant Ovation controllers connected to the network switches in a dual-homed configuration to provide back-up for controls and I/O capabilities. The current system is equipped with a back-up radio system to communicate critical monitoring points back to SCC on wide area network failure.

The Freud Pump Station has redundant network switches connected to Conner Creek's main control systems primary and back-up network switches in the Conner Creek CSO facility. The networks are connected via fiber optic cables in underground ductbanks between the two facilities. There is a rack mounted workstation and one redundant Ovation controller pair for the station. The Ovation controllers and the workstation are connected in a dual-homed configuration via copper Ethernet cables. Additional local PLCs are connected to the Ovation control system via local system switches.

The Conner Pump Station has redundant network switches connected to Conner Creek's main control system primary and back-up network switches in the Conner Creek CSO facility, similar to the Freud Pump Station. The networks are connected via fiber optic cables in underground ductbanks between the two facilities. There is a rack mounted workstation and one redundant Ovation controller pair for the station. The Ovation controllers and the workstation are connected in a dual-homed configuration via copper Ethernet cables. Additional local PLCs are connected to the Ovation control system via local system switches.

Flow and Level Sensors: Table 8-17 summarizes the level sensors and flow meters at the Conner Creek CSO Facility used to monitor flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 8-17. Summary of Flow Meters and Level Sensors at Connor Creek CSO Facility

Area	Quantity	Instrument Type
CSO Influent Flow Meters		
Influent (East, central, and west influent channel flow, Freud Ashland Relief, Freud Fox Creek Relief)	5	Transit-Time (AccuSonic)
CSO Facility Level Sensors		
Mixing Chambers	2	Ultrasonic
	10	Ultrasonic (back-up)

Area	Quantity	Instrument Type
Flushed Solids Sumps (Dewatering sumps (2), Retention Basin Distribution Channel, Screening Distribution Dchannel)	4	Ultrasonic
Conner Creek	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed Pumps	10	Magnetic
Chemical Mixers and Diffusers		
High Mixers	10	Magnetic
Middle Mixers	10	
Low Mixers	10	
Diffusers	10	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	4	Ultrasonic

8.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section .

- Evaluate the existing level sensors and flow meters to determine redundancy and identify instruments that could potentially be removed. The evaluation and recommended removal of level sensors is presented in the next section.
- Operators have no way to determine whether the dewatering pumps are functioning properly. To address this issue, they requested a new flow meter downstream of the junction chamber to provide indication and rate of flow.
- Evaluate replacement options for valve control network
- Need for tank level indication at Chemical Fill Station
- Need for process cameras at select locations
- Update Ovation control system to the latest version and increased monitoring capabilities
- Generator and ATS controls do not adequately report alarm signals into Ovation and are becoming less reliable. This issue is being addressed in an on-going project and is therefore not included in the capital improvement projects for CS-299.
- Need accurate river level measurement. GLWA is currently planning to install a river level sensor through a JOC. This issue is not included in the capital improvement projects for CS-299.

8.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project CON-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation control system upgrade, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. There are two alternatives for this project:

1) Alternative 1: Do Nothing/Replace In-Kind.

- Leave level sensors in place

2) Alternative 2: I&C Improvements including,

- Remove redundant level sensors
- Provide new flow meter for dewatering flow downstream of the junction chamber
- Evaluate replacement options for valve control network
- Provide tank level indication at Chemical Fill Station
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Remove redundant level sensors. The Conner Creek CSO Facility has 12 level sensors in the chemical mixing chambers downstream of the screens. There are two primary ultrasonic level sensors, one in Mixing Chamber 3 and one in Mixing Chamber 8, and a level sensor in each of the ten chemical mixing chambers. See Figure 8-8 for the location of these sensors.

The level sensor signals are used to turn on and off the lower, middle and upper level mixers based on the water level in the channels. Since all the channels are interconnected downstream of the screens, the water level should be fairly similar between the mixing channels. The readouts for the individual channel level sensors are not available on the Ovation screens. However, while these level sensors act as back-up for the primary sensors in Mixing Chamber Nos. 3 and 8, current I&C configurations rely on the readings from level sensors in individual mixing chambers to run the high, mid-, and low-level mixers. As such, the ten level sensors can be removed, but only if the signal from the primary ultrasonic level sensors are retrofit with an output relay to replace this function provided by the individual channel level sensors.

Modifications to allow removal of these level sensors are included in the cost estimate. Removal of the 10 redundant level sensors will reduce I&C maintenance on these sensors.

Provide new flow meter for dewatering flow downstream of the junction chamber. Operations has expressed a desire to have flow measurement for the dewatered flow that is pumped from the basin to the sanitary sewer. The recommendation is to install a non-contact laser flowmeter downstream of the junction chamber in an existing manhole. This meter should provide accurate enough data in this 48-in. larger diameter sewer. Figure CON-I&C-1-ALT-2 in Volume 6 – Appendices, Appendix B, shows the plan and profile of the sewer and the area of interest where the flow meter should be installed.

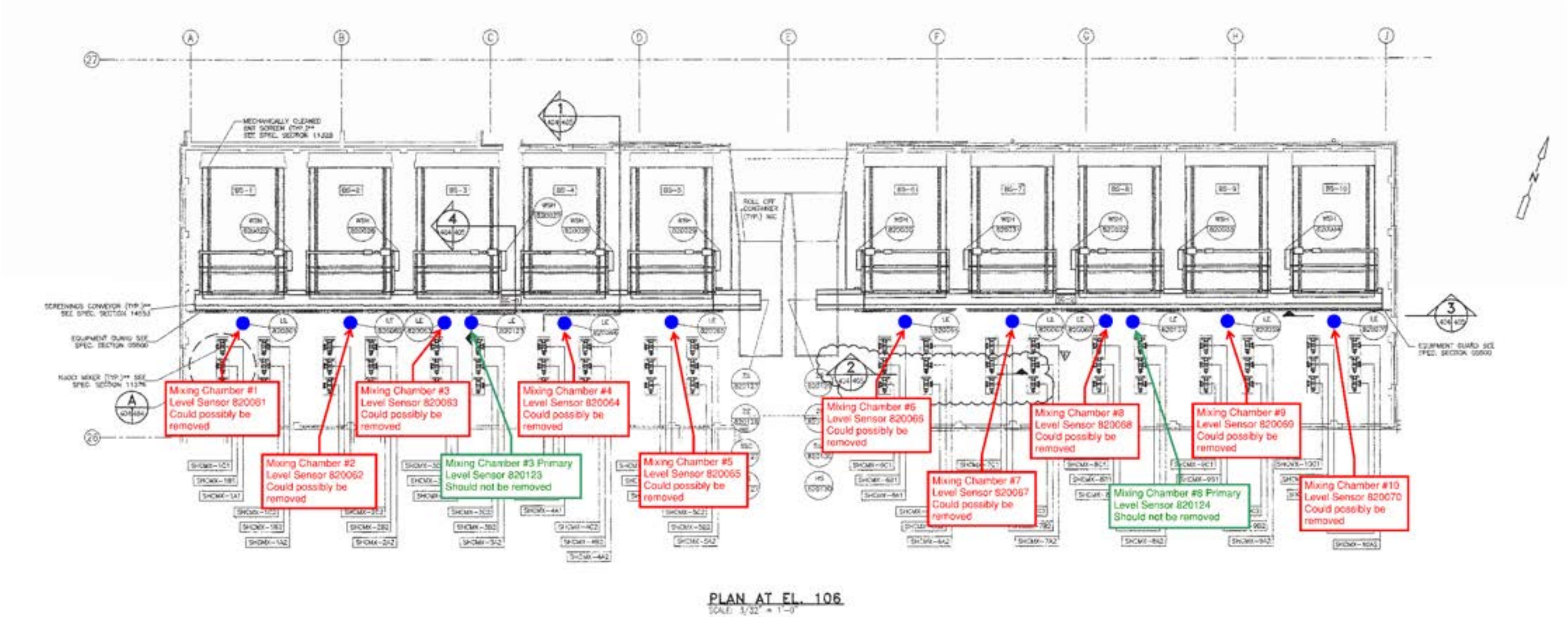


Figure 8-8. Conner Creek CSO Facility Level Sensor Identification

Evaluate replacement options for valve control network. See Section 5.4.6 for details of the Valve Control Philosophy – Valve Network (Pakscan) versus hardwired control. The recommendation is to continue the use of the Pakscan valve network for data and status while upgrading the 16 effluent relief gates valve controls to hardwired control.

Provide tank level indication at Chemical Fill Station. Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 8-18. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 includes the in-kind replacement for all level sensors.
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 1 include maintenance of the valve control network and the level sensors (downstream of the screens).
- The O&M costs for Alternative 2 include maintenance of the new instruments and cameras. It is difficult to quantify the monetary benefits of the improved operations through the improved monitoring and control.

This evaluation shows that Alternative 1, Do Nothing/Replace In-Kind, is the Best Value Alternative. The total benefit score for Alternative 2, however, is 0.6 higher than Alternative 1 due to improved component performance and ease of O&M. The NPV/benefit value of Alternative 2 is approximately \$157,000, which is a moderate cost compared to other projects recommended in this assessment. As such, **Alternative 2 - I&C Improvements, is the recommended alternative.**

Control System Upgrade (Project CON-I&C-2). It is recommended to update the Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2.

Because the Ovation system is the only alternative for the control system upgrade, it is the only alternative considered. Table 8-19 provides the summary of the Control System Upgrade, which is the recommended alternative. Capital costs are included in Volume 6 – Appendices, Appendix C under this project title.

Table 8-18. Alternative Evaluation for I&C Improvements (Project CON-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	3	2.68	\$ 60,900	\$ 10,000	\$ 271,796	\$ 101,291	Best Value Alternative
	<i>Definition:</i>	Replace level sensors in-kind.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 331,000	\$ 9,000	\$ 520,807	\$ 157,027	
	<i>Definition:</i>	Removal of redundant level sensors; addition of new flow meter for dewatering flow; provide tank level indication; upgrade effluent relief gate valves controls to hardwired control; and install process cameras.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Table 8-19. Alternative Evaluation for Control System Upgrade (Project CON-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 1,678,000	\$ 1	\$ 1,678,021	\$ 559,340	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved performance, standardized HMI screens, can have standardized redundant "on-the-shelf" parts.	Capacity Enhancement	3						
	<i>Disadv.:</i>	No performance related disadvantages.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

8.2.8 Site

8.2.8.1 Description of Existing Site

There is an access road to the site off Freud Avenue. The access entrance gate to the site is a 30-ft wide sliding vehicular gate across the 40-ft wide access road. Site security is provided by a 6-ft high ornamental fence along the north perimeter of the site. This includes the entrance gate located on the south side of Freud Avenue. The fence starting at the west end of the entrance gate extends easterly along the south right of way of Freud Avenue, extending around the stormwater detention pond and then ending at the creek. A 6-ft chain link fence is located at the west perimeter of the site facing the Federal Aviation Administration Tower Area. Site concrete sidewalks are 3 to 5 ft wide and approximately 4 in. thick. The site parking and drive areas are paved with 4.5 in. of asphalt on 10 in. of aggregate. The gravel drive farther south of the building is 8 in. thick.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

8.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- The entrance gate has reached the end of its useful service life
- Water ponds on top of the basin. In the winter, this water freezes and causes safety concerns
- Sidewalks have settled and heaved, causing safety issues and water infiltration next to building

8.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Site Improvements (Project CON-SITE-1). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) Alternative 1: Do Nothing.

2) Alternative 2: Site Improvements including,

- Replace Entrance Gate
- Address ponding on basin deck
- Replace Sidewalks in Select Areas

Each of the site related improvements listed above is described further below:

Replace Entrance Gate. The entrance gate at the Conner Creek CSO facility is a 30-ft wide automatic cantilever sliding gate. The gate has been subject to numerous recent mechanical failures. The gate has reached the end of its useful service life and is recommended to be replaced with a new similar style gate.

Address Ponding on Basin Deck. There are areas of significant ponding on the basin roof deck. Several of these areas are located on the east side of the deck adjacent to the Conner Creek canal. To remediate the ponding issue, it is recommended that holes be cored through the basin roof to allow discharge of ponded water to the basin. Recessed area drains would be installed in the cored holes to the basin. For those areas adjacent to the canal, scuppers through the basin parapet wall should be investigated to relieve ponded water directly to the canal.

Replace Sidewalks in Select Areas. The sidewalks next to the Control Building have settled, pulling away from the face of the building and allowing water to infiltrate the joints at the base of the building and sidewalks. This leads to heaving of sections of sidewalk and creates uneven sections, which is a safety concern. It is recommended that all damaged concrete sidewalk flags be demolished. In addition, the expansion joints at the face of the wall should be replaced and the joints caulked and sealed to prevent water infiltration.

The alternative evaluation is presented in Table 8-20. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Alternative 1 based on the improved health and safety and ease of O&M. The NPV/Benefit cost for Alternative 2 is \$24,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Site Improvements is the recommended alternative.**

Table 8-20. Alternative Evaluation for Site Improvements (Project CON-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Safety concerns uneven sidewalks and from ice buildup on the basin in winter.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 85,000	\$ -	\$ 85,000	\$ 24,286	Not Applicable
	<i>Definition:</i>	Replace entrance gate, sidewalks and core holes through deck at low points.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Restores sidewalks and removes water from top of basin.	Capacity Enhancement	3						
	<i>Disadv.:</i>		Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.9 Architectural

8.2.9.1 Description of Existing Facilities

The Conner Creek CSO Facility consists of a chemical room, chemical storage room, utility support (electrical and mechanical), control room, sample room, office area, hydraulic room, screen room and other miscellaneous rooms. The facility also includes adjoining retention basin.

8.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment, as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

8.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (CON-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove and replace isolation/ cove joint sealant and around building perimeter
 - Clean and coat bottom of all door frames
 - Remove corrosion from localized areas in roof framing, clean and coat
 - Apply skim coat and slope to redirect water to creek outside the Screening Building

- Provide flashing/ membrane system to protect column bases from ponding moisture to address pooling water between building/brick walls and to fix gap between brick and steel columns
- Clean and repaint surfaces where paint is debonding in Screening Building
- Remove and replace deteriorated ceiling tile in Control Building
- Remove and replace floor control joint sealant
- Investigate and repair water intrusion at door in Screening Building
- Address door hardware issues and door and door frame corrosion issues
- Clean rusted areas of structural steel column base of exterior Screenings Building

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings (Figure CON-ARCH-1-ALT-2) in Volume 6 – Appendices, Appendix B. Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project. It should be noted that recoating of the floor in the Chemical Room was originally included in the architectural items, but moved to the Chemical Feed project (CON-DIS-1).

The alternative evaluation is presented in Table 8-21. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, **Alternative 2 is the recommended alternative.**

Table 8-21. Alternative Evaluation for Architectural Rehabilitation (Project CON-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 361,000	\$ -	\$ 361,000	\$ 116,452	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

8.2.10 Safety

8.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

8.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 8-22. The capital improvement project to address these issues is included in the table.

Table 8-22. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Headworks – between bar screen No. 8 and No. 9 platforms	Railing does not extend over belt – fall hazard	Extend railing	Safety Improvements (Project CON-SAFE-1)
Stair B6 (Compartment 2) (Representative of all stair locations to basin)	No illuminated exit signs	Add or replace exit signs	Exit Sign Improvements ^a
Headworks – the “walkway” under the screenings conveyor and between grit rollofs	“Walkway” does not meet exit access width requirements – not adequate width, overhead hazard, column in center of walkway	Reroute personnel or the column/overhead horizontal beam will need to be moved	Conner Creek Conveyor Improvements ^b
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project CON-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

^b This project will be completed under the JOC.

8.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project CON-SAFE-1). This project should address the safety issues identified above. These issues include:

- Extend railing between bar screen #8 and #9 platforms to eliminate fall hazard
- Address fall protection

Because the importance of these issues relate to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 8-23 shows the one alternative.

Table 8-23. Alternative Evaluation for Safety Improvements (Project CON-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 358,000	\$ -	\$ 358,000	\$ 119,333	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection and fall hazard.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

8.2.11 Supporting Infrastructure

8.2.11.1 Description of Existing System

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above.

8.2.11.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- Dredging of the Conner Creek, based on analysis in the WWMP.

8.2.11.3 Discussion and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section.

Dredging of Conner Creek Channel (CON-SUPP-1). The WWMP investigated the accumulation of sediment within the Conner Creek channel that could potentially limit the discharge capacity of the Conner Creek CSO Facility. During peak wet weather events, it is necessary that the hydraulic capacity of the channel be sufficient to convey overflow from the facility to the Detroit River. Restrictions in the channel could reduce hydraulic capacity causing backup and potential surcharging within the RTB and collection system.

Section 8.8 of the WWMP presents the results of the physical investigation into the amount of sediment that has built up since the facility start-up in 2005. Based on the results of the survey, sediment deposition within the channel varies in depth from 0 to 3 ft, representing approximately 21,000 cubic yards (+/-20 percent) of sediment to be removed.

A cost estimate for dredging accumulated sediment within the Conner Creek channel was developed based on the assumption that the dredging operation will be performed using hydraulic dredging equipment similar to 2005. A material quantity of 35,000 CY was assumed for the estimate, assuming dredging will occur within the next 10 to 15 years. The total estimated cost of the project is \$11 million. For details are provided in Section 8.6 of the WWMP.

8.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Conner Creek CSO facility, Table 8-24 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table

8-24, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 8-24. Listing of Asset Condition Assessments for Conner Creek Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	110	110	0	100%
AHU	2	0	2	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	4	4	0	100%
BASIN	1	1	0	100%
BATTERY	1	1	0	100%
BREAKER	13	13	0	100%
BUILDING	4	2	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	0	0	0	N/A
COND-AIR	2	2	0	100%
CONVEYOR	2	0	2	100%
CRANE	2	2	0	100%
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A
DAMPER	4	4	0	100%
DISCONNECT	12	12	0	100%
DOOR	4	4	0	100%
DRIVE-ELEC	0	0	0	N/A
ELEVATOR	1	1	0	100%
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	7	7	0	100%
FAN	4	0	4	100%
FANVENT	37	37	0	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRSS	1	0	0	0% ^b
GASDETECTO	1	0	0	0% ^c
GASMONITOR	2	2	0	100%
GATE	111	59	6	59% ^d
GEARBOX	10	0	10	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	6	6	0	100%
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
MAU	2	2	0	100%
MCC	6	0	6	100%
METER	55	55	0	100%
MIXER	60	60	0	100%
MOTOR	26	10	16	100%
PANEL	30	30	0	100%
PIPING	4	4	0	100%
PUMP	22	14	8	100%
ROOF	2	2	0	100%
SAMPLER	2	1	0	50% ^e
SCADA	2	2	0	100%
SCREEN	10	0	10	100%
SCRUBBER	4	0	4	100%
SENSOR	22	22	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	4	4	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	3	0	3	100%
UNITHEATER	4	4	0	100%
UPS	5	5	0	100%
VALVE	79	79	0	100%
WATERHTR	1	1	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is not an asset. Another one of the building asset listed as "PLANNING - ORDERING PARTS/FILLING OUT WORK ORDER/COMPLETING INVENTORY OF PARTS ON HAND. (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is also not an asset.

^b The fire suppression was evaluated Simplex Grinnell in 2018 and not included in the ACES report.

^c The one gas detector is a portable unit and was not assessed.

^d The 46 individual flushing gates were not assessed. These were assessed as a group. The individual gates are being considered for removal from WAM.

^e The second sampler (ES-2) is listed as inactive and is being considered for removal from WAM.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the

Conner Creek Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

8.3 Capital Planning for Conner Creek CSO Facility

8.3.1 Summary of Capital Improvement Plan Projects Alternatives

Table 8-25 provides a summary of the recommended CIP projects and associated capital costs for the Conner Creek CSO facility based on the alternative evaluations conducted for this facility.

Table 8-25. Summary of Recommended Projects at Conner Creek CSO Facility

Project No.	Alternative	Description	Total Project Cost
CON-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 2,300,000
CON-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 156,000
CON-DIS-3	2	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000
CON-DIS-4	1	Do Nothing – Continue to Use Heat Tracing and Replace at Regular Intervals	\$ 144,000
CON-FD-1	2	Screening Distribution Channel Improvements	\$ 2,880,000
CON-FD-2	1	Flushing Water System Improvements Using River Water	\$ 2,692,000
CON-HVAC-1	2	HVAC Improvements	\$ 116,000
CON-ELEC-1	2	Electrical Improvements	\$ 129,000
CON-I&C-1	2	I&C Improvements	\$ 331,000
CON-I&C-2	1	Control System Upgrade	\$ 1,678,000
CON-SITE-1	2	Site Improvements	\$ 85,000
CON-ARCH-1	2	Architectural Rehabilitation	\$ 361,000
CON-SAFE-1	1	Safety Improvements	\$ 358,000
CON-SUPP-1	1	Dredging of Conner Creek Channel	\$ 11,000,000

8.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 8-26. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 8-26. Capital Improvement Plan Projects for Conner Creek CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
CON-1 Disinfection System Improvements	\$ 2,456,000	2035 <i>Timing based on asset condition</i>	CON-DIS-1	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 2,300,000
			CON-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 156,000
CON-2 Flushing System Improvements	\$ 5,572,000	2028 <i>Timing not dependent on existing asset condition</i>	CON-FD-1	Screening Distribution Channel Improvements	\$ 2,880,000
			CON-FD-2	Flushing Water System Improvements Using River Water	\$ 2,692,000
CON-3 HVAC Improvements	\$ 116,000	2033 <i>Timing based on priority of other needs</i>	CON-HVAC-1	HVAC Improvements	\$ 116,000
CON-4 Facility-Wide Electrical and I&C Improvements	\$ 2,138,000	2029 <i>Timing based on asset condition</i>	CON-ELEC-1	Electrical Improvements	\$ 129,000
			CON-I&C-1	I&C Improvements	\$ 331,000
			CON-I&C-2	Control System Upgrade	\$ 1,678,000
CON-6 Facility-Wide Safety and Architectural Improvements	\$ 719,000	2023 <i>Project should be initiated as soon as possible</i>	CON-ARCH-1	Architectural Rehabilitation	\$ 361,000
			CON-SAFE-1	Safety Improvements	\$ 358,000
CON-7 Dredging of Conner Creek Channel	\$ 11,000,000	2041 <i>Timing of project should be re-evaluated in about 2031</i>	CON-SUPP-1	Dredging of Conner Creek Channel	\$ 11,000,000
CON-10 Model Disinfection Performance	\$ 50,000	2021 <i>Timing based on potential for major maintenance cost reduction</i>	CON-DIS-3	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 8-27 and Table 8-28 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 8-28 indicates that CON-DIS-1 project has two assets that need to be replaced immediately due to condition score of "5". These assets, however, have already been replaced/rebuilt since the Condition Assessment was conducted in Summer 2020. The remaining 109 assets that are included in this project have an average condition score of 1.86 and an average replacement date of 2035. This information was used to propose a scheduled construction completion date of 2035.

Table 8-27. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
CON-DIS-1	109	1.19	1.86	2.28	22	2035	\$ 2,271,000
CON-I&C-2	2	2.29	1.57	4.08	12	2029	\$ 994,990

Table 8-28. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
CON-DIS-1	2	1.29	5.00	4.50	10	2021	\$ 108,000
CON-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -

There are recommended capital improvement projects presented in Table 8-26 that could be better delivered under capital outlay projects. These projects are listed in the following bullets:

- Continue to Use Heat Tracing and Replace at Regular Intervals (CON-DIS-4)
- Site improvements (CON-SITE-1) for the entrance gate replacement, sidewalk repair and basin drainage.

For the CFD Modeling of Mixers (CON-DIS-3), it is ultimately recommended to include this project with similar modeling projects at the Baby Creek and Leib CSO Facilities. See Section 2 (Volume 1 – Project Introduction and Capital Improvement and Outlay Plans) for proposed bundling of this project.

8.3.3 20-Year Capital Outlay Plan

Table 8-29 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 8-29. 20-Year Capital Outlay Plan for Conner Creek CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 751,200	\$ -	\$ -	\$ -	\$ 743,000	\$ -	\$ -	\$ 8,200	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 7,488,582	\$ -	\$ 16,962	\$ 2,867,520	\$ -	\$ -	\$ 4,604,100	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ 23,340	\$ -	\$ -	\$ -	\$ 23,340	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ 19,806	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 19,806	\$ -	\$ -	\$ -	\$ -
2025	\$ 6,854	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 6,854
2026	\$ 723,749	\$ -	\$ -	\$ -	\$ 637,601	\$ -	\$ -	\$ -	\$ 86,149	\$ -	\$ -	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 3,459,635	\$ 6,149	\$ -	\$ -	\$ 3,453,486	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,414,707	\$ -	\$ -	\$ 30,857	\$ 123,426	\$ -	\$ -	\$ -	\$ -	\$ 1,260,424	\$ -	\$ -	\$ -
2030	\$ 735,075	\$ 56,366	\$ -	\$ -	\$ 553,224	\$ -	\$ -	\$ -	\$ 9,786	\$ -	\$ 115,699	\$ -	\$ -
2031	\$ 1,743,475	\$ -	\$ -	\$ -	\$ 1,586,493	\$ -	\$ -	\$ 3,763	\$ -	\$ -	\$ 31,426	\$ -	\$ 121,792
2032	\$ 299,825	\$ 138,423	\$ -	\$ 122,920	\$ 7,752	\$ 30,730	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 1,261,697	\$ 49,572	\$ 213,376	\$ -	\$ -	\$ 330,420	\$ -	\$ 668,330	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 4,680,860	\$ 7,865	\$ -	\$ 460,886	\$ 2,989,482	\$ -	\$ -	\$ 16,638	\$ -	\$ -	\$ 105,276	\$ -	\$ 1,100,712
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 19,001,050	\$ 149,814	\$ 247,361	\$ 15,096,139	\$ -	\$ 1,266,355	\$ -	\$ 2,041,023	\$ 10,367	\$ -	\$ -	\$ 189,992	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 41,609,855	\$ 408,190	\$ 477,699	\$ 18,578,322	\$ 10,117,804	\$ 1,627,505	\$ 4,604,100	\$ 2,737,954	\$ 126,107	\$ 1,260,424	\$ 252,402	\$ 189,992	\$ 1,229,358

Notes:

Explanation of large capital outlays in first two years:

- Retention System: Flushing gate systems for basin distribution channel, screening distribution channel, and Compartment 1 to 4 received scores of 5 at the time of the Condition Assessment because some of the flushing gates were not functioning. A project to rehabilitate the gates is planned for late 2021.
- Disinfection System: One of the four mixers was covered in debris and the remaining three mixers were out of service at the time of the Condition Assessment (\$50,000 each; \$200,000 total) and received a score of 5. Two chemical feed pumps (\$54,000 each; \$108,000 total) were being repaired at the time of the Condition Assessment. The two Accusonic flow meters (\$217,500 each; \$435,000 total) were not installed at the time of the Condition Assessment.
- Odor Control System: Three scrubber systems (\$1,534,700 each) received scores of 5 since the motor (child of fan) was not functional at the time of the Condition Assessment.

9. Hubbell-Southfield CSO Control Facility

9.1 General Facility Description and Future Capacity Considerations

9.1.1 General Facility Description

The Hubbell Southfield CSO Facility is an RTB with 22 MG of storage, and a treatment capacity of 3,200 cfs. It was constructed in 1996. There are two buildings on site - a Headworks Building and a Control Building. The headworks building contains a headworks area, chemical room, mechanical room, and an odor control area. The control room building contains the control room, odor control room, work area, electrical room, basement area, restroom, locker room, and mechanical room.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

9.1.2 Future Capacity Considerations

There were no future capacity considerations identified at the time of this report.

9.2 Facility Assessment

9.2.1 Screening

9.2.1.1 Description of Existing System

The Hubbell-Southfield CSO Facility has six catenary bar screens that were installed in 1996. Screenings from the screens are discharged to a single conveyor belt, which conveys the screenings to a dumpster. The screenings are disposed in a landfill.

Table 9-1 provides an overview of the existing screening system at Hubbell-Southfield CSO facility.

Table 9-1. Overview of Existing Screening System Hubbell-Southfield CSO Facility

Parameter	Value
Treatment Capacity (cfs)	3,200
No. of Screens	6
Manufacturer	Jones and Atwood
Screen Type	Catenary Bar Screen
Opening Size	1.5-in. slot
Depth or Length / Width	22 ft 0 in / 9 ft 6 in
Screen Cleaning	Mechanical Rake
Screening Removal	Conveyor belt to dumpster and landfilled

9.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Provide a screening retention plate along entire conveyor to prevent screenings from falling off the conveyors at the back of the screens.

- O&M staff noted that the grating over the bar screen channel deflects when walking on it
- Prevent the edges of the bar screen rakes from dragging on concrete. This issue has been added to the scope of the OEM evaluation. This issue has been added to the scope of E&I's assessment, which has not occurred as of the time of this report. If there are capital costs associated with the retrofit to address this issue, it will be added based on OEM input.
- Prevent screens from swaying during operation. During higher flow events, the screens reportedly sway to some degree. The operators believe this is caused by the returning rake getting tossed by the rapid flow of water and affecting the rest of the screen. They noted that the Conner Creek screens (which is a similar screen but does not sway) has chain guide returns that extend closer to the floor of the channel. This issue was added to the scope of the OEM evaluation; however, the OEM was unable to see the swaying because flow did not occur during the site visit. If this issue causes problems in the future, it should be video-taped to document the issue.
- O&M staff noted that the overhead crane pendant is old and bulky.

9.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Screening Improvements (Project HS-SCR-1). Due to the relatively small nature of some of the screening-related projects identified as improvements, all of the identified screening improvements are proposed to be in one project – Screening Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Screening Improvements** including,
 - Screening Retention Plate Along Entire Conveyor
 - Walkway Grating Over Bar Screen Channels
 - Replace Overhead Crane Pendant

Each of the screening related improvements listed above are described further below:

Screening Retention Plate Along Entire Conveyor. Screenings from the screens occasionally fall off the conveyor at the back of the screens. A screenings retention plate would guide the discharged screenings to the middle of the conveyor belt. A cost for a screening retention plate (similar to screening retention plate at Conner Creek) is included in the capital cost estimate.

Walkway Grating Over Bar Screen Channels. O&M staff reported that grating does not feel sufficient (i.e., it deflects when walking on it). A cost for grating replacement is included in the capital costs.

Replace Overhead Crane Pendant. O&M staff indicated the current push-button, explosion-proof crane pendant is old and very bulky (Figure 9-1). Jacobs contacted Crane Technologies to obtain a replacement cost for a new pendant.



Figure 9-1. Existing Pendant for Overhead Crane at Hubbell-Southfield CSO Facility

The alternative evaluation is presented in Table 9-2. Capital costs for Alternative 2 are presented in Volume 6 – Appendices, Appendix C under this project title.

The total benefit score for Alternative 2, however, is about 1.0 higher than Alternative 1 due to improved health and safety, component performance, and ease of O&M. The NPV/Benefit cost for Alternative 2 is \$54,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the advantages with this alternative, Alternative 2 – Screening Improvements is the recommended alternative.**

Table 9-2. Alternative Evaluation for Screen Improvements (Project HS-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.62	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Some screenings fall off conveyor; walkway grating does not seem sufficient; pendant outdated.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Screening Improvements	Health and Safety	4	3.60	\$ 195,000	\$ -	\$ 195,000	\$ 54,167	Not Applicable
	<i>Definition:</i>	Addition of screening retention plate along entire conveyor; replace walkway grating over bar screen channels; replace overhead crane pendant.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Grating would be stronger; Cleaner screening operation	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.2 Disinfection

9.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP storage tanks, five gear pumps, and three induction mixers. There are six screens discharging into a common influent channel from which flow is directed to Basin Compartment 1 or to the Shunt Channel which can feed Basin Compartment 2. There are three induction mixers located upstream of the bar screens. The sodium hypochlorite pumps discharge to a common header with a flow meter that splits to the three induction mixers, the Shunt Channel, Basin 1, Basin 2, flushing, and odor control. During an event sodium hypochlorite is normally only fed to the three induction mixers. Flow splitting is not metered and there does not appear to be any basis for throttling the valves to individual induction mixers to achieve equal flow splitting. Table 9-3 provides an overview of the existing disinfection system at Hubbell-Southfield CSO facility.

Table 9-3. Overview of Existing Disinfection System at Hubbell-Southfield CSO Facility

Parameter	Value
Treatment Capacity (cfs)	2,200
Design Feed Strength (% hypochlorite)	5
Max. Dosage at Design Flow (mg/L Cl ₂)	10
Disinfection Contact Time (min)	20
Storage Tanks	
Number	2
Volume of Each Tank (gal)	15,000
Type	FRP
Pumps	
Number	5
Capacity (gpm)	10-55
Type	Gear
Mixers	
Number / Type	3 / Chemical induction mixers
Model Number/ hp / Manufacturer	Series 32 / 25 hp / Gas Mastrrr

9.2.2.2 Identified Needs and Issues

The needs and issues identified for Hubbell-Southfield were identified from meetings with O&M staff and Jacobs team site visit and investigations. The identified needs and issues are listed in the following bullets:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Hubbell Southfield chemical feed system has the following issue:
 - The feed pumps are in a confined basement are on short pump pads and as such at risk of being damaged if there was a spill or water leak.
 - The sump pumps in the feed pump area were not designed for corrosive or chemical service and have been damaged by exposure to sodium hypochlorite. Replacement with sump pumps suitable for corrosive chemical service is desired.

These issues are addressed in Replace Chemical Feed System (Project HS-DIS-1) below.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant,

overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project HS-DIS-2) below.

- Hypochlorite storage capacity is reportedly not enough for large storm events. GLWA requested that Jacobs investigate this issue. Jacobs found that the concrete containment area used for existing spill containment was the original sodium hypochlorite storage. The two existing 15,000 gallons FRP tanks installed in the original concrete storage tanks provide less chemical storage than the concrete tanks. Historical chemical usage from the four largest wet weather events from 2016 through 2018 was evaluated for all of the CSO facilities, including Hubbell Southfield. The data indicate that the volume of sodium hypochlorite fed exceeded the storage volume at Hubbell Southfield in one event. In that event 38,775 gallons was reportedly fed compared to 30,000 gallons storage volume. Chemical deliveries occurred during the event to address this. Based on the event above, additional hypochlorite storage is needed. This issue is addressed in Add New Chemical Storage Tank (Project HS-DIS-3).

9.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project HS-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel. Hose pumps will be larger than the existing gear pumps at Hubbell-Southfield and the need to enlarge the pump area was considered for this alternative. Although not all pumps may fit in the current row of pumps, there appears to be sufficient room to locate a couple of the pumps along the north wall under the stairway if necessary. The costs for demolishing the existing pads and adding new taller and larger pads was included in all alternatives and the cost will not substantially change with pump location. Details regarding pump layout are deferred to design.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

Each of the alternatives above would include provisions to address the additional concerns specific to the Hubbell Southfield feed system:

- **Sump Pump:** For cost estimating purposes, a chemically resistant sump pump is assumed for the sump in the chemical feed basement areas as well as hard-piped dilution water to the sump requested by plant personnel.
- **Spill Protection:** Jacobs evaluated two options to address the concern of sodium hypochlorite spill in the pump area, including:
 - **Option 1: Level sensors and raising pump pads.** This option would install a level sensor or contact switch in the pump area. The sensor would be programmed to close actuated valves from the tanks if a spill is detected. Also, this alternative includes raising the pump pads to 2 ft (from their current 4 in.) to further protect the pumps if a spill occurred.
 - **Option 2: Transfer Pump and Day Tank.** This option would include the sensor in Option 1 that would close the tank valves if a spill should occur. This option would also provide a transfer pump and day tank. However, the transfer pumps would remain a weak link in a flood. In order to address this, a vertical shaft

chemically resistant sump pump with the motor located above maximum flood level, as offered by Vanton Pumps, would serve as an emergency backup to a transfer pump. In a flood situation, the sump pump would serve as the transfer pump to the day tank or to return the sodium hypochlorite to one of the storage tanks after that tank's outlet valve is closed.

The cost for a level sensor in the pump area and programming to close actuated valves from the tanks if a spill is detected is a relatively low-cost alternative. As such it is included in Alternatives 2 and 3 above.

The alternative evaluation for these alternatives is presented in Table 9-4. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 was developed based on GLWA experience of pump rebuilds per year at a cost of \$30,000.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 9-4 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 9-4. Alternative Evaluation for Replace Chemical Feed System (Project HS-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System in-kind	Health and Safety	3	2.08	\$ 969,900	\$ 30,000	\$ 1,602,589	\$ 769,243	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 1,130,000	\$ 17,125	\$ 1,491,160	\$ 414,211	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per channel.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 534,000	\$ 3,000	\$ 597,269	\$ 165,908	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project HS-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

The sample point should be located approximately 15 minutes travel time downstream of the dosing point at average flow but peak flow travel time must also be considered. The exact location would be determined during design.

The automatic chemical feed system will require less operator input during an event. However, there will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 9-5. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains functional between storm events.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. Based on the improved ability to meet the NPDES permit TRC goal, **Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 9-5. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project HS-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less efficient chemical feed and possible overdosing of chemical.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 220,000	\$ 4,860	\$ 322,496	\$ 93,477	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more efficient use of chemical.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult with infrequent CSO facility use.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

Add New Chemical Storage Tank (Project HS-DIS-3). Based on the evaluation performed in the previous section, there is a need for additional chemical storage tank to ensure adequate chemical during larger events. There are two alternatives:

- 1) **Alternative 1: Do Nothing - Rely on Chemical Deliveries during Storm Event.** This approach was used during the large event that exceeded the existing chemical storage capacity. This alternative relies upon an outside contractor to deliver enough hypochlorite to make it through the storm event.
- 2) **Alternative 2: Add New Chemical Storage Tank.** The O&M staff requested a tank at grade to serve as a backup. They also requested the capability for gravity feed to the influent from the new tank in case the pump room floods. The lack of reliable influent flow measurement prevents sizing additional sodium hypochlorite storage based on influent flow, design doses, and assumed hypochlorite strength considering degradation potential. However, the installation of new flow meters in 2019 may help to inform tank sizing for design. For budgeting purposes, a third tank sized the same as the existing two 15,000 gallon tanks is assumed, inside a building with chemical containment, mechanical, electrical and I&C.

As requested by GLWA, the possibility of gravity feed from the chemical tanks with a meter and valve was evaluated. The effluent weir from the CSO basins into the effluent channel controls the hydraulic grade line at the influent induction mixers to above elevation 100 once the basin is filled. The bottom of a new at-grade sodium hypochlorite tank would be approximately elevation 111 and the maximum liquid depth is approximately 13 ft. Thus, there is approximately 11 ft of static head available with the tank empty and 24 ft with the tanks full. This corresponds to 4.8 pounds psig empty to 10.3 psig full available head. The induction mixers require back pressure valves to prevent siphoning chemical. Evoqua recommends a setting of 15 psig. Therefore, the available static head is inadequate for gravity feed before even accounting for friction loss and flow control valve loss. Thus, continued pumping as the means of chemical delivery is recommended.

The alternative evaluation is presented in Table 9-6. Capital costs for Alternative 2 are presented in Volume 6 – Appendices, Appendix C under this project title.

As shown in Table 9-6, Alternative 2 has a Total Benefit score about 1.5 higher than Alternative 1 because of the improved water quality and compliance (i.e., facility could run out of chemical during a storm and violate permit), and ease of O&M. Because of the risk of violating permit, **Alternative 2 is the recommended alternative.**

Table 9-6. Alternative Evaluation for Add New Chemical Storage Tank (Project HS-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/Rely on Chemical Deliveries during Storm Event	Health and Safety	3	2.00	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	1						
	<i>Adv.:</i>	Lower Cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	May run out of chemical during a large storm event, thereby violating permit.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Add a New Chemical Storage Tank	Health and Safety	3	3.50	\$ 753,000	\$ -	\$ 753,000	\$ 215,143	Not Applicable
	<i>Definition:</i>	Install new tank at grade to serve as a backup with capability for gravity feed	Water Quality & Compliance	4						
	<i>Adv.:</i>	Sufficient chemical for larger storm events.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.3 Odor Control

9.2.3.1 Description of Existing System

The Hubbell Southfield odor control system consists of two separate horizontal cross flow scrubber systems. Odorous air flows horizontally across the empty scrubber chamber and scrubbing solution is sprayed into the oncoming air from numerous spray nozzles. One system, located in the Headworks Building, treats air from the Headworks area and Basin No. 1. A second system, located in the Process Building, treats air from Basin No. 2. The systems were originally designed with the capability to spray a solution of sodium hypochlorite and sodium hydroxide to remove odorous gasses. However, the sodium hydroxide has not been used for some time. The chemical solution is recycled through the scrubber and recirculation tank, and fresh sodium hypochlorite is added as needed. Excess chemical solution overflows out of the recirculation tank into a drain.

The system was installed in 1996. Overall, the system is in good condition. The odor control system does not have an air permit.

Per GLWA, no formal odor complaints have been received for at least the past three years; however, the golf course has indicated that they can smell the facility.

9.2.3.2 Identified Needs and Issues

During meetings with O&M staff related to the odor control system, no needs were identified. The recommendation in this section is based on Jacobs evaluation of the existing system.

Potential Reduction of Odor Treatment during Operation. The facility does not have an air permit and is not required to operate the odor control system. The facility may not generate significant odors during wet weather events due to dilution of sewage with storm water. Storm water significantly reduces the concentration of sulfide and other odorous compounds in sewage. Odors may be more prevalent during the dewatering phase caused by odors from settled solids but may still be low. Due to the expected low odors from the facility, GLWA may want to consider operating the scrubber systems with water only and no sodium hypochlorite. Removal of H_2S is dependent on the H_2S concentration. Removal will be significantly less with only water, but there may be relatively low levels of H_2S to remove. Another option, which provides even less treatment, would be to operate the system without water and blow air through an empty scrubber system and out the stack. (This could be considered during the winter months when the golf course is not active, but is not recommended when the golf course is being used.)

Odor Study. Under both of these options, the discharged air may be non-odorous or sufficiently diluted with ambient air to render it non-odorous or non-detectable to receptors. Prior to implementing either one of these options, GLWA should conduct an odor study to sample influent air to the existing scrubber system for H_2S to determine if the H_2S concentration is sufficiently low. A non-detectable concentration of H_2S in the influent air means the systems can likely operate without sodium hypochlorite or water. The study would also sample the discharge when using water spray, to determine the measured effectiveness of such an operation.

9.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement "needs."

9.2.4 Flushing and Dewatering

9.2.4.1 Description of Existing System

Dewatering System: Basin dewatering can be accomplished by gravity or pumping. Gravity dewatering to the Northwest Interceptor (NWI) occurs by opening one of two flow control valves (BD-1 or BD-3). A control system regulates the valve position and corresponding flow from the basin to the NWI. The gravity discharge rate is controlled so as not to exceed the remaining capacity in the NWI as measured by a level sensor in the NWI. The Basin Compartments 1 and 2 can be dewatered from a basin water level of 99.5 ft down to about 94.75 ft. The basin could be dewatered by gravity down to 90.5 ft (if siphoning); however, at a water surface level below 94.75, the flow rate in the discharge line causes the velocity to drop below a recommended value of 3.5 ft/sec.

The remainder of volume in the basin must be removed by pumping. There are two 8,000 gpm pumps for each basin, for a total of four dewatering pumps. The system was designed for one pump as duty, with the other pump as backup. The dewatering pumps were designed to remove water down to about 74.5 ft, which is about 25 ft below the basin high water level.

The dewatering system originally included one 200 gpm sump pump for each compartment. These pumps have been removed. As noted below, Operators would like to see this pump replaced.

The basin was also designed to be decanted if there was no capacity in the NWI before a subsequent storm. The top 5 ft of water from the basin compartments could be decanted to the Rouge River. There are two decant gates located at the end of Basin 2: Basin Decant Slide Gate and Effluent Decant Gate. The Operators have not decanted flow and do not foresee the need to decant in the future. As such, these gates should remain closed and do not need to be replaced in the future. These gates could be removed in the future and the openings permanently filled with concrete.

Flushing System: The spray flushing system is intended to remove the remaining solids left on the floor of the basin and shunt channel after the basin has been dewatered. There are 22 flushing spray zones. Two submersible flushing water pumps are located in the effluent channel (referred to as the Pond) and a strainer is located in the Process Building dewatering pump room. If there is not enough effluent after a wet weather event in the effluent channel for the basin flushing, additional (City) water can be used to fill the effluent channel. The Pond fills at line pressure and there is no booster pump to help it fill faster.

The flushing system has not performed its intended function since it was originally installed. Solids accumulate across both basins and in the shunt channel. As such, the operators must lower a bobcat into the basin and use fire hoses to clean solids from the bottom of the basin. Due to the extraordinary difficulty of cleaning the basin, GLWA does not clean the basin after every event.

Table 9-7 provides an overview of the existing flushing and dewatering system at Hubbell-Southfield CSO facility.

Table 9-7. Overview of Existing Flushing and Dewatering System at Hubbell-Southfield CSO Facility

Parameter	Value
Total Basin Volume (MG)	22
Headworks and basin Dewatering and Flushing System	- Gravity dewatering can occur for the top portion of captured volume, but this is not typical operation - There are two 8,000 gpm dewatering pumps for Basin 1 and two 8,000 gpm dewatering pumps for Basin 2 - Two 5,000 gpm flushing pumps are located in the effluent channel. A strainer is provided in the Process Building Basement. - Flushing system consists of spray flushing system with 22 zones. System is largely ineffective at removing solids from the basins

9.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- There are significant issues with flushing solids from the floor of the basin and shunt channel.
- The dewatering pumps need to be upgraded and missing sump pumps need to be replaced. A fluidization system should be considered under the sump pumps to avoid large accumulations of solids in the sump
- There is no way to access to the effluent channel (Pond) area.

9.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Basin Flushing System (Project HS-FD-1). Flushing solids from the floor of the basin and shunt channel has been a problem since the facility was constructed. The existing flushing system using spray nozzles has been largely ineffective due to the large volume of solids that are generated during each storm and the fact that a subsequent storm may enter the facility before the entire contents have been cleaned. The configuration of the spray system (15 ft above the floor) also makes the spray system ineffective.

There are three alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing/ Continue Current Operation.** GLWA Operations staff to continue to manually clean the basin.
- 2) **Alternative 2: Contractor Clean Out.** Contractor to manually clean the basin. This alternative is similar to Alternative 1; however, it would include increased number of cleanings per year to meet the intent of the permit to have the basin ready for a subsequent storm event.
- 3) **Alternative 3: New Basin Flushing System.** Based on the poor performance of the existing spray flushing system at Hubbell Southfield and experience at another CSO basin in the Southeast Michigan region (Milk River CSO Basin), GLWA requested a completely new system. Jacobs initially considered both flushing gates and tipping buckets to replace the existing system. After consultations with several manufacturers and evaluating initial conceptual layouts, tipping buckets were removed from consideration due to the low head space inside of the basin areas and maximum flushing length limitation of only 200 ft. As such, the recommended flushing system involves flushing gates/reservoirs in the contact basins and an improved spray system in the shunt channel. This concept is shown in Figure HS-FD-1-ALT-3 in Volume 6 – Appendices, Appendix B.

Demolition. The demolition activities consist primarily of removing of the existing basin mixers and spray system components (pumps, pipes, fittings), concrete removal for construction and permanent access through the roof slab, and other equipment mounted inside of the tank to allow the extensive structural concrete placement. Temporary relocation of some equipment and piping/conduits on top of the tank to facilitate construction is assumed.

Flushing Gate Reservoir Configuration. The existing basin's semi-circular configuration, slope, alignment of the NWI dividing basin into two sections, and drainage channels create a challenging retrofit condition. Flushing gate reservoirs will be located along three lines in the upstream and downstream sections of the two basin compartments. The reservoir volume is determined by the length and slope of the surface that must be flushed by the flushing wave. The longest flushing length is along the northeastern wall of the facility is approximately 430 ft long. The average flushing reservoir volume for the conceptual configuration is approximately 15,000 gallons. The final design should validate and further refine the minimum volume requirement using a sediment fate-transport model (e.g., HEC-RAS) for each flushing lane based on length

and longitudinal channel slope. For 37 flushing reservoirs, the total flushing volume required is approximately 550,000 gallons.

Immediately downstream from the screens, an initial reservoir array will be constructed in Basin 1 with the flushing gate reservoirs suspended above the basin floor and with the gate openings directed towards the existing drainage channel in the upstream section. The suspended reservoirs, as shown in Figure HS-FD-1-ALT-3, allow low flows to continue underneath into the basin in a 2- to 3-foot high channel. As the water level continues to rise in the basin, the hydraulic gradient will build upstream of the suspended reservoirs and increase the velocity in the low-flow channel, effectively moving sediment into the basin sump and the dewatering pump station. Flows will eventually overtop the flushing gate reservoir walls (approximately 8 ft above the floor) and fill the reservoir volume.

A second array of flushing reservoirs is proposed in Basin 2 on the downstream side of the NWI alignment. The reservoirs of this array would be constructed on the existing basin floor with the gate openings directed towards the drainage channel that runs through the middle of Basin 2. The third and final array would be constructed along the finger weirs near the basin outlet. These reservoirs would also be constructed on the floor with the gate openings directed back towards the drainage channel in the middle of Basin 2.

Structural Retrofits. Flushing gates release a flushing wave that needs to be contained in a confined channel to maintain velocity and effectively carry resuspended sediment to a collection point. The basin floors will require concrete training walls along each flushing channel. Additionally, the existing floor will require concrete leveling across most of the entire basin to create level cross-sectional flushing channels. The conceptual design developed indicates that approximately 8,000 cy of concrete fill will be required to create adequate flushing wave channels and reservoirs. Additional concrete fill (structural and low-density concrete fill, approximately 1,000 cy) will be required throughout the basin as fillets and bulk fill to eliminate voids and areas where the flushing waves cannot remove sediment. The total displacement of the new concrete in the contact basin is approximately 1.82 million gallons.

A review of the existing facilities structural details indicate that the base slab could be susceptible to damage if any drainage channel realignments are made. The conceptual design avoids additional base slab structural improvements and subsurface improvements. Additionally, the facility's proximity to surface water and high groundwater would require extensive dewatering should any penetrations through the base slab be required. Additional modifications to the existing base slab, addition of concrete, and other improvements may negatively impact the structure and the foundation. A detailed analysis of the future condition live/dead loads should be completed during final design and structural/foundation improvements incorporated into the project by the final designer. These improvement could include additional piles, retrofitted structural supports, and use of higher strength concrete mixes.

Secondary Flushing Water Source. A secondary source of flushing water is recommended to provide additional flushing cycles for post-event cleaning. The base option for the concept development is to repurpose the existing flushing system water source and install a pipe network to fill the reservoirs in each array. A second option is to use a surface water source, similar to St. Aubin CSO Facility. The close proximity of the Rouge River at the outfall end of the facility allows for the installation of a pump intake, pump system and force main to provide water for a fill pipe network in the contact basin above the reservoirs. GLWA should consider large screens (4-in. bar-type or similar) to prevent floating debris from entering the effluent chamber. GLWA's experience with zebra mussel removal from other facilities in this area indicates that smaller screen openings should be avoided. Similarly, a small opening with a flap-gate opening inward to the effluent channel may help prevent floating debris from entering while ensuring adequate water is available for secondary flushing and shunt channel spray system operation.

The recommended alternative assumes each array of flushing gate reservoirs will be filled using surface water as the flushing water source, similar to the St. Aubin flushing system. Two 2,000-gpm submersible pumps will be mounted in the existing effluent channel. Each pump will discharge to separate 6-in. HDPE force mains that are mounted to the interior roof of the contact basin space (either at the centerline of the overall basin, or

along one wall). One pump will provide flushing water to the northernmost flushing reservoir array, and the other will provide flushing water to the other two arrays. At each array, a second run of 6-in. HDPE will extend over the top of the flushing reservoirs with a tee fitting. A concrete notch (3 ft long by 6 in. deep) cut into the walls between each reservoir would serve as a weir and will enable flows between the reservoirs to fill evenly as the pumps operate.

GLWA has noted that Basin 2 tends to accumulate more solids from wet weather events than Basin 1 and is expected to require more than one post-event flushing with the proposed flushing gate system. By dedicating one pump to the Basin 2 flushing gate arrays (closest to the finger weir), GLWA will be able to more quickly fill these reservoirs to provide a secondary cleaning of this area (estimated fill time at 2,000 gpm of 100 minutes). The other flushing reservoirs in the northern half of the basin will fill more slowly (approximately 180 minutes).

Alternative Gravity Filling System for Basin 2. A sub-alternative for filling the flushing gate reservoirs includes adding a new gated opening or repurposing an existing gated opening in the finger weirs between Basin 2 flushing chamber and the Pond. Each flushing reservoir will have a lower weir notched into the concrete walls between adjacent flushing reservoirs. Opening the gate will allow river water from the reservoir to quickly fill this array of flushing gate reservoirs from one source via overtopping the notched weirs and provide water for additional flushes. A screened and gated opening between the reservoir and the river channel is required to control flows into this space and limit floatable materials and larger aquatic organism from entering the facility. Pumping river water to the other flushing reservoirs using pumps would still be required with the conceptual configuration proposed. Extending a gravity pipe to the other arrays may be possible by adjusting or reconfiguring the elevations and layout of the proposed concept.

New Shunt Channel Flushing System. A new spray flushing system is proposed for the shunt channel. Two new flushing headers will be extended into the shunt channel on both sides of the conduit, and two new submersible pumps will draw river water from the effluent chamber near the secondary flushing gate water source pumps described above.

Each pump will provide water to one half of the shunt channel. Record drawings indicate a transverse slope in the channel's shelf of approximately 0.7 to 1.0 percent, draining from the exterior wall towards the low-flow channel next to the interior wall. The low-flow channel has a slope of approximately 0.5 percent and drains the northern and southern effluent channel sections towards the dewatering pumps. The northern (Basin 1) half of the channel will include two 590-foot, 8-in. HDPE (SDR 13.5) headers, mounted with stainless steel hardware approximately 6 ft from the floor, one above the top edge of the shelf and the other over the low-flow channel. Half-in. holes will be directionally drilled on 4-foot spacings to push solids towards the low flow channel, and along the low-flow channel towards the dewatering pumps. The pumping requirement for the northern half system is approximately 3,300 gpm. The southern (Basin 2) half of the channel includes two 280-foot, 8-in. HDPE headers mounted in a similar fashion and drilled accordingly. The pumping requirement for the southern half system is approximately 1,600 gpm. Similarly-sized pipe runs (approximately 560 ft) connect pumps to both headers.

The control strategy may require only running one half of the effluent channel cleaning system at a time in order to prevent overwhelming the dewatering pumps. Control valves to support pulsing may be required and are recommended to be installed on top of the facility or in new vaults installed in the roof. Flow rate, volume/pressure at application points and control strategy should be confirmed during final design using CFD or scale models.

Additional Mechanical Systems. The flushing gate hydraulic systems will require a new control room as the existing surface facilities at Hubbell Southfield do not have adequate space. Therefore, a new control room/building (occupied, declassified space) is assumed and will be constructed on top of the roof slab. The cost estimate assumes a stand-alone building rather than remodeling or adding to either of the existing buildings. An allowance for structural retrofits of the existing tank's roof slab and beams to support a new

surface structure is included in the costs. Hydraulic tubing would be routed inside of the basin along the ceiling to each gate actuator.

Advantages and Disadvantages of Alternative: This flushing gate option described above appears to be the most viable solution for improving the flushing of the basin using automated systems. The advantages of a flushing gate system at this facility include:

- Effective removal of sediment from the bottom of the basin: Currently, the sediment is only removed periodically due to the significant amount of time and effort. The new system should be able to flush the basins every time the basin is dewatered after a storm event.
- Improved NPDES permit compliance by being able to clean the basin after every event. Note that permit prohibits the discharge of sludge or residual accumulations from the basin to surface waters and requires the settled sludges to be promptly removed and disposed in accordance with procedures approved by EGLE.
- Improved safety for GLWA Operations staff: The flushing system eliminates the need for Operations personnel from entering and operating machinery in the confined space.
- Reduced O&M labor costs for sediment removal compared to current process: Currently, it takes about three personnel about one week to clean the entire basin and occurs about four times per year. This represents a cost of about \$50,000 per year.
- Potential reduction in flushing water usage: The existing spray system uses up to about 7 MG of City water after each event. The proposed flushing water system could eliminate the use of City water if river water can be used as the source of flushing water.
- Some other CSO basins in the area (i.e., Milk River) have removed flushing nozzle systems because they are ineffective.

The disadvantages of this system include:

- High capital cost. The cost estimate for the required modifications to the facility to construct a new flushing gate system is significant.
- Additional systems that require O&M: Adding about 37 flushing gates, hydraulic control system, and secondary flushing water system would add the number of assets that require preventative maintenance and replacement. Secondary flushing system pump operation power requirements would increase the facility's overall electrical consumption.
- New concrete used to construct the flushing system will displace approximately 1.8 million gallons of volume in the contact basin. This will reduce the contact time and may impact the CSO facility's ability to meet regulatory permit requirements. GLWA should assess this impact in more detail during final design of this improvement.
- Difficulty of Construction: Factors that make the construction of the flushing gates difficult include construction of the concrete flushing gates and training walls inside a covered basin, relatively tight site conditions, and the need to keep treating CSO flows. (It is noted that Basin 1 could be completely isolated during construction and allow treatment through Basin 2; however, it is not possible under current configuration to isolate Basin 2 and allow flow to be routed only through Basin 1)

The alternative evaluation for these alternatives is presented in Table 9-8. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 and 2 is based on the replacement cost of the piping and spray nozzle system in about 2014, inflated to 2021 dollars.

- The O&M costs for Alternative 1 includes GLWA labor cost for four cleanouts per year and associated water usage. The labor cost is based on GLWA labor cost of three staff for 40 hours per week and four times per year, or about \$48,000 per year. The water usage is estimated to be 7 MG per clean-out. At \$4,000 per MG, the cost is about \$112,000 per year.
- The O&M costs for Alternative 2 includes assumed Contractor labor cost for 12 cleanouts per year (average of one per month) and associated water usage. The labor cost is assumed to be about \$20,000 per clean-out, or about \$240,000 per year. This cost is an estimated cost to provide reliable cleaning of the basin on a periodic basis. The water usage is estimated to be 7 MG per clean-out. At \$4,000 per MG, the cost is about \$336,000 per year.
- The capital cost for the flushing system (Alternative 3) is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 3 includes \$10,000 for annual maintenance of the new equipment and electricity costs for the river water pumping.

This evaluation shows that Alternative 1 – Continue Current Operation has the lowest NPV/Benefit cost and is shown to be the Best Value Alternative. The poor health and safety conditions for GLWA operations personnel, however, are not properly conveyed in this analysis and the current four cleanings per year is not believed to be adequate to meet EGLE requirements to have the basin ready for subsequent storm events. Using contracted labor would allow GLWA to have the basin cleaned after most storm events; however, the NPV/Benefit cost is higher than Alternative 3. Alternative 3 provides the benefit of improved health and safety by not having to enter the basin for cleaning, and it is easily operated by the O&M staff after every storm. The Total Benefit score for Alternative 3 is about 2.0 points higher than Alternative 2. **As such, Alternative 3 – New Basin Flushing System is the recommended alternative.**

Table 9-8. Alternative Evaluation for Basin Flushing System (Project HS-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Continue Current Operation	Health and Safety	1	1.80	\$ 2,400,000	\$ 160,000	\$ 5,774,341	\$ 3,207,967	Best Value Alternative
	<i>Definition:</i>	Replace existing flushing system in-kind	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known approach; minimal mechanical equipment	Capacity Enhancement	3						
	<i>Disadv.:</i>	Labor intensive	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Contractor Clean out	Health and Safety	1	2.02	\$ 2,400,000	\$ 576,000	\$ 14,547,629	\$ 7,213,700	
	<i>Definition:</i>	Replace existing flushing system in-kind	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known approach; minimal mechanical equipment	Capacity Enhancement	3						
	<i>Disadv.:</i>	Relies on Contractor.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	2						
3	<i>Alt. Name:</i>	New Basin Flushing System	Health and Safety	5	3.98	\$ 24,800,000	\$ 10,000	\$ 25,010,896	\$ 6,278,886	
	<i>Definition:</i>	Flushing gates/reservoirs in the contact basins and an improved spray system in the shunt channel	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier maintenance. Safer operation.	Capacity Enhancement	2						
	<i>Disadv.:</i>	High capital cost; loss of treatment volume in basin	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	5						

Dewatering and Sump Pump Improvements (Project HS-FD-2). Sump pumps for Basin 1 and 2 were originally installed next to the basin dewatering pumps. Due to the large accumulations of solids in the sump, these pumps were routinely overwhelmed with solids. As such, O&M staff have removed them from both basins, but they indicated these pumps are beneficial for proper flushing and removal of solids.

There are two alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing/ Replace In-Kind.** Replace the dewatering and sump pumps in-kind.
- 2) **Alternative 2: Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System.** Two new 200 gpm, sump pumps should be installed. It is recommended that a solids fluidization system be installed under the intake of the new sump pumps and the dewatering pumps. This fluidization system could consist of a water jet to fluidize the accumulated grit before the pump turns on. The project should also provide a new base elbow, cleaning of the discharge pipes, replacement of valves on the discharge line, and replacement of the pump rail system.

O&M staff also requested that the type of dewatering pump be investigated to ones that better handle heavy grit loads. The existing four pumps are manufactured by Vaughan. The N-Series submersible pump by Flygt has replaced a number of dewatering pumps at other CSO facilities and are recommended at this location. Based on input from Kennedy Industries, a Flygt Model NP-3202 would be an appropriate replacement pump. The preliminary sizing indicated that these pumps have a slightly lower horsepower than the existing pumps. Detailed design is needed to confirm pump sizing. The elevation of each dewatering pumps should also be investigated (consider one higher than the other to avoid the heavy grit loads).

This project should be incorporated into the flushing gate project (Project HS-FD-1), if the new basin flushing system moves forward.

The alternative evaluation for these alternatives is presented in Table 9-9. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 is based on the pump replacement costs from the SRP.
- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title. It includes a new fluidizing system to allow the sump pumps to function properly. It also includes new piping to replace the existing and allow the pump elevations to be modified.

Alternative 1 is shown as the Best Value Alternative. The scope of Alternative 2 is generally similar to Alternative 1; however, there are additional improvements in Alternative 2 that are necessary to allow the system to function properly. As such, **Alternative 2 - Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System is the recommended alternative.**

Table 9-9. Alternative Evaluation for Dewatering and Sump Pump Improvements (Project HS-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	3	2.58	\$ 429,000	\$ -	\$ 429,000	\$ 166,065	Best Value Alternative
	<i>Definition:</i>	Replace the dewatering pumps and sump pumps in-kind.	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Difficulty with flushing and removal of solids.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System	Health and Safety	3	3.42	\$ 950,000	\$ -	\$ 950,000	\$ 278,049	
	<i>Definition:</i>	New dewatering and sump pumps and appurtenances will be installed. A solids fluidization system will be installed under the intake of the new sump pumps.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Proper flushing and removal of solids	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	4						

Access to Effluent Channel (Project HS-FD-3). There is no manned access to the effluent channel area (i.e., the area between the effluent weirs and the effluent flap-gates). GLWA needs to access this area to allow equipment to be lowered into this space for removal of settled solids from the floor.

There are two alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing**
- 2) **Alternative 2: Equipment Access to Effluent Channel.** A hatched opening is desired for this area in a location shown in Figure HS-FD-3-ALT-2 in Volume 6 – Appendices, Appendix B. One option is to cut an opening in one pre-stressed concrete plank and use removable covers, similar to the existing hatch shown in the photos in the Appendix. Another option that should be considered during design is providing an aluminum hatch opening, so that a boom truck is not needed to remove the cover.

This project should be incorporated into the flushing gate project (Project HS-FD-1), if the new basin flushing system moves forward.

The alternative evaluation for these alternatives is presented in Table 9-10. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

Due to need to access this location for solids clean-out, **Alternative 2 - Equipment Access to Effluent Channel is recommended.**

Table 9-10. Alternative Evaluation for Access to Effluent Channel (Project HS-FD-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Inability to access the effluent channel area	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Equipment Access to Effluent Channel	Health and Safety	3	3.22	\$ 126,000	\$ -	\$ 126,000	\$ 39,171	Not Applicable
	<i>Definition:</i>	Cut an opening in one pre-stressed concrete plank and use removable covers	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier access	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance of hatch	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.5 HVAC

9.2.5.1 Description of Existing System

The Hubbell-Southfield CSO Facility consists of a Headworks Building and a Process Building. The buildings contain a Headworks area, chemical room, utility support (electrical and mechanical rooms), control room, odor control rooms and other miscellaneous rooms. The facility also includes a retention basin. Table 9-11 provides a summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, emergency shower/eye wash and washroom regular shower. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 9.2.10.

Table 9-11. Major HVAC Equipment at Hubbell-Southfield CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	HVU-3	Heating Ventilating Unit	25,000 CFM
Basin 1	SF-1 to 6	6 × Supply Fans	50,000 CFM
Basin 2	SF-7 to 13	7 × Supply Fans	50,000 CFM
Chemical Room (Headworks Bldg)	EF-2	Exhaust Fan (Hypochlorite Rm)	2,200 CFM
	HVU-2	Heating Ventilating Unit	10,500 CFM
Process Control Bldg	PACU-1	Packaged Air Conditioning Unit	3,400 CFM

Note:

HVU = Heating Ventilation Unit

Table 9-12 provides a summary of the basis of design performance criteria for HVAC systems at Hubbell-Southfield and Table 9-13 provides the outdoor Basis of Design conditions.

Table 9-12. Hubbell-Southfield Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (°F)	Summer (°F)	
Odor Control Room – Process Building	Unclassified (Per As-Built Drawings)	70	N/A	12 ACH
Work Area, Electric Room, Toilet, Storage, etc., – Process Building	Unclassified	70 (Occupied) 60 (Unoccupied)	78	6 ACH
Dewatering Room – Process Building	Unclassified	70	N/A	3 ACH
Mechanical Room – Headworks Building	Unclassified	60	N/A	6 ACH
Odor Control Room – Headworks Building	Unclassified (Per As-Built Drawings)	70	N/A	12 ACH
NaOCl Room –Headworks Building	Unclassified	60	N/A	6 ACH
Headworks Room –Headworks Building	Class I, Div 1, Group D (Per As-Built Drawings)	70	N/A	12 ACH

Table 9-13. Hubbell-Southfield Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb °F)	Summer (Dry Bulb °F)	Summer (Wet Bulb °F)
3	91	73

9.2.5.2 Identified Needs and Issues

During discussions with GLWA O&M staff and GLWA's HVAC contractor, the following HVAC issues were noted:

- Heating in the dewatering room (basement of Process Building) was reported to be insufficient. No freezing of pipes was reported.
Jacobs further investigated this issue through review of design information and site visit. All spaces in the Process Building have a basis of design winter dry bulb temperature of 70°F. The dewatering room's HVU duct heater has a design capacity of 125,000 Btu/h which should be sufficient to heat the dewatering room to 70°F using 80 percent return air, as designed. EF-7 was not observed to be operating. Given the significant amount of corrosion that was observed on EF-7's motorized damper, it is very likely that the damper is seized. This could not be verified in the field due to the inaccessible location of the damper. The observed cold air temperatures in the dewatering room are most likely the result of HVU-4's outside air supply damper remaining fully open during heating mode and/or the return air damper remaining in its minimum position. Given the age of the equipment serving the dewatering room, a replacement in-kind of HVU-4, EF-7 and associated supply, return, and exhaust dampers is recommended and should resolve this issue. This project will come from the SRP.
- O&M staff requested that air conditioning in the Process Building odor control room. Upon further discussion, the main activity routinely performed in this area is sample preparation and analysis. Instead of air conditioning the entire odor control room, it was recommended to move the sample sink to the work area, which is already air conditioned. This is currently an on-going project to be completed by GLWA maintenance staff
- Heating and cooling issues in Process Building. Staff reported that improvements were needed.
- Historical Issues with Heating and Ventilation Units: GLWA's HVAC contractor noted there had been issues with the HVUs which had been resolved. They did not note any out of the ordinary wear or capacity issues with the units.

During Jacobs site investigations (June 2020) the following observations were noted:

- It was observed during the site visit that the air balance of PACU-1 in the Process Building had been adjusted since installation. It is very likely that this adjustment came from a desire to improve thermal comfort in occupied spaces. Additionally, it was noted that the supply air duct from PACU-1 runs from the West side to the East side of the Process Building; however, the return air duct terminates at the entrance to the odor control room (see Figure 9-2 below). This is likely to result in poor air quality as a result of a lack of air circulation in spaces on the East side of the Process Building.

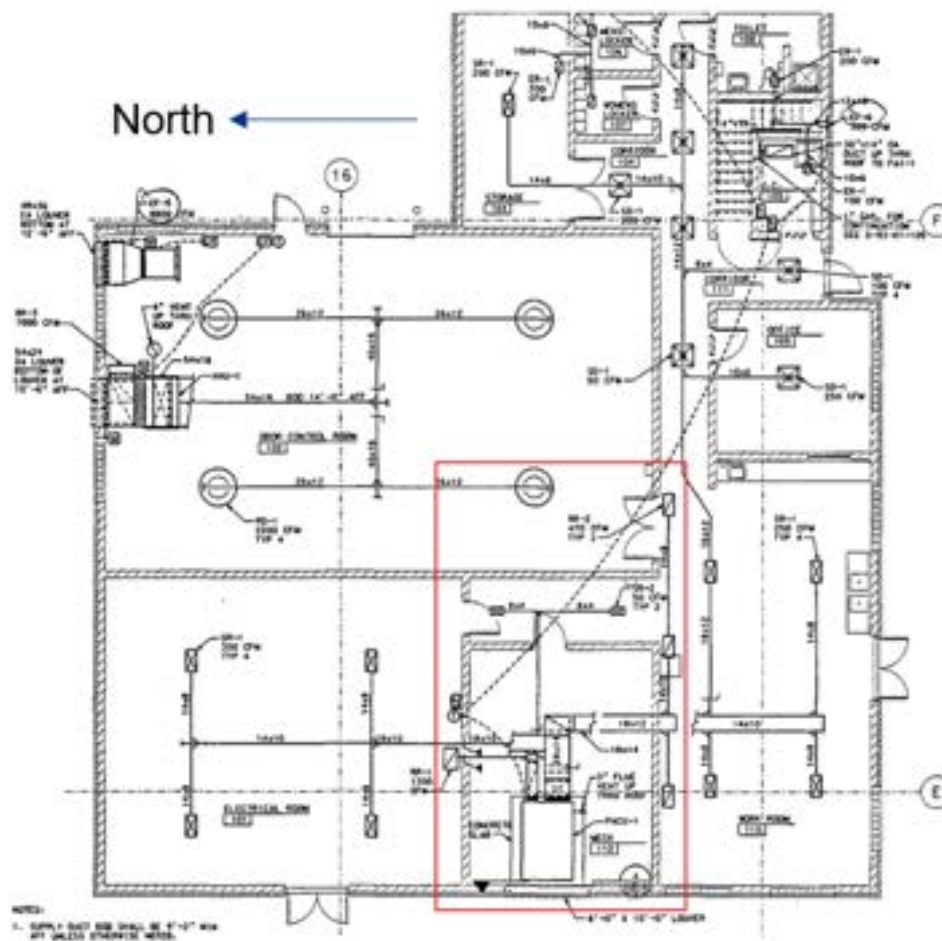


Figure 9-2. PACU-1 Return Air Ductwork

- The doors between the Process Building odor control room and the Work Area were observed to be open. Additionally, ventilation in the odor control room was switched off. Condensation was noted on the PACU-1 supply air duct directly in front of the Odor Control Room.
- Condensation was noted on the floor at the top of the dewatering room (basement) stairway. HVU-4, which serves the dewatering room was supplying ventilation air but EF-7 which provides relief for the air supplied to the dewatering room was not operating despite having its motorized damper in the open position. Additionally, significant corrosion was observed on the body of the dewatering room's duct mounted gas furnace (Figure 9-3).



Figure 9-3. Corrosion on EF-7 Ductwork

- HVU-2's supply fan, which provides ventilation to the odor control room in the Headworks Building, was observed to be running; however, EF-1, EF-2, EF-3 were not operating.

9.2.5.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Process Building Air Balance Study. An air balance is recommended for the Process Building to determine if the heating and cooling issues are the result of a poorly balanced system. It is noted that the operators occasionally leave the door to the odor control room open to cool this area, as observed during the site visit. This may be contributing to the issues related to poor cooling provided by PACU-1. Also, it should be noted that the spaces in the Process Building which are cooled are only designed to be cooled to 78°F.

If the air balance does not improve conditions in the Process Building, extending the return air to PACU-1 should be considered. This should improve air circulation and increase supply air flow to the spaces on the East side of the facility, including the Office.

Scheduled Replacement Plan: As noted in Section 9.2.5.2, many of the relatively small HVAC-related equipment at this facility is recommended to be replaced in-kind. Therefore, it is included in the SRP.

9.2.6 Electrical

9.2.6.1 Description of Existing System

The Hubbell Southfield facility's electrical system consists of one DTE utility feed from a 1,500 kVA, 480 V, 3-phase outdoor transformer (secondary metering) and one diesel generator feed from a 600 kW, 480 V, 3-phase stationary generator. The feeds are connected to a 2,500 A switchboard MDP with electrically operated breakers and automatic source transfer controls for a 1,200 A bus. The MDP switchboard also has a 2,000 A breaker before the ATS, which feeds a main circuit breaker panel switchboard (MCBP). The MDP and MCBP have breakers that

feed motor control centers (MCCs) and distribution panels. The MCCs and distribution panels then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 9-14 provides a summary of the major electrical equipment for this facility.

Table 9-14. Major Electrical Equipment at Hubbell-Southfield

Location	Major Electrical Equipment	Description
Electrical Room	Main Switchboard/ATS (MDP)	2,500 A, 480/277 V, 3-Phase
Outdoors	Generator (Diesel)	600 kW, 480 V, 3-Phase
Electrical Room	MCC-P1	600 A, 480/277 V, 3-Phase
Odor Control Room	MCC-H1	250 A, 480/277 V, 3-Phase
Electrical Room	MCC-P2	1,200 A, 480/277 V, 3-Phase
Odor Control Room	MCC-H2	600 A, 480/277 V, 3-Phase

9.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the next section.

9.2.6.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project HS-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles, however it will be less safe when operating at night and select locations within the basin.
- 2) **Alternative 2: Electrical Improvements.** Add Lighting and Exterior Power Receptacles at the following locations (and shown on the electrical drawings - Figure HS-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Basin Nos. 1 and 2—Add interior explosion-proof LED lighting fixtures to provide lighting within the basins.
 - Access road—Add light poles and associated LED light fixtures. Lighting foot-candles shall meet the requirements of the local outdoor lighting ordinances.
 - Outfall area—Add a light pole and overhead lighting at the facility's outfall. Lighting foot-candles shall meet the requirements of the local outdoor lighting ordinances.
 - External lighting on top of Basins—Add light poles and LED lighting fixtures on the facility's basins. Lighting foot-candles shall meet the requirements of the local outdoor lighting ordinances.
 - Add exterior power receptacles to assist in the maintenance and operations of the facility including receptacles every 75 ft on top of the basins for maintenance and operational needs.

This project should be incorporated into the flushing gate project (Project HS-FD-1,) if the new basin flushing system moves forward because of the amount of work on and in the basins.

The alternative evaluation is presented in Table 9-15. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$100,000, which is a moderate cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 9-15. Alternative Evaluation for Electrical Improvements (Project HS-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe when operating at night and when accessing select locations within the basin.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 349,000	\$ -	\$ 349,000	\$ 99,714	Not Applicable
	<i>Definition:</i>	Add additional lighting and receptacles at identified locations	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.7 I&C

9.2.7.1 Description of Existing System

Control System: The original control system at Hubbell Southfield was installed in 1996 under PC-694. Since then, several modifications to the original control system have taken place. In 2002 under PC-713, the facility's PLC control system was upgraded to interface with the Ovation system to enable remote monitoring and control the facility from SCC. In 2009, PC-761 replaced the control system and workstations with new Allen Bradley ControlLogix redundant PLCs and new operator workstations with Factory Talk View SE software. The existing hardwired back-up control panel and other miscellaneous PLCs and subsystems are incorporated into the overall control system. The current system is equipped with a back-up radio system to communicate critical monitoring points back to the SCC on wide area network failure.

The current PLC control system and back-up panels are obsolete and do not meet GLWA SCADA Governance standards, which stipulate that all CSO facilities use Ovation workstations with high-performance graphics.

Flow and Level Sensors: Table 9-16 summarizes the level sensors and flow meters at the Hubbell-Southfield CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 9-16. Summary of Flow Meters and Level Sensors at Hubbell-Southfield CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent channel (Upstream of inflatable dams)	2	Transit-Time (AccuSonic)
Shunt Channel (Shunt and bypass)	2	Transit-Time (AccuSonic)
Dewatering Flow	1	Magnetic
CSO Facility Level Sensors		
Influent channel (Upstream of inflatable dams)	2	Ultrasonic
Shunt Channel (Shunt and bypass)	2	Ultrasonic
Screening area (upstream and downstream of bar racks)	2	Ultrasonic
Basins	2	Ultrasonic
Dewatering Wells	2	Ultrasonic
Effluent Channel	1	Ultrasonic
Rouge River	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed	1	Ultrasonic

9.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- Evaluate level sensors and flow meters to determine redundancy and identify sensors or meters that could potentially be removed. Jacobs further evaluated this issue and found that the flow meter in the Shunt Channel is redundant to the flow meters for the Bypass Channel and Influent Channel and could possibly be eliminated. Under the current operation of first flush capture, the Shunt Channel flow meter provides the flow

rate for flow to Basin 2 (after Basin 1 is full) and flow to the Bypass Channel (when the Bypass gates are open). Since there is a flow meter on the influent and one on the Bypass, the Shunt Channel flow meter is redundant and could be removed. However, it does provide redundancy if the Influent flow meter fails and it was recently replaced. It is recommended that the Shunt Channel flow meter be considered for elimination when it is near the end of its useful life.

- Need for remote control capability of the Chemical Feed area from the Control Building
- Need for remote control of VR-8 gate. This need is scheduled to be addressed in Spring 2021 by SCC under CS-090A. This project will provide remote control of this gate from either the Hubbell Southfield CSO Basin or SCC.
- Need for local remote control for dewatering pumps
- Need for tank level indication at Chemical Fill Station
- Need for process cameras at select locations
- Update Ovation control system to the latest version and increased monitoring capabilities

9.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project HS-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, all of the identified I&C improvements, with the exception of the Ovation Control System Upgrade, are proposed to be in one project – I&C Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing**

2) **Alternative 2: I&C Improvements** including,

- Provide remote control capability of the Chemical Feed area from the Control Building
- Provide local remote control for dewatering pumps
- Provide tank level indication at Chemical Fill Station
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Provide remote control capability of the Chemical Feed area from the Control Building. A Remote I/O panel will be required at the Chemical Feed area which will be connected to the Control Building via a fiber optic cable. The Remote I/O panel will interface with the existing motor starter control circuits to be able to operate the equipment remotely.

Provide local remote control for dewatering pumps. Provide local control for the four Dewatering Pumps in accordance with Section 5.4.9.

Provide tank level indication at Chemical Fill Station. Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 9-17. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

- The increased O&M costs for the remaining improvements in Alternative 2 are difficult to quantify and would not affect the alternative evaluation. Similarly, it is difficult to quantify the monetary benefits of the improved operations through the improved monitoring and control.

This evaluation shows that Alternative 2 – I&C Improvements has a total benefit score about 0.3 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and ease of O&M provided by the various I&C improvements. The NPV/Benefit cost for Alternative 2 is \$120,000, which is a moderate cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – I&C Improvements is the recommended alternative.**

Table 9-17. Alternative Evaluation for I&C Improvements (Project HS-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	3.00	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 274,000	\$ 7,000	\$ 421,627	\$ 127,124	Not Applicable
	<i>Definition:</i>	Provide local control capability of the Chemical Feed area from the Control Building; provide local remote control for dewatering pumps; provide tank level indication at Chemical Fill Station; provide process cameras at select locations.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Control System Upgrade (Project HS-I&C-2). The current facility's PLC control system, network, workstations and control system back-up panels are obsolete and should be replaced in the near future. The control system does not meet GLWA SCADA Governance standards, which require that all CSO facilities use Ovation workstations with new high-performance graphics. GLWA's standards for local CSO facility's control systems can be either the latest Allen Bradley PLC system with Ovation workstations or a complete Ovation system. This approach is being used on an ongoing project at Leib, Seven Mile, and St. Aubin.

Because of the approach used on the ongoing project, there is only one overall control system alternative considered. The project should include decommissioning and removal of the original hardwired back-up local control panels. These local panels are no longer required with today's redundant control system processors and local Operator Interface Terminal (OIT) as local back-up to the facility's workstations.

Table 9-18 provides the summary of the **Control System Upgrade, which is the recommended alternative**. Capital costs are included in Volume 6 – Appendices, Appendix C under this project title. Consideration should be given to replacing various field instruments; however, these are not included in the capital costs.

Table 9-18. Alternative Evaluation for Control System Upgrade (Project HS-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 2,457,000	\$ -	\$ 2,457,000	\$ 819,000	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved performance, standardized HMI screens, can have standardized redundant "on-the-shelf" parts.	Capacity Enhancement	3						
	<i>Disadv.:</i>	No performance related disadvantages.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

9.2.8 Site

9.2.8.1 Description of Existing Site

The Hubbell-Southfield CSO Facility was constructed in 1994. The Hubbell-Southfield facility has two buildings situated on top of the basin, namely the Headworks Building over the north influent end of the basin and the Process Building over the dewatering pumps at the center of the basin. The access entrance to the site is through a 24-ft wide sliding vehicular gate. Security around the perimeter of the site is provide by an 8-ft high chain link fence. Site pavement consists of 9-in. reinforced concrete on undisturbed earth. There are no sidewalks near the basin. The access road from Rotunda Dr. to the basin consists of 10-in. asphalt on 12 in. of gravel base.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

9.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the section below.

- The existing 2-in NPW header line for flushing the basins provides insufficient pressure for washdown after storm event.
- Poor condition of the service drive around the basin
- Localized ponding of water on the basin surface. In the winter, this water freezes and causes safety concerns
- Poor condition of security fencing
- The detention ponds drainage from the gold course discharged over the access road creates an issue for GLWA vehicles driving through
- The following needs are generally preventative maintenance items intended to ensure that the site features or utilities are serviceable throughout their expected service lives.
 - Remove vegetation from the fence line around the perimeter of the basin
 - Re-caulk expansion joints at the base of the exterior walls around the Headworks and Control Buildings
 - Replace expansion joint membranes and expansion joint cover plates on the basin service drive.

9.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Flushing Water Pressure in Headworks Area (Project HS-Site-1). A 6-in. watermain services the Headworks Building and supplies the NPW service to the hose bibs in the basin. The 6-in. watermain is tapped from an 8-in. watermain outside of Headworks Building. The NPW is supplied through a 2-in. header that runs through the length of the basin with drop connections at hose bibs spaced approximately 100 ft apart. GLWA Operations staff

indicate that there is little pressure in the 2-in. NPW line for hose washdown inside the basin after a storm event. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area.** To increase pressure in the NPW line, it is recommended to demolish and replace approximately 950-ft of the existing 2-in. header in the basin with a 4-in. header (See Figures HS-SITE-1-ALT-2). The size of this header should be confirmed during detailed design.

The alternative evaluation is presented in Table 9-19. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and ease of O&M. The NPV/Benefit cost for Alternative 2 is \$33,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area, is the recommended alternative.**

Table 9-19. Alternative Evaluation for Flushing Water Pressure in Headworks Area (Project HS-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Insufficient water pressure for washdown after storm event.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area	Health and Safety	3	3.42	\$ 112,000	\$ -	\$ 112,000	\$ 32,780	Not Applicable
	<i>Definition:</i>	To increase the pressure in the non-potable water line, it is recommended to replace the existing 2" header with a 4" header in the basin.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier washdown	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	4						

Site Improvements (Project HS-SITE-2). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Site Improvements** including,
 - Resurface Service Drive Around Basin
 - Improve Basin Roof Surface Drainage
 - Replace Security Fencing
 - Culvert for Golf Course Drainage

Each of the site related improvements listed above are described further below:

Resurface Service Drive Around Basin: The existing service drive around the basin is in poor condition. The service drive along the east side of the basin consists of reinforced concrete slab, which is the roof of the Dearborn Channel and Shunt Channel. The remaining portion of the service drive that runs across the basin and then along the west side of the basin to the headworks building consists of 4-in. concrete topping reinforced with welded wire fabric (WWF) on top of double tee beams of the basin roof.

To restore the service drive along the east side, it is recommended to hydro-demolish the top surface of the Dearborn and Shunt Channels roof slab up to 2 in. below the top layer of reinforcement and reconstruct the slab. To restore the service drive across the basin and along the west side of the basin, it is recommended to hydro-demolish the entire 4-in. thick concrete topping and replace it with new air entrained reinforced concrete topping. The reconstruction of the slab along the east and west sides of the service drive should be sloped to provide drainage away from the structure and towards grassy areas.

It is noted that the hydro-demolition and reconstruction activities will require a temporary support system from below to maintain the integrity of existing structural systems (roof slab/double Tees) during construction activities. Representative concrete core samples should be taken and tested by a material testing company to check the integrity of the slabs prior to any demolition activities.

Improve Basin Roof Surface Drainage: There are numerous areas on the basin roof surface where localized ponding of water occurs (See Figure HS-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B). Ponding of water can become a safety issue for personnel who must navigate around these areas to access equipment or facilities during winter months when the surfaces turn to ice. It is recommended at the larger areas of ponding water that cores be made through the basin roof to drain the area. Recessed plaza deck drains should be installed in the cored holes to drain ponded water directly to the basin. As an alternative, to prevent stormwater from entering the basin, consideration could be given to piping the ponded water drainage on the underside of the basin through the basin exterior walls and discharge to drainage swales on either side of the basin. It is estimated that there are 10 to 15 significant sites of ponded water on the basin surface.

Replace Security Fencing: There are two locations where fencing needs to be replaced because it is in disrepair:

- The fencing at the entrance to the service drive from Rotunda Drive (see Figure HS-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B, for location). The fencing extends on the south side of the service road from Rotunda Drive to the gate on the service drive at the Tournament Players Club golf course maintenance building. This includes 360 ft of 5-ft tall cyclone fencing.
- The fencing on the north side of the access road from Rotunda Drive to the facility access gate (also shown in Figure HS-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B). This includes approximately 2,300 ft of 5-ft tall cyclone fencing.

It should be noted that the as-built drawings for this facility (PC-694) do not include fencing. As such, it appears the fencing was existing when the facility was built and may not be the responsibility of GLWA.

Culvert for Golf Course Drainage: Periodically, the Tournament Players Club golf course must drain detention ponds located on the course. This is generally accomplished by pumping pond contents through hoses and discharging over the access road to allow the water to drain to the Rouge River. To minimize soil erosion from this method of pumping, GLWA has proposed to create a drainage culvert beneath the access road so that the pond water can be discharged beneath the road rather than across its surface where it is tracked by GLWA vehicles. The new drain should be located beneath the access road in the vicinity of the Tournament Players Club Maintenance Building and should include a catch basin on the north side of the road and a rip rapped discharge with a headwall (or spillway) on the Rouge River side of the access road.

The alternative evaluation is presented in Table 9-20. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety, and ease of O&M. The NPV/Benefit cost for Alternative 2 is \$258,000. **Because of the improved drainage and safety and restoration of the road with Alternative 2 – Site Improvements, Alternative 2 is the recommended alternative.**

Table 9-20. Alternative Evaluation for Site Improvements (Project HS-SITE-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>		Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 902,000	\$ -	\$ 902,000	\$ 257,714	Not Applicable
	<i>Definition:</i>	Resurface Service Drive Around Basin; improve basin roof surface drainage; replace security fencing; culvert for Golf Course drainage	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved drainage & improved safety for accessing facility.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.9 Architectural

9.2.9.1 Description of Existing Facilities

The Hubbell-Southfield CSO Facility consists of Headworks Building and Process Building. The Headworks Building includes a screen room, chemical room, a mechanical room and an odor control room. The Process Building includes a control room, utility support (electrical and mechanical), odor control room, and other miscellaneous rooms. The facility also includes the retention basin.

9.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a roof replacement evaluation and a detailed assessment of architectural issues, as described in the following paragraphs.

Evaluation of Type of Future Roof Replacement. Jacobs reviewed the results of a roof assessment and prepared a 60-year life-cycle cost analysis between shingled roof and metal roof. Based on the results of this evaluation, which shows lower life cycle cost for shingled roof, Jacobs recommends replacement of the shingled roof with shingles when the roof is ready for replacement. The analysis is presented in Table 9-21. As such, the roof should be replaced in-kind and the costs and schedule for the roof replacement will come from the SRP.

Table 9-21. 60-Year Life Cycle Cost Evaluation of Shingled vs. Metal Roof for Hubbell-Southfield Facility

	Shingle Roof	Metal Roof
Replacement Cost ¹	\$282,000	\$940,000
Replacement Interval	20 years	60 years
Number of Roof Replacements During 60 Years	3	1
Total Life Cycle Cost (NPV) Discounted at 2.4%	\$766,000	\$940,000

¹ Based on 18,800 ft² roof area; \$15 ft² for shingle roof and \$50/ft² for metal roof.

CS-299 Architectural Assessment: Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

9.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (HS-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove and replace isolation/ cove joint sealant and around building perimeter
 - Install floor expansion joint in Process Building
 - Paint wood truss and plywood roof deck in Process Building
 - Remove corrosion on bollards, and clean and coat
 - Remove existing paint, clean and paint wood roof deck and framing
 - Install vertical expansion joint and repair concrete and wall in Headworks Building
 - Replace damaged/stained/missing acoustic ceiling tiles in Process Building
 - Address door hardware issues
 - Caulk gap of fascia board on Process Building

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings (Figure HS-ARCH-1-ALT-2) in Volume 6 – Appendices, Appendix B. Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 9-22. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, Alternative 2 is the recommended alternative.

Table 9-22. Alternative Evaluation for Architectural Rehabilitation (Project HS-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 371,000	\$ -	\$ 371,000	\$ 119,677	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

9.2.10 Safety

9.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

9.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 9-23. The capital improvement project to address these issues is included in the table.

Table 9-23. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Headworks	Mid-rail missing between bar screen 2 and 3	Add mid rail	Safety Improvements (Project HS-SAFE-1)
Basin Odor Control Room	At top of ladders, mid-rail chain needed	Add swing gate (original recommendation was to add chain; however, this is no longer current GLWA practice)	Safety Improvements (Project HS-SAFE-1)
Process Building Odor Control Room	Eyewash 0922552 too low	Adjust height of eyewash	Eyewash/Shower Improvements (Project HS-SAFE-1)
Basin Odor Control Room	Eyewash 0947279 too low	Adjust height of eyewash	Eyewash/Shower Improvements (Project HS-SAFE-1)
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project HS-SAFE-1)

9.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project HS-SAFE-1). This project should address the safety issues identified above. These issues include:

- Extend railing between bar screen #2 and #3 to eliminate fall hazard
- Add swing gate at top of ladders in the basin odor control room
- Adjust height of eyewash in the Process Building odor control room and basin odor control room
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 9-24 shows the one alternative.

Table 9-24. Alternative Evaluation for Safety Improvements (Project HS-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	5	3.78	\$ 158,000	\$ -	\$ 158,000	\$ 41,762	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection, eye wash.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.11 Supporting Infrastructure

9.2.11.1 Description of Existing System

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above.

9.2.11.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- The VR-8 Regulator upstream of the Hubbell-Southfield CSO Facility is located in the center median of Michigan Avenue east of the Southfield Freeway. The VR-8 Regulator consists of two stainless steel slide gates that are adjusted by SCADA control to regulate flow from the Hubbell-Southfield sewer to the NWI. A rehabilitation project was designed in 2013 by Metco, but not implemented. Rehabilitation of the VR-8 Regulator is still needed. It should be noted that the control system for the regulator is being upgraded in early 2021 under Project No. CS-090A. This upgrade will provide remote control of the two regulator gates from the Hubbell Southfield CSO Facility or SCC.

9.2.11.3 Discussion and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

VR-8 Regulator Rehabilitation (Project HS-SUPP-1). As described in the 2013 Final Basis of Design Report by Metco, the rehabilitation of the VR-8 Regulator included 1) Replacement of the slide gates and actuator; 2) SCADA system modifications; and 3) Access improvements in the median near the gates and control panel. As noted above, the SCADA system modifications are being addressed as part of a control system project. As such, Jacobs based the proposed rehabilitation on the cost estimate generated for this project (inflated to current dollars), excluding the SCADA system improvements. It was noted in the Metco report that the access improvements using geoblock units had not been approved by the Michigan Department of Transportation. These details would need to be resolved during detailed design.

The alternative evaluation is presented in Table 9-25. The capital cost is included in Volume 6 – Appendices, Appendix C under this project title. Since this is rehabilitation of an existing system, there is only one alternative considered. As such, **Alternative 1 is the recommended alternative.**

Table 9-25. Alternative Evaluation for VR-8 Regulator Rehabilitation (Project HS-SUPP-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	VR-8 Regulator Rehabilitation	Health and Safety	3	3.00	\$ 1,956,000	\$ -	\$ 1,956,000	\$ 652,000	Best Value Alternative
	<i>Definition:</i>	Replacement of the slide gates and actuator; and access improvements in the median.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Maintains system reliability and functionality.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

9.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Hubbell Southfield CSO facility, Table 9-26 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 9-26, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 9-26. Listing of Asset Condition Assessments for Hubbell Southfield Facility

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	45	45	0	100%
AHU	5	0	5	100%
AIRDRYER	1	1	0	100%
BACKFLOW	8	8	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	2	2	0	100%
BUILDING	4	2	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	3	3	0	100%
COND-AIR	2	2	0	100%
CONVEYOR	1	0	1	100%
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A
DAM	2	0	2	100%
DAMPER	3	3	0	100%
DISCONNECT	0	0	0	N/A
DOOR	3	3	0	100%
DRIVE-ELEC	5	5	0	100%
ELEVATOR	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	6	6	0	100%
FAN	2	0	2	100%
FANVENT	20	20	0	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	0	0	0% ^b
GASMONITOR	4	4	0	100%
GATE	26	26	0	100%
GEARBOX	7	0	7	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	0	0	0	N/A
MCC	6	0	6	100%
METER	7	7	0	100%
MIXER	23	23	0	100%
MOTOR	16	7	9	100%
PANEL	13	13	0	100%
PIPING	4	4	0	100%
PUMP	21	10	8	86% ^c
ROOF	2	2	0	100%
SAMPLER	0	0	0	N/A
SCADA	3	3	0	100%
SCREEN	6	0	6	100%
SCRUBBER	2	0	2	100%
SENSOR	12	12	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	1	1	0	100%
SWITCH	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	2	2	0	100%
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	1	0	1	100%
UNITHEATER	0	0	0	N/A
UPS	3	3	0	100%
VALVE	26	26	0	100%
WATERHTR	0	0	0	N/A

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is not an asset. Another one of the building asset listed as "PLANNING - ORDERING PARTS/FILLING OUT WORK ORDER/COMPLETING INVENTORY OF PARTS ON HAND. (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is also not an asset.

^b The one gas detector is a portable unit and was not assessed.

^c Two pumps are listed in WAM - Basin 1 Sample Pump and Shunt Channel Sample Pump. These umps are being considered for removal from WAM.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Hubbell-Southfield Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

9.3 Capital Planning for Hubbell-Southfield CSO Facility

9.3.1 Summary of Capital Improvement Plan Projects

Table 9-27 provides a summary of the recommended CIP projects and associated capital costs for the Hubbell Southfield CSO facility based on the alternative evaluations conducted for this facility.

Table 9-27. Summary of Recommended Projects at Hubbell-Southfield CSO Facility

Project No.	Alternative	Description	Total Project Cost
HS-SCR-1	2	Screening Improvements	\$ 195,000
HS-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 534,000
HS-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
HS-DIS-3	2	Add a New Chemical Storage Tank	\$ 753,000
HS-FD-1	3	New Basin Flushing System	\$ 24,800,000
HS-FD-2	2	Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System	\$ 950,000
HS-FD-3	2	Provide Equipment Access to Effluent Channel	\$ 126,000
HS-ELEC-1	2	Electrical Improvements	\$ 349,000
HS-I&C-1	2	I&C Improvements	\$ 274,000
HS-I&C-2	1	Control System Upgrade	\$ 2,457,000
HS-HVAC	N/A	Process Building Air Balance Study	\$ 5,000
HS-SITE-1	2	Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area	\$ 112,000
HS-SITE-2	2	Site Improvements	\$ 902,000
HS-ARCH-1	2	Architectural Rehabilitation	\$ 371,000
HS-SAFE-1	1	Safety Improvements	\$ 158,000
HS-SUPP-1	1	VR-8 Regulator Rehabilitation	\$ 1,956,000

9.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 9-28. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 9-28. Capital Improvement Plan Projects for Hubbell-Southfield CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
HS-1 Disinfection System Improvements	\$ 1,507,000	2029 <i>Timing based on asset condition</i>	HS-DIS-1	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 534,000
			HS-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
			HS-DIS-3	Add a New Chemical Storage Tank	\$ 753,000
HS-2 Flushing System Improvements	\$ 27,239,000	2026 <i>Timing based on safety issues</i>	HS-FD-1	New Basin Flushing System	\$ 24,800,000
			HS-FD-2	Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System	\$ 950,000
			HS-FD-3	Provide Equipment Access to Effluent Channel	\$ 126,000
			HS-ELEC-1	Electrical Improvements ^a	\$ 349,000
			HS-SITE-1	Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area	\$ 112,000
			HS-SITE-2	Site Improvements ^b	\$ 902,000
HS-3 Facility-Wide I&C Improvements	\$ 2,731,000	2029 <i>Timing based on asset condition</i>	HS-I&C-1	I&C Improvements	\$ 274,000
			HS-I&C-2	Control System Upgrade	\$ 2,457,000
HS-4 VR-8 Regulator Rehabilitation	\$ 1,956,000	2030 <i>Timing based on best judgment</i>	HS-SUPP-1	VR-8 Regulator Rehabilitation	\$ 1,956,000
HS-5 Facility-Wide Safety and Architectural Improvements	\$ 529,000	2023 <i>Project should be initiated as soon as possible</i>	HS-ARCH-1	Architectural Rehabilitation	\$ 371,000
			HS-SAFE-1	Safety Improvements	\$ 158,000

Notes:

^a Electrical Improvements were combined with Flushing System Improvements because most of electrical improvements are related to lighting within and on top of basin.^b Site Improvements were combined with Flushing System Improvements because road around basin will likely need to be repaired after construction.

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 9-29 and Table 9-30 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 9-29 indicates that HS-DIS-1 project has 12 assets that has an average condition score of 1.57 and an average replacement date of 2029. This information was used to propose a scheduled construction completion date of 2029.

Table 9-29. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
HS-DIS-1	12	1.57	1.57	2.86	12	2029	\$ 969,900
HS-FD-2	3	1.57	1.20	2.51	20	2039	\$ 302,100
HS-I&C-1	4	1.14	1.23	1.85	14	2033	\$ 447,179
HS-I&C-2	3	2.29	1.57	4.08	12	2029	\$ 1,481,175

Table 9-30. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
HS-DIS-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
HS-FD-2	3	1.38	5.00	4.83	20	2021	\$ 126,900
HS-I&C-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
HS-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -

There is a recommended capital improvement project presented in Table 9-28 that could be better delivered under capital outlay projects. This project is listed in the following bullet:

- Screening Improvements (HS-SCR-1)

9.3.3 20-Year Capital Outlay Plan

Table 9-31 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 9-31. 20-Year Capital Outlay Plan for Hubbell-Southfield CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 461,382	\$ 7,482	\$ -	\$ -	\$ -	\$ 453,900	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 336,501	\$ -	\$ -	\$ 313,841	\$ 22,660	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 46,226	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 46,226	\$ -	\$ -	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 1,404,270	\$ -	\$ -	\$ -	\$ 1,285,218	\$ -	\$ 115,608	\$ 3,444	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,945,736	\$ -	\$ 15,428	\$ 53,999	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1,876,308	\$ -	\$ -	\$ -
2030	\$ 1,057,677	\$ 19,833	\$ -	\$ -	\$ 767,207	\$ -	\$ 171,466	\$ -	\$ -	\$ -	\$ 99,172	\$ -	\$ -
2031	\$ 498,895	\$ 19,218	\$ -	\$ 357,885	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 121,792
2032	\$ 551,340	\$ -	\$ -	\$ 25,288	\$ -	\$ -	\$ 526,052	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 1,383,384	\$ 13,217	\$ 399,963	\$ -	\$ -	\$ -	\$ -	\$ 970,204	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 1,433,863	\$ 56,420	\$ -	\$ 986,965	\$ 179,091	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 211,388	\$ -	\$ -
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 3,861,037	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,861,037	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 3,645,566	\$ 1,508,672	\$ -	\$ -	\$ -	\$ 1,227,138	\$ 136,195	\$ 285,133	\$ -	\$ -	\$ -	\$ 488,428	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 16,625,877	\$ 1,624,841	\$ 415,392	\$ 1,737,978	\$ 2,254,175	\$ 1,681,038	\$ 949,321	\$ 1,258,781	\$ 3,907,263	\$ 1,876,308	\$ 310,560	\$ 488,428	\$ 121,792

Notes:

Explanation of large capital outlays in first two years:

- Retention System: Influent slide gate (ISG-2) received a score of 5 at the time of the Condition Assessment since the actuator was on the ground and not mounted to the gate.
- Pumping System: Flushing Water Pump (FWP-2; \$327,000) received a score of 5 since the unit was out of service at the time of the Condition Assessment. Dewatering Pump No. 4 (\$100,700) was not functional during electrical testing at the time of the assessment. The two immersible sump pumps (ISMP-1 and 2; \$13,100 each) have been removed from service for some time.

10. Leib CSO Control Facility

10.1 General Facility Description and Future Capacity Considerations

10.1.1 General Facility Description

The Leib CSO Facility is an SDF with 9.9 MG of storage, and a treatment capacity of 1,550 cfs. It was constructed in 2002. The facility has a nearly 1-mile long effluent conduit used for disinfection contact time before discharge into the Detroit River. The facility consists of a Headworks area in the basement, chemical room, utility support (electrical, emergency generator and mechanical rooms), control room, sample room, supply fan room and other miscellaneous rooms. The facility also includes an underground outfall vault.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

10.1.2 Future Capacity Considerations

The WWMP recommended projects to increase wet weather flows to existing CSO facilities to maximize the use of the facilities and minimize the construction of additional facilities. Many of the CSO facilities do not reach their design flows, so there is an ability to accept additional flows, without exceeding their design capacity.

The Meldrum Diversion Sewer to the Leib CSO Facility is one of the recommended projects from the WWMP that will increase flows to the existing Leib CSO facility. The magnitude of the increased flows and the potential impact on screening and disinfection performance is described below.

This project originated from the WWMP and involves diverting the Meldrum sewer to the Leib CSO facility by constructing 350 ft of 5-ft diameter diversion sewer along Waterloo just upstream of the Leib facility. See Figure 10-1 for the layout of this new diversion sewer. The Leib CSO facility was designed to treat 1,550 cfs and hydraulically pass 2,000 cfs. The design hydraulic grade line (HGL) conditions are between elevation 110.5 and 111.5 ft, with a peak hydraulic capacity of 2,000 cfs, and a Toward Treatment Sewer capacity limited to 150 cfs.

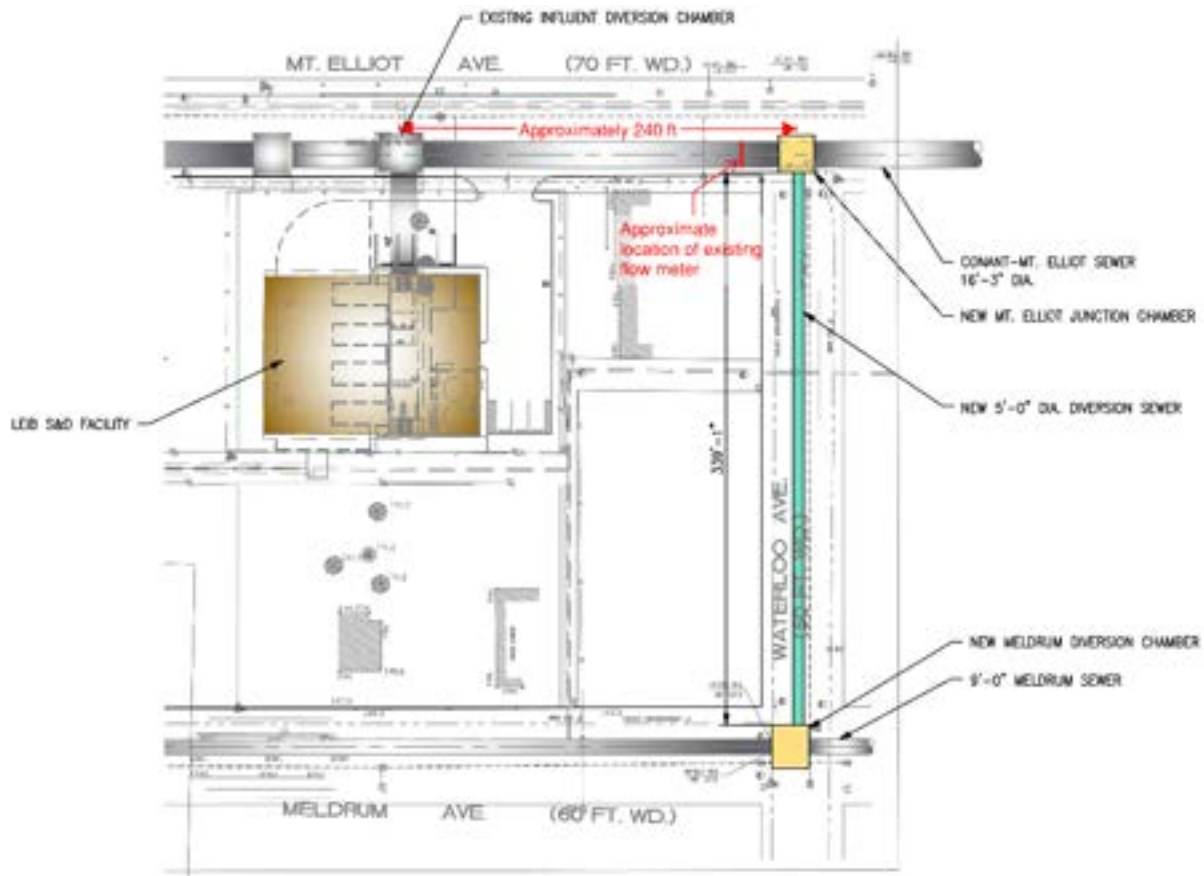


Figure 10-1. Layout of Proposed Meldrum Sewer Diversion near the Leib CSO Facility

The Regional Wastewater Collection System Model was used during the WWMP to predict the change in hydraulic grade line for the Leib facility for the 10-year 24-hour storm event. The WWMP reports that the 10-year 24-hour storm will add a peak flow of 427 cfs, and the HGL within the Leib CSO facility will stay within the critical elevation of El 589.72 (109.97 Detroit datum) at the crown of the Conant Mt. Elliot Sewer.

10.2 Facility Assessment

10.2.1 Screening

10.2.1.1 Description of Existing System

The Leib CSO Facility has two types of screens: 1) raked horizontal bar screen (original manufactured by COPA) and 2) raked vertical bar screens (manufactured by ROMAG). Constructed in 2002, the facility was intended to be a full-scale pilot facility for this type of fine screen. There are four screening channels in the facility, with a total of eight COPA screens and a total of four ROMAG screens.

During dry weather, raw sewage is routed through the facility and to the Toward Treatment Sewer. During wet weather events, the flow increases, and the flow enters the screening channels as the wet weather flow exceeds the capacity of the Toward Treatment Sewer.

Screenings are retained in the screening channels during the storm. After the storm event, the screenings are conveyed to the Toward Treatment Sewer and then the DRI for eventual removal at the WRRF.

The COPA screens recently received a complete overhaul in 2019. The existing ROMAG screens were also rebuilt in 2019; however, the control panels and power packs were not upgraded.

Table 10-1 provides an overview of the existing screening system at Leib CSO facility.

Table 10-1. Overview of Existing Screening System Leib CSO Facility

Parameter	Value	
Treatment Capacity (cfs)	1,550	
No. of Screens	4 (2 in each of 2 channels)	8 (4 in each of 2 channels)
Manufacturer	Westech ROMAG	COPA
Screen Type	Raked Vertical Bar Screen	Raked Horizontal Bar Screen
Opening Size	4-mm spacing	4-mm spacing
Depth or Length	29 ft 6 in	17 ft 0 in
Width	4 ft 0 in	4 ft 0 in
Screen Cleaning	Mechanical Comb	Mechanical Comb
Screening Removal	Conveyed to Toward Treatment Sewer and then to WRRF	

10.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issue was identified related to the screens:

- ROMAG screens are preferred over COPA for future screens: The screens at the facility are a combination of ROMAG vertical screens and COPA horizontal screens. Having dissimilar maintenance and operating characteristics presents a challenge for the GLWA O&M staff. In consideration that this facility was intended to be a "pilot" facility testing different technologies, it is reasonable to conclude, as it approaches 20-years in age, that some technologies should win out over others. In the case of the screens, the ROMAG screens present the simpler and easier O&M characteristics and therefore standardizing on these screens at this time, when major maintenance or rehabilitation is in the future for both screens, makes sense.
- The ROMAG screens offer a hydraulic benefit of allowing peak flows to overflow the top of the screen (this is not possible with the COPA screens). Although the portion that overflows does not receive screening, it does provide a hydraulic bypass for peak flows so that the screens are not overloaded or damaged. This is an important feature with the addition of the Meldrum Diversion Sewer in the near future.

10.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Screen Replacement (Project LEIB-SCR-1). The ROMAG screens present the simpler and easier O&M characteristics and therefore standardizing on these screens at this time makes sense. There are two alternatives with this option:

- Alternative 1: Replace Existing COPA Screens In-Kind.** This alternative would replace the existing eight COPA screens in-kind.

2) **Alternative 2: Replace Existing Screens with ROMAG Screens.** This project would replace the existing eight COPA screens with four ROMAG screens (Model RSW12x8/4) to make all the screens similar at the facility. The following modifications would be required for the replacement:

- **Structural Modifications:** A notch will need to be created in the channel concrete wall that the ROMAG screen will rest on, to match the existing ROMAG screen design.
- **Control Panel Upgrades:** The new ROMAG screens have new standard sequence of operations, updated electrical devices and controls. The controls for the existing ROMAG screens should be upgraded with these new items, as follows:
 - A touch screen operator interface to provide better functionality to adjust various setpoints.
 - New control functions including short stroke, blocked carriage, pressure settings in each direction, repeat cycle timer, park at home positioning, and level on and off settings.
 - The solenoid valve used on the carriage on the existing ROMAG screens should be replaced with an electrically actuated valve which changes the valve position according to the pressure setting that is seen by the cylinder. The new ROMAG screens will come with the electrically actuated valve used on the carriage.
 - The sequence of operation should be changed to eliminate the intermittent operation of the rake, which would maximize the cleaning frequency regardless of the liquid level once the screen is activated.
 - An ambient temperature thermostat should be installed and when the ambient temperature reaches less than 35°F, the control sequence to cycle the oil weekly would be disabled during periods of freezing temperatures. This will avoid a fault condition when the materials stuck to the screens freeze during winter months.

The alternative evaluation is presented in Table 10-2. The sources of costs used in this evaluation are listed below:

- Capital costs for Alternative 1 were obtained from the screen replacement costs of the SRP.
- Capital costs for Alternative 2 are presented in Volume 6 – Appendices, Appendix C under this project title.
- Although there are O&M benefits to having all the same screens (i.e., similar spare parts and needed familiarity with only one screen type), the difference in O&M costs for the COPA and ROMAG is difficult to monetize. As such, O&M costs are not included in this analysis. This issue, however, is reflected in the Ease of O&M scores.

This evaluation shows that Alternative 1 is the Best Value Alternative. Because of the large difference in capital costs between the two alternatives, **Alternative 1 - Replace Existing COPA Screens In-Kind is the recommended alternative.**

Table 10-2. Alternative Evaluation for Screen Replacement (Project LEIB-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace COPA Screens In Kind	Health and Safety	3	2.78	\$ 3,524,000	\$ -	\$ 3,524,000	\$ 1,266,108	Best Value Alternative
	<i>Definition:</i>	Replace In Kind	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Need to maintain two different types of screens.	Component Performance	3						
	<i>Comments:</i>	Note: This is only replacing the COPA screens with COPA screens. The existing ROMAG screens are not included.	O&M Ease	2						
2	<i>Alt. Name:</i>	Replace Existing COPA Screens with ROMAG Screens	Health and Safety	3	3.55	\$ 6,224,000	\$ -	\$ 6,224,000	\$ 1,753,239	
	<i>Definition:</i>	Replace Existing COPA Screens with ROMAG Screens	Water Quality & Compliance	3						
	<i>Adv.:</i>	ROMAG screens offer a hydraulic benefit of allowing peak flows to overflow the top of the screen. Also, all screens would be identical, making maintenance and spare parts more efficient	Capacity Enhancement	4						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	Note: This is only replacing the COPA screens. The existing ROMAG screens are not included.	O&M Ease	5						

10.2.2 Disinfection

10.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP tanks, six low-rate diaphragm pumps, two high-rate centrifugal pumps, four disinfectant rapid mix zones, and 18 induction mixers. There are two channels with four ROMAG screens and two channels with Copa screens discharging into a screened effluent channel. From there screened effluent flows to four disinfectant rapid mix zones. There are four induction mixers per disinfectant rapid mix zone consisting of one pair of mixers upstream and one pair of mixers downstream of a concrete baffle wall that directs all flow down and past the mixers. There are also two induction mixers in the influent channel upstream of screening referred to as prechlorination mixers. Four of the low-rate sodium hypochlorite pumps are each paired to a disinfectant rapid mix zone. Flow is metered from each pump and then flow is split in a manifold to the four induction mixers in each disinfectant rapid mix zone. The manifold includes a solenoid valve, manual valve, and a sight flow indicator to each induction mixer. Flow splitting between induction mixers is primarily dependent on equal back pressure valve settings to the induction mixers. The other two low-rate sodium hypochlorite pumps are each paired to one of the influent channel mixers. The two high-rate pumps discharge to a four-way manifold with flow metering on each branch. These tie into the discharge from the four low-rate pumps upstream of the manifold to each disinfectant rapid mix zone. There are also valved connections allowing the high-rate pumps to be used for the influent channel induction mixers.

The design which was intended to provide redundancy and flexibility is atypically complex and results in the manifolds including valves and sight flow indicators to be inaccessible due to their height on the wall. Table 10-3 provides an overview of the existing disinfection system at Leib CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G

Table 10-3. Overview of Existing Disinfection System at Leib CSO Facility

Parameter	Value
Treatment Capacity (cfs)	1,550
Design Feed Strength (% hypochlorite)	7.5
Max. Dosage at Design Flow (mg/L Cl ₂)	38
Disinfection Contact Time (min)	10
Storage Tanks	
Number	2
Volume of Each Tank (gal)	10,450
Type	FRP
Pumps	
Number	8 Total; 6 low-rate, 2 high-rate
Capacity (gpm)	Low-rate: 7.6, High-rate: 112
Type	Low-rate: Diaphragm, High-rate: Centrifugal
Mixers	
Number / Type	18 / Chemical induction mixers
Model Number / hp / Manufacturer	SWC15FX / 15 hp / Water Champ

10.2.2.2 Identified Needs and Issues

The needs and issues identified for Leib were identified from meetings with O&M staff and Jacobs team site visit and investigations. These needs and issues are listed in the following bullets :

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Leib chemical feed system has the following issues:
 - Pumps are expensive to maintain and replace
 - Complex piping with a high number of components
 - Inaccessible manifold components due to height on wall
 - The VFDs and electrical equipment are located in the corrosive environment of the chemical room
 - The chemical feed pump and motor are difficult to remove from the containment area
 - Currently, a hose must be moved and connected to each pump suction pipe to flush the hypochlorite solution from the feed system with NPW. A hard-piped flushing water connection is desired so that flushing could be accomplished by opening a valve to each pump.
 - The chemical room floor has been damaged due to a chemical leak from one of the storage tanks.

These issues are addressed in Replace Chemical Feed System (Project LEIB-DIS-1) below.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project LEIB-DIS-2) below.
- There are 18 chemical induction mixers that require relatively frequent and costly maintenance. This issue is addressed in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project LEIB-DIS-3).

10.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project LEIB-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, LEIB-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

Each of the alternatives above would include provisions to address the additional concerns specific to the Leib feed system:

- For cost estimating purposes, water piping and valving to each feed pump was assumed to allow water flushing for the entire chemical feed system from the feed pumps to the mixers.
- Move VFDs and electrical equipment out of the chemical room.
- For cost estimating purposes, a mast type jib crane (similar to the one described for Conner Creek) is assumed for moving the pumps and motors up and down the flight of stairs. The actual configuration should be included in the detailed design of a modified chemical feed system.

The alternative evaluation for these alternatives is presented in Table 10-4. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP and include pump replacement at Year 10.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 were estimated based on manufacturer pump rebuilds at a cost of \$20,000 per year and GLWA onsite rebuilds at a cost of \$24,000 per year.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 10-4 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 10-4. Alternative Evaluation for Replace Chemical Feed System (Project LEIB-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System In-Kind	Health and Safety	3	2.08	\$ 1,262,400	\$ 44,000	\$ 2,190,344	\$ 1,051,365	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 1,724,000	\$ 26,750	\$ 2,288,148	\$ 635,597	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 901,000	\$ 3,000	\$ 964,269	\$ 267,852	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project LEIB-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Operation in manual at Leib is noted by operations as being extremely difficult. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

The sample point should be located approximately 15 minutes travel time downstream of the dosing point at average flow but peak flow travel time and the future additional flow from Meldrum diversion must also be considered. The exact location would be determined during design. The original design included a sample pump about 50 ft from the mixing chamber. The appropriateness of this location should be evaluated during design. However, the operability of this pump is not known because it is not currently used for sampling. Given the uncertainties regarding whether this sample point and the condition of the sample pump, the cost for a new manhole to access a sampling pump in the effluent conduit was included. A buried pipe was assumed in the cost estimate to convey the sample flow into the existing building where the TRC analyzer would be located.

The automatic chemical feed system will require less operator input during an event. However, there will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 10-5. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains functional between storm events.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 10-5. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project LEIB-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less efficient chemical feed and possible overdosing of chemical.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 220,000	\$ 4,860	\$ 322,496	\$ 93,477	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more efficient use of chemical.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult with infrequent CSO facility use.	Component Performance	4						
	<i>Comments:</i>	O&M to maintain analyzers based on 4 hrs/month.	O&M Ease	2						

Reduce Cost Associated with Large Quantity of Chemical Induction Mixer (Project CON-LEIB-3). Plant personnel report that the mixers are expensive to maintain and due to the sealed nature of submersible mixers they must be sent back to the manufacturer for maintenance which adds shipping cost and takes months before the mixer is returned to service. The Leib facility has 16 chemical induction mixers in the mixing channels (and 2 pre-chlorination mixers, which would remain). A reduction in the number of mixers would reduce maintenance and the associated expense proportionate to the reduction. It would also reduce the complexity for equal flow splitting between mixers.

The alternatives to address this issue were identified previously in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Section 5.2.4); however, due to facility constraints, vertical shaft mixers would not be feasible at this location, so that option is not included. The alternatives include:

- 1) **Alternative 1. Replace Existing Chemical Induction Mixers In-Kind.** This alternative assumes replacement of the mixers in-kind.
- 2) **Alternative 2. Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers.** Computation fluid dynamic (CFD) modeling is assumed to be required to demonstrate to EGLE the adequacy of a lesser number of mixers. For illustration purposes, it is assumed that the number of mixers can be reduced by half (i.e., from four to two per channel). This needs to be confirmed by collection system modeling performed by others. Capital and O&M costs per mixer are identical to Alternative 1.

The alternative evaluation is presented in Table 10-6. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternatives 1 and 2 includes mixer replacement in-kind at the number of mixers shown. Capital costs are based on the SRP replacement cost of \$50,000 per mixer and a 10-year life. Because the life-cycle period is 20 years, the capital costs assume replacement of the mixers twice during the 20-year period.
- For Alternative 2, the cost of the CFD model is assumed to be \$50,000.
- The O&M costs for mixer replacement in Alternatives 1 and 2 is based on current costs for repairing a chemical induction mixer. It is assumed the mixer needs to be repaired every 2.5 years at a cost of \$15,500 per mixer.

This evaluation shows that Alternative 2 – Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers is the Best Value Alternative. As such, **Alternative 2 – Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers is the recommended alternative.**

It should be noted that the cost of the reduced number of mixers is not a new capital improvement cost for GLWA. Rather, it was used in this evaluation to compare alternatives. The cost for the CFD modeling would likely be included in a capital outlay, not a capital improvement project. If the CFD modeling does not prove that disinfection performance can be achieved, the number of mixers would remain the same as the current number.

Table 10-6. Alternative Evaluation for Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project LEIB-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace Existing Mixers in-kind	Health and Safety	3	2.57	\$ 1,600,000	\$ 84,800	\$ 3,388,401	\$ 1,320,156	
	<i>Definition:</i>	Replace existing mixers as required.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, lots of redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Expensive and impacts operations and maintenance. Equipment installed in basins.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	Health and Safety	3	3.00	\$ 850,000	\$ 42,400	\$ 1,744,200	\$ 581,400	Best Value Alternative
	<i>Definition:</i>	Perform computational fluid dynamics (CFD) model of basin and determine required number	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, maintains required redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less expensive and less impacts to operations and maintenance. Equipment installed in	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

10.2.3 Odor Control

There is no odor control system at the Leib facility. Building space for a carbon adsorber system, space in the electrical room for the fan motor, and a duct penetration to the screening facility below grade were provided, if odor control is needed in the future. However, odor complaints have not been received for this facility since it has been in operation. Therefore, an odor control system is not needed and, therefore, there are no associated "needs."

10.2.4 Flushing and Dewatering

10.2.4.1 Description of Existing System

The Leib CSO Facility does not have a dedicated dewatering or flushing system for the screening and disinfection area. The facility drains by gravity and, due to the limited use, solids accumulation has not been a major issue at this facility, with the exception of the screening channels, which are discussed in the next section.

The outfall conduit has dewatering pumps to dewater the lower portion of the effluent conduit. These pumps are located near the Outfall Sample Building. The dewatered flow is pumped to the DRI.

Table 10-7 provides an overview of the existing flushing and dewatering system at Leib CSO facility.

Table 10-7. Overview of Existing Flushing and Dewatering System at Leib CSO Facility

Parameter	Value
Headworks Dewatering and Flushing System	Headworks (basin) area is dewatered by gravity to the Toward Treatment sewer or disinfection conduit.
Effluent Conduit Dimensions	16-ft-dia. effluent sewer to Junction Chamber, two 11-ft-dia. pipes to dewatering gate, two 10 ft × 10.5 ft box conduits to Detroit River
Effluent Conduit Dewatering and Flushing System	- Two 1,500 gpm dewatering pumps located near Effluent Sample Building are used to dewater lower end of effluent conduit. Flow is pumped to the DRI - There is no flushing system in the effluent conduit.

10.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Flushing the screening channels after every storm event is difficult and time-consuming.
- The existing four screening channels cannot be isolated from the influent flow during rehabilitation or extensive maintenance activities. Jacobs reviewed options to install stop logs or sluice gates at the influent end of each channel. Although there is space for new slots to be constructed for either a new gate or stops logs, the lack of isolation of each screen channel from another channel downstream of the proposed gate would not provide the desired isolation. As such, there does not appear to be a feasible way to isolate channels. The current practice of installing scaffolding in the screen channels appears to be the best alternative.

10.2.4.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Screening Chamber Flushing (Project LEIB-FD-1). The screening channels must be manually sprayed down after every event. Flushing from the surface is somewhat difficult and time-consuming. There are two alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing.** Continue manual flushing.
- 2) **Alternative 2: Screening Chamber Flushing System.** A new flushing system piped from the existing NPW line, extending down to the screen channel floors and drilled with holes through the HDPE pipe is recommended to address this issue. Figure LEIB-FD-1-ALT-2, included in Volume 6 – Appendices, Appendix B, show the conceptual layout of this improvement.

The alternative evaluation for these alternatives is presented in Table 10-8. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 includes GLWA labor cost. It is based on 2 hours per event and 25 events per year, at \$100 per hour rate.
- It is assumed that the cost of water is similar between the two alternatives, so it is not included in this evaluation.

This evaluation shows that Alternative 2 – Screening Chamber Flushing System, is the Best Value Alternative. **As such, Alternative 2- Screening Chamber Flushing System is the recommended alternative.**

Table 10-8. Alternative Evaluation for Screening Chamber Flushing (Project LEIB-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.57	\$ -	\$ 5,000	\$ 90,228	\$ 35,154	
	<i>Definition:</i>	Do Nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Flushing from the surface is somewhat difficult and time-consuming	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Screening Chamber Flushing System	Health and Safety	3	3.43	\$ 16,000	\$ -	\$ 16,000	\$ 4,660	Best Value Alternative
	<i>Definition:</i>	A new flushing system piped from the existing NPW line, extending down to the screen channel floors and drilled with holes through the HDPE pipe	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less time to clean channel	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

10.2.5 HVAC

10.2.5.1 Description of Existing System

The Leib CSO facility consists of a Headworks area in the basement, chemical room, utility support (electrical, emergency generator and mechanical rooms), control room, sample room, supply fan room and other miscellaneous rooms. The facility also includes an underground influent channel. Table 10-9 provides summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, and emergency eyewash shower. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 10.2.10.

Table 10-9. Major HVAC Equipment at Leib CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks (Screening Chamber)	SF-1	Supply Fan	59,000 CFM
Chemical Room	HV-2	AHU	2,700 CFM 300 MBH
	EF-2	Exhaust Fan	3,010 CFM
Electrical Room	HV-1	AHU	2,700 CFM 300 MBH
	EF-3	Exhaust Fan	4,650 CFM

Table 10-10 provides a summary of the basis of design performance criteria for HVAC systems at Leib and Table 10-11 provides the outdoor Basis of Design conditions.

Table 10-10. Leib Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (°F)	Summer (°F)	
Headworks	Class I, Group D, Div 1	N/A	N/A	12 ACH (Occupied)
Mechanical Spaces	Unclassified	60	96	Heat Relief
Office, Sampling Room, and Toilet Rooms	Unclassified	70	78 F Dry Bulb, 50% Relative Humidity	15 cfm per occupant

Table 10-11. Leib Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb °F)	Summer (Dry Bulb °F)	Summer (Wet Bulb °F)
3	91	73

10.2.5.2 Identified Needs and Issues

During the CS-299 Needs Assessment meetings with GLWA O&M staff, the following HVAC issues were noted:

- Odor issue in Basin and Garage area. The louvered penthouses next to the stairwells had been seized closed and the supply air to the Headworks Area was not able to be relieved through the penthouses. This may have caused odorous air to be pushed out of the large blind flange for a potential future odor control system. It was noted after the meeting that the on-going CIP project HVAC Improvements, CIP 260611, GLWA Contract No. 1803718 will be restoring the louvers in the penthouses and installing new gasketing for the blind flange in the garage area. This should reduce odors in the garage.
- Access to SF-1 for maintenance and repair is difficult: There is very little clearance to service belts and bearings in the supply fan room.
- The Headworks is not provided with any heat: O&M staff noted that water has to be turned off after about November to prevent pipes from freezing and that humidity in the air can cause major condensation in the Headworks.
- Jacobs further evaluated this issue. The Headworks area was not originally designed to be a conditioned space. Adding heating/dehumidifying to prevent frozen pipes and condensation would be prohibitively expensive. Insulating and heat tracing pipes to prevent freezing was considered; however, heat tracing can fail without warning and then pipes could still freeze. Keeping a small flow of water through the pipes during the extreme winter cold periods could be explored. No capital costs have been applied to this issue.
- Improved cooling is needed in the control room. Jacobs further investigated this issue. GLWA's HVAC contractor noted that there have been major control issues at the facility in the past and control installations are taking place presently which should help improve operator comfort. It is recommended that the impact of the control changes on operator comfort be assessed after they are completed, and recommendations can be made for proposed changes if conditions do not improve. It should also be noted that the cooling equipment serving the office, sampling room, and toilet rooms was sized to provide a summer indoor temperature of 78°F. Because an operator routinely occupies the control room, consideration should be given to sizing the next AC unit for 72°F. No capital costs have been applied to this issue. The AC unit will be replaced.

During the discussions with GLWA's HVAC contractor the following historical issues were noted:

- Dampers on HV-1 and HV-2 mixing boxes are not completely functional: GLWA's HVAC contractor noted although the actuators on the dampers are being replaced as part of an on-going project, the dampers may be in poor shape. Currently, they manually actuate the dampers.

During site investigations (June 2020) the following observations were noted:

- A roof has been constructed over both Entrance Courtyards: The as-built drawings show that these areas had no roof when they were originally constructed. Roofs have since been constructed over these areas with screens to keep out birds and insects. See discussion and photos below for further details.
- The on-going HVAC-related upgrade project (CIP No. 260611) will be upgrade the HVAC control system with DDC, replace dampers and actuators in the penthouse and within the indoor HVAC system, and replace the actuator and damper for the supply air to the basement.

10.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

HVAC Improvements (Project LEIB-HVAC-1). Due to the relatively small nature of some of the HVAC related projects identified as improvements, all of the identified HVAC improvements are proposed to be in one project – HVAC Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: HVAC Improvements** including,
 - Entrance courtyard modifications
 - Improved access to SF-1 for maintenance

Each of the HVAC related improvements listed above is described further below:

Entrance courtyard modifications. Another potential source of odors and a code compliance issue are the stairwells which are currently connected to the interior unclassified areas of the facility via the Entrance Courtyards on the East and West sides of the facility (Figure 10-2). The as-built drawings (Figure 10-3) show these areas as having no roof. This design does not constitute an enclosed space under NFPA 820 because it is open to the atmosphere. The building has been modified since construction to include a roof over both Entrance Courtyards and has been enclosed with bird screen between the existing wall and newly constructed roof.



Figure 10-2. Existing West (left) and East (right) Entrance Courtyard



Figure 10-3. As-Built Entrance Courtyard Design – Section through Building

NFPA 820 defines a space with a roof as “Not Enclosed” if 50 percent of its wall area is open to the atmosphere. This is clearly no longer the case with either of the Entrance Courtyards (Figure 10-4).

Due to their connection to the Headworks Area, the stairwells are technically Class I, Division 1 spaces per NFPA 820. The fact that they are connected to other areas of the facility via man doors, through the now enclosed Entrance Courtyards, effectively classifies the rest of the facility as Class I, Division 1. Although the Entrance Courtyards have combustible gas detection and some relief to the atmosphere, current versions of NPA 820 make it clear that such connections between unclassified and classified areas are only allowed via a pressurized airlock, with combustible gas detection monitoring and alarm, positive pressurization monitoring and alarm, and alarm if the airlock door is open for more than 20 seconds. This is not a feasible solution for the West Entrance Courtyard due to the intake for the Emergency Generator room in this area, but may be feasible for the East Entrance.

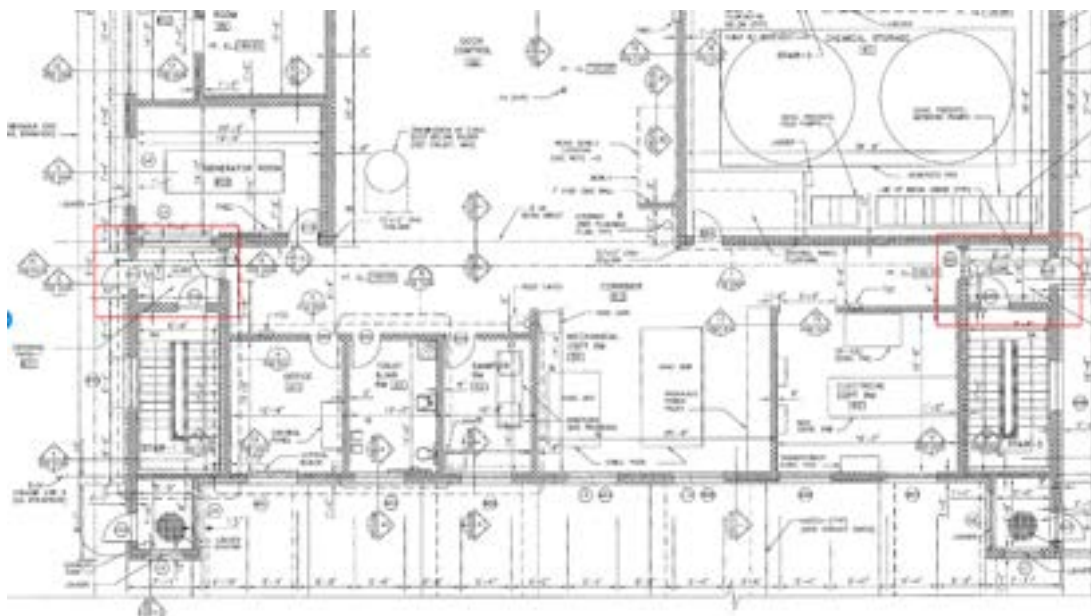


Figure 10-4. Entrance Courtyards – Plan view

To comply with NFPA 820 and ensure that hazardous gasses cannot enter the facility through the Entrance Courtyards in the future, Entrance Courtyard roofs should be removed.

Improved access to SF-1 for maintenance. SF-1 supplies ventilation air to the Headworks area and therefore the supply fan room is also a Class I, Division 1 area. Creating openings in either the generator room or garage area to improve access were considered; however, these would violate the physical separation between the classified supply fan room and unclassified generator room and garage area. One option would be to demolish the east wall of the supply fan room and move it further east with man door access added in the north wall, if necessary. See Figure 10-5 below.

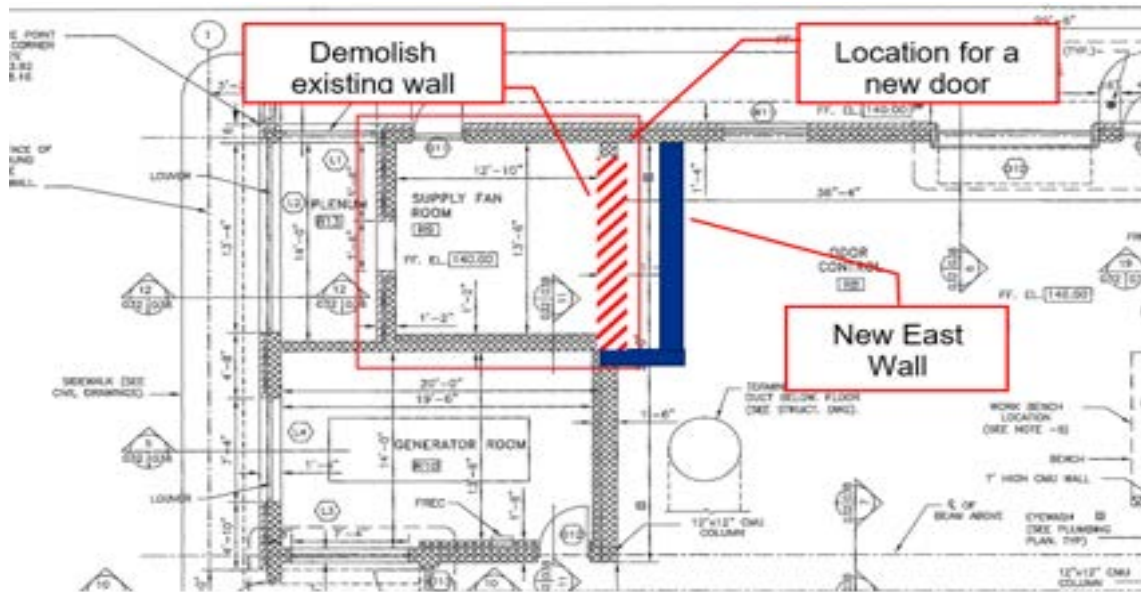


Figure 10-5. Supply Fan Room – Plan view

The alternative evaluation is presented in Table 10-12. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- Although the access to maintain SF-1 would be improved by moving the wall, it is difficult to monetize this benefit. As such, there is no measurable difference in O&M costs between the two alternatives.

Alternative 2 is recommended based on the need for code compliance. This project should be conducted when a major upgrade is performed at the facility.

Table 10-12. Alternative Evaluation for HVAC Improvements (Project LEIB-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Does not meet current code and very difficult access to SF-1 for maintenance	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	4	3.72	\$ 126,000	\$ -	\$ 126,000	\$ 33,901	Not Applicable
	<i>Definition:</i>	Improved access to SF-1 and address code issues.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved access for maintenance and improved safety.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

10.2.6 Electrical

10.2.6.1 Description of Existing System

The Leib facility's electrical system consists of one DTE utility feed from a 480 V, 3-phase outdoor transformer (secondary metering) and one diesel generator feed from a 350 kW, 480 V, 3-phase stationary generator. The utility feed is connected to a 600 A motor control center (MCC-B) with a 600 A sub-feed connection to a 600 A ATS. The ATS then feeds a distribution panel with two 600 A breakers, which feeds two MCCs (MCC-A and MCC-C). The MCCs feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 10-13 provides a summary of the major electrical equipment for this facility.

Table 10-13. Major Electrical Equipment at Leib

Location	Major Electrical Equipment	Description
Generator Room	Generator (Diesel)	350 kW, 480/277 V, 3-Phase
Electrical Room	MCC-A	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-B	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-C	600 A, 480/277 V, 3-Phase

10.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The operators need to call an electrician to reset the mixer units, which is time consuming.

10.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project LEIB-ELEC-1). The operators need to call an electrician to reset the mixer units, which is time consuming. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Continue calling the electrician to reset the mixer units.
- 2) **Alternative 2: Electrical Improvements.** Add Reset Buttons to the outside of the MCC buckets for each chemical induction mixer motor. See Figure LEIB-ELEC-1-ALT-2 in Volume 6 – Appendices, Appendix C for location. The reset buttons will enable Operations to reset the mixers themselves when a trip occurs instead of contacting electricians to reset the mixer unit.

The alternative evaluation is presented in Table 10-14. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved O&M. The NPV/Benefit cost for Alternative 2 is only \$6,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 10-14. Alternative Evaluation for Electrical Improvements (Project LEIB-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	The operators need to call electricians to reset the mixer units, which usually takes a long time.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	3	3.43	\$ 19,000	\$ -	\$ 19,000	\$ 5,534	Not Applicable
	<i>Definition:</i>	Add reset buttons to the outside of the MCC buckets for each chemical induction mixer motor	Water Quality & Compliance	3						
	<i>Adv.:</i>	The operators do not need to call electricians to reset the mixer units	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

10.2.7 I&C

10.2.7.1 Description of Existing System

Control System: The original control system was installed in 2002 under PC-732. In 2004 the system was upgraded and interfaced into GLWA's overall SCADA Ovation control system. This upgrade provided the ability to remotely monitor the operations of the facility and the local collection system at SCC.

The existing control system contains an Allen Bradley-based PLC system consisting of an Allen-Bradley redundant PLC-5 with local I/O controls that are installed in the facility's local control system panel. The operator workstation software has a Rockwell RSVIEW operating platform and is located in the control room. The existing hardwired local back-up control panel and other miscellaneous subsystems that are incorporated into the overall control system are outdated and need replacement. The control system network and switches are obsolete and do not meet GLWA SCADA Governance standards on redundant networks and switches, and that all CSO facilities use Ovation workstations with new high-performance graphics. The current system is equipped with a back-up radio system to communicate critical monitoring points back to GLWA System Control on wide area network failure.

Flow and Level Sensors: Table 10-15 summarizes the level sensors and flow meters at the Leib CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 10-15. Summary of Flow Meters and Level Sensors at Leib CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent Sewer (Larger Sewer)	1	Transit-Time (AccuSonic)
Influent Sewer (Smaller Sewer)	1	Transit-Time (AccuSonic)
Towards Treatment Sewer	1	Transit-Time (AccuSonic)
Outfall	1	Transit-Time (AccuSonic)
CSO Facility Level Sensors		
Influent (Sewer and channel)	2	Ultrasonic
Mixing Chamber	1	Ultrasonic
Dewatering (Pumping station and control gate)	2	Ultrasonic
Effluent (Outfall, Towards Treatment Sewer)	2	Ultrasonic
DRI Discharge Regulator Chamber	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed Pumps	8	Magnetic

10.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Install an Outfall OIT

- Evaluate repair or replacement of the DRI level sensor
- Need for remote control of the regulator gates
- Ensure influent flow meter is properly positioned with new Meldrum connection
- Need for process cameras at select locations
- Evaluate influent flow meter will be properly positioned with new Meldrum connection. Based on GLWA's WWMP, a new diversion sewer is proposed to connect the Meldrum Sewer to the Conant-Mt. Elliot Sewer, which will divert flow from Meldrum to the Leib CSO Facility during wet weather events. GLWA staff expressed concern that the proposed location of the new junction chamber may impact the accuracy of the existing multi-path flow meter. The approximate location of the existing flow meter, as well as the proposed location of the new diversion sewer was shown previously in Figure 10-1.

The existing meter will likely be in a zone of higher turbulence near the new sewer connection, which will result in less accurate flow measurement. It is recommended that the flow meter be about 10 pipe diameters, or 160 ft, from the proposed junction chamber to ensure that the meter functions reliably. The proposed junction chamber is approximately 240 ft upstream of the existing influent diversion chamber to the CSO facility. As such, there is sufficient pipe length to relocate the meter downstream. In discussions with GLWA, Jacobs recognizes that the flow meter will be replaced in the near future. It would be most efficient to relocate the meter to a point that would account for the future diversion flow. Because a new influent flow meter is going to be installed at this location, costs are not provided in this report for relocation to address this issue.

- Need to replace the regulator gate limit switches. Replacement of the switches will likely require dewatering and flow diversion in the regulator structure, which could be a significant effort and cost. As such, this work should be considered for combination with other upcoming work at or near this location.
- The control system should be upgraded. GLWA is currently developing an FP) for qualified design-build contractors to provide professional engineering and construction services for control system improvements at the Seven Mile CSO Facility under "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities." The project will replace the existing PLC-5 control system and back-up local control panels with a new control system, provide new Ovation workstations with high-performance graphics, and replace some of the field instruments. This is an on-going project that has already been included in the CIP.
- The screen graphics are very difficult to understand and should be updated to match other facilities. This improvement is included in the Control System Improvements project described in the previous bullet.
- Evaluate regulator gate limit switches. Remote control of the regulator gates is included under the "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" project. No further improvements are recommended.

10.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project LEIB-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation Control System Upgrade and the Automatic Transfer Switch and Generator Controls Upgrade, are

proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: I&C Improvements** including,

- Install an Outfall Operator Interface Terminal (OIT)
- Evaluate DRI level sensor
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Install an Outfall Operator Interface Terminal (OIT). In order to assist operations during CSO events, Operators requested an OIT at the Outfall. The OIT should be consistent with other OIT panels being installed throughout other CSO Facilities under the I&C Systems Project.

Evaluate DRI level sensor. It is recommended to replace the DRI level sensor.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 10-16. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the remaining improvements in Alternative 2 are difficult to quantify and would not affect the alternative evaluation. Similarly, it is difficult to quantify the monetary benefits of the improved operations through the improved monitoring and control.

This evaluation shows that Alternative 2 – I&C Improvements has a total benefit score about 0.9 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and O&M. The NPV/Benefit cost for Alternative 2 is \$49,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – I&C Improvements is the recommended alternative.**

Table 10-16. Alternative Evaluation for I&C Improvements (Project LEIB-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.53	\$ 109,000	\$ 3,000	\$ 172,269	\$ 48,755	Not Applicable
	<i>Definition:</i>	Install higher performance I&C instruments including Outfall OIT, level sensor, regulator gate limit switches, and process cameras. Project may be able to be split into multiple delivery projects if needed.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	5						

Control System Upgrade. The following control system improvements are recommended:

- Update Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2.

GLWA is currently developing an RFP for qualified design-build contractors to provide professional engineering and construction services for control system improvements at the Leib CSO Facility under *"Control System Improvements – St. Aubin, Leib and Seven Mile CSO Facilities"*. The project will replace the existing PLC-5 control system and back-up local control panels with a new control system, provide new Ovation workstations with high-performance graphics, and replace most of the field instruments.

The alternative evaluation table is not provided because this is an on-going project that has already been included in the CIP.

10.2.8 Site

10.2.8.1 Description of Existing Site

The Leib CSO facility was built in 2002. The site includes a 6-ft high security fence along the perimeter of the site. A sliding cantilever entrance gate is provided at the Mt. Elliott entrance. The parking lot consists of 8-in thick reinforced pavement with 8-in. crushed limestone base. There is a 5-ft wide, 4-in. thick sidewalk along the building entrances and 10-in. aggregate site pavement along the perimeter of the facility. Site utilities include potable water, natural gas, electrical, telephone services, stormwater, and sanitary sewer connections.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

10.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the section below.

- There are safety concerns for those accessing the Leib CSO facility through the sliding cantilever entrance gate off of Mt. Elliot St.
- Need for additional space to store outside summer/winter site maintenance equipment. Jacobs evaluated this issue. All the equipment required for outside summer/winter site maintenance is stored inside the Leib facility in the space originally planned for the odor control room outside the control room. GLWA has requested additional space to store this extraneous equipment outside of the building. There is limited space for a permanent structure on the site without locating it over the treatment basin or influent/effluent conduits. One available location is at the south side of the property where there is an approximately 15-ft wide strip inside the fence line. The available area will depend on the required size of the storage building. While there is limited space on the current facility site to construct a permanent storage structure, it may be possible to locate a new storage building if

property is acquired for the new access drive entrance and the security fence and new gate alignment can be realigned to accommodate a secure area for a new storage building.

- Based on our understanding of the equipment to be stored, it appears that a small commercial secure garden shed style structure would be adequate; however, a more secure option would be to continue to utilize the existing space inside the Leib facility and plan for a storage facility outside as a new larger space may become available. As such, no capital costs have been provided for this issue.
- The Leib facility influent and effluent diversion junction chambers are located in Mt Elliott St. outside the facility boundary extending across two lanes of north bound traffic (approximately 20 ft in width). The diversion chambers were constructed on piles. The concrete junction chambers extend to the surface in Mt. Elliott St. Settlement of the asphalt-surfaced road has occurred around these structures. The settlement issue is more pronounced at the effluent diversion structure. We recommend that the roadway around the structures be reconstructed with a modified engineered fill that can help stabilize the roadway surface around the structures. As Mt. Elliott is a city-owned road, road reconstruction should be performed by the City of Detroit. However, a line item is included in the New Access from Meldrum Street project to address this issue.

GLWA is currently addressing some of the site needs at the facility. These on-going projects are described below and are not included in the capital improvement projects for CS-299:

- There are significant water infiltration issues at the Leib Outfall Sampling Vault near the Detroit River. The Sampling Vault shares a common wall with the east barrel of the outfall. A number of conduits carrying power and control wiring and cables penetrate the common wall near the base of the vault that corresponds with the elevation of the base of the outfall. The existing conduits service dewatering and sampling pumps, level sensors, proximity switches on backwater gates and a multi-path transit time flowmeter located upstream of the Sampling Vault. When wet weather events occur, infiltration into the conduits flows back into the Sampling Vault, flooding the base of a floor mounted control panel.

To prevent the backflow of treated water into the Sampling Vault, it is recommended to realign the penetrations of the existing conduits to an elevation above the waterline in the outfall conduits. The existing conduit penetration should be demolished, removed and the openings grouted shut. There are six 1.25- in. conduit penetrations and two 2-in. conduit penetrations that would have to be relocated. This is an on-going project and will be completed through a JOC.

- The following issues were addressed under GLWA-CON-1902040 "Site Improvements at P-F Detention Facility and Leib Screening and Disinfection Facility" Contract.
 - Address Facility Drainage. The surface of grade over the treatment facility is very flat and as a result water ponded on it.
 - Repair Concrete Sidewalk. The 4-ft wide access sidewalk around the perimeter of the Leib CSO facility has been impacted by settlement issues that have caused the sidewalk to pull away from the building and crack.
 - Caulk joints at expansion joint between base of wall/sidewall – all sides of building.
 - Seal all control joints and cracks in the concrete parking lot pavement.
 - Repair collapsing catch basin.

10.2.8.3 Description and Evaluation of Alternatives

A project to address the need identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

New Site Access from Meldrum Street (Project LEIB-SITE-1). The existing site access through the sliding cantilever entrance gate off of Mt. Elliott St. creates safety concerns for those accessing the Leib CSO facility site. The existing site fence line and security gate on the west side of the facility is located immediately behind the street sidewalk. As a consequence, there is not enough space for vehicles to completely pull forward onto the drive approach to the site without the vehicle remaining partially in the lane of traffic on Mt. Elliott. As a result, some drivers exit their vehicles while in traffic to swipe security access cards to open the gate. Furthermore, some drivers park their vehicle in the turn lane and cross the traffic to open the gate. This poses a slip and fall safety concern, especially in the winter in inclement weather. Several alternatives have been investigated to address this issue, including realigning the fence and gate location off Mt. Elliott so that vehicles can pull fully out of the traffic lane to access the card reader and wait for the gate to open. This alternative, however, does not appear to be practical due to the significant encroachment on the existing parking lot necessary to create space for cars and trucks to pull off Mt. Elliott Street. In addition, realigning the gate would not allow proper maneuverability for vehicles in the parking lot.

There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: New Site Access from Meldrum Street.** This alternative includes relocating the site entrance to the east side of the site off Meldrum Street. See Figure LEIB-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, for the conceptual layout. There are several parcels of vacant property immediately adjacent to the east side of the Leib facility. Three of these parcels align with the existing Leib parking lot on the north side of the facility. An access road could be constructed off Meldrum to allow an alternative entrance to the Leib facility. This alternative would include construction of a new 24-ft wide access driveway. The length of the drive would be approximately 175-ft off Meldrum. The facility's existing east fence line would be modified to accommodate a new sliding cantilever gate and access card reader. The Detroit GIS parcel database indicates the vacant properties on the east side of the site are owned by the Detroit Water and Sewerage Department.

This alternative includes the paving of Mt. Elliot in front of the Leib facility.

The alternative evaluation is presented in Table 10-17. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.15 higher than the Do Nothing Alternative (Alternative 1) based on the improved safety and component performance. The NPV/Benefit cost for Alternative 2 is \$65,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 - New Site Access from Meldrum Street, is the recommended alternative.**

Table 10-17. Alternative Evaluation for Site Access (Project LEIB-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	1	2.23	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Safety concerns remain	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	New Site Access from Meldrum Street	Health and Safety	4	3.38	\$ 220,000	\$ -	\$ 220,000	\$ 65,025	Not Applicable
	<i>Definition:</i>	Relocate the site entrance to the east side of the site off Meldrum St.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Increased safety for personnel accessing the facility.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

10.2.9 Architectural

10.2.9.1 Description of Existing Facilities

The Leib CSO facility consists of chemical room, utility support (electrical, emergency generator and mechanical), control room, odor control room, screen room, sampler room and other miscellaneous rooms. The facility also includes an underground influent channel.

10.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment, as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff indicated the leak from the chemical storage tank damaged the floor coating in the chemical room. The recoating of the floor is included in LEIB-DIS-1 project.

10.2.9.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (LEIB-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

1) Alternative 1: Do Nothing.

2) Alternative 2: Architectural Rehabilitation. Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:

- Remove and replace sealant around doors, windows and other wall penetrations
- Remove and replace sealant at all control/ expansion wall joints
- Remove and replace isolation/ cove joint sealant and around building perimeter
- Clean and coat bottom of all door frames
- Clean corrosion and coat underside of roof deck

- Clean and coat localized areas of roof beams and framing members
- Remove debonding roof deck paint, clean and replace with new paint
- Replace cracked limestone windowsill and caulk on the southeast side of the building

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings (Figure LEIB-ARCH-1-ALT-2) in Volume 6 – Appendices, Appendix B. Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project. It should be noted that recoating of the floor in the Chemical Room was originally included in the architectural items, but moved to the Chemical Feed project (LEIB-DIS-1).

The alternative evaluation is presented in Table 10-18. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, Alternative 2 is the recommended alternative.

Table 10-18. Alternative Evaluation for Architectural Rehabilitation (Project LEIB-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 246,000	\$ -	\$ 246,000	\$ 79,355	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

10.2.10 Safety

10.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

10.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 10-19. The capital improvement project to address these issues is included in the table.

During the Needs Assessment meeting for Disinfection, O&M staff noted the tanks lack fall protection to allow safe access to appurtenances and valves above the tank. Fall protection is desired for safety.

It is recommended that either the handrail style fall protection, similar to Belle Isle and Oakwood, or the solid style fall protection similar to Hubbell-Southfield be added to the top of the two hypochlorite tanks. This will require a technician skilled in working with FRP to bond the fall protection to the tank. FRP tank manufacturers offering field repair services would be able to do this work.

Table 10-19. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Garage	No exit sign	Add exit sign	Exit Sign Improvements ^a
Chemical Room	No guardrails on tanks	Add guardrails	Safety Improvements (Project LEIB-SAFE-1)
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project LEIB-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

10.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project LEIB-SAFE-1). This project should address the safety issues identified above. These issues include:

- Extend guardrails on tanks in the chemical room to eliminate fall hazard
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 10-20 shows the one alternative.

Table 10-20. Alternative Evaluation for Safety Improvements (Project LEIB-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 211,000	\$ -	\$ 211,000	\$ 70,333	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

10.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at Leib CSO Facility.

10.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Leib CSO facility, Table 10-21 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 10-21, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 10-21. Listing of Asset Condition Assessments for Leib Facility

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	9	9	0	100%
AHU	1	0	1	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	3	3	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	1	0	1	100%
BUILDING	4	4	0	100%
CAMERA	1	1	0	100%
COMPRESSOR	0	0	0	N/A
COND-AIR	1	1	0	100%
CONVEYOR	0	0	0	N/A
CRANE	0	0	0	N/A
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
DAMPER	14	14	0	100%
DISCONNECT	0	0	0	N/A
DOOR	1	1	0	100%
DRIVE-ELEC	8	8	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	4	4	0	100%
FAN	0	0	0	N/A
FANVENT	5	4	1	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	1	0	0	0% ^a
GASDETECTO	1	0	0	0% ^b
GASMONITOR	2	2	0	100%
GATE	12	12	0	100%
GEARBOX	0	0	0	N/A
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	12	12	0	100%
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	2	2	0	100%
MCC	3	0	3	100%
METER	13	13	0	100%
MIXER	18	18	0	100%
MOTOR	1	0	1	100%
PANEL	4	4	0	100%
PIPING	4	4	0	100%
PUMP	13	10	2	92% ^c
ROOF	2	2	0	100%
SAMPLER	1	1	0	100%
SCADA	2	2	0	100%
SCREEN	12	0	12	100%
SCRUBBER	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
SENSOR	22	22	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	3	0	3	100%
UNITHEATER	0	0	0	N/A
UPS	3	3	0	100%
VALVE	4	4	0	100%
WATERHTR	1	1	0	100%
^a The fire suppression was evaluated Simplex Grinnell in 2018 and not included in the ACES report. ^b The gas detector is a portable unit and was not assessed. ^c The one pump not evaluated was a sample pump originally in the in the disinfection channel, which is no longer used.				

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Leib Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

10.3 Capital Planning for Leib CSO Facility

10.3.1 Summary of Capital Improvement Plan Projects

Table 10-22 provides a summary of the recommended CIP projects and associated capital costs for the Leib CSO facility based on the alternative evaluations conducted for this facility .

Table 10-22. Summary of Recommended Projects at Leib CSO Facility

Project No.	Alternative	Description	Total Project Cost
LEIB-DIS-1	3	Chemical Feed utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 901,000
LEIB-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
LEIB-DIS-3	2	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000
LEIB-FD-1	2	Screening Chamber Flushing System	\$ 16,000
LEIB-HVAC-1	2	HVAC Improvements	\$ 126,000
LEIB-ELEC-1	2	Electrical Improvements	\$ 19,000
LEIB-I&C-1	2	I&C Improvements	\$ 109,000
LEIB-I&C-2	1	Control System Upgrade	Ongoing Project
LEIB-SITE-1	2	New Site Access from Meldrum Street	\$ 220,000
LEIB-ARCH-1	2	Architectural Rehabilitation	\$ 246,000
LEIB-SAFE-1	1	Safety Improvements	\$ 211,000

10.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 10-23. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 10-23. Capital Improvement Plan Projects for Leib CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
LEIB-1 Disinfection System Improvements	\$ 1,206,000	2026 <i>Timing based on implementation of projects before Meldrum diversion to ensure reliable operation with increased flows.</i>	LEIB-DIS-1	Chemical Feed utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 901,000
			LEIB-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
			LEIB-DIS-3	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000
			LEIB-FD-1	Screening Chamber Flushing System	\$ 16,000
			LEIB-ELEC-1	Electrical Improvements	\$ 19,000
LEIB-2 Facility-Wide Safety and Architectural Improvements	\$ 583,000	2023 <i>Project should be initiated as soon as possible</i>	LEIB-HVAC-1	HVAC Improvements	\$ 126,000
			LEIB-ARCH-1	Architectural Rehabilitation	\$ 246,000
			LEIB-SAFE-1	Safety Improvements	\$ 211,000
LEIB-3 I&C Improvements	\$ 109,000	2030 <i>Timing based on best judgement</i>	LEIB-I&C-1	I&C Improvements	\$ 109,000
LEIB-4 Site Improvements	\$ 220,000	2026 <i>Timing based on need to address safety issue</i>	LEIB-SITE-1	New Site Access from Meldrum Street	\$ 220,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 10-24 and Table 10-25 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 10-24 indicates that LEIB-DIS-1 project has 28 assets that has an average condition score of 1.29 and an average replacement date of 2032. However, this project should be completed before the Meldrum diversion and therefore, the project was proposed a scheduled construction completion date of 2026 instead of 2032.

Table 10-24. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
LEIB-DIS-1	28	1.36	1.29	2.27	13	2032	\$ 904,400

Table 10-25. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
LEIB-DIS-1	0	0.00	0.00	0.00	N/A	N/A	\$ -

10.3.3 20-Year Capital Outlay Plan

Table 10-26 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 10-26. 20-Year Capital Outlay Plan for Leib CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 300,900	\$ -	\$ -	\$ 217,500	\$ 59,200	\$ -	\$ -	\$ 24,200	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 1,814,757	\$ -	\$ 1,814,757	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ 3,961	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,961	\$ -	\$ -	\$ -	\$ -
2025	\$ 21,112	\$ -	\$ -	\$ 6,854	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 14,258	\$ -	\$ -
2026	\$ 781,158	\$ -	\$ -	\$ 779,057	\$ -	\$ -	\$ -	\$ -	\$ 2,101	\$ -	\$ -	\$ -	\$ -
2027	\$ 56,120	\$ 56,120	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 54,606	\$ -	\$ -	\$ -	\$ 54,114	\$ -	\$ -	\$ 492	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,924,056	\$ -	\$ 30,857	\$ 38,571	\$ 84,856	\$ -	\$ -	\$ -	\$ -	\$ 1,769,773	\$ -	\$ -	\$ -
2030	\$ 1,215,181	\$ 39,143	\$ -	\$ -	\$ 1,142,981	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 33,057	\$ -	\$ -
2031	\$ 204,007	\$ 26,610	\$ -	\$ -	\$ 177,397	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 8,429	\$ -	\$ -	\$ 8,429	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 318,726	\$ -	\$ -	\$ -	\$ -	\$ 129,231	\$ -	\$ 189,495	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 1,805,282	\$ -	\$ -	\$ 1,579,749	\$ 89,545	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 108,572	\$ -	\$ 27,416
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 1,372,234	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1,372,234	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 254,817	\$ 44,126	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 106,402	\$ 41,469	\$ -	\$ -	\$ 62,820	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 10,135,347	\$ 165,999	\$ 1,845,614	\$ 2,630,160	\$ 1,608,094	\$ 129,231	\$ -	\$ 320,589	\$ 1,419,765	\$ 1,769,773	\$ 155,887	\$ 62,820	\$ 27,416

Notes:

Explanation of large capital outlays in first two years:

- Screening System: Screen #3, #5, and #7 received a score of 5 as the screens failed to start at the time of the Condition Assessment.
- Retention System: One Accusonic flow meter (FM-3; \$217,500) was not functional based on SCADA review in 2019 and 2020.
- Disinfection System: One chemical storage tank #2 (\$59,200 each) received a score of 5 as it had a small leak and had been taken out of service until repaired.

11. Oakwood CSO Control Facility

11.1 General Facility Description and Future Capacity Considerations

11.1.1 General Facility Description

The Oakwood CSO Facility is an RTB with 9 million gallons (MG) of storage and a treatment capacity of 1,660 cfs. It was constructed in 2012. There are three buildings. The main building contains the Storm Pump Station, Sanitary Pump Station, chemical room, control room, utility support (electrical and mechanical rooms), odor control room, sample room, shipping and receiving and miscellaneous other rooms. The Headworks Building contains the headworks, headworks control room, MAU room and hydraulic room. The basin odor control room contains the odor control systems for the East and West Basins.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

11.1.2 Northwest Interceptor Diversion to Oakwood CSO Facility

The WWMP proposed projects to increase wet weather flows to existing CSO facilities to maximize the use of the facilities and minimize the construction of additional facilities. Many of the CSO facilities do not reach their design flows, so there is capacity to accept additional flows, without exceeding their design flow.

The NWI Diversion to Oakwood CSO Facility is one of the recommended projects from the WWMP that will increase flows to the existing Oakwood CSO Facility. The magnitude of the increased flows and the potential impact on screening and disinfection performance is described in the following sections.

This project originated from the WWMP and involves diverting NWI flows to the Oakwood Storm Pump Station and CSO facility whenever the Detroit WRRF is overloaded, and capacity is available at the Oakwood facility. Based on information presented in the WWMP, the predicted peak wet weather flow rate expected at the Oakwood Pumping Station (PS) for the 10-year 24-hour storm event is about 1,100 cfs. The firm capacity of the Oakwood PS and the design flow for the CSO facility is 1,660 cfs. This leaves about 560 cfs of unused capacity at the Oakwood facility at design conditions.

The NWI diversion involves construction of a new control gate chamber on the NWI at Bayside and Sanders. About 3,100 ft of 10-ft-diameter tunnel is required to convey the peak wet weather flows from the NWI control gate chamber to a new diversion chamber at Liddesdale and Pleasant Streets, near the Oakwood influent junction chamber.

11.2 Facility Assessment

11.2.1 Screening

11.2.1.1 Description of Existing System

The Oakwood CSO Facility has six perforated plate screens that were installed in 2012. Raw wastewater is pumped to the screens from the Oakwood Storm Pump Station. Screened flow enters either one or both of the CSO basins via the Screen Outlet Chamber.

Screened material is removed from the screens using a rotating brush and high-pressure spray and discharged into a screw conveyor. The conveyor transports the screenings to a dumpster for eventual disposal in a landfill. A washer/compactor was originally installed at the end of the conveyor, prior to discharge to the dumpster.

The sanitary pump station has two manually cleaned bar screens upstream of the sanitary pumps. Space was provided in the Sanitary Pump Station for a monorail system and bucket that could be used to manually clean the screens if it were determined necessary in the future.

Table 11-1 provides an overview of the existing screening system at Oakwood CSO facility.

Table 11-1. Overview of Existing Screening System Oakwood CSO Facility

Parameter	Value	
Type	Retention Treatment Basin	Sanitary PS
Treatment Capacity (cfs)	1,660	NA
No. of Screens	6	2
Manufacturer	Andritz	Not known
Screen Type	Perforated Panel Screen	Manual Bar Rack
Opening Size	6-mm perforation	3-in.
Depth or Length	21 ft 6 in.	41 ft
Width	10 ft 0 in.	5 ft 0 in.
Screen Cleaning	Brush and high-pressure spray	Manual
Screening Removal	Screw conveyor to dumpster and landfilled	Manually cleaned (currently by washing screenings through the screens to the sanitary pumps)

11.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Provide a better means of cleaning the two bar racks at the sanitary pump station: The bar racks have 3-in. spacing to protect the sanitary pumps by capturing large debris. The sanitary pump station bar racks, however, become frequently blinded. During Jacobs Condition Assessment in June 2020, the differential through the screens was about 10 ft. The screens reportedly had not been cleaned for a prolonged period due to accessibility issues. The current method of cleaning involves lowering a worker in a man-basket into the wet well to manually remove the debris, which poses considerable safety risks. Alternatives to address this issue are discussed in the following section.
- Resolve water carry-over into screenings dumpster and onto floor near dumpster: Screenings and spray water from the screens are conveyed by the screw conveyor directly into the dumpster at ground floor. There is a significant amount of water that completely fills the dumpster during an event and spills onto the floor around the dumpster. A portable screenings washer/compactor was provided in the original system and can be moved into place to wash and compact the screenings. The washer/compactor has a drain that can divert the excess water to a drain line. The compactor, however, has been problematic because screenings fill the compactor chute, dry in place, and are unable to be pushed out of the chute during the subsequent storm. As such, the washer/compactor is bypassed.

- Jacobs recommends replacing the inclined discharge chute with a minimally modified chute. This will minimize compaction of the screenings and, most importantly, will allow the excess water to drain from the screenings prior to discharge into the dumpster below. This should significantly reduce the amount of water transferred to the dumpster. Jacobs contacted the washer/compactor manufacturer (JWC) to confirm this approach. The GLWA millwrights could construct and install a new horizontal section. The capital expenditure for this modification is minimal and not included in the capital outlay.
- Potential impact of higher flows on screening performance. The screens have not experienced peak design flows, and there is a concern that they may blind at the higher flows with the NWI diversion. It should be noted that the screens have emergency bypasses built-in to the screening channels to allow flows around the screens if the screens should become blinded. If screen blinding should become a problem in the future, potential modifications to the existing screens, including speeding up the screen, could be investigated. There is no room for additional screens at the facility.

11.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Sanitary Pump Station Screen Improvements (Project OKW-SCR-1). The existing manually raked bar screens excessively blind over time and cleaning them is a safety concern. There are four alternatives:

- 1) **Alternative 1: Do Nothing/Keep Existing Manual Bar Rack**
- 2) **Alternative 2: Remove Bar Racks.** The bar racks were installed to protect the sanitary pumps. Due to the excessive blinding of the bar racks, GLWA recently temporarily removed the bar racks. This will allow observation of pump performance without screening. If the pumps can convey most of the debris, this could be the long-term alternative. GLWA should observe this performance for at least a year to determine the impacts on the pumps and the material that remains in the wet well.
- 3) **Alternative 3: Monorail and Clamshell.** The facility was originally designed for a monorail and clamshell to remove the screenings from the manual bar racks, but it was not installed. A clamshell could be used to clean bar racks with 3-in. openings as the captured debris is usually large/heavy. A clamshell would be faster and safer to use than the man-basket that was previously used. However, GLWA subsequently requested a mechanical bar screen in lieu of continuing to use the manual bar racks based on operational experience with clamshells being unreliable.
- 4) **Alternative 4: Mechanical Bar Screen.** The bar racks could be replaced with mechanical bar screens with the same 3-in. bar spacing that extend the full depth of the channel. Duperon's FlexRake FP-F bar screen was evaluated and would perform well (see Figure OKW-SCR-1-ALT-4 in Volume 6 – Appendices, Appendix B). It was used as a representative screen for cost estimating purposes. A smaller bar spacing of 1.5-in. is an option but will result in additional screenings to manage. The spacing of a new screen, if this option is selected, should be further evaluated during detailed design.

Several options for screenings handling were evaluated for the mechanical screens in Alternative 4:

- **Screenings Handling Option 1: Rolling Dumpster:** A rolling dumpster with a drain should be adequate for screenings from a 3-in. bar screen. The portable dumpster could be moved just outside the roll-up door and picked up by a trash truck. Screenings captured with a 3-in. bar screen are not expected to be odorous.
- **Screenings Handling Option 2: Grinder After Mechanical Screen:** Rather than disposing of screenings at the Oakwood facility, screenings could be ground and returned to the screened wastewater and conveyed to the WRRF. Screens at the Detroit WWTP would remove the ground screenings. The grinder teeth can be set to grind the screenings to the desired size, so they are mostly removed by the treatment plant screens. Conversations with a Jacobs' screening expert

and Duperon indicated that maintenance on the grinder will be intensive due to the large material that will be ground. The likelihood and frequency of jammed grinders is high, and a rolling dumpster is a better disposal option.

- Based on the evaluation above, a rolling dumpster (Screenings Handling Option 1) is recommended as a grinder has a higher potential for future maintenance problems than its apparent overall value.

The alternative evaluation is presented in Table 11-2. The sources of costs used in this evaluation are listed the following bullets:

- O&M costs for Alternative 1 assume the manual bar rack is cleaned twice per year.
- Alternative 3 – Monorail and Clamshell is not considered a viable alternative by GLWA because of unfavorable experiences with this type of system at other facilities.
- Capital costs for Alternative 4 are presented in Volume 6 – Appendices, Appendix C under this project title.
- Screenings disposal costs are not included in Alternative 4 because the cost difference is so large between Alternative 2 and Alternative 4.

This evaluation shows that Alternative 2 – Remove Bar Racks is the Best Value Alternative. **As such, Alternative 2 is the Recommended Alternative.**

Table 11-2. Alternative Evaluation for Sanitary Pump Station Screen Improvements (Project OKW-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	Alt. Name:	Do Nothing.	Health and Safety	1	1.80	\$ -	\$ 3,200	\$ 67,487	\$ 37,493	
	Definition:	Do nothing.	Water Quality & Compliance	3						
	Adv.:	Known system	Capacity Enhancement	3						
	Disadv.:	Cleaning the screens requires manned-entry/suspension into channel, which is unsafe.	Component Performance	1						
	Comments:	None	O&M Ease	1						
2	Alt. Name:	Remove Bar Racks	Health and Safety	4	3.72	\$ -	\$ -	\$ -	\$ -	Best Value Alternative
	Definition:	Remove Bar Racks.	Water Quality & Compliance	3						
	Adv.:	No blinding	Capacity Enhancement	3						
	Disadv.:	Pumps may be unable to handle large debris	Component Performance	3						
	Comments:	None	O&M Ease	5						
3	Alt. Name:	Monorail and Clamshell	Health and Safety	3	2.47	No cost estimate prepared. GLWA has had unfavorable experience with clamshells				
	Definition:	A clamshell can be used to clean bar racks with 3-inch openings as the captured debris is usually large/heavy	Water Quality & Compliance	3						
	Adv.:	A clamshell would be faster and safer to use than a man-basket.	Capacity Enhancement	3						
	Disadv.:	Unfavorable experience at another location.	Component Performance	2						
	Comments:	None	O&M Ease	1						
4	Alt. Name:	Mechanical Bar Screen	Health and Safety	5	4.20	\$ 3,243,000	\$ -	\$ 3,243,000	\$ 772,143	
	Definition:	Replace existing sanitary pump station bar racks with mechanical bar screens with the same 3-inch bar spacing or smaller.	Water Quality & Compliance	3						
	Adv.:	Mechanically cleaned on a continuous basis, which is continuous and safer.	Capacity Enhancement	3						
	Disadv.:	Higher capital cost. Need for screenings disposal.	Component Performance	5						
	Comments:	Does not include screenings handling	O&M Ease	5						

11.2.2 Disinfection

11.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP tanks, 10 gear pumps, and multiport injection on the discharge of the eight stormwater vertical turbine pumps. The storm pumps pump stormwater into the CSO facility and are further described in Section 11.2.12.1. Three of the sodium hypochlorite pumps are low-rate and seven are high-rate. Sodium Hypochlorite Pumps 1 through 8 inject on the discharge of Storm Pumps 1 through 8, respectively. Sodium Hypochlorite Pump 9 is a high-rate pump serving as the backup to high-rate pumps 3 through 8. Sodium Hypochlorite Pump 10 is a low-rate pump serving as the backup to low-rate pumps 1 and 2. Each pump has a VFD to adjust chemical feed flow based on storm pumping rate. Flow is metered from each pump.

Table 11-3 provides an overview of the existing disinfection system at the Oakwood CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G.

Table 11-3. Overview of Existing Disinfection System at Oakwood CSO Facility

Parameter	Value
Treatment Capacity (cfs)	1,660
Design Feed Strength (% hypochlorite)	7.5
Max. Dosage at Design Flow (mg/L Cl ₂)	12
Disinfection Contact Time (min)	6 min w/ 1 basin, 12 min w/ 2 basins in service
Storage Tanks	
Number	2
Volume of Each Tank (gal)	11,500
Type	FRP
Pumps	
Number	10 Total; 3 low-rate, 7 high-rate
Capacity (gpm)	Low-rate: 0-26, High-rate: 151
Type	Gear
Mixers	
Number / Type	Hypo added to pump discharge
Model Number/ hp / Manufacturer	Not Applicable (Hypo added to pump discharge)

11.2.2.2 Identified Needs and Issues

The needs and issues for Oakwood were identified from meetings with O&M staff and Jacobs team site visit and investigations. These needs and issues are summarized as follows:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Oakwood chemical feed system has the following issue:
 - The gear pumps are expensive to replace and repair
 - The gear pumps vibrate despite efforts to eliminate vibration
 - The chemical feed pumps are on skids. The skid frames reduce access to the pumps and components and do not aid in the removal of the pumps.

These issues are addressed in Replace Chemical Feed System (Project OKW-DIS-1) in the following bullets.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project OKW-DIS-2) in the following bullet.
- Provide ability to sample basin at two levels. The basin effluent sample pump requires the water level to reach a certain level before chlorine residual can be determined. There is concern that it could be too late to adjust the sodium hypochlorite feed rate in response to variable influent conditions affecting chlorine demand by not being able to sample sooner. Therefore, it is desired to sample at two levels, one at low level in addition to the high level at end of basin. It should be noted that this capability will be provided in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project OKW-DIS-2) by installing a new pump well upstream of the effluent end of the CSO basins. As such, a separate capital improvement is not needed to address this issue.
- Feed piping overpressure alarms. There is a pressure sensor and associated alarm setpoint on the discharge of each pump. Over-pressurization alarms occur indicating the need to investigate whether the pressure relief valves are functioning properly or whether the pressure sensor is causing false alarms.

This should not be an issue after the chemical feed system is replaced, as recommended in the following bullet. In the interim, however, the pressure relief valves could be investigated to verify they are functioning properly and that the pressure sensors be checked to determine if they are causing false alarms. This can be done by installing a calibrated pressure gauge on the discharge of a pump and monitoring pressure concurrently with someone monitoring SCADA for an alarm. GLWA maintenance staff could perform this investigation or a mechanical contractor. Given that the system should be replaced in the near future, capital costs have not been included in this evaluation to address this issue.

- Investigate corrosion concern at chemical injection points on pump discharge. During meetings related to disinfection, GLWA expressed concern that corrosion could be occurring in the vicinity of where the hypochlorite is injected into the discharge pipes of each pump. Closed-circuit television (CCTV) results of the discharge pipes for each pump (conducted under another project) were reviewed for this evaluation. See Figure 11-1 for CCTV results from the chemical injection points of one pump (Pump 2) used to illustrate the condition. The CCTV did not show any serious corrosion. Based on these results, it is recommended to re-investigate the piping again in about 5 years.

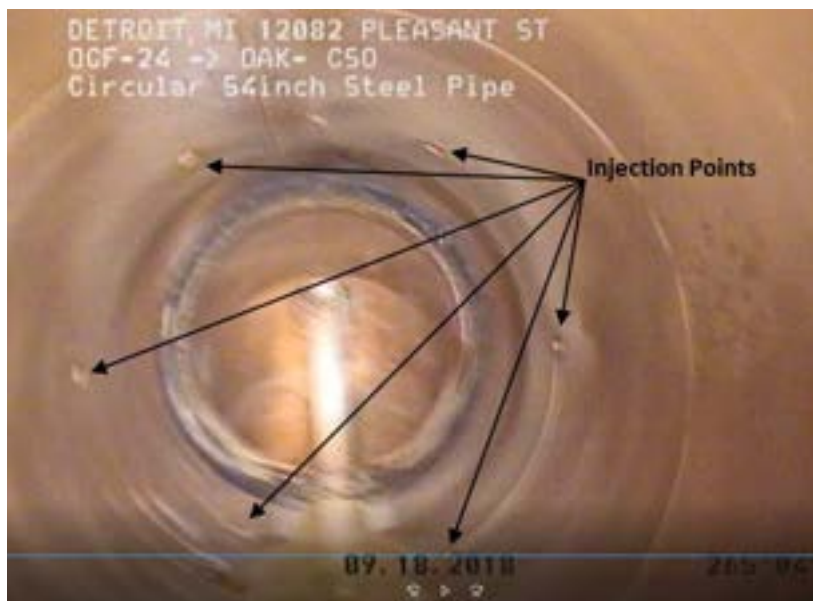


Figure 11-1. CCTV Inspection of Oakwood Storm Pump Discharge Piping Showing Chemical Injection Points

- Provide side access manway on hypochlorite tanks for improved ease of inspection and future relining.
- Provide backup storm pump flow measurement, for when the storm pump flow meter is not working properly—this issue is addressed in the Oakwood I&C section (Section 11.2.7).

11.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project OKW-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to each discharge point (i.e., pump discharge pipe).
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

The alternative evaluation for these alternatives is presented in Table 11-4. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP.

- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 were estimated based on average annual costs of \$66,000 for manufacturer rebuilds and \$57,000 for GLWA on-site rebuilds (includes GLWA labor) for a total of \$123,000.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on rebuild of \$20,000 per pump for three pumps at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 11-4 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 11-4. Alternative Evaluation for Replace Chemical Feed System (Project OKW-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System In-Kind	Health and Safety	3	2.08	\$ 1,964,300	\$ 123,000	\$ 4,558,325	\$ 2,187,996	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 1,332,000	\$ 13,275	\$ 1,611,965	\$ 447,768	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a discharge pipe.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 443,000	\$ 5,000	\$ 548,448	\$ 152,347	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project OKW-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose using an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The storm pump flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on storm pump flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the chemical dosing point to further adjust chemical feed flows. The sampling location would be near the influent end of the basin and near the bottom portion of the basin (to be able to measure TRC concentrations before the effluent sample point). Another sampling point can be provided at an intermediate level.

The automatic chemical feed system should require less operator input during an event; however, this cost difference is not included in this analysis because GLWA O&M staff believe that manual sampling to confirm the auto sample result will still be necessary. There will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 11-5. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains functional between storm events.
- As noted above, this evaluation did not account for any reduction in operations labor using the automatic control system.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 11-5. Alternative Evaluation for Provide Flow-paced and TRC-paced Automated Chemical Feed (Project OKW-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less efficient chemical feed and possible overdosing of chemical.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 156,000	\$ 4,860	\$ 258,496	\$ 74,926	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing. Also, provide sampling at two levels, one at low level and one at an intermediate level, in addition to the high level at end of basin.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more efficient use of chemical.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common of CSO facilities, but TRC-pacing is difficult with infrequent CSO facility use.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

Reline and Provide Side Access Manway on Hypochlorite Tanks (OKW-DIS-3). The hypochlorite storage tanks lack side entry manways making FRP repair significantly more difficult. A side entryway manhole near the bottom of each existing tank is recommended. This should be performed when the tank requires relining or a major repair. To determine the condition of the tanks, Jacobs reviewed a 2020 inspection by GHD and found that there was a only a small chip on the exterior of one tank and evidence of leakage from a drain valve (exterior to the FRP tank and not part of the tank).

Based on the limited extent of any defects to the existing tanks, it is recommended that the installation of the manways be done when the tanks near the end of their useful life and require relining. The costs for relining and adding manways to the existing tanks are included in the capital costs for this project. There is no alternative to this option. Table 11-6 provides the summary of **Reline and Provide Side Access Manway, which is the recommended alternative.**

Table 11-6. Alternative Evaluation for Reline and Provide Side Access Manway on Hypochlorite Tanks (OKW-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Reline and Provide Side Access Manways	Health and Safety	3	3.00	\$ 289,000	\$ -	\$ 289,000	\$ 96,333	Best Value Alternative
	<i>Definition:</i>	Reline and Provide Side Access Manways on Hypochlorite Tanks	Water Quality & Compliance	3						
	<i>Adv.:</i>	Re-use existing chemical tanks	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.3 Odor Control

11.2.3.1 Description of Existing System

There are three odor control systems at the Oakwood facility. One system, located in the Odor Control Building next to the sanitary pump station, treats air from the east and west storm wet wells, the sanitary wet wells, and the sanitary pump station room. The second and third systems, both located in the Basin Odor Control Building, treat air from the East and West Retention Basins. Each of the retention basin odor control systems also serves the headworks, as it is connected to both CSO basins.

The system serving the pump stations consists of a grease filter/mist eliminator, an odor control fan, and a single bed vertical activated carbon vessel. The system also includes a bypass ventilation fan, which allows foul air to be removed from the pump stations and bypass the carbon column. Carbon is replaced through the top access hatch on each vessel.

The systems serving the retention basins operate in parallel. Each system consists of an odor control fan and an activated carbon vessel (there are no grease filter/mist eliminators). Each system also has a bypass ventilation fan.

These odor control systems operate under air permit requirements (Permit to Install No. 91-06). The emission limit for the Pump Station system is 0.0043 pounds per hour (pph) of hydrogen sulfide. At a design air flow of 30,000 cfm, this equates to approximately 0.028 parts per million volume (ppmv) concentration of hydrogen sulfide. The emission limit for the CSO basin systems is 0.0031 pph. At a design air flow rate of 22,000 cfm (each), this equates to approximately 0.028 ppmv concentration of hydrogen sulfide. The carbon is tested for remaining bed life on a quarterly basis as required by the permit. Carbon was replaced in all three carbon vessels in Spring 2018, which was the first time it was replaced since it was put into service in 2012.

Per GLWA, no odor complaints have been received for at least the past three years.

11.2.3.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified:

- Improve odor control for the sanitary pump station.
- Provide improved access and safety for carbon replacement for both the sanitary and basin scrubbers.
- Provide improved access and safety for carbon sampling for both the sanitary and basin scrubbers.
- West basin odor control fan was out of service due to vibration. Vibration monitoring was not installed properly resulting in frequent fan shutdown when vibration is not excessive.

These issues are discussed below.

Oakwood HVAC Improvements Project (CIP No. 260619). The Oakwood HVAC project, currently in the design stage, will include 1) improvements to odor control for the sanitary pump station; 2) improvements for access and safety for carbon replacement for both the sanitary and basin scrubbers; and 3) improvements for access and safety for carbon sampling for both the sanitary and basin scrubbers. Capital costs are not provided because this is an ongoing project.

Vibration Sensor Modifications. Install vibration monitoring closer to the frame of the fan. This will be done as part of the Oakwood HVAC Improvements (CIP No. 260619).

11.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement “needs”.

11.2.4 Flushing and Dewatering

11.2.4.1 Description of Existing System

Dewatering System: The Oakwood screening facility and CSO basins (East and West) are largely dewatered by gravity through drain lines that discharge to the NWI force main. The CSO drain system has sufficient capacity to allow both CSO basin drain valves to be opened simultaneously; however, there is a flow control valve and magnetic flow meter provided on the drain line to the NWI to control the flow to the NWI to prevent overflows in the collection system between the CSO Basin and the WRRF. Also, there is a Surge Chamber on the gravity drain lines that will direct flow back to the head of the plant if the basin dewatering flow rate exceeds the available capacity in the line to the NWI.

Due to system hydraulics, the water in the lowest levels of the basins that cannot be discharged to the NWI by gravity is instead routed back to the Oakwood Pump Station, where flow is pumped by the sanitary wastewater pumps to the NWI.

Flushing System: A flushing gate system is used for cleaning solids from the floor of the basin following dewatering. There are 20 total flushing gates—eight in each of the two CSO basins, and two in each of the two basin influent channels. The flushing gates in each basin are arranged in two groups of four. The flushing gates operate in a latch-unlatch manner and are controlled by a common hydraulic power pack.

The flushing reservoirs are filled as the basins fill during a wet weather event. When the basin and screening facilities dewater, flushing water remains behind the flushing gates. Flushing is initiated by sequentially unlatching two basin flushing gates (one in each basin) at a time in the first basin reservoir until all are open. Then, if the last of the four reservoirs was full prior to its gate opening, the second set of flushing gates will sequentially open. Once basin flushing is completed, one gate is opened in each influent channel. The flushing sequence only allows one gate in each channel to be open at a time.

Table 11-7 provides an overview of the existing flushing and dewatering system at Oakwood CSO facility.

Table 11-7. Overview of Existing Flushing and Dewatering System at Oakwood CSO Facility

Parameter	Value
Total Basin Volume (MG)	9
Headworks and Basin Dewatering and Flushing System	- Basins are dewatered by gravity by opening the Drain Valve to the NWI - There are 20 flushing gates; 8 in each basin and 2 in each basin distribution channel - Flushed solids are routed to the Oakwood Pump Station for pumping to the NWI

11.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- Air-operated pinch valve intended to isolate the two sides of the Storm Pump Station during dry weather are encased in sand, making them extremely difficult to access, and the air lines that actuate them are underground and have a leak, which cannot be found.
- Flushing valves are hard to reach during maintenance activities and scaffolding needs to be setup to reach the valves, which is difficult due to steep slope on the floor
- Significant grit accumulation at the flushing sumps in the basin leads to plugging of the 12-in. drainage pipeline at the effluent end of the basin

11.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Influent Junction Chamber Isolation (Project OKW-FD-1). The existing influent chamber has two 18-ft diameter sewers from the junction chamber to the Oakwood Storm Pump Station. Within the junction chamber, at the bottom of each 18-ft diameter pipe, there is a 30-in. diameter pipe with an air-operated pinch valve intended to isolate the two sides of the Storm Pump Station during dry weather. These pinch valves are encased in sand, making them extremely difficult to access, and the air lines that actuate them are underground and have a leak, which cannot be found. As such, they have not been repaired after they failed. A means to isolate the two sides of the Storm Pump Station is still needed. A previous study (Oakwood CSO Pump Station Investigative Study, Brown and Caldwell, January 15, 2019) identified several alternatives that included replacement of the existing pinch valves and new stop logs. Jacobs reviewed this study and discussed cost effective options with GLWA. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.** Contractor to install isolation, when needed.
- 2) **Alternative 2: Influent Junction Chamber Isolation Improvements.** This alternative includes removal/replacement of the existing dry weather flow pinch valves with new small hand-pull slide gates. Figure OKW-FD-1-ALT-2 in Volume 6 – Appendices, Appendix B, shows the conceptual layout of this improvement. Following removal of the pinch valves and demolition of the concrete boxes, brackets for a 36-in. by 36-in. hand-pull slide gate will be mounted on the rehabilitated concrete face of the 30-in. pipe in each channel. The hand-pull gates (two service and one spare) could be stored in the upper part of this structure. Flow bypassing is assumed during modifications.

This project should be coordinated with the NWI Diversion project to coordinate and minimize shutdowns and bypass pumping requirements.

The alternative evaluation for these alternatives is presented in Table 11-8. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 includes the estimated cost of isolation, which is based on \$60,000 per event and frequency of use is assumed to be once every 5 years, for an annual O&M cost of \$12,000.
- The O&M costs for Alternative 2 includes the estimated cost of isolation, which is based on \$2,000 per event and frequency of use assumed to be once every 5 years, for an annual O&M of \$400.

The total benefit score for Alternative 2 is about 0.8 greater than Alternative 1. Also, the NPV/Benefit cost for Alternative 2 is less than Alternative 1. As such, **Alternative 2 - Influent Junction Chamber Isolation Improvements is the recommended alternative.**

Table 11-8. Alternative Evaluation for Influent Junction Chamber Isolation (Project OKW-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.58	\$ -	\$ 12,000	\$ 253,076	\$ 97,965	
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Unable to isolate the two sides of the Storm Pump Station during dry weather.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Influent Junction Chamber Isolation Improvements	Health and Safety	3	3.42	\$ 289,000	\$ 400	\$ 297,436	\$ 87,054	Best Value Alternative
	<i>Definition:</i>	Removal/replacement of the existing dry weather flow pinch valves with new small hand-pull slide gates.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Simple system to isolate storm pump wet well.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Still requires manned entry into junction chamber, when needed	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	4						

Reservoir Flushing Valves and Basin Sump Flushing (Project OKW-FD-2). The O&M staff noted that the flushing valves are hard to reach during maintenance activities and scaffolding needs to be setup to reach the valves, which is difficult due to steep slope on the floor.

O&M staff also report that significant grit accumulation at the flushing sump leads to plugging of the 12-in. drainage pipe at the effluent end of the basin. Frequent jetting of this pipe is difficult due to the configuration of the pipes below the facility's slab and the depth to the flushing sump below the adjacent finger weir. There are also two 10-in. drain lines on the influent end that plug, but at a lesser frequency.

There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.** Continue to jet-rod the pipe, when necessary.
- 2) **Alternative 2: Reservoir Flushing Valves Relocation and Basin Sump Flushing.** This alternative relocates the reservoir flushing valves and piping to downstream of flushing gates, where the slope of the floor is less steep. Figure OKW-FD-2-ALT-2 in Volume 6 – Appendices, Appendix B, show the conceptual layout of this improvement.

Improvements to mitigate the pipe clogging include installing submersible solids handling pumps (4-in. discharge) at each sump to recirculate effluent near the sump drains and resuspend accumulated materials. A 4-in. ductile iron discharge manifold mounted around the sump with two or three nozzles pointed toward the sump opening would support more complete resuspension while the basin is use. See Figure OKW-FD-2-ALT-2 in Volume 6 – Appendices, Appendix B for conceptual illustration. As the facility comes into operation, the pumps would start operating and continue operation for the duration of the event and as the facility is drained. By preventing a large accumulation at the sump, the draining process can more effectively dewater the facility and gradually remove settled materials. Pumps would be rail-mounted and removable to the surface through new hatched openings in the top of the structure.

The alternative evaluation for these alternatives is presented in Table 11-9. The sources of costs used in this evaluation are listed in the following bullets:

- The O&M cost for Alternative 1 includes the estimated cost of setting up scaffolding and jetrodding. The cost of scaffolding is based on \$15,000 per event and frequency of use to be once every 10 years. The cost of jetrodding is based on \$10,000 per event and frequency of use to be once every year.
- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 2 includes the estimated cost of setting up scaffolding. The cost of scaffolding is based on \$10,000 per event and frequency of use to be once every 10 years.

The total benefit score for Alternative 2 is two times higher than Alternative 1 because of the significant improvement to health and safety and ease of operation. Although the NPV/benefit cost is slightly higher for Alternative 2, the type of improvements make **Alternative 2 - Reservoir Flushing Valves Relocation and Basin Sump Flushing the recommended alternative.**

Table 11-9. Reservoir Flushing Valves and Basin Sump Flushing (Project OKW-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	1	2.00	\$ -	\$ 11,500	\$ 242,531	\$ 121,265	Best Value Alternative
	<i>Definition:</i>	Continue to jet-rod the pipe, when necessary.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Difficult to set-up scaffolding in basin to reach valves. Unsafe conditions for jetrodding drain line	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Reservoir Flushing Valves Relocation and Basin Sump Flushing	Health and Safety	5	4.00	\$ 536,000	\$ 1,000	\$ 557,090	\$ 139,272	
	<i>Definition:</i>	Relocate the reservoir flushing valves (RFVs) and piping to downstream of flushing gates and install sump flushing system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier to reach RFVs for maintenance; Sump flushing system should eliminate need to access basin when it is partially filled to jet-rod drain lines.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher capital cost.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

11.2.5 HVAC

11.2.5.1 Description of Existing System

The Oakwood CSO facility consists of three buildings. The main building contains the Storm Pump Station, Sanitary Pump Station, chemical room, control room, utility support (electrical and mechanical rooms), odor control room, sample room, shipping and receiving and miscellaneous other rooms. The Headworks Building contains the headworks, headworks control room, MAU room and hydraulic room. The Basin Odor Control Room contains the odor control systems for the East and West Basins. Table 11-10 provides summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, gas-fired water heater, emergency shower/eye wash, emergency eye wash, sump pumps, pressure booster pumping system, compressed air system etc. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 11.2.10.

Table 11-10. Major HVAC Equipment at Oakwood CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Main Pump Station	SF-1 to 2	Supply Fan	5,000 CFM
Headworks	MAU-3	MAU	35,800 CFM 3,000 MBH
Basin	EF-20 to 22	3 × Exhaust Fan (East Basin)	52,800 CFM
	EF-23 to 26	3 × Exhaust Fan (West Basin)	52,800 CFM
	SF-5 to 7, SF-10	4 × Supply Fan (East Basin)	52,800 CFM
	SF-5, SF-8 to 10	4 × Supply Fan (West Basin)	52,800 CFM
Chemical Room	AC-2	Air Conditioning Unit	315 CFM 1.25 ton
	MAU-4	MAU	5,000 CFM 400 MBH
	EF-18	Exhaust Fan	2,500 CFM
Electrical Room	AHU-1	AHU	25,000 CFM, Cooling Capacity (125 tons), Heating Capacity (353 MBH)
	EF-35	Exhaust Fan	13,880 CFM
	EUH-8	Electric Unit Heater	1,700 CFM 15 KW
Mechanical Room	AHU-1A	AHU	2,700 CFM
Make-up Air Room	MAU-3	MAU	35,800 CFM
Odor Control Room	EF-28, EF-29	Exhaust Fan	3,000 CFM
	EF-33, EF-34	Exhaust Fan	22,000 CFM
	EUH-6 to 7	Electric Unit Heater	1,700 CFM 15 KW

Table 11-11 provides a summary of the basis of design performance criteria for HVAC systems at Oakwood and Table 11-12 provides the outdoor Basis of Design conditions.

Table 11-11. Oakwood Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
Winter (F)	Summer (F)			
Control Building				
Restroom/ Locker	Unclassified	70	78	10 ACH
Electrical Equipment	Unclassified	70	78	6 ACH
Corridor	Unclassified	70	78	4 ACH
Sampling Room	Unclassified	70	78	6 ACH
Control Room	Unclassified	70	78	6 ACH
Conference/ Reference/ Lunch Room	Unclassified	70	78	6 ACH
Shipping/ Receiving Room	Unclassified	50	N/A	Negatively Pressurized
Mechanical/ HVAC Equipment Room	Unclassified	50	N/A	6 ACH
Instrumentation/Phone/ Communications Room	Unclassified	N/A	78	6 ACH
Storage	Unclassified	50	N/A	Negatively Pressurized
Janitor Closet	Unclassified	50	N/A	6 ACH
Pump Station				
Storm and Sanitary Wet Wells (Lower Level)	Class I, Div 1, Group D	N/A	N/A	2 ACH (Unoccupied) 30 ACH (Occupied)
Bearing Floor (Intermediate Level)	Unclassified	50	N/A	6 ACH
Motor or Ground Floor Level (Upper Level)	Unclassified	50	N/A	Ventilation Cooling
Sanitary Screen Room (Upper Level)	Class I, Div 1, Group D (Per Electrical Drawings)	50	N/A	12 ACH
Elevators and Stairwells	Class I, Div 1, Group D	N/A	N/A	30 ACH (Occupied)
Odor Control Room	Class I, Div 1, Group D (Per Electrical Drawings)	50	N/A	6 ACH
Chemical Facility				
Chemical Feed Room	Unclassified	50	N/A	6 ACH
Mechanical Room	Unclassified	50	N/A	4 ACH
Chem. Instrument Rm.	Unclassified	70	78	6 ACH
Stair	Unclassified	50	N/A	4 ACH
Corridor	Unclassified	50	N/A	4 ACH
Headworks				
Screening Room	Class I, Div 2, Group D	50	N/A	12 ACH
CSO Basins	Class I, Div 1, Group D	N/A	N/A	1.4 ACH (Unoccupied) 12 ACH (Occupied)

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Basin Odor Control Building	Class I, Div 2, Group D	50	N/A	Negatively Pressurized

Table 11-12. Oakwood Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
0	90	73

11.2.5.2 Identified Needs and Issues

During the CS-299 Needs Assessment meetings with GLWA O&M staff, the following HVAC issues were noted:

- Insufficient heating capacity in Headworks Area (served by MAU-3): Upon further investigation, the assessment of insufficient heating was based on the fact that a NPW pipe to one of the screens had burst during a cold period last year. It was determined that this issue was related to a problem with the booster pump system.
- Failed Basin supply air fans and exhaust air fans require replacement: this issue is part of the ongoing HVAC Improvements project (CIP No. 260619).

During the discussions with GLWA's HVAC contractor the following historical issues were noted:

- AHU-1 compressor failures: GLWA's HVAC contractor noted that there have been 4 compressor failures with the AHU-1 DX cooling coil in the past 5 years.
- Abnormally short life of Electric Unit Heaters: Per GLWA's HVAC Contractor, the Trane Electric Unit Heaters at Oakwood have a life of 2 to 3 years. The typical expected life of unit heaters that are properly selected for their environment is about 15 years.

Jacobs investigated this issue further. The Trane UHXA unit heaters in the Headworks Area have an aluminum-finned tubular steel heat exchanger that is directly exposed to the air stream in the Headworks Building when the heaters are running. Steel has very poor H₂S resistance and is a poor choice of materials for the environment the unit heaters are in. It is recommended that as the unit heaters fail they are replaced by properly rated units that have a 316 stainless steel heat exchanger and cabinet body, aluminum or 316 stainless steel fins, fan blade, and control enclosure and a motor with a corrosion-resistant protective coating that has passed the ASTM International Standard B117 salt-spray test. As such, this issue should be covered in the SRP.

- Failed Basin supply air fans, maintenance issues, and signs of advanced wear: Several basin supply air fans have failed. There have been bearing failures in the units but there is no access for bearing maintenance. The bearings are greased remotely but there is no way to verify if the grease is getting to the bearings. Despite the fact the units are only 10 years old, the bodies of the units are showing advanced signs of age. GLWA's HVAC contractor does not believe the bases of the units were properly installed; however, the manufacturer provided an inspection in 2020 and concluded that the apparent base settlement was not a concern. As noted above, these fans are being replaced as part of the HVAC Improvements project (CIP No. 260619).

During site investigations (June 2020), the following observations were noted:

- AHU-1 only had one compressor running: Although the weather on the day of the site visit was hot and humid, only one compressor was observed to be running. This underscores that most of the cooling load is driven by the heat generated by electrical equipment, which was not in service on the day of inspection. The main contributors to the cooling load in the space are the VFDs for the stormwater pumps, which rarely run. Jacobs confirmed, however, that the cooling capacity is correctly sized for the predicted heat generated by the electrical equipment when it is in service.
- MAU-4 for the Chemical Room has a complex burner control scheme: Heating output is controlled on MAU-4 by relay packs on each burner. This system is overly complicated and maintenance intensive as each relay represents a potential failure point in the system. GLWA's HVAC contractor noted that they recently had to replace the controller on the unit.

When MAU-4 fails or if maintenance issues become too costly, Jacobs recommends replacement of the unit with one that has a simpler mechanism to modulate the burner output. More efficient units with simpler control schemes are currently available. As such, this issue will be covered in the SRP.

- The Electrical Room was negatively pressurized: The Electrical Room has differential pressure control; however, the area was noted to be negatively pressurized. Electrical rooms are typically positively pressurized to reduce the ingress of dust and corrosive gases into the space. At some facilities, the incoming outside air is filtered with an activated carbon unit to remove H₂S and other corrosive airstream gases.
- MAU-1 has extensive corrosion: Extensive corrosion was noted on the interior of MAU-1. This is most likely the result of backflow of air from the Sanitary Pump Station Room. This MAU is being addressed under the ongoing HVAC Improvement project (CIP No. 260619).

11.2.5.3 Description and Evaluation of Alternatives

As noted above, the major existing HVAC issues and needs are being addressed by the ongoing HVAC capital improvement project. One issue remains and is discussed below. At this time, it is believed that this issue does not require a capital improvement.

AHU-1 Compressor Issues. The extremely high frequency of compressor replacement would suggest that AHU-1 is experiencing abnormal equipment operation. Given the dependence of the peak cooling load on stormwater VFD operation, which occurs rarely, it is likely that the compressors are short-cycling. Jacobs recommended monitoring the compressors using current transformers to determine if this is occurring. As a result of this recommendation, GLWA's mechanical contractor installed a monitoring system in August 2020. Based on review of this data, Jacobs observed that only one of the four compressors (Compressor No. 3) was operating and that it experienced occasions with extremely short cycle times where it was off for less than a minute or only ran for a minute. During the site walkthrough Jacobs noted a compressor was running when the temperature in the electrical room was 75°F despite the fact that the specified sequence of operations calls for AHU-1 to run only if the space temperature exceeds 87°F and that the sequence of operations calls for free cooling to be provided by outside air between a space temperature of 75°F and 87°F. Because AHU-1 was not operating in accordance with the sequence of operations, Jacobs recommended resetting AHU-1 to original factory settings as a next step to potentially reduce short cycle times.

Resetting the AHU did not result in a reduction in short cycle times. Jacobs then contacted Trane, which advised that minimum compressor runtimes and lockout times could be programmed into the unit.

As next steps Jacobs advises GLWA to:

- 1) Work with the mechanical maintenance provider to ensure AHU-1 is functioning as intended per the sequence of operations. As noted above, AHU-1 should economize before running any compressors.
- 2) Verify the cooling temperature setpoint in the space to determine if it has been set to an unreasonably low temperature (outside of the sequence of operations). If the temperature setting is lower than design, Jacobs recommends limiting which users can adjust the cooling setpoint.
- 3) Work with their mechanical maintenance provider to program the unit's compressors to run for a minimum of 15 minutes followed by a minimum lockout time of 15 minutes.

11.2.6 Electrical

11.2.6.1 Description of Existing System

The Oakwood facility's electrical system consists of double ended 4.8 kV, 3,000 A switchgear with dual (redundant) utility feeds, metering of the 4.8 kV feeds and an adjacent DTE substation with two 15 MVA outdoor transformers. The switchgear has a tie-breaker and automatic source transfer controls. Circuit breakers in the switchgear then feed eight storm pumps and two 2,500 kVA outdoor pad mount transformers. The 2,500 kVA transformers then feed a double ended 480 V, 3,200 A switchboard with a key interlocked tie-breaker. Circuit breakers in the switchboard then feed four MCCs and four 125 hp sanitary pumps. The MCCs then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 11-13 provides a summary of the major electrical equipment for this facility.

Table 11-13. Major Electrical Equipment at Oakwood

Location	Major Electrical Equipment	Description
Electrical Room	Double ended 4.8 kV switchgear w/ automatic source transfer	3,000 A, 4.8 kV, 3-Phase
Electrical Room	VFD (Storm Pumps)	(4) 4.8 kV, 3-Phase
Storm Pump Motor Room	Vertical turbine pumps	(2) 1,500 hp, (6) 2000 hp, 4.8 kV, 3-Phase
Outdoors	Pad Mount Transformers	(2) 2,500 kVA, 4.8 kV-480 V, 3-Phase
Electrical Room	Double ended switchboard w/ tie-breaker	3,200 A, 480 V, 3-Phase
Electrical Room	VFD (Sanitary Pumps)	(4) 480 V, 3-Phase
Sanitary Pump Room	Sanitary Pumps	(4) 125 hp, 480 V, 3-Phase
Electrical Room	MCC-1	1,200 A, 480/277 V, 3-Phase
Electrical Room	MCC-2	1,200 A, 480/277 V, 3-Phase
Screening Facility Control Room	MCC-3	1,200 A, 480/277 V, 3-Phase
Screening Facility Control Room	MCC-4	1,200 A, 480/277 V, 3-Phase

11.2.6.2 Identified Need and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the section below.

11.2.6.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project OKW-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure OKW-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Near drain vaults and effluent end of Basin – Add LED lighting fixtures to meet the required foot-candles per IES standards and meet the requirements of the local outdoor lighting ordinances for the areas.
 - Interior Basin at effluent channel – Add interior LED ceiling and wall mounted lighting fixtures within the area to address the required foot-candles and code requirements.
 - External lighting on top of Basin - Add additional light poles and LED lighting fixtures on the facility's basin, lighting foot-candles will meet the requirements of the local outdoor lighting ordinances.
 - Add power receptacles every 100 ft around the exterior of the basin at ground level.
 - Add power receptacles on the top of the basin.

The alternative evaluation is presented in Table 11-14. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$75,000, which is a relatively low cost compared to other projects recommended in this assessment.

Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.

Table 11-14. Alternative Evaluation for Electrical Improvements (Project OKW-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 262,000	\$ -	\$ 262,000	\$ 74,857	Not Applicable
	<i>Definition:</i>	Add additional lighting near drain vaults and effluent end of basin, interior basin at effluent channel, and top of basin; add power receptacles to assist workers.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

11.2.7 I&C

11.2.7.1 Description of Existing System

Control System: The original Ovation control system was installed in 2012 under PC-755. In 2015 under PC -773D, the Ovation control system controllers and software were upgraded to version O.V.3.5.0.

The existing Ovation system includes remote I/O cabinets located in the Headworks/CSO Basins that are networked to the Ovation controller/I/O cabinets and data concentrator cabinet located in the Communication Room. The system currently has one dual screen operator workstation, plus a database server with wall mounted displays and printers in the Control Room. The Ovation redundant pair of controllers provides the facility with a redundant network, controls and I/O capabilities. A 10 kVA Liebert uninterruptible power supply is used to provide constant power to the Ovation system and network. The Ovation network is equipped with primary and backup network switches. The switches are connected to the GLWA AT&T wide area network via the facility's router. The network connections inside the station are via copper Ethernet cables. All workstations and controller connections have redundant networks. The controller connections are dual-homed to provide system redundancy. Should one network fail, the backup, redundant network is available to provide station monitoring and control. The Ovation system is equipped with a backup radio system to communicate critical monitoring points back to the SCC on wide area network failure.

Flow and Level Sensors: Table 11-15 summarizes the level sensors and flow meters at the Oakwood CSO Facility and Sanitary Pump Station for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 11-15. Summary of Flow Meters and Level Sensors at Oakwood CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Storm Pump Flow Meters	8	Area Velocity
Drain to NWI Meter Vault	1	Magnetic
CSO Facility Level Sensors		
Screening Area	1	Ultrasonic
	1	Radar
Basin Influent (East and West)	2	Ultrasonic
	2	Radar
Basins (East and West)	2	Ultrasonic
	2	Radar
Basins Flush Gates (Gates 7, 8, 10, and 11)	4	Ultrasonic
NWI	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed	10	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Ultrasonic
Sanitary Pump Station Flow Meters		

Area	Quantity	Instrument Type
Pump Meter Vault (East and West)	2	Magnetic
<i>Sanitary Pump Station Level Sensors</i>		
Sanitary Wet Wells (East and West, Upstream and Downstream)	4	Ultrasonic
Sanitary Surge Relief Chamber	1	Ultrasonic

11.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Operators have indicated the human interface modules (HIMs) for the Chemical Feed Pump VFDs are difficult to operate locally.
- Eliminate basin gas monitoring.
- Minimize fire alarm systems. Elimination of fire alarm systems is not recommended at Oakwood based on the discussion in Section 5.4.7.
- Need for tank level indication at the Chemical Fill Station
- Need for process cameras at select locations to improve monitoring of facility during wet weather operation.
- Update Ovation control system
- Investigate cause of storm pump flow meter failures. Jacobs further investigated this issue. The storm pump flow meters (Teledyne Isco Inc Pro20 HotTap Insertion Meters) have experienced frequent, random outages. Jacobs investigated the issue with the manufacturer Teledyne and with technicians from PCI, who had investigated these meters. According to the Teledyne Isco Inc Pro20 HotTap installation instructions, the meter is suitable for a wide range of pipe sizes, pipe geometries, and varying hydraulic conditions. All of these installation conditions are met, which indicates the meter is being used in the proper application, but an underlying issue is still present, which is causing the random outages. In order to determine the root cause of the issue, a deeper evaluation from an instrumentation contractor familiar with these meters will be required. An allowance of \$50,000 is included in the capital cost estimate to further study this issue.
- Investigate backup flow measurement for each storm pump if the flow meter is not working properly. GLWA requested that Jacobs consider as a backup creating a programmed lookup table to estimate flow based on wet well level and pump curves. Jacobs discovered that this type of backup flow measurement was actually specified to be programmed into the control system according to the 2007 contract documents (Specification 17500 page 12) and may already exist in the software. If it is not included, it could be added by a controls system contractor. Based on this information, a capital improvement is not provided to address this issue.

11.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

I&C Improvements (Project OKW-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation

Control System Upgrade, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. There are two alternatives for this project:

1) **Alternative 1: Do Nothing/ Replace In-Kind**

- Replace Storm Pump flow meters in-kind
- Leave HIM modules for the Chemical Feed Pump VFDs in place

2) **Alternative 2: I&C Improvements** including,

- Improve local operation capabilities of chemical feed pump HIM
- Eliminate basin gas monitoring
- Provide tank level indication at Chemical Fill Station
- Provide process cameras at select locations
- Resolve existing storm pump flow meter reliability issues

Each of the I&C related improvements listed above is described further below:

Improve local operation capabilities of chemical feed pump HIM. Operators have indicated the HIMs for the chemical feed pump VFDs are difficult to operate locally. The buttons are small and navigating through the LCD screens is not intuitive or easy to use. The recommendation is to provide local control stations similar to the approach to add local control in Section 5.4.9. The VFD HIM modules would remain for troubleshooting, but operation of the chemical feed pumps will be from the local control stations.

Eliminate basin gas monitoring. Eliminate gas monitoring equipment in accordance with Section 5.4.7.

Provide tank level indication at Chemical Fill Station. Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

Resolve existing storm pump flow meter reliability issues. This issue should be further investigated by an instrumentation contractor.

The alternative evaluation is presented in Table 11-16. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 includes replacement of the Storm Pump flow meter.
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 2 include estimated annual O&M for the new cameras and new tank level indicators.

This evaluation shows that Alternative 1 – Do Nothing is the Best Value Alternative. **However, because of the improved reliability, control and operations associated with the I&C improvements, Alternative 2 is the recommended alternative.**

Control System Upgrade (OKW-I&C-2). It is recommended to update the Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2.

Because the Ovation system is the only alternative for the control system upgrade, it is the only alternative considered. Table 11-17 provides the summary of the **Control System Upgrade, which is the recommended alternative.**

Table 11-16. Alternative Evaluation for I&C Improvements (Project OKW-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	3	2.40	\$ 145,600	\$ -	\$ 145,600	\$ 60,667	Best Value Alternative
	<i>Definition:</i>	Replace Storm Pump flow meter in-kind.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to operation - flows and volumes, alarms, system status, etc.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.60	\$ 347,000	\$ 8,000	\$ 515,717	\$ 143,255	
	<i>Definition:</i>	Improve local operation capabilities of Chemical Feed Pumps; eliminate basin gas monitoring; provide tank level indication; and provide process cameras.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Higher performance, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Table 11-17. Alternative Evaluation for Control System Upgrade (Project OKW-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 1,003,000	\$ -	\$ 1,003,000	\$ 334,333	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Replace Sample Building local control panel. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Updates the control system to allow for enhanced performance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.8 Site

11.2.8.1 Description of Existing Site

Access to the site is off Pleasant Street through a 26-ft wide sliding vehicular gate. The parking lot consists of 8-in. thick reinforced concrete pavement. Roads onsite consist of 26 ft wide, 9 in. thick reinforced concrete pavement with 8-in. aggregate base designed to support HS-20 loading. There is also a gravel road going around the basin building consisting of 8 in. of aggregate. Concrete sidewalks are 4 to 5 ft wide and 4 in. thick with a 2-in. sand base. Site security is provided by a perimeter fence comprised of an 8-ft ornamental iron fence and an 8-ft chain-link fence. Stormwater runoff from the site is collected and conveyed to the storm junction chamber upstream of the pump station.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's geographic information system (GIS). Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GP) date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

11.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the following bullets.

- The current road around the basin is gravel and susceptible to potholing .
- There are areas around the basin with poor drainage, including electrical and instrumentation vaults.
- There are several locations around the perimeter of the Control Building where the concrete access sidewalk has settled, leaving uneven cracked flags of sidewalk.
- The following needs are generally preventative maintenance items intended to ensure that the site features or utilities are serviceable throughout their expected service lives.
 - Clear vegetation overgrowth from Surge Relief Basin
 - Seal joints in concrete pavement drive to ensure serviceability

11.2.8.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Site Improvements (Project OKW-SITE-1). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: Site Improvements** including,

- Add paved road around the basin
- Address drainage around the basin
- Address drainage in electrical and instrumentation vaults
- Replace settled concrete sidewalk

Each of the site related improvements listed above is described further below:

Add Paved Road Around the Basin. The access service road around the perimeter of the Control and Pump Station Buildings includes reinforced concrete pavement and gutter. However, the access road around the CSO basin is a gravel surface. A number of areas around the perimeter of the basin have experienced poor drainage, that has impacted the service drive, resulting in potholing and reducing accessibility around the CSO basin. It is recommended that the gravel service road be replaced with new reinforced concrete pavement that will extend around the perimeter of the basin connecting with the existing concrete service road on either side of the basin. See Figure OKW-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, for the location of new pavement. The concrete pavement should have a minimum 16-ft width.

Address Drainage Around CSO Basin. There are areas around the CSO basin that are poorly drained. Runoff from the CSO basin roof is collected at six scupper/downspout locations on either side of the basin and discharged to grassy areas at grade between the basin and service road on either side of the basin. These areas do not have significant slope, so basin roof discharge during wet weather tends to accumulate at grade at the base of the basin. The west side of the basin is particularly poorly drained. This may be an area that could benefit from a Green Stormwater Infrastructure solution that would feature a bioswale to collect runoff from the poorly drained grassy area between the basin and service drive. On the basin's west service drive, there is a shallow drainage swale with dimensions of approximately 360 ft by 30 ft. The area tributary to this swale includes areas surrounding its immediate perimeter.

It is recommended that the swale be excavated to increase its volume to accept the flow that is discharged from the west side of the basin roof during wet weather. Figure OKW-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, presents the proposed layout for these improvements. The flat area between the basin and existing service drive is recommended to be regraded away from the basin, and new catch basins and a storm sewer be added to capture the surface runoff and direct the flow under the service drive to discharge into the new bioswale.

Address Drainage in Electrical and Instrumentation Vaults. In the past, the basin electrical/I&C vaults on the west side of the basin had experienced flooding through electrical conduits, allowing groundwater to flow into the vaults. Per discussion with GLWA, the damaged duct-banks have been replaced and the issue of water infiltration into the vaults has been fixed. Having inspected the ground surfaces around the basin, this area should be regraded and the top of the vaults should be adjusted to avoid any surface drainage from going into these vaults. If there is still infiltration into these vaults and there is a desire to keep them free of water, a permanent sump pump should be installed in each vault.

Replace Settled Concrete Sidewalk. There are several locations around the perimeter of the Control Building where the concrete access sidewalk has settled, leaving uneven cracked flags of sidewalk. It is recommended that the damaged sections of sidewalk be removed and replaced to mitigate the potential tripping hazard created by the uneven surfaces. Expansion joints at the base of the building wall should be replaced and caulked to prevent water infiltration.

The alternative evaluation is presented in Table 11-18. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – Site Improvements has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved O&M. The NPV/Benefit cost for Alternative 2 is \$209,000, which is a moderate cost compared to other projects recommended in this assessment. However, because of the improved drainage and safety with **Alternative 2 – Site Improvements, Alternative 2 is the recommended alternative.**

Table 11-18. Alternative Evaluation for Site Improvements (Project OKW-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Potholing of gravel road; ponding water around basin; submerged electrical and instrumentation vaults; settled sidewalk.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 732,000	\$ -	\$ 732,000	\$ 209,143	Not Applicable
	<i>Definition:</i>	Replace gravel road with new reinforced concrete pavement around the basin and improve drainage around CSO Basin and drainage into electrical and instrumentation vaults. Replace settled concrete sidewalk.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Smoother road; proper drainage around basin and better access to vaults.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

11.2.9 Architectural

11.2.9.1 Description of Existing Facilities

The Oakwood facility consists of chemical room, utility support (electrical and mechanical), control room, odor control room, screen room, sampler room, storm pump room, sanitary pump room, hydraulic room, make-up air room, shipping and receiving and miscellaneous other rooms. The facility also includes the retention basins.

11.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment, as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/coverings systems
- Stairways
- Corrosion on visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

11.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (OKW-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove and replace isolation/ cove joint sealant and around building perimeter
 - Remove failed concrete floor coating, clean floor and reseal floor in Headworks and Odor Control Rooms

- Clean rust/ corrosion and coat localized areas in roof framing and beams in the Sanitary Pump Station and Headworks
- Clean and coat corroded areas of vehicle barriers and bollards
- Investigate and repair cause of water intrusion at skylight, between roof decking and skylight installation
- Remove and replace various door hardware and address corrosion on door hardware
- Clean and coat debonding paint from wall
- Clean corrosion of column base plate and apply moisture resistant coat in Pump Station Odor Control Room
- Fasten and replace damaged face brick façade flashing

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure OKW-ARCH-1-ALT-2).

The alternative evaluation is presented in Table 11-19. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, **Alternative 2 is the recommended alternative.**

Table 11-19. Alternative Evaluation for Architectural Rehabilitation (Project OKW-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 880,000	\$ -	\$ 880,000	\$ 283,871	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.10 Safety

11.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

11.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 11-20. The capital improvement project to address these issues is included in the table.

Table 11-20. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Storm Pump Station	Stairway to lower level has excessive gap at landing	Extend railing	Safety Improvements (Project OKW-SAFE-1)
Top of basin	Conduit posing a trip hazard (multiple locations)	Install conduit ramps	Safety Improvements (Project OKW-SAFE-1)
Storm Pump Station lower level	No eyewash and shower present on this level, yet there are containment jugs for hypochlorite, one of which was full and had recently overflowed onto the floor	Add eyewash and shower	Safety Improvements (Project OKW-SAFE-1)
Effluent Sample Room	Eyewash is out of service	Replace eyewash	Safety Improvements (Project OKW-SAFE-1)
Sanitary Pump Room	Illuminated exit sign not working	Replace exit sign	Exit Sign Improvements ^a
Basin Odor Control Room	Illuminated exit signs not working	Replace exit signs	Exit Sign Improvements ^a
Chemical Room	Gaps between ladder and tanks 1 and 2 at top of ladders are too large	Install step platform	Safety Improvements (Project OKW-SAFE-1)
Storm Pump Station	Gaps between ladder and motors at top of ladders are too large	Install step platform	Safety Improvements (Project OKW-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

11.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project OKW-SAFE-1). This project should address the safety issues identified above. These issues include:

- Extend railing on the stairway in the Storm Pump Station to eliminate fall hazard
- Install conduit ramps at the top of basin to eliminate trip hazard
- Replace eyewash/shower in the Storm Pump station, Effluent Sample Room, and Sanitary Pump Room
- Install step platform between ladder and tanks 1 and 2 at top of the ladder in the Chemical Room

- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency, the Table 11-21 showing the one alternative is presented below.

Table 11-21. Alternative Evaluation for Safety Improvements (Project OKW-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 338,000	\$ -	\$ 338,000	\$ 112,667	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address tripping hazards, fall protection, and eye wash.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at Oakwood CSO Facility.

11.2.12 Storm Pump Station

11.2.12.1 Description of Existing System

The storm water pump station consists of eight vertical mixed flow pumps. Design criteria is presented in Table 11-22. The pump station is divided into two equal sized wet wells. Each wet well contains one smaller pump and three larger pumps. The storm pumps are equipped with an external flushing water system for bearing cooling and lubrication. The seal water system consists of potable water piping with a dedicated seal water booster pump for each storm pump. As the wet wells fill, the storm pumps start based on the wet well levels and control system logic. The station was designed for operation using a constant-level control strategy. Features of this control strategy include narrow wet well operating range, pump speed ramping up and down, and pumps turning on/off to match a set level. This requires pumps with VFDs and a high degree of turn-down capability for the pumps.

Table 11-22. Design Criteria for Oakwood Storm Pump Station

Storm Pump No.	Design Capacity, MGD	Total Dynamic Head, ft	Drive Type
1 and 2	97	48	VFD
3, 4, 7, and 8	178	48	Constant Speed
5 and 6	178	48	VFD

11.2.12.2 Identified Needs and Issues

For the Storm Pump Station, Jacobs examined existing conditions and obtained information from O&M staff members. Many of the stormwater pumping issues were evaluated separately in a report by Brown and Caldwell dated January 15, 2019. Jacobs confirmed in June 2020 that it appeared the recommendations for the stormwater pumps had not yet been implemented.

SP1 and SP2 (small pumps) were found to have an unstable operating zone below 60 MGD at typical wet well levels and motor speeds below approximately 85 percent. Currently, the majority of SP1 and SP2 operating time is at a motor speed of 75 percent within this unstable zone. SP5 and SP6 have an unstable zone below 110 MGD (motor speeds below 80 percent). SCADA data documents significantly increased pump vibration levels and rapidly fluctuating discharge flowrates while operating in this unstable zone. Pump operation outside of the preferred operating range (POR) and especially in the unstable zone will lead to diminished reliability. Anticipated consequences include increased rate of failure of bearings and seals. The low annual runtime of the pumps may mask reliability issues related to the poor operating conditions. The recommended discharge-flowrate turn-down range for SP1, SP2, SP5 and SP6 is significantly less than the original design intent. Pumps SP3, SP4, SP7, and SP8 operate in a stable zone at all normal operating conditions.

The storm pumps operate within a narrow range of wet well levels. The pump net positive suction head (NPSH) margin was analyzed, and based on the analysis performed, it may be possible to start pump operations at a lower wet well level.

Based on this information, it was recommended that the operating setpoints be modified and tested. The potential setpoint modifications include the following:

- Operate SP1 and SP2 within a speed range of 85 to 100 percent to avoid unstable operating zones. Jacobs confirmed that, as of June 2020, this modification had not yet been made.
- Operate SP5 and SP6 within a speed range of 85 to 100 percent to avoid unstable operating zones. Jacobs confirmed that, as of June 2020, this modification had not yet been made for SP6.
- Lower lead pump shut-off WSE from EL 71-ft to EL 65-ft to reduce pump cycling on/off. Prior to implementing this recommendation, at a minimum, the submergence should be calculated for the large pumps using the equation in ANSI/HI 9.8 (Pump Intake Design) to determine if the proposed minimum WSE is feasible. A more robust study would be to perform physical model tests for low water level for the large storm pumps.
- For the near term, modify controls to provide continuous seal/lube water to all storm pumps to prevent clogging of seal water lines. Note that the facility SOP indicates that the "seal water system" is to be run continuously if the storm pump wet well level is above the bell of the storm pumps. Consider whether the modified controls will allow the seal water to run at a lower than advised wet well level, implications, and modifications to run seal water continuously under appropriate conditions. Jacobs confirmed that, as of June 2020, the seal water pumps run continuously.

The seal water systems for the storm water pumps were found to experience various operational issues. Previously, tripping of the seal water booster pump circuit breakers frequently caused failure of the storm pumps. This issue was addressed by replacing the breakers. Recently, the seal water lines have become plugged and proved difficult to clear. These events coincided with the blinding of bar rack in the sanitary PS. Because the racks were blinded, the sanitary sewage level in the storm wet well raised to nearly EL 70-ft. Exposure of the storm pump bearings to sanitary sewage floatables may have plugged the bearing flushing lines.

11.2.12.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Rehabilitate Storm Pumps (Project OKW-PUMP-1). This project would include removal of each pump for inspection in the factory and necessary rehabilitation of all eight storm pumps. The conversion of the water bearing lubrication system with a grease bearing lubrication system would be included to alleviate the plugging problems experienced in the past. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.** Continue to operate pumps in existing condition and rehabilitate at some time in the future.
- 2) **Alternative 2: Rehabilitate Storm Pumps.** This alternative includes removal of all pump rotating assemblies for inspection and rehabilitation, as necessary. The alternative also includes conversion of all pumps from a water bearing lubrication system to a grease lubrication system. This task should include: Confirm details of required modifications with pump manufacturer (Xylem/Flygt); identify the recommended type of grease; determine where the excess water for motor bearing cooling and seal water services would be conveyed (enclosing tube typically fills with grease); modifications required to seal the bottom of enclosing tube around the shaft to prevent wastewater/ grease mixing in tube; and, obtain state regulator buy-in for this modification.

This task should also evaluate and recommend the feasibility of lowering the lead pump shut-off water surface elevation from EL 71-ft to EL 65-ft in an effort to reduce pump cycling on/off. This task may require physical model tests for the large storm pumps.

The alternative evaluation for these alternatives is presented in Table 11-23. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

Due to the importance of reliable storm pumping after the diversion of additional flow from the NWI in the near future, **Alternative 2 – Rehabilitate Storm Pumps is the recommended alternative.**

Table 11-23. Alternative Evaluation for Rehabilitate Storm Pumps (Project OKW-PUMP-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.80	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do not rehabilitate pumps	Water Quality & Compliance	3						
	<i>Adv.:</i>	Same as existing	Capacity Enhancement	3						
	<i>Disadv.:</i>	Potential pump failures (i.e., plugging of seal water lines, bearing and seal failures)	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Rehabilitate Storm Pumps with Grease Lubrication System	Health and Safety	3	3.10	\$ 4,100,000	\$ -	\$ 4,100,000	\$ 1,322,581	Not Applicable
	<i>Definition:</i>	Rehab Storm Pumps and convert water bearing with grease bearing lube system	Water Quality & Compliance	3						
	<i>Adv.:</i>	More reliable operation	Capacity Enhancement	3						
	<i>Disadv.:</i>	Regulatory concerns with grease in wastewater	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.13 Sanitary Pump Station

11.2.13.1 Description of Existing System

The Sanitary Pump Station of the Oakwood CSO Facility consists of two separate wet wells (east and west) and an enclosed sanitary pump station room located at ground level. Each wet well includes a manual bar screen and two submersible sanitary sewage pumps for a total of four pumps. Even number pumps (SN2 and SN4) are located in the east wet well, while odd numbered pumps (SN1 and SN3) are located in the west wet well.

11.2.13.2 Identified Needs and Issues

For the Sanitary Pump Station, Jacobs examined existing conditions and obtained information from O&M staff members. Many of the sanitary pumping issues were evaluated separately in a report by Brown and Caldwell dated January 15, 2019.

The manual bar screen frequently become blinded, resulting in differential water levels of 12-15 ft from upstream to downstream of the bar racks. This can contribute to submergence of the storm pump intakes during dry weather flow. This issue is evaluated in the Screening section above and removal of the bar racks is recommended.

In general, the pumps have normal annual pump runtimes. Operation of east and west wells is imbalanced due to failure of the Influent Junction Chamber isolation pinch valves. Modifications to the Influent Junction Chamber are discussed in the Dewatering and Flushing section above.

The new Flygt pumps are expected to run over a range of static head that spans wet well elevation 78 down to wet well elevation 43.6, a static head range of 34.5-ft between low wet well elevation and high wet well elevation. These pumps are operating without VFDs. The Flygt pumps operate to the right side of the best efficiency point (BEP) for most operating conditions. At low wet well elevations, the pumps operate most efficiently at approximately 83 percent speed. At high wet well levels, the pumps run well to the right of the POR (nearly off of pump curve) under all speeds. At target dry weather wet well elevations, the pumps run between the minimum and maximum POR only at a pump speed of 75 to 85 percent.

When the storm pumps are operating and there is no wet weather capacity in the downstream sewer to the NWI, the control system should automatically operate the sanitary pumping system in recirculation mode, to minimize settling of grit and solids within the sanitary pump wet wells. (It is currently operated in manual.) Recirculating sanitary flow during wet weather events may be delaying the time it takes to empty the wet well and wasting energy. However, the cost/down time associated with unclogging pumps may outweigh the energy utilized to recirculate flow.

The maximum firm capacity from Sanitary PS is approximately 15 to 20 MGD. The minimum recommended flowrate for the Storm PS is approximately 65 to 75 MGD. The dead band between these two capacities significantly limits ease-of-operations for small and intermediate sized storm events based on current operating strategies.

11.2.13.3 Recommendations

The following actions are recommended to address issues identified with the sanitary pumps:

- Modify operating setpoints and test new operation. Testing would include the further development of proposed new operating procedures and setpoints, coordination with GLWA Oakwood CSO O&M staff

GLWA field Services O&M staff and execution on one or more storm events. Update O&M manual with the new operating procedures

- It is recommended that the manual operated bar racks be removed to prevent sewage backup into the storm pump intakes. See Screening Section 11.2.1 above for further discussion.

11.2.14 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Oakwood CSO facility, Table 11-24 and Table 11-25 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 11-24 and Table 11-25, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 11-24. Listing of Asset Condition Assessments for Oakwood CSO (CSO-OKW) Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	52	52	0	100%
AHU	2	0	2	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	18	18	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	4	0	4	100%
BUILDING	5	3	0	60%
CAMERA	1	1	0	100%
COMPRESSOR	1	1	0	100%
COND-AIR	7	7	0	100%
CONVEYOR	2	0	2	100%
CRANE	6	6	0	100%
CTRLPANEL	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAM	0	0	0	N/A
DAMPER	8	8	0	100%
DISCONNECT	2	2	0	100%
DOOR	7	5	2	100%
DRIVE-ELEC	0	0	0	N/A
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	4	4	0	100%
FAN	4	2	2	100%
FANVENT	39	11	28	100%
FENCE	1	1	0	100%
FIREALARM	2	2	0	100%
FIRESUPRES	1	0	0	0% ^b
GASDETECTO	1	0	0	0% ^c
GASMONITOR	5	5	0	100%
GATE	9	9	0	100%
GEARBOX	15	1	14	100%
GENERATOR	0	0	0	N/A
GRINDER	1	1	0	100%
GROUNDS	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	1	1	0	100%
MAU	3	2	1	100%
MCC	4	0	4	100%
METER	12	12	0	100%
MIXER	0	0	0	N/A
MOTOR	33	13	20	100%
PANEL	17	17	0	100%
PIPING	3	3	0	100%
PUMP	21	17	2	90% ^d
ROOF	3	3	0	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SAMPLER	1	1	0	100%
SCADA	1	1	0	100%
SCREEN	6	0	6	100%
SCRUBBER	2	0	2	100%
SENSOR	15	15	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	1	0	1	100%
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	6	0	6	100%
UNITHEATER	11	11	0	100%
UPS	5	5	0	100%
VALVE	49	49	0	100%
WATERHTR	2	2	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The fire suppression was evaluated Simplex Grinnell in 2018.

^c The one gas detector is a portable unit and was not assessed.

^d There are two sump pumps SMP-1 and SMP-2, listed in the WAM data, which were not found at the facility. These assets are being considered to be removed from the WAM data.

Table 11-25. Listing of Asset Condition Assessments for Oakwood Sewage Pump Station (SPS-OKW)

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	7	7	0	100%
AHU	1	0	1	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	0	0	0	N/A
BASIN	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
BATTERY	0	0	0	N/A
BREAKER	8	0	8	100%
BUILDING	1	0	0	0% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	1	1	0	100%
COND-AIR	0	0	0	N/A
CONVEYOR	0	0	0	N/A
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A
DAMPER	9	9	0	100%
DISCONNECT	1	1	0	100%
DOOR	3	3	0	100%
DRIVE-ELEC	12	0	12	100%
ELEVATOR	2	2	0	100%
EMERGLIGHT	0	0	0	N/A
EYEWASHSTA	0	0	0	N/A
FAN	0	0	0	N/A
FANVENT	8	1	7	100%
FENCE	0	0	0	N/A
FIREALARM	0	0	0	N/A
FIRESUPRES	0	0	0	N/A
GASDETECTO	0	0	0	N/A
GASMONITOR	0	0	0	N/A
GATE	0	0	0	N/A
GEARBOX	0	0	0	N/A
GENERATOR	0	0	0	N/A
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	0	0	0	N/A
MANHOLE	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
MAU	2	2	0	100%
MCC	0	0	0	N/A
METER	11	11	0	100%
MIXER	0	0	0	N/A
MOTOR	25	0	25	100%
PANEL	2	2	0	100%
PIPING	1	1	0	100%
PUMP	32	4	28	100%
ROOF	0	0	0	N/A
SAMPLER	0	0	0	N/A
SCADA	0	0	0	N/A
SCREEN	0	0	0	N/A
SCRUBBER	1	0	1	100%
SENSOR	6	6	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	0	0	0	N/A
SYSTEM	5	0	0	0%
TANK-PROC	0	0	0	N/A
TANK-STOR	0	0	0	N/A
TIPBUCKET	0	0	0	N/A
TRANSFRMR	0	0	0	N/A
UNITHEATER	8	8	0	100%
UPS	0	0	0	N/A
VALVE	12	12	0	100%
WATERHTR	0	0	0	N/A
^a The Oakwood – Pumping Station Building was not evaluated.				

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near

future. Based on the review of the Oakwood Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

11.3 Capital Planning for Oakwood CSO Facility

11.3.1 Summary of Capital Improvement Plan Projects

Table 11-26 provides a summary of the recommended CIP projects and associated capital costs for the Oakwood CSO facility based on the alternative evaluations conducted for this facility.

Table 11-26. Summary of Recommended Projects at Oakwood CSO Facility

Project No.	Alternative	Description	Total Project Cost
OKW-SCR-1	2	Remove Bar Racks	Capital Outlay
OKW-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 443,000
OKW-DIS-2	2	Install Flow-paced and TRC-paced Chemical Feed Control System	\$ 156,000
OKW-DIS-3	1	Reline and Provide Side Access Manways	\$ 289,000
OKW-FD-1	2	Influent Junction Chamber Isolation Improvements	\$ 289,000
OKW-FD-2	2	Reservoir Flushing Valves Relocation and Sump Flushing	\$ 536,000
OKW-ELEC-1	2	Electrical Improvements	\$ 262,000
OKW-I&C-1	2	I&C Improvements	\$ 347,000
OKW-I&C-2	1	Control System Upgrade	\$ 1,003,000
OKW-SITE-1	2	Site Improvements	\$ 732,000
OKW-ARCH-1	2	Architectural Rehabilitation	\$ 880,000
OKW-SAFE-1	1	Safety Improvements	\$ 338,000
OKW-PUMP-1	2	Rehabilitate Storm Pumps	\$ 4,100,000

11.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 11-27. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 11-27. Capital Improvement Plan Projects for Oakwood CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
OKW-1 Disinfection System Improvements	\$ 1,424,000	2026 <i>Timing based on implementation of projects before NWI diversion to ensure reliable operation with increased flows.</i>	OKW-DIS-1	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 443,000
			OKW-DIS-2	Install Flow-paced and TRC-paced Chemical Feed Control System	\$ 156,000
			OKW-DIS-3	Reline and Provide Side Access Manways	\$ 289,000
			OKW-FD-1	Influent Junction Chamber Isolation Improvements	\$ 289,000
			OKW-FD-2	Reservoir Flushing Valves Relocation and Sump Flushing	\$ 536,000
OKW-3 Facility-Wide Electrical and I&C Improvements	\$ 1,612,000	2029 <i>Timing based on asset condition</i>	OKW-ELEC-1	Electrical Improvements	\$ 262,000
			OKW-I&C-1	I&C Improvements	\$ 347,000
			OKW-I&C-2	Control System Upgrade	\$ 1,003,000
OKW-4 Site Improvements	\$ 732,000	2030 <i>Timing based on best judgement</i>	OKW-SITE-1	Site Improvements	\$ 732,000
OKW-5 Facility-Wide Safety and Architectural Improvements	\$ 1,218,000	2023 <i>Project should be initiated as soon as possible</i>	OKW-ARCH-1	Architectural Rehabilitation	\$ 880,000
			OKW-SAFE-1	Safety Improvements	\$ 338,000
OKW-6 Rehabilitate Storm Pumps	\$ 4,100,000	2022 <i>Timing based on condition</i>	OKW-PUMP-1	Rehabilitate Storm Pumps	\$ 4,100,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 11-28 and Table 11-29 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 11-28 indicates that OKW-DIS-1 project has 52 assets that have an average condition score of 1.15 and an average replacement date of 2041. However, this project should be completed before the NWI diversion to ensure reliable operation with increased flows and therefore, the project was proposed a scheduled construction completion date of 2026 instead of 2041.

Table 11-28. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
OKW-DIS-1	52	1.24	1.15	1.95	23	2041	\$ 1,819,300
OKW-DIS-3	2	2.14	1.00	3.21	15	2035	\$ 118,400
OKW-I&C-1	8	1.14	1.91	2.24	15	2031	\$ 145,600
OKW-I&C-2	1	2.29	1.57	4.08	12	2029	\$ 580,725

Table 11-29. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
OKW-DIS-1	1	1.29	5.00	4.50	10	2021	\$ 145,000
OKW-DIS-3	0	0.00	0.00	0.00	N/A	N/A	\$ -
OKW-I&C-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
OKW-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -

11.3.3 20-Year Capital Outlay Plan

Table 11-30 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 11-30. 20-Year Capital Outlay Plan for Oakwood CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 671,213	\$ 20,010	\$ 30,000	\$ -	\$ 145,000	\$ -	\$ -	\$ 429,435	\$ -	\$ -	\$ 46,768	\$ -	\$ -
2022	\$ 1,574,631	\$ -	\$ -	\$ 26,883	\$ -	\$ -	\$ 1,534,700	\$ -	\$ -	\$ -	\$ 13,048	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ 59,417	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 59,417	\$ -	\$ -	\$ -	\$ -
2025	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 4,499,155	\$ -	\$ -	\$ 4,405,601	\$ -	\$ -	\$ -	\$ 9,506	\$ 84,047	\$ -	\$ -	\$ -	\$ -
2027	\$ 37,493	\$ 37,493	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 234,006	\$ 6,149	\$ -	\$ -	\$ 205,389	\$ -	\$ -	\$ 6,887	\$ -	\$ -	\$ 15,580	\$ -	\$ -
2029	\$ 851,357	\$ -	\$ -	\$ 100,284	\$ 15,428	\$ -	\$ -	\$ -	\$ -	\$ 735,645	\$ -	\$ -	\$ -
2030	\$ 2,015,008	\$ 58,715	\$ -	\$ -	\$ 1,923,236	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 33,058	\$ -	\$ -
2031	\$ 205,384	\$ 6,988	\$ -	\$ -	\$ -	\$ 65,583	\$ -	\$ 11,020	\$ -	\$ -	\$ -	\$ -	\$ 121,792
2032	\$ 9,274	\$ -	\$ -	\$ 9,274	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 1,890,027	\$ 89,945	\$ 343,637	\$ -	\$ -	\$ -	\$ -	\$ 1,456,445	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 720,327	\$ 73,209	\$ -	\$ -	\$ 179,091	\$ -	\$ -	\$ 146,419	\$ -	\$ -	\$ 321,608	\$ -	\$ -
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 1,831,683	\$ 302,378	\$ 919,060	\$ -	\$ -	\$ -	\$ 150,961	\$ 364,288	\$ -	\$ -	\$ -	\$ 94,996	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 14,598,975	\$ 594,888	\$ 1,292,697	\$ 4,542,042	\$ 2,468,144	\$ 65,583	\$ 1,685,661	\$ 2,424,000	\$ 143,464	\$ 735,645	\$ 430,062	\$ 94,996	\$ 121,792

Notes:

Explanation of large capital outlays in first two years:

- Screening System: The screen spray water booster pump in the makeup air room was out of service at the time of the Condition Assessment. GLWA has repaired this asset since then.
- Retention System: Two reservoir fill valves (Nos. 3 and 5) in the West Basin (\$6,900 each) received a score of 5 because the valves may not open again if they are closed. One drain valve (DV-7; \$13,000) received a score of 5 because the valve body was removed from the pipeline.
- Disinfection System: One chemical feed pump (No. 6) received a score of 5 since the pump had been removed from the skid at the time of the Condition Assessment.
- Odor Control System: One carbon scrubber in the basin Odor Control Room received a score of 5 because the unit was not in service at the time of the Condition Assessment.
- HVAC System: Three exhaust fans (EF-5, EF-20, and EF-24) and four supply fans (SF-7 to 10) received a score of 5 since they have been out of service for some time. An ongoing HVAC project is addressing these units.

12. Puritan-Fenkell CSO Control Facility

12.1 General Facility Description and Future Capacity Considerations

12.1.1 General Facility Description

The Puritan-Fenkell CSO Facility is an RTB with 2.8 MG of storage and a treatment capacity of 845 cfs. It was constructed in 1996. The facility has not experienced the originally anticipated level of flows, in fact, the facility did not discharge from 2016-2018 and only a few times in 2019 and 2020. For this reason, Section 12.1.2 describes potential modifications to make this facility into a "Capture-Only" facility. A similar recommendation is made for Seven Mile CSO Facility.

The facility consists of a headworks area, chemical room, odor control room, electrical room, control room, metering room in the basement, and miscellaneous other rooms and a courtyard.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

12.1.2 Modifications to Make Puritan-Fenkell Facility into a Capture-Only Facility (PF-WWMP-1)

The WWMP recognized that "GLWA has developed a protocol to operate the Puritan-Fenkell and Seven Mile basins in capture-only mode (no treatment or discharge) for flows up to the 10-year 1-hour design storm. This finding provides a significant water quality benefit because the 1,114-acre service area can be captured, stored, and returned to the WRRF following a storm event preventing release of an estimated 700 million gallons of CSO each year."

Operating these two facilities in capture mode would allow for the cost avoidance of operating and maintaining the hypochlorite feed and storage systems and it would likely not require operations labor to be onsite during a storm event. Screening the influent flow is still recommended, particularly since the screens are already installed, to prevent large debris from entering the capture basin.

Wade Trim conducted a study ("Puritan-Fenkell and Seven Mile CSO Retention and Treatment Basins Basin Collection System and Hydraulic Analysis", dated August 29, 2019). This hydraulic study included an analysis "to evaluate the potential of operating the basins in capture-only mode as a possible operational protocol for the system. Capture basin operation was evaluated to understand the impacts on untreated overflow from the 17 Main Rouge River outfalls on the Detroit West Side system, flooding impacts of the utility tunnels within the two basins, and the risk of upstream basement flooding."

The findings of the study included:

- Limited (approximately 2 percent) increase in untreated overflow from the 17 Main Rouge River outfalls as a result of capture mode operation.
- Impact to the utility tunnels when operating in capture mode is expected for design storms between the 10-year, 24-hour and the 25-year, 24-hour storm at the Puritan-Fenkell basin. At the Seven Mile basin, design storms slightly smaller than the 10-year, 24-hour storm will begin to impact the utility tunnel.
- The evaluation of basement flooding risk shows the basins can be operated in capture mode for the 10-year, 24-hour storm without risk of basement flooding. However, during the 25-year, 24-hour storm significant basement flooding can be expected.

The report concluded that operating the basins in capture-only mode in their current configuration is not recommended due to the risk of basement flooding. The report indicated, however, that capture-only mode may be possible if high level emergency overflows are added to the basins to relieve the system during extreme events to protect basements from flooding.

To aid in the analysis of operating both Puritan-Fenkell and Seven Mile as capture-only basins, conceptual cost estimates have been generated under CS-299 for both facilities including capital improvements listed below. The Wade Trim hydraulic study provided some details regarding these issues, which are included in the description of the conceptual cost estimate; however, additional study and design will be needed.

- 1) Emergency overflow relief. The current weir wall is about 12 ft high at both facilities. A new weir wall about 20 ft high and associated structural modifications are needed at the effluent end of the basin to construct a taller weir wall (see Figure 12-1). The length of weir was not reported and should be included in the future study.
- 2) Utility tunnel flooding protection. Water-tight doors are recommended where there is access to the basin from the utility tunnel and at the influent end of the utility tunnel. The proposed doors can withstand 20-ft of static head.
- 3) Replace the existing effluent butterfly gates with flap gates. The Wade Trim report evaluated two different locations for these gates at each facility, which would prevent backflow into the facility (see Figure 12-2). Additional study should be performed to determine if these flap gates are still needed with the taller proposed weir wall.

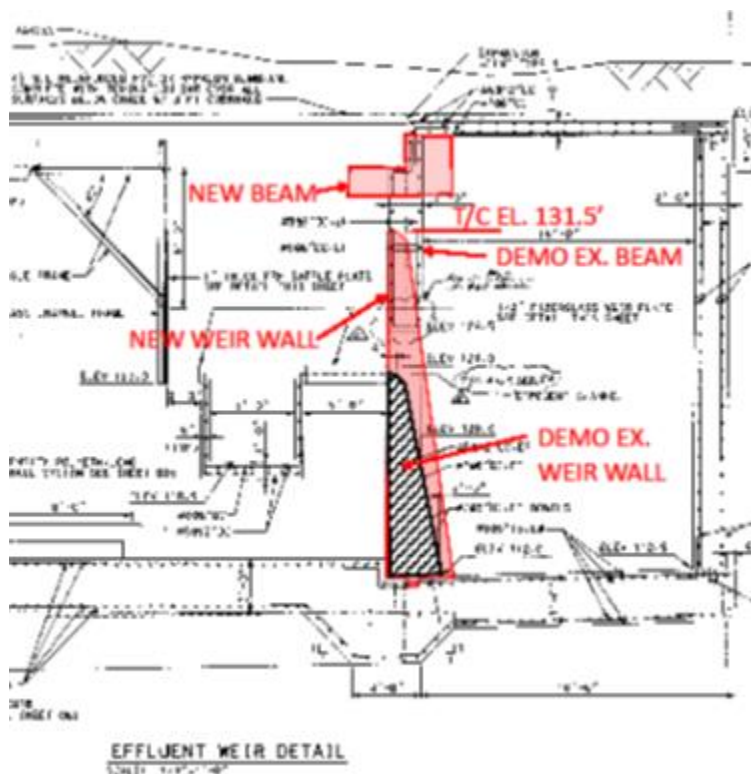


Figure 12-1. Proposed Modification to Effluent Weir Wall for Emergency Overflow Relief

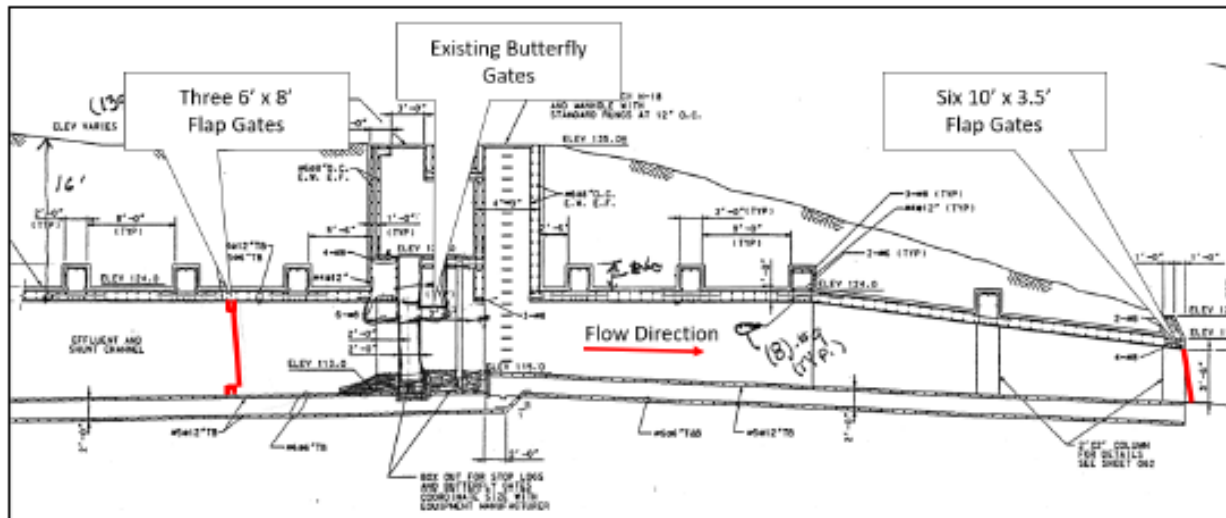


Figure 12-2. Potential Options for Flap Gate Retrofit – Puritan-Fenkell (from Wade Trim Report)

A preliminary life-cycle comparison is presented in Table 12-1. Alternative 1 represents the scenario where the facility continues to operate as an RTB. Alternative 2 represents a scenario where the facility operates in the complete capture mode. The intent of this comparison is to present the cost of the emergency overflow weirs and flap gates compared to the avoided costs associated with maintaining the disinfection system and flow meters for the flow-through treatment mode of operation. The following costs are used in this evaluation:

- The period of evaluation is assumed to be 50 years, which represents an approximate remaining life of the basin.
- For Alternative 1, the capital costs were obtained from the SRP replacement costs and include the chemical feed pumps, drives, piping, and storage tanks. It also includes the flow meters for the effluent and shunt channel. It is assumed for this analysis that all of these assets would be replaced twice during the period of evaluation.
- For Alternative 1, the O&M costs include those items that are currently needed, but would no longer be needed under a complete capture mode. These costs include Operations labor before and during storm events to make the facility ready for discharge, if necessary (assumed to be 8 storm events per year and 10 hours per storm event). Costs also include hypochlorite usage or degradation of the hypochlorite in one tank (4,000 gallons) every six months at a unit cost of \$0.90 per gallon.
- For Alternative 2, the total project cost for the modifications described for the emergency weirs and flap gates is provided in Volume 6 – Appendices, Appendix C, under PF-WWMP-1. The costs also include permitting and modeling to demonstrate and coordinate the modifications with Michigan EGLE.

As shown in Table 12-1, the Best Value Alternative is Alternative 2 – Convert to Complete Capture Basin. As such, it is recommended that this alternative be pursued through additional modeling to confirm water levels in the collection system during peak storm events and coordination with Michigan EGLE.

Table 12-1. Alternative Evaluation for Puritan-Fenkell Convert to Complete Capture Basin

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.50	\$ 2,836,400	\$ 15,200	\$ 3,702,286	\$ 1,480,914	
	<i>Definition:</i>	Do nothing. Continue to operate as an RTB	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system; no new regulatory issues	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher level of operator attention during storm events. Must maintain hypochlorite storage and feed system.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Convert to Complete Capture Basin	Health and Safety	4	3.72	\$ 2,600,000	\$ -	\$ 2,600,000	\$ 699,552	Best Value Alternative
	<i>Definition:</i>	Convert to Complete Capture Basin	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less operator attention during storm events. No O&M for hypochlorite system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires regulatory approval; Modeling confirmation of acceptability	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

12.2 Facility Assessment

12.2.1 Screening

12.2.1.1 Description of Existing System

The Puritan-Fenkell CSO Facility has three mechanically cleaned bar screens that were installed in 1996. Influent wastewater from a 12-ft diameter influent sewer enters the headworks area of the facility and flows through the screens into the basin compartments. Material collected by the screens is mechanically raked from the bar screens and deposited into a dumpster to be hauled to the landfill.

Table 12-2 provides an overview of the existing screening system at Puritan-Fenkell CSO facility.

Table 12-2. Overview of Existing Screening System at Puritan-Fenkell CSO Facility

Parameter	Value
Treatment Capacity (cfs)	845
No. of Screens	3
Manufacturer	Jones and Attwood
Screen Type	Catenary Bar Screen
Opening Size	0.5-in. spacing
Depth or Length / Width	29 ft 1 in / 9 ft 4 in
Screen Cleaning	Mechanical Rake
Screening Removal	Conveyor belt to dumpster and landfilled

12.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Provide screening retention plate along entire conveyor. Screenings from the screens occasionally fall off the conveyor at the back of the screens. A screenings retention plate would guide the discharged screenings to the middle of the conveyor belt.
- Replace conveyor belt as corrugated sidewall part of belt has torn off from large sections of the belt.
- Need for automatic start for screens and belt.
- Change location of screen controls.
- Prevent screens from swaying during operation. During higher flow events, the screens reportedly sway to some degree. The operators believe this is caused by the returning rake getting tossed by the rapid flow of water and affecting the rest of the screen. They noted that the Conner Creek screens (which is a similar screen but does not sway) has chain guide returns that extend closer to the floor of the channel. This issue was added to the scope of the OEM evaluation; however, the OEM was unable to see the swaying because flow did not occur during the site visit. If this issue causes problems in the future, it should be video-taped to document the issue.

- Address worn teeth on screen rakes. The OEM condition assessment assessed the condition of the screen components. They noted some rakes had a significant amount of corrosion, but they did not indicate the need for replacement.
- Provide improved means to install stop logs in influent area. GLWA requested a means for installing the stop logs with a permanent type of system. The channels for the stop logs for each screen are very close to Headworks building wall (see drawing in Figure 12-3). The reach of the overhead crane is unable to lower the logs directly into place.

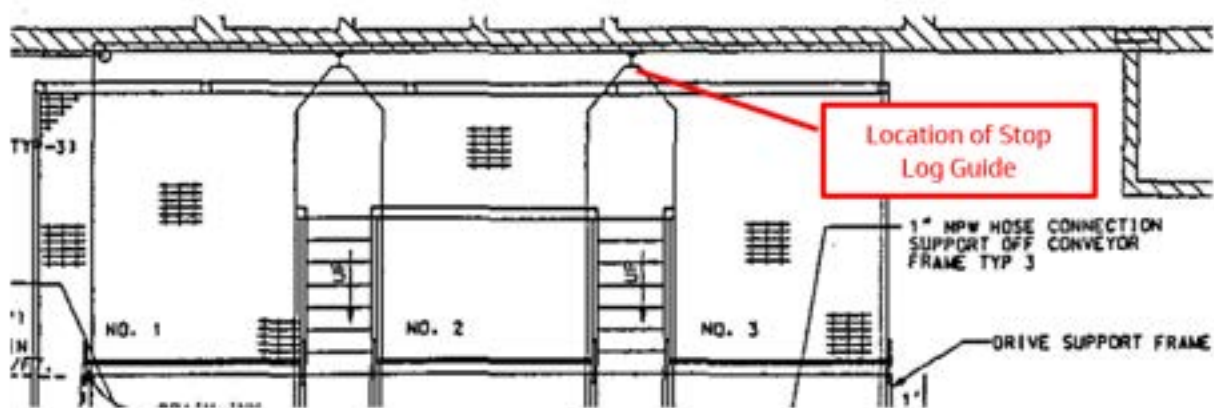


Figure 12-3. Location of Stop Log Guides at Puritan-Fenkell Headworks

It should be noted that a sluice gate is proposed upstream of the sanitary pumps (and downstream of the screens) in the Flushing and Dewatering section (Section 12.2.4). This will allow isolation of the sanitary wet well from the rest of the facility.

It should also be noted that one of the screen channels has the influent channel running through the bottom of the opening. It is not clear how the existing stop log were intended to stop flow, given the 2 ft by 2 ft channel running through the bottom of the channel floor. Furthermore, all of the stop logs would need to be installed (and the channel properly isolated) to isolate the screen channel during a wet weather event because there is no stop log on the downstream side of the screen.

Jacobs investigated installing sluice gates. Based on the hydraulic profile, gates with 18 ft height and 10 ft width would be needed. This size would require two leaf gates; however, there is not enough room for two leaves. The gates could be shorter height if designed for a smaller storm event. Then, one gate could be used. The proposed gates would normally reside in the “up” position, out of the water channel and be lowered using an actuator when needed.

Given the infrequent need for installing the stop logs and the redundancy of the screens, it is suggested that a temporary means of installing the stop logs should be utilized when screen replacement or major rehabilitation is required.

12.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Screening Improvements (Project PF-SCR-1). Due to the relatively small nature of some of the screening-related issues identified as improvements, all of the identified screening improvements are proposed to be in one project – Screening Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: Screening Improvements** including,

- Screening retention plate along entire conveyor
- New conveyor belt
- Provide programming modifications for automatic start for screens and belt
- Relocate screen controls.

Each of the screening related improvements listed above is described further below:

Screening Retention Plate Along Entire Conveyor. Screenings from the screens occasionally fall off the conveyor at the back of the screens. A screenings retention plate would guide the discharged screenings to the middle of the conveyor belt. A cost for a screening retention plate (similar to screening retention plate at Conner Creek) is included in the capital cost estimate.

New conveyor belt. A new conveyor belt is recommended, as opposed to rehabilitating the existing belt. The cost estimate includes a new belt.

Provide programming modifications for automatic start for screens and belt. Programming modifications to provide automatic start of the screen and conveyor belt based on influent water level (for the screens) and start of screens (for the conveyor belt).

Relocate screen controls. The screen control box is located on the wall next to the conveyor. During screening operation, access to this location requires the operator to stand by a discharging screen. Although the screening plate may reduce splatter, it may still occur.

The alternative evaluation is presented in Table 12-3. The sources of costs used in this evaluation are listed below:

- Capital costs for Alternative 2 are presented in Volume 6 – Appendices, Appendix C under this project title.
- The difference in O&M costs between the two alternatives will be negligible.

This evaluation shows that Alternative 2 has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M. The NPV/Benefit cost for Alternative 2 is \$66,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – Screening Improvements is the recommended alternative.**

Table 12-3. Alternative Evaluation for Screen Improvements (Project PF-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Operator needs to be present to start screen.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Screening Improvements	Health and Safety	4	3.50	\$ 230,000	\$ -	\$ 230,000	\$ 65,714	Not Applicable
	<i>Definition:</i>	Provide screening retention plate, new conveyor belt, automatic screen and conveyor	Water Quality & Compliance	3						
	<i>Adv.:</i>	Operator does not need to be present to start screen, cleaner/safer operation	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

12.2.2 Disinfection

12.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP tanks, four gear pumps, two induction mixers, and two in basin mixers. There are three screens discharging into a common influent channel to Basins 1 or 2. There are two induction mixers located upstream of the bar screens and two submersible mixers with chemical feed, one in each basin. The sodium hypochlorite pumps discharge to a common header with a flow meter that splits to the two induction mixers, Basin 1 mixer, and Basin 2 mixer. Although there are flow indicators after the split to the two induction mixers, flow splitting is not metered and there does not appear to be any basis to achieve equal flow splitting. Currently, operations primarily feed to the basin mixers and if they suspect a strong chlorine demand in the influent, they will also feed to the two induction mixers in the influent.

Table 12-4 provides an overview of the existing disinfection system at Puritan-Fenkell CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G.

Table 12-4. Overview of Existing Disinfection System at Puritan-Fenkell CSO Facility

Parameter	Value
Treatment Capacity (cfs)	845
Design Feed Strength (% hypochlorite)	5
Max. Dosage at Design Flow (mg/L Cl ₂)	10 @ 845 cfs
Disinfection Contact Time (min)	20
Storage Tanks	
Number	2
Volume of Each Tank (gal)	4,000
Type	FRP
Pumps	
Number	4
Capacity (gpm)	20
Type	Gear
Mixers	
Number / Type	2 / Chemical induction mixers
Model Number/ hp / Manufacturer	SWC5R / 5 hp / Water Champ
Number/Type	2 / Submersible mixers
Model Number / hp / Manufacturer	4600-Series / 20 / Flygt

12.2.2.2 Identified Needs and Issues

The needs and issues identified for Puritan-Fenkell were identified from meetings with O&M staff and Jacobs team site visit and investigations. These needs and issues are summarized as follows:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Puritan-Fenkell chemical feed system has the following issues:
 - No flow metering to individual feed points to control the feed split
 - Consider need to enlarge area to accommodate alternative type of pumps.
 - Evaluate possibility of gravity feed from the chemical tanks with a meter and control valve. Jacobs evaluated the possibility of this type of feed system. The effluent weir from the CSO basins

controls the hydraulic grade line at the influent induction mixers to above elevation 124 once the basin is filled. The bottom of the sodium hypochlorite tanks are at approximately elevation 142 and the maximum liquid depth is approximately 8 ft. Thus, there is approximately 18 ft of static head available with the tanks empty and 26 ft with the tanks full. This corresponds to 7.8 pounds per square in. gauge (psig) empty to 11.2 psig full available head. The induction mixers require back pressure valves to prevent siphoning chemical. Evoqua recommends a setting of 15 psig. Therefore, the available static head is inadequate for gravity feed before even accounting for friction loss and flow control valve loss. Thus, continued pumping as the means of chemical delivery is recommended.

The first two issues are addressed in Replace Chemical Feed System (Project PF-DIS-1).

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project PF-DIS-2) below.

12.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project PF-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, PF-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.

It should be noted that hose pumps will be larger than the existing gear pumps and the need to enlarge the pump area was considered to verify the feasibility of this alternative. The Bredel 65 pumps have a base of 29 in. by 28 in. The pump and motor cantilever beyond the base plate and pad and have maximum dimensions of 42 in. by 46 in. The existing pump area is about 5 ft wide and 18 ft long excluding the doors. If one pump were provided per feed point using the pump distribution alternative, then there would be 5 pumps including a spare. This would fully consume the approximate 18 foot length with no space between the pumps for maintenance or access. Thus, the pump area would need to be expanded for this alternative. The separate pump containment could be eliminated, and the pumps located on pads at a sufficient height for spill protection. This is reflected in the cost estimate for this alternative.

- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

The alternative evaluation for these alternatives is presented in Table 12-5. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP.

- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 were estimated based on manufacturer pump rebuilds at a cost of \$7,500 per year.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 12-5 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Note that this project would not be recommended if the basin is converted to complete capture.

Table 12-5. Alternative Evaluation for Replace Chemical Feed System (Project PF-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System in-kind	Health and Safety	3	2.08	\$ 340,000	\$ 7,500	\$ 498,172	\$ 239,123	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 687,000	\$ 4,410	\$ 780,005	\$ 216,668	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed utilizing Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 383,000	\$ 3,000	\$ 446,269	\$ 123,964	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project PF-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose using an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The storm pump flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on storm pump flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the chemical dosing point to further adjust chemical feed flows. The sampling location would be near the influent end of the basin and near the bottom portion of the basin (to be able to measure TRC concentrations before the effluent sample point).

The automatic chemical feed system will require less operator input during an event. However, there will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 12-6. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains functional between storm events.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Note that this project would not be recommended if the basin is converted to complete capture.

Table 12-6. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project PF-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed Control System	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Replace existing chemical feed control system utilizing current level of controls and	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Install Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 220,000	\$ 4,860	\$ 322,496	\$ 93,477	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common of CSO facilities, but TRC-pacing is difficult	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

12.2.3 Odor Control

12.2.3.1 Description of Existing System

The Puritan-Fenkell odor control system consists of two separate odor control systems. One system treats foul air from the Headworks and pump station wet well area and the other treats foul air from the basins. Each system includes a scrubber tower, recirculation pump, caustic feed system, hypochlorite feed system, and an odor control fan. The original system was designed to feed sodium hydroxide and sodium hypochlorite; however, the sodium hydroxide has not been used for some time. The scrubber tower contains 5.5 ft of plastic media with a chemical spray section located above the media.

The system was installed in 1996. Overall, the system is in good condition. The odor control system does not have an air permit.

Per GLWA, no odor complaints have been received for at least the past 3 years.

12.2.3.2 Identified Needs and Issues

During meetings with O&M staff related to the odor control system, no needs were identified. The recommendation in this section is based on Jacobs evaluation of the existing system.

Potential Reduction of Odor Treatment during Operation. The facility does not have an air permit and is not required to operate the odor control system. The facility may not generate significant odors during wet weather events due to dilution of sewage with storm water. Storm water significantly reduces the concentration of sulfide and other odorous compounds in sewage. Odors may be more prevalent during the dewatering phase caused by odors from settled solids but may still be low. Due to the expected low odors from the facility, GLWA may want to consider operating the scrubber systems with water only and no sodium hypochlorite. Removal of H_2S is dependent on the H_2S concentration. Removal will be significantly less with only water, but there may be relatively low levels of H_2S to remove. Another option, which provides even less treatment, would be to operate the system without water and blow air through an empty scrubber system and out the stack.

Under both of these options, the discharged air may be non-odorous or sufficiently diluted with ambient air to render it non-odorous. Prior to implementing either one of these options, GLWA could sample influent air to the existing scrubber system for H_2S to determine if the H_2S concentration is sufficiently low. A non-detectable concentration of H_2S in the influent air means the systems can likely operate without sodium hypochlorite or water.

12.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement "needs."

12.2.4 Flushing and Dewatering

12.2.4.1 Description of Existing System

Dewatering System: Water from the basin can be dewatered by gravity after a storm event. There are also three dewatering pumps used to dewater the basin. Dewatered flow is conveyed to the NWI.

Flushing System: There are a total of 16 tipping buckets on the side walls of both basin compartments and the influent channels. City water is used to fill the tipping buckets.

Table 12-7 provides an overview of the existing flushing and dewatering system at Puritan-Fenkell CSO facility.

Table 12-7. Overview of Existing Flushing and Dewatering System at Puritan-Fenkell CSO Facility

Parameter	Value
Total Basin Volume (MG)	2.8
Headworks and basin Dewatering and Flushing System	- There are three 3,200-4,500 gpm dewatering pumps 7 tipping buckets for each basin (14 total) 2 tipping buckets in influent distribution channel

12.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- There is no way to achieve positive isolation between the dry weather and wet weather wet wells
- The bearing assemblies for the tipping buckets are inaccessible for periodic inspection
- A number of actuators on the flushing lines have been removed and not replaced
- The dewatering force main from the CSO facility to the NWI is inaccessible but may require future inspection and cleaning
- O&M staff noted that a water spray system is needed near the influent and dewatering pumps to clean the platform and grating around the area

12.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Isolation of Sanitary and Dewatering Wet Well (Project PF-FD-1). The Puritan-Fenkell CSO facility continuously functions as a lift station for dry weather flows using two dry weather submersible pumps. These pumps and associated wet well are fed through a low-flow trough in the influent channel and they are adjacent to the basin dewatering pumps and their associated wet well. Currently, there is no secure way to achieve positive isolation between the dry weather and wet weather wet wells and GLWA O&M staff requested this be provided.

There are two alternatives for this project:

- Alternative 1: Do Nothing.**
- Alternative 2: Wet Well Improvements.** In 2013, Metco prepared a basis of design report, with a figure and cost estimate to provide a new 30-in. by 30-in. stainless steel gate on the influent to the dry weather wet well. See Volume 6 – Appendices, Appendix B, for figures (Figure PF-FD-1-ALT-2) of the proposed layout.

O&M staff noted that a water spray system is needed near the influent and dewatering pumps to clean the platform and grating around the area. An NPW line running from the Control Building to the hypochlorite storage room could be tapped and routed to the catwalk area located below the

Headworks floor. Multiple water cannons could be arranged to adequately clean the area. See Volume 6 – Appendices, Appendix B, for figures (Figure PF-FD-1-ALT-2) for a conceptual layout.

The alternative evaluation for these alternatives is presented in Table 12-8. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.5 higher than the Do Nothing Alternative (Alternative 1) based on the increased ease of O&M and component performance provided by the added wet well isolation and spray system. The NPV/Benefit cost for Alternative 2 is \$24,000, which is a relatively low cost compared to other projects recommended in this assessment. As such, **Alternative 2 – Wet Well Improvements is the recommended alternative.**

Access to Tipping Buckets (Project PF-FD-2). O&M staff noted that the bearing assemblies for the tipping buckets are inaccessible; however, they require periodic inspection. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Provide Access to Tipping Buckets for Maintenance.** This alternative consists of constructing manhole openings above each adjoining set of rotating groups. A total of 19 manhole openings are required, including one over each bearing assembly on the end tipping buckets.

The bearing assemblies are located in an unpaved area atop of the basins. Installation requires excavating to the top of the existing roof slab. A 24-in. opening will be cored through the roof, and manhole grade rings set/doweled over the opening and extended to 6 in. above the existing ground surface to prevent runoff intrusion. A standard 24-in. manhole ring and lid will be set and bolted to the grade rings, and the excavation backfilled around the new access point. Final restoration will include lawn seeding.

The costs include extending a 0.5-in. metal grease tube and grease gun fitting from each bearing assembly to within 6 in. of the surface at the nearest new manhole opening (two zerks per manhole, one each at the end tipping buckets). After consultation with the tipping bucket gate manufacturer, regular greasing of the bearings is not required for the model of tipping buckets installed at the Puritan-Fenkell CSO Facility. GLWA may elect to install the access for better visual confirmation of tipping bucket condition and operation and better access to limit switches at each bearing assembly. Figures PF-FD-2-ALT-2, included in Volume 6 – Appendices, Appendix B, show the conceptual layout of this improvement.

Finally, a number of actuators have been removed and not replaced. The replacement of these actuators has been included in the cost estimate.

The alternative evaluation for these alternatives is presented in Table 12-9. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and increased ease of O&M provided by the improved access to the tipping bucket bearings. The NPV/Benefit cost for Alternative 2 is \$27,000, which is a relatively low cost compared to other projects recommended in this assessment. **As such, Alternative 2 – Provide Access to Tipping Buckets for Maintenance is the recommended alternative.**

Table 12-8. Alternative Evaluation for Wet Well Improvements (Project PF-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Unable to isolate between the dry weather and wet weather wet wells.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Wet Well Improvements	Health and Safety	3	3.32	\$ 79,000	\$ -	\$ 79,000	\$ 23,819	Not applicable
	<i>Definition:</i>	Provide a sluice gate on the influent to wet well. Install water spray system	Water Quality & Compliance	3						
	<i>Adv.:</i>	Simple system to provide isolation of Sanitary and Dewatering wet well.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Table 12-9. Alternative Evaluation for Access to Tipping Buckets (Project PF-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Inaccessible bearing assemblies for the tipping buckets.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Access to Tipping Buckets for Maintenance	Health and Safety	4	3.50	\$ 95,000	\$ -	\$ 95,000	\$ 27,143	Not applicable
	<i>Definition:</i>	Construct 19 manhole openings, including one over each bearing assembly on the end tipping buckets	Water Quality & Compliance	3						
	<i>Adv.:</i>	Access for better visual confirmation of tipping bucket condition and operation and better access to limit switches at each bearing assembly	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

Access to Dewatering Force Main (Project PF-FD-3). GLWA noted that the dewatering force main from the CSO facility to the NWI is inaccessible but will require future inspection and cleaning. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Access to Dewatering Force Main for Inspection and Cleaning.** This alternative consists of the installation of cleanouts at the following locations: 1) at the end of the force main, southwest of the siphon head chamber in Manhole No. 1 for cleaning of the force main, 2) northeast of the Manhole No. 1 before the inverted siphon, and 3) on the east side of the Rouge River, just before Manhole No. 2. (See Figure PF-FD-3-ALT-2 included in Volume 6 – Appendices, Appendix B.)

The alternative evaluation for these alternatives is presented in Table 12-10. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.6 higher than the Do Nothing Alternative (Alternative 1) based on the increased ease of O&M and improved component performance provided by the ability to access the force main. The NPV/Benefit cost for Alternative 2 is \$27,000, which is a relatively low cost compared to other projects recommended in this assessment. **As such, Alternative 2 –Access to Dewatering Force Main is the recommended alternative.**

Table 12-10. Alternative Evaluation for Access to Dewatering Force Main (Project PF-FD-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Dewatering forcemain from the CSO facility to the NWI remains inaccessible.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Access to Dewatering Force Main for Inspection and Cleaning	Health and Safety	3	3.32	\$ 90,000	\$ -	\$ 90,000	\$ 27,136	Not applicable
	<i>Definition:</i>	Install cleanouts at a number of locations.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Access to the dewatering forcemain from the CSO facility to the NWI for future inspection	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

12.2.5 HVAC

12.2.5.1 Description of Existing System

The Puritan-Fenkell CSO facility consists of a headworks area, chemical room, odor control room, electrical room, control room, metering room in the basement, and miscellaneous other rooms and a courtyard. The facility also includes the retention basins. Table 12-11 provides summary of the major equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, emergency shower/eye wash, regular shower, and drinking fountain. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 12.2.10.

Table 12-11. Major HVAC Equipment at Puritan-Fenkell CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	HVU-2	Heating and Ventilating Unit	11,100 CFM
	EF-5	Exhaust Fan	10,000 CFM
Basin	SF-1 and 2	2 × Supply Fans (Basin Ventilation)	97,000 CFM
	SF-3	Supply Fan (Shunt Valve Chamber)	2,300 CFM
	SF-4	Supply Fan (Effluent Valve Chamber)	2,300 CFM
	EF-7	Exhaust Fan (Shunt Channel Valve Chamber)	400 CFM
	EF-8	Exhaust Fan (Effluent Valve Chamber)	400 CFM
	UH-1	Unit Heater (Shunt Channel Valve Chamber)	400 CFM 17.0 MBH
	UH-2	Unit Heater (Effluent Valve Chamber)	400 CFM 17.0 MBH
Odor Control Room	HVU-1	Heating Ventilating Unit	4,700 CFM
	EF-5	Exhaust Fan	4,700 CFM
Electrical Room	PACU-1	Heating Ventilating Unit	2,200 CFM

Table 12-12 provides a summary of the basis of design performance criteria for HVAC systems at Puritan-Fenkell and Table 12-13 provides the outdoor Basis of Design conditions.

Table 12-12. Puritan-Fenkell Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Retention Basin	Class I, Group D, Div 1	N/A	N/A	10 ACH
Headworks and Pump Room	Class I, Group D, Div 1	60	N/A	12 ACH
Odor Control Room	Unclassified for areas greater than 3 ft from odor control vessel. Class I, Group D, Div 2 for areas closer than 3 ft.	70	N/A	10 ACH
Electrical Room, Work Room, Office, Toilet, Etc.	Unclassified	70	78	2 cfm/ft ²
Basement (Magnetic Meter Room)	Unclassified	70	N/A	6 ACH
NaOCl Storage Room	Unclassified	60	N/A	6 ACH

Table 12-13. Puritan-Fenkell Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

12.2.5.2 Identified Needs and Issues

During the Needs Assessment meetings with GLWA O&M staff, the following HVAC issues were noted:

- PACU-1 requires replacement.
- HVU-1 in Odor Control Room requires replacement.
- Supply and exhaust fans in Shunt Channel and Effluent Channel require replacement.

During the discussions with GLWA's HVAC contractor the following historical issues were noted:

- PACU-1 requires constant maintenance to keep running: GLWA's HVAC contractor noted that PACU-1 has had a multitude of problems including damper problems, actuator problems, refrigerant leaks and wiring issues.
- HVU-1 locks out at least once a week.
- HVU-3 is very difficult to service due to location.

During site investigations (June 2020), the following observations were noted:

- PACU-1 was down for repair and GLWA's HVAC contractor staff were working on it on the day the site investigation took place.
- The exhaust fan was off in the Headworks Area

- Improvements are needed for code compliance in the Odor Control and Headworks Areas
- SF-1 and SF-2 were functional but had corroded bases

12.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

HVAC Improvements (Project PF-HVAC-1). Due to the numerous HVAC-related assets that require replacement in-kind and the additional need to provide monitoring for code compliance in the Odor Control Room and Headworks, all of the identified HVAC improvements are proposed to be in one capital improvement project – HVAC Improvements. As such, there is only one alternative for this project, which includes:

- PACU-1 Replacement
- Improvements to Enhance Safety in Odor Control Area
- Improvements to Enhance Safety in Headworks Area
- HVU-1 and 2 Replacement
- HVU-3 Replacement (with improved access)
- SF-1 and SF-2 Replacement
- Exhaust Fan Replacement
- Removal of Shunt Channel and Effluent Channel HVAC Equipment

Each of the HVAC-related improvements listed above are described further below:

PACU-1 Replacement. Given the age of PACU-1 (24 years), the lengthy history of various issues, and the fact that the unit was undergoing repair the day of site walkthrough, replacement of PACU-1 with a more efficient modern unit and controls is recommended.

Improvements to Enhance Safety in Odor Control Area. The Odor Control area is classified as a Class I, Division 2 space under NFPA 820 if it is not continuously ventilated at a rate of 6 ACH. The space does not meet the 6 ACH ventilation requirement and does not currently have electrical equipment rated for a Class I, Div 2 environment. HVU-1 is designed to provide 10 ACH of ventilation air in cooling mode but was sized to provide only 2 ACH of outside air in heating mode. Additionally, EF-2 is only designed to operate in cooling mode at 10 ACH. NFPA 820 requires both supply and exhaust fans to operate continuously to declassify odor control areas.

Given the age of HVU-1 and EF-2 and the problems HVU-1 is exhibiting, Jacobs recommends replacement of both units. HVU-1 and EF-2 could be replaced with units with two-speed fans or VFDs to provide 6 ACH continuously during ventilation and heating and 10 ACH in cooling mode.

Regardless of whether the space is unclassified by providing 6 ACH of outside air, NFPA 820 requires the installation of combustible gas detection in the Odor Control area with audible and visible alarms at all entrances to the Odor Control area and within the space.

If ventilation is used to declassify the space as described above, ventilation flow monitoring of both the supply and exhaust fan is required with visible and audible alarms of a low or no flow condition required at entrances and within the space.

Improvements to Enhance Safety in Headworks Area. HVU-2 serves the Headworks Area, which is classified as a Class I, Division 1 space per the design drawings. Given its age, and general condition, it should be replaced. Because the electrical equipment in the space is rated for a Class I, Division 1

environment continuous ventilation and ventilation flow monitoring are not required. NFPA 820 does, however, require combustible gas detection with visible and audible alarms at the entrances to the Headworks area and inside the space, which the Headworks area currently does not have. Jacobs recommends making this change to comply with NFPA 820.

HVU-3 Replacement (relocated with improved access). HVU-3 is currently mounted high in the Metering Room in the basement making access for maintenance very difficult (Figure 12-4). Placing HVU-3 lower in the space would make access to the magnetic meter and associated piping very difficult, which is likely the reason the decision to mount the unit high in the space was made. Jacobs recommends replacing HVU-3 with a unit mounted on a concrete pad on the North side of the building when HVU-3 requires replacement. There is an existing opening for the Meter Room supply air duct, which could be utilized by the outdoor unit. This approach would allow ample space for maintenance and would make removal much easier. Currently, HVU-3 will need to be removed in sections when replacement is necessary.



Figure 12-4. HVU-3 Located in Difficult to Access Location Located in Inaccessible Area

SF-1 and SF-2 Replacement. SF-1 and 2 are functional despite having corroded bases (Figure 12-5). These units will require replacement in the near future.



Figure 12-5. Corroded Supply Fan Bases – View from Above (left) and View from Below (right)

Exhaust Fan Replacement. There are five relatively small exhaust fans that are original to the facility and should be included in the replacement project.

Removal of Shunt Channel and Effluent Channel HVAC Equipment. The unit heater, supply and exhaust fans in the Shunt Channel and Effluent Channel are not used and are inoperable. These units could be retired. Portable ventilation could be utilized, if necessary, when operators need to enter these areas.

The alternative evaluation is presented in Table 12-14. **The capital cost for Alternative 1, which is the recommended alternative,** is included in Volume 6 – Appendices, Appendix C under this project title.

Table 12-14. Alternative Evaluation for HVAC Improvements (Project PF-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	3	3.00	\$ 810,000	\$ -	\$ 810,000	\$ 270,000	Best Value Alternative
	<i>Definition:</i>	Facility-wide HVAC Improvements	Water Quality & Compliance	3						
	<i>Adv.:</i>	Code compliance, less emergency maintenance, improved asset reliability.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.6 Electrical

12.2.6.1 Description of Existing System

The Puritan-Fenkell electrical system consists of one DTE utility feed from a 750 kVA, 480/277 V, 3-Phase outdoor transformer (secondary metering) and diesel generator feed from a 400 kW, 480/277 V, 3-Phase stationary generator. The feeds are connected to a 1,200 A MDP with electrically operated breakers and automatic source transfer controls for a 1,200 A bus. The MDP has breakers that feed MCCs and distribution panels. The MCCs and distribution panels then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 12-15 provides a summary of the major electrical equipment for this facility.

Table 12-15. Major Electrical Equipment at Puritan-Fenkell

Location	Major Electrical Equipment	Description
Electrical Room	Main distribution panel with ATS	1,200 A, 480/277 V, 3-Phase
Courtyard	Generator (Diesel)	400 kW, 480/277 V, 3-Phase
Electrical Room	MCC-1	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-2	600 A, 480/277 V, 3-Phase

12.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the following section.

12.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project PF-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure PF-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Wet Well Chamber Area – Add LED lighting fixtures within the area to address the required foot-candles and code requirements.
 - Effluent channel – Add interior LED ceiling and wall mounted lighting fixtures within the area to address the required foot-candles and code requirements.
 - Basin – Add additional basin interior explosion-proof LED lighting fixtures to provide lighting within the Basins. Lighting to meet the required foot-candles and codes for the area.
 - Add exterior power receptacles to assist in the maintenance and operations of the facility including receptacles every 100 ft on the backside exterior of the facility at ground level.

The alternative evaluation is presented in Table 12-16. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$59,000, which is a relatively low cost compared to other projects recommended in this assessment.

Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.

Table 12-16. Alternative Evaluation for Electrical Improvements (Project PF-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe due to poorer lighting at night	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 205,000	\$ -	\$ 205,000	\$ 58,571	Not applicable
	<i>Definition:</i>	Add additional lighting in wet well chamber area, effluent channel, and basins. Provide exterior power receptacles.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

12.2.7 I&C

12.2.7.1 Description of Existing System

Control System: The original Allen Bradley control system was installed in 1996 under PC-697. Since then, several modifications to the original system have taken place. These upgrades provided the ability to locally and remotely monitor the operations of the facility and the overall collection system, including from the SCC. The control system and workstation software are Allen Bradley PLC-5 redundant PLCs with Rockwell RSView software. The existing hardwired backup control panel and other miscellaneous PLCs and subsystems were also incorporated into the overall control system. The current PLC-5 control system, workstations and backup panels are obsolete, and do not meet GLWA SCADA Governance standards, which stipulate that all CSO facilities use Ovation workstations with new high-performance graphics. The current system is equipped with a backup radio system to communicate critical monitoring points back to SCC on wide area network failure.

Flow and Level Sensors: Table 12-17 summarizes the level sensors and flow meters at the Puritan-Fenkell CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 12-17. Summary of Flow Meters and Level Sensors at Puritan-Fenkell CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent (Storm sewer)	1	Transit-Time (AccuSonic)
Shunt Channel	1	Transit-Time (AccuSonic)
Effluent Overflow Weir	2	Ultrasonic ^a
Basin Dewatering	1	Magnetic
CSO Level Sensors		
Influent (Storm Sewer)	1	Ultrasonic
Shunt Channel	1	Ultrasonic
Screening Area (Upstream and downstream of bar racks)	2	Ultrasonic
Basins	2	Ultrasonic
Wet Well	1	Ultrasonic
	1	Radar
Effluent	1	Ultrasonic
River	1	Ultrasonic
Chemical System Flow Meters		
Process Water	1	Magnetic
Chemical Feed	1	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Pressure

^a Ultrasonic level sensor readings are used to measure height of water to allow calculation of effluent flow rate.

12.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Replacement options for valve control network for the chemical feed system is discussed in detail in Section 5.4.6. The cost/benefit of the hardwired control was not favorable and therefore was not considered further.
- Need for tank level indication at Chemical Fill Station
- Need for process cameras at select locations
- Update Ovation control system

12.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project PF-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation Control System Upgrade, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: I&C Improvements** including,

- Provide tank level indication at Chemical Fill Station
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Provide tank level indication at Chemical Fill Station. Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 12-18. The sources of costs used in this evaluation are listed below:

- The O&M costs for Alternative 2 include estimated annual maintenance costs for the additional instrumentation provided.
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – I&C Improvements, has a total benefit score about 0.3 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and ease of O&M provided by the various I&C improvements. The NPV/Benefit cost for Alternative 2 is \$53,000, which is a relatively lost cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – I&C Improvements is the recommended alternative.**

Table 12-18. Alternative Evaluation for I&C Improvements (Project PF-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	3.00	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 70,000	\$ 5,000	\$ 175,448	\$ 52,899	Not applicable
	<i>Definition:</i>	Install tank level indication and process cameras.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Control System Upgrade (Project PF-I&C-2). The current facility's PLC control system, network, workstations and control system backup panels are obsolete and should be replaced in the near future. The control system does not meet GLWA SCADA Governance standards, which require that all CSO facilities use Ovation workstations with new high-performance graphics. GLWA's standards for local CSO facility's control systems can be either the latest Allen Bradley PLC system with Ovation workstations or a complete Ovation system. This approach is being used on an ongoing project at Leib, Seven Mile, and St. Aubin.

Because of the approach used on the ongoing project, there is only one overall control system alternative considered. The project should include decommissioning and removal of the original hardwired backup local control panels. These local panels are no longer required with today's redundant control system processors and local Operator Interface Terminal (OIT) as local backup to the facility's workstations.

Table 12-19 provides the summary of the **Control System Upgrade, which is the recommended alternative**. Capital costs are included in Volume 6 – Appendices, Appendix C under this project title. Consideration should be given to replacing various field instruments during this project; however, these are not included in the capital costs.

Table 12-19. Alternative Evaluation for Control System Upgrade (Project PF-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 2,323,000	\$ -	\$ 2,323,000	\$ 774,333	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved performance, standardized HMI screens, can have standardized redundant "on-the-shelf" parts.	Capacity Enhancement	3						
	<i>Disadv.:</i>	No performance related disadvantages.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.8 Site

12.2.8.1 Description of Existing Site

Access to the site is off of Five Mile Road through a 25-ft wide swing gate. Site security is provided by a perimeter fence comprised of an 8-ft chain-link fence. The parking lot consists of 4-in. thick asphalt pavement with 8-in. gravel base. Sidewalks are 5 ft wide and consist of 4 in. of concrete with a 4-in. sand base. Site utilities include watermain, gas, sanitary and electric.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

12.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the section below.

- Removal and installation of effluent stop logs is difficult.
- Rain gutters and downspouts are not installed, causing roof runoff to pond around the sidewalk, creating a safety issue for personnel accessing the building.
- Entrance Gate. The existing entrance security gate at the site is a 25-ft wide swing gate. This gate has been experiencing recurring maintenance issues recently and has reached the end of its useful service life. The gate should be replaced with a rolling gate.
- Repair cracks in asphalt parking lot surface.

The following issues were addressed under "*GLWA-CON-1902040 Site Improvements at P-F Detention Facility and Leib Screening and Disinfection Facility*" Contract and are not included in the capital improvement projects for CS-299.

- Extend Security Fence. The existing security fencing only extends around three sides of the Control Headworks Building and Basin. The river side of the site is not fenced.
- Address Drainage on Basin. The overburden cover on top of the basin roof is poorly drained and typically remains saturated for several days following a rain event. Service trucks with equipment have trouble navigating the basin roof while the soil is saturated.

12.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Stop Log Removal System for Effluent Gates (Project PF-Site-1). Removal and installation of stop logs is difficult. There are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

- 2) **Alternative 2: Stop Log Removal System for Effluent Gates.** A davit arm crane is recommended at the three hatch openings of the effluent gates and stop logs to assist in removal of hatch covers, the installation and removal of stop logs and other equipment from the effluent butterfly gate vault. A small area in the vicinity is recommended to be paved with concrete for temporary storage of stop logs.

Additionally, construction of a service road would assist access to the effluent gate vault site. Because the Puritan-Fenkell facility is located in a City park, the appearance of the service drive must blend in with the grass covered surroundings. It is recommended that the installed service road consist of an engineered fill base that will support a grass paver surface that will eventually support vegetation growth to better blend in with the natural surroundings, while giving vehicles access to the effluent gates. The service drive will extend from the existing Eliza Howell office parking lot and will be about 16 ft wide and approximately 265 ft long. Since this is in City park, it will likely require an easement. See Figure PF-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, for the conceptual layout.

The alternative evaluation is presented in Table 12-20. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.4 higher than the Do Nothing Alternative (Alternative 1) based on the improved O&M. The NPV/Benefit cost for Alternative 2 is \$75,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – Stop Log Removal System for Effluent Gates, is the recommended alternative.**

Table 12-20. Alternative Evaluation for Stop Log Removal System for Effluent Gates (Project PF-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Removal and installation of stop logs is difficult.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Stop Logs Removal System for Effluent Gates	Health and Safety	3	3.22	\$ 240,000	\$ -	\$ 240,000	\$ 74,611	Not applicable
	<i>Definition:</i>	A davit arm crane is recommended at the three hatch openings of the effluent gates and stop logs to assist in removal of hatch covers, the installation and removal of stop logs and other equipment from the effluent butterfly gate vault.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Ease of removal and installation of stop logs.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

General Site Improvements (Project PF-SITE-2). The roof on the Puritan-Fenkell Control and Headworks Buildings was recently replaced. However, rain gutters and downspouts were not installed. Roof runoff currently runs to the front of the Control Building and drops to grade where it tends to pond around the sidewalk, creating icy conditions during the winter and a safety issue for personnel accessing the building.

The Courtyard in the Headworks area has an open roof and is exposed to rain and snow falling on its floor surface. There are scuppers in the base of the south wall of the Courtyard to allow runoff to drain through the Courtyard wall onto the basin roof surface outside the wall. The Courtyard floor, however, does not provide adequate slope for the runoff to flow to the scuppers and consequently ponds on the floor surface.

This project also includes replacement of the entrance gate and restoration of the pavement.

There are two alternatives to address these issues:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: General Site Improvements:** It is recommended that a rain gutter and downspouts be added to the Control and Headworks Buildings to capture roof runoff and funnel it away from the building at grade. The Courtyard in the Headworks area has an open roof and is exposed to rain and snow falling on its floor surface. There are scuppers in the base of the south wall of the Courtyard to allow runoff to drain through the Courtyard wall onto the basin roof surface outside the wall. The Courtyard floor, however, does not provide adequate slope for the runoff to flow to the scuppers and consequently ponds on the floor surface. To alleviate the water ponding on the Courtyard floor, it is recommended that holes be cored through the courtyard floor to the basin below. Recessed area drains can be installed in the cored holes to funnel floor drainage to the basin.

This alternative also includes replacement of the entrance gate and restoration of the pavement.

The alternative evaluation is presented in Table 12-21. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved O&M. The NPV/Benefit cost for Alternative 2 is \$34,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – General Site Improvements, is the recommended alternative.**

Table 12-21. Alternative Evaluation for General Site Improvements (Project PF-SITE-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.62	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Safety concern related to ponding water and security issue with non-functioning gate	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	General site Improvements	Health and Safety	4	3.28	\$ 112,000	\$ -	\$ 112,000	\$ 34,112	Not applicable
	<i>Definition:</i>	Install rain gutter and downspouts; repair pavement	Water Quality & Compliance	3						
	<i>Adv.:</i>	Safety concern with ponding is eliminated	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.9 Architectural

12.2.9.1 Description of Existing Facilities

The Puritan-Fenkell CSO facility consists of chemical room, utility support (electrical), control room, odor control room, screen room, miscellaneous other rooms and a courtyard. The facility also includes retention basins.

12.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment, as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the ongoing Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff raised the following issues:

- It was identified that the existing basin access is through a 4 ft by 6 ft hatch with temporary wooden stairs and these stairs are not code-compliant.
- There is no access to the Headworks area and the Courtyard during a power outage.

These two issues are being addressed in an ongoing project under a JOC.

12.2.9.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (PF-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:

- Remove and replace sealant around doors, windows and other wall penetrations
- Remove and replace sealant at all control/ expansion wall joints

- Remove and replace isolation/ cove joint sealant and around building perimeter
- Remove and replace cracked façade limestone panels
- Replace damaged/stained/missing acoustic ceiling tiles in Control Building
- Address door hardware issues
- Clean, prepare surface and coat stained CMU walls in the Headworks

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure PF-ARCH-1-ALT-2). Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 12-22. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, Alternative 2 is the recommended alternative.

Table 12-22. Alternative Evaluation for Architectural Rehabilitation (Project PF-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 351,000	\$ -	\$ 351,000	\$ 113,226	Not applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.10 Safety

12.2.10.1 Description of Existing System

Safety-related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

12.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 12-23. The capital improvement project to address these issues is included in the table.

Table 12-23. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Odor Control Room	No tempering valve on eyewash/shower	Provide tempering valve	Safety Improvements (Project PF-SAFE-1)
Chemical Room	Emergency eyewash/shower outside containment	Add eyewash/shower inside tank containment	Safety Improvements (Project PF-SAFE-1)
Chemical Room	Emergency eyewash/shower 0943390 outside containment	Add eyewash/shower inside tank containment	Safety Improvements (Project PF-SAFE-1)
Basement stairwell	No illuminated exit signs	Add exit signs	Exit Sign Improvements ^a
Headworks	Illuminated exit signs not working	Replace exit signs	Exit Sign Improvements ^a
Utility tunnel	Illuminated exit signs not present	Add exit signs	Exit Sign Improvements ^a
Utility Tunnel Access	Illuminated exit signs are out. Exit signs missing in locations.	Add or replace exit signs.	Exit Sign Improvements ^a
Utility Tunnel	Ladder at end of tunnel has an exit sign but hatch is locked.	Add placard to fixed ladder "Not An Exit." Replace existing exit sign with directional exit sign away from ladder access.	Exit Sign Improvements ^a
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project PF-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

12.2.10.3 Description and Evaluation of Needs and Issues

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project PF-SAFE-1). This project should address the safety issues identified above. These issues include:

- Provide tempering valve on eyewash/shower in the Odor Control Room
- Add eyewash/shower outside containment in the Chemical Room
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 12-24 shows the one alternative.

Table 12-24. Alternative Evaluation for Safety Improvements (Project PF-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 126,000	\$ -	\$ 126,000	\$ 42,000	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection, and eye wash.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at Puritan-Fenkell CSO Facility.

12.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Puritan-Fenkell CSO facility, Table 12-25 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 12-25, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 12-25. Listing of Asset Condition Assessments for Puritan-Fenkell Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	34	34	0	100%
AHU	3	0	3	100%
AIRDRYER	1	1	0	100%
BACKFLOW	2	2	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	0	0	0	N/A
BUILDING	2	1	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	1	1	0	100%
COND-AIR	1	1	0	100%
CONVEYOR	1	0	1	100%
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAM	0	0	0	N/A
DAMPER	6	6	0	100%
DISCONNECT	0	0	0	N/A
DOOR	3	3	0	100%
DRIVE-ELEC	4	4	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	2	2	0	100%
FAN	2	0	2	100%
FANVENT	11	9	2	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	0	0	0% ^b
GASMONITOR	2	2	0	100%
GATE	15	15	0	100%
GEARBOX	4	0	4	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUND	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	0	0	0	N/A
MCC	3	0	3	100%
METER	8	8	0	100%
MIXER	6	6	0	100%
MOTOR	8	0	8	100%
PANEL	7	7	0	100%
PIPING	4	4	0	100%
PUMP	19	11	5	84% ^c
ROOF	2	2	0	100%
SAMPLER	2	1	0	50% ^d
SCADA	2	2	0	100%
SCREEN	3	0	3	100%
SCRUBBER	2	0	2	100%
SENSOR	12	12	0	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	2	2	0	100%
TANK-STOR	2	2	0	100%
TIPBUCKET	1	1	0	100%
TRANSFRMR	2	0	2	100%
UNITHEATER	3	3	0	100%
UPS	1	1	0	100%
VALVE	27	27	0	100%
WATERHTR	1	1	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The one gas detector is a portable unit and was not assessed.

^c Three inactive pumps are listed in WAM - Basin 1 Sample Pump, Basin 2 Sample Pump, and Shunt Channel Sample Pump. These pumps are being considered for removal from WAM.

^d The Shunt Sampler 1 is listed in WAM. This sampler is being considered for removal from WAM.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Puritan-Fenkell Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

12.3 Capital Planning for Puritan-Fenkell CSO Facility

12.3.1 Summary of Capital Improvement Plan Projects

Table 12-26 provides a summary of the recommended CIP projects and associated capital costs for the Puritan-Fenkell CSO facility based on the alternative evaluations conducted for this facility.

Table 12-26. Summary of Recommended Projects at Puritan-Fenkell CSO Facility

Project No.	Alternative	Description	Total Project Cost
PF-WWMP-1	2	Convert to Complete Capture Basin	\$ 2,600,000
PF-SCR-1	2	Screening Improvements	\$ 230,000
PF-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 383,000
PF-DIS-2	2	Install Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
PF-FD-1	2	Wet Well Improvements	\$ 79,000
PF-FD-2	2	Provide Access to Tipping Buckets for Maintenance	\$ 95,000
PF-FD-3	2	Access to Dewatering Force Main for Inspection and Cleaning	\$ 90,000
PF-HVAC-1	1	HVAC Improvements	\$ 810,000
PF-ELEC-1	2	Electrical Improvements	\$ 205,000
PF-I&C-1	2	I&C Improvements	\$ 70,000
PF-I&C-2	1	Control System Upgrade	\$ 2,323,000
PF-SITE-1	2	Stop Log Removal System for Effluent Gates	\$ 240,000
PF-SITE-2	2	General Site Improvements	\$ 112,000
PF-ARCH-1	2	Architectural Rehabilitation	\$ 351,000
PF-SAFE-1	1	Safety Improvements	\$ 126,000

12.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 12-27. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 12-27. Capital Improvement Plan Projects for Puritan-Fenkell CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
PF-1 Convert to Complete Capture Basin	\$ 2,600,000	2030 <i>Timing based on general CSO project priorities</i>	PF-WWMP-1	Convert to Complete Capture Basin	\$ 2,600,000
PF-2 Disinfection System Improvements	\$ 603,000	2032 <i>Timing based on asset condition</i>	PF-DIS-1	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 383,000
			PF-DIS-2	Install Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
PF-3 Flushing System Improvements	\$ 616,000	2032 <i>Timing based on best judgement</i>	PF-FD-1	Wet Well Improvements	\$ 79,000
			PF-FD-2	Provide Access to Tipping Buckets for Maintenance	\$ 95,000
			PF-FD-3	Access to Dewatering Force Main for Inspection and Cleaning	\$ 90,000
			PF-SITE-1	Stop Log Removal System for Effluent Gates	\$ 240,000
			PF-SITE-2	General Site Improvements	\$ 112,000
PF-4 HVAC Improvements	\$ 810,000	2027 <i>Timing based on asset condition</i>	PF-HVAC-1	HVAC Improvements	\$ 810,000
PF-5 Facility-Wide Electrical and I&C Improvements	\$ 2,598,000	2029 <i>Timing based on asset condition</i>	PF-ELEC-1	Electrical Improvements	\$ 205,000
			PF-I&C-1	I&C Improvements	\$ 70,000
			PF-I&C-2	Control System Upgrade	\$ 2,323,000
PF-6 Facility-Wide Safety and Architectural Improvements	\$ 477,000	2023 <i>Project should be initiated as soon as possible</i>	PF-ARCH-1	Architectural Rehabilitation	\$ 351,000
			PF-SAFE-1	Safety Improvements	\$ 126,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 12-28 and Table 12-29 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 12-29 indicates that PF-DIS-1 project has one asset that needs to be replaced immediately due to condition score of "5". This asset, however, has already been replaced/rebuilt since the Condition Assessment was conducted in Summer 2020. The remaining nine assets that are included in this project have an average condition score of 1.27 and an average replacement date of 2032 (See Table 12-28). This information was used to propose a scheduled construction completion date of 2032.

Table 12-28. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
PF-DIS-1	9	1.67	1.27	2.75	12	2032	\$ 311,400
PF-HVAC-1	10	1.19	1.47	2.06	20	2039	\$ 306,011
PF-I&C-2	2	2.29	1.57	4.08	12	2029	\$ 1,397,075
PF-SCR-1	1	1.43	1.89	2.78	20	2034	\$ 146,071

Table 12-29. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
PF-DIS-1	1	1.29	5.00	4.50	10	2021	\$ 29,000
PF-HVAC-1	1	2.57	5.00	9.00	20	N/A	\$ 63,500
PF-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -
PF-SCR-1	0	0.00	0.00	0.00	N/A	N/A	\$ -

12.3.3 20-Year Capital Outlay Plan

Table 12-30 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 12-30. 20-Year Capital Outlay Plan for Puritan-Fenkell CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 142,700	\$ -	\$ -	\$ -	\$ 29,000	\$ -	\$ -	\$ 113,700	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 314,150	\$ -	\$ -	\$ 314,150	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 42,024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 42,024	\$ -	\$ -	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 29,886	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 29,886	\$ -
2029	\$ 1,842,719	\$ 34,375	\$ 7,714	\$ 15,428	\$ -	\$ 15,428	\$ -	\$ -	\$ -	\$ 1,769,773	\$ -	\$ -	\$ -
2030	\$ 668,481	\$ 109,601	\$ -	\$ 260,955	\$ 243,993	\$ -	\$ 20,876	\$ -	\$ -	\$ -	\$ 33,057	\$ -	\$ -
2031	\$ 891,017	\$ 14,111	\$ -	\$ 876,905	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 33,718	\$ -	\$ 8,429	\$ 25,288	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 475,484	\$ 13,217	\$ 214,511	\$ -	\$ -	\$ -	\$ 19,238	\$ 228,519	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 841,458	\$ 34,790	\$ -	\$ 579,615	\$ 90,453	\$ -	\$ -	\$ 12,403	\$ -	\$ -	\$ 96,782	\$ -	\$ 27,416
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 2,185,352	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2,185,352	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 1,060,565	\$ 16,292	\$ -	\$ -	\$ -	\$ 558,909	\$ 216,549	\$ 268,814	\$ -	\$ -	\$ -	\$ -	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 8,527,553	\$ 222,386	\$ 230,654	\$ 2,072,341	\$ 363,445	\$ 574,337	\$ 256,664	\$ 623,437	\$ 2,227,376	\$ 1,769,773	\$ 129,839	\$ 29,886	\$ 27,416

Notes:

Explanation of large capital outlays in first two years:

- Retention System: Two influent slide gate (SG-1 and SG-5; \$157,000 each) received a score of 5 since they were locked out of service at the time of the Condition Assessment.
- HVAC System: One AHU (HV-1, \$63,500) was out of service at the time of inspection. Two electric unit heaters (\$19,500 each) , two supply fans (SF-3 and SF-4; \$3,000 each), and two exhaust fans (EF-7 and EF-8; \$2,600 each) received a score of 5 due to severe corrosion on the units and have been out of service for some time.

13. Seven Mile CSO Control Facility

13.1 General Facility Description and Future Capacity Considerations

13.1.1 General Facility Description

The Seven Mile CSO Facility is an RTB with 2.2 MG of storage and a treatment capacity of 655 cfs through the treatment system. It was constructed in 1997. Since it was constructed, the facility has rarely discharged, with one recorded event of 490,000 gallons of discharge in 2014 from a nearly 6-in. rain event. For this reason, Section 13.1.2 describes potential modifications to make this facility into a "Capture-Only" facility. A similar recommendation is made for the Puritan-Fenkell CSO Facility.

The facility consists of a headworks area, chemical room, odor control room, electrical room, control room, metering room in the basement, and miscellaneous other rooms and a courtyard.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

13.1.2 Modifications to Make Seven Mile Facility into a Capture-Only Facility (SM-WWPM-1)

The WWMP recognized that "GLWA has developed a protocol to operate the Puritan-Fenkell and Seven Mile basins in capture-only mode (no treatment or discharge) for flows up to the 10-year 1-hour design storm. This finding provides a significant water quality benefit because the 1,114-acre service area can be captured, stored, and returned to the WRRF following a storm event preventing release of an estimated 700 million gallons of combined sewer overflow each year."

Operating these two facilities in capture mode would allow for the cost avoidance of operating and maintaining the hypochlorite feed and storage systems, and it would likely not require operations labor to be onsite during a storm event.

Wade Trim conducted a study ("Puritan-Fenkell and Seven Mile CSO Retention and Treatment Basins Basin Collection System and Hydraulic Analysis", dated August 29, 2019). This hydraulic study included an analysis "to evaluate the potential of operating the basins in capture-only mode as a possible operational protocol for the system. Capture basin operation was evaluated to understand the impacts on untreated overflow from the 17 Main Rouge River outfalls on the Detroit West Side system, flooding impacts of the utility tunnels within the two basins, and the risk of upstream basement flooding."

The findings of the study included:

- Limited (approximately 2 percent) increase in untreated overflow from the 17 Main Rouge River outfalls as a result of capture mode operation.
- Impact to the utility tunnels when operating in capture mode is expected for design storms between the 10-year, 24-hour and the 25-year, 24-hour storm at the Puritan-Fenkell basin. At the Seven Mile basin, design storms slightly smaller than the 10-year, 24-hour storm will begin to impact the utility tunnel.
- The evaluation of basement flooding risk shows the basins can be operated in capture mode for the 10-year, 24-hour storm without risk of basement flooding. However, during the 25-year, 24-hour storm significant basement flooding can be expected.

The report concluded that operating the basins in capture-only mode in their current configuration is not recommended due to the risk of basement flooding. The report indicated, however, that capture-only

mode may be possible if high level emergency overflows are added to the basins to relieve the system during extreme events to protect basements from flooding.

To aid in the analysis of operating both Puritan-Fenkell and Seven Mile as capture-only basins, conceptual cost estimates have been generated under CS-299 for both facilities including capital improvements listed below. The Wade Trim hydraulic study provided some details regarding these issues, which are included in the description of the conceptual cost estimate; however, additional study and design will be needed.

- 1) Emergency overflow relief. The current weir wall is about 12 ft high at both facilities. A new weir wall about 20 ft high and associated structural modifications are needed at the effluent end of the basin to construct a taller weir wall. The length of weir was not reported and should be included in the future study.
- 2) Utility tunnel flooding protection. Water-tight doors are recommended where there is access to the basin from the utility tunnel and at the influent end of the utility tunnel. The proposed doors can withstand 20 ft of static head.
- 3) Replace the existing effluent butterfly gates with flap gates. The Wade Trim report evaluated two different locations for these gates at each facility, which would prevent backflow into the facility (see Figure 13-1 below showing one of the locations, which was used for the cost estimate). Additional study should be performed to determine if these flap gates are still needed with the taller proposed weir wall.

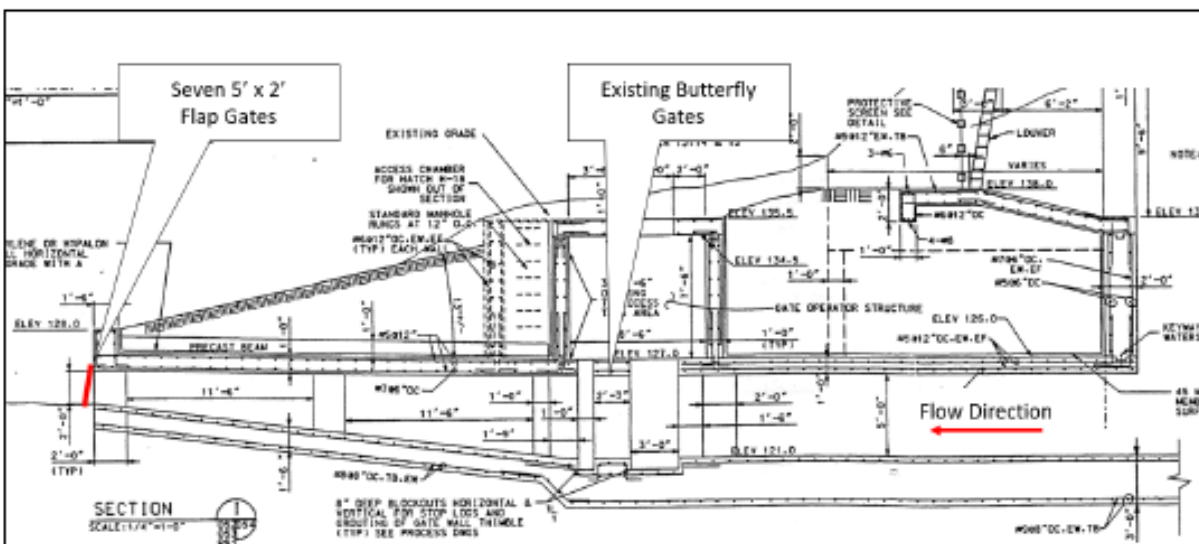


Figure 13-1. Potential Options for Flap Gate Retrofit – Seven Mile (from Wade Trim report)

A preliminary life-cycle comparison is presented in Table 13-1. Alternative 1 represents the scenario where the facility continues to operate as an RTB. Alternative 2 represents a scenario where the facility operates in the complete capture mode. The intent of this comparison is to present the cost of the emergency overflow weirs and flap gates compared to the avoided costs associated with maintaining the disinfection system and flow meters for the flow-through treatment mode of operation. The following costs are used in this evaluation:

- The period of evaluation is assumed to be 50 years, which represents an approximate remaining life of the basin.
- For Alternative 1, the capital costs were obtained from the SRP replacement costs and include the chemical feed pumps, drives, piping, and storage tanks. It also includes the flow meters for the

effluent and shunt channel. It is assumed for this analysis that all of these assets would be replaced twice during the period of evaluation.

- For Alternative 1, the O&M costs include those items that are currently needed, but would no longer be needed under a complete capture mode. These costs include Operations labor before and during storm events to make the facility ready for discharge, if necessary (assumed to be 8 storm events per year and 10 hours per storm event). Costs also include hypochlorite usage or degradation of one tank (2,400 gallons) every six months at a unit cost of \$0.90 per gallon.
- For Alternative 2, the total project cost for the modifications described for the emergency weirs and flap gates is provided in Volume 6 – Appendices, Appendix C, under SM-WWMP-1. The costs also include Permitting and Modeling to demonstrate and coordinate the modifications with Michigan EGLE (assumed to be \$100,000).

As shown in Table 13-1, the Best Value Alternative is Alternative 2 – Convert to Complete Capture Basin. As such, it is recommended that this alternative be pursued through additional modeling to confirm water levels in the collection system during peak storm events and coordination with Michigan EGLE.

Table 13-1. Alternative Evaluation for Seven Mile to Convert to Complete Capture Basin

Alt.	Description			Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.		Health and Safety	2	2.50	\$ 2,531,000	\$ 12,320	\$ 3,232,823	\$ 1,293,129	
	<i>Definition:</i>	Do nothing. Continue to operate as an RTB		Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system; no new regulatory issues		Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher level of operator attention during storm events. Must maintain hypochlorite storage and feed system.		Component Performance	3						
	<i>Comments:</i>	None		O&M Ease	2						
2	<i>Alt. Name:</i>	Convert to Complete Capture Basin		Health and Safety	4	3.72	\$ 2,500,000	\$ -	\$ 2,500,000	\$ 672,646	Best Value Alternative
	<i>Definition:</i>	Convert to Complete Capture Basin		Water Quality & Compliance	3						
	<i>Adv.:</i>	Less operator attention during storm events. No O&M for hypochlorite system.		Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires regulatory approval; Modeling confirmation of acceptability		Component Performance	3						
	<i>Comments:</i>	None		O&M Ease	5						

13.2 Facility Assessment

13.2.1 Screening

13.2.1.1 Description of Existing System

The Seven Mile CSO Facility has two bar screens that were installed in 1997. Influent wastewater enters the facility from the Seven Mile Sewer and is routed through the screens to the basin compartments. Material collected by the screens is mechanically raked from the bar screens and deposited into individual dumpsters to be hauled to a landfill.

It should be noted that this facility is planned to become a complete capture facility with emergency overflow to prevent basement flooding based on the recommendations from the WWMP. It is recommended that the screens remain at the facility to prevent large debris from entering the facility.

Table 13-2 provides an overview of the existing screening system at Seven Mile CSO facility.

Table 13-2. Overview of Existing Screening System at Seven Mile CSO Facility

Parameter	Value
Treatment Capacity (cfs)	655
No. of Screens	2
Manufacturer	E & I Corporation
Screen Type	Catenary Bar Screen
Opening Size	0.5-in. spacing
Depth or Length / Width	23 ft 0 in. / 9 ft 6 in.
Screen Cleaning	Mechanical Rake
Screening Removal	Conveyor belt to dumpster and landfilled

13.2.1.2 Identified Needs and Issues

There were no needs identified by GLWA or the Jacobs team.

13.2.1.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no screening-related issues that that would be classified as capital improvement "needs."

13.2.2 Disinfection

13.2.2.1 Description of Existing System

This facility was constructed in 1996 and has rarely discharged. Recent studies have been conducted under the WWMP recommending that this basin be modified from a treatment basin to a complete capture basin. Under this scenario, the disinfection system would not be used. As such, it is recommended that the disinfection system be removed or moth-balled at this site.

Table 13-3 provides an overview of the existing disinfection system at Seven Mile CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G.

Table 13-3. Overview of Existing Disinfection System at Seven Mile CSO Facility

Parameter	Value
Treatment Capacity (cfs)	655
Design Feed Strength (% hypochlorite)	5
Max. Dosage at Design Flow (mg/L Cl ₂)	10 @ 655 cfs
Disinfection Contact Time (min)	30
Storage Tanks Number Volume of Each Tank (gal) Type	2 2,400 FRP
Pumps Number Capacity (gpm) Type	4 20 Gear
Mixers Number / Type Model Number/ hp / Manufacturer	1 / Chemical induction mixers Series 32 / 10 hp / Gas Mastrrr

13.2.2.2 Identified Needs and Issues

The disinfection system should ultimately be demolished and removed from this facility. This includes the chemical storage tanks, chemical feed pumps, piping and associated electrical and instrumentation components. These costs are included in the conversion to a complete capture basin.

13.2.2.3 Description and Evaluation of Alternatives

There were no disinfection-related issues identified by the GLWA or the Jacobs team that would be classified as capital improvements “needs”.

13.2.3 Odor Control

13.2.3.1 Description of Existing System

The Seven Mile odor control system consists of one cross-current vertical scrubber vessel that treats air from the Headworks area and basins. The system includes a scrubber tower, recirculation pump, caustic addition system, sodium hypochlorite addition system and an odor control fan. The scrubber tower contains 5.5 ft of plastic media with a chemical spray section located above the media. The original system was designed to feed sodium hydroxide and sodium hypochlorite; however, the sodium hydroxide has not been used for some time.

The system was installed in 1997. Overall, the system is in good condition. The odor control system does not have an air permit.

Per GLWA, no odor complaints have been received for at least the past three years.

13.2.3.2 Identified Needs and Issues

During meetings with O&M staff related to the odor control system, no needs were identified. The recommendation in this section is based on Jacobs evaluation of the existing system.

Potential Reduction of Odor Treatment during Operation. The facility does not have an air permit and is not required to operate the odor control system. The facility may not generate significant odors during wet weather events due to dilution of sewage with storm water. Storm water significantly reduces the concentration of sulfide and other odorous compounds in sewage. Odors may be more prevalent during the dewatering phase caused by odors from settled solids but may still be low. Due to the expected low odors from the facility, GLWA may want to consider operating the scrubber systems with water only and no sodium hypochlorite. Removal of H_2S is dependent on the H_2S concentration. Removal will be significantly less with only water, but there may be relatively low levels of H_2S to remove. Another option, which provides even less treatment, would be to operate the system without water and blow air through an empty scrubber system and out the stack.

Under both of these options, the discharged air may be non-odorous or sufficiently diluted with ambient air to render it non-odorous. Prior to implementing either one of these options, GLWA could sample influent air to the existing scrubber system for H_2S to determine if the H_2S concentration is sufficiently low. A non-detectable concentration of H_2S in the influent air means the systems can likely operate without sodium hypochlorite or water.

13.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement “needs”.

13.2.4 Flushing and Dewatering

13.2.4.1 Description of Existing System

Dewatering System: There are three dewatering pumps and one sump pump used to dewater the basin after a storm event. Dewatered flow is pumped to the NWI.

Flushing System: There are 14 tipping buckets on the side walls of both basin compartments and the influent channels. City water is used to fill the tipping buckets.

Table 13-4 provides an overview of the existing flushing and dewatering system at Seven Mile CSO facility.

Table 13-4. Overview of Existing Flushing and Dewatering System at Seven Mile CSO Facility

Parameter	Value
Total Basin Volume (MG)	2.2
Headworks and basin Dewatering and Flushing System	- There are three 2,000 gpm dewatering pumps 6 tipping buckets for each basin (12 total) 2 tipping buckets in influent distribution channel

13.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Provide access to tipping buckets for inspection
- Provide access to dewatering force main for inspection and cleaning

13.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Access to Tipping Buckets (Project SM-FD-1). O&M staff noted that the bearing assemblies for the tipping buckets are inaccessible; however, they require periodic inspection and greasing.

There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Provide Access to Tipping Buckets for Maintenance.** This alternative provides access for visual inspection of the tipping bucket bearing assemblies consists of constructing manhole openings above each adjoining set of rotating groups. A total of 17 manhole openings would be required, including one over each bearing assembly on the end tipping buckets.

Installation will require removing pavement and excavating to the top of the existing roof slab. A 24-in. opening will be cored through the roof, and manhole grade rings set/doweled over the opening and extended to the existing surface. A standard 24-in. manhole ring and lid will be set flush with the pavement, and the excavation backfilled around the new access point. Final restoration will include pavement repairs and patching to the concrete parking area.

The costs include extending a 0.5-in. metal grease tube and grease gun fitting from each bearing assembly to within 6 in. of the surface at the nearest new manhole opening (2 zerks per manhole, 1 each at the end tipping buckets). After consultation with the tipping bucket gate manufacturer, regular greasing of the bearings is not required for the model of tipping buckets installed at the Seven Mile CSO Facility. GLWA may elect to install the access for better visual confirmation of tipping bucket condition and operation and better access to limit switches at each bearing assembly. Figures (Figure SM-FD-1-ALT-2) included in Volume 6 – Appendices, Appendix B, show the conceptual layout of this improvement.

The alternative evaluation for these alternatives is presented in Table 13-5. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and increased ease of O&M provided by the improved access to the tipping bucket bearings. The NPV/Benefit cost for Alternative 2 is \$36,000, which is a relatively low cost compared to other projects recommended in this assessment. **As such, Alternative 2 –Access to Tipping Buckets is the recommended alternative.**

Table 13-5. Alternative Evaluation for Access to Tipping Buckets (Project SM-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Inaccessible bearing assemblies for the tipping buckets	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Access to Tipping Buckets for Maintenance	Health and Safety	4	3.50	\$ 125,000	\$ -	\$ 125,000	\$ 35,714	Not Applicable
	<i>Definition:</i>	Construct manhole openings over each bearing assembly of tipping buckets	Water Quality & Compliance	3						
	<i>Adv.:</i>	Access for better visual confirmation of tipping bucket condition and operation and better	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

Access to Dewatering Force Main (Project SM-FD-2). GLWA noted that the force main from the CSO facility to the NWI is inaccessible but will require future inspection and cleaning.

There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Access to Dewatering Force Main for Inspection and Cleaning.** this alternative consists of the installation of cleanouts at the following locations: 1) at the end of the force main, southwest of the siphon head chamber in Manhole No. 1 for cleaning of the force main, 2) just to the northeast of the Manhole No. 1 before the inverted siphon, and 3) east side of the Rouge River, just before Manhole No. 2. (see Figure SM-FD-2-ALT-2 included in Volume 6 – Appendices, Appendix B)

The alternative evaluation for these alternatives is presented in Table 13-6. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.4 higher than the Do Nothing Alternative (Alternative 1) based on the increased ease of O&M provided by the ability to access the force main. The NPV/Benefit cost for Alternative 2 is \$28,000, which is a relatively low cost compared to other projects recommended in this assessment. **As such, Alternative 2 –Access to Dewatering Force Main is the recommended alternative.**

Table 13-6. Alternative Evaluation for Access to Dewatering Force Main (Project SM-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Dewatering forcemain from the CSO facility to the NWI remains inaccessible.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Access to Dewatering Force Main for Inspection and Cleaning	Health and Safety	3	3.22	\$ 90,000	\$ -	\$ 90,000	\$ 27,979	Not Applicable
	<i>Definition:</i>	Install cleanouts at a number of locations.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Access to the dewatering forcemain from the CSO facility to the NWI for future inspection and cleaning.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

13.2.5 HVAC

13.2.5.1 Description of Existing System

The Seven Mile CSO facility consists of a headworks area, chemical room, odor control room, electrical room, control room, metering room in the basement, and miscellaneous other rooms and a courtyard. The facility also includes the retention basins. Table 13-7 provides summary of the major HVAC equipment for the facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, multiple emergency shower/eye wash, regular shower, and sump pump. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 13.2.10.

Table 13-7. Major HVAC Equipment at Seven Mile CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	HVU-2	Heating and Ventilating Unit	12,190 CFM
	EF-5	Exhaust Fan	11,480 CFM (Pump Area)
Basin	SF-1 and 2	Supply Fan (for Basin)	102,420 CFM
	SF-3	Supply Fan (Utility Tunnel)	1,472 CFM
	SF-4	Supply Fan (Shunt Channel)	2,600 CFM
	EF-7	Exhaust Fan (Shunt Channel)	500 CFM
	EF-8	Exhaust Fan (Effluent Channel)	500 CFM
	UH-1 and 2	Unit Heater (Shunt Chamber)	400 CFM 17.0 MBH
Odor Control Room	HVU-1	Heating and Ventilating Unit	2,400 CFM 65 MBH
	EF-6	Exhaust Fan	2,000 CFM
Basement (Meter Vault)	HVU-3	Heating Ventilation Unit	1,200 cfm
Electrical Room	PACU-1	Packaged Air Conditioning Unit	2,200 CFM 51.2 MBH

Table 13-8 provides a summary of the basis of design performance criteria for HVAC systems at Seven Mile and Table 13-9 provides the outdoor Basis of Design conditions.

Table 13-8. Seven Mile Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Retention Basin	Class I, Div 1, Group D	N/A	N/A	10 ACH
Headworks and Pump Room	Class I, Div 1, Group D	60	N/A	12 ACH
Odor Control Room	Unclassified for areas greater than 3 ft from odor control vessel. Class I, Div 2, Group D	70	N/A	10 ACH

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
	for areas closer than 3 ft.			
Electrical Room, Work Room, Office, Toilet	Unclassified	70	78	2 cfm/ft ²
Basement (Magnetic Meter Room)	Unclassified	70	N/A	6 ACH
NaOCl Storage Room	Unclassified	60	N/A	6 ACH

Table 13-9. Seven Mile Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

13.2.5.2 Identified Needs and Issues

During the Needs Assessment meetings with GLWA O&M staff, the following HVAC issues were noted:

- PACU-1 requires replacement.

During the discussions with GLWA's HVAC contractor the following historical issues were noted:

- PACU-1 requires frequent maintenance to keep running: GLWA's HVAC contractor noted that PACU-1 at Seven Mile has had issues very similar to unit at Puritan-Fenkell, including damper problems, actuator problems, refrigerant leaks and wiring issues.
- SF-1 and SF-2 motorized dampers are not fully functional.
- SF-2 has audible motor bearing problems.

During site investigations (June 2020), the following observations were noted:

- SF-1 and SF-2 were functional but had damaged duct connections.
- The motorized dampers for SF-1 and SF-2 were seized and not fully open.
- HVU-3 is difficult to access for maintenance.

13.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

HVAC Improvements (Project SM-HVAC-1). Due to the numerous HVAC-related assets that require replacement and the additional need to provide monitoring for code compliance in the Odor Control Room and Headworks, all of the identified HVAC improvements are proposed to be in one project – HVAC Improvements. As such, there is only one alternative for this project, which includes:

- PACU-1 Replacement
- Improvements to Enhance Safety in Odor Control Area

- Improvements to Enhance Safety in Headworks Area
- HVU-1 and 2 Replacement
- HVU-3 Replacement (with improved access)
- SF-1 and SF-2 Replacement
- Exhaust Fan Replacement
- Removal of Shunt Channel and Effluent Channel HVAC Equipment

Each of the HVAC-related improvements listed above are described further below:

PACU-1 Replacement. Given the age of PACU-1 (24 years) and the lengthy history of various issues, replacement of PACU-1 with a more efficient modern unit and controls is recommended.

Improvements to Enhance Safety in Odor Control Area. The Odor Control area is classified as a Class I, Division 2 space under NFPA 820 if it is not continuously ventilated at a rate of 6 ACH. The space does not meet the 6 ACH ventilation requirement and does not currently have electrical equipment rated for a Class I, Div 2 environment. HVU-1 is designed to provide 10 ACH of ventilation air in cooling mode but was sized to provide only 2 ACH of outside air in heating mode. Additionally, EF-2 is only designed to operate in cooling mode at 10 ACH. NFPA 820 requires both supply and exhaust fans to operate continuously to unclassify odor control areas.

Given the age of HVU-1 and EF-2 and the problems HVU-1 is exhibiting, Jacobs recommends in-kind replacement of both units. HVU-1 and EF-1 could be replaced with two-speed fans or VFDs to provide 6 ACH continuously during ventilation and heating and 10 ACH in cooling mode.

Regardless of whether the space is unclassified by providing 6 ACH of outside air, NFPA 820 requires the installation of combustible gas detection in the Odor Control area with audible and visible alarms at all entrances to the Odor Control area and within the space.

If ventilation is used to unclassify the space as described above, ventilation flow monitoring of both the supply and exhaust fan is required with visible and audible alarms of a low or no flow condition required at entrances and within the space.

Improvements to Enhance Safety in Headworks Area. HVU-2 serves the Headworks Area, which is classified as a Class I, Division 1 space per the design drawings. Given its age and general condition, HVU-2 should be replaced. Because the electrical equipment in the space is rated for a Class I, Division 1 environment continuous ventilation and ventilation flow monitoring are not required. NFPA 820 does, however, require combustible gas detection with visible and audible alarms at the entrances to the Headworks area and inside the space, which the Headworks area currently does not have. Jacobs recommends making this change to comply with NFPA 820.

HVU-3 Replacement (relocated with improved access). HVU-3 is currently mounted high in the Metering Room space making access for maintenance very difficult (Figure 13-2). Placing HVU-3 lower in the space would make access to the magnetic meter and associated piping very difficult. Jacobs recommends replacing HVU-3 with a unit mounted on a concrete pad on the North side of the building when HVU-3 requires replacement. There is an existing opening for the Meter Room supply air duct, which could be utilized by the outdoor unit. This approach would allow ample space for maintenance and would make removal much easier. Currently, HVU-3 will need to be removed in sections when replacement is necessary.



Figure 13-2. HVU-3 Located in Inaccessible Area Difficult to Access Location

SF-1 and SF-2 Replacement. SF-1 and 2 are functional despite having damaged duct connections. These units will require replacement in the near future. The motorized dampers on the units have seized and will need to be removed or replaced. It is worth noting that the design documents for the Puritan-Fenkell facility (which is very similar to Seven Mile Road) indicated the Basin ventilation units had motorized dampers, which were not seen during the site walkthrough and presumably have since been removed. Motorized dampers are not necessary for this application and add a potential failure point as well as increased maintenance and repair costs. The selection of fans with corrosion-resistant construction should negate the need to have motorized dampers.

Exhaust Fan Replacement. There are five relatively small exhaust fans that are original to the facility and should be included in the replacement project.

Removal of Shunt Channel and Effluent Channel HVAC Equipment. The unit heater, supply and exhaust fans in the Shunt Channel and Effluent Channel are not used and are inoperable. These units could be retired. Portable ventilation could be utilized, if necessary, when operators need to enter these areas.

The alternative evaluation is presented in Table 13-10. **The capital cost for Alternative 1, which is the recommended alternative,** is included in Volume 6 – Appendices, Appendix C under this project title.

Table 13-10. Alternative Evaluation for HVAC Improvements (Project SM-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	3	3.00	\$ 858,000	\$ -	\$ 858,000	\$ 286,000	Best Value Alternative
	<i>Definition:</i>	Facility-wide HVAC Improvements	Water Quality & Compliance	3						
	<i>Adv.:</i>	Code compliance, less emergency maintenance, improved asset reliability.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

13.2.6 Electrical

13.2.6.1 Description of Existing System

The Seven Mile facility's electrical system consists of one DTE utility feed from a 750 kVA, 480/277 V, 3-Phase outdoor transformer (secondary metering) and one diesel generator feed from a 350 kW, 480/277 V, 3-Phase stationary generator. The feeds are connected to a 1,200 A MDP with electrically operated breakers and automatic source transfer controls for a 1,200 A bus. The MDP has breakers that feed MCCs and distribution panels. The MCCs and distribution panels then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 13-11 provides a summary of the major electrical equipment for this facility.

Table 13-11. Major Electrical Equipment at Seven Mile

Location	Major Electrical Equipment	Description
Electrical Room	Main distribution panel with ATS	1,200 A, 480/277 V, 3-Phase
Courtyard	Generator (Diesel)	350 kW, 480/277 V, 3-Phase
Electrical Room	MCC-1	400 A, 480/277 V, 3-Phase
Electrical Room	MCC-2	400 A, 480/277 V, 3-Phase

13.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the section below.

13.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project SM-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure SM-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Basin – Add additional basin interior explosion-proof LED lighting fixtures to provide lighting within the basins. Lighting to meet the required foot-candles and codes for the area.
 - Add exterior power receptacles to assist in the maintenance and operations of the facility including additional power receptacles at the facility's outfall.

The alternative evaluation is presented in Table 13-12. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$39,000, which is a relatively low cost compared to other projects recommended in this assessment.

Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.

Table 13-12. Alternative Evaluation for Electrical Improvements (Project SM-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 136,000	\$ -	\$ 136,000	\$ 38,857	Not Applicable
	<i>Definition:</i>	Add additional lighting in basins. Provide exterior power receptacles.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

13.2.7 I&C

13.2.7.1 Description of Existing System

Control System: The original PLC control system and hardwired backup control system were installed in 1996 under PC-696. The system has the ability to remotely monitor the operations of the facility and the overall area collection system at SCC.

The existing control system consists of Allen Bradley redundant PLC-5 processors with local I/O for monitoring and control of the facility processes. The system has hardwired backup capabilities to control the facility on an overall control system failure. The PLC's control system network communicates via an Ethernet network to the facility's control system and operator workstation. The workstation currently uses the Rockwell RSView software package that provides the existing operator workstation the additional software applications to provide historical data storage and retrieval, reporting, as well as other functions to monitor and control the system. The local hardwired backup control panel is obsolete and with new redundant control systems, this type of backup hardwired control panel is no longer used. The current system is equipped with a backup radio system to communicate critical monitoring points back to SCC on wide area network failure.

Flow and Level Sensors: Table 13-13 summarizes the level sensors and flow meters at the Seven Mile CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 13-13. Summary of Flow Meters and Level Sensors at Seven Mile CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Shunt Channel	1	Transit-Time (AccuSonic)
Effluent Weir	2	Ultrasonic
Dewatering	1	Magnetic
CSO Level Sensors		
Influent	1	Ultrasonic
Screening Area (Downstream of bar racks)	1	Ultrasonic
Basin	2	Ultrasonic
Effluent Channel	1	Ultrasonic
Dewatering Well	1	Ultrasonic
NWI	1	Ultrasonic
River	1	Ultrasonic
Chemical System Flow Meters		
Secondary Water	1	Magnetic
Chemical Feed	1	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Ultrasonic

13.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Replacement options for valve control network for the chemical feed system is discussed in detail in Section 5.4.6. The cost/benefit of the hardwired control was not favorable and therefore was not considered further.
- Update control system. GLWA is currently developing a RFPs for qualified design-build contractors to provide professional engineering and construction services for control system improvements at the Seven Mile CSO Facility under "Control System Improvements – St. Aubin, Leib and Seven Mile CSO Facilities." The project will replace the existing PLC-5 control system and backup local control panels with a new control system, provide new Ovation workstations with high-performance graphics, and replace some of the field instruments. This is an ongoing project that has already been included in the CIP.

13.2.7.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no I&C related issues that that would be classified as capital improvement "needs."

13.2.8 Site

13.2.8.1 Description of Existing Site

The Seven Mile CSO Facility was constructed in 1994. Access to the site is off of Shiawassee St. through a 25-ft wide sliding gate. Site security is provided by perimeter fencing comprised of a 6-ft high chain-link fence along the west side of the CSO building along Shiawassee St. The parking lot consists of 4-in. thick asphalt pavement with 8-in. gravel base. Concrete sidewalks are 5 ft wide and 4 in. thick with 4-in. sand base. The top of most of the basin roof area is used as a parking lot by the nearby church.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

13.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the section below.

- There is no security fencing around the north, south and east sides of the Seven Mile CSO Control/Headworks Building.
- The Courtyard floor does not provide adequate slope for the rain/snow runoff to flow to the scuppers and consequently ponds on the floor surface.
- The existing hatch cover plates are heavy and difficult to remove.

13.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Security Fencing (Project SM-Site-1). There is currently no security fencing around the north, south and east sides of the Seven Mile CSO Control/Headworks Building. Painted chain-link fencing exists on the west side of the CSO building along Shiawassee St. There are two alternatives to address this issue:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Extend Security Fencing Around Entire Building.** It is recommended that security fencing be installed along the remainder of the building site to secure building operations.

The alternative evaluation is presented in Table 13-14. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.9 higher than the Do Nothing Alternative (Alternative 1) based on the improved safety. Because of the importance of this issue related to safety, **Alternative 2 – Extend Security Fencing Around Entire Building is the recommended alternative.**

Table 13-14. Alternative Evaluation for Security Fencing (Project SM-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Security issue.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Extend Security Fencing Around Entire Building	Health and Safety	5	3.57	\$ 347,000	\$ -	\$ 347,000	\$ 97,290	Not Applicable
	<i>Definition:</i>	Security fencing to be installed along the remainder of the building site.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Secure building operations	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

Site Improvements (Project SM-SITE-2). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Site Improvements** including,
 - Improve Drainage in the Courtyard
 - Replace Existing Effluent Gate and Shunt Channel Hatches

Each of the site related improvements listed above is described further below:

Improve Drainage in the Courtyard. The Courtyard at the Headworks of the Seven Mile CSO Basin has an open roof and is exposed to rain and snow falling on the floor surface. There are scuppers in the base of the east wall of the Courtyard to allow runoff to drain through the Courtyard wall onto the basin roof surface outside the wall. The Courtyard floor, however, does not provide adequate slope for the runoff to flow to the scuppers and consequently ponds on the floor surface. To alleviate the water ponding, it is recommended that holes be cored through the courtyard floor to the basin below. Recessed area drains can be installed in the cored holes to funnel floor drainage to the basin.

Replace Existing Effluent Gate and Shunt Channel Hatches. There are three hatch openings over the three existing effluent butterfly gates and their corresponding stop log guides. The hatch openings at the effluent gates have dimensions of 8 ft by 3 ft. The existing hatch cover plates are heavy and difficult to remove. GLWA would like to replace cover plates with an alternative plate design that improves accessibility to the gates and stop log guides below.

There are also two hatch openings over the two shunt channel butterfly gates and their corresponding stop log guides. These hatch openings also have dimensions of 8 ft by 3 ft. These hatch covers have been recently replaced and are not included in the cost estimate.

The improvements at these locations should be coordinated with the potential modification of this basin to a complete capture facility, described in Section 13.1.2.

The alternative evaluation is presented in Table 13-15. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M. The NPV/Benefit cost for Alternative 2 is \$35,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Site Improvements is the recommended alternative.**

Table 13-15. Alternative Evaluation for Site Improvement (Project SM-SITE-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Safety issues.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 122,000	\$ -	\$ 122,000	\$ 34,857	Not Applicable
	<i>Definition:</i>	Improve drainage in the Courtyard and replace existing effluent gate and shunt channel hatches.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved drainage and ease of O&M.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

13.2.9 Architectural

13.2.9.1 Description of Existing Facilities

The Seven Mile Road CSO facility consists of chemical room, utility support (electrical), control room, work room, odor control room, screen room, miscellaneous other rooms and a courtyard.

13.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a roof replacement evaluation and a detailed assessment of architectural issues, as described in the following paragraphs.

Evaluation of Type of Future Roof Replacement. Jacobs reviewed the results of a roof assessment and prepared a 60-year life-cycle cost analysis between shingled roof and metal roof. Based on the results of this evaluation, which shows lower life cycle cost for shingled roof, Jacobs recommends replacement of the shingled roof with shingles when the roof is ready for replacement. The analysis is presented in Table 13-16. As such, the roof should be replaced in-kind and the costs and schedule for the roof replacement will come from the SRP.

Table 13-16. 60-Year Life-Cycle Cost Evaluation of Shingled vs. Metal Roof for Seven Mile Facility

	Shingle Roof	Metal Roof
Replacement Cost ^a	\$93,000	\$311,000
Replacement Interval	20 years	60 years
Number of Roof Replacements During 60 Years	3	1
Total Life-Cycle Cost (NPV) Discounted at 2.4%	\$252,000	\$311,000

^a Based on 6,225 ft² roof area; \$15 ft² for shingle roof and \$50/ ft² for metal roof.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff indicated that that there is no access to the Headworks area and the Courtyard during a power outage.

13.2.9.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (SM-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address this issue:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove corrosion at bottom of man door and coat steel framing
 - Remove paint debonding from wall, clean and coat
 - Address door hardware issues
 - Remove painted debonding from roof framing, clean and coat

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure SM-ARCH-1-ALT-2). Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 13-17. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, Alternative 2 is the recommended alternative.

Table 13-17. Alternative Evaluation for Architectural Rehabilitation (Project SM-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 156,000	\$ -	\$ 156,000	\$ 50,323	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

Access to Courtyard and Headworks (Project SM-ARCH-2). If there is a power outage and the generator does not kick on, there would be no access to the Headworks area and the Courtyard. There are two alternatives to address this issue:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Additional Access to Courtyard and Headworks.** GLWA requested access doors be provided from the Courtyard to the outside. Two 3-ft by 7-ft heavy-duty hollow metal double doors and frame with commercial grade stainless steel hardware is recommended to provide emergency access.

The alternative evaluation is presented in Table 13-18. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M. The NPV/Benefit cost for Alternative 2 is \$10,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Additional Access to Courtyard and Headworks is the recommended alternative.**

Table 13-18. Alternative Evaluation for Access to Courtyard and Headworks (Project SM-ARCH-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	No access to the Headworks and Courtyard, during a power outage.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Additional Access to Courtyard and Headworks	Health and Safety	4	3.50	\$ 34,000	\$ -	\$ 34,000	\$ 9,714	Not Applicable
	<i>Definition:</i>	Install door into Courtyard.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Provides emergency access to the Headworks and Courtyard during a power outage.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

13.2.10 Safety

13.2.10.1 Description of Existing System

Safety-related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

13.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 13-19. The capital improvement project to address these issues is included in the table.

Table 13-19. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Chemical Room	Emergency eyewash/shower 0943390 outside containment	Add eyewash/shower inside tank containment	Safety Improvements (Project SM-SAFE-1)
Utility Tunnel	Ladder at end of tunnel has an exit sign but hatch is locked.	Add placard to fixed ladder "Not An Exit." Replace existing exit sign with directional exit sign away from ladder access.	Exit Sign Improvements ^a

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

13.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project SM-SAFE-1). This project should address the safety issues identified above. These issues include:

- Add eyewash/shower outside containment in the Chemical Room
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency, the Table 13-20 showing the one alternative is presented below.

Table 13-20. Alternative Evaluation for Safety Improvements (Project SM-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 92,000	\$ -	\$ 92,000	\$ 30,667	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection, and eye wash.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

13.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at Seven Mile CSO Facility.

13.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Seven Mile CSO facility, Table 13-21 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 13-21, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 13-21. Listing of Asset Condition Assessments for Seven Mile Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	29	29	0	100%
AHU	4	0	4	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	3	3	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	0	0	0	N/A
BUILDING	2	1	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	1	1	0	100%
COND-AIR	0	0	0	N/A
CONVEYOR	0	0	0	N/A
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAMPER	6	6	0	100%
DISCONNECT	0	0	0	N/A
DOOR	3	3	0	100%
DRIVE-ELEC	4	4	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	3	3	0	100%
FAN	0	0	0	N/A
FANVENT	12	8	4	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	0	0	0% ^b
GASMONITOR	2	2	0	100%
GATE	6	6	0	100%
GEARBOX	2	0	2	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	0	0	0	N/A
MCC	5	0	5	100%
METER	6	6	0	100%
MIXER	5	5	0	100%
MOTOR	5	0	5	100%
PANEL	7	7	0	100%
PIPING	4	4	0	100%
PUMP	16	9	4	81% ^c
ROOF	2	2	0	100%
SAMPLER	1	1	0	100%
SCADA	2	2	0	100%
SCREEN	2	0	2	100%
SCRUBBER	1	0	1	100%
SENSOR	10	10	0	100%
SMOKE	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	1	0	1	100%
SYSTEM	0	0	0	N/A
TANK-PROC	1	1	0	100%
TANK-STOR	2	2	0	100%
TIPBUCKET	1	1	0	100%
TRANSFRMR	3	0	3	100%
UNITHEATER	0	0	0	N/A
UPS	2	2	0	100%
VALVE	27	27	0	100%
WATERHTR	0	0	0	N/A

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The one gas detector is a portable unit and was not assessed.

^c Three inactive pumps are listed in WAM - Basin 1 Sample Pump, Basin 2 Sample Pump, and Shunt Channel Sample Pump. These pumps are being considered for removal from WAM.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Seven Mile Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

13.3 Capital Planning for Seven Mile CSO Facility

13.3.1 Summary of Capital Improvement Plan Projects

Table 13-22 provides a summary of the recommended CIP projects and associated capital costs for the Seven Mile CSO facility based on the alternative evaluations conducted for this facility.

Table 13-22. Summary of Recommended Projects at Seven Mile CSO Facility

Project No.	Alternative	Description	Total Project Cost
SM-WWMP-1	2	Convert to Complete Capture Basin	\$ 2,500,000
SM-FD-1	2	Provide Access to Tipping Buckets for Maintenance	\$ 125,000
SM-FD-2	2	Access to Dewatering Force Main for Inspection and Cleaning	\$ 90,000
SM-HVAC-1	1	HVAC Improvements	\$ 858,000
SM-ELEC-1	2	Electrical Improvements	\$ 136,000
SM-I&C-1	1	Control System Upgrade	Ongoing Project
SM-SITE-1	2	Extend Security Fencing Around Entire Building	\$ 347,000
SM-SITE-2	2	Site Improvements	\$ 122,000
SM-ARCH-1	2	Architectural Rehabilitation	\$ 156,000
SM-ARCH-2	2	Additional Access to Courtyard and Headworks	\$ 34,000
SM-SAFE-1	1	Safety Improvements	\$ 92,000

13.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 13-23. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 13-23. Capital Improvement Plan Projects for Seven Mile CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
SM-1 Flushing Improvements	\$ 337,000	2032 <i>Timing based on Best judgement</i>	SM-FD-1	Provide Access to Tipping Buckets for Maintenance	\$ 125,000
			SM-FD-2	Access to Dewatering Force Main for Inspection and Cleaning	\$ 90,000
			SM-SITE-2	Site Improvements	\$ 122,000
SM-2 HVAC Improvements	\$ 858,000	2027 <i>Timing based on asset condition</i>	SM-HVAC-1	HVAC Improvements	\$ 858,000
SM-3 Electrical Improvements	\$ 136,000	2032 <i>Timing based on best judgement</i>	SM-ELEC-1	Electrical Improvements	\$ 136,000
SM-4 Facility-Wide Safety and Architectural Improvements	\$ 629,000	2023 <i>Project should be initiated as soon as possible</i>	SM-SITE-1	Extend Security Fencing Around Entire Building	\$ 347,000
			SM-ARCH-1	Architectural Rehabilitation	\$ 156,000
			SM-ARCH-2	Additional Access to Courtyard and Headworks	\$ 34,000
			SM-SAFE-1	Safety Improvements	\$ 92,000
SM-5 Convert to Complete Capture Basin	\$ 2,500,000	2030 <i>Timing based on general CSO project priorities</i>	SM-WWMP-1	Convert to Complete Capture Basin	\$ 2,500,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 13-24 and Table 13-25 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 13-24 indicates that SM-HVAC-1 project has 12 assets that has an average condition score of 1.61 and an average replacement date of 2034. Although the average replacement date suggests 2034, the SM-HVAC-1 project was moved up to 2027 due to equipment age and performance.

Table 13-24. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
SM-HVAC-1	12	1.19	1.61	2.15	20	2034	\$ 224,880

Table 13-25. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
SM-HVAC-1	0	0.00	0.00	0.00	N/A	N/A	\$ -

13.3.3 20-Year Capital Outlay Plan

Table 13-26 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 13-26. 20-Year Capital Outlay Plan for Seven Mile CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 335,368	\$ -	\$ -	\$ 322,802	\$ -	\$ -	\$ -	\$ -	\$ 12,566	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ 19,806	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 19,806	\$ -	\$ -	\$ -	\$ -
2025	\$ 112,551	\$ -	\$ -	\$ 112,551	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 18,911	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2,101	\$ -	\$ 16,809	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 228,757	\$ 6,149	\$ -	\$ 61,494	\$ 161,113	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,831,486	\$ 7,714	\$ 15,428	\$ 23,142	\$ 15,428	\$ -	\$ -	\$ -	\$ -	\$ 1,769,773	\$ -	\$ -	\$ -
2030	\$ 200,940	\$ 37,838	\$ -	\$ -	\$ 103,077	\$ -	\$ 10,438	\$ -	\$ -	\$ -	\$ 49,586	\$ -	\$ -
2031	\$ 584,604	\$ -	\$ -	\$ 292,302	\$ -	\$ 292,302	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 853,103	\$ -	\$ 278,369	\$ 574,734	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 471,031	\$ 14,054	\$ -	\$ -	\$ -	\$ 161,098	\$ 55,809	\$ 240,070	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 954,856	\$ 21,630	\$ -	\$ 657,977	\$ 90,453	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 157,381	\$ -	\$ 27,416
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 813,118	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 813,118	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 521,153	\$ 18,877	\$ -	\$ -	\$ 68,097	\$ 356,888	\$ 22,302	\$ 54,989	\$ -	\$ -	\$ -	\$ -	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 6,945,682	\$ 106,262	\$ 293,797	\$ 2,045,001	\$ 438,169	\$ 810,288	\$ 88,549	\$ 295,060	\$ 847,591	\$ 1,769,773	\$ 223,776	\$ -	\$ 27,416

- Notes:
- Explanation of large capital outlays in first two years:
- Retention System: Two influent slide gate (SG-1 and SG-5; \$157,000 each) received a score of 5 because the gates were locked out at the time of the Condition Assessment. Two flushing water ball valve (FW-1 and FW-8; \$4,000 each) received a score of 5 because the actuator for the valve was not functional or had been removed.

14. St. Aubin CSO Control Facility

14.1 General Facility Description and Future Capacity Considerations

14.1.1 General Facility Description

The St. Aubin CSO Facility is an SDF with 2.4 MG of storage, and a treatment capacity of 250 cfs. It was constructed in 2002. The facility has a nearly 1/3-mile long effluent conduit used for disinfection contact time before discharge into the Detroit River. The facility consists of an underground headworks, chemical room, odor control area, supply fan room, control room, and utility support (electrical, emergency generator, and mechanical rooms) and a restroom. The facility has an offsite sample building at the end of the outfall.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

14.1.2 Future Capacity Considerations

Based on a review of the WWMP, there were no future increased capacity considerations identified at this facility.

14.2 Facility Assessment

14.2.1 Screening

14.2.1.1 Description of Existing System

The St. Aubin CSO Facility has two vertical ROMAG screens that were installed in 2002. Screenings are retained in the influent chamber during the storm. After the storm event, the screenings are pumped to the Detroit River Interceptor for eventual removal at the WRRF.

Table 14-1 provides an overview of the existing screening system at St. Aubin CSO facility.

Table 14-1. Overview of Existing Screening System at St. Aubin CSO Facility

Parameter	Value
Treatment Capacity (cfs)	250
No. of Screens	2
Manufacturer	Westech ROMAG
Screen Type	Raked Vertical Bar Screens
Opening Size	4-mm spacing
Depth or Length / Width	3 ft 7 in. / 22 ft 0 in.
Screen Cleaning	Mechanical Comb
Screening Removal	Pumped to Toward Treatment Sewer and to WRRF

14.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issue was identified related to the screens:

- Evaluate potential improvements to existing screening system to remove screenings during wet weather.

14.2.1.3 Description and Evaluation of Alternatives

The evaluation of the need identified above is presented in this section.

Replace Screens with Improved Screens. Due to the configuration of the St. Aubin CSO Facility, the screenings accumulate during a wet weather event in the influent chamber in front of the screens. Although each screen has a mechanically operated comb that cleans the screens during a wet weather event, the screenings continue to accumulate in front of the screens. Some provisions were made in the original system to direct the screens to the dewatering well; however, these were found to be ineffective.

Jacobs investigated a new type of screen by Enviro-Care (SAVI Overflow Spillway – Model VSE-700/6) that could transport the screenings away from the influent chamber and convey them using an integral screw conveyor to the dewatering chamber (see Figure 14-1). The manufacturer developed a layout within the existing facility that would allow the screenings to discharge near the dewatering chamber. A short connection would be required to connect the discharge end to the facility's Dewatering Chamber.



Figure 14-1. Enviro-Care SAVI Overflow Spillway Screen

There are a number of concerns with the Enviro-Care screen and the retrofit of this screen into the St. Aubin facility:

- The proposed screen, within the given facility layout, only has a capacity of 217 cfs, which is less than the facility capacity of 250 cfs.
- The proposed screen has 8-mm openings. The other GLWA SDF with perforated openings (Baby Creek) has perforations of 6-mm. The Enviro-Care screen is available in 6-mm; however, the capacity of a screen with 6-mm perforations would be further reduced. Although the perforation size could potentially be negotiated with Michigan EGLE, there is a risk that EGLE would require 6-mm perforations.

Given the fact that the screen does not meet facility's design capacity of 250 cfs, it is not recommended for further consideration.

14.2.2 Disinfection

14.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP tanks, two low-rate diaphragm pumps, three high-rate diaphragm pumps, two rapid mix zones, and seven induction mixers. There are two ROMAG screens discharging into a screened effluent channel. From there screened effluent flows to two disinfectant rapid mix zones. There are three induction mixers per disinfectant rapid mix zone consisting of one pair of mixers upstream and one mixer downstream of a concrete baffle wall that directs all flow down and past the mixers. There is also one induction mixer in the influent channel upstream of screening referred to as prechlorination and the influent channel mixer. The discharges of Low-rate Pump 1 and High-rate Pump 2 combine and serve disinfectant rapid Mix Zone 1. The discharges of Low-rate Pump 3 and High-rate Pump 4 combine and serve disinfectant rapid Mix Zone 2. Sodium Hypochlorite Pump 5 serves the prechlorination mixer or as a backup to either rapid mix zone. Flow is metered from each pump and then flow is split in a manifold to the three induction mixers in each disinfectant rapid mix zone. The manifold includes a solenoid valve, manual valve, and a sight flow indicator to each induction mixer. Flow splitting between induction mixers is primarily dependent on equal back pressure valve settings to the induction mixers. Some valves are inaccessible due to their height on the wall.

Table 14-2 provides an overview of the existing disinfection system at St. Aubin CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G.

Table 14-2. Overview of Existing Disinfection System at St. Aubin CSO Facility

Parameter	Value
Treatment Capacity (cfs)	250
Design Feed Strength (% hypochlorite)	10
Max. Dosage at Design Flow (mg/L Cl ₂)	38
Disinfection Contact Time (min)	10
Storage Tanks	
Number	2
Volume of Each Tank (gal)	5,200
Type	FRP
Pumps	
Number	5 Total; 2 low-rate, 5 high-rate
Capacity (gpm)	Low-rate: 7.6, High-rate: 22.8
Type	Hydraulic diaphragm
Mixers	
Number / Type	7 / Chemical induction mixers
Model Number/ hp / Manufacturer	SWC7.5FX / 7.5 hp / Water Champ

14.2.2.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations.

This facility, however, will be treated differently in this project because Hazen performed a Sodium Hypochlorite Storage and Feed System Assessment, dated October 15, 2019, for disinfection system improvements and AECOM is developing scope for an upcoming design project for facility improvements, including chemical feed pumps, relocation of pump control panels, mixer modifications, and building storage improvements.

Sodium Hypochlorite Feed and Storage System Improvements (Project STA-DIS-1). The recommendations from the Hazen report, although not identical, are similar to the chemical feed system improvements recommended in CS-299. Chemical feed pumps as peristaltic (hose) pumps or mag drive centrifugal pumps were recommended for further consideration during detailed design. It is recommended that the firm selected for detailed design consider the improvements from this CS-299 Facilities Assessment evaluation of the disinfection systems to best standardize this system with the other future systems. Other disinfection-related improvements were recommended as part of this project, including operation in automatic mode and provisions to flush the feed system piping.

14.2.2.3 Description and Evaluation of Alternatives

Because this is an upcoming project (CIP 260617), an alternative evaluation was not conducted, and capital costs are not included in this report.

14.2.3 Odor Control

14.2.3.1 Description of Existing System

The St. Aubin odor control system consists of a Calgon Carbon PHOENIX automatic regeneration system, which utilizes radial flow canisters filled with Centaur HP carbon. Several years ago, Calgon Carbon sold its odor control equipment division to Continental Carbon along with the Centaur HP carbon. The unit consists of 30 canisters and an odor control fan, which delivers air through the carbon filters or directly to the exhaust stack. Air is pulled from the screening and disinfection chambers by the odor control fan and is uniformly distributed through the carbon canisters, bringing the air in direct contact with the carbon. The regeneration process consists of programmed filling of a single compartment of canisters with water, letting the water sit for a period of time, and then draining and drying the carbon.

The system was installed in 2002. The carbon has not been replaced since installation. Overall, the system is in good condition. The odor control system does not have an air permit.

Per GLWA, no odor complaints have been received for at least the past three years.

14.2.3.2 Identified Needs and Issues

The identified needs for the St. Aubin CSO facility are included in the following sections. The following issue was identified:

- Evaluate improvements to enhance safety around odor control system inside building, if needed.

Improvements to Enhance Safety Around Odor Control System. Hazen prepared a preliminary design report for the St. Aubin CSO Facility entitled *Sodium Hypochlorite Storage and Feed System Assessment*, dated October 15, 2019. In this report, they investigated the facility's current compliance with NFPA 820. Based on this evaluation, the following deficiencies were noted:

- Air flow monitoring
- Horns and strobes
- Backup power supply for horns/strobes and flow monitoring.

The Hazen report recommends that these items be included in the upcoming facility improvement project. This issue is being addressed in an upcoming project (CIP 260617).

The recommendations related to the odor control system below are based on the Jacobs team evaluation of the existing system.

Future Carbon Replacement Considerations. Centaur HP carbon contains a catalyst that oxidizes H_2S and converts it to sulfuric acid. As a result, the carbon can be restored for H_2S uptake by water washing. As discussed for the Baby Creek CSO Facility in Section 6.2.3.2, the Centaur HP carbon loses capacity over time. One typically determines the need for carbon regeneration by measuring the H_2S concentration in the discharged air. When H_2S is still detected in the discharged air after a regeneration cycle, the carbon is spent and should be replaced. Centaur HP replacement is about every two years under typical municipal wastewater applications. GLWA CSO facilities are not typical applications as the odor control systems are operated infrequently and are likely under low loads from H_2S and odorous compounds meaning the carbon will last a lot longer. According to O&M staff, the St. Aubin system is regenerated every two months based on the recommended PM in the manufacturer's O&M manual. The system may not need to be regenerated that frequently given the light load. The existing practice of carbon regeneration every two months may continue, but carbon capacity may decrease with each washing due to compounds in the regeneration water that adsorb to the carbon and that less than 100 percent of the sulfuric acid generated during the adsorption process is removed. Laboratory analysis of the carbon for H_2S capacity is likely the best way to determine the remaining carbon life for the St. Aubin system. Sampling the discharged air for H_2S breakthrough likely will not be an effective indicator due to the likely low H_2S load.

Although the current carbon capacity may be significantly less than the original capacity, the lack of any odor complaints from the community suggests that any odors being discharged are either not noticeable, not objectionable or are masked by other odor sources in the area. It is recommended that GLWA sample the influent and discharge of the odor control system during at least two storm events in the summer months (i.e., the period with the highest odor potential) to better understand the magnitude of odors generated from the CSO facility.

If the influent H_2S levels are low, replacement of the carbon would not be needed. Further testing could then be performed to determine if the carbon could be removed and not replaced. A non-detectable concentration of H_2S in the influent air means the system can likely operate without carbon. The following bullets provides considerations for the carbon replacement.

- The existing Centaur HP carbon in the PHOENIX system has an H_2S capacity of 0.09 g H_2S /cubic centimeter of carbon (15 percent by weight). The cost for replacement of the carbon is about \$20,400 (30 canisters at \$680/canister). The cost includes a new canister, sealing and loading the canister with Centaur HP carbon, and delivery.
- ECS manufactures a direct equivalent to Centaur HP carbon at a lower cost. ECS reuses the existing canisters. The cost for ECS's water regenerable catalytic carbon is about \$12,750 (30 canisters at \$425/canister). The cost includes shipping the full canisters to ECS, disposal of the spent carbon, cleaning the canisters, charging the canisters with ECS water regenerable catalytic carbon, and delivery.

As noted above, an evaluation of influent and discharge H_2S concentrations is recommended prior to carbon replacement. When it is time to replace the Centaur HP carbon, GLWA should evaluate replacing it with either Centaur HP or ECS water regenerable catalytic carbon.

14.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement "needs".

14.2.4 Flushing and Dewatering

14.2.4.1 Description of Existing System

Dewatering System: The Headworks (screening and disinfection) area and the effluent conduits are dewatered after a storm event using three dewatering pumps located in the Headworks Dewatering Well.

The dewatering of the effluent conduit also relies on two submersible dewatering pumps located at the end of the effluent conduit. These pumps convey any water remaining at the end of the effluent conduit (after the Headworks Dewatering Pumps have removed as much of the water as possible) back to the Headworks Dewatering Well.

Flushing System: The original facility did not include a flushing system for the effluent conduits. Around 2010, a flushing system for the final one-third of the effluent conduits was installed. This system consists of two 100 gpm flushing pumps located at the outfall, just downstream of the backwater gates. These pumps use Detroit River water to pump to two locations in the effluent conduit with spray nozzles.

A manually operated, gravity flushing system consisting of a pipe with nozzles is provided for the area upstream of screens. This system uses water captured in the disinfection chambers as flushing water. The area upstream of the screens is dewatered first, while water remains in the mixing chambers. The head pressure from the water in the mixing chambers provides the pressure in the flushing pipe to provide a sufficient flush of the floor area.

Table 14-3 provides an overview of the existing flushing and dewatering system at St. Aubin CSO facility.

Table 14-3. Overview of Existing Flushing and Dewatering System at St. Aubin CSO Facility

Parameter	Value
Headworks Dewatering and Flushing System	- Headworks (screening and disinfection) area is dewatered using three 1,100 gpm dewatering pumps located in the Headworks Dewatering Well. - Manually operated flushing system consisting of a pipe with nozzles for area upstream of screens.
Effluent Conduit Dimensions	10 ft. × 10 ft.
Effluent Conduit Dewatering and Flushing System	- Effluent conduit is dewatered using three 1,100 gpm dewatering pumps located Headworks Dewatering Well. - There are two 200 gpm submersible dewatering pumps located at the end of the effluent conduit, which pump back to the Headworks Dewatering Well. - There are two 100 gpm flushing pumps that provide water to a spray flushing system for the second half of the effluent conduit.

14.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the flushing and dewatering system:

- Settled solids buildup in the 10-ft by 10-ft effluent conduit for this facility. A flushing system was installed since the facility was constructed; however, this system has not proved effective at removing the solids buildup.
- Provide flushing system in mixing chambers to flush accumulated solids from the floor.

14.2.4.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

New Effluent Conduit Flushing System (Project STA-FD-1). There are two alternatives for addressing the solids buildup in the effluent conduits and the chemical mixer chambers. These alternatives include:

- 1) **Alternative 1: Do Nothing/ Contractor Cleanout**
- 2) **Alternative 2: New Effluent Conduit Flushing System.** This alternative includes mounting a 6-in. HDPE flushing header along both sides of the effluent conduit approximately 2 ft above adjacent lower concrete surface. See Volume 6 – Appendices, Appendix B, for Figure STA-FD-1-ALT-2 showing conceptual layouts. HDPE pipe is recommended for this application due to its corrosion resistance and its flexibility that imparts resistance to damage from impacts by heavy debris suspended in wet weather flows. The flushing header should be specified with an adequate wall thickness to allow for directionally drilled holes (up to 0.75-in.-diameter) that create a water jet aimed in a specific direction. The proposed hole spacing along the header will be approximately 18 to 24 in. A cursory analysis based on channel dimensions, slopes and anticipated grit sizes indicates that a minimum total flow rate of 3,500 gpm is required to adequately resuspend sediment from the floor of the square conduit and maintain adequate volume and velocity to carry the sediment to the terminus ends.

A small valve is also recommended at the terminus end of each spray header with a rising stem and automated actuator mounted outside of the chamber. At the start of the cleaning cycle, these valves will automatically open for several minutes, allowing the potable water to flush any materials that have entered the header through openings out the open end. These terminus valves would close, and the header would pressurize and start spraying.

Two new flushing pumps (approx. 5,200 gpm, 100 ft total dynamic head) will be installed at the end of the conduit and the existing flushing pumps removed. The pump size has been selected to provide a 1.5 safety factor on flushing anticipated grit volumes and particle sizes. The existing flushing system will also be removed. The new flushing pumps will be manifolded with a control valve to allow flushing of one-half of the conduit at a time. The existing flushing pump electrical system is assumed to have adequate load capacity for the new pumps; however, an allowance is included for rewiring and new conduits in the cost estimate. An allowance is also included for SCADA and PLC/human-machine interface programming.

Existing dewatering pumps may be overwhelmed by the large flushing flows generated by continuous post-event cleaning. The costs for this improvement include replacing the existing 100 gpm and 200 gpm dewatering pumps with larger pumps (1,000 gpm) and allowances for replacing some of the exposed discharge piping and valves. To avoid replacing the dewatering pumps, the flushing system could be operated in 15-minute intervals with adequate time between to drain the flushing water and sediment. Preliminary analysis indicates a total of 2 hours of flushing per pump unit should be considered as a starting point for operations. GLWA staff may increase or decrease the number of intervals over time as the effectiveness of the cleaning system is observed. The final designer should evaluate and refine the flushing volumes and generated header nozzle velocities using a sediment fate/transport model, CFD or lab scale model. Grit characterization is strongly recommended for proper sizing.

The likely flow management scenario assumed for construction will be to isolate the facility structurally or using existing controls. Seasonal restrictions are also assumed such that much of the work will take place in the dry season to minimize inundation risk during construction.

GLWA O&M staff also requested that a dedicated flushing system be provided for the two chemical mixing channels to flush accumulated solids from the floor after a storm event. A new flushing system

pipled from the existing NPW line in the “basin” area, extending down to the mixing chamber floors and drilled holes through HDPE pipe is recommended to address this issue. Figures (Figure STA-FD-1-ALT-2) that show the conceptual layout of this improvement are included in Volume 6 – Appendices, Appendix B.

The alternative evaluation for these alternatives is presented in Table 14-4. The sources of costs used in this evaluation are listed below:

- Contractor cleanout of this area is estimated to be \$400,000 every 5 years, based on costs at other screening and disinfection facilities. This O&M cost is annualized to \$80,000.
- The capital cost for the flushing system (Alternative 2) is included in Volume 6 – Appendices, Appendix C under this project title. It should be noted that the capital cost includes an allowance of \$90,000 for cleaning the influent channel prior to installing the flushing system. The \$140,000 equates to about \$400,000 after contingencies, and standard markups for design, construction assistance and contractor overhead and profit have been applied.
- The O&M costs for the current and proposed flushing system (Alternatives 1 and 2) are based on using Detroit River water, so there is no cost for water usage.
- Alternative 2 will provide the benefit of improved effluent water quality and hydraulic capacity because the conduit will be cleaned after every event. This will prevent the scouring of built up solids accumulation and will maintain hydraulic capacity of the effluent conduits.

This evaluation shows that Alternative 2 has the lowest NPV/Benefit cost and is the Best Value Alternative. Because of the improved health and safety, effluent water quality and hydraulic capacity, **Alternative 2 – New Effluent Conduit Flushing System is the recommended alternative.**

Table 14-4. Alternative Evaluation for New Effluent Conduit Flushing System (STA-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Contractor Clean-out	Health and Safety	2	2.10	\$ -	\$ 80,000	\$1,687,171	\$ 803,415	
	<i>Definition:</i>	Allow solids to build up and have a Contractor clean out the conduit, as needed	Water Quality & Compliance	2						
	<i>Adv.:</i>	No system to maintain	Capacity Enhancement	2						
	<i>Disadv.:</i>	Significant build-ups can impact facility hydraulic capacity. Cleaning effluent area is a high-risk activity, which requires significant GLWA coordination. Solids build-up may scour out of basin and negatively affect effluent water quality.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	New Effluent Conduit Flushing System	Health and Safety	5	4.18	\$ 2,472,000	\$ -	\$2,472,000	\$ 590,916	Best Value Alternative
	<i>Definition:</i>	Provide flushing system in effluent conduit using river water and provide a flushing system in the chemical mixing area.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Minimizes solids from being scoured from floor and affecting effluent water quality. No confined space entry to clean conduit.	Capacity Enhancement	4						
	<i>Disadv.:</i>	Increased maintenance of equipment.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

14.2.5 HVAC

14.2.5.1 Description of Existing System

The St. Aubin CSO facility consists of an underground headworks, chemical room, odor control area, supply fan room, control room, and utility support (electrical, emergency generator, and mechanical rooms) and a restroom. The facility has an offsite sample building. Table 14-5 provides a summary of the major equipment for the facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, and emergency shower/eye wash. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 14.2.10.

Table 14-5. Major HVAC Equipment at St. Aubin CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	SF-1	Supply Fan (Basin)	9,555 CFM
Chemical Room	HV-1	Heating Ventilating Unit (Mech Rm)	2,710 CFM
	EF-2	Exhaust Fan	3,010 CFM
Electrical Room	HV-2	Heating Ventilating Unit (Mech Rm)	4,665 CFM
	EF-3	Exhaust Fan (Odor Control Rm)	3,720 CFM

Table 14-6 provides a summary of the basis of design performance criteria for HVAC systems at St. Aubin and Table 14-7 provides the outdoor Basis of Design conditions.

Table 14-6. St. Aubin Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Headworks	Class I, Div 1, Group D	N/A	N/A	12 ACH (Occupied)
Mechanical Spaces	Unclassified	60	96	Heat Relief
Office, Sampling Room, and Toilet Room	Unclassified	70	78 F Dry Bulb, 50% Relative Humidity	15 cfm per occupant
Odor Control Room	Unclassified for areas greater than 3 ft from odor control vessel. Class I, Div 2, Group D for areas closer than 3 ft.	60	96	6 ACH

Table 14-7. St. Aubin Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

report, they investigated the facility's current compliance with NFPA 820. Based on this evaluation, the following ventilation related deficiencies were noted:

- Air flow monitoring
- Horns and strobes
- Backup power supply for horns/strobes and flow monitoring

The Hazen report recommended these items should be included in the upcoming facility improvement project. Jacobs agrees with the proposed recommendations and would add that in addition to the Hazen recommendations, combustible gas detection and alarm of gas in excess of 10 percent of the lower explosion limit is also required by NFPA 820 in the Odor Control Area. These recommendation are being addressed in an upcoming project (CIP 260617).

14.2.5.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no HVAC-related issues that that would be classified as capital improvement “needs”.

14.2.6 Electrical

14.2.6.1 Description of Existing System

The St. Aubin electrical system consists of one DTE utility feed from a 480 V, 3-Phase outdoor transformer (secondary metering) and one generator feed from a 175 kW, 480 V, 3-Phase stationary diesel generator. The utility feed is connected to a 600 A motor control center (MCC-B) with a 200 A sub-feed connection to a 225A ATS. The ATS then feeds a distribution panel with one 200 A breaker and one 150 A breaker, which feeds two MCCs (MCC-A and MCC-C, respectively). The MCCs feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 14-8 provides a summary of the major electrical equipment for this facility.

Table 14-8. Major Electrical Equipment at St. Aubin

Location	Major Electrical Equipment	Description
Generator Room	Generator (Diesel)	175 kW, 480/277 V, 3-Phase
Electrical Room	MCC-A	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-B	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-C	600 A, 480/277 V, 3-Phase

14.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for less safe working conditions. These lighting needs are in addition to the recent LED lighting project. This issue is further described in the next section.

14.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project STA-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure STA-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Basin Interior – Add additional basin interior explosion-proof LED lighting fixtures to provide lighting within the basin area to meet operational needs.
 - Outfall area – Add additional lighting at the facility's outfall.
 - Exterior power receptacles are needed on the wall of the facility near the basin to assist in the maintenance and operations of the facility.

The alternative evaluation is presented in Table 14-9. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$41,000, which is a relatively low cost compared to other projects recommended in this assessment.

Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.

Table 14-9. Alternative Evaluation for Electrical Improvements (Project STA-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 144,000	\$ -	\$ 144,000	\$ 41,143	Not Applicable
	<i>Definition:</i>	Add additional lighting in basin interior and outfall area.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

14.2.7 I&C

14.2.7.1 Description of Existing System

Control System: The original control system was installed in 1999 under PC-731. In 2002 the system was upgraded and interfaced into GLWA's overall SCADA Ovation control system. This upgrade provided the ability to remotely monitor the operations of the facility and the local collection system at SCC.

The existing control system contains an Allen Bradley-based PLC system consisting of an Allen Bradley redundant PLC-5 with local I/O controls that are installed in the facility's local control system panel. The operator workstation has a Rockwell RSView operating software platform and is located in the Control Room. The existing hardwired local backup control panel and other miscellaneous subsystems that are incorporated into the overall control system are outdated and need replacement. The control system network and switches are obsolete and do not meet GLWA SCADA Governance standards on redundant networks and switches stipulates and that all CSO facilities use Ovation workstations with new high-performance graphics. The current system is equipped with a backup radio system to communicate critical monitoring points back to the SCC on wide area network failure.

Flow and Level Sensors: Table 14-10 summarizes the level sensors and flow meters at the St. Aubin CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 14-10. Summary of Flow Meters and Level Sensors at St. Aubin CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent	1	Transit-Time (AccuSonic)
Effluent	1	Transit-Time (AccuSonic)
Toward Treatment Dewatering	1	Magnetic
CSO Level Sensors		
Dubois Diversion Chamber	1	Ultrasonic
Influent Channel	1	Ultrasonic
Mixing Chamber	1	Ultrasonic
Dewatering Chamber	1	Ultrasonic
Effluent Channel	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed	5	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Ultrasonic

14.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- The outfall level sensor level fluctuates significantly when the levels are high during discharge.

- GLWA staff note that local control of the equipment is needed, including dewatering pumps, flushing valve, and regulator gates) to improve maintenance. (It is noted that remote control of the regulator gates is included under the “Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities” project, so they are not further addressed in this report.)
- Process cameras are needed to observe process performance from the Control Room during a wet weather event
- The control system should be upgraded. GLWA is currently developing an RFP for qualified design-build contractors to provide professional engineering and construction services for control system improvements at the Seven Mile CSO Facility under “Control System Improvements – St. Aubin, Leib and Seven Mile CSO Facilities.” The project will replace the existing PLC-5 control system and backup local control panels with a new control system, provide new Ovation workstations with high-performance graphics, and replace some of the field instruments. This is an ongoing project that has already been included in the CIP.
- The screen graphics are very difficult to understand and should be updated to match other facilities. This improvement is included in the Control System Improvements project described in the previous bullet.

14.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

I&C Improvements (Project STA-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the control system upgrade and simplifying the screen graphics, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing**

2) **Alternative 2: I&C Improvements** including,

- Address outfall level sensor fluctuations
- Provide remote control of:
 - Flushing and dewatering pumps at outfall
 - Flushing valve for influent channel
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Address outfall level sensor fluctuations. During wet weather, the level sensor signal fluctuates. To remedy, it is recommended to ensure at least 18-in. are clear between the water surface and the level sensor element. Modify the installation, as necessary, to raise the level sensor element to be a minimum of 18 in. above the surface of the highest expected water level. This should be a maintenance issue that gets addressed before this I&C project; however, it is included as a capital improvement in case it is not completed before this project.

Provide remote control of flushing and dewatering pumps at outfall and flushing valve for influent channel. Outfall Flushing and Dewatering Pumps: Provide remote control of the Flushing and Dewatering Pumps at the outfall from the CSO facility. The recommendation is to install a dedicated fiber optic cable from the CSO facility to a control panel located at the outfall.

Influent Channel Flushing Valve: It is recommended to provide remote control of the influent channel flushing valve to allow operations more flexibility when operating the facility during CSO events.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 14-11. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the remaining improvements in Alternative 2 are difficult to quantify and would not affect the alternative evaluation. Similarly, it is difficult to quantify the monetary benefits of the improved operations through the improved monitoring and control.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.5 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and improved O&M. The NPV/Benefit cost for Alternative 2 is \$67,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved control and maintainability associated with the I&C improvements, Alternative 2 is the recommended alternative.**

Table 14-11. Alternative Evaluation for I&C Improvements (Project STA-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Someone needs to be in Control Room to operate pump remotely during maintenance.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 170,000	\$ 2,500	\$ 222,724	\$ 67,153	Not Applicable
	<i>Definition:</i>	Add local control to pumps and valves; add process cameras.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved ease of maintenance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased instrumentation to maintain.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

14.2.8 Site

14.2.8.1 Description of Existing Site

The St. Aubin facility was constructed in 1999. Access to the site is off of Atwater Street. The access entrance gate is a 25-ft wide sliding vehicular gate. Site security is provided by a 6-ft high security fence around the perimeter of the site. The parking lot consists of 8-in. reinforced concrete pavement with 8-in. crushed limestone base. Concrete sidewalk widths vary from 5 to 14 ft and are approximately 4 in. thick.

The St. Aubin outfall site includes the Sampling Building and access hatch opening to the outfall conduit. The Sampling Building and outfall discharge site are secured by cyclone fencing on all four sides of the site. A 12-ft cantilever sliding gate is located on the west fence line to provide access to the secured area. The secured outfall site is located approximately 340 ft off Atwater Street. A gravel drive extends from Atwater Street to the entrance gate.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

14.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- There are several site issues at the St. Aubin outfall site including: 1) poor drainage in the access drive area between Atwater St. and the fenced area; 2) fencing in disrepair; 3) difficulty in removing hatch plates; and 4) access to the backwater gates. The poor drainage of the access drive has damaged the road surface and has created issues with accessibility to the secured area.
- The concrete surface at the northwest corner of the St. Aubin CSO facility has cracked due to settlement, causing runoff to flow back toward the building.
- At the St. Aubin CSO Control and Headworks Building, are stored in the Odor Control Room or outdoors. There is insufficient space inside the existing building to efficiently store all of the O&M equipment, as well as the equipment to maintain the site, in the main building. A storage building is needed to protect this equipment from ultraviolet light degradation and the elements. This building is currently planned to be installed under a separate project (CIP 260617).
- There are cracks in the sidewalks on the south and east sides of the Control Building.

14.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Outfall Site Improvements (Project STA-Site-1). There are two alternatives to address the issues identified at the St. Aubin outfall:

- 1) **Alternative 1: Do Nothing**
- 2) **Alternative 2: Outfall Site Improvements**

At the outfall site area, which is approximately 340 ft by 75 ft, regrading of the site is included in this alternative to direct the drainage north to the exiting channel to help alleviate poor drainage in this area. Additionally, the gravel drive in this area could be replaced with an alternative design featuring a grass paver surface supported on a new engineered support base. The grass pavers could be for the full width of the access drive, replacing the existing gravel drive. This will also complement the Detroit Riverwalk area in the vicinity. Figure STA-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, shows the location of these issues and suggested improvements.

The cyclone fencing around the site is in disrepair. The fencing includes approximately 400 ft of 8-ft-tall cyclone fencing. The fencing should be replaced to maintain security. Since the facility is located in a city park in a high visibility location, it is suggested that the cyclone fencing on the west, east and south sides of the site be replaced with ornamental fencing. The existing 12-ft wide automatic cantilever sliding gate has experienced numerous recent breakdowns. This equipment has likely reached the end of its useful service life and should be replaced.

The hatch openings over the two outfall backwater gates have dimensions of 8 ft by 10.5 ft. The openings over the two stop log guides are 10.25 ft by 3 ft. The hatch plates over the outfall gate openings are 0.5-in. thick stainless steel plates. These cover plates are very cumbersome to remove due to their weight. It is suggested that the outfall cover plate design be changed to a lighter weight cover plate. The cover plates over the stop log gates are Bilco style hatch covers – these gates should be considered for replacement due to their age.

Accessing the outfall backwater gates and stop logs within the secured fence line can be difficult as the area is all grass surface. It is suggested that the grass paver system identified for the entrance access road to the site be extended within the site so that trucks and equipment can access the outfall structure and gate and stop log hatch openings.

The minor repair to the concrete surface at the facility is included in this project. It is suggested that that this portion of the slab be removed, the subsurface regraded, and the concrete slab replaced to provide proper drainage away from the building.

The alternative evaluation is presented in Table 14-12. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the added features are assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M. **However, because of the improved accessibility, security and maintenance with the Outfall Site Improvements, Alternative 2 is the recommended alternative.**

Table 14-12. Alternative Evaluation for Outfall Site Improvements (Project STA-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lowest cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Site issues remain a concern.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Outfall Site Improvements	Health and Safety	4	3.50	\$ 806,000	\$ -	\$ 806,000	\$ 230,286	Not Applicable
	<i>Definition:</i>	Site improvements at the outfall area to address accessibility, security, and ease of maintenance.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved accessibility, security and maintenance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

14.2.9 Architectural

14.2.9.1 Description of Existing Facilities

The St. Aubin CSO facility consists of chemical room, utility support (electrical, emergency generator and mechanical), control room, odor control room and miscellaneous other rooms. The facility has an separate sample building at the end of the outfall.

14.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering system
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff indicated that that additional storage is desired at the St. Aubin facility. Since the meeting, the GLWA Program Management team generated a proposal for a new storage building to be located along the west side of the building, near the existing electrical room. This building is intended to be added during the upcoming capital improvement project (CIP 260617).

14.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (STA-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

1) Alternative 1: Do Nothing.

2) Alternative 2: Architectural Rehabilitation. Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation include the following:

- Remove and replace sealant around doors, windows and other wall penetrations
- Remove and replace sealant at all control/ expansion wall joints
- Remove and replace isolation/ cove joint sealant and around building perimeter

- Remove failed concrete floor coating, clean floor, and reseal floor with chemical resistant coating
- Remove corrosion at bottom of man door and coat steel framing

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure STA-ARCH-1-ALT-2). Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 14-13. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, **Alternative 2 is the recommended alternative.**

Table 14-13. Alternative Evaluation for Architectural Rehabilitation (Project STA-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 136,000	\$ -	\$ 136,000	\$ 43,871	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

14.2.10 Safety

14.2.10.1 Description of Existing System

Safety-related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

14.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 14-14. The capital improvement project to address these issues is included in the table.

Table 14-14. Identification of Capital Improvements for Safety Issues

Location	Description	Proposed Corrective Action	Capital Improvement Project
Basin	Seal-off fittings for mixer electrical feed is bypassed (typical of some other mixers also) and open junction box	Incorporate seal-off fitting into electrical wiring.	I&C Improvements
Dewatering Chamber	Exposed power wires in junction box and bypass of explosion-proof seal-off fitting in dewatering pump chamber	Enclose junction box and incorporate seal-off fitting into electrical wiring.	I&C Improvements
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project STA-SAFE-1)

14.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project STA-SAFE-1). This project should address the safety issues identified above. These issues include:

- Fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 14-15 shows the one alternative.

Table 14-15. Alternative Evaluation for Safety Improvements (Project STA-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	5	3.78	\$ 79,000	\$ -	\$ 79,000	\$ 20,881	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

14.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at St. Aubin CSO Facility.

14.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the St. Aubin CSO facility, Table 14-16 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 14-16, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 14-16. Listing of Asset Condition Assessments for St. Aubin Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	5	5	0	100%
AHU	5	2	3	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	1	1	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	1	1	0	100%
BUILDING	4	3	0	75% ^a
CAMERA	1	1	0	100%
COMPRESSOR	0	0	0	N/A
COND-AIR	0	0	0	N/A
CONVEYOR	0	0	0	N/A
CRANE	0	0	0	N/A
CTRLPANEL	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAM	1	0	1	100%
DAMPER	11	10	1	100%
DISCONNECT	0	0	0	N/A
DOOR	1	1	0	100%
DRIVE-ELEC	5	5	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	6	6	0	100%
FAN	1	0	1	100%
FANVENT	5	4	1	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	1	0	0	0% ^b
GASDETECTO	1	0	0	0% ^c
GASMONITOR	1	1	0	100%
GATE	8	8	0	100%
GEARBOX	0	0	0	N/A
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	2	2	0	100%
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	0	0	0	N/A
MCC	3	0	3	100%
METER	8	8	0	100%
MIXER	8	8	0	100%
MOTOR	1	0	1	100%
PANEL	5	5	0	100%
PIPING	4	4	0	100%
PUMP	16	8	7	94% ^d
ROOF	2	2	0	100%
SAMPLER	1	1	0	100%
SCADA	2	2	0	100%
SCREEN	2	0	2	100%
SCRUBBER	1	1	0	100%
SENSOR	9	9	0	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	1	0	1	100%
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	3	0	3	100%
UNITHEATER	2	2	0	100%
UPS	3	3	0	100%
VALVE	5	5	0	100%
WATERHTR	0	0	0	N/A

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The fire suppression system was assessed independently by Simplex Grinnell and not included in the ACES report.

^c The one gas detector is a portable unit and was not assessed.

^d The one pump not assessed was the Disinfection Sample Pump No. 2, which was inactive.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the St. Aubin Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

14.3 Capital Planning for St. Aubin CSO Facility

14.3.1 Summary of Capital Improvement Plan Projects

Table 14-17 provides a summary of the recommended CIP projects and associated capital costs for the St. Aubin CSO facility based on the alternative evaluations conducted for this facility.

Table 14-17. Summary of Recommended Projects at St. Aubin CSO Facility

Project No.	Alternative	Description	Total Project Cost
STA-FD-1	2	New Effluent Conduit Flushing System	\$ 2,472,000
STA-ELEC-1	2	Electrical Improvements	\$ 144,000
STA-I&C-1	2	I&C Improvements	\$ 170,000
STA-I&C-2	1	Control System Upgrade	Ongoing Project
STA-SITE-1	2	Outfall Site Improvements	\$ 806,000
STA-ARCH-1	2	Architectural Rehabilitation	\$ 136,000
STA-SAFE-1	1	Safety Improvements	\$ 79,000

14.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 14-18. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 14-18. Capital Improvement Plan Projects for St. Aubin CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
STA-1 Flushing System Improvements	\$ 2,472,000	2028 <i>Timing based on need to clean effluent channel in 10 years from last cleaning in</i>	STA-FD-1	New Effluent Conduit Flushing System	\$2,472,000
STA-2 Facility-Wide Electrical and I&C Improvements	\$ 314,000	2035 <i>Timing based on best judgement</i>	STA-ELEC-1	Electrical Improvements	\$144,000
			STA-I&C-1	I&C Improvements	\$170,000
STA-3 Outfall Site Improvements	\$ 806,000	2028 <i>Timing based on best judgement</i>	STA-SITE-1	Outfall Site Improvements	\$806,000
STA-4 Facility-Wide Safety and Architectural Improvements	\$ 215,000	2023 <i>Project should be initiated as soon as possible</i>	STA-ARCH-1	Architectural Rehabilitation	\$136,000
			STA-SAFE-1	Safety Improvements	\$79,000

Unlike the other sections, there are no existing assets in the projects listed above. As such, the Asset Information tables shown for the other facilities are not included here.

14.3.3 20-Year Capital Outlay Plan

Table 14-19 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 14-19. 20-Year Capital Outlay Plan for St. Aubin CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 113,300	\$ 23,500	\$ -	\$ 48,800	\$ -	\$ 22,300	\$ -	\$ 4,200	\$ -	\$ -	\$ 14,500	\$ -	\$ -
2022	\$ 176,144	\$ -	\$ -	\$ 176,144	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 27,315	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 6,304	\$ -	\$ -	\$ -	\$ 21,012
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 202,929	\$ 30,747	\$ -	\$ -	\$ 172,182	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,831,486	\$ 7,714	\$ -	\$ 38,571	\$ 15,428	\$ -	\$ -	\$ -	\$ -	\$ 1,769,773	\$ -	\$ -	\$ -
2030	\$ 524,523	\$ 2,610	\$ -	\$ -	\$ 472,328	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 49,585	\$ -	\$ -
2031	\$ 332,485	\$ -	\$ -	\$ 292,302	\$ 40,183	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 8,429	\$ 8,429	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 842,645	\$ -	\$ -	\$ 632,938	\$ -	\$ 65,056	\$ -	\$ 144,651	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 425,483	\$ -	\$ -	\$ 328,988	\$ 45,226	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 51,269	\$ -	\$ -
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 508,199	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 508,199	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 409,967	\$ 74,025	\$ -	\$ -	\$ -	\$ 150,325	\$ 40,007	\$ 95,847	\$ 49,762	\$ -	\$ -	\$ -	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 5,402,905	\$ 147,025	\$ -	\$ 1,517,743	\$ 745,348	\$ 237,681	\$ 40,007	\$ 244,698	\$ 564,265	\$ 1,769,773	\$ 115,354	\$ -	\$ 21,012

- Notes:
- Explanation of large capital outlays in first two years:
- Retention System: St. Aubin “basin” (\$176,000) received a score of 5 based on the NTH structural assessment. One magnetic flow meter (FM-2; 49,000) received a score of 5 because the meter was not functioning properly based on SCADA data review in early 2020.

Appendix F

Project Risk Register

PROJECT RISK REGISTER

Updated: 7/17/23

Project No.: 276260
Project Name: OAKWOOD AND LEIB CSO FACILITIES IMPROVEMENTS
Client: GREAT LAKES WATER AUTHORITY (GLWA)
Project Manager: Ali Khraizat
Project Technical Lead: Steve Fehniger

Identification					Risk Response Planning
Risk ID	Activity	Risk Category	Risk Description	Cause of Risk	Risk Response
6	CFD modeling will require time for troubleshooting if we have issues with solution convergence and to understand/explain why the results are different than expected.	CFD Modeling	The time it takes to resolve solution convergence issues impacts our ability to complete the required CFD modeling and design for the Leib Facility.	CFD modeling results in solution convergence issues and results that are different than expected or not within acceptable tolerances.	CFD Model Task Lead (Carrie Knatz) must stay in close communication with CSL/PM (Ali Khraizat) and PTL (Steve Fehniger) on the status of the CFD modeling and whether she is having issues with solution convergence that may adversely impact our ability to meet the design milestones.
12	We must have a proactive conversation with GLWA to establish agreement on the CFD model boundary conditions (or limits) since it was not clearly stated in the contract terms.	CFD Modeling	GLWA does not accept our CFD model boundary condition assumptions from which our current budget was developed. CFD modeling recommendations are unable to be defended with EGLE.	GLWA is unwilling to accept the CFD model boundary conditions since it was not explicitly stated in the contract.	Conduct interim CFD model meetings, review, discuss and justify the model boundaries as a team to confirm compliance with the overall project goals.
7	Update and share a frozen (key) decision list or action item list with GLWA’s PM to prevent circle back on decisions.	Change Management	Project team must redo work and/or frustrated client and potential impact to overall schedule	Concise direction not achieved and/or priorities/preferences shifted	Thoroughly document and review client directives and decisions and internal directives and decisions during design review meetings. Develop key decision summary logs to help guide the process moving forward.
5	Engage the appropriate GLWA staff and stakeholders (management, operations and maintenance personnel) at the right times during the entire process from conceptual design through start-up and commissioning such that they are integral team members that can make quick, decisive decisions and that they are comfortable with the intended operation of the facilities.	Communications	Key GLWA stakeholders do not attend meetings or workshops where their attendance is required. Receiving GLWA's input from a single unified voice (versus conflicting feedback and opinions) when it is required and not beyond due dates.	A "Core GLWA Team" is not identified early to this project and departments within GLWA that must interact with the CDM Smith project team for this project to be successful (management, engineering, operations and maintenance personnel).	The CDM Smith team will bring this risk to the attention of GLWA at meeting and explain to GLWA the importance and need to identify a “Core GLWA Team” (management, engineering, operations and maintenance personnel) that can make decisive decisions on the project (from conceptual design through start-up, commissioning and operations) and confirm this GLWA team's commitment to attend all required meetings/workshops/ride alongs.
17	Realize the scope of work of other construction projects (ongoing or future)	Construction	The team has limited knowledge of the scope of work of other projects at Leib and Oakwood.	Design decisions and improvements are based on an incomplete or inaccurate understanding of other projects which may interrupt the construction schedule.	Continued cooperation and coordination meetings with the other project teams. Obtain information regarding completed projects, awaiting construction at the time of this project's improvements (Upstream Junction Chamber at OKW) from GLWA.
18	Understanding of the timing long lead items	Construction and Schedule	Major pieces of equipment requiring longer lead times than originally expect could impact the overall construction schedule	Lack of understanding of the long lead items and/or inaccurate actual lead times associated with them.	The design team to follow-up with local vendors and/or manufacturers for updated lead times throughout the design project lifecycle. Consider addition of scheduled float to address longer lead times.
1	Prevent project "circle back" on design decisions, especially during the detailed design phase. - CSF #9	Design Process	Project team must redo work and make modifications to the design multiple times.	Stakeholders do not provide clear direction or makes changes in their priorities and/or preferences previously agreed upon without considering how these changes may impact the overall project.	The design team will maintain a "frozen" items list (Key Decisions List) and review this list with the client at monthly design review meetings and discuss the impact to the project schedule and/or budget. Should the client decide to change their direction, the design team will assess the impact to schedule and budget and discuss with GLWA to explain the impacts to the project.
4	Resolve the Leib screening issue.	Design Process	The CDM Smith design recommended solution does not resolve the Leib screening issues of blinded screens and screenings blowby.	Team is not able to discern the root causes of the problematic equipment, process and/or activity.	The CDM Smith team will come to fully understand the current situation and the limitations and capabilities of the current equipment and will engage GLWA on their desired outcomes and develop alternatives for improvement that achieves those desired outcomes in coordination with the screen manufacturer.

Identification					Risk Response Planning
Risk ID	Activity	Risk Category	Risk Description	Cause of Risk	Risk Response
8	Develop solutions that address the root cause of the problematic equipment, process and/or activities by studying, using and leveraging previous studies and past evaluations and by conducting objective root cause evaluations.	Design Process	Alternative solutions do not address the root cause of the problematic equipment, process and/or activity.	Team is not able to discern the root causes of the problematic equipment, process and/or activity.	CDM Smith PM will clearly communicate to each of the Task Leads the criticality and importance of developing solutions that address the root cause of the problematic equipment, process and/or activities. A list (overall summary) for each facility (including equipment, processes and activities) of what data we have and what we still might need and whether what we have is sufficient to proceed with design. This individual must engage the appropriate GLWA staff to obtain all studies and evaluations that have been conducted by others at each facility and provide CDM Smith access to them.
9	Improve reliability, flexibility, operability, safety, and reduce maintenance by improving operational and maintenance efficiencies while facilitating system readiness for increases to influent flow rate within the discharge permit limits.	Design Process	Final facilities design fails to satisfy GLWA's criteria of improved operational and maintenance efficiency (i.e. reduced maintenance), reliability, flexibility and safety during increases to influent flow rate while meeting discharge permit limits.	The project team is over confident and/or faulty in their analysis and belief that the design alternatives considered and recommended improve reliability, flexibility, operability, safety, etc.	When identifying the various design options for alternatives analysis, the design team must clearly articulate and receive acceptance from GLWA on how each design alternative will be evaluated against it ability to improve reliability, flexibility, operability, safety, and reduce maintenance by improving operational and maintenance efficiencies and facilitating system readiness for increases to influent flow rate within the discharge permit limits.
10	Prepare and update auxiliary systems/facilities and properly design the mechanical equipment needs to accommodate future demands and additional loads (coming after inter-sewer connections are made) to minimize the potential for system interruptions and high hydraulic grade lines in the collection system by establishing early on what the future flow rates/loads are going to be with GLWA.	Design Process	Final facilities design fails to accommodate future flow rates and additional loads.	Inaccurate future flow rate/load data or the project team is over confident and/or faulty in our analysis and belief that our designs can properly accommodate these future flow rates/loads.	A dedicated conversation(s)/TM/Workshop with GLWA to establish what is the appropriate design criteria be used regarding future flow rates/loads and when we need to have a final decision on this information so as to not adversely impact the baseline project schedule. PM should document these conversations in writing and obtain GLWA's acknowledgement of the decisions that are made. Using this information, the design team must confirm that the design to address the mechanical equipment needs and the design updates to the auxiliary systems/facilities can properly accommodate these future flow rates/loads.
15	Identify a means to provide sufficient mixing performance with reduced maintenance costs (e.g., reduced number of induction mixers) at Baby Creek, Connor Creek and Leib facilities.	Design Process	Final facilities design fails to provide sufficient mixing performance with reduced maintenance costs (e.g., reduced number of induction mixers) at Baby Creek, Connor Creek and Leib facilities.	The project team is over confident and/or faulty in their analysis and belief that our recommendations will provide sufficient mixing performance.	CFD Modeling Task Lead must establish the following necessary information on the existing systems: 1) As-built drawings of Baby Creek, Connor Creek and Leib facilities including mixer locations; 2) Existing mixer data sheets including flow and geometry information; and 3) Available head loss for retrofit configurations. Both CFD and Disinfection task leads, must develop what is needed for "sufficient" mixing means.
3	Design improvements must account for the integration of construction activities and maintenance of facility operations during construction for a seamless transition and to minimize or eliminate shutdowns during construction.	MOPO	Facilities and/or process areas are unexpectedly shut down due to site activities without any contingency plan.	The MOPO Construction Sequencing Plan/Specification and/or the Critical Path Method Construction schedule is poorly prepared and does not work properly when followed and implemented. Constructability analysis is incomplete or not thorough enough to identify all constructability issues.	MOPO specifications and workshops are programmed into the scope at 30% and 60% but to further mitigate this risk, CDM Smith project management team will work with the Task Leads to verify that these specifications and workshops progress with design definition and sequence of construction and to engage EGLE as needed for part 41 permit requirements.
16	Provide effective means to operate the CSO's during disinfection upgrades, pump rehab and screen replacement.	MOPO	CSO Treatment Facilities will not be able to meet/exceed permit compliance during construction during a wet weather event.	The temporary operational recommendations are not followed or don't address operational needs during equipment replacement.	The design team must determine which team members are vital to developing the temporary operational strategies required to maintain plant operations. These recommendations must be reviewed and agreed upon by GLWA. Update SOPs per outage impact results.
2	The newly constructed facility must operate reliably "on demand" without a complicated process (keep it simple).	O&M	Our design includes a complicated process that does not allow the facility to operate reliably "on demand" per the client's definition and expectations.	CDM Smith design team does not obtain clear insights from GLWA with regards to the definition of a simple vs. a complicated process.	This was identified as Risk #5 during the client project kickoff meeting. To mitigate this risk, it was agreed that will incorporate and communicate this premise at the internal Guiding Principles Decision Making meeting and Task Leaders to lay out all principles and precepts that will guide the design team throughout the project. Review the design with client at 30% with a focus on identification of improvements or controls for improvements that are deemed too complicated.

Appendix G

Comment Resolution Log

GLWA Contract - 2101475
CSO Facilities Improvements Project
Study Phase Technical Memorandum Comment Resolution Form
TMs Submitted 3/20/2023, 3/24/2023, 4/10/2023 – Review Comments Received from 3/22/2023 thru 4/19/2023

Comment No.	TM	Pg, Paragraph	Reviewer	Comment	Consultant Response	Incorporated in Final TM Deliverable
1	1	1,1	Nastally	How come the ASI memo covers baby and conner creek, but this TM does not?	Project needs required the creation of detailed hydraulic models for the Leib SDF and the Oakwood CSO PS & RTB. Detailed hydraulic models were not prepared at Baby Creek and Conner Creek.	No
2	1	8, Table 3-2	Nastally	This includes the NWI diversion?	Yes. Better clarification of future flow rate conditions identified in the Table 3-2.	Yes
3	1	9, bullet 1	Nastally	Is this right? We don't consider one channel out of service for firm capacity?	For existing conditions, the facility was modeled with all screen in-service to align with the original design assumptions. An existing conditions scenario was created with one channel out-of-service to evaluate the firm capacity.	Yes
4	1	9, bullet 2	Nastally	Wouldn't this condition result in additional blinding above manufacturers information because there is no sideflow being generated?	This condition was reviewed hydraulically to provide a consistent hydraulic condition for each scenario reviewed. Actual operations will be coordinated with the screen design. The headlosses through the screen are based off of an assumed blinding factor and a flow rate.	No
5	1	9, 4.2 bullet 1	Nastally	Why not also modeling 4 channels of ROMAG screens, per earlier discussions?	TM-1 updated to include model scenario with 4 channels of ROMAG screens.	Yes
6	1	9, 4.2 bullet 1	Nastally	What also about 4 channels of duperon? I would think we need to model these 3 situations regardless. The last one assumes the cost of retrofitting w/ dupérons is acceptable to GLWA for 1, and then ultimately 3 more.	The hydraulic analysis initially focused on the leading alternative for the screen replacement in one screen channel with multi-rake screen (pilot). This was followed by a hydraulic analysis of the GLWA preferred alternative of all-Romag screens to determine technical feasibility from a hydraulic perspective. Feasibility was confirmed given the maximum HGL in influent channel was lower than the existing conditions maximum HGL in the influent channel.	No
7	1	9, 4.2, para 4	Nastally	See comment above	The hydraulic modeling scenarios were aligned to the screening alternative analysis. Additional hydraulic scenarios can be added once the recommended screen arrangement is selected.	No

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Comment No.	TM	Pg, Paragraph	Reviewer	Comment	Consultant Response	Incorporated in Final TM Deliverable
8	1	10,2	Nastally	What memo will this be in, and how will we tie back to here?	The proposed conditions alternatives are considered hydraulically acceptable if the proposed conditions gradeline is below the existing conditions gradeline at the upstream end of the facility. The study phase hydraulics have found the proposed conditions hydraulic gradeline to be below the existing conditions gradeline which does not warrant additional analysis. This check will be completed at major milestones throughout the design phase of the project to confirm the hydraulics are acceptable.	No
9	1	11,3	Nastally	See comments above on other "proposed" conditions.	Better clarification of current and future flow rate conditions identified in Table 3-2.	Yes
10	1	12,1	Nastally	See comment on Leib for closed TTS and closed Screenings gate	This condition was reviewed hydraulically to provide a consistent hydraulic condition for each scenario reviewed. Actual operations will be coordinated with the screen design.	No
11	1	12,3	Nastally	So this needs to be updated based on other scenarios. It's difficult for GLWA to make a decision with only limited information.	Hydraulic analysis was updated to include the evaluation of the all Romag alternative.	Yes
12	1	Appendix A, 16(3), Notes	Nastally	It was designed to several river levels from what I can tell. The main difference is the higher the river, the less throughput.	Statement made in TM reflects what is found in the BOD report for these facilities.	Yes
13	1	Appendix B, 19(2), Data Sheet Sample	Nastally	How much of their headloss is based on sideflow. I recall this being discussed of 10% of the total flow going over the weir, but the way it was modeled (100%) wouldn't yield the proper results, right?	Manufacturer's data was provided based on a given throughput of the screen and a given blinding percentage. The hydraulic model was set up to determine the HGL for the given condition.	No
14	1	Appendix C, 25, HGL matrix	Nastally	Is this w/NWI or without?	Better clarification of current and future flow rate conditions identified in Table 3-2.	Yes
15	2	2,2	Nastally	inserted "as"	"as" inserted as indicated.	Yes

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Comment No.	TM	Pg, Paragraph	Reviewer	Comment	Consultant Response	Incorporated in Final TM Deliverable
16	2	3,4	Nastally	See email I sent to Ali on this...the operations team is now (after 3 years) indicating that it is causing problems, but for 3 years there were none. I still wonder what's going on and asked CDM to look into and perhaps this would be additional costs.	CDM Smith has completed a review of pump condition reports (4) from Kennedy Industries and coverage of the system curve envelope operationally (See TM-15) as well as operational practices. Suggest discuss findings in a future meeting.	No
17	2	3,4	Worth	Has it been determined if this is a clogging screen issue or a flushing system issue, or both?	This has been determined to be a sanitary influent channel screen blinding/clogging issue (screens manually cleaned). CDM Smith does not anticipate the flushing system in storm wet well caused screen issues as it is not frequently utilized based on discussions with operations staff.	No
18	2	4,1	Worth	Pullman is going to remove less than 150 tons from the wet wells. Compared to other facilities, quantity was not overwhelming and it was a relatively quick process once flows were managed and air flow was established into the wet wells	Noted, favorable that not much material removed comparatively. Photos noted some pump bells nearly surrounded in debris which would impact performance. As discussed in TM workshop No. 2, we plan to discuss lessons learned from the OKW wet well cleaning with Pullman and their cleaning sub.	No
19	2	4,5	Nastally	I'm not sure I follow this. If we turn on storm pumps, it's going to the RTB, and so why wouldn't the number be the same? Or clarify that 25 times a year means high wet well, but no storm pumps turn on. To me if that is the case here, it wouldn't be "operates about 25 times per year" then.	TM description clarified to reflect 25 time a year at least one storm pump turns on. The activation of the RTB is linked to discharge to the river which historically has happened far less than frequency of pump starts.	Yes
20	2	5,4	Nastally	Added "the"	"the" added where indicated.	Yes
21	2	6,1	Nastally	Replaced "if" with "whether a"	Replaced "if" with "whether a" where indicated.	Yes
22	2	7, bullet 2	Worth	Are these in use? If not, why clean them?	Yes, the approach tunnels and integral sanitary trenches are in use, will be part of the list of areas to be cleaned as part of the construction contract.	No
23	2	7, bullet 3	Worth	Has this been discussed with Pullman? Cleaning was straight forward, except for the sanitary wet well which is proving difficult to access	This discussion has been added to the Next Steps section to be conducted in the BOD phase.	Yes

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Comment No.	TM	Pg, Paragraph	Reviewer	Comment	Consultant Response	Incorporated in Final TM Deliverable
24	2	8,3	Nastally	We agree	Noted. Based on discussion at TM Workshop No. 2 we plan to identify that the contractor will be able to discharge decant water to MH along sanitary system but not use the sanitary pumps.	Yes
25	2	8,4	Nastally	It needs to be vac'd out and hauled off.	Noted.	Yes
26	2	8,5	Nastally	Now that I type this, I wonder if the previous cleaning efforts are slurring up the sludge and using our pumps and thus after 3 years of removing the bar racks we are experiencing issues (not because of screenings, but because of heavy grit being sent to them). Please confirm if this is your understanding	As briefly discussed at the TM workshop CDM Smith noted the use of sanitary pumps during cleaning process could be a contributor but not likely the primary cause of sanitary pump issues. As noted in comment 16, plan to discuss further with GLWA.	No
27	2	8,5	Worth	Review process with Pullman. Vac'd out, decanted, landfilled.	The potential methods and constraints will be defined in a cleaning specification. The TM updated to reflect a meeting with Pullman to be conducted in the BOD Phase (Next Steps section).	Yes
28	2	10,1	Nastally	What about a "dingo" (like a skid steer, but smaller).	As discussed in the TM workshop CDM Smith does not recommend equipment due to limited maneuverability space and risk to damage pump if impacted by the equipment. In addition, recent Pullman cleaning procedures did not include equipment such as a dingo.	No
29	2	16, table 3-2	Nastally	I'd be curious what Tom Hall thinks, but I think Option 1 is the best.	As discussed in TM workshop, CDM Smith discussed with Tom Hall and confirmed his strong preference for Option 1 (dedicated grease lube system).	Yes
30	2	16, 4	Nastally	See my comment above	See response immediately above.	Yes
31	2	17,1	Nastally	This area doesn't need to be for storage	Noted. No longer avoiding the motor room for grease lube system equipment based on input at 2/13/2023 workshop as summarized in TM that no need to maintain storage function.	No
32	2	17,1	Nastally	I think it makes most sense here	Noted.	Yes
33	2	17,1	Worth	Will this part of the reality capture?	Yes, the new equipment will be included in the 3D model as part of the 30% drawing preparation thereby resulting in capture in the virtual reality capture.	No
34	2	18,2	Nastally	Added "as the design progresses"	Added "as the design progresses" where indicated.	Yes

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35	2	19,3	Nastally	If it's manual today and we make it automated, and it's pennies...it makes sense to me to do so	Understood, planning to include in the design of the lubrication system.	Yes, below Table 3-4
36	2	19,5	Nastally	We agree	Noted.	Yes
37	2	21, bullet 1	Nastally	Add period at end of bullet	Period added.	Yes
38	2	21, bullet 5	Nastally	No doubt about it.	Noted.	No
39	2	22, bullet 1	Nastally	Does this even include treatment costs? Or is this just GLWA direct costs we pay to Detroit for our water bill?	This is only the direct cost on water bill which includes the clean water cost and the cost for treatment of an equivalent quantity of wastewater even if not directed to collection system as indicated in TM "combined water and sewer charges".	No
40	2	22, bullet 4	Nastally	Add "are"	"are" added where indicated.	Yes
41	2	22,2	Nastally	Also we should take GLWA's procurement into account. Given our procurement is almost a 1 year long process, we need to be sure it makes sense. So if the full design was only 6 months behind, it probably doesn't make sense to separate them because the net effect is 6 months time savings.	Noted, procurement process is included at about 13 months. The analysis with associated assumptions showed less than 6 months time savings.	No
42	2	22, bullet 5	Nastally	This will need to be updated	Updated.	Yes
43	2	22, bullet 5	Worth	This should be verified as part of Task B	This was clarified to be a basis for comparison of a stand alone contract but will be further reviewed as the design progresses.	Yes
44	2	23, bullet 1	Nastally	How long is this compared with getting everything else done?	The separate contract schedule was compared to the current construction schedule in TM workshop demonstrating a time savings of approximately 3 months inclusive of associated assumptions.	Yes
45	2	23, bullet 1	Nastally	See above	See responses above.	No
46	2	23, bullet 1	Nastally	Is this inclusive of bid phase? If so, I think we're close here with actual time in procurement.	No, bid phase is separate. The comparison of 1 year to the 1 year + 1 month was discussed at the TM workshop.	No

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47	2	24, 1	Worth	My thinking is that this makes sense only if there is a demonstrated advantage to starting early, the longer duration can be managed in the contract. Interim milestones, special provisions for releasing retention, there are coordination advantages and potential savings from already engaging all the same players under the main contract.	As discussed at the TM workshop not a significant time savings based on analysis and assumptions.	No
48	2	25,1	Nastally	Is there a risk of this "sump pump" failing and we flood out the intermediate level?	Discussed in the TM workshop and concluded an additional sump pump will be required either in the sump (if will fit) or on floor beside the sump pit.	Yes
49	2	25,1	Nastally	Inserted text "a"	Inserted "a" where indicated.	Yes
50	2	26,2	Nastally	I assume CDM is performing this confirmation? I thought we had discussed CDM providing us with some sketches and part numbers and we'd install. What is the status of that?	CDM Smith team selected an instrument and provided guidance to GLWA for temporary monitoring of OKW secondary water near Storm Pump 7. Results of monitoring will be reviewed when installed and operated for sufficient duration leading to recommendation in preliminary design if monitoring period completed in that phase.	No
51	2	27,5	Nastally	See my questions above	See responses above.	No
52	3	6,1	Nastally	Remove Not used. section	Removed section and renumbered subsequent sections.	Yes
53	4	2,1	Nastally	Text added- in subsequent storm events	"in subsequent storm events" added where indicated.	Yes

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Comment No.	TM	Pg, Paragraph	Reviewer	Comment	Consultant Response	Incorporated in Final TM Deliverable
54	4	10,1	Nastally	But this would likely change with NWI diversion, I assume. Also - based on the next paragraph, if we had 6 or 7 storm pumps running, the amount of debris on the screens would increase 6 or 7 fold I presume. The screen wash waster then could have a different impact when there are 6-7x more screenings.	Noted and agree that more screenings are anticipated when NWI is connected. Amount removed per screen may not increase as much as the total amount of screenings increase, based on observation that most screenings are removed by the screen closest to the operating pump discharge and the screen(s) farther from the operating pump have fewer screenings. Screenings capture estimates from WWMP were 1-3 cf/MG for 6mm screens. The 3 cf/MG equals 134 cf/h at OKW capacity of 1660 cfs (<150 cf/h, capacity of screenings grinder) Description of estimated screenings removal with additional flow based on WWMP estimates has been added as new Section 3.5. See related comment 59.	Yes
55	4	10,1	Worth	Whats the confidence level that this is typical based on fluctuations throughout the year?	At the end of paragraph 2 on page 10 there is a reference to seasonal variability in the screenings collected, based on operator interviews.	No
56	4	10,2	Nastally	"if" replaced with "during"	"if" replaced with "during" where indicated.	Yes
57	4	13,1	Nastally	I don't recall "horizontal". 11-1/4 degree incline is what I recall.	As noted in the TM text, "horizontal" was stated in the CS-299 report. The JWC field report did recommend an 11 degree elbow. The modification in place is effectively horizontal. The performance of existing configuration is what is important to the current evaluation.	No
58	4	15,5	Nastally	The real test is when the diversion is completed (if ever).	Noted. These evaluations were conceptual. We are not recommending reducing the washwater volume by pressure reduction or nozzle replacement, due to importance of screen cleaning and preventing screens from entering the basin for permit compliance.	No
59	4	17, bullet 10	Nastally	I didn't see the purpose of this in our meeting in February.	We needed to consider it for the alternatives evaluation. Refer to first full paragraph on next page (starts with words "The existing grinder capacity..")	No

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60	4	17,2	Nastally	But how will it change with the NWI diversion?	We don't know for sure, but anticipate debris will be similar to what currently arriving at Oakwood and PS-2. For items to get to the grinder they have to be lifted by the storm pumps and the screens and be able to be conveyed to the grinder. See related response to comment #53. An estimate of screenings removal and collection after additional flow routed to Oakwood was added to the TM. Discussion of additional screenings collected in the dumpster was added to the recommendations section based on feedback received at the workshop on 4/19/23.	Yes
61	4	27, Table 5-4 col 1	Nastally	think we stick with what we have.	Noted. This is the recommended alternative.	No
62	4	27, Table 5-4, col 3	Nastally	We've done almost nothing since 2012	Understood. We expect the hours of runtime to increase with the equipment online for most events since the discharge chute modification and increased runtime hours after connection of NWI.	No
63	5	2, Table ES-1	Nastally	How has EGLE responded since this newly calculated flow essentially derates the facility.	The new Leib peak flow after Meldrum sewer connection (950 cfs) were presented and discussed with EGLE on 2/7/23. No comment or objection is received about it.	No
64	5	2,1	Nastally	Deleted ", "	Comma deleted.	Yes
65	5	2,bullet 1	Nastally	Renovate, or replace? They're ~ 20 years old.	Replace	Yes
66	5	2, bullet 2	Nastally	Added text "(aka side flow)"	"(aka side flow)" added where indicated	Yes
67	5	3, last para	Nastally	Deleted space	Extra space deleted	Yes
68	5	4,2		I think CDM smith needs to figure out how to test this today...so we can verify. \$1.8 Million (I assume applies to the final solution of all vertical screens, is nothing to shake a stick at. I will read on though.	Per discussion during the workshops and per field visit of the manufacturer representative, there are promising signs that ROMAG rehabilitation can improve the system operation to some extent. Extent of improvements can be determined in practice. Also, per clarifications provided during the workshop about the phasing of Alt A & G, the cost difference between these alternatives is expected to be higher.	No
69	5	4,4	Nastally	Inserted word "that"	"that" inserted where indicated.	Yes

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70	5	8,2	Nastally	Have you verified via the videos that this is what occurs? My understanding is that before water starts flowing through the screens that the screens turn on pre-emptively as to not be starting from behind.	The videos of the last five events at the time of drafting the TM showed many anomalies. Some screens were coming on before the flow started (~Elv. 108'), while others stayed off. Those screens that came on a few minutes earlier than starting flow soon turned off after a few minutes of flow through the screen. The turning on and off at different events were random, and no pattern was observed. Based on the discussion with the operator on 01/26/23, the anomalies could be attributed to the manual operation or signal loss/equipment fault. Some clarifications were added to the TM about the exact expected turning on and off set point of screens based on SOP (screen on at Elv. 110' (13' depth) and off at Elv. 109.8' (12.8' depth). Based on O&M, ROMAG screen should not run while the bottom of the screen is out of water to prevent damage to the equipment while running dry.	Yes
71	5	13, #2	Nastally	Deleted '	Apostrophe deleted where indicated.	Yes
72	5	13,list	Nastally	Periods added to end of sentence in numbered list	Periods added as indicated.	Yes
73	5	13, #5	Nastally	Changed "operation' to "operating"	Word changed as indicated.	Yes
74	5	13,5	Nastally	Provide date.	Added	Yes
75	5	15,1	Nastally	Replaced "gpm" with "cfs"	"gpm" replaced with "cfs"	Yes
76	5	15,1	Nastally	@David McCord Isn't the TTS gate supposed to be open to 20	From design team: Yes, but during this specific event the gate was open at 12.5% and was sending about 15 to 25% flow to TTS	No
77	5	15, 1	Nastally	CFS?	Yes	Yes
78	5	15,1	Nastally	Modified wording	Wording in sentence modified as indicated.	Yes
79	5	17,3	Nastally	What is this data, what tags did you use, and how exactly are you getting this interpretation?	More details about data points, findings and a sample graph for one event were added with a description	Yes
80	5	17,3	Nastally	@David McCord Please confirm this is your understanding.	The 12 percent open of the TT Gate was discussed in WS No. 2 including gate position observe during ride-along site visit. Dave and Chris may discuss further.	No

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81	5	17,3	Nastally	Were observations made / discussed with the operator about manual versus automatic operations?	Yes, a separate Team meeting with the operation team and CDM Smith team was held on 01/26/23. Based on the operator's inputs and notes, the anomalies could be attributed to manual operation or signal loss/equipment fault.	No
82	5	19,2	Nastally	Insert "side"	"side" inserted where indicated.	Yes
83	5	19,3	Nastally	Above, however, you keep saying 12%.	12% is based on existing SOP. 12.5% was observed during the wet weather event operation at that specific event, resulting in 15% to 25% side flow. The 20% is mentioned by Dave as their current goal. Although these #s have some variations, the goal is to keep the minimum side flow to 10% of inflow which seems can be achieved by both 12% and 20% opening. The further hydraulic simulation aims to define the gate opening for the new design peak flow. Having an automatic control to adjust the position of the gate to maintain min 10% side flow to TSS is an optimal solution.	No
84	5	20,5	Nastally	Deleted "s"	"s" deleted as indicated.	Yes
85	5	22,1	Nastally	Wouldn't the screenings then wrap around the gate?	Yes, there is a possibility for that. However, per discussion with the manufacturer that is provided in the following paragraph, this modification is not recommended due to a lack of real data from past experiences and a lack of a need to change the gates that don't show signs of corrosion or malfunction.	Yes
86	5	22,2	Nastally	But why are we separating this from the all romag option?	See the response above about the lack of practical evidence.	No
87	5	22,4	Nastally	It's influent per channel, right?	Yes, however, in practice, due to the turbulent condition of the flow through the screening inlet channel, it is hard to measure the flow in each channel, and adjusting the side flow for each channel will be challenging and add more complexity to the operation. So, the min 10% side flow can be controlled in a more practical way based on flow measured at TTS and changing the TTS gate position.	No

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88	5	22,4	Nastally	What percent open would this correspond to? Are we hitting the mark or not? I was told we were...and what happens when the side flow is greater than 10%?	In some of the past events, it was observed that the TTS gate was closed, and the side flow was almost zero. However, in the event on 2/27/23, the gate was open 12.5%, and side flow exceeded min 10%. The further hydraulic simulation aims to define the gate opening for the new design peak flow. The gate position to transfer min 10% to TSS will be affected by the downstream level.	No
89	5	23,1	Nastally	Laser flows?	The turbulent flow condition and a considerable amount of swirling observed during an event in the screening inlet channel make it hard to measure the flow in each channel. So, adjusting the side flow for each channel will be challenging and add more complexity to the operation and need more instruments. So, the min 10% side flow can be controlled in a more practical way based on flow measured at TTS and changing the TTS gate position.	No
90	5	23,2	Nastally	Is there actually an option for this?	After receiving more input from ROMAG manufacturer, the answer for that screen is no. However, multi-rake screens have these option. The text changed for clarification.	Yes
91	5	24,2	Nastally	Replaced "at" with "to be"	"at" replaced with "to be" where indicated.	Yes
92	5	24,4	Nastally	Sentence does not read properly	Corrected.	Yes
93	5	30,1	Nastally	What if instead of this, we just replaced both COPAs with these? Could we do this? OR because of the larger screen needed, would this not really be an option?	It is feasible but needs multiple screens on the sides of channels, and controlling the downstream level of these screens to limit the max slot velocity will be very challenging due to the existing structure configuration. So, the final system will have more complexity that would not match guiding principles, and perpendicular installation of screens is not very common, and there are limited past installations in this arrangement. So only one manufacturer felt comfortable about it.	No
94	5	38, bullet 10	Nastally	As written this is confusing...revise it.	Edited	Yes
95	5	39, bullet 3	Nastally	As written this doesn't make sense.	Edited	Yes

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96	5	36, bullets	Nastally	Periods added	Periods added where indicated.	Yes
97	5	36,1	Nastally	Insert comma after "so:	Comma inserted.	Yes
98	5	39, bullet 5	Nastally	Add period to end of bullet.	Period added.	Yes
99	5	45,	Nastally	Replaced "one" with "two", added s to channel	"one" corrected to "two", "s" added to channel.	Yes
100	5	45,4	Nastally	There should be an A.2 where it's all the channels.	Per discussion during the workshop Alt phase was broken down to two phases for LCCA calculation then the total cost of phase 1 & 2 is compared with cost of alt G in one phase, clarification was added to LCCA description.	Yes
101	5	47, Table 7-1, col 1	Nastally	What does alternative A cost for in the interim, where I have to rehab the existing COPA's, that we know we don't want? What is the cost associated with that? I think that cost would get added to this...because no matter what I have to do it unless we pursue all new screens all at once.	Edited based on discussion during the workshop and clarifications provided for the Alt A & G modifications in 2 phases and 1 phase, respectively. Clarification was added to LCCA section and numbers got updated.	Yes
102	5	48,2	Nastally	Even if they haven't changed it, after a 20+ year installation, wouldn't we want to replace some major items?	COPA components to be rehabilitated or replaced were added.	Yes
103	5	48,4	Nastally	What does your CFD show for the sideflows that could be generated by the gate during facility operation?	The further ongoing hydraulic simulation aims to define the gate opening for the new design peak flow.	No
104	5	48,5	Nastally	Insert comma after "also"	Comma added.	Yes
105	6		Nastally	No comments	NA	NA
106	7	1,2	Nastally	Can you check with Jared Buzo - he's also working on a "process" cameras project that may be on a faster schedule and may or may not include Leib and/or Oakwood. If nothing else, there will be standards / standard approach in his that CDM can copy.	Yes, CDM Smith followed up with Metco / Jared Buzo on the status of their process camera project to coordinate work and follow standard and approach developed under that project.	No
107	7	1,2	Nastally	review should include a reduction and "right-sizing" from what is currently out there which is 4 level sensors per side (east/west) (8 total).	Agree, number of sensors and redundancy was discussed. Obsolete sensor tags will be deleted, end result will have a	Yes

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					redundant pair of sensors on the upstream and a redundant pair on the downstream of each wet well.	
108	7	1,2	Nastally	For the "spares" should you coordinate with Burns & McDonald to ensure they have sufficient spares installed as a part of their controls improvements?	CDM Smith has conducted one coordination call with Burns & McDonnell to coordinate between the two projects at Leib. Spare points / slots availability is being coordinated.	No
109	7	7,2	Nastally	Do we talk about the future pipe diversion from Meldrum?	This would not effect instruments at the facility. New connection is proposed upstream of the flow/level sensor in the Mt. Elliot sewer.	N/A
110	7	7,4	Nastally	Can you please confirm who is the design team here?	The design team refers to CDM Smith and their sub-consultant on this project. The instrumentation work for this project is being completed by a combination of CDM Smith and PCI personnel.	Yes
111	7	7,5	Nastally	I don't understand what this last sentence means...in relation to the sentences before it.	Sentence was cut off. Supposed to read "LIT-3 will not be considered for replacement or re-calibration as part of this project."	Yes
112	7	7,5	Nastally	Delete word "in"	Deleted	Yes
113	7	7,last	Nastally	Where do we talk about relocating the MCC for the chemical feed pumps to outside of the chemical room?	Relocation of MCC / local control panels to outside the chemical room is discussed under a separate TM. Language has been added to TM-7 for communicating via a digital / Ethernet link to the new soft starters.	N/A
114	7	9,1	Nastally	The title of this section 2.2 was LEIB and here we talk about Oakwood. Please fix. What is missing? Where do we talk about process cameras at Leib?	Copy and paste error on the text. Process cameras will be installed at both Oakwood and Leib under this project. Coordination will be completed with Metco project to identify any overlap and follow the standards developed under that project.	Yes
115	7	9,2	Nastally	I'd really like a section dedicated to Leib, and one to Oakwood...fully. It makes the read easier.	The design team evaluated providing dedicated sections for OKW and Leib for the level sensor evaluation in Section 3 and concluded Leib coverage so limited that clearer to maintain within same subsection which also is better aligned with the TM template guidance as the design team works toward a degree of consistency from TM to TM.	N/A
116	7	9,2	Nastally	Add s to "provide"	Corrected spelling	Yes

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117	7	11.3	Nastally	Replace “that” with than	Word replaced	Yes
118	7	12,1	Nastally	You must reach out to Chris VanPoppelen and ensure he wants this same standard incorporated.	Reference to CS-108 standard has been eliminated from document as it relates to the water side of GLWA facilities.	Yes
119	7	12,5	Nastally	I never did see another option, unless it was "rockwell" hardware in paragraph 2.	Language has been added to identify PLCs / Rockwell hardware as an option for integrating I/O signals into the existing Ovation DCS.	Yes
120	7	12,5	Nastally	Replace word, “are” with at	Word replaced	Yes
121	7	12,5	Nastally	Identify the CIP # 260617, and the project number here for this.	Noted, project number has been added to TM to reference Burns & McDonnell project at Leib.	Yes
122	7	12,5	Nastally	Is there a better place to install it that will result in less conduit installation? Because I would think we can utilize fiber optic communication from the remote I/O back to the main I/O which will save on installation.	Agreed, installation of a new remote I/O rack would minimize wiring runs to some locations and equipment. Fiber optic would most likely be implemented from the remote I/O rack to the existing controller cabinet.	N/A
123	7	13,1	Nastally	Location will be based on meetings with GLWA during design.	Agreed, location of process cameras will be based on GLWA input during the design.	Yes
124	7	13,2	Nastally	Delete Not used. Section	Removed section and renumbered subsequent sections	Yes
125	7	13,3	Nastally	We don't want 50 level sensors though. Like if I have a level in the west wet well (during wet weather), would it basically be the same as east wet well? For sanitary, I get maybe redundancy is needed, but for storm, I'm thinking east/west can back each other up. Tell me why I'm wrong :)	Agreed, a reduction in the number of level sensors was discussed. Cleanup of the system of obsolete sensors and their signals will be included. Redundant sensors will be included for the upstream and downstream sides of each wet well.	Yes
126	7	13,4	Nastally	Identify	Assume this comment is requesting the language to be modified to identify the CIP number for the Burns & McDonnell project at Leib. Language has been updated to include the GLWA contract #.	Yes
127	7	14, bullet 2	Nastally	plan view should show camera coverage / cone of view.	Agreed, language has been modified to indicate the plan views will show camera coverage / intended cone of view for the process cameras.	Yes

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128	7	14, bullet 7	Nastally	Integration will be performed by DA Central...we need to engage them, establish an allowance in the construction contract, etc.	Noted, D/A Central will be engaged during preliminary design to discuss the process camera system, integration required, and develop an allowance for inclusion on the bid sheet.	Yes
129	7	14, sec 8, bullet 2	Nastally	It's critical. See my above comments.	Noted, level measurement critical to facility operations.	Yes
130	7	14, sec 8, bullet 3	Nastally	talk about fail over techniques too...	Noted, fail-over techniques for level measurement are discussed in TM-15. A reference to TM-15 has been added.	Yes
131	8	1,2	Nastally	This will result in piping and electrical demolition and re-routing.	Correct. To move the wall some electrical and piping have been identified in the report needing to be relocated.	No
132	8	1.4	Nastally	Spelling, add A to GLW	Spelling corrected	Yes
133	8	3, figure	Nastally	Since we're going to be doing brick block work, should we consider a larger opening now to be able to get this fan in / out in the future for replacement?	After discussions in the TM workshop and with Dave McCord, the Alternate 2 concept has been revised to remove the added man door at the west end of the north exterior wall, and add a set of double doors positioned and sized to allow for the removal of the Supply Fan SF-1 in the future.	Yes
134	8	8, bullet 3	Nastally	Bullet 3, highlighted text	"Demo and remove 12-in. CMU wall that extends" is highlighted, but unclear as to why.	No
135	8	8, bullet 14	Nastally	We probably need to add another XP light or two in the fan area too, right?	Agreed, an added light fixture will be added to the alternate description, if determined to be needed.	Yes
136	8	8, bullet 15	Nastally	Highlighted text, and comment. We want this.	The floor drain shall be relocated.	Yes
137	8	9, figure	Nastally	Should this opening be large enough to facilitate removal of the fan one day?	Yes, see response to Comment 30.	Yes
138	8	10, figure	Nastally	Can we maybe add a storage rack or 2 on the other side of the bump out that can help organize the materials in the garage?	Additional storage racks can be added to help organize the stored materials	Yes
139	8	10, 2	Nastally	Shouldn't we figure out if the "bigger foundations" are actually needed for alternative one. I think that would be if they're providing structural support then it's required, but if the wall we're going	Yes. The space is tight, while the existing skid frame is galvanized steel and showing little signs of corrosion. It is our understanding that the maintenance access to maintenance points were the requirements of the scope, and not	No

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				through is not load bearing, then it would be the same as this alternative # 2, except we don't install a beam that we have to maintain against corrosion. What am I missing here?	providing a new means of removing the fan from the room. The current method for removing the fan is described in comment #30 response.	
140	8	12,1	Nastally	Spelling	Spelling corrected	Yes
141	8	13, 1	Nastally	It seems like it would require maintenance for the frame against corrosion, the issue of getting the fan out / moving it still exists. Unless I'm mistaken here.	Yes. The space is tight, while the existing skid frame is galvanized steel and showing little signs of corrosion. The concept allows the needed additional maintenance access to the key maintenance points. See response to Comment 30 concerning removal of the fan.	Yes
142	8	16, figure	Nastally	The fan would have to come completely out of the room to do this, right? Would the fan lose efficiency and not move the correct amount of air? What is the risk of this steel platform increasing vibration in the fan unit? What are the pitfalls of this option?	a. The operation of the fan would need to be shutdown temporarily, while the fan is temporarily lifted to allow for construction of a new support frame. b. There would be some loss in efficiency with the jog, but not significant. This would be analyzed during the detailed design if the alternate is selected. c. The existing SF-1 has vibration isolators, which can be reused or replaced. The new frame would be designed to limit vibrations while using vibration isolators. Disadvantages are identified under Section 5.0 Alternatives Analysis and Evaluation, 5.1.3. The disadvantages are limited space to perform the work, access points are raised so that a step ladder may be needed, and the availability of space to allow for the NEC required clearances for electrical enclosures.	No
143	8	17, 3	Nastally	Highlighted text	The text preceded by “no”, “further work related to these HVAC Controls is required under the scope of the Project.” Is highlighted. Unclear.	No
144	8	18, 1	Nastally	Highlighted text, extra period	Extra period removed.	Yes

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145	8	18, 2	Nastally	the issue with this request is that this pulls in freezing cold air in the winter and if it's forgotten on, it will freeze all of our pipes. That is the reason for the occupancy sensor. We can adjust the timing of the sensor, or see if it can be started in SCADA with an automatic timer so that unless occupancy is sensed, it will automatically turn off after a period.	Per the direction given by C. Nastally 4/20/2023 email, this is not an item that is part the Project scope.	No
146	8	20, table	Nastally	What were the items considered in 1 through 5?	Is the maintenance access given to the maintenance points on the SF-1. Both Alternate 1 and 2 provide similar access to the Fan belt and motor, etc.	No
147	8	20, table column 2	Sworth	What information was used to score the costs, are there construction estimates?	The Design Team's understanding of the extent of work needed to complete each alternative described in the memo. For Alt 1 the much larger area of wall that will need to be built including the deeper foundation and more relocation that includes fire riser, domestic water, and more resulted in the lowest score, while the other 2 alternates had similar costs. Alt 2 includes some relocations, and limited masonry and concrete work, while Alt 3, had the steel support frame, and very difficult work area to complete the task. OPCC estimates for the design of Alternate 2, the selected alternative, will be provided during the 30% submission for the Basis of Design.	No
148	8	20, table column 1	Sworth	Should this all have the reality modeling to assess the access?	The Design Team has provided alternate plans and sections showing the access provided. The final product will be modeled.	No
149	8	21, table	Nastally	Select this one.	Replacing the wall mounted thermostat with a similar model that also displays the temperature will be the direction. This direction was discussed and confirmed with Dave McCord, provided the temperature can still be monitored and controlled through the PLC and Ovation.	Yes
150	8	21	Nastally	Delete Not used. Section	Removed section and renumbered subsequent sections	Yes

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151	8	21,4	Nastally	This report was finalized in 2021, not 2013.	This has been corrected	Yes
152	8	21,5	Nastally	Spelling	Spelling corrected	Yes
153	8	22,1	Nastally	Ok, but see my comments on this one above.	Yes, your comment about adding storage racks will be incorporated into design.	No
154	8	23, last	Nastally	Where do you address the requested switch at down here?	Per the direction provided in the C. Nastally email dated 4/20/23, controls for the supply fan SF-1 are not in the scope of this project, nor are they anticipated to be added to the scope.	No
155	8	Meeting 4/18/23	D. McCord	Water lines and chemical feed lines have been freezing and breaking during cold events in the Screening and Disinfection Area (basement). The lines will freeze, and then are found in the spring when they thaw out.	Per the direction provided in the C. Nastally email dated 4/20/23, controls for the supply fan SF-1 are not in the scope of this project, nor are they anticipated to be added to the scope.	No
156	9	1 ,bullet 2	sworth	Removal of the structure in the garage comes at a cost, it could be left in place, correct?	Yes, there is a cost associated with removal of the structure. In the memo, an alternate has been proposed to leave it the odor control ductwork in place, while providing the needed gastight physical separation. GLWA decided to remove the structure to provide this area as usable space in the room.	No
157	9	2, table	Nastally	The basement is unclassified? I'm not sure this is correct. I see it's Main Level - so what is this area?	This area does not exist and has been removed from the table	Yes
158	9	9,1	Nastally	On the east side it would restrict movement around the basin, right?	Yes. However, an option could be to add a second door to the vestibule to make it a pass thru. However, during the workshop discussion the second door was not considered a secure option, and Alternate 2 has been selected to proceed with.	No
159	9	10, figure	Nastally	Can we show the concepts and how they'd look on the site plans?	A site plan has been added to Alternate 1 section to clarify the restrictions of adding the vestibules.	Yes
160	9	10, figure	Nastally	The door should be on the parking lot side...	We understand that the door on the parking lot side was discussed during our previous meeting. However, we	No

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					decided on this configuration that provides access to the sidewalks and the ADA ramp. If we were to place the door on the parking lot side, there cannot be a step, and an additional sidewalk with ADA ramp would have to be constructed eliminating some of the parking lots. The Design Team believes this was the more cost-effective alternative to explore.	
161	9	11, figure 4-2	Nastally	I assume this would have foundation requirements too (not shown).	Yes. Foundations are noted on Page 9, 4.1.1 under "Alternative 1 requires the following alterations:"	No
162	9	12,2	Nastally	Extra word?	Word deleted	Yes
163	9	15, figure	Nastally	We keep showing just the west side on here, but don't discuss the east side. Would alternative 1 and 2 work for the east side? I'm thinking no. I'm thinking we could wind up choosing both alternatives, one for each side.	Both alternatives will work for either the East and West Vestibules as noted in the memo. However, the vestibule extension on the east side may require a City of Detroit Variance for encroachment on the setback. This disadvantage has been added to the memo	Yes
164	9	15, figure	Nastally	I want to discuss these alternatives with O&M. I'm thinking this one is the least expensive, but would want to add an awning outside, and potentially extend side walls to get the weather further away from the staff (if it's raining and winds blowing from the west, it's a problem in this space. I think Alternative 1 is the best option, it's just the most expensive one too.	We have discussed both Alternates for solving the classification issues at the vestibules during the Workshop and with Dave McCord. After discussing with Dave, we agreed that Alternate 2 was the best choice, as it provided the open area in the wall needed, and increased the weather protection for the staff at the east and west entrances with an added canopy, supported off of the wall. It was determined that a larger canopy with columns or a partially solid vestibule extension with roof is not needed for additional weather protection. The additional screening to be added to the fence gate panel only needs to be sized to keep out pests like birds, bats, squirrels.	Yes
165	9	20,table, col 3	sworth	Are there estimates?	There are no estimates for these architectural alternates. The decision to proceed with Alternative 2 was determined during TM Workshop 1 and after discussions with the CSO Manager after the workshop, without cost estimates.	No

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166	9	20, table, col 1	Nastally	Also what are the actual criteria that result in a 1, 2, 3, 4, or 5?	For Weather Protection we felt that both alternates provided similar protection from the weather, as they both have exterior gated doors to allow for the needed open area with exterior overhang or canopy. For security, both alternates offered similar security benefits. The scope of the work for Alt 2 far exceeds the scope of work for Alt 1, resulting in lower costs, the range from 1 to 4 is noted to account possible unknowns in the conceptual design.	No
167	9	20, 1	Nastally	Highlighted text. This doesn't make any sense because it would then be a 1 or a 5 only...	The table has been corrected to show the Alt 2 cost score as 5, resulting in Alt 2 with a total score of 12.	Yes
168	9	21,table, col 2	sworth	Cost estimates?	See response for Comment 61 above.	No
169	9	21, table	Nastally	We want this alternative	Understood.	No
170	9	21, table	sworth	Is this truly much different than current? Does that merit a 1?	In the Design Teams opinion, it merits a 1. We are told of the maintenance associated with having to dewater and sometimes send a diver into the duct for inspections, and the duct sticks up in the middle of the Garage, where parking and storage space is limited.	No
171	11	2,5	Nastally	Please confirm GLWA CAD standards were utilized for this.	Yes.	Yes
172	11	2,5	Nastally	Highlighted text. This is included in this TM? Please identify.	Noted, reference to appendix provided.	Yes
173	11	2,5	Nastally	what report?	This paragraph is referencing to the Geotechnical Report.	No
174	11	2, last	Nastally	Coordinate this fact with TM-24 and improvements along Mt. Elliot that were required, but are not any longer.	Noted.	Yes
175	11	4,1	Sworth	PCS-79 Sewer not shown on these drawings, 10' Sewer along west border with about 20' of cover	10' diameter sewer is shown on the drawings	Yes
176	11	5, figure	Nastally	When we pave this, I think we're going to need to place some bollards over here to prevent plows	Noted, bollards provided to protect the existing structures near the proposed pavement.	Yes

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				and vehicles from accidentally hitting this stuff. Include in design for site.		
177	11	10, table	Nastally	Miss Dig usually ends at the fenceline. Was anything of value actually received?	During geotechnical exploration, surveyor visited the site and noted the flags and marking on the ground. No additional information received.	No
178	11	Appendix 14	Nastally	Please fill out title block appropriately.	Noted.	Yes
179	11	Appendix 20, item 3	Nastally	Fix highlighted	Updated with the surveying information	Yes
180	11	Appendix 20, item 5	Nastally	Would this even matter given # 3 above?	Question is not clear. Summary #3 addresses groundwater. The importance of the statement in question is that the existing gravel has degraded overtime and broke down into excessive fines thus rendering it unsuitable for re-use as base material below the new pavement.	Yes
181	11	Appendix 30, ,3	Nastally	Fix highlighted	Updated with the surveying information	Yes
182	11	33,1 Appendix	Nastally	Make sure radius' around basin corners are large enough to facilitate as large a vehicle turning through there as possible. If semis cannot traverse it, we need to post signage.	Noted. Next Step - signs will be posted at the site to prevent semi-trailers from entering the north side of the facility.	Yes
183	11	Appendix 35, 2	Nastally	Fix highlighted	Updated with the surveying information	Yes
184	11	Appendix 39,2	Nastally	Fix highlighted	Updated with the surveying information	Yes
185	11	Appendix 42, figure	Nastally	Fix	Updated with the surveying information	Yes
186	11	Appendix 43, figure	Nastally	7 dots and text boxes to be added to the figure	These were markups by original authors and not comments by the reviewer. Was affixed in pdf so to not show as markups.	Yes

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187	11	Appendix 43, figure	Nastally	Why is the google image here on to site plan? Fix.	Was kept as a separate page of the soil boring layout.	Yes
188	11	Appendix 170, item 3	Nastally	FIX highlighted text	Updated with the surveying information	Yes
189	11	Appendix 173,1	Nastally	Fix all XXX.XX elevations pages 173 - 183	Updated with the surveying information	Yes
190	15	3,5	Nastally	Insert "the"	"the" inserted where indicated.	Yes
191	15	3, bullet 6	Nastally	There was also a memo by ASI on the recirculation of sanitary flow during storm events. This may not be needed, but can you confirm you are aware of this?	Noted. Not aware of this ASI memo. Key observation from our ride-along visits is that the pumps are not being buried in grit when off-line during wet weather events.	No
192	15	3,2	Nastally	I think right here you need to define what "questions it will actually answer". And what questions it will not answer, and where to find the answers to those questions.	Revised accordingly.	Yes
193	15	7, last	Nastally	Add "ing" to follow	Word modified.	Yes
194	15	8,3	Nastally	Modify sentence as noted.	Changes in sentence made as indicated.	Yes
195	15	10,2	Nastally	You should speculate here on why. I believe it's because of the dip in the curve and that we've always had high vibration and therefore the pumps likely kept tripping out on vibration.	Speculation added.	Yes
196	15	16, last	Nastally	So our plan is to fix this right?	The sanitary pump alarm for high moisture not triggering again in Ovation required further definition. Will identify that this requires a control logic change. This was added to the Next Steps section.	Yes
197	15	17,2	Nastally	Revise sentence, it does not read right.	Revised	Yes
198	15	17,2	Nastally	Have you communicated this to the PACS team, or operations? We should address this right away. Could this be why we're experiencing pump failures? I know you said cracked impellar, but just curious if this is a cause...i.e. burning them up.	Communicated to Dave with suggestion to loop in the PACS team to Scott. This could be contributor if not caught during manual operation as pump would be below min water level below 40.2'. This would lead to potential seal damage resulting in leakage and then stator damage observed. Pumps equipped with closed cooling loop thus not likely	No

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					burning up. Frequency and duration of occurrence would contribute. Wet well level data review identified less than 0.1% east; 0.5% west of time below 40.2' (based on calibration of in-service level instrument).	
199	15	20,2	Nastally	Correct spelling of dominant.	Spelling corrected.	Yes
200	15	21,1	Nastally	Insert "are"	"are" inserted where indicated.	Yes
201	15	22, bullet 2	Nastally	Any ideas or correlation?	Evaluated further to assess if a correlation with other operating pumps in vicinity of units with elevated vibration amplitudes focused on ST1, ST2, & ST3 based on summary in Table 3-3. These are the units where noted vibration >0.5 in/sec at times when pump not running. The dates with very high vibration spikes (>0.5 ips) for ST1 and ST3 did not have another pump in service. ST2 most of high vibrations for this pump were while the pump was running. When high vibration levels and pump is not running, there were no other pumps running either. There was one common date, 10/20/22, between all 3 pumps, but at various times between 5:45-7:00AM. This time frame could coincide with activities at the pump station which were independent of the storm pumps but resulted in vibration within the structure being transmitted to the pumping units.	Yes
202	15	23, 3	Nastally	What is the status of CDM investigating this, the failure of pumps, removal of the bar screen, and perhaps adding mechanical screens to this?	Obtained insights from Kennedy Industries through four SN pump condition reports. A summary of findings was reviewed with GLWA in a meeting held 5/24/23. The lack of understanding of where pumps located relative to the removed bar screen section impacts ability to conclude if cause of failures of sanitary pumps were a result of screen removal. CDM Smith identified that more likely due to operation outside the AOR leading to reduced seal life coupled with moisture alarm clearing practice observed which may result in the associated stator and terminal board damage which is the most common failure mode reported.	No

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203	15	24,1	Nastally	This is interesting considering our plan to perhaps do 2 at a time. We probably will need more analytical data on this. Like if we only turned on 5, and let them run a bit longer, would it still have been ok in terms of flooding? Did you pull data longer than last 3 years on on/off? Since this relates to our rehab strategy, I think we're going to need to be able to make EGLE comfortable.	Noted, although inherent event to event variability exists. Our ability to predict if will be ok as projected in comment is limited. However, we have obtained rainfall data and more pump runtime data to assess number of storm pumps in operation over more than the last three years. This is summarized in Table 3-5 which has been revised to reflect the additional analysis findings including number of pumps in operation at one time, duration at maximum number of pumps and wet weather event maximum measured wet well level. We did so with consideration of future coordination with EGLE and other involved stakeholders. We propose to rely on the recently obtained expanded dataset as basis for assessment of risk that event will require more than 5 pumps in operation such that still would be N+1 with the sixth on-line pump.	Yes
204	15	24,2	Nastally	Do we know what the associated total rainfall near Oakwood was for these events where 5 and 6 pumps ran?	Event rainfall total and peak hour was added to Table 3-5.	Yes
205	15	25,1	Nastally	This requires the operator to record it running, which can easily be missed in the haste of a larger event.	We are working with the Operator's who recorded the events for conditions which are highly unusual. However, it is possible to miss a pump if a lot going on and limited staff on-site. There are also opportunities to misinterpret in the historized data when attempt to turn on a pump and it fails to start but the data indicates the pump turned on or timing of one pump turning off and the next one turning on. In these cases the log book may be more reliable. Each major multi-pump event identification has potential for on-line pumps to be missed. Additional analysis was conducted to better assess the number of operating pumps based on runtime data obtained from the GDRSS recorded data and compared to major rain events as now summarized in the TM.	Yes
206	15	27,	Nastally	This doesn't read right. Fix.	Revised for clarity.	Yes

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		bullet 5				
207	15	28, bullet 2	Nastally	Our future design must consider this...we don't want bleach pumps to take storm pumps out of service.	The future design does consider this with the metering pumps discharging to a common discharge header from which control valves to individual storm pumps will be provided.	No
208	15	28, bullet 4	Nastally	Insert "the"	"the" inserted	Yes
209	15	28, bullet 14	Nastally	Change "pump" to "pumps"	Word modified.	Yes
210	15	28, bullet 6	Nastally	Was this discussed with Flygt?	This was discussed with Xylem, Flygt AC Custom pump, the OEM. ST-5 was modified by Kennedy with the swap of line shaft and bowl bearings from Thordon SKL to cutlass rubber which is more flexible. Xylem indicated that when running this far to the left, recirculation and increased vibration would be expected. It is possible that with the increased vibration the impeller is intermittently touching the cone causing the bang. Also, as a follow-up to this insight CDM Smith asked about insufficient NPSH margin. Xylem did not respond, possibly due to not collecting NPSHR data this far left of AOR left limit.	No
211	15	29, bullet 7	Nastally	Awesome! Is it this leading to more frequent pump failures? What's up with the mechanical seal?	Yes, it likely is. Mechanical seal may be failing sooner than anticipated due to sustained operation outside the AOR as discussed at 5/24/23 meeting.	No
212	15	29, last	Nastally	It would seem like the failure of the gates at the wet well would cause this. You can draw it down, but it doesn't really make a difference, right?	Assuming referring to the pinch valves in the upstream junction chamber, expect that the sanitary pump could operate at a rate greater than influent flow rate under dry weather conditions resulting in the desired draw down of wet well for short duration.	No
213	15	29, last	Nastally	Insert "is", make do, does.	Wording modified.	Yes
214	15	31,3	Nastally	This analysis is interesting.	Noted.	No
215	15	34, last	Nastally	Fix sentence.	Revised.	Yes

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216	15	35, Table 3-6 Notes	Nastally	Does this reduce overall pumping capacity below 1675 cfs? Based on your sheet it doesn't look like it with 7 pumps on, but then just curious as to what this means.	No this does not reduce overall firm pumping capacity as able to operate at 100% speed with VFD speed controlled pumps. The highlighted statement means less turndown of the small pumps to allow control system to operate all pumps at the same speed.	No
217	15	41, Section 3.6 Bullets	Nastally	OK	Noted that ok with our recommendations which differ from CS-299 report/B&C TM for pump speed range and minimum wet well level.	No
218	15	42, Table 3-9	Nastally	I see no issues with these recommendations...as long as they're programmed into SCADA.	Noted. Confirmed the operational strategy will advance to the associated specification section and ultimately be programmed into Ovation.	No
219	15	42,3	Nastally	One question about our permit...can you review the NPDES permit and ensure this proposal would not put us in violation of our permit...like certain limits established, etc.?	The NPDES permit was reviewed relative to sanitary flow rate limits or constraints for OKW to determine if proposed operational strategy would result in a violation. We found the following: permit does not specifically provide operational constraints on sanitary pumps, but references regional operating plan which (in detailed op. plan version only, not directly linked to permit) provides maximum dewatering flow rate of 23 cfs. No other operational constraints.	No
220	15	42, last	Nastally	Should we consider now? Once the above is programmed into SCADA, I would think it's going to stick for a while. So we either change pumps and change that, or we stick with what we got. I'm ok with what we got as long as it doesn't violate our permit	Given the budgetary sensitivity and the investment in the sanitary pumps (approx. \$150,000 each) recommend retain existing pumps. We had heard that additional pumps may be purchased soon from KI a couple months ago. See response immediately above for permit considerations.	No
221	15	44,4	Nastally	I would like this in a table eventually. All of these.	Noted. The storm pump cycling through pumps as flow rates increase can be summarized in table as part of the control description specification. Included as a next step.	Yes
222	15	45,1	Nastally	Why not first started? Wouldn't this help to balance run hours? I believe it has to do w/ VFD...but could it be first constant speed started is first off, first vfd is first off, when we get to those thresholds?	Revised to reflect first started of each pump size/ speed control type (VFD speed controlled or constant) will be first off as step pumps off to allow runtime distribution.	Yes

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223	15	45, last	Nastally	I only want an alarm, and the alarm can be scaled. Like if we're 0-33% over, it's an alarm that lets me know, if its 33-100% over, it tells me is causing damage and recommends me to shut it down, or something like this. I want to retain control, and not have it automatically shut it down until there is a catastrophic level (I don't know what that level is) where pump damage or endangerment of PS operations lifes is expected. Make sense? Maybe it can recommend starting another pump, and when that happens, they can shut down and lock out the problem child...thoughts? @David McCord Please concur. Like if the alarm goes unacknowledged for more than 60 minutes, and it's above 33% of allowable, it will then automatically shut off...or something like that. Dave - thoughts?	Recommend that the alarm and recommendation for shutdown be defined in the BOD phase with GLWA input from Dave McCord and other stakeholders, proceeding as recommended by Chris. This monitoring plan and associated operational strategy changes would also consider the capabilities and constraints of the Multilin protection relay which receives the vibration velocity inputs and the vibration switches. This path forward was clarified in Next Steps section.	Yes
224	15	48,3	Nastally	Lead pump doesn't turn on until 75 or 76 (right), so we need sanitary pumps to either run to this point, or shut off at 62...let's discuss.	Lead storm pumps to turn on at 73', indicating sanitary pumps required to operate until point that storm pumps start? This has not been operational practice. This was discussed at the 5/12 conducted TM WS No. 3 and concluded that operational practice would be maintained as currently performed – sanitary pumps turned off at approximately 62.	No
225	15	48,5	Nastally	As long as this isn't a permit violation, OK.	This proposed maximum flow rate constraint is aligned with the permit requirements.	Yes
226	17	2,5	Nastally	Can you confirm in all samples taken that there was NO TRC in them?	Yes, all samples were taken with no TRC in them. Oakwood samples were taken from the influent wet wells, and Leib samples were taken from the influent channel after turning off the pre-mixers.	Yes
227	17	6,2	sworth	Wasn't the additional sampling completed?	The additional sampling event was completed after submitting the TM 17	No
228	17	6,2	Nastally	Highlighted text, please define this.	Data related to the sampling event or to a future wet weather events like dosage, storage volumes, Flowrates, TRC, Fecal coliform, TSS etc. that can help us to refine the model.	Yes

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229	17	Appendix 22,last	Nastally	After Thursday?	Corrected: If wet weather happens Monday through Wednesday, Samples will be shipped to the CDM Smith RTL and analyzed immediately. If wet weather happens after Wednesday, then samples will be collected and shipped to the CDM Smith RTL, stored at the lab, and will be analyzed depending on the CDM Smith RTL staff schedule.	Yes
230	17	Appendix 23, 1	Nastally	Highlighted text, What does this mean?	The field coordinator participated in the first chlorine dose response analysis at the CDM Smith laboratory in Bellevue WA.	Yes
231	18	1,3	Nastally	Correct spelling of Team	Spelling corrected.	Yes
232	18	2, Table 4-1	Nastally	How come Oakwood was never tested at 12ppm, and how come Leib was not tested at lower values than 5 and Oakwood was?	Initial chlorine demand testing was performed on the samples before starting the dose response testing. The doses for each dose response test were selected based upon that chlorine demand testing. Ultimately, Leib had a higher chlorine demand than Oakwood. A paragraph was added to clarify.	Yes
233	18	3, Table 4-2	Nastally	How was temperature taken by them and not the person grabbing the sample?	This is the temperature for the dose response test, which is performed in the lab. It is not the temperature of the raw CSO flow at the time of sample collection.	No
234	18	8,1	Nastally	Conservative = oversized. I don't like where this is heading already. St. Aubin used conservative values for the system too, and we struggle to dose in anything other than plug flow because the system is waaaaayyyy oversized.	While ICT selection followed a conservative approach, the proposed feed design (TM20) includes turndown capabilities, allowing for delivery of a range of chlorine dose and flow conditions.	No
235	18	8,	Nastally	These systems must be sized to handle the largest, but this isn't in reality where we spend most of our time at. We spend most of our time at the other end of this conservative spectrum and operators struggle because engineers get conservative and oversize everything. I want to make sure this is recognized and want to understand what CDM is going to do to overcome this.	While ICT selection followed a conservative approach, the proposed feed design (TM20) includes turndown capabilities, allowing for delivery of a range of chlorine dose and flow conditions.	No

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236	18	8,1	Nastally	Did CDM obtain water quality data from the WRRF?	Yes, but there are no historic undisinfected bacteria data available from the WRRF.	No
237	18	8,2	Nastally	This may or may not be true. We could have had a snow melt event the week before that could have flushed out the pipes. What was total rainfall for each event? Did CDM obtain this data from GLWA CSO Operations team?	An analysis of rainfall data was added to the TM to address differences in TSS and chlorine demand across the sampling events.	Yes
238	18	10,1	Nastally	Were we adding Chlorine (CL2) or Sodium Hypochlorite (NaOCl)? I know I'm not a chemist...and I recognize they do the same thing...but how do the results port from one to the other?	Sodium hypochlorite is the term used for the delivery, storage and feed, while chlorine is used for the dose and residual.	No
239	18	12,	Nastally	It's not a "theory". What does this sentence mean?	The word "theory" was deleted for clarity	Yes
240	18	18,1	Nastally	Why 200? This seems to add a factor of safety of 2 = 2x larger than it needs to be for the worst case (first flush in the summer). Help me understand.	From a log-reduction standpoint, decreasing coliform counts from 400 to 200 represents a 12% decrease. It is not recommended that the system be designed to the 400 CFU/100mL value, which represents a maximum permit limit during the recreation season. Using a value of 200 CFU/100mL accounts for variability in influent water quality and system performance. The text was updated to provide clarity.	Yes
241	18	19, last	Nastally	Ok, but will be considered in the design of the system?	Yes, the 2/27 Oakwood Inactivation Goals were considered in designing the minimum capacity of the feed system.	Yes
242	18	30,1 (overall comment on TM)	Nastally	In my opinion, there was a lot of technical jargon in this memo, all fine, but it should also provide explanation in terms we commonly reference. For example, the maximum dose the system will be sized to, and the minimum dose the system will be sized to in mg/L of NaOCl, and what this does in terms of pump number and pump size as compared with existing. What is the existing system sized at in comparison to what the proposed system is sized at, in total (from the highest NaOCL concentration to the lowest).	The sizing of the system, and comparisons between existing and proposed design criteria, are discussed in TM20.	No
243	19	3,3	Nastally	Where does the data come from, and how & what database does it get fed into to actually support this?	The data from the upstream water characteristics originate from the sensor to be evaluated and described in section	Yes

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				Have you had conversations with GLWA PACS team regarding this?	4.1.4.3 and Table 4-2—precipitation data from rain gauge sensor and NOAA source. Data will be gathered via Ovation integration to be defined in I&C design. This will be discussed with GLWA PACS team (Bassem Almatar and if needed Chris Vanpoppelen. The discussion will be focused on the security related consideration for the edge computer and access through Ovation.	
244	19	3,4	Nastally	How will we incorporate this into the delivery of the project? Will disinfection be installed, and able to gain sufficient data while the storm pumps are still being rehabbed into order to tweak? What exactly would be installed on the SCADA system (to actually make it "machine learn")?	The design delivery, data collection, and model development are defined in detail in ML section 4.1.4.3 Project Work Plan. In summary, the project scope is to evaluate the feasibility of incorporating modification of the ICT approach and the potential for an ML dosing model to optimize system operation across multiple flows and bacterial loading scenarios estimating. The model will be evaluated with test (Unseeing = new) data offline. The evaluation will compare the model prediction with the measured value. If the feasibility study is within the expected performance, an implementation phase will be recommended as part of the final report.	No
245	19	4,1	Nastally	Please also discuss with Andrea Busch. She worked on a trial for us, and I'd just like to understand if she concurs here. I'd also like Dave McCord's buy in too!	TM text has been updated based upon input from Andrea Busch at TM Workshop 3 which are summarized in the meeting notes for that workshop. Team is proceeding based on the insights and path forward defined at the workshop.	Yes
246	19	5, ES-1	Nastally	Do we need the same size?	Pump flow capacity could be lowered. The sample piping will be reused, and pump flow capacity could be lowered to 75 gpm to maintain minimum velocities. Following text added in Section 4.2: "During basis of design phase, the feasibility of reducing flow capacity and option of Flygt N series pump will be evaluated."	Yes
247	19	5, ES-1	Nastally	This seems like a bit...How does this fit into our guiding principals for the project?	Subsection 4.2.1, Table 4-3 provides explanation about proposing six sample locations. Multiple sampling locations will be needed to cover the different flow scenarios,	Yes

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					operation of different storm pumps, and different screens in operations. This was discussed at WS No. 3 on 5/12 and highlighted the TM sourced summary why three sample pumps each with two sample draw offs are recommended. GLWA offered input and concurrence during the workshop as summarized in meeting notes. The alternate sampling approach showing 3 submersible pumps is added to the TM, along with the associated figures. This approach is recommended. The exact location of the TRC analyzers will be evaluated in the Basis of Design Phase.	
248	19	5, ES-1	Nastally	Also - why so many sample locations? Doesn't the water essentially mix into a common chamber that utilizes all screens? How would the six sample points be analyzed then if we did, averaged?	Subsection 4.2.1, Table 4-3 provides explanation about proposing six sample locations. Multiple sampling locations will be needed to cover the different flow scenarios, operation of different storm pumps, and different screens in operations. This was discussed at WS No. 3 on 5/12 and highlighted the TM sourced summary why three sample pumps each with two sample draw offs are recommended. GLWA offered input and concurrence during the workshop as summarized in meeting notes. The alternate sampling approach showing 3 submersible pumps is added to the TM, along with the associated figures. This approach is recommended. The exact location of the TRC analyzers will be evaluated in the Basis of Design Phase.	Yes
249	19	7,1	Nastally	Delete extra space between words.	Space deleted.	Yes
250	19	7. last	Nastally	Delete extra space between words.	Space deleted.	Yes
251	19	11,1	Nastally	Add "d" to word.	"d" added where indicated.	Yes
252	19	12,3	Nastally	Insert "The" at beginning of sentence, modify effluent to lower case.	"The inserted and word modified	Yes
253	19	15,3	Nastally	Change 'come' to 'came'	Word modified.	Yes
254	19	15,4	Nastally	I am ok with switching to a TRC analyzer based system, but we must have the ability to do it manually also, as a part of the design. SIMPLE.	Manual Mode will be part of design.	No

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255	19	15,5	Nastally	Please expand. This causes what? This is a concern why?	Excessive chorine off gassing may result in corrosion of metal items in the vicinity. Following text added 'Excessive chorine off gassing may result in corrosion of metal items and be a health and safety concern in the vicinity.'	Yes
256	19	16,1	Nastally	Deleted "from the"	Words deleted.	Yes
257	19	20,2	Nastally	Fix. Doesn't make sense.	The paragraph was changed to "The ML problem to be resolved requires the development of a supervised regression model to predict chlorine demand based on CSO flow, environmental factors, and upstream properties. "	Yes
258	19	20,2	Nastally	Change w in water to lower case.	W changed to lower case.	Yes
259	19	24,1	Nastally	Add "s" to consideration. Replace "taken" with "incorporated"	Wording modified as indicated.	Yes
260	19	24,bullet 3	Nastally	Delete extra period.	Extra period deleted.	Yes
261	19	24,2	Nastally	Modify denoised to denoising	Word modified.	Yes
262	19	26,2	Nastally	So far, the one thing I haven't necessarily seen is where this "model" is truth checked. Where do people come in and input data that tells the "model" its full of crap, or it's spot on?!!!!	The ML workflow describes that a Model metric definition and analysis will be defined during design; the data collected will be divided into two sets 70 to 80 % for training and 30 to 20% for testing. The model is trained using the training data and it's performance is check using the testing (Unseeing = new) data. The metrics will be used to justify the feasibility of the model. Text was updated to include a description of how the data is used to train and test the model.	Yes
263	19	27,6	Nastally	Is it one year, or so many rain events?	The duration is one year with assumption that will be events that activate the facility disinfection system. As noted in WS No. 3, at Leib this may extend beyond one year.	No
264	19	29, bullet 3	Nastally	It is also possible that 6 months of data provides more than enough.	As discussed at WS No. 3, CDM Smith anticipates that one year will be required to generate a sufficient data set necessary to train and then test the model. In addition, would like to include every season which requires the one year duration.	No
265	19	29, Section 4.2	Nastally	Insert "a", add "s" to provide.	Modifications made as indicated.	Yes

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266	19	30,2	Nastally	Modify adaption to adaptation.	Word modified.	Yes
267	19	31,1	Nastally	Add "s" to "event". Insert "a"	"s" added. "a" added where indicated.	Yes
268	19	49,1	Nastally	We have to talk about how these are going to be incorporated into the actual operations & SCADA operations, and also the training we provide to the operators on each.	Anticipate further discussions as the design process continues. Each task includes updates to the system O&M manual and training of O&M staff.	No
269	19	53	Nastally	Text formatting	Proper formatting verified.	Yes
270	20	2, bullet 2	Nastally	When we replace tanks at both facilities, lets ensure the piping, configuration, layout of them afterwards, and how they'd be changed in the future is fully thought though so we don't create future extra work, or make our everyday lives in O&M more difficult.	Will consider existing and potential future needs, and operations and maintenance requirements when developing facility layout. Will engage GLWA staff for feedback on design. Modified text in next steps section under GLWA Coordination subheading to incorporate this in the design.	Yes
271	20	2, bullet 4	Nastally	@David McCord you will want to be very aware of this in the future. It will be similar to Hubbell Southfield.	Discussed with Dave McCord during May 12, 2023 TM No. 3 workshop. It is understood there is no action required to update the technical memorandum to address this comment.	No
272	20	2, bullet 5	Nastally	Change "once" to "in anticipation of"	Wording modified.	Yes
273	20	2, last	Nastally	Insert "facilities".	'facilities' inserted where indicated.	Yes
274	20	2, bullet 6	Nastally	I wonder if this is determined after dilution. Can you confirm? I'm pretty sure they actually deliver near 13%	Correct, 7.5% is after dilution and not as delivered. Updated description of value in TM.	Yes
275	20	4,1	Nastally	Insert "the" before Hubbell, change Connor to Conner.	"the" inserted where indicated. Conner spelling corrected.	Yes
276	20	17, Figure 2-2	Nastally	Some text is cut off. Fix.	Corrected figure to prevent text from being cut off.	Yes
277	20	28, bullet 2	Nastally	Was there effluent data from the basin? How did it compare to that? Also, basin is a fixed volume before discharge begins, so it can be checked. So was this done and was it close to the "reasonably accurate" pump data?	At Oakwood, chlorine is added only when the storm pumps are added. The analysis includes flow where hypo was added (i.e., Oakwood storm pumps are active), which includes flow that was not discharged over the basin effluent weir. Therefore, storm pump flow data is required to account for the portion of flow that was treated with hypo but not discharged to the outfall. This accounts for the volume in the basins not being fixed.	Yes

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					As discussed in the May 12, 2023 TM No. 3 workshop, a comparison between the storm pump flowmeter reported flow and flow predicted from the observed pump speed and pump performance curve was used to evaluate the potential impact of the inaccuracy of the existing flowmeters. Single point of comparison suggests the historic chlorine dose could be ~30% lower than as determined using historic flowmeter data and chlorine tank levels. The recommend ICT based dose would still be below the adjusted historic average dose (150 lbs/MG). GLWA and CDM Smith agreed this was sufficient to assess the potential impact of the flowmeter inaccuracy. Results from flowmeter accuracy sensitivity analysis are included in updated TM.	
278	20	29, bullet 4	Nastally	Decreases in tank levels is more likely due to leaking drain valves.	This statement was in reference to tank level changes that were comparable to storm events (i.e., considerable tank level change in relatively short duration). Added statement to indicate that prolonged decreases in tank level could be attributed to leaking valves and were also not included in the historic dose analysis.	Yes
279	20	29, last	Nastally	Wow!! Is that even right?	For this event, Tank 1 level dropped 6.2 feet corresponding to 7,130 gallons of hypo used. According to EGLE reports the storm event was 9.99 MG. Chlorine concentration was 10.8% so it doesn't appear the operator was using the storm event to dump low concentration chlorine. Events with similar hypo usage had flows 3 to 4 times this event with doses closer to the median value of 23 mg/L. This appears to be a legitimate data point.	No
280	20	29, last	Nastally	Did you calculate when it was overflowing (we do weir calc for overflow - more robust).	Effluent weir calculation was not completed because the storm pump flow data was used to account for flow that was not discharged to the outfall but was treated with hypo. This accounts for the volume in the basins not being fixed. As discussed in the May 12, 2023 TM No. 3 workshop, a comparison between the storm pump flowmeter reported	Yes

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					flow and flow predicted from the observed pump speed and pump performance curve was used to evaluate the potential impact of the inaccuracy of the existing flowmeters. Single point of comparison suggests the historic chlorine dose could be ~36% lower than as determined using historic flowmeter data and chlorine tank levels. Added flowmeter accuracy sensitivity analysis results to the updated TM.	
281	20	29, last	Nastally	What are the typical / historical measured TRCs?	Historically TRCs range from 1.1 to 2.8 mg/L at Oakwood and Leib. TRCs tends to be higher at Leib than Oakwood.	No
282	20	35,1	Nastally	Delete "s" from relations.	"s" deleted.	Yes
283	20	35, bullet 4 & 5	Nastally	This will need to be specifically highlighted with operations.	Discussed impact of sodium hypochlorite concentration on storage requirements under various design scenarios during TM 3 workshop held on May 12, 2023. It is understood there is no action required to update the technical memorandum to address this comment.	No
284	20	36, bullet 3	Nastally	Is this provided?	A copy of the Chlorine Contact Chamber Design and Flow Evaluation worksheet can be provided as an appendix item in the final TM.	Yes
285	20	37, Table 3-5	Nastally	Why is a design peak of 1,071 versus future collect system max of 794 yield opposite in terms of contact time?	At 1,071 mgd two CSO basins are in service while at 794 mgd one CSO basin is in service which increases the effective volume considerably for the 1,071 mgd scenario. See third row of table where the number of CSO basins in service is listed for each flow scenario.	No
286	20	37, Table 3-5	Nastally	If all else is equal, wouldn't 1071 be less contact time than 794?	At 1,071 mgd two CSO basins are in service while at 794 mgd one CSO basin is in service which increases the effective volume considerably for the 1,071 mgd scenario. See third row of table where the number of CSO basins in service is listed for each flow scenario.	No
287	20	37, Table 3-5	Nastally	TRC as measured where at?	At the effluent channel downstream of the CSO basins. Added sentence after Table 3-5 to clarify. Clarification also added to Leib discussion Table 3-10.	Yes

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288	20	40, Table 3-7	Nastally	If we "ruled" out baffles, why are we saying "proposed baffles"? Or maybe we state later on again...and proposed storage is 30K.	Conclusion that baffles are not recommended is included in the executive summary and after table 3-7. Changed description to "Baffle Alternative" to clarify baffles were a consideration and not necessarily recommended.	Yes
289	20	41, Table 3-8	Nastally	Out of curiosity, would this ICT change if we had better / more accurate flow data? How does this compare if you use the "nominal" values of the pump, and work with Steve Fehniger to approximate flow based on Pump On and VFD speed?	No. Historic flow data does not impact ICT or required dose. ICT is based on chlorine response test results and required dose is a function of ICT and effective contact time at various design flows conditions.	No
290	20	41, Table 3-8	Nastally	Want to make sure we discuss this with McCord make sure he understands. I also think the "future" condition will never happen.	Discussed storage requirements under various design conditions during TM 3 workshop held on May 12, 2023. It is understood there is no action required to update the technical memorandum to address this comment. The working volume is shown for the future collection system condition as required to accommodate it whenever it is constructed.	No
291	20	48, Table 3-9	Nastally	So if I read the above bullet correctly, this is the feed rate at 5%, correct?	Yes, this flowrate corresponds to 5% sodium hypochlorite concentration. Added footnotes to table to clarify.	Yes
292	20	54, Figure 3-17	Nastally	For original - shouldn't it be 56,000? Are the numbers right here? Original, per your table above is 10% 56,000, with asbuilt 10% 22,000. Can you help me understand what I'm missing?	The 56,000 gallons from the original basis of design and 22,000 from as-built condition are under the peak design storm condition (Figure 3-18). Figure 3-17 presents storage volume requirements for two average design storms.	No
293	20	56, bullet 7	Nastally	When we make these tanks taller, make sure we minimize the amount of work required on top (or verify head space is adequate).	As discussed in Section 4.4.1, the design will reduce work required on top of tanks to the extent feasible in design phase or provide adequate head space for work where feasible.	No
294	20	57, Table 3-14	Nastally	@ XXX % NaOCl	Added footnotes to table to clarify % hypo that corresponds to each parameter.	Yes
295	20	59, bullet 6	Nastally	Modify reinforce to reinforced.	Word modified.	Yes
296	20	60, Table 4-1	Nastally	What permissives, or feedback loops would have to fail for this to become a reality?	Flowmeter on the duty control valve station and flowmeter for backup control valve station would need to fail or the electric actuator would need to fail on multiple flow control	No

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					valves. In addition, for most storm events staff can change the storm pump(s) in operation to provide operable combination of storm pump and control valve station. Therefore, manual operation is only required after numerous failures of back up system.	
297	20	61,1	Nastally	Modify "summarized" to summarizes.	Word modified.	Yes
298	20	66,1	Nastally	Modify "Recommend" to "Recommended" in Section title	Word modified.	Yes
299	20	66, Section 4.3.2	Nastally	Delete "and Leib and"	Words deleted.	Yes
300	20	70, Figure 4-4	Nastally	Given limited head clearance, we'll need to consider tank access at the top, and head knockers.	Agreed. Maintenance activities requiring access to the top of the tank will need to be accessible from the side of the tank. This will need to be coordinated as the design progresses with tank manufacturers. This is discussed in second paragraph below Figure 4-4.	No
301	20	71, bullet 3	Nastally	We would also need temperature controls and temporary measures of having a temp wall in place, I'm thinking.	Added statements to Leib and Oakwood discussions that temporary wall system and temperature controls would be required to avoid freezing temperatures, reduce degradation of hypo at high temperatures, and keep facility secure during replacement.	Yes
302	20	71, bullet 4	Nastally	Add "s" to appurtenance.	"s" added.	Yes
303	20	73,1	Nastally	Do you want to increase the tank height even more (since we apparently have the head space)? Or will that create "containment" issues? Just curious since this would likely give us a little more cushion.	It appears there is enough secondary containment to accommodate tanks that are several feet taller; however, the limiting factor is whether the taller tanks could be stood up within the room after being passed through the knockout wall openings on their side (smallest dimension). This will require field investigations to verify clearance requirements. We will also have to verify manufacturer capabilities for larger tanks. Recommend considering this in preliminary design phase.	No
304	20	73,2	Nastally	It would be nice if we can re-configure the sump and the stairs to allow access around all sides of the tanks. I feel	Opportunities to modify the sump and stairs can be considered in the preliminary design phase. Added item to next steps list.	Yes

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				like not being able to traverse them could be a potential safety issue.		
305	20	76,1	Nastally	The new chemical piping / system needs to have a way for GLWA to actually discharge a tank to the sewer when the tank contents (strength) becomes too weak for us to hold onto the tank anymore. Otherwise, we have no way to dump it. We don't want to dump it through the mixers....there should be direct piping. Consideration of dilution when draining should be made too.	Acknowledged. Will consider provisions for dumping and dilution during preliminary design phase. Added item to next steps list.	Yes
306	20	81, Table 5-3	Nastally	Will recircing bleach at this rate back into the tanks during low-flow / low demand events cause a degradation of the bleach via aeration? Same question applied to Oakwood.	Aeration could degrade hypo. A VFD could be used to reduce the recirculation flow under low feed rate conditions. Locating the recirculation discharge connection near the bottom of the tank could reduce aeration effect but will add head to the pump system. This should be considered further in the preliminary design phase with hydraulic modeling of the system to refine recirculation flow requirements. Added item to next steps list.	Yes

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307	21	2, bullet 12	Nastally	Why couldn't we consider on the influent piping and then dose according to total flow and make that dose proportional (to each pump that's on) to the pump on and it's speed and approximate proportion of pumped (nominal based on curves and turn down for VFDs) flow in relation to total flow? Even if we didn't alter for VFDs, the turndown is only to 85% anyways, so it's close enough to 100% in terms of proportion of total flow and nominal pumping capacity, is it not?	Revised TM to include this alternative in the introduction. Upstream flow meter would be calibrated in dry-weather but used in wet-weather. Dry-weather flow conditions are low depth and free flowing into the facility. Wet-weather flow conditions are high depth, high velocity, and subject to backwater conditions from the facility. Oakwood storm water pump operations result in this upstream meter location going into and out of backwater multiple times during each wet-weather event. Related to chlorine dosing: Cannot use influent flow rate for chemical pacing. Will almost always be a difference between influent flow rate and what is being pumped (wet well filling and drawing down). PS influent flow metering would not achieve the primary goal of flow paced and TRC paced dosing. An influent meter would tend to show flow rate changes more gradually and may show changes prematurely or with a delay compared to pump operation. Could lead to over- or under-dosing TRC as flow changes throughout an event. Eight flow meters along the storm pump discharge piping could pick up the rapid changes in flow as pump operation changes.	Yes
308	21	2, bullet 12	Nastally	Wouldn't this also contribute to guiding principal of reduced maintenance?	Captured in new Table 5-2	Yes
309	21	6,1	Nastally	Capitalized no	Word capitalized.	Yes
310	21	10,3	Nastally	Added text " and reduce maintenance"	"and reduce maintenance" added where indicated.	Yes
311	21	14,2	Nastally	As a backup, with a toggle in SCADA to switch to it, this is ok.	Yes, the SCADA alternative is a backup.	Yes
312	21	15,2	Nastally	There is no recycled flow stream during storm events (when storm pumps are in service) because the sanitary pumps are shut down during storm pumping.	TM revised accordingly.	Yes

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313	21	15,3	Nastally	See my notes above. This could be used with a hybrid calculation from 4.6 to make it work and give reliable influent flow data.	Included in Section 4.7.	Yes
314	21	17, Table 5-1	Nastally	Where is the transit time?	External and internal ultrasonic meter technologies are the transit time meters.	Yes
315	21	18,1	Nastally	What is required maintenance? What is expected up time? What is expected life? I wouldn't mind this if the answers above are good. I struggled with the current insertion meters and I don't want that unreliability again.	Required maintenance, expected up time, and expected lifespan are not certain at this time. Design team has discussed maintenance and reliability with the meter manufacturers and they recommend monitoring diagnostic parameters such as signal strength to improve maintenance efficiency (identify when sensor cleaning is needed). This will be coordinated with I&C in the BOD/detailed design and has been added to the TM in Sect 8 (Recommendations) and Sect 9 (Next Steps). There is no definitive answer on uptime and lifespan. As electronic devices the average lifespan of this type of meter is typically estimated around 10 years.	Yes
316	21	21,5	Nastally	I don't know that I agree. See above.	Reviewed during the workshop on 4/19/23. Added Table 5-2 to TM.	Yes
317	21	22,1	Nastally	Maybe...maybe not...need to discuss. If it's the cheapest, most reliable...I'm good. Need to have my questions answered.	Reviewed during the workshop on 4/19/23. No edit made to TM.	No
318	22	2, bullet 9	Nastally	This seems like it could spread the stream out sufficiently that it won't move solids. Is there a maximum depth of solids that this would be effective at? I imagine with the NWI diversion that after 1 event we may have significant solids down there.	As discussed at TM workshop 2, the flushing system physical modeling and associated analysis provides qualitative and relative comparisons. CDM Smith does not have an approximation of maximum debris depth for which the flushing would be effective. The spray angle will be evaluated further in the BOD phase coupled with number of nozzles.	No
319	22	11,2	Nastally	What is the condition of the existing 2" line?	No issues have been noted of the existing 2" header. Header will be field inspected to determine if in good enough condition for continued use and modifications. Included in TM Next Steps.	Yes

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320	22	13,5	Nastally	These models need to be turned over to GLWA.	Acknowledged.	No
321	22	14,8	Nastally	Please provide videos and Clemson report.	Physical model study report was included as appendix to TM-15. Videos will be provided for baseline testing and flushing system operation.	No
322	22	18, bullet 6	Worth	This was a fairly loose sludge that could be waded through, heavy water content	Noted. Description of sludge characteristics added.	Yes
323	22	21,3	Nastally	Costs? How much time does the operator spend cleaning these areas? What are the chances of a flushing system being effective?	Project problem statement and interview with facility staff indicated that flushing of the facility required significant time after an event. The flushing system is not intended to replace the manual cleaning but rather decrease the time required for cleaning and to address the most common locations for sediment build-up (screening inlet channels).	No
324	22	25, Figure 4-7	Nastally	We have laser scans and this was the best picture we could come up with?	Figures have been updated in TM.	Yes
325	22	25,3	Nastally	Would running it while the basin is in service cause it to run out on its curve when the basin is full?	The pump curve for the conditioning pump model is fairly vertical, which allows for pumping over a wide range of basin levels. Final pump selection will confirm pump will not operate at run out.	No
326	22	27, 5	Nastally	Keep in mind that we don't really want to open up them in the drain vaults because then we pull all debris into the drain vault and create a big problem. Flushing should allow us to pull it into the surge chamber.	The proposed concept is to provide a connection that will allow debris to be flushed back into the basin. Once line is clear, debris and flushing water will be conveyed to the surge chamber.	No
327	24	2,bullet 3	Nastally	Put this on your list, but when we get to the design of this, we will need to coordinate with Jonathan Farrugia.	Noted. Next steps item in TM.	Yes
328	24	3, bullet 2	Nastally	bullets below should be sub-indented	Bullet formatting corrected	Yes
329	24	3, bullet 4	Nastally	confirm that this has not already been completed.	The ROW permitting has not been completed	No
330	24	9, 2	Nastally	Let's talk about this too as far as bid table...some of these items I want quantities and unit prices for in the bid...rather than just lump sum.	Noted, Next steps item: CDM Smith will discuss the bid table with GLWA team during design phase.	Yes

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331	24	10,figure	Nastally	Should we consider enlarging these radius a little more to make sure we have ample clearance for trucks. See auto-turn and barely clearing curb lines tells me the truck driver needs to be perfect, which means he'll be mounting our curb and causing damage to our ground. We could also consider this mounting, and just make it concrete on top too...just make sure it's thought through.	The current design is based on the WB-50 design vehicle. Next steps item.: During design phase, Team will check if the driveway radius can be increased for wider turns.	Yes
332	24	11, figure	Nastally	See leib comments on the "perfect trucker" :)	The current design is based on the Terex boom truck as a design vehicle. Next steps item: During design phase, Team will provide signs to prevent semi-trailers from entering the north side of the facility.	Yes
333	24	13,1	Nastally	We agree.	Acknowledged.	No
334	24	13, bullet 1	Nastally	"the" existing (no capital E)	Noted	Yes
335	24	13, bullet 4	Nastally	Lower case e	Noted	Yes
336	24	14, figure	Nastally	Why a curb with curb cuts and not sheet flow off the entire road? doesn't that make grading the roadway easier?	Curbs were recommended in the CS-299 report. The curb and curb cuts were provided as an alternative to allow stormwater to go across the pavement.	Yes
337	24	14,2	Nastally	Could we also do some verification that these new extended chimneys will be waterproofed to prevent any leakage into them?	Text in TM updated to specify waterproofing of the chimneys as part of the design.	Yes
338	24	15,figure	Nastally	Whatever we utilize to convey this drainage down, across the grass, and over the roadway must be mountable by a lawn mower and permanent enough that as the mower is driving over it that it doesn't simple break up or separate.	Noted.	Yes
339	24	16, figure	Nastally	Show the proposed swale here too?	The existing swales are shown on the profiles. The proposed surface is not yet defined, but it will be graded to promote positive drainage towards the swales. Next steps item	Yes

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Comment No.	TM	Pg, Paragraph	Reviewer	Comment	Consultant Response	Incorporated in Final TM Deliverable
340	24	18, 1	Nastally	This is the preferred option with a roller gate.	Noted	Yes
341	24	19,4	Nastally	Do we know if DWSD will buy in to this?	Preliminary discussion with DWSD indicated that DWSD would not have an issue with blind tapping into a sewer or tapping into an existing structure. A permit would be needed to tap into the existing DWSD system.	Yes
342	24	20	Nastally	Remove paragraph 4.3.2	Paragraph 4.3.2 has been removed from TM.	Yes
343	24	23, figure	Nastally	This would cross DTE line...I'd prefer not to.	The Design Team agrees. Intent is to avoid the DTE line.	Yes
344	24	23,1	Nastally	I like this option best. Do we know that the runoff would not cause issues to the north? Could we implement small bioswales w/ thirsty plants on the edges, and then if it overflows them, it goes to the grass? Thoughts.	TM has been updated to recommend this alternative.	Yes
345	24	25,2	Nastally	the key to the roadway is paved surface with a shoulder. That way plows don't destroy the edge.	Noted.	Yes
346	24	25,3	Nastally	But it won't be, right? ;)	Correct. Statement has been rephrased in TM.	Yes
347	24	25,3	Nastally	see my note on this above.	Noted	No
348	24	25,4	Nastally	Delete sec 5.2.2 We don't want this option.	Section 5.2.2, this alternative was removed.	Yes
349	24	27,6	Nastally	New fencing should meet GLWA security standard. Need to coordinate with GLWA security.	Agree. Next steps item.: During design phase, team will coordinate with GLWA security for details.	Yes
350	24	27,7	Nastally	I'm thinking DWSD won't like this one. I like alternative 5. What has DWSD said about this? I also don't like the idea of blind taps...it makes tracing systems harder. Manholes should occur at taps unless it's a building lead.	Preliminary discussion with DWSD indicated that DWSD would not have an issue with blind tapping into a sewer or tapping into an existing structure. A permit would be needed to tap into the existing DWSD system.	Yes

GLWA Contract - 2101475
CSO Facilities Improvements Project
Study Phase Technical Memorandum Comment Resolution Form
TMs Submitted 3/20/2023, 3/24/2023, 4/10/2023 – Review Comments Received from 3/22/2023 thru 4/19/2023

Comment No.	TM	Pg, Paragraph	Reviewer	Comment	Consultant Response	Incorporated in Final TM Deliverable
351	24	28,2	Sworth	Has this been verified? (typical)	Confirmed. It is a median capital cost of construction services and does not reflect design services.	No
352	24	28.3	Nastally	Agreed	Noted.	Yes

Appendix B: NPDES Permit

PERMIT NO. MI0022802

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENT, GREAT LAKES,
AND ENERGY

**AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM**

In compliance with the provisions of the Federal Water Pollution Control Act, 33 U.S.C., Section 1251 *et seq.*, as amended; Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA); Part 41, Sewerage Systems, of the NREPA; and Michigan Executive Order 2011-1,

City of Detroit Water and Sewerage Department

735 Randolph
Detroit, MI 48226

and

Great Lakes Water Authority

735 Randolph
Detroit, MI 48226

are authorized to discharge from the **Great Lakes Water Authority Water Resource Recovery Facility** located at

9300 W. Jefferson
Detroit, MI 48209

designated as **GLWA WRRF**

to the receiving water named the Detroit River and the Rouge River, and from combined sewer overflow facilities to the receiving waters named the Detroit River, the Rouge River, and Conner Creek in accordance with effluent limitations, monitoring requirements, and other conditions set forth in this permit.

This permit is based on a complete application submitted on March 29, 2017 and amended through May 25, 2017.

This permit takes effect on July 18, 2019. The provisions of this permit are severable. After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term in accordance with applicable laws and rules. On its effective date, this permit shall supersede National Pollutant Discharge Elimination System (NPDES) Permit No. MI0022802 (expiring October 1, 2017).

This permit and the authorization to discharge shall expire at midnight on **October 1, 2022**. In order to receive authorization to discharge beyond the date of expiration, the permittees shall submit an application that contains such information, forms, and fees as are required by the Michigan Department of Environment, Great Lakes, and Energy (Department) by **April 4, 2022**.

Issued: June 28, 2019. This permit was modified (minor) on July 18, 2019.

Original signed by Christine Alexander
Christine Alexander, Manager
Permits Section
Water Resources Division

PERMIT FEE REQUIREMENTS

In accordance with Section 324.3120 of the NREPA, the permittees shall make payment of an annual permit fee to the Department for each October 1 the permit is in effect regardless of occurrence of discharge. The permittees shall submit the fee in response to the Department's annual notice. The fee shall be postmarked by January 15 for notices mailed by December 1. The fee is due no later than 45 days after receiving the notice for notices mailed after December 1.

Annual Permit Fee Classification: Municipal Major, 500 MGD or greater (IP)

In accordance with Section 324.3132 of the NREPA, the permittees shall make payment of an annual biosolids land application fee to the Department if the permittees land applies biosolids. In response to the Department's annual notice, the permittees shall submit the fee, which shall be postmarked no later than January 31 of each year.

CONTACT INFORMATION

Unless specified otherwise, all contact with the Department required by this permit shall be made to the Southeast Michigan District Office of the Water Resources Division. The Southeast Michigan District Office is located at 27700 Donald Court, Warren, MI, 48092-2793, Telephone: 586-753-3700, Fax: 586-751-4690.

CONTESTED CASE INFORMATION

Any person who is aggrieved by this permit may file a sworn petition with the Michigan Administrative Hearing System within the Michigan Department of Licensing and Regulatory Affairs, c/o the Michigan Department of Environment, Great Lakes, and Energy, setting forth the conditions of the permit which are being challenged and specifying the grounds for the challenge. The Department of Licensing and Regulatory Affairs may reject any petition filed more than 60 days after issuance as being untimely.

PART I

Section A. Limitations and Monitoring Requirements

1. Effluent Limitations, Monitoring Point 049F

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittees are authorized to discharge treated municipal wastewater from Monitoring Point 049F through Outfall 049 (DRO). Outfall 049 (DRO) discharges to the Detroit River. Such discharge shall be limited and monitored by the permittees as specified below.

Until the initiation of operation of the Rouge River Outfall (RRO) Disinfection Project, this discharge shall consist of secondary treated municipal wastewater and additional primary treated municipal wastewater up to the hydraulic capacity of Outfall 049 (DRO). After initiation of operation of the RRO Disinfection Project, this discharge shall consist of secondary treated municipal wastewater typically, but primary treated municipal wastewater and additional secondary treated municipal wastewater up to the hydraulic capacity of Outfall 049 (DRO) during wet weather events. During such wet weather events, the permittees are approved to discharge primary treated municipal wastewater from 049A thorough Outfall 049 (DRO).

Whenever Outfall 049 (DRO) is out of service for repairs, the permittees may discharge through Outfall 050 (RRO). All effluent authorized for discharge from Outfall 049F, and the monitoring, limitations and other requirements specified below shall apply to the discharge through Outfall 050 (RRO) unless otherwise specified. At least 10 days in advance of scheduled maintenance and within 24-hours after initiation of diversion due to emergency conditions, the permittees shall notify the Department of the reason for the diversion and the expected duration of the diversion.

<u>Parameter</u>	<u>Maximum Limits for Quantity or Loading</u>				<u>Maximum Limits for Quality or Concentration</u>				<u>Monitoring Frequency</u>	<u>Sample Type</u>
	<u>Monthly</u>	<u>7-Day</u>	<u>Daily</u>	<u>Units</u>	<u>Monthly</u>	<u>7-Day</u>	<u>Daily</u>	<u>Units</u>		
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Fecal Coliform Bacteria	---	---	---	---	200	400	(report)	cts/100 ml	Daily	Grab
Total Residual Chlorine	---	---	---	---	---	---	0.11	mg/l	Daily	Grab
Oil & Grease	---	---	---	---	---	15	(report)	mg/l	Daily	Grab
Polychlorinated Biphenyls (PCBs)										
PCB Aroclor 1016	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1221	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1232	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1242	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1248	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1254	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1260	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
Maximum PCB Aroclor										
PCB Aroclor (see I.A.1.g.)	---	---	---	---	<0.1	---	---	µg/l	Monthly	See I.A.1.g.
Acute Toxicity	---	---	---	---	---	---	(report)	TU _A	Quarterly	24-Hr Composite
Carbonaceous Biochemical Oxygen Demand (CBOD ₅)										
	---	---	(report)	lbs/day	---	---	(report)	mg/l	Daily	24-Hr Composite
Ammonia Nitrogen (as N)	---	---	(report)	lbs/day	(report)	---	(report)	mg/l	Daily	24-Hr Composite
Available Cyanide	---	---	(report)	lbs/day	---	---	(report)	µg/l	Monthly	Grab

Perfluorooctane sulfonate (PFOS)	(report)	---	(report)	lbs/day	(report)	---	(report)	ng/l	Quarterly	Grab
Perfluorooctanoic acid (PFOA)	(report)	---	(report)	lbs/day	(report)	---	(report)	µg/l	Quarterly	Grab
Total Copper	---	---	(report)	lbs/day	---	---	(report)	µg/l	Quarterly	24-Hr Composite
					Minimum	Maximum				
					<u>Daily</u>	<u>Daily</u>				
pH	---	---	---	---	6.0	---	9.0	S.U.	Daily	Grab
Dissolved Oxygen	---	---	---	---	(report)	---	---	mg/l	Daily	Grab

The following design flow was used in determining the above limitations, but is not to be considered a limitation or actual capacity: a combined 930 MGD of secondary treated effluent.

- a. **Narrative Standard**
The receiving water shall contain no turbidity, color, oil films, floating solids, foams, settleable solids, or deposits as a result of this discharge in unnatural quantities which are or may become injurious to any designated use.
- b. **Sampling Locations**
The sampling locations for the pollutants indicated in Part I.A.1. of this permit shall be representative of the effluent and consistent with the locations approved by the Department. The Department may approve alternate sampling locations that are demonstrated by the permittees to be representative of the effluent.
- c. **Quarterly Monitoring**
Quarterly samples shall be taken during the months of January, April, July, and October. If the facility does not discharge during these months, the permittees shall sample the next discharge occurring during the period in question. If the facility does not discharge during the period in question, a sample is not required for that period. For any month in which a sample is not taken, the permittees shall enter "*G" on the Discharge Monitoring Report (DMR).
- d. **Total Residual Chlorine (TRC)**
Compliance with the TRC limit shall be determined on the basis of one or more grab samples. If more than one (1) sample per day is taken, the additional samples shall be collected in near equal intervals over approximately eight (8) hours. The samples shall be analyzed immediately upon collection and the average reported as the daily concentration. Samples shall be analyzed in accordance with Part II.B.2. of this permit.
- e. **Monitoring Frequency Reduction for Perfluorooctane Sulfonate (PFOS) and/or Perfluorooctanoic Acid (PFOA)**
After the submittal of 24 months of data, the permittee may request, in writing, Department approval of a reduction in monitoring frequency for PFOS and/or PFOA. This request shall contain an explanation as to why the reduced monitoring is appropriate. Upon receipt of written approval and consistent with such approval, the permittee may reduce the monitoring frequency indicated in Part I.A.1. of this permit. The monitoring frequency for PFOS and/or PFOA, shall not be reduced to less than annually. The Department may revoke the approval for reduced monitoring at any time upon notification to the permittee.
- f. **Analytical Methods and Quantification Levels for Available Cyanide and Total Copper**
The sampling procedures, preservation and handling, and analytical protocol for compliance monitoring for Available Cyanide shall be in accordance with EPA Method OIA-1677. The quantification level for Available Cyanide and Total Copper shall be 2.0 µg/l and 1.0 µg/l respectively unless a higher level is appropriate because of sample matrix interference. Justification for higher quantification levels shall be submitted to the Department within 30 days of such determination. Upon approval from the

Department, the permittees may use alternate analytical methods (for parameters with methods specified in Title 40 of the Code of Federal Regulations (CFR), Part 136, the alternate methods are restricted to those listed in 40 CFR, Part 136).

- g. Limits Below the Quantification Level – Total Polychlorinated Biphenyls (PCBs)
The sampling procedures, preservation and handling, and analytical protocol for compliance monitoring for Total PCBs shall be in accordance with EPA Method 608.3. Upon approval from the Department, the permittees may use alternate analytical methods (for parameters with methods specified in 40 CFR, Part 136, the alternate methods are restricted to those listed in 40 CFR, Part 136). The quantification level shall be 0.1 ug/l unless a higher level is appropriate because of sample matrix interference. Justification for a higher quantification level shall be submitted to the Department within 30 days of such determination.

The water quality-based effluent limitation for Total PCBs is 2.6×10^{-5} ug/l (2.0×10^{-4} lbs/day) maximum monthly average. This is less than the quantification level. Control requirements are therefore established consistent with R 323.1213. **The discharge of any individual aroclor at or above the quantification level of 0.1 ug/l is a specific violation of this permit.** If concentrations of all aroclors representing a monitoring period are less than their quantification levels, the permittees will be considered to be in compliance with the permit for the monitoring period that the analyses represent, provided that the permittees are also in full compliance with the Pollutant Minimization Program for Total PCBs set forth in Part I.A.10 of this permit. For the purpose of reporting on the Daily tab of the DMR, individual aroclor results less than the quantification level shall be reported as "<0.1." For the purpose of reporting on the Summary tab of the DMR, the value reported under PCB Aroclor shall be the highest aroclor concentration observed during the monitoring period. This permit condition does not authorize the discharge of PCBs at levels that are injurious to the designated uses of the waters of the state or that constitute a threat to the public health or welfare.

- h. Acute Toxicity Requirements
Test species shall include *Ceriodaphnia dubia*. Testing and reporting procedures shall follow procedures contained in EPA-821-R-02-012, "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" (Fifth Edition). When the effluent ammonia nitrogen (as N) concentration is greater than 5 mg/l, the pH of the toxicity test shall be maintained at the pH of the effluent at the time of sample collection. The acute toxic unit (TU_A) value for **each species tested** shall be reported on the DMR. For **each species not tested**, the permittees shall enter **"*W"** on the DMR. Completed toxicity test reports for each test conducted shall be retained by the permittees in accordance with the requirements of Part II.B.5. of this permit and shall be available for review by the Department upon request. Toxicity test data acceptability is contingent upon the validation of the test method by the testing laboratory. Such validation shall be submitted to the Department upon request.

The Department will review the toxicity data submitted by the permittees to determine if the acute toxicity requirements of R 323.1219 are being satisfied.

1) If the data indicate persistent exceedance of the acute toxicity requirements of R 323.1219, upon written notification by the Department, the following conditions apply. Within 90 days of the above notification, the permittees shall implement a Toxicity Reduction Evaluation (TRE). The objective of the TRE shall be to reduce the toxicity of the final effluent from Monitoring Point 049F to <3.0 TU_A within three (3) years of notification. The following documents are available as guidance to reduce toxicity to acceptable levels: Phase I, EPA/600/6-91/003; Phase II, EPA/600/R-92/080; Phase III, EPA/600/R-92/081; and Publicly Owned Treatment Works, EPA/833B-99/002. The tests shall be conducted and reported as specified above. Upon approval from the Department, the acute toxicity tests may be performed using the more sensitive species identified in the acute toxicity database. If a more sensitive species cannot be identified, the acute toxicity tests shall be performed with both species. Annual progress reports shall be submitted to the Department within 30 days of the completion of the last test of each annual cycle.

2) This permit may be modified in accordance with applicable laws and rules to include additional whole effluent toxicity control requirements as necessary.

2. Effluent Limitations, Monitoring Point 049A

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittees are approved to discharge treated municipal wastewater and treated storm water runoff from Monitoring Point 049A through Outfall 049 (DRO). Outfall 049 (DRO) discharges to the Detroit River. Such discharge shall be limited and monitored by the GLWA as specified below.

Monitoring Point 049A is a primary treated effluent conduit. There shall be no discharge from Monitoring Point 049A directly to the Detroit River through Outfall 049 (DRO) unless the discharge from Monitoring Point 049B exceeds a peak hourly flow of 930 MGD (which includes recycle) or in accordance with an approved GLWA Wet Weather Operational Plan (see Part I.A.11.). Discharges from Monitoring Point 049A shall be limited and monitored by the permittees as specified below.

<u>Parameter</u>	<u>Maximum Limits for Quantity or Loading</u>			<u>Maximum Limits for Quality or Concentration</u>			<u>Monitoring Frequency</u>	<u>Sample Type</u>
	<u>Monthly</u>	<u>Daily</u>	<u>Units</u>	<u>Monthly</u>	<u>Daily</u>	<u>Units</u>		
Flow	(report)	(report)	MGD	---	---	---	Daily	Report Total Daily Flow
Carbonaceous Biochemical Oxygen Demand (CBOD ₅)	---	---	---	40	(report)	mg/l	Daily	24-Hr Composite
Total Suspended Solids	---	---	---	70	(report)	mg/l	Daily	24-Hr Composite
Total Phosphorus (as P)	---	---	---	1.5	(report)	mg/l	Daily	24-Hr Composite
Ammonia Nitrogen (as N)	---	---	---	(report)	(report)	mg/l	Daily	24-Hr Composite
Total Mercury								
– Corrected	(report)	(report)	lbs/day	(report)	(report)	ng/l	2x Monthly	Calculation
– Uncorrected	---	---	---	---	(report)	ng/l	2x Monthly	Grab
– Field Duplicate	---	---	---	---	(report)	ng/l	2x Monthly	Grab
– Field Blank	---	---	---	---	(report)	ng/l	2x Monthly	Preparation
– Laboratory Method Blank	---	---	---	---	(report)	ng/l	2x Monthly	Preparation
	<u>12-Month Rolling Average</u>			<u>12-Month Rolling Average</u>				
Total Mercury	0.19	---	lbs/day	25	---	ng/l	Monthly	Calculation

- a. Sampling Locations
The sampling locations for the pollutants in Part 1.A.2. of this permit shall be representative of the effluent and consistent with the locations approved by the Department. Samples for CBOD₅, Total Suspended Solids, Ammonia Nitrogen, Total Mercury, and Total Phosphorus shall be taken prior to mixing with other waste streams. The Department may approve alternate sampling locations that are demonstrated by the permittees to be representative of the effluent
- b. Sampling of Short-Term Wet Weather Events
If the first calendar day of the discharge event through Monitoring Point 049A includes less than three hours of flow but continues into the next calendar day, the sampling can be included as a part of the subsequent event the following day.
- c. Final Effluent Limitation for Total Mercury
The final limit for total mercury is the Discharge Specific Level Currently Achievable (LCA) based on a multiple discharger variance from the WQBEL of 1.3 ng/l, pursuant to Rule 1103(9) of the Water Quality Standards. Compliance with the LCA shall be determined as a 12-month rolling average, the calculation of which may be done using blank-corrected sample results. The 12-month rolling average shall be determined by adding the present monthly average result to the preceding 11 monthly average results then dividing the sum by 12. For facilities with quarterly monitoring requirements for total mercury, quarterly monitoring shall be equivalent to three (3) months of monitoring in calculating the

12-month rolling average. Facilities that monitor more frequently than monthly for total mercury must determine the monthly average result, which is the sum of the results of all data obtained in a given month divided by the total number of samples taken, in order to calculate the 12-month rolling average. If the 12-month rolling average for any month is less than or equal to the LCA, the GLWA will be considered to be in compliance for total mercury for that month, provided the GLWA is also in full compliance with the Pollutant Minimization Program for Total Mercury, set forth in Part I.A.10. of this permit.

The permittee may choose to demonstrate that an alternate site-specific LCA is appropriate and request a permit modification. Such request and supporting documentation shall be submitted in writing to the Department. Supporting documentation shall include a minimum of 12 samples taken over 12-month period in accordance with EPA Method 1631. Upon approval, this permit may be modified in accordance with applicable laws and rules to incorporate the alternate site-specific LCA as the effluent limitation for Total Mercury.

After a minimum of 12 monthly data points have been collected, the permittees may request a reduction in the monitoring frequency for total mercury. This request shall contain an explanation as to why the reduced monitoring is appropriate and shall be submitted to the Department. Upon receipt of written approval and consistent with such approval, the permittees may reduce the monitoring frequency for total mercury indicated in Part I.A.2. of this permit. The Department may revoke the approval for reduced monitoring at any time upon notification to the permittees.

d. Total Mercury Testing and Additional Reporting Requirements

The analytical protocol for total mercury shall be in accordance with EPA Method 1631, Revision E, "Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry." The quantification level for total mercury shall be 0.5 ng/l, unless a higher level is appropriate because of sample matrix interference. Justification for higher quantification levels shall be submitted to the Department within 30 days of such determination.

The use of clean technique sampling procedures is required unless the permittees can demonstrate to the Department that an alternate sampling procedure is representative of the discharge. Guidance for clean technique sampling is contained in EPA Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels (Sampling Guidance), EPA-821-R96-001, July 1996. Information and data documenting the permittee's sampling and analytical protocols and data acceptability shall be submitted to the Department upon request.

In order to demonstrate compliance with EPA Method 1631E and EPA Method 1669, the permittees shall report, on the daily sheet, the analytical results of all field blanks and field duplicates collected in conjunction with each sampling event, as well as laboratory method blanks when used for blank correction. The permittees shall collect at least one (1) field blank and at least one (1) field duplicate per sampling event. If more than ten (10) samples are collected during a sampling event, the permittees shall collect at least one (1) additional field blank AND field duplicate for every ten (10) samples collected. Only field blanks or laboratory method blanks may be used to calculate a concentration lower than the actual sample analytical results (i.e., a blank correction). Only one (1) blank (field OR laboratory method) may be used for blank correction of a given sample result, and only if the blank meets the quality control acceptance criteria. If blank correction is not performed on a given sample analytical result, the permittees shall report under "Total Mercury – Corrected" the same value reported under "Total Mercury – Uncorrected." The field duplicate is for quality control purposes only; its analytical result shall not be averaged with the sample result.

3. Effluent Limitations, Monitoring Point 049B

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittees are authorized to discharge treated municipal wastewater from Monitoring Point 049B through Outfall 049 (DRO), or through Outfall 050 (RRO) when there is reduced hydraulic capacity through DRO or during wet weather, once the RRO Disinfection Project is completed. Outfall 049 (DRO) discharges to the Detroit River. Outfall 050 (RRO) discharges to the Rouge River. In addition, the permittees are authorized to discharge treated municipal wastewater from Monitoring Point 049B through Outfall 050 to the Rouge River as provided in Part I.A.4.

Outfall 049B is the combined secondary treated effluent conduit for all dry weather flows and all wet weather flows up to and including a peak hourly flow of 930 MGD (which includes recycle).

Discharges from Monitoring Point 049B shall be limited and monitored by the permittees as specified below.

Parameter	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration				Monitoring Frequency	Sample Type
	Monthly	7-Day	Daily	Units	Monthly	7-Day	Daily	Units		
Flow (This flow measurement is all secondary flow minus recycle and buffer flows)	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Recycled Flow (Screened Final Effluent)	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily SFE Flow
Buffer Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Carbonaceous Biochemical Oxygen Demand (CBOD ₅)	194,000	310,000	(report)	lbs/day	25	40	(report)	mg/l	Daily	24-Hr Composite
Total Suspended Solids	233,000	349,000	(report)	lbs/day	30	45	(report)	mg/l	Daily	24-Hr Composite
Ammonia Nitrogen (as N)		---	---	---	(report)	---	(report)	mg/l	Daily	24-Hr Composite
Total Mercury										
– Corrected	(report)	---	(report)	lbs/day	(report)	---	(report)	ng/l	Quarterly	Calculation
– Uncorrected	---	---	---	---	---	---	(report)	ng/l	Quarterly	Grab
– Field Duplicate	---	---	---	---	---	---	(report)	ng/l	Quarterly	Grab
– Field Blank	---	---	---	---	---	---	(report)	ng/l	Quarterly	Preparation
– Laboratory Method Blank	---	---	---	---	---	---	(report)	ng/l	Quarterly	Preparation
	12 Month Rolling Average				12 Month Rolling Average					
Total Mercury	0.023	---	---	lbs/day	3.0	---	---	ng/l	Monthly	Calculation
					Minimum Daily		Maximum Daily			
pH	---	---	---	---	6.0		9.0	S.U.	Daily	Grab
Total Phosphorus (as P)	5400	---	(report)	lbs/day	0.7	---	(report)	mg/l	Daily	24-Hr Composite
	Six Month Average (April - Sept.)				Six Month Average (April - Sept.)					
Total Phosphorus	4600	---	---	lbs/day	0.6	---	---	mg/l	(see I.A.3.c)	Calculation

				Minimum Monthly					
CBOD ₅ Minimum % Removal	---	---	---	85	---	(report)	%	Monthly	Calculation
Total Suspended Solids Minimum % Removal			---	85	---	(report)	%	Monthly	Calculation

- a. **Sampling Locations**
Samples for CBOD₅, Total Suspended Solids, Ammonia Nitrogen, Total Phosphorus, Total Mercury and pH shall be taken prior to mixing with other waste streams. Samples for pH shall be collected only during periods of discharge from Monitoring Point 049A through Outfall 049 (DRO).
- b. **Percent Removal Requirements**
These requirements shall be calculated based on the monthly (30-day) effluent CBOD₅ and TSS concentrations and the monthly influent concentrations for approximately the same period.
- c. **Total Phosphorus Six Month Average Limit (April - September)**
The six month average shall be determined by adding the six monthly average results from April through September and dividing the sum by six. For the purpose of reporting on the Discharge Monitoring Reports, the permittees shall calculate and report the six month average on the October Discharge Monitoring Report.
- d. **Quarterly Monitoring**
Quarterly samples shall be taken during the months of January, April, July, and October. If the facility does not discharge during these months, the permittee shall sample the next discharge occurring during the period in question. If the facility does not discharge during the period in question, a sample is not required for that period. For any month in which a sample is not taken, the permittee shall enter "*G" on the Discharge Monitoring Report (DMR). (For purposes of reporting on the Daily tab of the DMR, the permittee shall enter "*G" on the first day of the month only).
- e. **Final Effluent Limitation for Total Mercury**
The final limit for total mercury is the Discharge Specific Level Currently Achievable (LCA) based on a multiple discharger variance from the WQBEL of 1.3 ng/l, pursuant to Rule 1103(9) of the Water Quality Standards. Compliance with the LCA shall be determined as a 12-month rolling average, the calculation of which may be done using blank-corrected sample results. The 12-month rolling average shall be determined by adding the present monthly average result to the preceding 11 monthly average results then dividing the sum by 12. For facilities with quarterly monitoring requirements for total mercury, quarterly monitoring shall be equivalent to three (3) months of monitoring in calculating the 12-month rolling average. Facilities that monitor more frequently than monthly for total mercury must determine the monthly average result, which is the sum of the results of all data obtained in a given month divided by the total number of samples taken, in order to calculate the 12-month rolling average. If the 12-month rolling average for any month is less than or equal to the LCA, the permittees will be considered to be in compliance for total mercury for that month, provided the permittees are also in full compliance with the Pollutant Minimization Program for Total Mercury, set forth in Part I.A.10. of this permit.

The permittee may choose to demonstrate that an alternate site-specific LCA is appropriate and request a permit modification. Such request and supporting documentation shall be submitted in writing to the Department. Supporting documentation shall include a minimum of 12 samples taken over 12-month period in accordance with EPA Method 1631. Upon approval, this permit may be modified in accordance with applicable laws and rules to incorporate the alternate site-specific LCA as the effluent limitation for Total Mercury.

After a minimum of 12 monthly data points have been collected, the permittees may request a reduction in the monitoring frequency for total mercury. This request shall contain an explanation as to why the reduced monitoring is appropriate and shall be submitted to the Department. Upon receipt of written approval and consistent with such approval, the permittees may reduce the monitoring frequency for total mercury indicated in Part I.A.3. of this permit. The Department may revoke the approval for reduced monitoring at any time upon notification to the permittees.

f. Total Mercury Testing and Additional Reporting Requirements

The analytical protocol for total mercury shall be in accordance with EPA Method 1631, Revision E, "Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry." The quantification level for total mercury shall be 0.5 ng/l, unless a higher level is appropriate because of sample matrix interference. Justification for higher quantification levels shall be submitted to the Department within 30 days of such determination.

The use of clean technique sampling procedures is required unless the permittees can demonstrate to the Department that an alternate sampling procedure is representative of the discharge. Guidance for clean technique sampling is contained in EPA Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels (Sampling Guidance), EPA-821-R96-001, July 1996. Information and data documenting the permittee's sampling and analytical protocols and data acceptability shall be submitted to the Department upon request.

In order to demonstrate compliance with EPA Method 1631E and EPA Method 1669, the permittees shall report, on the daily sheet, the analytical results of all field blanks and field duplicates collected in conjunction with each sampling event, as well as laboratory method blanks when used for blank correction. The permittees shall collect at least one (1) field blank and at least one (1) field duplicate per sampling event. If more than ten (10) samples are collected during a sampling event, the permittees shall collect at least one (1) additional field blank AND field duplicate for every ten (10) samples collected. Only field blanks or laboratory method blanks may be used to calculate a concentration lower than the actual sample analytical results (i.e., a blank correction). Only one (1) blank (field OR laboratory method) may be used for blank correction of a given sample result, and only if the blank meets the quality control acceptance criteria. If blank correction is not performed on a given sample analytical result, the permittees shall report under "Total Mercury – Corrected" the same value reported under "Total Mercury – Uncorrected." The field duplicate is for quality control purposes only; its analytical result shall not be averaged with the sample result.

4. Interim Effluent Limitations, Monitoring Point 050A

During the period beginning on the effective date of this permit and lasting until initiation of operation of the RRO Disinfection Project, the permittees are approved to discharge treated municipal wastewater and treated storm water runoff from Monitoring Point 050A through Outfall 050 (RRO). Normally, the discharge may consist of only primary treated effluent when the discharge is necessary due to hydraulic constraints resulting from wet weather events. There shall be no discharge from Monitoring Point 050A unless the discharge from Monitoring Point 049B exceeds a peak hourly flow of 930 MGD (which includes recycle) or in accordance with an approved GLWA WRRF Wet Weather Operational Plan (see Part I.A.11.). Discharge from Outfall 050 (RRO) is not allowed unless hydraulically or structurally necessary. Outfall 050 (RRO) discharges to the Rouge River.

Other options for discharge from Outfall 050 include, 1) when Outfall 049 (DRO) is out-of-service, the discharge may consist of secondary or secondary and primary treated wastewater, 2) when Outfall 049 (DRO) has reduced hydraulic capacity the discharge may consist of secondary or secondary and primary treated wastewater, and 3) when there is department approved limited secondary capacity when Outfall 049 cannot be used due to construction, the discharge may consist of secondary or secondary and primary treated wastewater. Discharges from Monitoring Point 050A shall be limited and monitored by the permittees as specified below.

Parameter	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration				Monitoring Frequency	Sample Type
	Monthly	7-Day	Daily	Units	Monthly	7-Day	Daily	Units		

Limitations and monitoring requirements in effect when Outfall 049 is out-of-service and prior to initiation of operation of the RRO Disinfection Project:

All limitations and monitoring specified in Part I.A.1. apply except for the Available Cyanide monitoring requirement, Total Residual Chlorine requirement, and the Fecal Coliform Bacteria limitations, which are replaced with the limitations and monitoring requirements specified below with the Total Residual Chlorine monitoring and limitation removed:

Available Cyanide	---	---	---	---	---	---	89	µg/l	Daily	Grab
Fecal Coliform Bacteria	---	---	---	---	(report)	(report)	---	cts/100 ml	Daily	Grab

- a. Sampling of Short-Term Wet Weather Events
If the first calendar day of the discharge event through Monitoring Point 050A includes less than three hours of flow but continues into the next calendar day, the sampling can be included as a part of the subsequent event the following day.

4. Interim Effluent Limitations, Monitoring Point 050A (continued)

Parameter	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration				Monitoring Frequency	Sample Type
	Monthly	7-Day	Daily	Units	Monthly	7-Day	Daily	Units		
Limitations and monitoring requirements in effect during other periods of discharge from Monitoring Point 050A and prior to Initiation of operation of the RRO Disinfection Project:										
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Carbonaceous Biochemical Oxygen Demand (CBOD ₅)	---	---	---	---	40	---	(report)	mg/l	Daily	24-Hr Composite
Total Suspended Solids	---	---	---	---	70	---	(report)	mg/l	Daily	24-Hr Composite
Total Phosphorus (as P)	---	---	---	---	1.5	---	(report)	mg/l	Daily	24-Hr Composite
Available Cyanide	---	---	---	---	---	---	89	µg/l	Daily	Grab
Fecal Coliform Bacteria	---	---	---	---	(report)	---	(report)	cts/100 ml	Daily	Grab
Ammonia Nitrogen (as N)	---	---	---	---	(report)	---	(report)	mg/l	Daily	24-Hr Composite
Total Copper	---	---	---	---	---	---	(report)	µg/l	Daily	24-Hr Composite
Polychlorinated Biphenyls (PCBs)										
PCB Aroclor 1016	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1221	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1232	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1242	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1248	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1254	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1260	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
Maximum PCB Aroclor										
PCB Aroclor (see I.A.4.e.)	---	---	---	---	(report)	---	---	µg/l	Monthly	See I.A.4.e.
Minimum DailyMaximum Daily										
pH	---	---	---	---	6.0		9.0	S.U.	Daily	Grab
Dissolved Oxygen	---	---	---	---	(report)		---	mg/l	Daily	Grab

- a. Narrative Standard
The receiving water shall contain no turbidity, color, oil films, floating solids, foams, settleable solids, or deposits as a result of this discharge in unnatural quantities which are or may become injurious to any designated use.

- b. **Sampling Locations**
The sampling locations for the pollutants in Part 1.A.4. of this permit shall be representative of the effluent and consistent with the locations approved by the Department. The Department may approve alternate sampling locations that are demonstrated by the GLWA to be representative of the effluent.
- c. **Sampling of Short-Term Wet Weather Events**
If the first calendar day of the discharge event through Monitoring Point 050A includes less than three hours of flow but continues into the next calendar day, the sampling can be included as a part of the subsequent event the following day.
- d. **Analytical Methods and Quantification Levels for Available Cyanide and Total Copper**
The sampling procedures, preservation and handling, and analytical protocol for compliance monitoring for Available Cyanide shall be in accordance with EPA Method OIA-1677. The quantification levels for Available Cyanide and Total Copper shall be 2.0 µg/l and 1.0 µg/l respectively unless a higher level is appropriate because of sample matrix interference. Justification for higher quantification levels shall be submitted to the Department within 30 days of such determination. Upon approval of the Department, the permittees may use alternate analytical methods (for parameters with methods specified in 40 CFR 136, the alternate methods are restricted to those listed in 40 CFR 136).
- e. **Limits Below the Quantification Level – Total Polychlorinated Biphenyls (PCBs)** The sampling procedures, preservation and handling, and analytical protocol for compliance monitoring for Total PCBs shall be in accordance with EPA Method 608.3. Upon approval from the Department, the permittees may use alternate analytical methods (for parameters with methods specified in 40 CFR, Part 136, the alternate methods are restricted to those listed in 40 CFR, Part 136). The quantification level shall be 0.1 ug/l unless a higher level is appropriate because of sample matrix interference. Justification for a higher quantification level shall be submitted to the Department within 30 days of such determination.

For the purpose of reporting on the Daily tab of the DMR, individual aroclor results less than the quantification level shall be reported as "<0.1." For the purpose of reporting on the Summary tab of the DMR, the value reported under PCB Aroclor shall be the highest individual aroclor concentration observed during the monitoring period. This permit condition does not authorize the discharge of PCBs at levels that are injurious to the designated uses of the waters of the state or that constitute a threat to the public health or welfare.

5. Final Effluent Limitations, Monitoring Point 050A

Upon initiation of operation of the RRO Disinfection Project, the permittees are approved to discharge secondary treated municipal wastewater and primary treated municipal wastewater when hydraulically necessary from Monitoring Point 050A through Outfall 050 (RRO). Outfall 050 (RRO) discharges to the Rouge River. Discharge from Outfall 050 (RRO) is approved when the hydraulic capacity of Outfall 049 (DRO) is not sufficient to meet the approved GLWA wet weather operational plan (see Part I.A.11.). Such discharge shall be limited and monitored by the permittees as specified below.

<u>Parameter</u>	<u>Maximum Limits for Quantity or Loading</u>				<u>Maximum Limits for Quality or Concentration</u>				<u>Monitoring Frequency</u>	<u>Sample Type</u>
	<u>Monthly</u>	<u>7-Day</u>	<u>Daily</u>	<u>Units</u>	<u>Monthly</u>	<u>7-Day</u>	<u>Daily</u>	<u>Units</u>		
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Available Cyanide	---	---	---	---	---	---	44	µg/l	Daily	Grab
Total Copper	---	---	---	---	---	---	(report)	µg/l	Monthly	24-Hr Composite
Fecal Coliform Bacteria	---	---	---	---	200	400	(report)	cts/100 ml	Daily	Grab
Total Residual Chlorine	---	---	---	---	---	---	38	µg/l	Daily	Grab
Oil & Grease	---	---	---	---	---	15	(report)	mg/l	Daily	Grab
Total Polychlorinated Biphenyls (PCBs)										
PCB Aroclor 1016	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1221	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1232	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1242	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1248	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1254	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
PCB Aroclor 1260	---	---	---	---	---	---	(report)	µg/l	Weekly	24-Hr Composite
Maximum PCB Aroclor										
PCB Aroclor (See I.A.5.f.)	---	---	---	---	<0.1	---	---	µg/l	Monthly	See I.A.5.f.
Minimum Daily Maximum Daily										
pH	---	---	---	---	6.0	---	9.0	S.U.	Daily	
Dissolved Oxygen	---	---	---	---	3.0	---	---	mg/l	Daily	Grab

- a. Narrative Standard
The receiving water shall contain no turbidity, color, oil films, floating solids, foams, settleable solids, suspended solids, or deposits as a result of this discharge in unnatural quantities which are or may become injurious to any designated use.
- b. Sampling Locations
The sampling locations for the pollutants in Part I.A.5. of this permit shall be representative of the effluent and consistent with the locations approved by the Department. The Department may approve alternate sampling locations that are demonstrated by the permittees to be representative of the effluent.
- c. Sampling of Short-Term Wet Weather Events
If the first calendar day of the discharge event includes less than three hours of flow but continues into the next calendar day, the sampling can be included as part of the subsequent event the following day.

- d. Total Residual Chlorine (TRC)
Compliance with the TRC limit shall be determined on the basis of one or more grab samples. If more than one (1) sample per day is taken, the additional samples shall be collected in near equal intervals over approximately eight (8) hours. The samples shall be analyzed immediately upon collection and the average reported as the daily concentration. Samples shall be analyzed in accordance with Part II.B.2. of this permit.
- e. Analytical Methods and Quantification Levels for Available Cyanide and Total Copper
The sampling procedures, preservation and handling, and analytical protocol for compliance monitoring for Available Cyanide shall be in accordance with EPA Method OIA-1677. The quantification levels for Available Cyanide and Total Copper shall be 2.0 µg/l and 1.0 µg/l, respectively, unless a higher level is appropriate because of sample matrix interference. Justification for higher quantification levels shall be submitted to the Department within 30 days of such determination. Upon approval of the Department, the permittees may use alternate analytical methods (for parameters with methods specified in 40 CFR 136, the alternate methods are restricted to those listed in 40 CFR 136).
- f. Limits Below the Quantification Level – Total Polychlorinated Biphenyls (PCBs)
The sampling procedures, preservation and handling, and analytical protocol for compliance monitoring for Total PCBs shall be in accordance with EPA Method 608.3. Upon approval from the Department, the permittees may use alternate analytical methods (for parameters with methods specified in 40 CFR, Part 136, the alternate methods are restricted to those listed in 40 CFR, Part 136). The quantification level shall be 0.1 ug/l unless a higher level is appropriate because of sample matrix interference. Justification for a higher quantification level shall be submitted to the Department within 30 days of such determination.

The water quality-based effluent limitation for Total PCBs is 2.6×10^{-5} µg/l (2.0×10^{-4} lbs/day) maximum monthly average. This is less than the quantification level. Control requirements are therefore established consistent with R 323.1213. **The discharge of any individual aroclor at or above the quantification level of 0.1 ug/l is a specific violation of this permit.** If concentrations of all aroclors representing a monitoring period are less than their quantification levels, the permittees will be considered to be in compliance with the permit for the monitoring period that the analyses represent, provided that the permittees are also in full compliance with the Pollutant Minimization Program for Total PCBs set forth in Part I.A.10 of this permit. For the purpose of reporting on the Daily tab of the DMR, individual aroclor results less than the quantification level shall be reported as "<0.1." For the purpose of reporting on the Summary tab of the DMR, the value reported under PCB Aroclor shall be the highest aroclor concentration observed during the monitoring period. This permit condition does not authorize the discharge of PCBs at levels that are injurious to the designated uses of the waters of the state or that constitute a threat to the public health or welfare.

- g. Schedule of Implementation
The permittees shall implement the following for Outfall 050 (RRO) Disinfection Program:
- 1) On or before February 1, 2010 (submitted), the permittees shall submit for review and approval a basis of design report for the previously proposed Outfall 084 (RRO2).
 - 2) On or before March 1, 2011 (submitted), the permittees shall submit for review and approval complete plans and specifications for Segment 1 of the previously proposed Outfall 084 (RRO2) project. Segment 1 consists of improvements undertaken at the WRRF consistent with the approved Basis of Design report.
 - 3) On or before July 1, 2012 (submitted), the permittees shall commence construction of Segment 1, consistent with the approved plans and specifications.
 - 4) On or before July 1, 2013 (submitted), the permittees shall submit a construction progress report for Segment 1 of the previously proposed Outfall 084 (RRO2).
 - 5) On or before March 1, 2015, (completed) the permittees shall complete construction of Segment 1 of the previously proposed Outfall 084 (RRO2) project.

- 6) On or before June 1, 2016, (submitted) the permittees shall submit for review and approval a complete basis of design report, and complete plans and specifications, for the Outfall 050 (RRO) Disinfection Project (if design, bid, build). Alternatively, if DWSD chooses to pursue design-build for the Outfall 050 (RRO) Disinfection Project, DWSD shall submit on or before June 1, 2016, (submitted) a detailed engineering report for the overall project, a permitting plan (that includes a description of the construction segments), a timetable for Part 41 permit application submittal, and sufficient project schematics for the overall project.
- 7) On or before November 1, 2016, (completed) the permittees shall submit complete plans and specifications for at a minimum the first segment to be construction under a design-build contract.
- 8) On or before April 1, 2017, (commenced) the permittees shall commence construction of the RRO Disinfection Project, consistent with the approved plans and specifications.
- 9) On or before April 1, 2018, (submitted) the permittees shall submit a construction progress report for RRO Disinfection Project.
- 10) On or before April 1, 2019, (completed) the permittees shall complete construction of RRO Disinfection Project and place into full operation the facilities to achieve final effluent limits specified in Part I.A.5.

6. Combined Sewer Overflow Retention Treatment Basin Discharge Authorization, Monitoring Points 101A, 102A, 103A, 104A, 108A and 109A

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittees are authorized to discharge treated combined sewage from the Hubbell/Southfield Combined Sewer Overflow (CSO) Retention Treatment Basin (RTB), Monitoring Point 101A, through Outfall 101; from the Puritan/Fenkell CSO RTB, Monitoring Point 102A, through Outfall 102; from the Seven Mile CSO RTB, Monitoring Point 103A, through Outfall 103; from the Belle Isle RTB, Monitoring Point 108A, through Outfall 108; from the Oakwood RTB, Monitoring Point 109A, through Outfall 109; and from the Conner Creek CSO RTB Monitoring Point 104A, through Outfall 104 when the basins are full and wastewater flows exceed downstream interceptor capacity. Outfall 101, Outfall 102, Outfall 103, and Outfall 109 discharge to the Rouge River. Outfall 108 discharges to the Detroit River. Outfall 104 discharges to Conner Creek. Such discharges shall be limited and monitored by the permittees as specified below:

Influent Characteristics	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration				Monitoring Frequency	Sample Type
	Monthly	7-Day	Daily	Units	Monthly	7-Day	Event	Units		
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Effluent Characteristics										
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Carbonaceous Biochemical Oxygen Demand (CBOD ₅)	---	---	---	---	(report)	---	(report)	mg/l	Event	Composite
Total Suspended Solids	---	---	---	---	(report)	---	(report)	mg/l	Event	Composite
Ammonia Nitrogen (as N)	---	---	---	---	(report)	---	(report)	mg/l	Event	Composite
Total Phosphorus (as P)	---	---	---	---	(report)	---	(report)	mg/l	Event	Composite
Fecal Coliform Bacteria										
May 1 – October 31	---	---	---	---	---	---	400	cts/100 ml	See I.A.6.a.	Grab
November 1 – April 30	---	---	---	---	---	---	1000	cts/100 ml	See I.A.6.a.	Grab
					Event Average		Event Maximum			
Total Residual Chlorine										
Any Event	---	---	---	---	(report)	---	(report)	mg/l	See I.A.6.a.	Grab
(See additional controls specified in Part I.A.8.)										

<u>Effluent Characteristics</u>	<u>Maximum Limits for Quantity or Loading</u>				<u>Maximum Limits for Quality or Concentration</u>				<u>Monitoring Frequency</u>	<u>Sample Type</u>
	<u>Monthly</u>	<u>7-Day</u>	<u>Daily</u>	<u>Units</u>	<u>Monthly</u>	<u>7-Day</u>	<u>Event</u>	<u>Units</u>		
Oil & Grease (Monitoring Point 109A only)	---	---	---	---	(report)	---	(report)	mg/l	Daily During Discharge	Grab
					<u>Event Minimum</u>		<u>Event Maximum</u>			
pH	---	---	---	---	(report)	---	(report)	S.U.	Daily During Discharge	Grab
Dissolved Oxygen	---	---	---	---	(report)	---	---	mg/l	Daily During Discharge	Grab

a. Retention Basin Monitoring and Reporting

The permittee shall conduct retention basin monitoring and report consistent with the requirements of Part II.C.2. of this permit. The permittee shall supply the results of each sample analyzed during each discharge period.

An Event starts when combined sewage is discharged into a facility, and ends when effluent flow (if any) ceases and does not resume within 24 hours.

Influent flow shall be reported for all wet weather events where combined sewage is discharged into the facility. Influent flow reporting shall also indicate the component of the total influent flow that is dewatered to the interceptor from the facility during an event and shall be reported in the comment section of the monthly Discharge Monitoring Reports (DMR). Alternate procedures may be approved by the Department.

Effluent flow shall be reported for all events that cause discharge from the facility to the receiving waters.

Effluent sampling for CBOD₅, TSS, Ammonia Nitrogen (as N), and Total Phosphorus (as P) shall be by effluent flow-weighted composite sampling over the entire event. Alternate procedures for determining an event composite may be approved by the Department if existing equipment cannot reliably determine a flow-weighted composite. For purposes of reporting for a discharge event that occurs on multiple calendar days, the composite pollutant concentrations for the event shall be reported on the day the discharge event ended. Individual events shall be determined by a lack of effluent discharge for 24 hours.

For **effluent pH**, report the maximum value of any individual sample taken during the month in the "Maximum" column under "Quality or Concentration" on the monthly DMRs and the minimum value of any individual sample taken during the month in the "Minimum" column under "Quality or Concentration" on the monthly DMRs. The individual values taken during the month shall be reported on the daily DMRs.

For **effluent dissolved oxygen**, report the lowest concentration of any individual sample in the "Minimum" column under the "Quantity or Concentration" on the monthly DMRs. The individual values taken during the month shall be reported on the daily DMRs.

For **effluent Fecal Coliform Bacteria and Total Residual Chlorine**, grab samples shall be collected every two (2) hours for the first six (6) hours of the discharge and every four (4) hours thereafter for the duration of the discharge; the first sample shall be collected as soon as practical after the discharge begins. For fecal coliform, the "event maximum" shall be reported on the daily DMRs as the geometric mean of all samples taken during an event, provided that three (3) or more samples are collected. For TRC, report the average of all samples in an event as the "Event Average" and the maximum individual sample in an event as the "Event Maximum" on the daily DMRs. The goal of the effluent sampling program is to collect at least three samples during each discharge event, and samples shall be collected at shorter intervals at the onset of the event, if the permittee estimates that the event duration may be less than six hours. For purposes of reporting for a discharge event that occurs on multiple calendar days, the pollutant concentrations for the event shall be reported on the day the discharge event ended. The highest event averages for Fecal Coliform and TRC shall also be reported in the "Maximum" columns under "Quality and Concentration" on the monthly DMRs.

b. Retention Treatment Basin Dewatering

The retention treatment basin shall be promptly dewatered as in accordance with the Department Approved Consolidated Annual Report following the need to divert flow to the basin and shall be maintained in readiness for use. The discharge of sludge or residual accumulations from the basin to the surface waters is prohibited. These sludges shall be promptly removed and disposed in accordance with procedures approved by the Department.

For this permit while the Regional Operational Plan is being revised, if up to 930 MGD (including recycle) is being processed with secondary treatment at the WRRF and no primary flow is being discharged, then tributary combined or sanitary storage basins in the GLWA system may be dewatered. Such dewatering will not be considered a violation of this permit, even if contrary to the Wet Weather Event definition (see Part II.A.). Once a revised Regional Operation Plan is developed, it shall be implemented once reviewed and approved by the Department.

c. Narrative Standard

The receiving water shall contain no turbidity, color, oil films, floating solids, foams, settleable solids, or deposits as a result of this discharge in unnatural quantities which are or may become injurious to any designated use.

d. Operation and Maintenance Plan

The permittee shall assure that discharges only occur in response to rainfall (or snowmelt) events and cease soon thereafter. Any rehabilitation and maintenance needs shall be addressed to ensure adequate sewer capacity and functionality. This may be accomplished through continued implementation of the approved Operation and Maintenance Plan.

7. Combined Sewer Overflow Screening and Disinfection Facilities Discharge Authorization, Monitoring Points 105A, 106A and 107A

During the period beginning on the effective date of this permit and lasting until the expiration date of this permit, the permittees are authorized to discharge treated combined sewage from the Leib Combined Sewer Overflow (CSO) Screening and Disinfection Facility Monitoring Point 105A through Outfall 105, from the St. Aubin CSO Screening and Disinfection Facility Monitoring Point 106A through Outfall 106, and from the Baby Creek CSO Screening and Disinfection Facility Monitoring Point 107A through Outfall 107 when the wastewater flows exceed downstream interceptor capacities. Outfall 105 and Outfall 106 discharge to the Detroit River. Outfall 107 discharges to the Rouge River. Such discharges shall be limited and monitored by the permittees as specified below:

Effluent Characteristics	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration				Monitoring Frequency	Sample Type
	Monthly	7-Day	Daily	Units	Monthly	7-Day	Daily	Units		
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Carbonaceous Biochemical Oxygen Demand (CBOD ₅)	---	---	---	---	(report)	---	(report)	mg/l	Quarterly	Grab
Total Suspended Solids	---	---	---	---	(report)	---	(report)	mg/l	Quarterly	Grab
Ammonia Nitrogen (as N)	---	---	---	---	(report)	---	(report)	mg/l	Quarterly	Grab
Total Phosphorus (as P)	---	---	---	---	(report)	---	(report)	mg/l	Quarterly	Grab
Oil & Grease (Baby Creek CSO Screening & Disinfection Facility, only)	---	---	---	---	(report)	---	(report)	mg/l	Daily During Discharge	Grab
Event Maximum										
Fecal Coliform Bacteria										
May 1 – October 31	---	---	---	---	---	---	400	cts/100 ml	See I.A.7.a.	Grab
November 1 – April 30	---	---	---	---	---	---	1000	cts/100 ml	See I.A.7.a.	Grab
Event Average										
Total Residual Chlorine	---	---	---	---	(report)	---	(report)	mg/l	See I.A.7.a.	Grab
Any Event (see additional controls specified in Part 1.A.8.)										
Event Minimum										
pH	---	---	---	---	(report)	---	(report)	S.U.	Daily During Discharge	Grab
Dissolved Oxygen	---	---	---	---	(report)	---	---	mg/l	Daily During Discharge	Grab

- a. Screening and Disinfection Facilities Monitoring and Reporting
The permittees shall monitor screening and disinfection facilities performance and report the monitoring consistent with the requirements of Part II.C.2. of this permit. The permittees shall supply the results of each sample taken during each discharge period.

Effluent flow shall be reported for all events that cause discharge from the facility to the receiving waters.

For **effluent pH**, report the maximum value of any individual sample taken during the month in the "Maximum" column under "Quality or Concentration" on the monthly DMRs and the minimum value of any individual sample taken during the month in the "Minimum" column under "Quality or Concentration" on the monthly DMRs. The individual values taken during the month shall be reported on the daily DMRs.

For **effluent dissolved oxygen**, report the lowest concentration of any individual sample in the "Minimum" column under the "Quantity or Concentration" on the monthly DMRs. The individual values taken during the month shall be reported on the daily DMRs.

For **effluent Fecal Coliform Bacteria and Total Residual Chlorine**, grab samples shall be collected every two (2) hours for the first six (6) hours of the discharge and every four (4) hours thereafter for the duration of the discharge; the first sample shall be collected as soon as practical after the discharge begins. For fecal coliform, the "event maximum" shall be reported on the daily DMRs as the geometric mean of all samples taken during an event, provided that three (3) or more samples are collected. For TRC, report the average of all samples in an event as the "Event Average" and the maximum individual sample in an event as the "Event Maximum" on the daily DMRs. The goal of the effluent sampling program is to collect at least three samples during each discharge event, and samples shall be collected at shorter intervals at the onset of the event, if the permittees estimate that the event duration may be less than six hours. For purposes of reporting for a discharge event that occurs on multiple calendar days, the pollutant concentrations for the event shall be reported on the day the discharge event ended. The highest event averages for Fecal Coliform and TRC shall also be reported in the "Maximum" columns under "Quality and Concentration" on the monthly DMRs.

b. **Narrative Standard**

The receiving water shall contain no turbidity, color, oil films, floating solids, foams, settleable solids, or deposits as a result of this discharge in unnatural quantities which are or may become injurious to any designated use.

Consider for Leib screen evaluation

c. **Sampling Locations**

The sampling locations for the pollutants indicated in Part I.A.7 of this permit shall be representative of the effluent and consistent with the locations approved by the Department.

d. **Operation and Maintenance Plan**

The permittees shall assure that discharges only occur in response to rainfall (or snowmelt) events and cease soon thereafter. Any rehabilitation and maintenance needs shall be addressed to ensure adequate sewer capacity and functionality. This may be accomplished through continued implementation of the approved Operation and Maintenance Plan.

e. **Treatment Facility Dewatering**

The treatment facility shall be promptly dewatered (if applicable) in accordance with the Department Approved Consolidated Annual Report possible following the need to divert flow to the facility and shall be maintained in readiness for use. The discharge of sludge or residual accumulations from the facility to the surface waters is prohibited.

For this permit while the Regional Operational Plan is being revised, if up to 930 MGD (including recycle) is being processed with secondary treatment at the WRRF and no primary flow is being discharged, then tributary combined or sanitary storage basins in the GLWA system may be dewatered. Such dewatering will not be considered a violation of this permit, even if contrary to the Wet Weather Event definition (see Part II.A). Once a revised Regional Operation Plan is developed, it shall be implemented once reviewed and approved by the Department.

f. **Quarterly Monitoring**

Quarterly samples shall be taken during the months of January, April, July, and October. If the facility does not discharge during these months, the permittee shall sample the next discharge occurring during the period in question. If the facility does not discharge during the period in question, a sample is not required for that period. For any month in which a sample is not taken, the permittee shall enter "*G" on the Discharge Monitoring Report (DMR). (For purposes of reporting on the Daily tab of the DMR, the permittee shall enter "*G" on the first day of the month only).

8. Total Residual Chlorine Minimization Program

Section 8. Applies to all the CSO facilities

The goal of the Total Residual Chlorine (TRC) Minimization Program is operate the CSO RTBs and the CSO screening and disinfection facilities in a manner that will provide consistent, effective disinfection while minimizing the discharge of TRC, recognizing the overall goal is compliance with the TRC Final Acute Value of 0.038 mg/l at any point in the receiving stream, unless it is determined by the Department by a permit action that a higher level is acceptable.

In addition, the Operational Goals for this facility are 1.5 mg/l TRC as an event average value and 2.0 mg/l (November – April) or 3.0 mg/l (May – October) TRC as an event instantaneous maximum value.

- a. TRC Minimization Assessment (Assessment) (submitted)  These were completed by CDM Smith as a sub to METCO. (Oakwood was not included in the report)
- The permittees shall prepare and conduct a program to assess the capability of each of the 5 CSO RTBs and screening and disinfection facilities as agreed to (a subset of those listed in Part I.A.6. and Part I.A.7.), to minimize the discharge of TRC. Each Assessment shall be conducted according to a schedule acceptable to the Department. Compliance with the Fecal Coliform Bacteria effluent limits set forth in Part I.A.6. and Part I.A.7. of this permit shall be maintained during each Assessment. Each Assessment shall include an evaluation of various operational practices under a variety of wet weather events to identify measures which can be taken to reduce TRC discharge concentrations. Upon notification by the Department, the permittees shall begin conducting each Assessment over an 18-month period and shall submit a report summarizing the results to the Department within 60 days of completion. An extension of an Assessment period beyond 18 months may be requested by the permittees for approval by the Department in the event that a sufficient number of CSO discharge events have not occurred to allow for an adequate assessment of operational procedures.

Each Assessment report shall include the expected achievable TRC discharge concentrations, recommendations as to specific protocols to be used to manage sodium hypochlorite (NaOCl) dosage rates under various conditions to achieve the Operational Goals, and recommended facility modifications to enhance the ability to control TRC levels while maintaining compliance with the Fecal Coliform Bacteria limits. Specific procedures for adjustment of NaOCl feed rates to minimize the discharge of TRC shall be submitted as part of the Operational Plan (and revised as appropriate in annual updates), as required by Part I.A.15.e. of this permit. The TRC minimization procedures, developed as part of each Assessment, shall be implemented upon approval by the Department.

- b. Operational Goals
- Upon completion of each Assessment, the permittees shall operate the facility with a goal of 1.5 mg/l TRC as an event average value and a goal of 2.0 mg/l (November – April) or 3.0 mg/l (May – October) TRC as an event instantaneous maximum value. If upon completion of an Assessment, the permittees determine the facility can achieve lower TRC goals than those specified above, then the permittees shall operate the facility to achieve the lower TRC levels. If either TRC goal is exceeded for a CSO discharge event, the permittees shall submit a written report to the Department within seven (7) days explaining the cause of the exceedance and describing the corrective measures that will be undertaken to prevent a future recurrence.

- c. In-Stream TRC Effluent Plume Evaluation (submitted)  These were completed by CDM Smith as a sub to Hinshon Environmental Co. (preceded Ed Hogan, Wade Trim as .compliance consultant)
- The permittees shall conduct an evaluation of the in-stream TRC effluent plume attributable to each of the agreed-to 5 CSO RTBs screening and disinfection facility discharges. The evaluation shall identify the location and size of the TRC effluent plume during and after CSO discharge events and identify the maximum TRC concentrations in-stream at various downstream locations. Upon notification by the Department to begin conducting each Assessment (Part I.A.8.a.), the permittees shall have 60 days to submit a TRC effluent plume work plan describing the proposed evaluation including sampling locations and a proposed implementation schedule such that the In-Stream TRC Effluent Plume Evaluation shall occur after completion of each Assessment and when the operational goals begin. The permittees shall implement the In-Stream TRC Effluent Plume Evaluation following the schedule upon Department approval of the TRC effluent plume work plan. The permittees shall submit a report documenting the results of the TRC Effluent Plume Evaluation within 90 days after completion of the field work.

- d. Permit Re-Opener Clause
- Upon completion of each TRC Minimization Assessment and each In-Stream TRC Effluent Plume Evaluation, the Department may reevaluate the need for TRC effluent limitations. This permit may be

modified in accordance with applicable laws and rules to incorporate such revisions as may be necessary to comply with Water Quality Standards at the time of discharge.

- e. Best Management Practices/Operator Coordination Work Group (Work Group)
The permittees shall attend and participate in at least quarterly Work Group meetings with representatives from other CSO facilities in Southeast Michigan to exchange information and share experiences relating to the operation and maintenance of CSO control facilities. Such Work Group meetings shall be used to develop Best Management Practices (BMPs) relating to CSO RTB operation, with an initial focus on actions to minimize the TRC discharge levels. At a minimum, the Work Group shall include representatives of the following CSO facilities: Birmingham CSO RTB, Bloomfield Village CSO RTB, Dearborn CSO, GLWA WRRF CSO Facilities, Inkster-Dearborn Heights CSO, Oakland County-Acacia Park (Acacia Park CSO Drainage District, Village of Beverly Hills, City of Birmingham), Redford Township CSO, River Rouge CSO, Wayne County – Dearborn Heights CSO, Wayne County – Inkster CSO, Wayne County – Inkster – Dearborn Heights CSO, and Wayne County – Redford – Livonia CSO. The Work Group shall submit an annual report summarizing the meetings and BMPs developed to the Department by March 1st of each year.

9. Additional Monitoring Requirements This applies to WRRF Outfalls (Not CSOs)

As a condition of this permit, the permittees shall monitor the discharge from monitoring points 049F and 050A for the constituents identified below. This monitoring is an application requirement of 40 CFR 122.21(j), effective December 2, 1999. Testing shall be conducted in October 2019, May 2020, March 2021, and August 2021. Grab samples shall be collected for total phenols, and the Volatile Organic Compounds identified below. For all other parameters, 24-hour composite samples shall be collected.

Test species for whole effluent toxicity monitoring shall include fathead minnow **and** *Ceriodaphnia dubia*. If the permittees have received Department approval to conduct chronic toxicity testing using the more sensitive species identified in the toxicity database, the first three (3) tests required above may be performed using the more sensitive species. The last (4th) test shall be conducted using both species. Testing and reporting procedures shall follow procedures contained in EPA-821-R-02-013, "Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (Fourth Edition). When the effluent ammonia nitrogen (as N) concentration is greater than 3 mg/l, the pH of the toxicity test shall be maintained at a pH of 8 Standard Units. Acute and chronic toxicity data shall be included in the reporting for the toxicity test results. Toxicity test data acceptability is contingent upon the validation of the test method by the testing laboratory. Such validation shall be submitted to the Department upon request.

For selected parameters required under this section, the maximum acceptable quantification levels and analytical methods shall be as specified under Quantification Levels and Analytical Methods for Selected Parameters, below, unless a higher quantification level is appropriate because of sample matrix interference. Justification for higher quantification levels shall be submitted to the Department within 30 days of such determination.

The results of such additional monitoring shall be submitted with the application for reissuance (see the cover page of this permit for the application due date). The permittees shall notify the Department within 14 days of completing the monitoring for each month specified above in accordance with Part II.C.5. Additional reporting requirements are specified in Part II.C.11. The permittees shall report to the Department any whole effluent toxicity test results greater than 1.0 TU_A or 1.0 TU_C within five (5) days of becoming aware of the result. If, upon review of the analysis, it is determined that additional requirements are needed to protect the receiving waters in accordance with applicable water quality standards, the permit may then be modified by the Department in accordance with applicable laws and rules.

Whole Effluent Toxicity
chronic toxicity

Hardness
calcium carbonate

Metals (Total Recoverable), Cyanide and Total Phenols

antimony	arsenic	barium	
beryllium	boron	cadmium	chromium
copper	lead	nickel	
selenium	silver	thallium	zinc
total phenolic compounds			

Volatile Organic Compounds

acrolein	acrylonitrile	benzene	bromoform
carbon tetrachloride	chlorobenzene	chlorodibromomethane	chloroethane
2-chloroethylvinyl ether	chloroform	dichlorobromomethane	1,1-dichloroethane
1,2-dichloroethane	trans-1,2-dichloroethylene	1,1-dichloroethylene	1,2-dichloropropane
1,3-dichloropropylene	ethylbenzene	methyl bromide	methyl chloride
methylene chloride	1,1,2,2,-tetrachloroethane	tetrachloroethylene	toluene
1,1,1-trichloroethane	1,1,2-trichloroethane	trichloroethylene	vinyl chloride

Acid-Extractable Compounds

4-chloro-3-methylphenol	2-chlorophenol	2,4-dichlorophenol	2,4-dimethylphenol
4,6-dinitro-o-cresol	2,4-dinitrophenol	2-nitrophenol	4-nitrophenol
Pentachlorophenol	phenol	2,4,6-trichlorophenol	

Base/Neutral Compounds

acenaphthene	acenaphthylene	anthracene	benzidine
benzo(a)anthracene	benzo(a)pyrene	3,4-benzofluoranthene	benzo(ghi)perylene
benzo(k)fluoranthene	bis(2-chloroethoxy)methane	bis(2-chloroethyl)ether	bis(2-chloroisopropyl)ether
bis(2-ethylhexyl)phthalate	4-bromophenyl phenyl ether	butyl benzyl phthalate	2-chloronaphthalene
4-chlorophenyl phenyl ether	chrysene	di-n-butyl phthalate	di-n-octyl phthalate
dibenzo(a,h)anthracene	1,2-dichlorobenzene	1,3-dichlorobenzene	1,4-dichlorobenzene
3,3'-dichlorobenzidine	diethyl phthalate	dimethyl phthalate	2,4-dinitrotoluene
2,6-dinitrotoluene	1,2-diphenylhydrazine	fluoranthene	fluorene
Hexachlorobenzene	hexachlorobutadiene	hexachlorocyclo-pentadiene	hexachloroethane
indeno(1,2,3-cd)pyrene	isophorone	naphthalene	nitrobenzene
n-nitrosodi-n-propylamine	n-nitrosodimethylamine	n-nitrosodiphenylamine	phenanthrene
pyrene	1,2,4-trichlorobenzene		

Quantification Levels and Analytical Methods for Selected Parameters

Parameter	Quantification Level	Analytical Method
1,2-Diphenylhydrazine (as Azobenzene)	3.0 ug/l	
2,4,6-Trichlorophenol	5.0 ug/l	
2,4-Dinitrophenol	19 ug/l	
3,3'-Dichlorobenzidine	1.5 ug/l	EPA Method 605
4-chloro-3-methylphenol	7.0 ug/l	
4,4'-DDD	0.05 ug/l	EPA Method 608
4,4'-DDE	0.01 ug/l	EPA Method 608
4,4'-DDT	0.01 ug/l	EPA Method 608
Acrylonitrile	1.0 ug/l	
Aldrin	0.01 ug/l	EPA Method 608
Alpha-Hexachlorocyclohexane	0.01 ug/l	EPA Method 608
Antimony, Total	1 ug/l	
Arsenic, Total	1 ug/l	
Barium, Total	5 ug/l	
Benzidine	0.1 ug/l	EPA Method 605
Beryllium, Total	1 ug/l	
Beta-Hexachlorocyclohexane	0.01 ug/l	EPA Method 608

Parameter	Quantification Level		Analytical Method
Bis (2-Chloroethyl) Ether	1.0	ug/l	
Boron, Total	20	ug/l	
Cadmium, Total	0.2	ug/l	
Chlordane	0.01	ug/l	EPA Method 608
Chromium, Hexavalent	5	ug/l	
Chromium, Total	10	ug/l	
Copper, Total	1	ug/l	
Cyanide, Available	2	ug/l	EPA Method OIA 1677
Cyanide, Total	5	ug/l	
Delta-Hexachlorocyclohexane	0.01	ug/l	EPA Method 608
Dieldrin	0.01	ug/l	EPA Method 608
Di-N-Butyl Phthalate	9.0	ug/l	
Endosulfan I	0.01	ug/l	EPA Method 608
Endosulfan II	0.01	ug/l	EPA Method 608
Endosulfan Sulfate	0.01	ug/l	EPA Method 608
Endrin	0.01	ug/l	EPA Method 608
Endrin Aldehyde	0.01	ug/l	EPA Method 608
Fluoranthene	1.0	ug/l	
Heptachlor	0.01	ug/l	EPA Method 608
Heptachlor Epoxide	0.01	ug/l	EPA Method 608
Hexachlorobenzene	0.01	ug/l	EPA Method 612
Hexachlorobutadiene	0.01	ug/l	EPA Method 612
Hexachlorocyclopentadiene	0.01	ug/l	EPA Method 612
Hexachloroethane	5.0	ug/l	
Lead, Total	1	ug/l	
Lindane	0.01	ug/l	EPA Method 608
Lithium, Total	10	ug/l	
Mercury, Total	0.5	ng/l	EPA Method 1631E
Nickel, Total	5	ug/l	
PCB-1016	0.1	ug/l	EPA Method 608.3
PCB-1221	0.1	ug/l	EPA Method 608.3
PCB-1232	0.1	ug/l	EPA Method 608.3
PCB-1242	0.1	ug/l	EPA Method 608.3
PCB-1248	0.1	ug/l	EPA Method 608.3
PCB-1254	0.1	ug/l	EPA Method 608.3
PCB-1260	0.1	ug/l	EPA Method 608.3
Pentachlorophenol	1.8	ug/l	
Perfluorooctane sulfonate (PFOS)	2.0	ng/l	ASTM D7979 or an isotope dilution method (sometimes referred to as Method 537 modified)
Perfluorooctanoic acid (PFOA)	2.0	ng/l	ASTM D7979 or an isotope dilution method (sometimes referred to as Method 537 modified)
Phenanthrene	1.0	ug/l	
Selenium, Total	1.0	ug/l	

Parameter	Quantification Level	Analytical Method
Silver, Total	0.5 ug/l	
Strontium, Total	1000 ug/l	
Sulfide, Dissolved	20 ug/l	
Thallium, Total	1 ug/l	
Toxaphene	0.1 ug/l	EPA Method 608
Vinyl Chloride	0.25 ug/l	
Zinc, Total	10 ug/l	

10. Pollutant Minimization Program for Total Mercury and PCBs

The goal of the Pollutant Minimization Program is to maintain the effluent concentration of total mercury at or below 1.3 ng/l and the final effluent limitations for Total Polychlorinated Biphenyls (PCBs). The permittees shall continue to implement the Pollutant Minimization Program approved on November 9, 1995, and updated in October, 1996, and modifications thereto, to proceed toward the goal. The Pollutant Minimization Program includes the following:

- an annual review and semi-annual monitoring of potential sources of mercury and PCBs entering the wastewater collection system, including wet weather sources such as runoff/contributions from contaminated sites in the collection area;
- a program for quarterly monitoring of influent and periodic monitoring of sludge for mercury and PCBs; and
- implementation of reasonable cost-effective control measures when sources of mercury and/or PCBs are discovered. Factors to be considered include significance of sources, economic considerations, and technical and treatability considerations.

On or before October 1st of each year, the permittees shall submit a status report for the previous calendar year to the Department that includes 1) the monitoring results for the previous year, 2) an updated list of potential mercury and/or PCB sources, and 3) a summary of all actions taken to reduce or eliminate identified sources of mercury and/or PCBs.

Any information generated as a result of the Pollutant Minimization Program set forth in this permit may be used to support a request to modify the approved program or to demonstrate that the Pollutant Minimization Program requirement has been completed satisfactorily.

A request for modification of the approved program and supporting documentation shall be submitted in writing to the Department for review and approval. The Department may approve modifications to the approved program (approval of a program modification does not require a permit modification), including a reduction in the frequency of the requirements under items a. and b.

This permit may be modified in accordance with applicable laws and rules to include additional mercury and/or PCB conditions and/or limitations as necessary.

11. Water Resource Recovery Facility Wet Weather Operational Plan

The approved Water Resource Recovery Facility Wet Weather Operational Plan provides the protocol for operations during the interim period before full completion of the Long-term CSO Control Plan. This plan details the necessary requirements to maximize wet weather treatment at the WRRF, while complying with effluent limits and all other conditions of this permit, and minimizing untreated combined sewage discharges in the tributary collection system.

The GLWA WRRF Wet Weather Operational Plan shall be coordinated with the Collection System and CSO Treatment Facilities Operational Plan that is required in accordance with Part I.A.15.d. of this permit. Annually, on or before April 1st, the permittees shall submit an update of the Water Resource Recovery Facility Wet Weather Operational Plan in conjunction with the Collection System and CSO Treatment Facilities Operational Plan update as part of the Consolidated Annual Report to the Department for review and approval.

12. Facilities Improvement Program

The permittees shall continue to meet the sludge dewatering, conveyance, and final disposal requirements; submit and implement the solids disposal plans; correct the alum sludge issue; submit the WRRF shutdown schedules; and develop and implement the asset management program as detailed below.

a. WRRF Solids Processing Requirements and Corrections

- 1) Capacity for sludge dewatering, conveyance, and final disposal; Required maximum solids inventory loads.

The permittees shall ensure that sludge dewatering equipment, sludge conveyance equipment, and final sludge disposal capability is available at the GLWA WRRF as follows:

- a) The permittees shall ensure that the WRRF sludge dewatering equipment, sludge conveyance equipment, and final sludge disposal capability are maintained for use; and in good operational working order to meet the following requirements:
- (1) Average capacity of 500 dry tons per day (dtpd), calculated as a calendar monthly average;
 - (2) Peak capacity of 850 dtpd, calculated as a 10-day average;
 - (3) The peak 10-day average shall be available during any wet weather event when the WRRF is operated in the "Storm Period" of the currently approved WRRF Wet Weather Operational Plan as required by Part I.A.11.

The permittees shall also:

- (4) Notify the Department within one business day if solids are recycled from the gravity thickeners to the head of the WRRF for more than 72 hours and provide an explanation for the recycled solids. Recycled solids are defined as a TSS overflow concentration of 1000 mg/l or greater from Complex A thickeners;
- (5) Maintain a monthly average solids inventory of less than 750 dtpd, when there are less than 5 days of discharge from Outfall 049A during the month, and maintain a calendar quarterly average solids inventory not to exceed 1000 dtpd. Solids inventory is defined as the total solids in gravity thickener complexes A and B, determined daily in dtpd;
- (6) This Section will be reviewed during the next NPDES reissuance based on WRRF performance; and
- (7) The permittees are allowed to submit to the Department for review and approval a request to modify the numerical levels specified in Part I.A.12.a. of this permit. This modification request shall include supporting rationale for the revised numerical levels.

2) Long-Term Solids Disposal Plan

- a) The permittees submitted to the Department for review and approval a Long-Term Solids Disposal Plan (LTSDP). This Solids Disposal Plan is designed to ensure the availability of sufficient sludge dewatering equipment and sludge disposal capability to meet the capacity requirements specified in Parts I.A.12.a.1).a).(1)&(2) of this permit. The permittees shall implement the LTSDP in accordance with the following schedule:

- (1) On or before December 31, 2018, (submitted) the permittees shall submit for approval, a disposal plan for 250 dtpd. This requirement is based on the LTSDP approved on September 24, 2013. Upon notification from the Department, the permittees shall implement the approved disposal plan;
- (2) On or before December 31, 2025, the permittees shall complete implementation of the approved plan referenced in item (1) above;

- b) The GLWA are advised that implementation of individual elements of the LTSDP may require Part 41 wastewater construction permits or may require other Department approvals.

3) Alum Sludge Correction

The permittees shall continue to implement the approved plan to correct the solids dewatering concerns at the WRRF due to alum sludge discharges from GLWA water treatment plants (WTPs) into the collection system.

Annually, on or before September 1st the permittees shall submit a report to the Department describing if the implemented plan continued to meet the conditions specified above for the preceding fiscal year (July 1 – June 30).

Part 41 construction permits at the WRRF and/or Act 399 construction permits at the specific WTPs may be needed depending on the components of the approved plan.

b. WRRF Quarterly Shutdown Schedules

On or before December 1, March 1, June 1, and September 1, the permittees shall submit quarterly WRRF Shutdown Schedules, until notified in writing by the Department. Consistent with the quarterly dates indicated above, these schedules shall be submitted to the Department in a mutually agreeable format one month prior to the start of each calendar quarter for review and approval. Each quarterly schedule shall detail the primary treatment capacity, secondary treatment capacity, and sludge processing capacity that is planned to be available during the upcoming quarter, considering coordinated shutdowns necessary to complete all rehabilitation and other projects. The shutdown schedules shall be proposed to minimize environmental impact and maximize available treatment during construction of all projects, consistent with the requirements of the rules associated with Act 451, Part 41, being 299.2943 and 299.2955(1) and (3).

c. Operation, Maintenance & Replacement/Asset Management

The permittees shall at all times properly operate and maintain all facilities (i.e., sewer system, treatment works, as defined in Part 41 of Act 451, 1994 as amended, and control systems) that are installed or used by the permittees to operate the treatment works and sewer system and achieve and maintain compliance with the conditions of this permit. The requirements of an asset management program contain goals of effective performance, adequate funding, and adequate operator staffing and training. Asset management is a planning process focused on gaining optimum value for each asset and providing the financial resources to rehabilitate and replace them when necessary; Asset management is centered on a framework of five (5) core elements: the current state of the assets, the required sustainable level of service, the assets critical to sustained performance, the best-value life-cycle costs, and the best long-term funding strategy.

- 1) The permittees shall continue to implement the approved Asset Management Program that addresses the following items:

- A comprehensive fixed asset inventory that is maintained, managed, and updated within a computerized maintenance management system (CMMS),

- A comprehensive inventory of the collection system fixed assets and collection system map,
- A Preventive Maintenance Program that may include predictive and reliability centered maintenance,
- A Needs Assessment updated every five years as part of the Project Plan (due on or before October 1, 2021), including condition assessment and evaluation of service level,
- An assessment of asset criticality and risk management,
- A capital planning process,
- A Scheduled Replacement Program (SRP) for assets,
- Monitoring and periodic performance evaluation through Key Performance Indicators (KPIs),
- Management oversight of system performance.

The permittees' Asset Management Program submitted on January 1, 2014, was approved on January 14, 2014, and substantially revised on September 29, 2017.

2) An Annual Report covering implementation of the Asset Management Program during the prior Fiscal Year (July 1 – June 30) shall be prepared by the permittees and submitted to the Department on or before October 1st. The Annual Report shall include:

- a) A description and evaluation of the sufficiency of the staffing levels maintained during the year,
- b) A description and evaluation of the sufficiency and adequacy of inspections and maintenance activities conducted and corrective actions taken during the previous year,
- c) Expenditures for collection system maintenance activities, treatment works maintenance activities, corrective actions, and capital investment during the previous year, compared with budgeted/projected expenditures, including an evaluation of the sufficiency of expenditures,
- d) A summary of asset/areas identified for inspection/action (including capital improvement) in the upcoming year based on the five (5) core elements and the criticality and risk analysis,
- e) A maintenance budget and capital improvement budget for the upcoming year, based on implementation of an effective asset management program that meets the five (5) core elements,
- f) An updated estimate of the revenue necessary to complete anticipated OM&R activities, the associated rate schedule impact, and an assessment of the adequacy of the revenue to perform necessary OM&R work, and
- g) A description of the progress made towards completion of the outstanding tasks as described in the previous year's Asset Management Annual Report and an updated schedule for completion of any outstanding tasks.

d. Staffing Plan

A Staffing Plan, as required by ACO-00131, has been approved by the Department. The GLWA shall provide an adequate staffing level, in accordance with the approved Staffing Plan, to carry out the operation, maintenance, repair, and testing functions required to ensure compliance with the terms and conditions of this permit. During the term of ACO-00131, a change in the minimum staffing level may be requested by the GLWA by submittal of a revised Staffing Plan, including training requirements, and may be revised only by mutual agreement in writing between the GLWA and the Department. Should ACO-00131 be terminated, then the staffing plan shall be updated as required by the Operations and Maintenance Manual (Part II.C.14 of this permit), and an up to date copy of the manual shall be kept at the WRRF. The Department may review the manual in whole or in part (i.e. staffing) at their discretion and require modifications to it if portions are determined to be inadequate.

- e. Key Performance Indicator Monthly Report
The permittee shall update the Key Performance Indicator (KPI) report monthly. If Administrative Consent Order No. ACO-000131, as amended, is terminated, the KPI report shall be submitted by the last day of the month following the termination of the ACO.
- f. Public Participation
The permittees will participate in Department initiated public outreach meetings during the term of this permit as resources allow and provided there is adequate notification by the Department.

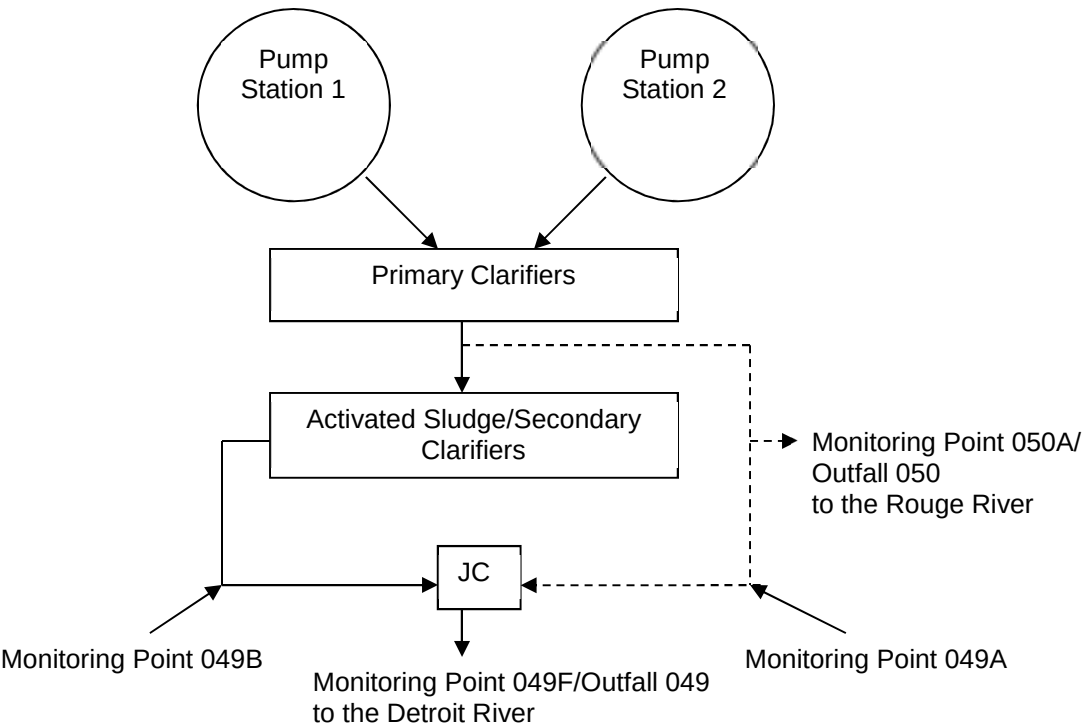
13. Reopener for Primary and Secondary Treatment Capacity

The permittees are required to maintain a wet weather primary treatment capacity of 1700 MGD (raw) and wet weather secondary treatment capacity of 930 MGD (which includes recycle). When the elevation of the influent wet well is greater than 85 feet and the facility is not pumping at 1700 MGD (raw), the discharge from untreated combined sewage overflow (CSO) upstream of the facility are not authorized, unless caused by localized storm conditions.

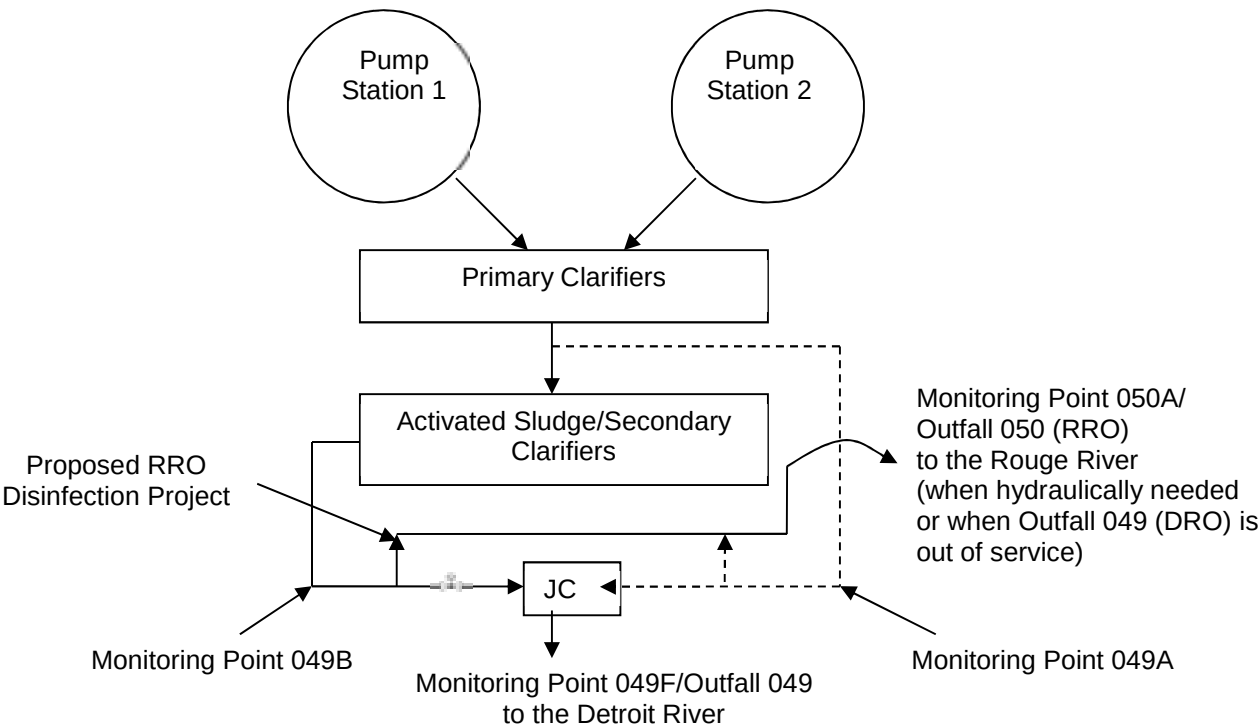
These required wet weather treatment capacities may be revised if new/altered wet weather conditions (such as initiation of operation of upstream CSO facilities, etc.) indicate that either less or more flow can be effectively processed. The criteria used to determine whether the required wet weather primary treatment capacities should be revised must include additional plant evaluation under the updated conditions, using testing procedures approved by the Department.

For reference, outfall/monitoring point designations are shown on the following diagrams:

Prior to Initiation of Operation of RRO Disinfection Project



After Initiation of Operation of RRO Disinfection Project



14. Outfalls Prohibited from Discharge to Combined Sewer System

The following Outfalls are prohibited from discharge except as provided for in Part II.C.9.:

<u>OUTFALL</u>	<u>LOCATION</u>	<u>LAT/LONG</u>	<u>RECEIVING STREAM</u>
004	Fairview (DWF) Pump Station (P28 through P31) Parkview & Detroit River - Emergency only	42°21'20" 082°58'01"	Discharge to Detroit River (Stop-logged)
014	Dubois (B12) Dubois & Detroit River	42°20'01" 083°01'19"	Detroit River
051	Carbon (B46) Carbon & Rouge River	42°17'07" 083°08'17"	Rouge River
054	Fort St. (DWSD Northwest) Interceptor) (B50) South Fort St. & Rouge River (West Shore)	42°17'25" 083°08'35"	Rouge River
056	Fort St. (Oakwood District) (B49) South Fort St. & Rouge River (West Shore)	42°17'27" 083°08'33"	Rouge River
080	Fox Creek Backwater Gates (B01) East Jefferson & Fox Creek.	42°22'28" 082°56'27"	Fox Creek to Detroit River

The permittees shall provide for ongoing monitoring (Flow, Duration) for these outfalls should they discharge. This monitoring shall be used to comply with the requirements of Section 324.3112(a) of The Michigan Act (See Part I.A.16.).

15. Discharges from Combined Sewer System

a. Limited Discharge Authorization

The permittees are required to utilize, to the maximum extent practicable, available sewerage system transportation capabilities for the delivery of combined sewage to treatment facilities. For an interim period during which the amended Long-Term CSO Control Plan is to be implemented, the permittees are authorized to discharge during wet weather events (see Part II.A.) combined sewage from the outfalls and locations listed below in accordance with the following conditions:

- 1) a flow rate equivalent to the peak dry weather flow rate has been conveyed to the secondary treatment facilities for treatment without bypass,
- 2) the total sewerage system storage and transportation capacity for conveyance of wet weather flows to the treatment facilities for treatment has been utilized within the hydraulic design constraints of the system,
- 3) all primary treatment plant capacity and secondary treatment plant capacity has been utilized in accordance with the approved WRRF Wet Weather Operation Plan (Part 1.A.11.), unless a storm event is localized to the extent that the hydraulic capacity of a portion of the collection system (considering storage) is exceeded prior to reaching plant capacities, and
- 4) the permittees are in full compliance with all requirements as set forth in Part I.A.16. Combined Sewer Overflow discharges to the Rouge River, the Detroit River, and the Old Channel of the Rouge River are authorized until prohibited, eliminated, or adequately treated to meet water quality standards at times of discharge in accordance with the requirements below, and as specified in Part 1.A.15.f. and g.
- 5) the outfalls that immediately follow this paragraph are included in the Limited Discharge Authorization. There are some untreated CSO outfalls that appear to discharge only during extreme events. Extreme is defined as; (a) no more than one untreated discharge in ten years from a CSO outfall during the April 1 through October 31 growth period, (b) modeled to not discharge at the 25 year – 24 hour event (during growth period, with normal soil moisture, rainfall distributed to a SCS Type II distribution), or (c) monitored to occur only at rainfalls greater than 4 inches in a 24 hour period. The Department does not intend to require construction of treatment facilities at the following outfalls should they continue to only discharge at the extreme event. This addresses CSO outfalls consistently with SSO outfalls according to the 2002 SSO Policy and 2003 Clarification Statement. The list of untreated CSO outfalls that only discharge at the extreme event is flexible and may be adjusted with the adaptive management CSO correction program.

<u>OUTFALL</u>	<u>LOCATION</u>	<u>LAT/LONG</u>	<u>RECEIVING STREAM</u>
029	Rosa Parks (B27) Rosa Parks & Detroit River	42°19'13" 083°03'56"	Detroit River
030	Vermont (B28) Vermont (extended) & Detroit River	42°19'06" 083°04'09"	Detroit River
037	McKinstry (B35) McKinstry & Detroit River	42°18'19" 083°05'13"	Detroit River
042	Campbell (B40) Campbell & Detroit River	42°18'01" 083°05'30"	Detroit River
048	Pulaski (B59A &B) Pulaski & Rouge River	42°17'21" 083°07'11"	Old Channel Rouge River

6) the outfalls that immediately follow this paragraph are also included in the Limited Discharge Authorization. There are some untreated CSOs that appear to discharge at a minimal frequency and volume. Minimal discharge is defined as actual monitoring of a volume less than 0.3 MG of discharge over a five year period. The Department does not intend to require construction of treatment facilities at the following outfalls should they continue to only discharge at this minimal frequency and volume. The list of untreated CSO outfalls that only discharge at a minimal frequency and volume is flexible and may be adjusted with the adaptive management CSO correction program.

<u>OUTFALL</u>	<u>LOCATION</u>	<u>LAT/LONG</u>	<u>RECEIVING STREAM</u>
024	Griswold (B22) Griswold & Detroit River	42°19'35" 083°02'28"	Detroit River
032	Twenty-First St. (B30) Twenty-First St. & Detroit River	42°18'53" 083°04'31"	Detroit River
034	West Grand Blvd. (B32) West Grand Blvd. & Detroit River	42°18'41" 083°04'50"	Detroit River
035	Swain (B33) Swain & Detroit River	42°18'35" 083°04'56"	Detroit River
036	Scotten (B34) Scotten & Detroit River	42°18'31" 083°05'02"	Detroit River
041	Junction (B39) Junction & Detroit River	42°18'07" 083°05'25"	Detroit River
043	Dragoon (Livernois Relief) (B41) Dragoon (extended) & Detroit River	42°17'49" 083°05'41"	Detroit River
047	Dearborn St. (B45) Dearborn St. & Rouge River	42°17'26" 083°06'59"	Old Channel Rouge River
073	Riverdale (B79) Florence & Rouge River	42°24'36" 083°16'13"	Rouge River

7) the outfalls that immediately follow this paragraph are also included in the Limited Discharge Authorization. These are untreated CSOs that represent the remaining non-core outfalls that will be required to be addressed under the adaptive management CSO correction program. They include the high-priority non-core CSOs. Note that the list of untreated CSO outfalls is flexible and may be adjusted with the adaptive management CSO correction program.

<u>OUTFALL</u>	<u>LOCATION</u>	<u>LAT/LONG</u>	<u>RECEIVING STREAM</u>
005	McClellan (B03) McClellan (extended) & Detroit River	42°21'20" 082°58'02"	Detroit River
006	Fischer (B04) Fischer & Detroit River	42°21'16" 082°59'15"	Detroit River
007	Iroquois (B05) Iroquois & Detroit River	42°21'14" 082°59'21"	Detroit River
008	Helen (B06) Helen & Detroit River	42°20'40" 083°00'06"	Detroit River
009	Mt. Elliott (B07) Mt. Elliott & Detroit River	42°20'24" 083°00'28"	Detroit River
011	Adair (B09) Adair & Detroit River	42°20'16" 083°00'41"	Detroit River
012	Joseph Campau (B10) Joseph Campau & Detroit River	42°10'08" 083°01'02"	Detroit River
016	Orleans Relief (B15) Orleans (Eastside of) & Detroit River	42°19'54" 083°01'36"	Detroit River
017	Orleans (B14) Orleans (Westside of) & Detroit River	42°19'53" 083°01'37"	Detroit River
018	Riopelle (B16) Riopelle & Detroit River	42°19'52" 083°01'42"	Detroit River
019	Rivard (B17) Rivard & Detroit River	42°19'48" 083°01'55"	Detroit River
020	Hastings (B18) Schweizer Place & Detroit River	42°19'46" 083°02'03"	Detroit River
021	Randolph (B19) Randolph & Detroit River	42°19'29" 083°02'26"	Detroit River
022	Bates (B20) Bates & Detroit River	42°19'38" 083°02'32"	Detroit River
023	Woodward (B21) Woodward & Detroit River	42°19'37" 083°02'35"	Detroit River
025	First-Hamilton (B23) First (extended) & Detroit River	42°19'30" 083°02'57"	Detroit River
026	Third St. (B24) Third St. & Detroit River	42°19'28" 083°03'07"	Detroit River

<u>OUTFALL</u>	<u>LOCATION</u>	<u>LAT/LONG</u>	<u>RECEIVING STREAM</u>
027	Cabacier (B25) Brooklyn (extended) & Detroit River	42°19'24" 083°03'26"	Detroit River
028	Eleventh St. (B26) Eleventh St. & Detroit River	42°19'17" 083°03'46"	Detroit River
031	Eighteenth St. (B29) Eighteenth St. & Detroit River	42°18'57" 083°04'31"	Detroit River
033	Twenty-Fourth St. (B31) Twenty-Fourth St. & Detroit River	42°18'47" 083°04'42"	Detroit River
038	Summit-Clark (B36) Summit & Detroit River	42°18'14" 083°05'18"	Detroit River
039	Ferdinand (B37) Ferdinand & Detroit River	42°18'13" 083°05'19"	Detroit River
040	Morrell (B38) Morrell & Detroit River	42°18'10" 083°05'22"	Detroit River
044	Schroeder (B42) Schroeder & West Jefferson	42°17'32" 083°06'00"	Detroit River
046	Cary (B44) Cary & Rouge River	42°17'29" 083°06'47"	Old Channel Rouge River
059	Warren (B54) West Warren & Rouge River	42°20'34" 083°14'57"	Rouge River
060	Tireman (B56, 57 & 58) Tireman & Rouge River	42°20'59" 083°14'51"	Rouge River
061	West Chicago (B60, 61 & 62) West Chicago & Rouge River (East Shore)	42°21'46" 083°14'56"	Rouge River
062	West Chicago (B63) West Chicago & Rouge River (West Shore)	42°21'52" 083°15'18"	Rouge River
063	Plymouth (B64) Plymouth & Rouge River	42°22'18" 083°15'21"	Rouge River
064	Glendale Relief (B65) Rouge Park Golf Course	42°22'33" 083°14'52"	Rouge River
065	Lahser (Dolson) (B67 & 68) Lahser & Rouge River	42°22'52" 083°15'23"	Rouge River
066	Schoolcraft (B70) Jeffries Freeway, I-96 & Rouge River	42°23'07" 083°16'02"	Rouge River

<u>OUTFALL</u>	<u>LOCATION</u>	<u>LAT/LONG</u>	<u>RECEIVING STREAM</u>
067	West Parkway (B69) Jeffries Freeway, I-96 & Rouge River	42°23'07" 083°16'02"	Rouge River
068	Brammel (B71) Ray & Rouge River	42°23'30" 083°15'56"	Rouge River
069	Lyndon (B72) Lyndon & Rouge River	42°23'35" 083°15'57"	Rouge River
072	Puritan (B77) Puritan & Rouge River (East Shore)	42°24'28" 083°16'14"	Rouge River
074	McNichols (B80 & 81) West McNichols & Rouge River	42°24'52" 083°15'59"	Rouge River
075	Glenhurst (B82) Glenhurst & Rouge River	42°25'32" 083°16'19"	Rouge River
077	Seven Mile (B85) West Seven Mile & Rouge River (East Shore)	42°25'44" 083°16'09"	Rouge River
079	Pembroke (B87) Frisbee & East Shore Rouge River	42°26'02" 083°16'24"	Rouge River

Nothing in this section of the permit shall be construed to limit the State of Michigan's ability to pursue remedies under the Michigan Act.

- b. **Qualified Operations and Maintenance Manager for CSO Discharges**
The permittees shall place the wastewater collection system under the supervision of a qualified Operations and Maintenance Manager who shall serve as the contact person for the Department regarding combined sewer discharges. The permittees may replace the manager at any time and shall notify the Department within ten days after the replacement.
- c. **Disconnection of Eaves Troughs and Roof Downspouts**
The permittees shall eliminate direct connections of eaves troughs and roof downspouts to the sewer system throughout the service area tributary to the Upper Rouge CSO outfalls (Outfalls 059-069, 072-075, 077, and 079). This requirement shall be completed for residential property and commercial and industrial properties or as approved by the Department consistent with the permittees' implementation of the Green Storm Water Infrastructure program. In addition, the permittees shall eliminate direct connections of eave troughs and roof downspouts in the service areas tributary to the CSO RTBs, to the CSO Screening & Disinfection Facilities, and to the remaining untreated CSOs based upon the plan detailed in the revised Long-term Control Program. This requirement does not apply if the permittees demonstrates that the disconnection of eaves troughs and roof downspouts is not a cost-effective means of reducing the frequency or duration of combined sewer overflows or of maintaining compliance with this permit. Such a demonstration and supporting documentation shall be submitted to the Department for approval.
- d. **Collection System and CSO Treatment Facilities Operational Plan**
The permittees shall continue implementation of the approved Collection System and CSO Treatment Facilities Operational Plan (Operational Plan). The implementation of the Operational Plan shall be coordinated with the WRRF Wet Weather Operational Plan that is required for development and implementation in accordance with Part I.A.11. of this permit.

On or before April 1 (annually), the permittees shall submit a revised Operational Plan for Department review and approval, which incorporates all changes made to the plan during the last calendar year (items 1-12 below), and supplies the annual discharge documentation (item 13 below). Any changes to the Operational Plan that affect the rate, volume, or characteristics of the discharge, or the system

storage and transportation for conveyance of wet weather flows, shall be submitted to the Department and approved prior to implementation. The operational plan shall define the hydraulic design constraints of the system during both dry and wet weather operation.

The plan shall include:

- 1) the procedures utilized at the permittees' CSO RTBs and Screening & Disinfection Facilities for adjustment of NaOCl disinfectant feed rates to minimize the discharge of total residual chlorine,
- 2) the procedures and schedule for sampling/monitoring the stored NaOCl disinfectant at the permittees' CSO RTBs and Screening & Disinfection Facilities to determine the concentration of available chlorine and assure that the stored NaOCl is of sufficient strength to provide effective disinfection,
- 3) the procedures for sampling/monitoring the available chlorine concentration of each load of NaOCl delivered to the permittees' CSO RTBs and Screening & Disinfection Facilities,
- 4) if applicable, the procedures utilized at the permittees' CSO RTBs and Screening & Disinfection Facilities for adjustment of dehalogenating reagent feed rates to minimize the discharge of excess reagent,
- 5) the procedures to ensure that the collection and treatment systems are operated to maximize treatment,
- 6) the procedures to ensure that all dry weather flows are conveyed to the treatment facilities for treatment without bypass,
- 7) the hydraulic profile and hydraulic operational elevations for system pump stations, regulators, diversion devices, gates, level sensors, interceptors, etc., to ensure the conveyance of all dry weather flows to the treatment facilities for treatment without bypass,
- 8) the procedures to ensure that the sewerage system hydraulic and storage capacity is identified and fully utilized during wet weather events with eventual treatment of stored flows,
- 9) the procedures to ensure that the greatest quantity of wet weather flow is conveyed to the treatment facilities for treatment to minimize untreated wastewater discharges within the region tributary to the GLWA WRRF,
- 10) the hydraulic profile and hydraulic operational elevations for system pump stations, regulators, diversion devices, gates, level sensors, interceptors, etc., to ensure that the greatest quantity of wet weather flow is conveyed to the treatment facilities for treatment to minimize combined sewage discharges,
- 11) the procedures for ongoing inspection of the sewer system within the permittees' jurisdiction for excessive inflow and infiltration and, where necessary, reduction of the excessive infiltration and inflow sources, and the elimination of unauthorized sewer system connections, and
- 12) identification of the location of the rain gauges.
- 13) The permittees shall submit annual reports that supply the documentation of rainfall and the frequency, duration, and volume of all discharge events during the previous 12-month period (from January 1st through December 31st of the previous year).

The permittees shall continue to pursue the coordination of operational plans (Regional Operational Plan) with tributary communities with the intent of maximizing flow conveyance to the GLWA system and minimizing regional CSOs. Once the Regional Operational Plan is approved by the Department, it shall be implemented.

e. New Wastewater Flows

Increased levels of discharge of sanitary sewage from the combined sewer overflow outfalls listed in Part I.A.15.a. of this permit, the CSO RTBs (see Part I.A.6. of this permit), and the CSO Screening and Disinfection Facilities (see Part I.A.7. of this permit) are prohibited unless:

- 1) the increased discharges are the result of new sanitary wastewater flows which, on the basis of sound professional judgment, are within design peak dry weather transportation capacity, or
- 2) the permittees have officially adopted and are timely implementing a definite program, satisfactory to the Department, leading to the construction and operation of necessary collection, transportation, or treatment devices.

f. CSO Control Projects This is related to uncontrolled CSO Outfalls and not pertinent to the CSO treatment facilities.1) Pertinent CSO Program History

The permittees are continuing to implement CSO Control Programs for the various CSO outfalls that discharge to the Rouge River and the Detroit River. Depending upon the particular CSO Control Program and outfall, the permittees are required to provide for the prohibition, elimination, or adequate treatment of combined sewage discharges containing raw sewage, to comply with the Water Quality Standards at times of discharge.

For the CSO outfalls discharging to the Rouge River, the development and implementation of the CSO Control Programs for the various outfalls was initially established based upon the goals of the Rouge River Remedial Action Plan (RAP), which called for a phased approach to solving the water quality problems of the river. Phase I of the Rouge River RAP extended to 1993 and included 1) monitoring and optimization of the existing combined sewer system, 2) detailed local planning for CSO controls and 3) resolution of financing and institutional problems. Phase II of the Rouge River RAP extended to 2005 (2012 for a few limited outfalls) and called for facility construction based on the goal of protection of public health through the elimination of raw sewage discharges and the control of toxic pollutants. Phase III of the Rouge River RAP follows completion of Phase II facilities and includes further improvements, if necessary, to comply with water quality standards at the time of discharge. Due to the demonstrated financial capability of the permittees for City of Detroit residents in 2009, 2012 and 2017, the CSO Control Program for the CSOs discharging to the Rouge River has been revised as reflected below.

For the CSO outfalls discharging to the Detroit River and the Old Channel of the Rouge River, Department approval of the CSO Control Programs is determined on a case-by-case basis with considerations for environmental impacts, public health impacts, technical feasibility, and economic affordability. As was the case for the Rouge River program, the demonstrated financial capability of the permittees for City of Detroit residents in 2009, 2012 and 2017 also affected the CSO Control Program for the Detroit River and the Old Channel of the Rouge River, and has been revised as reflected below.

In addition, the CSO Control Program now includes significant Green Storm water Infrastructure (GSI) requirements that are an important component of the approved Long-Term CSO Control Program.

Previous Long-Term CSO Control Program Documents include:

- Original Long-Term CSO Control Plan (1996)
- Long-Term CSO Control Plan Update (2002)
- Amendment Rouge (2008)
- Amendment Detroit (2008)
- Evaluation of CSO Control Alternative (for the Upper Rouge Outfalls) (December 15, 2009)

- Supplemental Report on Alternative CSO Controls for the Upper Rouge Outfalls) (April 30, 2010)

The implementation and completion of the CSO Control Program indicated in Part I.A.15.f. and g. are a necessary and essential requirement of this permit.

2) CSO Correction Program Moving Forward

The permittees shall control remaining combined sewer discharges, that are not classified as either extreme or minimal (see Part 1.A.15.a.5) & 6)), to eliminate the discharges or provide adequate treatment of the combined sewage discharges to comply with Water Quality Standards at times of discharge. Upon completion of the RRO disinfection project at the GLWA WRRF and commencing final use of Outfall 050A, the permittees will have completed core elements of their CSO control program and will have achieved a very high level of CSO control. It has been determined that this core level of control has routinely achieved adequate treatment of 95% of the annual combined sewer volume to the collection system. While additional CSO control measures are needed to fully comply with Michigan's Water Quality Standards, as the permittees moves into the final phases of the CSO control program it is appropriate to plan and schedule the remaining control measures, taking into account what has been put in place to date and lessons learned, the unique technical and financial situation of the city of Detroit, and the nature of the remaining CSO challenges.

Based on the foregoing, the permittees shall proceed with remaining CSO corrections using an adaptive management approach. This means that as new information is gained from: (1) evaluation of existing CSO projects and new treatment technologies, (2) evaluation of real-time collection system controls, (3) more accurate and complete data on CSO discharge frequency and volume, (4) benefits of less flow to the collection system from green storm water infrastructure (GSI), (5) benefits of less flow to the collection system due to the City's drainage charge program and new storm water ordinance, (6) benefits of less flow to the collection system as the City continues its sewer rehabilitation program, and (7) any other pertinent information, future CSO controls can be adapted to best provide cost-effective elimination of discharges, adequate treatment of discharges, or classification of discharges as minimal or extreme. Note that for purposes of designing CSO correction projects, minimal discharge is defined as less than 0.3 MG of discharge over a five year period, and extreme is defined as; (a) no more than one untreated discharge in ten years from a CSO outfall during the April 1 through October 31 growth period, (b) modeled to not discharge at the 25 year – 24 hour event (during growth period, with normal soil moisture, rainfall distributed to a SCS Type II distribution), or (c) monitored to occur only at rainfalls greater than 4 inches in a 24 hour period. The performance standard can be based on actual monitoring data normalized for a typical and representative 10-year period of rainfall record or predictively determined based on a calibrated and verified continuous model using a typical and representative 10-year period of rainfall record or other method as determined acceptable by the Department.

The permittees shall propose the non-core CSO correction projects to be designed, constructed, and operated to provide CSO elimination or adequate treatment during the subsequent five-year permit cycle, with each permit reapplication beginning in April 2022. High priority non-core outfalls should generally be addressed first, and outfalls thought of as high priority can change at any time due to implementation of the adaptive management approach. City of Detroit residents within the DWSD service area are "high burden" status based on sewer fees paid as a percentage of median annual household income. Planning of CSO control measures may reflect the permittees' financial capacity for City of Detroit residents determined in the Financial Capability Evaluation that is submitted with each permit reapplication. Based on current and projected CSO capital revenue requirements, and the current average cost per Detroit household for wastewater treatment and CSO control as a percentage of Detroit median household income, the Department does not expect the permittees to propose non-core CSO correction projects with this permit. The permittees shall next propose non-core CSO correction projects for review and approval with the permit reapplication required by April 4, 2022 (and then on April 4, 2027, and April 4, 2032). However, this first tier of non-core projects during 2023 through 2027 is expected to be relatively low cost. Discussion between the permittees and the Department have determined that low cost projects can include connection of CSO discharges to existing CSO treatment facilities, limited storage projects based on the performance standard with no disinfection, outfall gates and in-system storage projects, increased regulator flow capacity, separation projects that use smaller sanitary pipes in existing larger combined sewers to carry sanitary sewage to

GLWA interceptors while the existing combined sewer becomes a storm sewer, and others. At each application submittal in 2022, 2027, and 2032, the project proposal shall include an updated Financial Capability Evaluation that may also include other financial factors as appropriate. Reissued permits will then be drafted and issued with schedules for approved CSO correction projects that provide continuing progress toward meeting water quality standards. The permittees shall prepare an evaluation of Financial Capability, consistent with state and federal guidance, and shall submit the evaluation with the applications for reissuance of this permit (see the cover page of this permit for the next application due date). The Financial Capability Report shall be in the form of previous reports utilizing the EPA Financial Capability Guidance Document (USEPA 832-B-97-004; February, 1997), and updated with information as may be available in order to assess the permittees' ability to undertake future capital improvement projects related to the Long-Term CSO Control Program. This permit may be modified in accordance with applicable law and rules to incorporate revisions to conform to pertinent laws or rules, or as necessary to address prevailing situations.

Based on information currently available, the following are lists by water body that are high priority CSOs that require control. These outfalls can be revised at any time by the permittees or the Department, reflecting adaptive management considerations. While either the permittees or Department can propose changes at any time, an agreement between the two parties is required and shall be made in writing. The goal will be to complete projects fully addressing all high priority outfalls before October 1, 2037.

Rouge River non-core CSOs (these can be changed by mutual agreement between the permittees and the Department)

High Priority Outfalls
059, 061, 064, 065, 074

Detroit River non-core CSOs (these can be changed by mutual agreement between the permittees and the Department)

High Priority Outfalls
005, 007, 009, 012, 022, 025, 031, 038

3) Adaptive Management Program for this Permit

The adaptive management approach for this permit, before beginning relatively low cost CSO correction projects from 2023-2027, looks at the (1) evaluation of existing CSO projects and new treatment technologies, (2) evaluation of real-time collection system controls, (3) more accurate and complete data on CSO discharge frequency and volume, (4) benefits of less flow to the collection system from green storm water infrastructure (GSI), (5) benefits of less flow to the collection system due to the City's drainage charge program and new storm water ordinance, (6) benefits of less flow to the collection system as the City continues its sewer rehabilitation program, and (7) any other pertinent information. The permittees shall use the above measures, as appropriate, to further reduce untreated CSO discharges on an ongoing basis from the collection system before starting CSO projects from 2023 - 2037.

On or before April 1st (annually starting in 2020), the permittees shall prepare a joint Progress Report that summarizes; 1) significant real time controls that occurred during the preceding calendar year, 2) GSI implementation work during the preceding year that has been undertaken and completed, including a work plan for GSI implementation projects for the next year, documentation of the annual expenditure for the preceding year, and documentation of a cumulative total-spent-to-date on the GSI program, 3) benefits from the new storm water ordinance and green credit program, and 4) benefits from the City sewer rehabilitation program. The report shall summarize the total benefits from all programs by including; a) an updated estimate of the annual volume of wet weather flow that has been removed from the combined sewer system, b) the resulting frequency, volume and duration of CSO discharges (based on actual monitoring), and c) the predicted change modeled continuously and at design events to frequency, volume and duration of CSO discharges based on the calibrated hydraulic model developed in the Master Plan effort. The report shall reference the CSO discharge report submitted under Part I.A.15.d.(13) of this permit and include the pertinent data as a reference. As part of this reporting process, it shall be documented that an average of \$3 million dollars per fiscal year was spent for 2018

and 2019, and \$2 million dollars per year for 2020, 2021, and 2022 for the GSI program (these expenditures are an enforceable requirement of this permit).

A more complete description of the adaptive management approach includes:

a) Real-time Control

The GLWA is in the process of determining if real-time control can be used to help further minimize or even eliminate some untreated CSO discharges. One real-time control discussion currently taking place is the Interim Wet Weather Operations Plan (IWOP). The operational changes agreed to between the permittees and the Department in the IWOP will be reported in the Operational Plan Annual Update (Part 1.A.15 d.). The IWOP is evaluating if critical system regulators, gates, pumps, etc., can be adjusted to allow for more treated CSO, and less untreated CSO from the remaining CSO outfalls. Approved adjustments will be at least acceptable until completion of all non-core CSO correction projects and shall be included in Operational Plan Annual Updates. The evaluation shall include all necessary supporting documentation, including hydraulic model runs if appropriate.

b) Green Storm Water Infrastructure (GSI)

For the west side of the City, there is a GSI program in the tributary area to Rouge River Outfalls 059-069, 072-075, 077, and 079. DWSD has developed and is implementing a Department approved GSI Plan for this area consistent with the "Evaluation of CSO Control Alternatives" report dated December 15, 2009. The GSI Plan describes a process for locating, designing, constructing, operating, and evaluating GSI in these sewersheds. GSI implementation shall be planned to capture, reduce, or otherwise control wet weather flows that would otherwise flow into the sewer system and contribute to CSOs, at the permittees' direction. The Plan includes the following elements:

- (1) Provisions for disconnection of residential downspouts and disconnection of commercial and industrial downspouts where feasible (see Part I.A.15.c.).
- (2) Provisions for demolition and removal of vacant structures and replacement with pervious land cover. Where demolition is planned and implemented at sites that will be re-purposed for GSI, the demolition specifications shall ensure that basements and other impervious surfaces at the sites are removed, that the site is raked to remove large rocks and construction debris, and that engineered soils consisting of an appropriate mix of topsoil, compost, and sand is applied following the demolition to support plant growth and promote infiltration.
- (3) Provisions for installation of bioswales along roadways and parking lots to intercept runoff and reduce storm water inputs to the combined sewer system from impervious surfaces.
- (4) Provisions for installation of GSI and/or BMPs at commercial and residential properties to capture and retard storm water runoff.
- (5) Provisions for tree planting for uptake and evapotranspiration along roadways and open spaces.
- (6) Provisions for other GSI implementation projects as determined to be appropriate.
- (8) Processes for public outreach and public participation in selecting sites and implementing GSI practices.
- (9) Procedures/methods for tracking GSI implementation and measuring effects.
- (10) Provisions for ensuring appropriate maintenance of sites where GSI has been implemented, including roles and schedules for maintenance.
- (11) Provisions for ensuring storm water management (runoff reduction) benefits associated with GSI implementation continue over time, even as redevelopment may occur in the sewersheds.

The permittees shall continue to implement GSI in these sewersheds. The investment in GSI in these sewersheds shall be an average of 3 million dollars per fiscal year for the ten-year period ending 2019

(for a total of \$30 million), and an average of 2 million dollars per year for the following 10 years (for a total of \$20 million). GSI implementation will be in accordance with the GSI Plan.

For the near-east side of the City, there has been another GSI program in the tributary area to Detroit River Outfalls 005 - 009, 011, and 012. Because of the potential for some larger-scale green projects due to a relatively large amount of vacant land in the area, it may be possible to eliminate or reduce the size of some previously envisioned CSO treatment facilities for this area using the combination of GSI implementation along with possible sewer separation, and other engineering solutions. With GSI implementation now spreading across the city, it is acceptable for the city to use one-third (1/3) of the total GSI expenditures on projects upstream of untreated CSOs other than Rouge River Outfalls 059-069, 072-075, 077, and 079.

c) Storm Water Control

1) On or before April 1, 2018, (submitted) the permittees shall submit to the Department for review and approval a storm water control requirement for areas of new development and/or redevelopment. This storm water control requirement is primarily a focus within the Rouge Sewer District and Central Sewer District, as it is these two Districts that have untreated CSOs. Therefore, the permittees shall propose a level of storm water control for new development and redevelopment in these two sewer districts, and for the circumstances stated above, that is designed to help further reduce the volume and frequency of untreated CSO discharges, and a procedure and schedule for implementing this control requirement.

2) Storm water runoff from new development and redevelopment that will be conveyed through storm sewers to DWSD's combined sewers will require control to help further reduce volume and frequency of untreated CSO discharges. These are projects that will require construction plan review by the permittees, and a Part 41 construction permit issued by the Department. Please note that in most cases, new combined sewers will no longer be permitted under Part 41 (except for combined sewer relocation projects). Note that this is not a requirement for storm sewers subject to Permit No. MIS040000 issued to the City of Detroit, as the storm sewers under MIS040000 discharge directly to surface waters and are not owned by the DWSD.

d) City Sewer Rehabilitation

DWSD is currently working on a more robust annual program to remove infiltration/inflow (I/I) from its combined collection system. It is the Department's understanding that this program has a budget of about \$20 million per year.

g. Combined Sewer Overflow Control Program Schedule

1) West-side Model; Rouge River Outfalls 059-069, Outfalls 072-075, Outfall 077, and Outfall 079. For untreated combined sewer overflows from Outfalls 059-069, Outfalls 072-075, Outfall 077, and Outfall 079, the permittees shall determine the accurate frequency and volume of untreated CSO discharges and amend the "Supplemental Report on Alternative CSO Controls for the Upper Rouge River," dated April 30, 2010 according to the following schedule:

- a) The work plan has been approved by the Department that (1) sets forth the monitoring of the 17 CSOs that will be accomplished to accurately determine the frequency and volume of these untreated CSO discharges, (2) uses this monitoring along with the current Ovation monitoring as appropriate in a calibrated and verified model to accurately detail the volume and frequency of the 17 CSOs during a representative and typical 10-year period of rainfall record, and (3) to determine the peak hour flow at the 10 yr – 1 hr event of each of the 17 CSOs. The permittees shall continue to implement the approved work plan.
- b) On or before April 15, 2019, (submitted) the permittees shall submit a report to the Department for review and approval that summarizes the determination and provides the volume and frequency of these 17 CSOs over a representative and typical 10-year period of rainfall record and provides the peak hour flow at the 10 yr – 1 hr event for each of these 17 CSOs;

- c) On or before November 15, 2022, the permittees shall submit an amendment for Department review and approval to the "Supplemental Report on Alternative CSO Controls for the Upper Rouge River" (dated April 30, 2010) that describes any changes to the recommended long-term CSO control projects for the 17 CSOs. This plan may propose an alternative to the use of 10 minutes of detention at the 10 year – 1 hour event, at the permittees' discretion;
- 2) Near eastside; Detroit River Outfalls 005-009, 011, and 012. The permittees shall develop a revised CSO Control Plan for this tributary area in accordance with the following schedule:

On or before November 15, 2022, the permittees shall submit to the Department for review and approval an update to their Long-term CSO Control program (Detroit update 2008) for providing elimination or adequate treatment of CSO Outfalls 005-009, Outfall 011, and Outfall 012 to meet water quality standards at times of discharge. This plan shall consider the GI recommendations and potential for storm water reduction from the completed 205(j) report for this area. This plan may propose an alternative control requirement for the Long-term CSO control program.
- 3) The permittees may choose to offer an entire updated Long-term CSO Control program for all Detroit River CSOs. This updated plan can include a totally revised Detroit update (2008) for all remaining CSOs. Note that CSOs can be prohibited, eliminated, or adequately treated to meet water quality standards at times of discharge. If the permittees decide to pursue this approach, then the revised plan is due on or before November 15, 2022, for Department review and approval.

Following implementation of any phase of any of the approved Control Programs contained in Part I.A.15.f. and g. of this permit, the Control Program(s) may be reevaluated by the permittees or the Department. Future permits may include requirements to conduct water quality evaluations designed to verify that the overall CSO control program is providing adequate treatment to meet water quality standards. This permit may be modified in accordance with applicable laws and rules, to incorporate revisions necessary to conform to pertinent rules or laws, or as necessary to address prevailing situations, such as technical or financial constraints.

h. Notification and Testing Requirements

The federal rule promulgated by the United States Environmental Protection Agency in 40 CFR Part 122 establishing the public notification requirements for CSO discharges to the Great Lakes basin took effect February 7, 2018.

On or before August 7, 2018, (submitted) the permittees shall submit to the Department for approval, a public notification plan in accordance with 40 CFR 122.38(c). Additionally, on or before April 4, 2022, with the application for reissuance, the permittees shall submit to the Department for approval, an updated public notification plan.

Beginning November 7, 2018, all permittees authorized to discharge untreated or treated CSO to the Great Lakes Basin must provide public notification of CSO discharges in accordance with 40 CFR 122.38(a) and the approved public notification plan. The requirements include but are not limited to the following: notification of the local public health department, other potentially affected public entities and the public; and signage, where feasible at discharge points and other potentially impacted public access areas. In addition, in accordance with Section 324.3112a of the NREPA, the permittees shall provide notification to a newspaper of general circulation in the county in which the discharge occurred or is occurring. To the extent that a conflict may arise between Part I.A.15.h. and Part I.A.16., the Department approved Public Notification Plan shall govern.

16. Untreated or Partially Treated Sewage Discharge Reporting and Testing Requirements

In accordance with Section 324.3112a of the NREPA, if untreated or partially treated sewage is directly or indirectly discharged from a sewer system onto land or into the waters of the state, the entity responsible for the sewer system shall immediately, but not more than 24 hours after the discharge begins, notify, by telephone, the Department, local health departments, a daily newspaper of general circulation in the county in which the permittees are located, and a daily newspaper of general circulation in the county or counties in which the municipalities whose waters may be affected by the discharge are located that the discharge is occurring.

The permittees shall also annually contact municipalities, including the superintendent of a public drinking water supply with potentially affected intakes, whose waters may be affected by the permittees' discharge of untreated or partially treated sewage, and, if those municipalities wish to be notified in the same manner as specified above, the permittees shall provide such notification. Such notification shall also include a daily newspaper in the county of the affected municipality.

At the conclusion of the discharge, written notification shall be submitted in accordance with and on the "Report of Discharge Form" available via the internet at: <http://www.deq.state.mi.us/csosso/>, or, alternatively for combined sewer overflow discharges, in accordance with notification procedures approved by the Department.

In addition, in accordance with Section 324.3112a of the NREPA, each time a discharge of untreated or partially treated sewage occurs, the permittees shall test the affected waters for *Escherichia coli* to assess the risk to the public health as a result of the discharge and shall provide the test results to the affected local county health departments and to the Department. The testing shall be done at locations specified by each affected local county health department but shall not exceed ten (10) tests for each separate discharge event. The affected local county health department may waive this testing requirement, if it determines that such testing is not needed to assess the risk to the public health as a result of the discharge event. The results of this testing shall be submitted with the written notification required above, or, if the results are not yet available, submitted as soon as they become available. This testing is not required, if the testing has been waived by the local health department, or if the discharge(s) did not affect surface waters.

Permittees accepting sanitary or municipal sewage from other sewage collection systems are encouraged to notify the owners of those systems of the above reporting and testing requirements.

17. Pollutant Minimization and Source Evaluation Program for Perfluorooctane Sulfonate (PFOS) and/or Perfluorooctanoic Acid (PFOA)

The goal of the Pollutant Minimization and Source Evaluation Program is to identify and address sources of perfluorooctane sulfonate (PFOS) and/or perfluorooctanoic acid (PFOA) and to reduce and maintain the effluent concentrations of PFOS and/or PFOA at or below the water quality standards (WQS) and/or the Water Quality-Based Effluent limit (WQBEL). The WQS is 11 ng/L for PFOS and the WQBEL for PFOA is 8.04 ug/l.

On or before October 1, 2019, the permittee shall submit an approvable Pollutant Minimization and Source Evaluation Program for PFOS and/or PFOA to proceed toward the goal. The Pollutant Minimization and Source Evaluation Program shall continue work under the IPP Interim Initiative and shall include the following at a minimum:

- a. Identification of and strategies to identify any additional potential and probable PFOS and/or PFOA sources
- b. Monitoring plan for the permitted facility's influent and effluent and effluent from potential sources
- c. Implemented measures thus far to eliminate, reduce, and/or control sources, and an assessment of the degree of success and the strategies used to measure success
- d. Proposed measures and implementation schedules for elimination, control, and/or reduction of the identified sources (prioritizing highest loadings and concentrations), and the strategies that will be used to measure success

The Pollutant Minimization and Source Evaluation Program shall be implemented upon approval by the Department.

On or before May 1 of each year following Pollutant Minimization and Source Evaluation Program implementation, the permittee shall submit to the Department a status report for the previous calendar year. Upon written notification by the Department, the permittee may be required to submit more frequent status reports. Status reports at a minimum shall include:

- a. Complete listing of PFOS and/or PFOA sources
- b. Summary of influent and effluent monitoring data
- c. Summary of monitoring data from known or potential sources
- d. History and compliance status for sources
- e. Implemented measures to eliminate, reduce, or control sources, (prioritizing highest loadings and concentrations), and an assessment of the degree of success and the strategies used to measure success
- f. Proposed measures and schedules for elimination, control, or reduction of any newly identified PFOS and/or PFOA sources (prioritizing highest loadings and concentrations), and the strategies that will be used to measure success
- g. Barriers to implementation and revisions to the implementation schedule
- h. Laboratory reports, if not previously supplied

Any information generated as a result of the Pollutant Minimization and Source Evaluation Program set forth in this permit may be used to support a request to modify the Pollutant Minimization and Source Evaluation Program or to demonstrate that the requirement has been completed satisfactorily.

A request for modification of the approved Pollutant Minimization and Source Evaluation Program shall be submitted in writing to the Department along with supporting documentation for review and approval. The Department may approve modifications to the approved Pollutant Minimization and Source Evaluation Program, including a reduction in the frequency of the influent and known or potential source monitoring requirements. Approval of a Pollutant Minimization and Source Evaluation Program modification does not require a permit modification.

This permit may be modified in accordance with applicable laws and rules to include additional PFOS and/or PFOA conditions and/or limitations as necessary.

18. Collection System Contingency Plan

An emergency condition at the WRRF might occur that requires reduced (or even no) influent flows to the WRRF. Under Rule 299.2959 of Part 41, the permittee is required to minimize discharge of excessive pollutants. On or before July 1, 2020, the permittee shall submit to the Department for review and approval, a report that documents how the collection system and WRRF would be operated if an emergency condition required reduced influent flow (or no flow) to the WRRF to minimize discharge of excessive pollutants per Rule 299.2959 of Part 41 of PA 451. This could involve in-system storage of flows, use of Retention Treatment Basins for storage and potentially treated discharge, rerouting of flow, use of portions of the WRRF as appropriate, etc. The report shall evaluate operation of the collection system and WRRF, considering at least two hypothetical conditions with no influent flow to the WRRF; a duration of six (6) hours of no influent flow, and a duration of 24 hours of no influent flow.

19. Facility Contact

The "Facility Contact" was specified in the application. The permittees may replace the facility contact at any time, and shall notify the Department in writing within 10 days after replacement (including the name, address and telephone number of the new facility contact).

- a. The facility contact shall be (or a duly authorized representative of this person):
 - for a corporation, a principal executive officer of at least the level of vice president; or a designated representative if the representative is responsible for the overall operation of the facility from which the discharge originates, as described in the permit application or other NPDES form,
 - for a partnership, a general partner,
 - for a sole proprietorship, the proprietor, or
 - for a municipal, state, or other public facility, either a principal executive officer, the mayor, village president, city or village manager or other duly authorized employee.
- b. A person is a duly authorized representative only if:
 - the authorization is made in writing to the Department by a person described in paragraph a. of this section; and
 - the authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the facility (a duly authorized representative may thus be either a named individual or any individual occupying a named position).

Nothing in this section obviates the permittees from properly submitting reports and forms as required by law.

20. Monthly Operating Reports

Part 41 of Act 451 of 1994 as amended, specifically Section 324.4106 and associated R 299.2953, requires that the permittees file with the Department, on forms prescribed by the Department, operating reports showing the effectiveness of the treatment facility operation and the quantity and quality of liquid wastes discharged into waters of the state.

Within thirty (30) days of the effective date of this permit, the permittees shall submit to the Department a revised treatment facility monitoring program to address monitoring requirement changes reflected in this permit, or submit justification explaining why monitoring requirement changes reflected in this permit do not necessitate revisions to the treatment facility monitoring program. The permittees shall implement the revised treatment facility monitoring program upon approval from the Department. Applicable forms and guidance are available on the Department's web site at http://www.michigan.gov/deq/0,1607,7-135-3313_44117---,00.html. The permittees may use alternate forms if they are consistent with the approved treatment facility monitoring program. Unless the Department provides written notification to the permittees that monthly submittal of operating reports is required, operating reports that result from implementation of the approved treatment facility monitoring program shall be maintained on site for a minimum of three (3) years and shall be made available to the Department for review upon request.

21. Discharge Monitoring Report – Quality Assurance Study Program

The permittees shall participate in the Discharge Monitoring Report – Quality Assurance (DMR-QA) Study Program. The purpose of the DMR-QA Study Program is to annually evaluate the proficiency of all in-house and/or contract laboratory(ies) that perform, on behalf of the facility authorized to discharge under this permit, the analytical testing required under this permit. In accordance with Section 308 of the Clean Water Act (33 U.S.C. § 1318); and R 323.2138 and R 323.2154 of Part 21, Wastewater Discharge Permits, promulgated under Part 31 of the NREPA, participation in the DMR-QA Study Program is required for all major facilities, and for minor facilities selected for participation by the Department.

Annually and in accordance with DMR-QA Study Program requirements and submittal due dates, the permittees shall submit to the Michigan DMR-QA Study Program state coordinator all documentation required by the DMR-QA Study. DMR-QA Study Program participation is required only for the analytes required under this permit and only when those analytes are also identified in the DMR-QA Study.

If the permitted facility's status as a major facility should change, participation in the DMR-QA Study Program may be reevaluated. Questions concerning participation in the DMR-QA Study Program should be directed to the Michigan DMR-QA Study Program state coordinator.

All forms and instructions required for participation in the DMR-QA Study Program, including submittal due dates and state coordinator contact information, can be found at <http://www.epa.gov/compliance/discharge-monitoring-report-quality-assurance-study-program>.

Section B. Storm Water Pollution Prevention

This section is not required.

PART I**Section C. Industrial Waste Pretreatment Program****1. Federal Industrial Pretreatment Program**

- a. The permittees shall implement the Federal Industrial Pretreatment Program approved on June 26, 1997, and any subsequent modifications approved up to the issuance of this permit. Approval of substantial program modifications after the issuance of this permit shall be incorporated into this permit by minor modification in accordance with 40 CFR 122.63.
- b. The permittees shall comply with R 323.2301 through R 323.2317 of the Michigan Administrative Code (Part 23 Rules), the General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR Part 403), and the approved Federal Industrial Pretreatment Program.
- c. The permittees shall have the legal authority and necessary interjurisdictional agreements that provide the basis for the implementation and enforcement of the approved Federal Industrial Pretreatment Program throughout the service area. The legal authority and necessary interjurisdictional agreements shall include, at a minimum, the authority to carry out the activities specified in R 323.2306(a).
- d. The permittees shall develop procedures which describe, in sufficient detail, program commitments which enable implementation of the approved Federal Industrial Pretreatment Program, 40 CFR Part 403, and the Part 23 Rules in accordance with R 323.2306(c).
- e. The permittees shall establish an interjurisdictional agreement (or comparable document) with all tributary governmental jurisdictions. Each interjurisdictional agreement shall contain, at a minimum, the following:
 - 1) identification of the agency responsible for the implementation and enforcement of the approved Federal Industrial Pretreatment Program within the tributary governmental jurisdiction's boundaries; and
 - 2) the provision of the legal authority which provides the basis for the implementation and enforcement of the approved Federal Industrial Pretreatment Program within the tributary governmental jurisdiction's boundaries.
- f. The permittees shall prohibit discharges that:
 - 1) cause, in whole or in part, the permittees, failure to comply with any condition of this permit or the NREPA;
 - 2) restrict, in whole or in part, the permittee's management of biosolids;
 - 3) cause, in whole or in part, operational problems at the treatment facility or in its collection system;
 - 4) violate any of the general or specific prohibitions identified in R 323.2303(1) and (2);
 - 5) violate categorical standards identified in R 323.2311; and
 - 6) violate local limits established in accordance with R 323.2303(4).
- g. The permittees shall maintain a list of its nondomestic users that meet the criteria of a significant industrial user as identified in R 323.2302(cc).
- h. The permittees shall develop an enforcement response plan which describes, in sufficient detail, program commitments which will enable the enforcement of the approved Federal Industrial Pretreatment Program, 40 CFR Part 403, and the Part 23 Rules in accordance with R 323.2306(g).

- i. The Department may require modifications to the approved Federal Industrial Pretreatment Program which are necessary to ensure compliance with 40 CFR Part 403 and the Part 23 Rules in accordance with R 323.2309.
- j. The permittees shall not implement changes or modifications to the approved Federal Industrial Pretreatment Program without notification to the Department. Any substantial modification shall be subject to Department public noticing and approval in accordance with R 323.2309.
- k. The permittees shall maintain an adequate revenue structure and staffing level for effective implementation of the approved Federal Industrial Pretreatment Program.
- l. The permittees shall develop and maintain, for a minimum of three (3) years, all records and information necessary to determine nondomestic user compliance with 40 CFR Part 403, Part 23 Rules and the approved Federal Industrial Pretreatment Program. This period of retention shall be extended during the course of any unresolved enforcement action or litigation regarding a nondomestic user or when requested by the Department or the United States Environmental Protection Agency. All of the aforementioned records and information shall be made available upon request for inspection and copying by the Department and the United States Environmental Protection Agency.
- m. The permittees shall evaluate the approved Federal Industrial Pretreatment Program for compliance with the 40 CFR Part 403, Part 23 Rules and the prohibitions stated in item f. (above). Based upon this evaluation, the permittees shall propose to the Department all necessary changes or modifications to the approved Federal Industrial Pretreatment Program no later than the next Industrial Pretreatment Program Annual Report due date (see item o. below).
- n. The permittees shall develop and enforce local limits to implement the prohibitions listed in item f above. Local limits shall be based upon data representative of actual conditions demonstrated in a maximum allowable headworks loading analysis. An evaluation of whether the existing local limits need to be revised shall be submitted to the Department by June 1, 2021. The submittal shall provide a technical evaluation of the basis upon which this determination was made which includes information regarding the maximum allowable headworks loading, collection system protection criteria, and worker health and safety, based upon data collected since the last local limits review.

The following pollutants shall be evaluated:

- 1) Arsenic, Cadmium, Chromium, Copper, Cyanide, Lead, Mercury, Nickel, Silver, and Zinc;
 - 2) Pollutants that are subject to limits or monitoring in this permit;
 - 3) Pollutants that have an existing local limit; and,
 - 4) Other pollutants of concern which would reasonably be expected to be discharged or transported by truck or rail or otherwise introduced into the POTW.
- o. On or before April 1 of each year, the permittees shall submit to the Department, as required by R 323.2310(8), an Industrial Pretreatment Program Annual Report on the status of program implementation and enforcement activities. The reporting period shall begin on January 1 and end on December 31. At a minimum, the Industrial Pretreatment Program Annual Report shall include:
- 1) the Pretreatment Program Report data identified in Appendix A to 40 CFR part 127 – NPDES Electronic Reporting;
 - 2) a summary of changes to the approved IPP that have not been previously reported to the Department;

- 3) a summary of results of all the sampling and analyses performed of the WRRF's influent, effluent, and biosolids conducted in accordance with approved methods during the reporting period. The summary shall include the monthly average, daily maximum, quantification level, and number of samples analyzed for each pollutant. At a minimum, the results of analyses for all locally limited parameters for at least one monitoring event that tests influent, effluent and biosolids during the reporting period shall be submitted with each report, unless otherwise required by the Department. Sample collection shall be at intervals sufficient to provide pollutant removal rates, unless the pollutant is not measurable; and;
 - 4) any other relevant information requested by the Department.
- p. The permittee is required under this permit and R 323.2303(4) of the Michigan Administrative Code to review and update their local limits when:
- 1) New pollutants are introduced.
 - 2) New pollutants that were previously unevaluated are identified
 - 3) New water quality or biosolids standards are established or additional information becomes available about the nature of pollutants, such as removal rates and accumulation in biosolids. Substantial increases of pollutants are proposed as required in the notification of new or increased uses in accordance with the provisions of 40 CFR 122.42.

2. Schedule for Notification to Contributing Jurisdictions

On or before May 1st and November 1st of each year, the permittees shall submit to the Department a report demonstrating the efforts and progress toward achieving the requirement of having all contributing jurisdictions adopt a legal authority that is equivalent to or more restrictive than the permittees', including the revised local limits to be incorporated by the permittees as result of the requirements of Part I.C.2. of this permit. This legal authority includes the provisions of Ordinance 08-05 (Detroit City Code Chapter 56, Article III. Division 3) and subsequent revisions to the local limits. These progress reports shall be submitted every six months until the requirement is achieved. The biannual progress reports shall contain:

- a. a listing of all contributing jurisdictions,
- b. the status of each contributing jurisdiction's adoption of adequate legal authority, and
- c. for contributing jurisdictions who have not yet adopted adequate legal authority, a description of the steps/actions the permittees have taken to assure progress toward the contributing jurisdiction's adoption of adequate legal authority.

The permittees shall, to the best of its ability, work with those contributing jurisdictions who did not adopt adequate legal authority by January 1, 2008, to obtain such legal authority.

PART I**Section D. Residuals Management Program****1. Residuals Management Program for Land Application of Biosolids**

The permittees are authorized to land-apply bulk biosolids or prepare bulk biosolids for land application in accordance with the permittees' approved Residuals Management Program (RMP) approved on April 22, 2008, and approved modifications thereto, in accordance with the requirements established in R 323.2401 through R 323.2418 of the Michigan Administrative Code (Part 24 Rules). The approved RMP, and any approved modifications thereto, are enforceable requirements of this permit. Incineration, landfilling and other residual disposal activities shall be conducted in accordance with Part II.D.7. of this permit. The Part 24 Rules can be obtained via the internet (<http://www.michigan.gov/deq/> and on the left side of the screen click on Water, Biosolids & Industrial Pretreatment, Biosolids then click on Biosolids Laws and Rules Information which is under the Laws & Rules banner in the center of the screen).

a. Annual Report

On or before October 30 of each year, the permittees shall submit an annual report to the Department for the previous fiscal year of October 1 through September 30. The report shall be submitted electronically via the Department's MiWaters system at <https://miwaters.deq.state.mi.us>. At a minimum, the report shall contain:

- 1) a certification that current residuals management practices are in accordance with the approved RMP, or a proposal for modification to the approved RMP; and
- 2) a completed Biosolids Annual Report Form, available at <https://miwaters.deq.state.mi.us>.

b. Modifications to the Approved RMP

Prior to implementation of modifications to the RMP, the permittees shall submit proposed modifications to the Department for approval. The approved modification shall become effective upon the date of approval. Upon written notification, the Department may impose additional requirements and/or limitations to the approved RMP as necessary to protect public health and the environment from any adverse effect of a pollutant in the biosolids.

c. Record Keeping

Records required by the Part 24 Rules shall be kept for a minimum of five years. However, the records documenting cumulative loading for sites subject to cumulative pollutant loading rates shall be kept as long as the site receives biosolids.

d. Contact Information

RMP related submittals to the Department shall be to the Southeast Michigan District Supervisor of the Water Resources Division. The Southeast Michigan District Office is located at 27700 Donald Court, Warren Michigan, 48092-2793, Telephone: 586-753-3750, Fax: 586-753-3751.

PART II

Part II may include terms and /or conditions not applicable to discharges covered under this permit.

Section A. Definitions

Acute toxic unit (TU_A) means $100/LC_{50}$ where the LC_{50} is determined from a whole effluent toxicity (WET) test which produces a result that is statistically or graphically estimated to be lethal to 50% of the test organisms.

Annual monitoring frequency refers to a calendar year beginning on January 1 and ending on December 31. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Authorized public agency means a state, local, or county agency that is designated pursuant to the provisions of section 9110 of Part 91 of the NREPA to implement soil erosion and sedimentation control requirements with regard to construction activities undertaken by that agency.

Best management practices (BMPs) means structural devices or nonstructural practices that are designed to prevent pollutants from entering into storm water, to direct the flow of storm water, or to treat polluted storm water.

Bioaccumulative chemical of concern (BCC) means a chemical which, upon entering the surface waters, by itself or as its toxic transformation product, accumulates in aquatic organisms by a human health bioaccumulation factor of more than 1000 after considering metabolism and other physiochemical properties that might enhance or inhibit bioaccumulation. The human health bioaccumulation factor shall be derived according to R 323.1057(5). Chemicals with half-lives of less than 8 weeks in the water column, sediment, and biota are not BCCs. The minimum bioaccumulation concentration factor (BAF) information needed to define an organic chemical as a BCC is either a field-measured BAF or a BAF derived using the biota-sediment accumulation factor (BSAF) methodology. The minimum BAF information needed to define an inorganic chemical as a BCC, including an organometal, is either a field-measured BAF or a laboratory-measured bioconcentration factor (BCF). The BCCs to which these rules apply are identified in Table 5 of R 323.1057 of the Water Quality Standards.

Biosolids are the solid, semisolid, or liquid residues generated during the treatment of sanitary sewage or domestic sewage in a treatment works. This includes, but is not limited to, scum or solids removed in primary, secondary, or advanced wastewater treatment processes and a derivative of the removed scum or solids.

Bulk biosolids means biosolids that are not sold or given away in a bag or other container for application to a lawn or home garden.

Certificate of Coverage (COC) is a document, issued by the Department, which authorizes a discharge under a general permit.

Chronic toxic unit (TU_C) means $100/MATC$ or $100/IC_{25}$, where the maximum acceptable toxicant concentration (MATC) and IC_{25} are expressed as a percent effluent in the test medium.

Class B biosolids refers to material that has met the Class B pathogen reduction requirements or equivalent treatment by a Process to Significantly Reduce Pathogens (PSRP) in accordance with the Part 24 Rules. Processes include aerobic digestion, composting, anaerobic digestion, lime stabilization and air drying.

Combined sewer system is a sewer system in which storm water runoff is combined with sanitary wastes.

Daily concentration is the sum of the concentrations of the individual samples of a parameter divided by the number of samples taken during any calendar day. If the parameter concentration in any sample is less than the quantification limit, regard that value as zero when calculating the daily concentration. The daily concentration will be used to determine compliance with any maximum and minimum daily concentration limitations (except for pH and dissolved oxygen). When required by the permit, report the maximum calculated daily concentration for the month in the "MAXIMUM" column under "QUALITY OR CONCENTRATION" on the Discharge Monitoring Reports (DMRs).

For pH, report the maximum value of any *individual* sample taken during the month in the "MAXIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs and the minimum value of any *individual* sample taken during the month in the "MINIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs. For dissolved oxygen, report the minimum concentration of any *individual* sample in the "MINIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs.

Daily loading is the total discharge by weight of a parameter discharged during any calendar day. This value is calculated by multiplying the daily concentration by the total daily flow and by the appropriate conversion factor. The daily loading will be used to determine compliance with any maximum daily loading limitations. When required by the permit, report the maximum calculated daily loading for the month in the "MAXIMUM" column under "QUANTITY OR LOADING" on the DMRs.

Daily monitoring frequency refers to a 24-hour day. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Department means the Michigan Department of Environment, Great Lakes, and Energy.

Detection level means the lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated level of probability.

Discharge means the addition of any waste, waste effluent, wastewater, pollutant, or any combination thereof to any surface water of the state.

EC₅₀ means a statistically or graphically estimated concentration that is expected to cause 1 or more specified effects in 50% of a group of organisms under specified conditions.

Fecal coliform bacteria monthly

FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – Fecal coliform bacteria monthly is the geometric mean of all daily concentrations determined during a discharge event. Days on which no daily concentration is determined shall not be used to determine the calculated monthly value. The calculated monthly value will be used to determine compliance with the maximum monthly fecal coliform bacteria limitations. When required by the permit, report the calculated monthly value in the "AVERAGE" column under "QUALITY OR CONCENTRATION" on the DMR. If the period in which the discharge event occurred was partially in each of two months, the calculated monthly value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – Fecal coliform bacteria monthly is the geometric mean of all daily concentrations determined during a reporting month. Days on which no daily concentration is determined shall not be used to determine the calculated monthly value. The calculated monthly value will be used to determine compliance with the maximum monthly fecal coliform bacteria limitations. When required by the permit, report the calculated monthly value in the "AVERAGE" column under "QUALITY OR CONCENTRATION" on the DMR.

Fecal coliform bacteria 7-day

FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – Fecal coliform bacteria 7-day is the geometric mean of the daily concentrations determined during any 7 consecutive days of discharge during a discharge event. If the number of daily concentrations determined during the discharge event is less than 7 days, the number of actual daily concentrations determined shall be used for the calculation. Days on which no daily concentration is determined shall not be used to determine the value. The calculated 7-day value will be used to determine compliance with the maximum 7-day fecal coliform bacteria limitations. When required by the permit, report the maximum calculated 7-day geometric mean value for the month in the “MAXIMUM” column under “QUALITY OR CONCENTRATION” on the DMRs. If the 7-day period was partially in each of two months, the value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – Fecal coliform bacteria 7-day is the geometric mean of the daily concentrations determined during any 7 consecutive days in a reporting month. If the number of daily concentrations determined is less than 7, the actual number of daily concentrations determined shall be used for the calculation. Days on which no daily concentration is determined shall not be used to determine the value. The calculated 7-day value will be used to determine compliance with the maximum 7-day fecal coliform bacteria limitations. When required by the permit, report the maximum calculated 7-day geometric mean for the month in the “MAXIMUM” column under “QUALITY OR CONCENTRATION” on the DMRs. The first calculation shall be made on day 7 of the reporting month, and the last calculation shall be made on the last day of the reporting month.

Flow-proportioned sample is a composite sample with the sample volume proportional to the effluent flow.

General permit means a National Pollutant Discharge Elimination System permit issued authorizing a category of similar discharges.

Geometric mean is the average of the logarithmic values of a base 10 data set, converted back to a base 10 number.

Grab sample is a single sample taken at neither a set time nor flow.

IC₂₅ means the toxicant concentration that would cause a 25% reduction in a nonquantal biological measurement for the test population.

Illicit connection means a physical connection to a municipal separate storm sewer system that primarily conveys non-storm water discharges other than uncontaminated groundwater into the storm sewer; or a physical connection not authorized or permitted by the local authority, where a local authority requires authorization or a permit for physical connections.

Illicit discharge means any discharge to, or seepage into, a municipal separate storm sewer system that is not composed entirely of storm water or uncontaminated groundwater. Illicit discharges include non-storm water discharges through pipes or other physical connections; dumping of motor vehicle fluids, household hazardous wastes, domestic animal wastes, or litter; collection and intentional dumping of grass clippings or leaf litter; or unauthorized discharges of sewage, industrial waste, restaurant wastes, or any other non-storm water waste directly into a separate storm sewer.

Individual permit means a site-specific NPDES permit.

Inlet means a catch basin, roof drain, conduit, drain tile, retention pond riser pipe, sump pump, or other point where storm water or wastewater enters into a closed conveyance system prior to discharge off site or into waters of the state.

Interference is a discharge which, alone or in conjunction with a discharge or discharges from other sources, both: 1) inhibits or disrupts the POTW, its treatment processes or operations, or its sludge processes, use or disposal; and 2) therefore, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation) or, of the prevention of sewage sludge use or disposal in compliance with the following statutory provisions and regulations or permits issued thereunder (or more stringent state or local regulations): Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA) (including Title II, more commonly referred to as the Resource Conservation and Recovery Act (RCRA), and including state regulations contained in any state sludge management plan prepared pursuant to Subtitle D of the SWDA), the Clean Air Act, the Toxic Substances Control Act, and the Marine Protection, Research and Sanctuaries Act. [This definition does not apply to sample matrix interference].

Land application means spraying or spreading biosolids or a biosolids derivative onto the land surface, injecting below the land surface, or incorporating into the soil so that the biosolids or biosolids derivative can either condition the soil or fertilize crops or vegetation grown in the soil.

LC₅₀ means a statistically or graphically estimated concentration that is expected to be lethal to 50% of a group of organisms under specified conditions.

Maximum acceptable toxicant concentration (MATC) means the concentration obtained by calculating the geometric mean of the lower and upper chronic limits from a chronic test. A lower chronic limit is the highest tested concentration that did not cause the occurrence of a specific adverse effect. An upper chronic limit is the lowest tested concentration which did cause the occurrence of a specific adverse effect and above which all tested concentrations caused such an occurrence.

Maximum extent practicable means implementation of best management practices by a public body to comply with an approved storm water management program as required by a national permit for a municipal separate storm sewer system, in a manner that is environmentally beneficial, technically feasible, and within the public body's legal authority.

MGD means million gallons per day.

Monthly concentration is the sum of the daily concentrations determined during a reporting period divided by the number of daily concentrations determined. The calculated monthly concentration will be used to determine compliance with any maximum monthly concentration limitations. Days with no discharge shall not be used to determine the value. When required by the permit, report the calculated monthly concentration in the "AVERAGE" column under "QUALITY OR CONCENTRATION" on the DMR.

For minimum percent removal requirements, the monthly influent concentration and the monthly effluent concentration shall be determined. The calculated monthly percent removal, which is equal to 100 times the quantity [1 minus the quantity (monthly effluent concentration divided by the monthly influent concentration)], shall be reported in the "MINIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs.

Monthly loading is the sum of the daily loadings of a parameter divided by the number of daily loadings determined during a reporting period. The calculated monthly loading will be used to determine compliance with any maximum monthly loading limitations. Days with no discharge shall not be used to determine the value. When required by the permit, report the calculated monthly loading in the "AVERAGE" column under "QUANTITY OR LOADING" on the DMR.

Monthly monitoring frequency refers to a calendar month. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Municipal separate storm sewer means a conveyance or system of conveyances designed or used for collecting or conveying storm water which is not a combined sewer and which is not part of a publicly-owned treatment works as defined in the Code of Federal Regulations at 40 CFR 122.2.

Municipal separate storm sewer system (MS4) means all separate storm sewers that are owned or operated by the United States, a state, city, village, township, county, district, association, or other public body created by or pursuant to state law, having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under state law, such as a sewer district, flood control district, or drainage district, or similar entity, or a designated or approved management agency under Section 208 of the Federal Act that discharges to the waters of the state. This term includes systems similar to separate storm sewer systems in municipalities, such as systems at military bases, large hospital or prison complexes, and highways and other thoroughfares. The term does not include separate storm sewers in very discrete areas, such as individual buildings.

National Pretreatment Standards are the regulations promulgated by or to be promulgated by the Federal Environmental Protection Agency pursuant to Section 307(b) and (c) of the Federal Act. The standards establish nationwide limits for specific industrial categories for discharge to a POTW.

No observed adverse effect level (NOAEL) means the highest tested dose or concentration of a substance which results in no observed adverse effect in exposed test organisms where higher doses or concentrations result in an adverse effect.

Noncontact cooling water is water used for cooling which does not come into direct contact with any raw material, intermediate product, by-product, waste product or finished product.

Nondomestic user is any discharger to a POTW that discharges wastes other than or in addition to water-carried wastes from toilet, kitchen, laundry, bathing or other facilities used for household purposes.

Outfall is the location at which a point source discharge enters the surface waters of the state.

Part 91 agency means an agency that is designated by a county board of commissioners pursuant to the provisions of section 9105 of Part 91 of the NREPA; an agency that is designated by a city, village, or township in accordance with the provisions of section 9106 of Part 91 of the NREPA; or the Department for soil erosion and sedimentation activities under Part 615, Part 631, or Part 632 pursuant to the provisions of section 9115 of Part 91 of the NREPA.

Part 91 permit means a soil erosion and sedimentation control permit issued by a Part 91 agency pursuant to the provisions of Part 91 of the NREPA.

Partially treated sewage is any sewage, sewage and storm water, or sewage and wastewater, from domestic or industrial sources that is treated to a level less than that required by the permittees' National Pollutant Discharge Elimination System permit, or that is not treated to national secondary treatment standards for wastewater, including discharges to surface waters from retention treatment facilities.

Point of discharge is the location of a point source discharge where storm water is discharged directly into a separate storm sewer system.

Point source discharge means a discharge from any discernible, confined, discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, or rolling stock. Changing the surface of land or establishing grading patterns on land will result in a point source discharge where the runoff from the site is ultimately discharged to waters of the state.

Polluting material means any material, in solid or liquid form, identified as a polluting material under the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code).

POTW is a publicly owned treatment work.

Pretreatment is reducing the amount of pollutants, eliminating pollutants, or altering the nature of pollutant properties to a less harmful state prior to discharge into a public sewer. The reduction or alteration can be by physical, chemical, or biological processes, process changes, or by other means. Dilution is not considered pretreatment unless expressly authorized by an applicable National Pretreatment Standard for a particular industrial category.

Public (as used in the MS4 individual permit) means all persons who potentially could affect the authorized storm water discharges, including, but not limited to, residents, visitors to the area, public employees, businesses, industries, and construction contractors and developers.

Public body means the United States; the state of Michigan; a city, village, township, county, school district, public college or university, or single-purpose governmental agency; or any other body which is created by federal or state statute or law.

Qualified Personnel means an individual who meets qualifications acceptable to the Department and who is authorized by an Industrial Storm Water Certified Operator to collect the storm water sample.

Qualifying storm event means a storm event causing greater than 0.1 inch of rainfall and occurring at least 72 hours after the previous measurable storm event that also caused greater than 0.1 inch of rainfall. Upon request, the Department may approve an alternate definition meeting the condition of a qualifying storm event.

Quantification level means the measurement of the concentration of a contaminant obtained by using a specified laboratory procedure calculated at a specified concentration above the detection level. It is considered the lowest concentration at which a particular contaminant can be quantitatively measured using a specified laboratory procedure for monitoring of the contaminant.

Quarterly monitoring frequency refers to a three month period, defined as January through March, April through June, July through September, and October through December. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Regional Administrator is the Region 5 Administrator, U.S. EPA, located at R-19J, 77 W. Jackson Blvd., Chicago, Illinois 60604.

Regulated area means the permittee's urbanized area, where urbanized area is defined as a place and its adjacent densely-populated territory that together have a minimum population of 50,000 people as defined by the United States Bureau of the Census and as determined by the latest available decennial census.

Secondary containment structure means a unit, other than the primary container, in which significant materials are packaged or held, which is required by State or Federal law to prevent the escape of significant materials by gravity into sewers, drains, or otherwise directly or indirectly into any sewer system or to the surface or ground waters of this state.

Separate storm sewer system means a system of drainage, including, but not limited to, roads, catch basins, curbs, gutters, parking lots, ditches, conduits, pumping devices, or man-made channels, which is not a combined sewer where storm water mixes with sanitary wastes, and is not part of a POTW.

Significant industrial user is a nondomestic user that: 1) is subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N; or 2) discharges an average of 25,000 gallons per day or more of process wastewater to a POTW (excluding sanitary, noncontact cooling and boiler blowdown wastewater); contributes a process waste stream which makes up five (5) percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the permittees as defined in 40 CFR 403.12(a) on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's treatment plant operation or violating any pretreatment standard or requirement (in accordance with 40 CFR 403.8(f)(6)).

Significant materials Significant Materials means any material which could degrade or impair water quality, including but not limited to: raw materials; fuels; solvents, detergents, and plastic pellets; finished materials such as metallic products; hazardous substances designated under Section 101(14) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (see 40 CFR 372.65); any chemical the facility is required to report pursuant to Section 313 of Emergency Planning and Community Right-to-Know Act (EPCRA); polluting materials as identified under the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code); Hazardous Wastes as defined in Part 111 of the NREPA; fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with storm water discharges.

Significant spills and significant leaks means any release of a polluting material reportable under the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code).

Special-use area means secondary containment structures required by state or federal law; lands on Michigan's List of Sites of Environmental Contamination pursuant to Part 201, Environmental Remediation, of the NREPA; and/or areas with other activities that may contribute pollutants to the storm water for which the Department determines monitoring is needed.

Stoichiometric means the quantity of a reagent calculated to be necessary and sufficient for a given chemical reaction.

Storm water means storm water runoff, snow melt runoff, surface runoff and drainage, and non-storm water included under the conditions of this permit.

Storm water discharge point is the location where the point source discharge of storm water is directed to surface waters of the state or to a separate storm sewer. It includes the location of all point source discharges where storm water exits the facility, including *outfalls* which discharge directly to surface waters of the state, and *points of discharge* which discharge directly into separate storm sewer systems.

SWPPP means the Storm Water Pollution Prevention Plan prepared in accordance with this permit.

Tier I value means a value for aquatic life, human health or wildlife calculated under R 323.1057 of the Water Quality Standards using a tier I toxicity database.

Tier II value means a value for aquatic life, human health or wildlife calculated under R 323.1057 of the Water Quality Standards using a tier II toxicity database.

Total maximum daily loads (TMDLs) are required by the Federal Act for waterbodies that do not meet water quality standards. TMDLs represent the maximum daily load of a pollutant that a waterbody can assimilate and meet water quality standards, and an allocation of that load among point sources, nonpoint sources, and a margin of safety.

Toxicity reduction evaluation (TRE) means a site-specific study conducted in a stepwise process designed to identify the causative agents of effluent toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in effluent toxicity.

Water Quality Standards means the Part 4 Water Quality Standards promulgated pursuant to Part 31 of the NREPA, being R 323.1041 through R 323.1117 of the Michigan Administrative Code.

Weekly monitoring frequency refers to a calendar week which begins on Sunday and ends on Saturday. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Wet Weather Flow is the wastewater flow (domestic, industrial, commercial and institutional) including infiltration and inflow that occurs as the result of a precipitation or snowmelt event.

Wet Weather Event, for the interim period, is defined as those days on which an average 0.10 inches or more of precipitation was recorded by six strategically located rainfall gauges (as defined in Part I.9.c.(10) of the Operational Plan) in the WRRF's service area, plus two days immediately following days of 0.10 inch to 1.00 inch days of precipitation or three days following days of 1.00 inch or more precipitation. Rainfall days are further limited to those days in which the air temperature exceeds 32° F (0° C) for at least an eight hour period. The permittee may demonstrate that certain events such as snowmelt, and other unforeseen events will be considered rainfall days.

The above definition of wet weather event is not adequate on a long term basis, or for the purposes of planning, designing, or implementing the combined sewer overflow improvements required in this permit. For purposes of planning and designing future CSO improvements, the permittee shall consider the effect of dewatering tributary storage basins on overall system recovery, both at the WRRF and CSO overflow points in the collection system.

For this permit while the Regional Operational Plan is being revised, if up to 930 MGD (including recycle) is being processed with secondary treatment at the WRRF and no primary flow is being discharged, then tributary combined or sanitary storage basins in the GLWA system may be dewatered. Such dewatering will not be considered a violation of this permit, even if contrary to the above Wet Weather Event definition. Once a revised Regional Operation Plan is developed, it shall be implemented once reviewed and approved by the Department.

Upon approval of the Department, an alternate "wet weather event" definition may be used.

WWSL is a wastewater stabilization lagoon.

WWSL discharge event is a discrete occurrence during which effluent is discharged to the surface water up to 10 days of a consecutive 14 day period.

3-portion composite sample is a sample consisting of three equal-volume grab samples collected at equal intervals over an 8-hour period.

7-day concentration

FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – The 7-day concentration is the sum of the daily concentrations determined during any 7 consecutive days of discharge during a WWSL discharge event divided by the number of daily concentrations determined. If the number of daily concentrations determined during the WWSL discharge event is less than 7 days, the number of actual daily concentrations determined shall be used for the calculation. The calculated 7-day concentration will be used to determine compliance with any maximum 7-day concentration limitations. When required by the permit, report the maximum calculated 7-day concentration for the WWSL discharge event in the "MAXIMUM" column under "QUALITY OR CONCENTRATION" on the DMR. If the WWSL discharge event was partially in each of two months, the value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – The 7-day concentration is the sum of the daily concentrations determined during any 7 consecutive days in a reporting month divided by the number of daily concentrations determined. If the number of daily concentrations determined is less than 7, the actual number of daily concentrations determined shall be used for the calculation. The calculated 7-day concentration will be used to determine compliance with any maximum 7-day concentration limitations in the reporting month. When required by the permit, report the maximum calculated 7-day concentration for the month in the "MAXIMUM" column under "QUALITY OR CONCENTRATION" on the DMR. The first 7-day calculation shall be made on day 7 of the reporting month, and the last calculation shall be made on the last day of the reporting month.

7-day loading

FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – The 7-day loading is the sum of the daily loadings determined during any 7 consecutive days of discharge during a WWSL discharge event divided by the number of daily loadings determined. If the number of daily loadings determined during the WWSL discharge event is less than 7 days, the number of actual daily loadings determined shall be used for the calculation. The calculated 7-day loading will be used to determine compliance with any maximum 7-day loading limitations. When required by the permit, report the maximum calculated 7-day loading for the WWSL discharge event in the “MAXIMUM” column under “QUANTITY OR LOADING” on the DMR. If the WWSL discharge event was partially in each of two months, the value shall be reported on the DMR of the month in which the last day of discharge occurred

FOR ALL OTHER DISCHARGES – The 7-day loading is the sum of the daily loadings determined during any 7 consecutive days in a reporting month divided by the number of daily loadings determined. If the number of daily loadings determined is less than 7, the actual number of daily loadings determined shall be used for the calculation. The calculated 7-day loading will be used to determine compliance with any maximum 7-day loading limitations in the reporting month. When required by the permit, report the maximum calculated 7-day loading for the month in the “MAXIMUM” column under “QUANTITY OR LOADING” on the DMR. The first 7-day calculation shall be made on day 7 of the reporting month, and the last calculation shall be made on the last day of the reporting month.

24-hour composite sample is a flow-proportioned composite sample consisting of hourly or more frequent portions that are taken over a 24-hour period. In accordance with the Department Approved Wet Weather Operational Plan (See Part I.A.11.), alternate requirements for 24-hour composite sampling may be utilized to satisfy the monitoring requirements of this permit.

PART II

Section B. Monitoring Procedures

1. Representative Samples

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. Test Procedures

Test procedures for the analysis of pollutants shall conform to regulations promulgated pursuant to Section 304(h) of the Federal Act (40 CFR Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants), unless specified otherwise in this permit. **Test procedures used shall be sufficiently sensitive to determine compliance with applicable effluent limitations.** Requests to use test procedures not promulgated under 40 CFR Part 136 for pollutant monitoring required by this permit shall be made in accordance with the Alternate Test Procedures regulations specified in 40 CFR 136.4. These requests shall be submitted to the Section Manager of the Permits Section, Water Resources Division, Michigan Department of Environment, Great Lakes, and Energy, P.O. Box 30458, Lansing, Michigan, 48909-7958. The permittees may use such procedures upon approval.

The permittees shall periodically calibrate and perform maintenance procedures on all analytical instrumentation at intervals to ensure accuracy of measurements. The calibration and maintenance shall be performed as part of the permittees' laboratory Quality Control/Quality Assurance program.

3. Instrumentation

The permittees shall periodically calibrate and perform maintenance procedures on all monitoring instrumentation at intervals to ensure accuracy of measurements.

4. Recording Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittees shall record the following information: 1) the exact place, date, and time of measurement or sampling; 2) the person(s) who performed the measurement or sample collection; 3) the dates the analyses were performed; 4) the person(s) who performed the analyses; 5) the analytical techniques or methods used; 6) the date of and person responsible for equipment calibration; and 7) the results of all required analyses.

5. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Regional Administrator or the Department.

PART II

Section C. Reporting Requirements

1. Start-up Notification

If the permittees will not discharge during the first 60 days following the effective date of this permit, the permittees shall notify the Department within 14 days following the effective date of this permit, and then 60 days prior to the commencement of the discharge.

2. Submittal Requirements for Self-Monitoring Data

Part 31 of the NREPA (specifically Section 324.3110(7)); and R 323.2155(2) of Part 21, Wastewater Discharge Permits, promulgated under Part 31 of the NREPA, allow the Department to specify the forms to be utilized for reporting the required self-monitoring data. Unless instructed on the effluent limitations page to conduct "Retained Self-Monitoring," the permittees shall submit self-monitoring data via the Department's MiWaters system.

The permittees shall utilize the information provided on the MiWaters website, located at <https://miwaters.deq.state.mi.us>, to access and submit the electronic forms. Both monthly summary and daily data shall be submitted to the Department no later than the 20th day of the month following each month of the authorized discharge period(s). The permittees may be allowed to submit the electronic forms after this date if the Department has granted an extension to the submittal date.

3. Retained Self-Monitoring Requirements

If instructed on the effluent limits page (or otherwise authorized by the Department in accordance with the provisions of this permit) to conduct retained self-monitoring, the permittees shall maintain a year-to-date log of retained self-monitoring results and, upon request, provide such log for inspection to the staff of the Department. Retained self-monitoring results are public information and shall be promptly provided to the public upon request.

The permittees shall certify, in writing, to the Department, on or before January 10th (April 1st for animal feeding operation facilities) of each year, that: 1) all retained self-monitoring requirements have been complied with and a year-to-date log has been maintained; and 2) the application on which this permit is based still accurately describes the discharge. With this annual certification, the permittees shall submit a summary of the previous year's monitoring data. The summary shall include maximum values for samples to be reported as daily maximums and/or monthly maximums and minimum values for any daily minimum samples.

Retained self-monitoring may be denied to permittees by notification in writing from the Department. In such cases, the permittees shall submit self-monitoring data in accordance with Part II.C.2., above. Such a denial may be rescinded by the Department upon written notification to the permittees. Reissuance or modification of this permit or reissuance or modification of an individual permittees' authorization to discharge shall not affect previous approval or denial for retained self-monitoring unless the Department provides notification in writing to the permittees.

4. Additional Monitoring by Permittees

If the permittees monitor any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report. Such increased frequency shall also be indicated.

Monitoring required pursuant to Part 41 of the NREPA or Rule 35 of the Mobile Home Park Commission Act (Act 96 of the Public Acts of 1987) for assurance of proper facility operation shall be submitted as required by the Department.

5. Compliance Dates Notification

Within 14 days of every compliance date specified in this permit, the permittees shall submit a *written* notification to the Department indicating whether or not the particular requirement was accomplished. If the requirement was not accomplished, the notification shall include an explanation of the failure to accomplish the requirement, actions taken or planned by the permittees to correct the situation, and an estimate of when the requirement will be accomplished. If a written report is required to be submitted by a specified date and the permittees accomplish this, a separate written notification is not required.

6. Noncompliance Notification

Compliance with all applicable requirements set forth in the Federal Act, Parts 31 and 41 of the NREPA, and related regulations and rules is required. All instances of noncompliance shall be reported as follows:

- a. 24-Hour Reporting
Any noncompliance which may endanger health or the environment (including maximum and/or minimum daily concentration discharge limitation exceedances) shall be reported, verbally, within 24 hours from the time the permittees becomes aware of the noncompliance. A written submission shall also be provided within five (5) days.
- b. Other Reporting
The permittees shall report, in writing, all other instances of noncompliance not described in a. above at the time monitoring reports are submitted; or, in the case of retained self-monitoring, within five (5) days from the time the permittees become aware of the noncompliance.

Written reporting shall include: 1) a description of the discharge and cause of noncompliance; and 2) the period of noncompliance, including exact dates and times, or, if not yet corrected, the anticipated time the noncompliance is expected to continue, and the steps taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

7. Spill Notification

The permittees shall immediately report any release of any polluting material which occurs to the surface waters or groundwaters of the state, unless the permittees have determined that the release is not in excess of the threshold reporting quantities specified in the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code), by calling the Department at the number indicated on the second page of this permit (or, if this is a general permit, on the COC); or, if the notice is provided after regular working hours, call the Department's 24-hour Pollution Emergency Alerting System telephone number, 1-800-292-4706 (calls from **out-of-state** dial 1-517-373-7660).

Within ten (10) days of the release, the permittees shall submit to the Department a full written explanation as to the cause of the release, the discovery of the release, response (clean-up and/or recovery) measures taken, and preventive measures taken or a schedule for completion of measures to be taken to prevent reoccurrence of similar releases.

8. Upset Noncompliance Notification

If a process "upset" (defined as an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittees) has occurred, the permittees who wishes to establish the affirmative defense of upset, shall notify the Department by telephone within 24 hours of becoming aware of such conditions; and within five (5) days, provide in writing, the following information:

- a. that an upset occurred and that the permittees can identify the specific cause(s) of the upset;
- b. that the permitted wastewater treatment facility was, at the time, being properly operated and maintained (note that an upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation); and
- c. that the permittees has specified and taken action on all responsible steps to minimize or correct any adverse impact in the environment resulting from noncompliance with this permit.

No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

In any enforcement proceedings, the permittees, seeking to establish the occurrence of an upset, has the burden of proof.

9. Bypass Prohibition and Notification

- a. Bypass Prohibition
Bypass is prohibited, and the Department may take an enforcement action, unless:
 - 1) bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
 - 2) there were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass; and
 - 3) the permittees submitted notices as required under 9.b. or 9.c. below.
- b. Notice of Anticipated Bypass
If the permittees know in advance of the need for a bypass, it shall submit prior notice to the Department, if possible at least ten (10) days before the date of the bypass, and provide information about the anticipated bypass as required by the Department. The Department may approve an anticipated bypass, after considering its adverse effects, if it will meet the three (3) conditions listed in 9.a. above.
- c. Notice of Unanticipated Bypass
The permittees shall submit notice to the Department of an unanticipated bypass by calling the Department at the number indicated on the second page of this permit (if the notice is provided after regular working hours, use the following number: 1-800-292-4706) as soon as possible, but no later than 24 hours from the time the permittees becomes aware of the circumstances.

d. Written Report of Bypass

A written submission shall be provided within five (5) working days of commencing any bypass to the Department, and at additional times as directed by the Department. The written submission shall contain a description of the bypass and its cause; the period of bypass, including exact dates and times, and if the bypass has not been corrected, the anticipated time it is expected to continue; steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass; and other information as required by the Department.

e. Bypass Not Exceeding Limitations

The permittees may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to ensure efficient operation. These bypasses are not subject to the provisions of 9.a., 9.b., 9.c., and 9.d., above. This provision does not relieve the permittees of any notification responsibilities under Part II.C.11. of this permit.

f. Definitions

1) Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

2) Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

10. Bioaccumulative Chemicals of Concern (BCC)

Consistent with the requirements of R 323.1098 and R 323.1215 of the Michigan Administrative Code, the permittees are prohibited from undertaking any action that would result in a lowering of water quality from an increased loading of a BCC unless an increased use request and antidegradation demonstration have been submitted and approved by the Department.

11. Notification of Changes in Discharge

The permittees shall notify the Department, in writing, as soon as possible but no later than 10 days of knowing, or having reason to believe, that any activity or change has occurred or will occur which would result in the discharge of: 1) detectable levels of chemicals on the current Michigan Critical Materials Register, priority pollutants or hazardous substances set forth in 40 CFR 122.21, Appendix D, or the Pollutants of Initial Focus in the Great Lakes Water Quality Initiative specified in 40 CFR 132.6, Table 6, which were not acknowledged in the application or listed in the application at less than detectable levels; 2) detectable levels of any other chemical not listed in the application or listed at less than detection, for which the application specifically requested information; or 3) any chemical at levels greater than five times the average level reported in the complete application (see the first page of this permit, for the date(s) the complete application was submitted). Any other monitoring results obtained as a requirement of this permit shall be reported in accordance with the compliance schedules.

12. Changes in Facility Operations

Any anticipated action or activity, including but not limited to facility expansion, production increases, or process modification, which will result in new or increased loadings of pollutants to the receiving waters must be reported to the Department by a) submission of an increased use request (application) and all information required under R 323.1098 (Antidegradation) of the Water Quality Standards or b) by notice if the following conditions are met: 1) the action or activity will not result in a change in the types of wastewater discharged or result in a greater quantity of wastewater than currently authorized by this permit; 2) the action or activity will not result in violations of the effluent limitations specified in this permit; 3) the action or activity is not prohibited by the requirements of Part II.C.10.; and 4) the action or activity will not require notification pursuant to Part II.C.11. Following such notice, the permit or, if applicable, the facility's COC may be modified according to applicable laws and rules to specify and limit any pollutant not previously limited.

13. Transfer of Ownership or Control

In the event of any change in control or ownership of facilities from which the authorized discharge emanates, the permittees shall submit to the Department 30 days prior to the actual transfer of ownership or control a written agreement between the current permittees and the new permittees containing: 1) the legal name and address of the new owner; 2) a specific date for the effective transfer of permit responsibility, coverage and liability; and 3) a certification of the continuity of or any changes in operations, wastewater discharge, or wastewater treatment.

If the new permittees are proposing changes in operations, wastewater discharge, or wastewater treatment, the Department may propose modification of this permit in accordance with applicable laws and rules.

14. Operations and Maintenance Manual

For wastewater treatment facilities that serve the public (and are thus subject to Part 41 of the NREPA), Section 4104 of Part 41 and associated Rule 2957 of the Michigan Administrative Code allow the Department to require an Operations and Maintenance (O&M) Manual from the facility. An up-to-date copy of the O&M Manual shall be kept at the facility and shall be provided to the Department upon request. The Department may review the O&M Manual in whole or in part at its discretion and require modifications to it if portions are determined to be inadequate.

At a minimum, the O&M Manual shall include the following information: permit standards; descriptions and operation information for all equipment; staffing information; laboratory requirements; record keeping requirements; a maintenance plan for equipment; an emergency operating plan; safety program information; and copies of all pertinent forms, as-built plans, and manufacturer's manuals.

Certification of the existence and accuracy of the O&M Manual shall be submitted to the Department at least sixty days prior to start-up of a new wastewater treatment facility. Recertification shall be submitted sixty days prior to start-up of any substantial improvements or modifications made to an existing wastewater treatment facility.

15. Signatory Requirements

All applications, reports, or information submitted to the Department in accordance with the conditions of this permit and that require a signature shall be signed and certified as described in the Federal Act and the NREPA.

The Federal Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance, shall, upon conviction, be punished by a fine of not more than \$10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

The NREPA (Section 3115(2)) provides that a person who at the time of the violation knew or should have known that he or she discharged a substance contrary to this part, or contrary to a permit, COC, or order issued or rule promulgated under this part, or who intentionally makes a false statement, representation, or certification in an application for or form pertaining to a permit or COC or in a notice or report required by the terms and conditions of an issued permit or COC, or who intentionally renders inaccurate a monitoring device or record required to be maintained by the Department, is guilty of a felony and shall be fined not less than \$2,500.00 or more than \$25,000.00 for each violation. The court may impose an additional fine of not more than \$25,000.00 for each day during which the unlawful discharge occurred. If the conviction is for a violation committed after a first conviction of the person under this subsection, the court shall impose a fine of not less than \$25,000.00 per day and not more than \$50,000.00 per day of violation. Upon conviction, in addition to a fine, the court in its discretion may sentence the defendant to imprisonment for not more than 2 years or impose probation upon a person for a violation of this part. With the exception of the issuance of criminal complaints, issuance of warrants, and the holding of an arraignment, the circuit court for the county in which the violation occurred has exclusive jurisdiction. However, the person shall not be subject to the penalties of this subsection if the discharge of the effluent is in conformance with and obedient to a rule, order, permit, or COC of the Department. In addition to a fine, the attorney general may file a civil suit in a court of competent jurisdiction to recover the full value of the injuries done to the natural resources of the state and the costs of surveillance and enforcement by the state resulting from the violation.

16. Electronic Reporting

Upon notice by the Department that electronic reporting tools are available for specific reports or notifications, the permittees shall submit electronically all such reports or notifications as required by this permit, on forms provided by the Department.

PART II

Section D. Management Responsibilities

1. Duty to Comply

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit, more frequently than, or at a level in excess of, that authorized, shall constitute a violation of the permit.

It is the duty of the permittees to comply with all the terms and conditions of this permit. Any noncompliance with the Effluent Limitations, Special Conditions, or terms of this permit constitutes a violation of the NREPA and/or the Federal Act and constitutes grounds for enforcement action; for permit or Certificate of Coverage (COC) termination, revocation and reissuance, or modification; or denial of an application for permit or COC renewal.

It shall not be a defense for permittees in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

2. Operator Certification

The permittees shall have the waste treatment facilities under direct supervision of an operator certified at the appropriate level for the facility certification by the Department, as required by Sections 3110 and 4104 of the NREPA. Permittees authorized to discharge storm water shall have the storm water treatment and/or control measures under direct supervision of a storm water operator certified by the Department, as required by Section 3110 of the NREPA.

3. Facilities Operation

The permittees shall, at all times, properly operate and maintain all treatment or control facilities or systems installed or used by the permittees to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance includes adequate laboratory controls and appropriate quality assurance procedures.

4. Power Failures

In order to maintain compliance with the effluent limitations of this permit and prevent unauthorized discharges, the permittees shall either:

- a. provide an alternative power source sufficient to operate facilities utilized by the permittees to maintain compliance with the effluent limitations and conditions of this permit; or
- b. upon the reduction, loss, or failure of one or more of the primary sources of power to facilities utilized by the permittees to maintain compliance with the effluent limitations and conditions of this permit, the permittees shall halt, reduce or otherwise control production and/or all discharge in order to maintain compliance with the effluent limitations and conditions of this permit.

5. Adverse Impact

The permittees shall take all reasonable steps to minimize or prevent any adverse impact to the surface waters or groundwaters of the state resulting from noncompliance with any effluent limitation specified in this permit including, but not limited to, such accelerated or additional monitoring as necessary to determine the nature and impact of the discharge in noncompliance.

6. Containment Facilities

The permittees shall provide facilities for containment of any accidental losses of polluting materials in accordance with the requirements of the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code). For a Publicly Owned Treatment Work (POTW), these facilities shall be approved under Part 41 of the NREPA.

7. Waste Treatment Residues

Residuals (i.e. solids, sludges, biosolids, filter backwash, scrubber water, ash, grit, or other pollutants or wastes) removed from or resulting from treatment or control of wastewaters, including those that are generated during treatment or left over after treatment or control has ceased, shall be disposed of in an environmentally compatible manner and according to applicable laws and rules. These laws may include, but are not limited to, the NREPA, Part 31 for protection of water resources, Part 55 for air pollution control, Part 111 for hazardous waste management, Part 115 for solid waste management, Part 121 for liquid industrial wastes, Part 301 for protection of inland lakes and streams, and Part 303 for wetlands protection. Such disposal shall not result in any unlawful pollution of the air, surface waters or groundwaters of the state.

8. Right of Entry

The permittees shall allow the Department, any agent appointed by the Department, or the Regional Administrator, upon the presentation of credentials and, for animal feeding operation facilities, following appropriate biosecurity protocols:

- a. to enter upon the permittee's premises where an effluent source is located or any place in which records are required to be kept under the terms and conditions of this permit; and
- b. at reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect process facilities, treatment works, monitoring methods and equipment regulated or required under this permit; and to sample any discharge of pollutants.

9. Availability of Reports

Except for data determined to be confidential under Section 308 of the Federal Act and Rule 2128 (R 323.2128 of the Michigan Administrative Code), all reports prepared in accordance with the terms of this permit, shall be available for public inspection at the offices of the Department and the Regional Administrator. As required by the Federal Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Federal Act and Sections 3112, 3115, 4106 and 4110 of the NREPA.

10. Duty to Provide Information

The permittees shall furnish to the Department, within a reasonable time, any information which the Department may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or the facility's COC, or to determine compliance with this permit. The permittees shall also furnish to the Department, upon request, copies of records required to be kept by this permit.

Where the permittees become aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or information.

PART II**Section E. Activities Not Authorized by This Permit****1. Discharge to the Groundwaters**

This permit does not authorize any discharge to the groundwaters. Such discharge may be authorized by a groundwater discharge permit issued pursuant to the NREPA.

2. POTW Construction

This permit does not authorize or approve the construction or modification of any physical structures or facilities at a POTW. Approval for the construction or modification of any physical structures or facilities at a POTW shall be by permit issued under Part 41 of the NREPA.

3. Civil and Criminal Liability

Except as provided in permit conditions on "Bypass" (Part II.C.9. pursuant to 40 CFR 122.41(m)), nothing in this permit shall be construed to relieve the permittees from civil or criminal penalties for noncompliance, whether or not such noncompliance is due to factors beyond the permittee's control, such as accidents, equipment breakdowns, or labor disputes.

4. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittees from any responsibilities, liabilities, or penalties to which the permittees may be subject under Section 311 of the Federal Act except as are exempted by federal regulations.

5. State Laws

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittees from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by Section 510 of the Federal Act.

6. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize violation of any federal, state or local laws or regulations, nor does it obviate the necessity of obtaining such permits, including any other Department of Environment, Great Lakes, and Energy permits, or approvals from other units of government as may be required by law.

Appendix C: Environmental Assessment

Oakwood Wetland Map

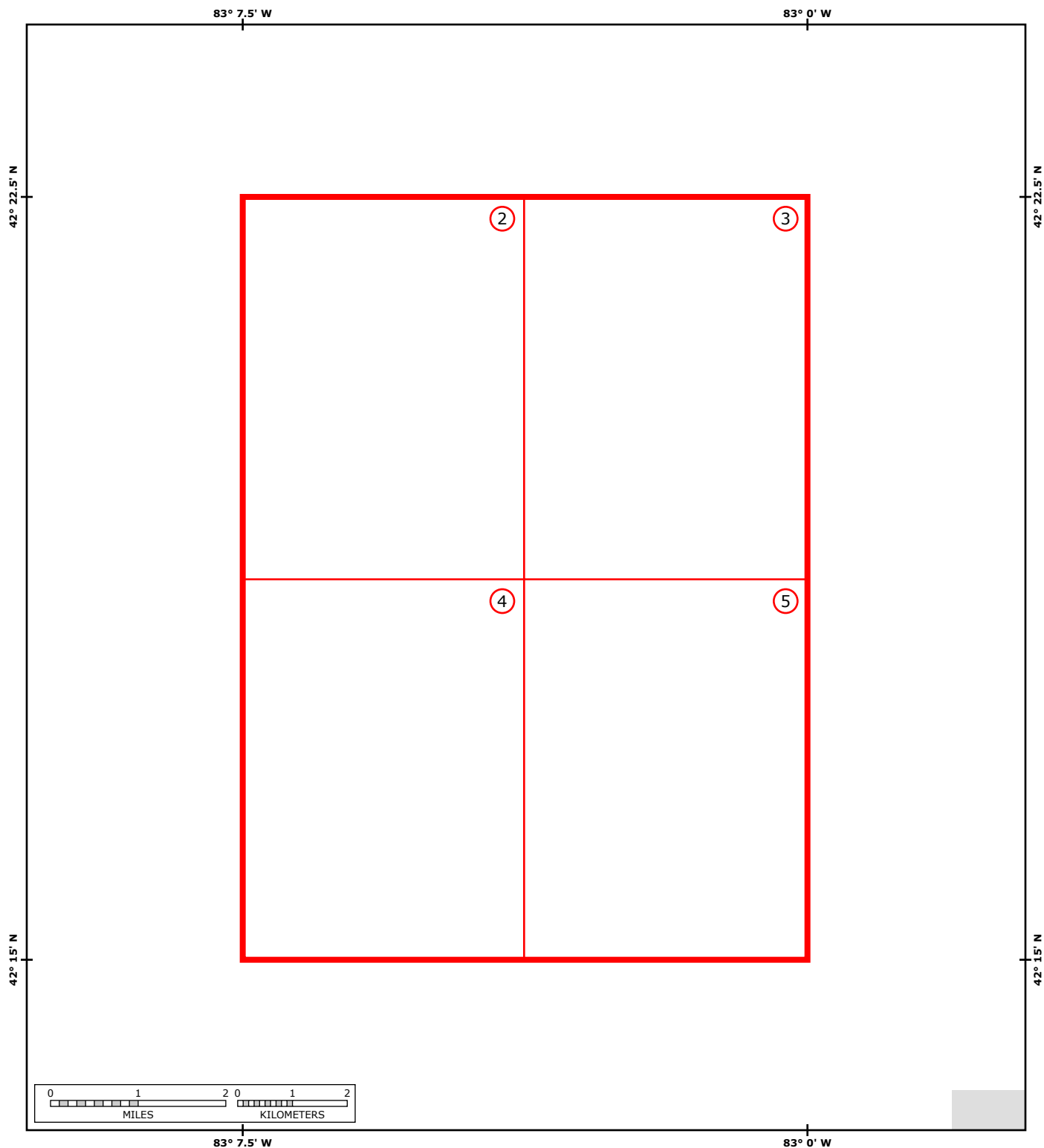


March 14, 2024

Wetlands

	Estuarine and Marine Deepwater		Freshwater Emergent Wetland		Lake
	Estuarine and Marine Wetland		Freshwater Forested/Shrub Wetland		Other
			Freshwater Pond		Riverine

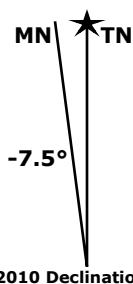
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.



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2010 Declination

Michigan

USGS Revision Date: 1980
Contour Interval on 7.5' Maps: 5 ft

Adjoining 7.5' Quads

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W	*	E
SW	S	SE

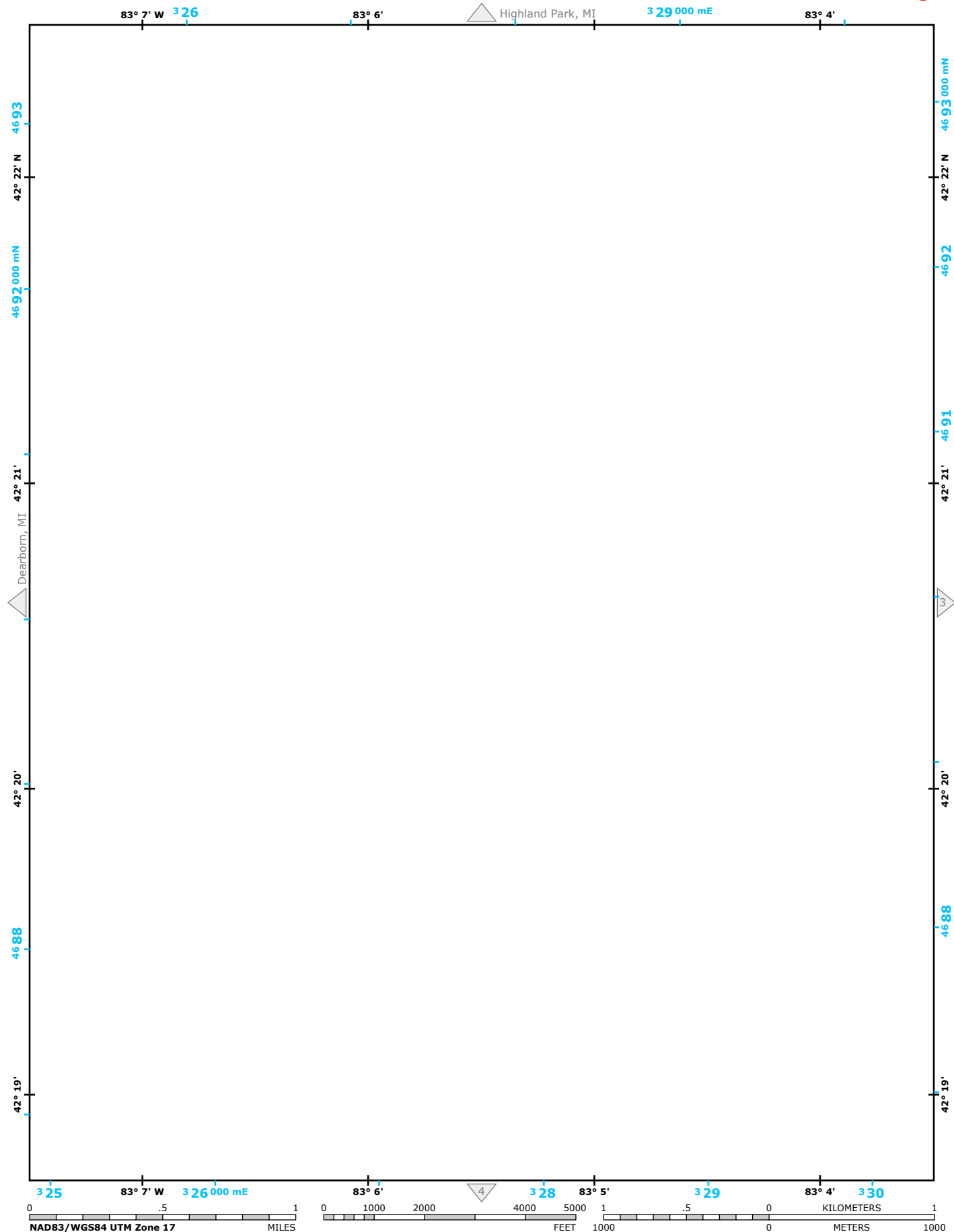
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N: Highland Park, MI
NE: Grosse Pointe, MI
W: Dearborn, MI
* Detroit, MI
E: Belle Isle, MI
SW: Wyandotte, MI
S: Wyandotte, MI
SE:

Detroit, MI



USGS 7.5' Map Series

2



NAD83/WGS84 UTM Zone 17

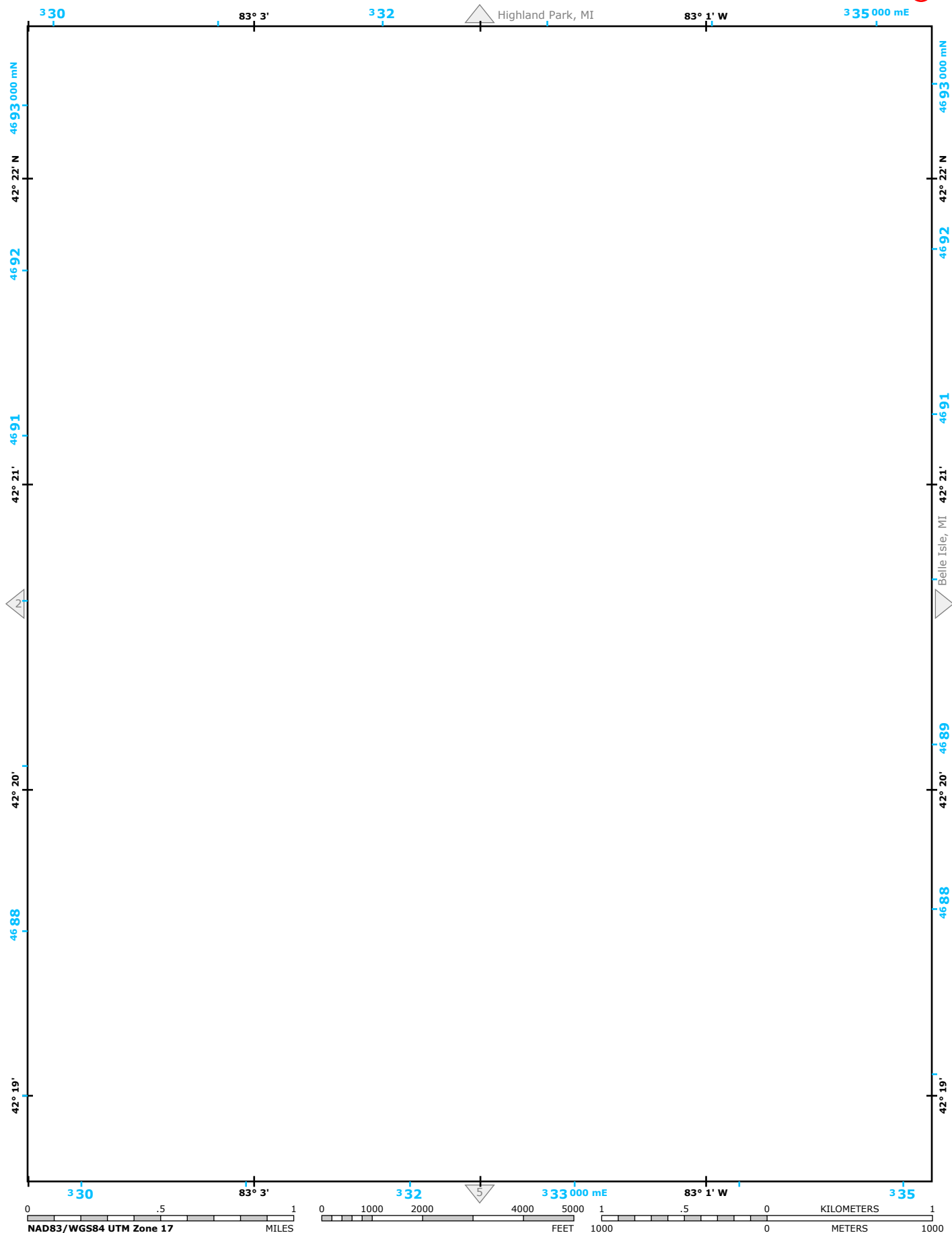
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Detroit, MI



USGS 7.5' Map Series

3



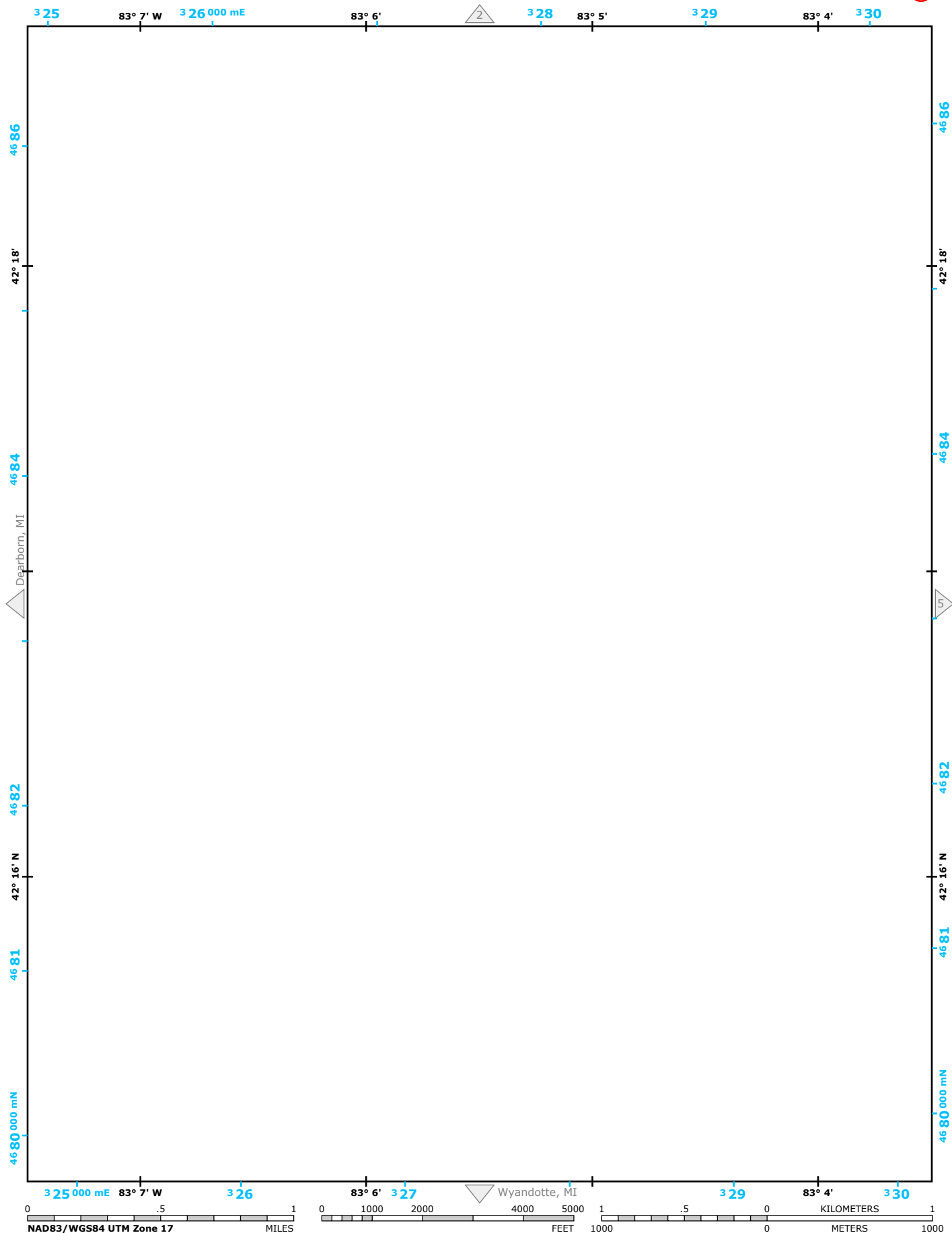
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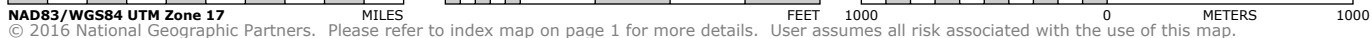
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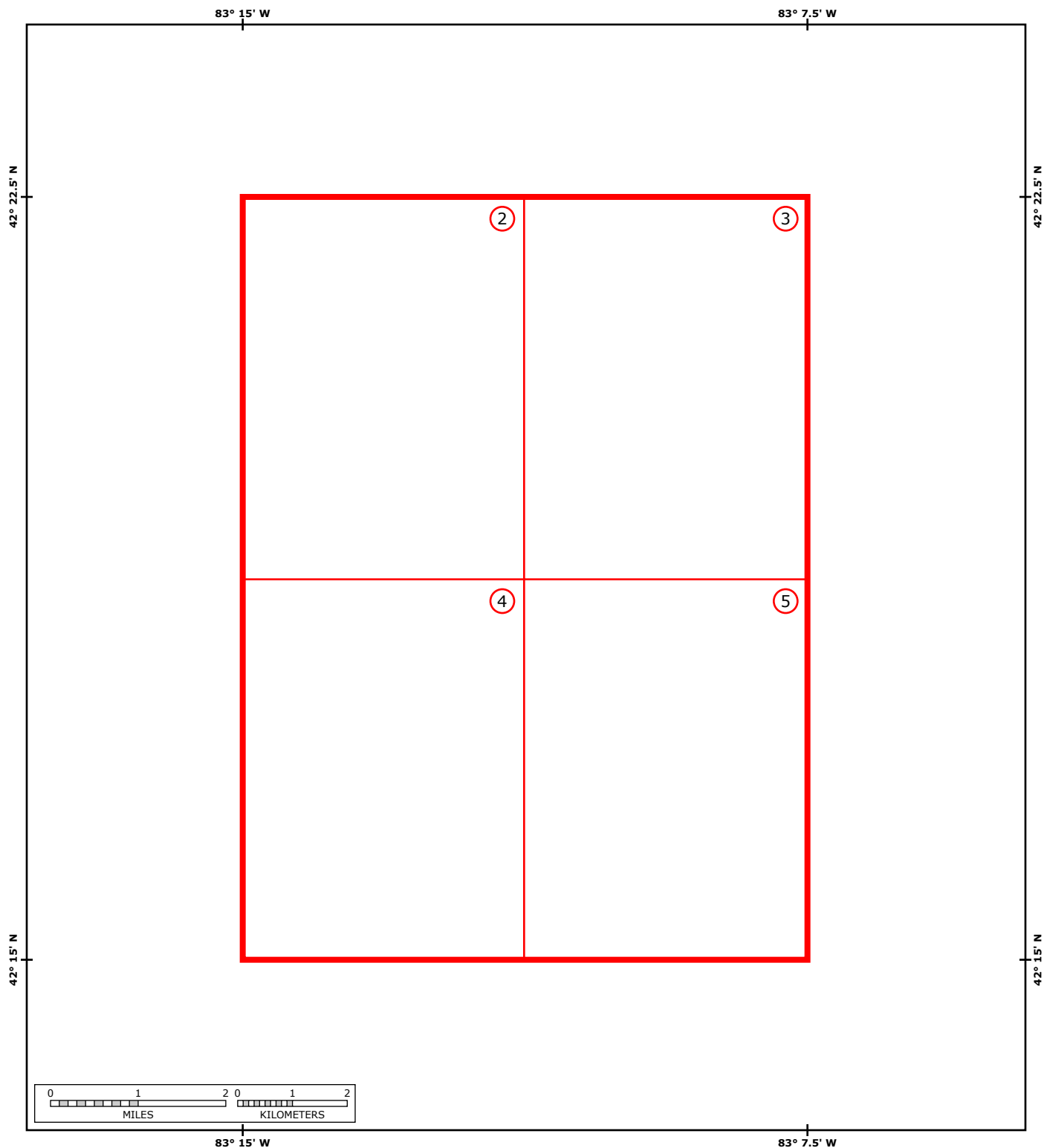
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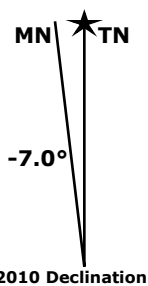




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Michigan

USGS Revision Date: 1983
Contour Interval on 7.5' Maps: 5 ft
Adjoining 7.5' Quads

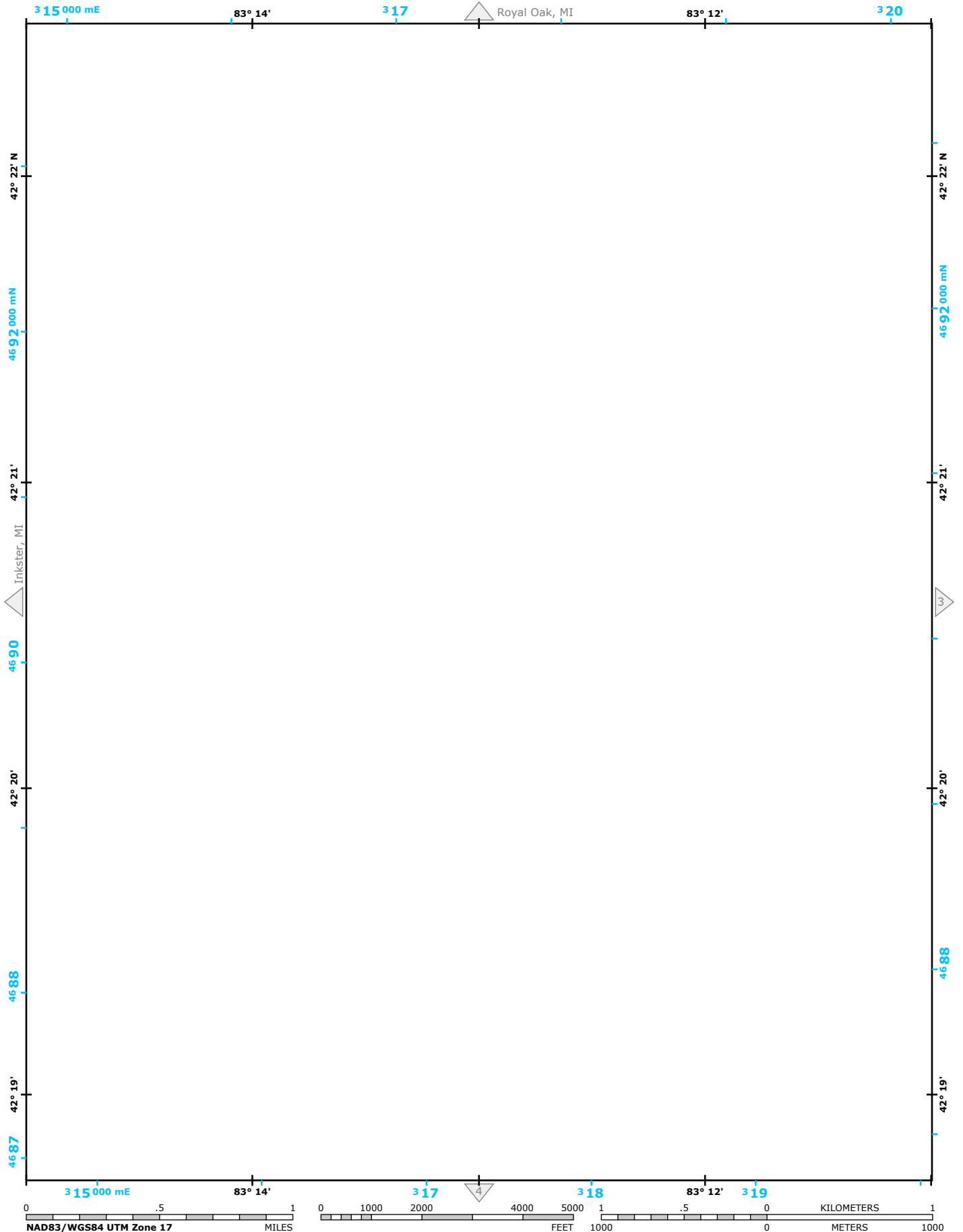
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W	*	E
SW	S	SE

NW: Redford, MI
N: Royal Oak, MI
NE: Highland Park, MI
W: Inkster, MI
* Dearborn, MI
E: Detroit, MI
SW: Flat Rock NE, MI
S: Wyandotte, MI
SE: Wyandotte, MI

Dearborn, MI

USGS 7.5' Map Series

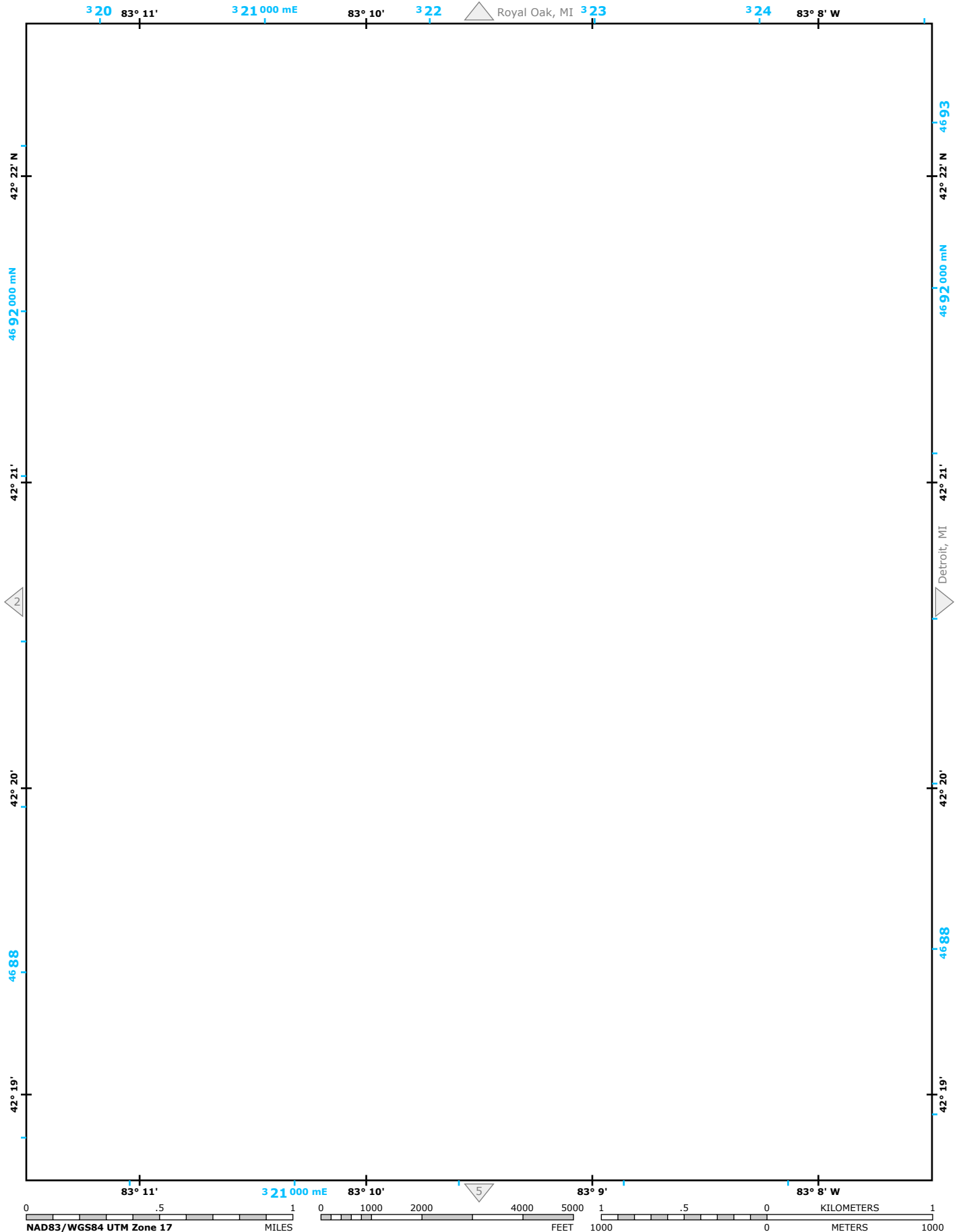
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Dearborn, MI

USGS 7.5' Map Series

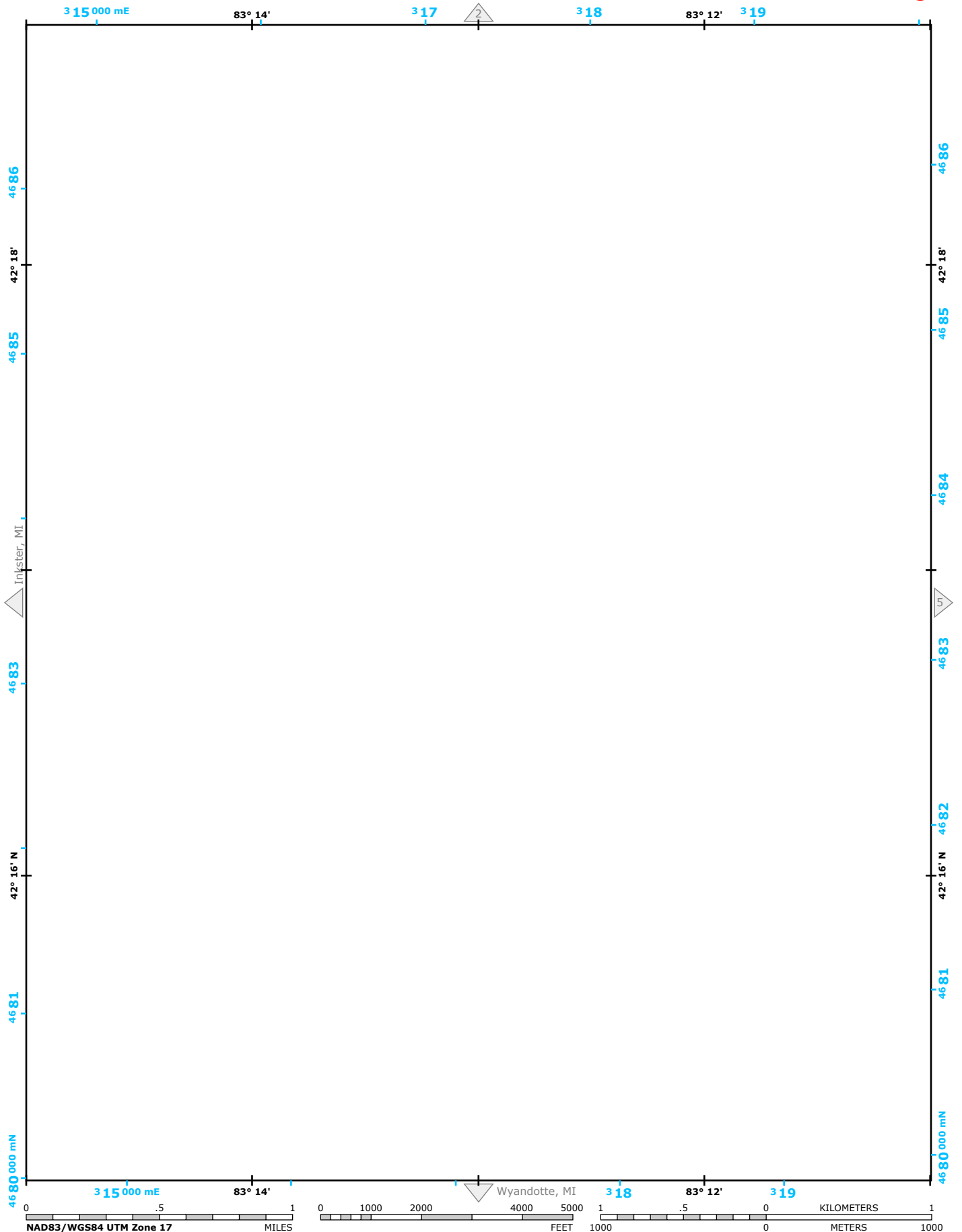
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USGS 7.5' Map Series

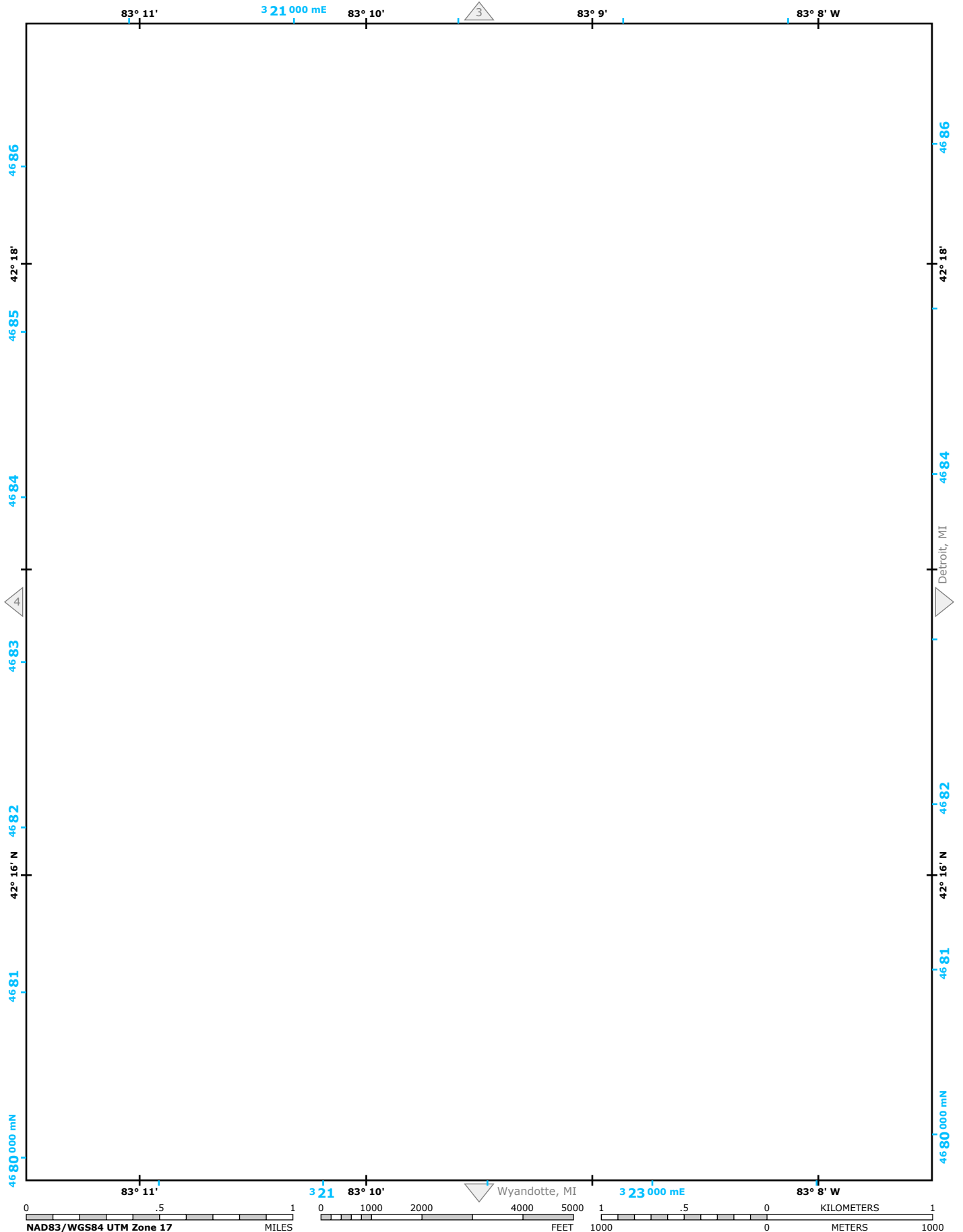
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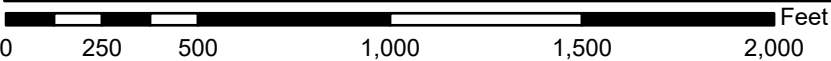
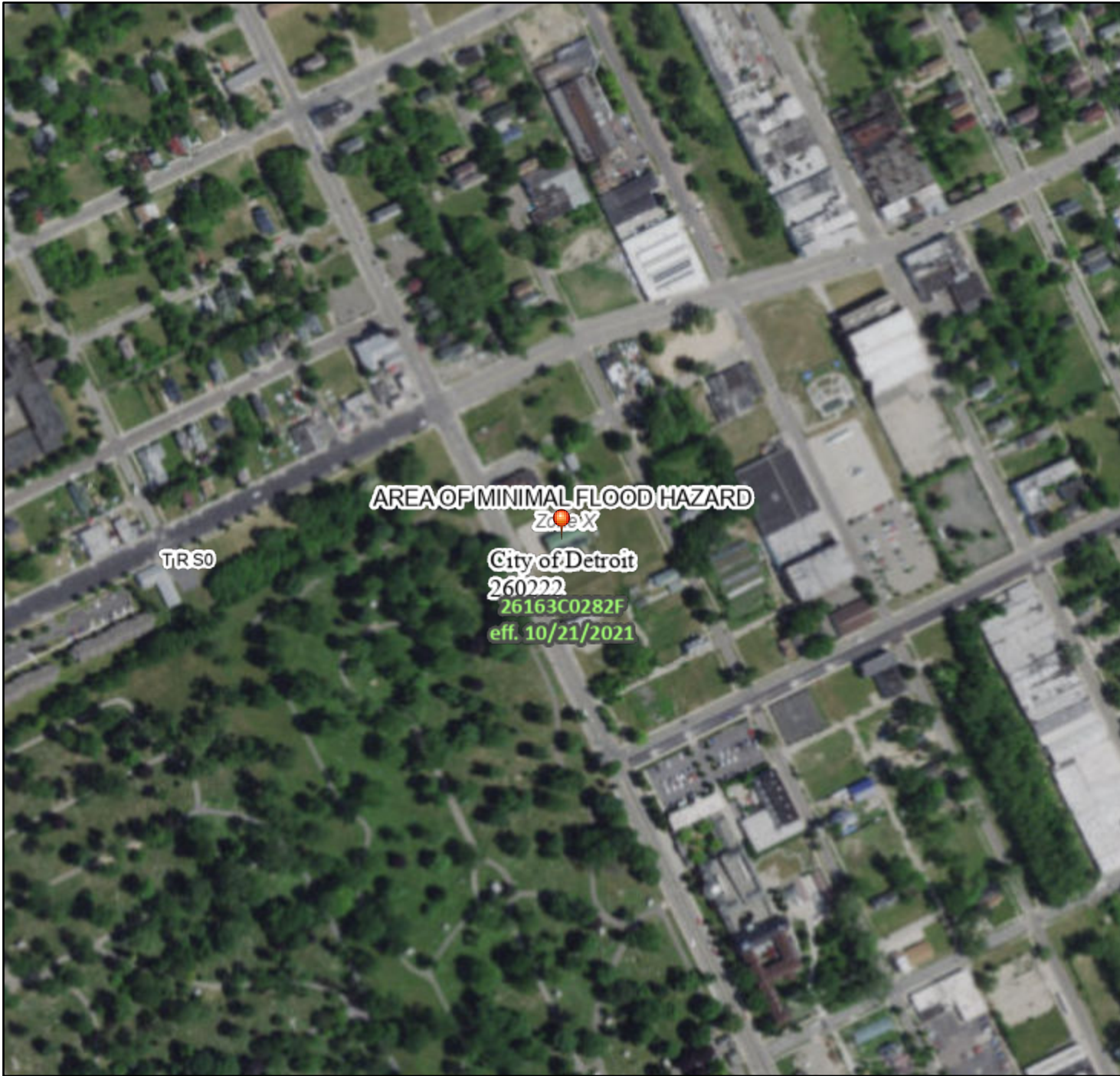
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NAD83/WGS84 UTM Zone 17 © 2016 National Geographic Partners. Please refer to index map on page 1 for more details. User assumes all risk associated with the use of this map.

National Flood Hazard Layer FIRMMette



83°1'17"W 42°21'28"N



1:6,000

83°0'40"W 42°21'2"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

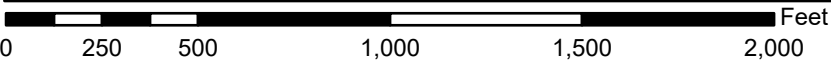
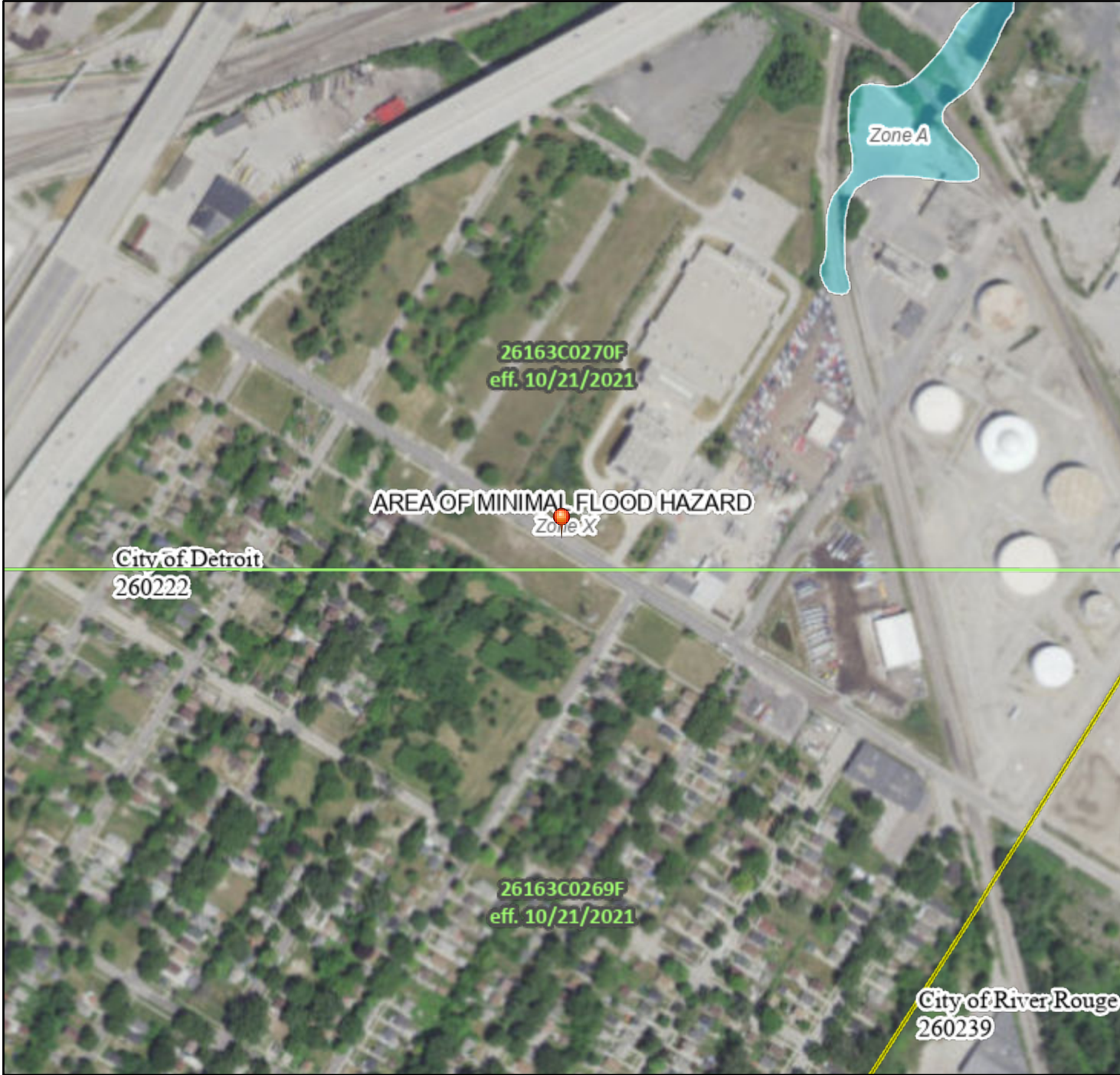
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National Flood Hazard Layer FIRMMette



83°9'W 42°17'N



1:6,000

83°8'22\"/>

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
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		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
MAP PANELS		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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Appendix D: Notice of Project Planning Public Meeting

Appendix E: CS-299



CS-299 CSO Facilities Assessment

Volume 2 Multi-disciplinary Facilities Assessment

FINAL

April 9, 2021

Great Lakes Water Authority



CS-299 CSO Facilities Assessment

Project No: C6A13300
Document Title: Volume 2 - Multi-Disciplinary Facilities Assessment
Revision: Final
Date: April 9, 2021
Client Name: Great Lakes Water Authority
Project Manager: Bruce Allman / Allen Gelderloos

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Document history and status

Version	Date	Description
Draft	August 21, 2020	Draft Multi-Disciplinary Needs Assessment
Final	April 9, 2021	Final Multi-Disciplinary Facilities Assessment

Contents

Overall CS-299 Facilities Assessment Organization

Volume 1 – Project Introduction and Capital Improvement and Outlay Plans

Volume 2 – Multi-Disciplinary Facilities Assessment

Volume 3 – Asset Audit, Condition Assessment, FMEAs, and Schedule Replacement Plan

Volume 4 – Reporting

Volume 5 – CSO System 5-Year SRF Project Plan

Volume 6 – Appendices

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Acronyms and Abbreviations

A	amperes
AACE	Association for the Advancement of Cost Engineering
ACH	air changes per hour
AHU	air handling unit
ATS	automatic transfer switch
BC	Baby Creek
BCE	Business Case Evaluation
BLI	Belle Isle
BTU	British thermal unit(s)
CCTV	closed-circuit television
CFD	computational fluid dynamics
cfm	cubic feet per minute
cfm/ft ²	cubic feet per minute per square feet
cfs	cubic feet per second
CIP	Capital Improvement Plan
Cl ₂	chlorine
CON	Conner Creek
CSO	combined sewer overflow
ct	counts
DDC	direct digital controller
DRI	Detroit River Interceptor
DTE	DTE Energy
EGLE	Environment, Great Lakes, and Energy
FRP	fiber-reinforced plastic
FSP	flushed solids pump
ft	feet
ft ²	square feet
gal	gallon(s)
GIS	geographic information system
GLWA	Great Lakes Water Authority
gpm	gallon(s) per minute
GPS	Global Positioning System
H ₂ S	hydrogen sulfide
HDPE	high-density polyethylene

HGL	hydraulic grade line
HIM	human interface module
HMI	human-machine interface
hp	horsepower
HS	Hubbell Southfield
HVAC	heating, ventilation, and air conditioning
HVU	heating ventilation unit
I&C	Instrumentation and Controls
I&I	infiltration and inflow
in.	inch
Jacobs	Jacobs Consultants, Inc
JOC	Job Order Contract
kV	kilovolt(s)
kVA	kilovolt-ampere(s)
kW	kilowatt(s)
LED	light-emitting diode
LEIB	Leib
mA	milliampere(s)
MAU	make-up air unit
MBH	1000 British thermal unit(s) per hour
MBtu	million British thermal unit(s)
MCC	motor control center
MG	million gallon
mg/L	milligram(s) per liter
MGD	million gallons per day
mL	milliliter(s)
mm	millimeter(s)
N/A	not applicable
NaOCl	sodium hypochlorite
NaOH	sodium hydroxide
NFPA	National Fire Protection Association
No.	Number
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
NPW	non-potable water

NWI	Northwest Interceptor
O&M	operation and maintenance
OEM	original equipment manufacturer
OIT	Operator Interface Terminal
OKW	Oakwood
PF	Puritan-Fenkell
PLC	programmable logic controller
pph	pound(s) per hour
ppmv	part(s) per million volume
PS	pumping station
psi	pound(s) per square inch
psig	pound(s) per square inch gauge
PTZ	point, tilt, zoom (camera)
PVC	polyvinyl chloride
RFP	request for proposal
rpm	revolutions per minute
RTB	retention treatment basin
RWCS	Regional Wastewater Collection System
SCADA	supervisory control and data acquisition
SDF	Screening and Disinfection Facility
SM	Seven Mile
SRP	Scheduled Replacement Plan
STA	St. Aubin
TDH	total dynamic head
TOES	Task Order Engineering Services
TRC	total residual chlorine
UV	ultraviolet
VFD	variable frequency drive
WAM	Work and Asset Management
WO	work order
WRRF	Water Resource Recovery Facility
WWMP	Wastewater Master Plan

4. Process Overview

4.1 General Combined Sewer Overflow Facility Descriptions

The Great Lakes Water Authority (GLWA) operates and maintains nine combined sewer overflow (CSO) facilities. The primary function of the CSO facilities is to screen, settle, skim, and disinfect combined sewer/storm water during rain events before discharge to the receiving water body or return captured water to the Wastewater Resource Recovery Facility (WRRF) for further treatment. These CSO facilities play a vital role in keeping combined sewer water out of residents of the City of Detroit's basements and protecting public health and the environment. All facilities must meet discharge requirements contained in GLWA's National Pollutant Discharge Elimination System (NPDES) permit. Detailed facility descriptions are provided in the following sections.

There are two types of CSO facilities: Retention Treatment Basins (RTBs) and Screening and Disinfection Facilities (SDFs). Both facilities provide screening and disinfection. The RTB provides dedicated settling within a retention basin. The SDFs provide contact time for disinfection within effluent conduits prior to discharge to the river. The effluent conduits are up to 1 mile long.

Table 4-1 presents key design criteria and general information for each facility.

4.2 Project Overview

This project consists of three main activities, which consist of the following:

- Asset Management Planning (Scheduled Replacement Plan)
- Performance Based Planning (Facilities Assessment)
- 20-Year Capital Improvement and Capital Outlay Planning

The three main activities and their relationship is demonstrated in Figure 4-1 and described in Sections 4.2.1 through 4.2.3.

Table 4-1. Key Design Criteria and General Information for GLWA’s CSO Facilities

	Baby Creek	Belle Isle	Conner Creek	Hubbell Southfield	Leib	Oakwood	Puritan-Fenkell	Seven Mile	St. Aubin
Facility Abbreviation	BC	BLI	CON	HS	LEIB	OKW	PF	SM	STA
Facility Type	SDF	RTB	RTB	RTB	SDF	RTB	RTB	RTB	SDF
Year of Startup	2005	2007	2005	1996	2002	2012	1996	1997	2002
Hydraulic Capacity (cfs)	5,100	33	13,963	3,200	2,000	1,660	845	655	310
River Level Basis for Hydraulic Capacity (Detroit Datum)	92.0	Not influenced by river elevation	97.5	102.0	Not influenced by river elevation	N/A	129.0	135.2	Documentation not found
Treatment Capacity ^a (cfs)	5,100	33	13,963/ 13,262 ^b	3,200/ 2,200 ^c	1,550	1,660	845	655	250
Storage Volume (MG)	3.0	0.3	30	22	9.9	9	2.8	2.2	2.4
Screen Type (size of slot or opening)	Perforated Plate (6-mm)	Perforated Plate (6-mm)	Bar Screen (1.5-inch)	Bar Screen (1.5-inch)	Raked Vertical and Horizontal Bar Screens (4-mm)	Perforated Plate (6-mm)	Bar Screen (0.5-inch)	Bar Screen (0.5-inch)	Raked Vertical Bar Screens (4-mm)
Disinfectant Type	Liquid Sodium Hypochlorite (NaOCl)								
Receiving Water Body	Rouge River	Detroit River	Detroit River	Rouge River	Detroit River	Rouge River	Rouge River	Rouge River	Detroit River

^a Treatment capacity refers to the design capacity of the screening and disinfection systems.

^b Based on Conner Creek Basis of Design report, the screening capacity is 13,963 cfs and disinfection capacity is 13,262 cfs.

^c Based on Hubbell Southfield O&M Manual, the disinfection capacity is 2,200 cfs. The screening capacity is not specifically listed and is assumed to be equal to the hydraulic capacity.

Notes:

cfs = cubic feet per second

MG = million gallon(s)

mm = millimeter(s)

N/A = not applicable

NaOCl = sodium hypochlorite

O&M = operation and maintenance

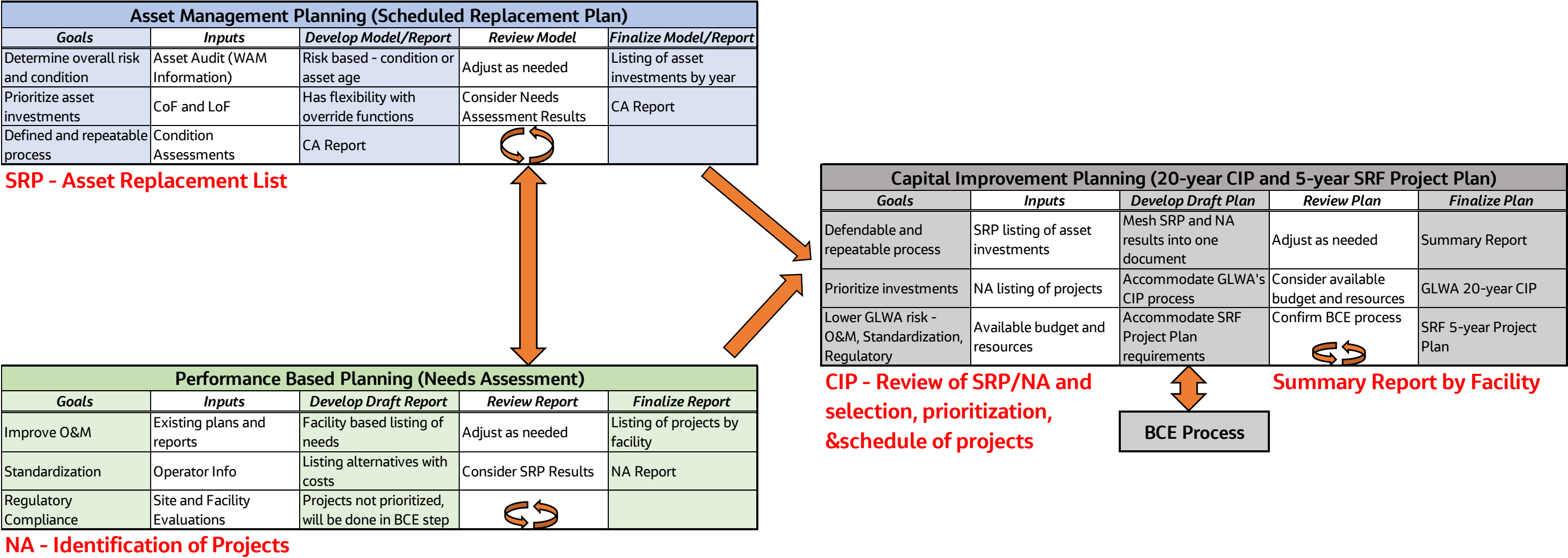


Figure 4-1. Relationship of Main Project Activities

4.2.1 Asset Management Planning (Scheduled Replacement Plan)

The Asset Management Planning (Scheduled Replacement Plan) is further described and the work was completed in Volume 3 – Asset Audit, Condition Assessment, FMEAs, and Scheduled Replacement Plan. This portion of the work focused on the existing GLWA CSO assets, populated asset information into GLWA's Computerized Maintenance Management System (CMMS) Oracle Work and Asset Management (WAM), gathered asset condition and depreciation information, and then utilized a mathematical model to determine when an asset should be replaced.

The Scheduled Replacement Plan (SRP) is an output of the SRP Model and is a listing of asset replacements and their costs over a 20-year planning period. The SRP utilizes the condition assessment results and asset information to calculate a scheduled replacement plan for each asset. The SRP information is then compared to the Facilities Assessment information to help make decisions on selection of Facilities Assessment alternatives, selected alternative implementation date, and possible bundling of alternatives into larger projects.

The SRP is strictly identifying when an asset should be replaced. This replacement is in-kind or with the current version, often the case of control systems. The SRP does not take into account future conditions such as regulatory change or increased/decreased flows. As shown in Figure 4-1, the SRP information is then coordinated with the Facilities Assessment to avoid duplication of budgets and to optimize bundling and scheduling of replacements and/or projects, while considering both existing and future asset needs.

The work completed in Volume 3 - Asset Audit, Condition Assessment, FMEAs, and Schedule Replacement Plan, specifically the SRP, is the first work completed within the overall CSO CS-299 project. This is the foundation of the condition and replacement of existing assets. This information will be pulled into Volume 2 – Facilities Assessment and used to optimize the overall delivery of existing asset replacement and Facilities Assessment projects. In this process, information in Volume 3 may become out of date if Volume 2 optimizes timing of the scheduled replacement of existing assets due to the Facilities Assessment. Therefore, Volume 3 information may not match the final information found in Volume 2.

4.2.2 Performance Based Planning (Facilities Assessment)

The Performance Based Planning (Facilities Assessment) is further described in this Volume 2 – Facilities Assessment. This portion of the work focuses on the current and future needs of the GLWA CSO Facilities such as improving Operations & Maintenance (O&M), increasing safety, standardizing equipment, anticipated flow requirements, and anticipated regulatory requirements.

Within the Facilities Assessment, site reviews of assets, interviews of O&M staff, and evaluation of current and reasonably anticipated future requirements of the CSO Facilities occurred. This resulted in a list of Facility Needs which should be addressed. Alternatives were developed to address these needs and generally include a Do Nothing alternative and one or more implementation alternatives. Each alternative was scored with non-economic benefit rankings and those benefits were compared to the Net Present Value (NPV) of the alternative. The NPV consists of the alternative's capital cost and annual operations and maintenance cost. The best value alternative consisted of the alternative with the lowest NPV/benefit ratio, which indicates the least amount of money required for the largest benefit.

Generally, the best value alternative was the selected alternative which moved on to Capital Improvement Plan (CIP) consideration. However, occasionally some alternatives had very similar NPV/benefit ratios or had external non-quantified benefits and therefore the best value alternative may not have been selected.

Once the Facilities Assessment alternatives were selected and a project identified, consideration of the accompanying assets from the SRP was completed. Some Facilities Assessment alternatives offered enhancements to existing assets or new assets and some alternatives offered replacement of existing assets. Therefore, consideration of the SRP was critical to avoid double budgeting of assets (replacement and needs) and to develop optimal bundling and scheduling of alternatives and projects to maximize the value of the existing assets. For example, the enhancement of a disinfection system should consider the condition of the existing disinfection system and, if appropriate, the enhancement implementation schedule should coincide with maximizing the life of the existing disinfection system.

The work completed in Volume 2 – Facilities Assessment, is the second phase of work completed with the overall CSO CS-299 project. This is the foundation of the facility performance needs and is impacted by the existing condition of assets and the scheduled replacement plan. Volume 2 – Facilities Assessment will optimize the facility needs and scheduled replacement plan and develop the 20-year CIP and 20-year Capital Outlay Plan on a Facility by Facility basis. This information will ultimately proceed to the Volume 1 – Project Information and Capital Improvement and Capital Outlay Plan.

4.2.3 20-Year Capital Improvement and Capital Outlay Planning

Following the development of the Facilities Assessment and SRP, individual CSO Facility 20-year CIPs and 20-year Capital Outlay Plans were created. This process is further described in this Volume 2 – Facilities Assessment report.

Projects for individual CSO Facilities were bundled and scheduled, and a 20-year CIP was developed. These nine 20-year CIPs are contained in this report in the following sections below. The intent of this report is to develop the nine individual CIPs.

Within the Facilities Assessment, a Capital Outlay Plan is developed for each CSO Facility. This plan was developed following the development of the specific CSO Facility CIP. Assets identified in the SRP, that are not being replaced in the Facilities Assessment selected alternatives, make it into the Capital Outlay Plan. Occasionally, a Facilities Assessment selected alternative may be of low complexity, low capital cost, and/or impacted with asset replacements and, therefore, may be included in the Capital Outlay Plan and not the CIP.

4.3 Purpose of Multi-Disciplinary Facilities Assessment

The purpose of this Multi-Disciplinary Facilities Assessment report is to document the identified improvements or needs at GLWA's nine CSO Control Facilities. A facility need is a required or desired improvement to meet current or anticipated changes to the CSO system such as regulatory requirements, hydraulic changes, health and safety, equipment standardization, and/or ease operation and maintenance (O&M).

Jacobs, in collaboration with GLWA staff, identified and evaluated these needs, developed total project capital costs, and provided information for needs prioritization through GLWA's business case evaluation process. The Facilities Assessment projects, along with projects from the Scheduled Replacement Plan (SRP), described further in the following section, will be incorporated into the CIP or Capital Outlay Plan.

4.4 Approach for Multi-Disciplinary Facilities Assessment

Jacobs Consultants, Inc (Jacobs) assembled a team of discipline-specific engineers to help identify and evaluate improvements at each CSO facility. The disciplines for this assessment included:

- Screening

- Disinfection
- Odor Control
- Flushing and Dewatering
- Heating, Ventilation, and Air Conditioning (HVAC) and Plumbing
- Electrical
- Instrumentation and Control (I&C)
- Site
- Architectural
- Safety
- Supporting Infrastructure
- Sanitary and Storm Pumping, if applicable

The needs were identified through the following activities:

- Review of the Wastewater Master Plan (WWMP) for any planned increased/decreased flows at each facility and the potential need for increased facility capacity or modified operation (i.e., RTBs converted to capture-only basins). The WWMP was completed by CDM Smith Inc. in 2020.
- Discipline-specific meetings with GLWA CSO O&M staff to obtain input on needs and issues within the facilities
- Observations during site visits by Jacobs team staff members
- Review of maintenance work orders from WAM
- Review of supervisory control and data acquisition (SCADA) data
- Review of original equipment manufacturer (OEM) condition assessments conducted under CS-299
- Projects to address the identified needs and issues were developed with two or more alternatives. The approach for alternatives evaluation is described in Section 4.7.

4.5 Organization of Multi-Disciplinary Facilities Assessment

The Multidisciplinary Facilities Assessment is organized by facility (in alphabetical order of facility name). The Facilities Assessment starts at Section 4. Section 4 provides the process overview for the Facilities Assessment and how the work was performed. Section 5 provides the evaluation of issues that are common to multiple facilities, such as standardized chemical feed system replacement. In an effort to reduce repetition, these issues are described once in this section and referred to in the facility-by-facility assessments, where applicable.

Sections 6 through 14 include the facility-by-facility assessment of needs. For each facility assessment, the needs are addressed by discipline in the order presented in Section 4.4.

4.6 Coordination with Scheduled Replacement Plan

In conjunction with the Multi-Disciplinary Facilities Assessment, Jacobs reviewed existing WAM data, as-built record drawings, O&M manuals, and met with GLWA O&M staff to identify assets, develop an asset hierarchy, and populate WAM with updated or new asset information. With current asset information established, GLWA and Jacobs collaboratively identified how condition assessments would be performed, either visually or detailed. The visual condition assessment was performed whether the asset was operating or not. Therefore, this was a less intensive condition assessment and a method commonly employed on lower risk assets. The detailed condition assessment was performed on operating assets and, depending on asset type, included such items as vibration, temperature, voltage, and amperage.

Jacobs performed onsite visual and detailed condition assessments of approximately 3,200 assets. This resulted in an asset condition score of 1 through 5, with 1 being nearly new and 5 being extremely poor or not operating. Utilizing the asset condition score, along with additional asset information such as useful life, install date, and replacement cost, Jacobs was able to calculate the asset's scheduled replacement.

The SRP consists of all the CSO assets and their calculated individual replacement date and costs. While a robust SRP following Asset Management best practices is highly important to balance asset risk and expenditures, the SRP process has a very limited ability to address future needs, such as those mentioned above and consisting of regulatory requirements, hydraulic changes, health and safety, equipment standardization, and/or ease O&M.

The SRP process and the Multi-Disciplinary Facilities Assessment report need to be coordinated to avoid excessive expenditures as well as balancing the upgrading of good condition assets. Once the Multi-Disciplinary Facilities Assessment projects are identified, projects that are directly impacting existing assets will be noted and linked to the asset. This will pull all information together so that GLWA staff and Jacobs can develop the prioritized projects for the CIP. For example, see Table 4-2, which demonstrates how decisions might be made based on the Facilities Assessment and SRP information.

Table 4-2. Example of Facilities Assessment and SRP Interaction

Facilities Assessment		Scheduled Replacement Plan		Recommendation
Description	Need Date	Condition	Replacement Date	
Project No. 1	2021	2	2035	Implement Facilities Assessment Project
Project No. 2	2025	5	2021	Implement SRP Project
Project No. 3	None Identified	3	2024	Implement SRP Project

The prioritization of the Facilities Assessment and SRP projects into the CIP may result in some assets in good condition being replaced early as in Project No. 1 above or some Facilities Assessment projects being implemented sooner based on corresponding poor condition assets such as in Project No. 2. The Facilities Assessment and SRP coordination process will be a manual and iterative process, however it is benefited by the work being completed concurrently.

Finally, Project No. 3 illustrates a project or asset that is not included in the Facilities Assessment and will ultimately be replaced as part of the SRP. As such, the intent of the Facilities Assessment is not to evaluate the replacement of every asset, especially those that will be replaced in-kind. Rather, the Facilities Assessment focuses on those needs associated with new regulatory requirements, hydraulic changes, health and safety, equipment standardization, and/or ease O&M.

4.7 Alternatives Evaluation Approach

Once needs were identified, projects were developed, and each project consisted of several types of alternatives for consideration:

- Do Nothing Alternative – replace existing assets in-kind or do not add enhancement assets
- Improvement Alternative – replace/improve existing assets with new technology or approach (includes standardization). This alternative is benefited by a comparison to the Do Nothing alternative which includes existing asset information.

- Improvement Alternative – enhance existing facility performance by adding new assets. This alternative is not benefited by a comparison to the Do Nothing alternative.

4.7.1 NPV/Benefit Ratio

To evaluate alternatives, a best value approach was established. This approach considers the non-economic benefit scoring of each alternative along with the economic Net Present Value (NPV) of each alternative. Then the ratio of NPV to benefit can be determined and an alternative with the lowest NPV/benefit ratio, is the best value alternative.

The non-economic benefits that were considered include:

- Benefit #1 – Health and Safety
- Benefit #2 - Water Quality and Compliance
- Benefit #3 – Capacity Enhancement
- Benefit #4 - Component Performance
- Benefit #5 - O&M Ease

These non-economic benefits were ranked on a scale of 1 to 5 for each benefit and each alternative, with the least benefit being 1 and greatest benefit being 5. When considering the benefit score, the actual number is not as important as the relationship of the scores between alternatives. For example, an alternative that has a significantly greater benefit should be scored accordingly with regards to other alternatives.

The NPV is determined by understanding the alternatives immediate capital cost along with the projected annual O&M cost. For several projects, the differential in O&M costs between alternatives is negligible so for simplicity, the alternatives did not include O&M costs in the NPV, as it would not change the results of the best value alternative.

This best value alternative works very well to defend and justify project alternative selections. However, occasionally additional external factors or the scale of the NPV versus the scale of the non-economic benefits do not align which results in the NPV/benefit ratio not being the best method of selecting an alternative. In those cases, engineering judgement and knowledge of the CSO facility and needs were utilized to select an alternative.

4.7.2 Do Nothing Alternative

Alternatives generally consisted of improvements to the facility but also considered a Do Nothing alternative. The Do Nothing alternative typically consists of pulling the SRP information for the existing assets associated with the Facilities Assessment project. This information contains total replacement costs of the associated assets. The Do Nothing alternative was then given benefit and NPV scores, and an NPV/benefit ratio was developed and considered against improvement alternatives.

Comparing the NPV/benefit ratios of the Do Nothing alternative against the improvement alternatives helped guide the selection of the best value alternative. In some cases, the improvement alternative was selected and, in some cases, the Do Nothing alternative.

Occasionally the Do Nothing alternative did not relate to existing assets as the project was based strictly on adding new assets. In these cases, the Do Nothing alternative did not have costs or an NPV/benefit ratio and, therefore, a best value alternative was not determined. However, the improvement alternative may have been selected when comparing its NPV/benefit ratio to other alternatives throughout this process and when considering external factors.

The SRP also pulls the information listed below (this information is pulled by assigning the Facilities Assessment project number, for example "BC-DIS-1", to the appropriate assets in the SRP):

- Total number of assets selected
- Maximum Consequence of Failure score of the selected assets
- Average Consequence of Failure score of the selected assets
- Maximum Condition Score of the selected assets
- Average Condition Score of the selected assets
- Maximum Risk Score of the selected assets
- Average Risk Score of the selected assets
- Average Life Expectancy of the selected assets
- Average Replacement Date (based on the condition score) of the selected assets
- Total Replacement Cost of the selected assets

The information listed above for the Do Nothing alternative is extremely helpful in determining the scheduling of projects. For example, when considering the standardization of a chemical feed system, the improvement alternative selected may suggest standardizing the chemical feed system. Then, when considering the asset information of the existing chemical feed system, it may be determined that the existing chemical feed system is projected to reach the end of its useful life in a few years and that time may be the optimal time for chemical feed system standardization.

4.7.3 Improvement Alternative

The improvement alternative typically consists of 1) replacing/improving existing assets with a new technology/ approach or 2) enhancement of the existing facility performance through the addition of new assets.

4.8 Capital Improvement Plan and Capital Outlay Plan Approach

The 20-year CIP and 20-year Capital Outlay Plan approach consists of projects for all nine CSO facilities that are to be debt financed (CIP) or revenue/cash financed (Capital Outlay). The CIP projects generally consists of improvements identified in the Facilities Assessment while the Capital Outlay Plan generally consists of the SRP assets.

4.8.1 Capital Improvement Plan Process Overview

The development of the 20-year CIP is based on the results of the Asset Audit, Asset Condition Assessments, SRP, and the Facilities Assessments. While all of this information influenced the development of the CIP, the greatest influencer is the Facilities Assessments and selected implementation alternatives.

Within the Facilities Assessment, site reviews of assets, interviews of O&M staff, and evaluation of current and reasonably anticipated future requirements of the CSO Facilities occurred. This resulted in a list of Facility Needs which should be addressed. Alternatives were developed to address these needs and generally include a Do Nothing alternative and one or more implementation alternatives. Each alternative was scored with non-economic benefit rankings and those benefits were compared to the Net Present Value (NPV) of the alternative. The NPV consists of the alternative's capital cost and annual O&M cost. The best value alternative consisted of the alternative with the lowest NPV/benefit ratio, which indicates the least amount of money required for the largest benefit.

Generally, the best value alternative was the selected alternative which moved on to CIP consideration. However, occasionally some alternatives had very similar NPV/benefit ratios or had external non-quantified benefits and therefore the best value alternative may not have been selected.

Once the Facilities Assessment alternatives were selected and a project identified, consideration of the accompanying assets from the SRP was completed. Some Facilities Assessment alternatives offered enhancements to existing assets or new assets and some alternatives offered replacement of existing assets. Therefore, consideration of the SRP was critical to avoid double budgeting of assets (replacement and needs) and to develop optimal bundling and scheduling of alternatives and projects to maximize the value of the existing assets. For example, the enhancement of a disinfection system should consider the condition of the existing disinfection system and, if appropriate, the enhancement implementation schedule should coincide with maximizing the life of the existing disinfection system.

4.8.2 Capital Outlay Plan Process Overview

The development of the 20-year Capital Outlay Plan is based on the results of the Asset Audit, Asset Condition Assessments, SRP, and the Facilities Assessments. While all of this information influenced the development of the Capital Outlay Plan, the greatest influencer is the SRP.

Within the Facilities Assessment, a Capital Outlay Plan was developed for each CSO Facility. This plan was developed following the development of the specific CSO Facility CIP. Assets identified in the SRP, that are not being replaced in the Facilities Assessment selected alternatives, make it into the Capital Outlay Plan. Occasionally, a Facilities Assessment selected alternative may be of low complexity, low capital cost, and/or impacted with asset replacements and therefore may be included in the Capital Outlay Plan and not the CIP.

4.9 Capital Cost Estimating Approach

Capital cost estimates were developed for capital improvement projects presented in this Facilities Assessment and for SRP projects (i.e., replace in-kind).

4.9.1 Capital Improvement Project Costs

Capital improvement projects represent those projects that would likely require design and construction assistance by a Professional Engineer and installation/construction by a Contractor. Capital cost estimates (included in Volume 6 – Appendices, Appendix C for all Facilities Assessment projects) used a uniform template with individual construction costs for major components of the project and then typical percentages for planning, design services, services during construction, additional project costs for the contractor, and design and construction contingencies. The total cost presented for each project represents a Total Project Cost. A summary of the cost categories and the associated source of costs is included in Table 4-3.

Table 4-3. Cost Categories for Capital Cost Estimating

Cost Category	Description	Method for Cost Generation
Project Definition, Planning and Preliminary Design	Represents costs for professional services to develop the project definition, planning and preliminary design concepts. Typically, this information would be used in development of the Design Services procurement documents. Budget for this scope is provided for every project, however GLWA staff may choose to complete this scope internally at minimal cost.	5% of Total Construction Cost

Cost Category	Description	Method for Cost Generation
Design Services	Represents costs for professional design services to produce contract documents that can be bid by a Contractor.	The cost of this service is based on a percentage inversely proportional to the total construction cost, with a higher percentage for lower cost projects and a lower percentage for higher cost projects.
Non-Construction Contingency	Contingency for the design phase to include unforeseen issues that need to be included in the design or be evaluated during design.	15% of Total Construction Cost for most projects.
Services During Construction	Represents costs for professional services that are not covered by GLWA staff to provide construction administration services, including submittal reviews, Requests for Information (RFIs), field inspection, material testing, etc.	Similar to Design Services, the cost of this service is based on a percentage inversely proportional to the total construction cost with a higher percentage for lower cost projects and a lower percentage for higher cost projects.
Total Construction Cost	Represents the cost for a Contractor to perform the work, assuming a Design/Bid/Build type of project delivery.	Sum of Project Cost of Work and Additional Project Cost for Construction.
Project Cost of Work	This cost represents the costs for the material, labor, and equipment to construct the scope of work.	Based on vendor quotes, Jacobs construction cost estimating software, and experience.
Additional Project Cost for Construction	Represents the additional costs of the Contractor to manage and deliver the scope of work. Also includes Construction Contingency based on Final Design.	▪ Contractor Overhead – 8% (of Project Cost of Work, typical for all costs in this category) ▪ Contractor Profit – 5% ▪ General Conditions – 10% ▪ Mobilization/Demobilization – 5% ▪ Insurance – 2% ▪ Performance Bond General – 1% ▪ Performance Bond Electrical – 1%
Construction Contingency Based on Final Design	Contingency (30% for most projects) to cover ancillary items not included in the line item costs and unforeseen conditions that are not known in the project planning phase.	30% of Project Cost of Work for most projects
Total Project Cost		Sum of the Project Definition, Planning & Preliminary Design, Design Services, Services During Construction and the Total Construction Costs

The Total Project Costs represent Class 4 estimates, as defined by the Association for the Advancement of Cost Engineering (AACE) International. The expected range of costs is -30% and +50% from the median value. It should be noted that in providing opinions of cost for projects, Jacobs has no control over performance of third party engineers/contractors; cost or price of labor and materials; unknown or latent conditions of existing equipment or structures that may affect operation or maintenance costs; competitive bidding procedures and market conditions; time or quality of performance by operating personnel or third parties; and other economic and operational factors that may materially affect the ultimate project cost or schedule. Therefore, Jacobs makes no warranty that the actual project costs will not vary from Jacobs opinions or estimates of cost.

4.9.2 Scheduled Replacement Plan Asset Replacement Costs

Replacement costs are provided for every asset in the CSO WAM database. These costs are used to provide capital costs in the SRP. The costs are intended to represent installed costs for the in-kind (or latest version) replacement of each asset. To populate these costs, Jacobs used previously generated costs from the 2013 SRP project (inflated to 2021 dollars), which included costs from Schedule of Values from the original construction project for the CSO basins. Where costs were not available, Jacobs obtained costs from construction cost estimating software or vendor quotes. Table 4-4 provides the mark-ups applied to the unit costs to generate the total replacement cost for each asset.

Table 4-4. Cost Categories for SRP Replacement Costs

Cost Category	Method of Cost Generation
Replacement Cost (including installation)	Previous SRP Replacement costs (inflated to 2021 dollars), construction cost estimating software, and vendor quotes
Engineering and Contingency	30% of replacement cost
Contractor Overhead and Profit	15% of replacement cost

5. Common Needs Among Multiple Facilities

5.1 Introduction

This section provides the evaluation of needs that are common or similar among multiple or all facilities. Disciplines with common needs include Disinfection, Electrical, Instrumentation and Controls (I&C), Structural, and Safety. To reduce repetition, these issues are described once in this section and referred to in the facility-by-facility assessments, where applicable. The review of past Maintenance Work Orders for all assets is included at the end of this section.

5.2 Disinfection

5.2.1 Overview and Review of Current Disinfection Performance

This section describes needs related to disinfection that are common among multiple facilities. Common needs for the disinfection systems at each facility include:

- 1) Replacement of Chemical Feed Systems
- 2) Provide Flow-Paced and Total Residual Chlorine (TRC)-Paced Automatic Chemical Feed
- 3) Reduce Costs Associated with Large Quantity of Chemical Induction Mixers

Table 5-1 provides a summary of the disinfection system at each CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G. Table 5-2 provides a summary of the sodium hypochlorite pumps and capacities at each facility.

Table 5-1. Overview of Disinfection Systems

Facility	Type	Install Date	Disinfection System Design Storm Flow (cfs)	Disinfectant Used	Design Feed Strength (% Hypo.)	Max. Dosage at Design Flow (mg/L Cl ₂)	No. of Storage Tanks	Total Vol. of Storage Tanks (gal)	Storage Tank Material	Type of Mixing at Feed Point	Contact Time (min)	No. of Mixers	Model Number/ hp	Manufacturer
Baby Creek	SDF	2006	5,100	Sodium hypochlorite	5	20	4	144,000	Rubber-lined steel	Chemical induction mixers	10	32	SWC15XPL 15 hp	Water Champ
Belle Isle	RTB	2007	33	Sodium hypochlorite	6-8	25	2	2,668	FRP	Chemical induction mixers	10	4	SWC15XP 15 hp	Water Champ
Conner Creek	RTB	2005	13,262	Sodium hypochlorite	10	25	4	380,000	Rubber-lined steel	Chemical induction mixers	5	60	SWC20XP 20 hp	Water Champ
Hubbell-Southfield	RTB	1996	2,200	Sodium hypochlorite	5	10	2	30,000	FRP	Chemical induction mixers	20	3	Series 32 25 hp	Gas Mastrrr
Leib	SDF	2002	1,550	Sodium hypochlorite	7.5	38	2	20,900	FRP	Chemical induction mixers	10	18	SWC15FX 15 hp	Water Champ
Oakwood	RTB	2012	1,660	Sodium hypochlorite	7.5	12	2	23,000	FRP	Diffuser ring	6 w/ 1 basin, 12 w/ 2 basins in service	Hypo added to pump discharge	N/A	N/A
Puritan-Fenkell	RTB	1996	845	Sodium hypochlorite	5	10 @ 845 cfs	2	8,000	FRP	Chemical induction mixers	20	2	SWC5R 5 hp	Water Champ
Seven Mile	RTB	1996	655	Sodium hypochlorite	5	10 @ 655 cfs	2	4,800	FRP	Chemical induction mixers	30	1	Series 32 10 hp	Gas Mastrrr
St. Aubin	SDF	2002	250	Sodium hypochlorite	10	38	2	10,400	FRP	Chemical induction mixers	10	7	SWC7.5FX 7.5 hp	Water Champ

Notes:
% = percent
Cl₂ = chlorine
FRP = fiber-reinforced plastic
hp = horsepower
mg/L = milligram(s) per liter

Table 5-2. Hypochlorite Pump Summary

Facility	Disinfection System Design Storm Flow (cfs)	No. of Pumps	Type of Pump	Capacity of Pump (gpm)	Manufacturer	Drive Type
Baby Creek	5,100	8 Total 2 low-rate 3 mid-rate 3 high-rate	Centrifugal	Low-rate: 0-50 Mid-rate: 0-150 High-rate: 0-400	Corcoran	VFD
Belle Isle	33	3	Diaphragm	10.4	Milton Roy	Adjustable stroke length and speed
Conner Creek	13,262	10	Centrifugal, magnetic drive	197	ITT Goulds Company	Constant speed
Hubbell-Southfield	2,200	5	Gear	10-55	Pulsafeeder (w/ standard coupler/drive)	VFD
Leib	1,550	8 Total 6 low-rate 2 high-rate	Low-rate: Diaphragm High-rate: Centrifugal	Low-rate: 7.6 High-rate: 112	Low-rate: Pulsa Series High-rate: Goulds	VFD
Oakwood	1,660	10 (3 low-rate, 7 high-rate)	Gear	Low-rate: 0-26 High-rate: 1.0-51	Pulsafeeder (with magnetic coupler/drive)	VFD
Puritan-Fenkell	845	4	Gear	20	Liquiflo	VFD
Seven Mile	655	4	Gear	20	Pulsafeeder (w/ standard coupler/drive)	VFD
St. Aubin	250	5 (2 low-rate, 3 high-rate)	Hydraulic diaphragm	Low-rate: 7.6 High-rate: 22.8	Pulsafeeder	VFD

Notes:
gpm = gallon(s) per minute
VFD = variable-frequency drive

NPDES Permit Requirements: The NPDES Permit No. M10022802 contains limits for fecal coliform and goals for TRC for all the CSO facility discharges. The permit specifies event maximum limits for fecal coliform bacteria of 400 counts (cts)/100 milliliter (mL) during the summer and 1000 cts/100 mL during the winter. The event maximum is reported as the geometric mean of all samples taken during an event, provided that three or more samples are collected.

The goals for TRC minimization are to "...operate the CSO retention treatment basins and CSO screening and disinfection facilities in a manner which will provide consistent, effective disinfection while minimizing the discharge of TRC...". The permit specifies operation goals for effluent TRC concentrations of 1.5 mg/L as an event average value and 2.0 mg/L (November 1 – April 30 or "winter") or 3.0 mg/L (May 1 – October 31 or "summer") as event instantaneous maximum values.

The permit defines that an "event" starts when combined sewage is discharged into a facility and ends when effluent flow ceases and does not resume within 24 hours. During an event, grab samples for effluent fecal coliform and TRC are collected every two hours for the first six hours of the discharge and every four hours thereafter for the duration of the discharge. For TRC, the average of all samples in an event is the "Event Average" and the maximum individual sample in an event is the "Event Maximum". On multiday events, the pollutant concentrations for the event are reported on the day the discharge event ends.

Historical Facility Disinfection Performance: Historical facility performance related to disinfection performance from 2016 through 2018 is presented in Volume 6 – Appendices, Appendix D. There are two graphs for each facility:

- 1) Daily Maximum Effluent TRC concentrations
- 2) Effluent Fecal Coliform and Average TRC concentrations

Effluent performance was assessed by comparing the reported event geometric mean fecal coliform concentrations to permit limits and the reported maximum and average TRC measurements to the permit operation goals. Upon review of the TRC data, it was apparent that the measurements were *daily* average and maximum measurements, rather than *event* average and maximum values. Additionally, there were several instances when the recorded maximum TRC value was less than the recorded average TRC value. In such cases, the dataset provided was checked against the Daily Monitoring Reports submitted to Environment, Great Lakes, and Energy (EGLE), and it was determined that the recorded values were simply switched. These errors were corrected by listing the greater value as the daily maximum measurement and the lesser value as the daily average measurement.

A summary of the findings and observations from this evaluation are provided in the following list:

- 1) The fecal coliform limit is typically met for every event, with a few exceptions. The facilities exceeding the limits and the corresponding number of times were as follows: Conner Creek (1), Leib (1), St. Aubin (2), and Baby Creek (2).
- 2) The summer and winter maximum effluent TRC goals of 2 and 3 mg/L are typically met. The SDFs appear to have slightly higher maximum values than the RTBs.
- 3) The operational goal for average TRC of 1.5 mg/L is typically exceeded for all facilities that discharge. This is likely due to the variable nature of CSO influent water quality, the fact that the operators first priority is to achieve permit compliance for fecal coliform, and the lack of automated chemical feed pacing.
- 4) There was no discharge from Puritan-Fenkell or Seven Mile during this period, therefore, the figures indicate "No Data Collected."

5.2.2 Replace Chemical Feed System

5.2.2.1 Introduction

Based on GLWA personnel input and observations during the site visits, the chemical feed systems at most of the facilities are in need of replacement to address one or more of the following:

- Replace aging, unreliable, and/or expensive to maintain chemical feed pumps and mixers
- Address inaccessible valves and appurtenances due to overly complex flow distribution schemes, and poorly laid out piping
- Increase turndown to not overdose during the more typical storm events while providing capacity for the infrequent peak instantaneous design storm flows
- Simplify the chemical feed system to improve manual operations should automated components be unavailable
- Ensure appropriate flow splitting to multiple mixers and diffusers in a given mixing zone including:
 - Replace old and unreliable back pressure valves to each mixer and diffuser
 - Provide a means of measuring pressure to verify back pressure valves are functioning properly and set equally
 - Provide flow indication for visual verification that flow is occurring to each location.

Additional facility specific needs are discussed in the facility-by-facility evaluation in the following sections. The evaluation and identification of chemical feed system alternatives for each facility are presented here and referenced in the facility-by-facility section because this section applies to most facilities.

5.2.2.2 Chemical Feed System Sizing

Based on GLWA observations and historical storm events, the chemical feed systems are generally oversized. The conservative sizing of chemical feed pump capacities is a result of the original facility design storm flows being greater than what has been observed as well as conservative assumptions on the required chlorine dose to meet permit fecal coliform requirements. Turndown of the oversized chemical feed system is exacerbated at Conner Creek where reliability issues with isolation gates results in flow being distributed across all bays regardless of how small the wet weather event is. The lack of isolation gates into the mixing zones results in a similar situation at Leib. Oversized chemical feed systems make it difficult to control dosing during smaller events. This increases the risk of exceeding the operational goals for TRC. Relevant information from past CSO facility studies was considered for sizing the chemical feed pumps for purposes of developing a capital cost budget.

The CSO facilities were originally designed based on modeled peak flow for a 10-year recurrence, 1-hour rainfall. Although continuous flow measurement records are not available, the design capacity at most or all of the facilities has never been reached based on available flow data and observations by GLWA personnel. Collection system modeling tools have improved since the modeling used for the design of these facilities. The most recent design storm results were obtained from the December 2019 Existing Conditions version of the Regional Wastewater Collection System model developed for the 2019 GLWA WWMP. The current predicted 10-year, 1-hour storm flows and the ratio of those flows as a percent of the original design flows are presented in Table 5-3.

Table 5-3. Comparison of Original and Current Predicted CSO Facility Design Storm Peak Flow Rates (10-Year, 1-Hour Flow Rates)

Facility	BC	BLI	CON	HS	Leib	OKW	PF	SM	STA
Original Predicted Facility Design Storm Peak Flow (cfs)	5,100	33	13,262	3,000 ^a	1,550	1,660	655 ^a	493 ^a	250
Current Predicted Facility Design Storm Peak Flow (cfs)	1,661	37	2,569	1,501	194	475	136	82	235
Ratio of Current to Originally Predicted Storm Flows (%)	33%	111%	19%	Not a comparable storm comparison	13%	29%	Not a comparable storm comparison	Not a comparable storm comparison	94%

^a The O&M manual provides the "10-year" Design Flow for 3.5 inch storm. It is assumed this is the 10-year, 24-hour storm event, since the 10-year, 1-hour storm is about 1.8 inches.

For the larger facilities with comparable design storms (i.e., Baby Creek, Conner Creek, Leib, and Oakwood) the predicted flows are less than half what was predicted for the same storm event when the facilities were designed. The generally lower flow predictions are partially explainable by:

- Recently modeled flows are in terms of peak hour while the original modeled flows were a shorter time increment
- The percent imperviousness of many of the service areas has decreased, thus contributing to less runoff
- More conservative assumptions in the original model

However, two concerns prevent revising the chemical feed system sizing based on the recent 10-year 1-hour modeling as follows:

- 1) There have been issues calibrating the model predicted flows to actual measured flows from storm events
- 2) The model predicted flows are less than past observed peak hour flows

At Conner Creek, which is the largest facility, the recently modeled 10-year 1-hour flow is only 19 percent of the original modeled flow. This would indicate that the facility is significantly oversized. However, the WWMP evaluated the flow distribution of 78 storms, 25 from 2005 to January of 2008 from the "Conner Creek CSO Basin Final Evaluation Report", and 53 from 2010 to 2014 discharge records, and found the peak flow at Conner Creek was 8,600 cfs and the average peak flow was 2,600 cfs. Thus, the modeled peak 10-year 1-hour event of 2,569 cfs was essentially equal to the average peak flow and significantly less than the historical peak from the 78 storms analyzed. The 8,600 cfs peak flow identified in the WWMP corresponds to 65 percent of the facility's design capacity. Based on the years analyzed, it would appear that the original design capacity of Conner Creek is overly conservative. However, the more recent modeled peak 10-year 1-hour flow does not appear to be conservative enough. Unfortunately, complete flow data is not available for the last 10 years at the CSO facilities to allow evaluation of the peak 10-year flow. Due to the absence of historical data and the fact that the recently modeled 10-year 1-hour event does not appear sufficiently conservative for design of disinfection facilities, the original facility design capacities will be used for sizing the chemical feed systems for capital budgeting. As additional flow data

becomes available with upgrades to flow measurement and recording, more modeling calibrated to actual flows could be considered during design to avoid oversizing the chemical feed system.

The selected design dose is also important to chemical feed system sizing. The original design doses vary from 10 mg/L as Cl_2 to 38 mg/L between CSO facilities. Experience at other CSO facilities indicates that the high doses assumed at some facilities are overly conservative considering both the improbability of needing the peak dose concurrent with peak flow when fecal coliform concentrations are likely diluted, and test data that would indicate diminishing disinfection benefits above certain doses.

For this evaluation under CS-299, a dose of 20 mg/L was assumed for all facilities except St. Aubin. A dose of 25 mg/L was assumed for St. Aubin because this facility had the highest average dose for the four largest storms evaluated from 2016 through 2018 and because a relatively recent report by another consultant assumed 24 mg/L. However, it is suspected that the higher dosing at St. Aubin was a result of turndown issues and lack of an automated control system and thus conservative. In addition, planning and budgeting for St. Aubin's disinfection system is not required because there is an ongoing design by another consultant at St. Aubin. Therefore, dosing requirements at St. Aubin are not further evaluated in this Facilities Assessment. The dose assumptions are believed to be sufficiently conservative for sizing the chemical feed systems for capital budgeting, especially when used in conjunction with the design peak flow rate. It may be appropriate to assume less conservative doses during design because oversizing the chemical feed system can lead to turndown issues for typical storm events.

The third most significant factor affecting chemical feed system sizing is the sodium hypochlorite strength. The sodium hypochlorite strength can vary either due to degradation or intentional dilution of a new delivery of sodium hypochlorite done to slow the degradation of sodium hypochlorite. The degradation of sodium hypochlorite is unique compared to most other chemicals used in wastewater treatment. The lower the sodium hypochlorite strength the larger the chemical feed system needs to be. The sodium hypochlorite strength is important because twice the feed rate is required for the same TRC if the sodium hypochlorite has degraded from 10 percent to 5 percent. An evaluation of sodium hypochlorite strength reported in recent years for the CSO facilities indicates that the strength has dropped to as low as 2 to 3 percent for all facilities that data was available, except Conner Creek. At Conner Creek the lowest reported strength was 5 percent. The hypochlorite strength has such a significant impact on sizing the chemical feed system that it is important to develop and abide by a policy of replacing the hypochlorite when the strength drops below a certain value. Depending on the quantity stored, this may be achieved by ordering a new delivery and mixing the low strength hypochlorite with the new full strength (e.g., typically on the order of 12.5 percent) hypochlorite. However, if the volume stored will excessively reduce the strength of a new delivery it would be necessary to dispose of the excess hypochlorite. Careful management of hypochlorite can be practiced to minimize the latter. For this evaluation under CS-299, a value of 5 percent was assumed as the minimum strength that sodium hypochlorite would be managed to for sizing the chemical feed pumps for purposes of developing a capital cost budget.

The assumed pump sizing is dependent on the sodium hypochlorite distribution approach and is thus presented in Section 5.2.2.4.

5.2.2.3 Chemical Feed System Pump Type

It is recommended that the existing pumps be replaced with either hose pumps (referred to as peristaltic pumps for smaller sizes) or magnetic drive centrifugal pumps. The advantages and disadvantages of these two types of pumps are noted in the following paragraphs. The final decision between the recommended types of pumps shall be determined during design. The preferred type of pump may also depend on what alternative is selected for flow distribution of sodium hypochlorite.

Hose Pumps: The advantages of hose pumps are listed in the following bullets:

- High turndown: With a totally enclosed non-ventilated motor and 60:1 variable-frequency drive (VFD), the hose pump maximum and minimum acceptable revolutions per minute (rpms) become the limiting factor. Higher than 20:1 turn down can be achieved by designing around atypically high rpms for the design peak flow storm events if this condition is expected to be rare. Turndowns on the order of the 60:1 VFD turndown may be possible by this approach.
- Positive displacement for accurate and repeatable metering
- Self-priming and suction lift capability of up to 30 ft thereby allowing full tank drawdown and allowing the pumps to be elevated on pads for spill protection
- Can pump air during priming, and sodium hypochlorite off-gassing will not bind the pump
- Hoses readily available for sodium hypochlorite (common application)
- No seals, diaphragms, glands, or exposed components to leak, corrode, or replace
- Eliminates need for check valves, seal water flush systems, and run-dry protection
- Standard parts (hose, bearings) for rehab

The disadvantages of hose pumps are listed in the following bullets:

- Higher initial cost than some other pumps
- Requires hose replacement
- Requires pulsation dampener which GLWA has had O&M issues with elsewhere
- If a hose wears through or bursts before replacement, then components of the pump will be exposed to the corrosive sodium hypochlorite
- Requires bumping the pumps per manufacturer's suggested schedule when idle (i.e., during dry weather and spare pumps) because the rollers compressing a fixed point of the hose for an extended period of time reduces hose life

The largest hose pump offered by Bredel is rated for 317 gallons per minute (gpm) continuous duty.

Magnetic Drive Centrifugal Pumps: The advantages of magnetic drive centrifugal pumps are listed in the following bullets:

- Generally lower initial cost than most pumps suitable for sodium hypochlorite
- Smaller footprint for the capacity than most pumps suitable for sodium hypochlorite
- Magnetic drive eliminates seals and leaks from drive shaft
- Centrifugal pumps are generally low maintenance
- GLWA has favorable experience using this type of pump at Conner Creek
- Eliminates need for pulsation dampeners
- Depending on the flow and head condition, higher capacities generally available compared to hose pumps

The disadvantages of magnetic drive centrifugal pumps are listed in the following bullets:

- Significantly less turndown than a positive displacement pump. This can result in the need for more pumps and potentially pumps of different sizes to cover the required range of flows.

- Not self-priming and less suction lift capability than a positive displacement pump. Therefore, these pumps cannot be elevated above the bottom of the tank as much as self-priming pumps for spill protection, and these pumps may not be able to draw a tank down to empty without supplemental priming provisions. The latter issue adds components and complexity and may decrease reliability. Although there are some self-priming models available, there are far fewer offerings than the standard non-self-priming sizes to cover the required range of flow and head conditions.
- Requires some appurtenances not required with a hose pump (e.g., check valves).
- Cannot run dry.
- Possibility of cavitation.

5.2.2.4 Sodium Hypochlorite Distribution Approach

In conjunction with pump replacement, it is recommended that the piping be replaced, and that the new piping be simplified compared to the current arrangement. Reasons for piping replacement include overly complex piping layouts, inaccessible valves and appurtenances, and failing joints in some facilities (e.g., Baby Creek). It is recommended that piping to and from the pumps be as simple as possible while maintaining necessary flexibility. Adding additional flexibility that is unlikely to be used adds complexity including additional valves to be exercised, the need for additional pressure relief valves wherever sodium hypochlorite off-gas could be trapped and can result in inaccessibility of components which is a common problem at the GLWA facilities. It is recommended that these points be carefully considered as the details of the piping are determined during design. A standardized pump per mixing zone or a standardized manifold approach is recommended for all GLWA CSO facilities. The final decision between the recommended options for sodium hypochlorite distribution should be determined during design considering the advantages and disadvantages. Two recommended options and piping arrangements are presented in the following paragraphs.

Option 1—Standardized Pump Distribution

This option would consist of utilizing a positive displacement pump for each mixing zone. The recommended type of positive displacement pump for this option is a hose pump (or peristaltic pump for smaller capacities) because of the advantages noted in Section 5.2.2.3. Each pump would require a VFD to adjust the dose in response to varying storm flows and chlorine demands. Each pump would pump to one mixing zone. One spare pump, or more if desired, is recommended with a tie-in to each primary pump to provide redundancy to each mixing zone without significantly increasing the complexity of the piping. The proposed configuration is illustrated in Figure 5-1.

Flow to each mixing zone would be split between mixers using back pressure valves. New back pressure valves are recommended to split the flow between injection points (e.g., mixers and or diffusers). A setting of 15 pounds per square inch gauge (psig) is recommended by Evoqua for Water Champ induction mixers. A pressure tap is recommended upstream of each back pressure valve to allow a calibrated pressure gauge to be moved between these taps to allow verification that each back pressure valve is set equally and to adjust the back pressure valve setting if not. A flow meter is also recommended to further verify equal flow splitting and to allow calculation of total flow rate to that mixing zone. Minimization of mixers and feed points is recommended as discussed herein to reduce the number of flow splits with back pressure valves, flow meters, and pressure gauge taps.

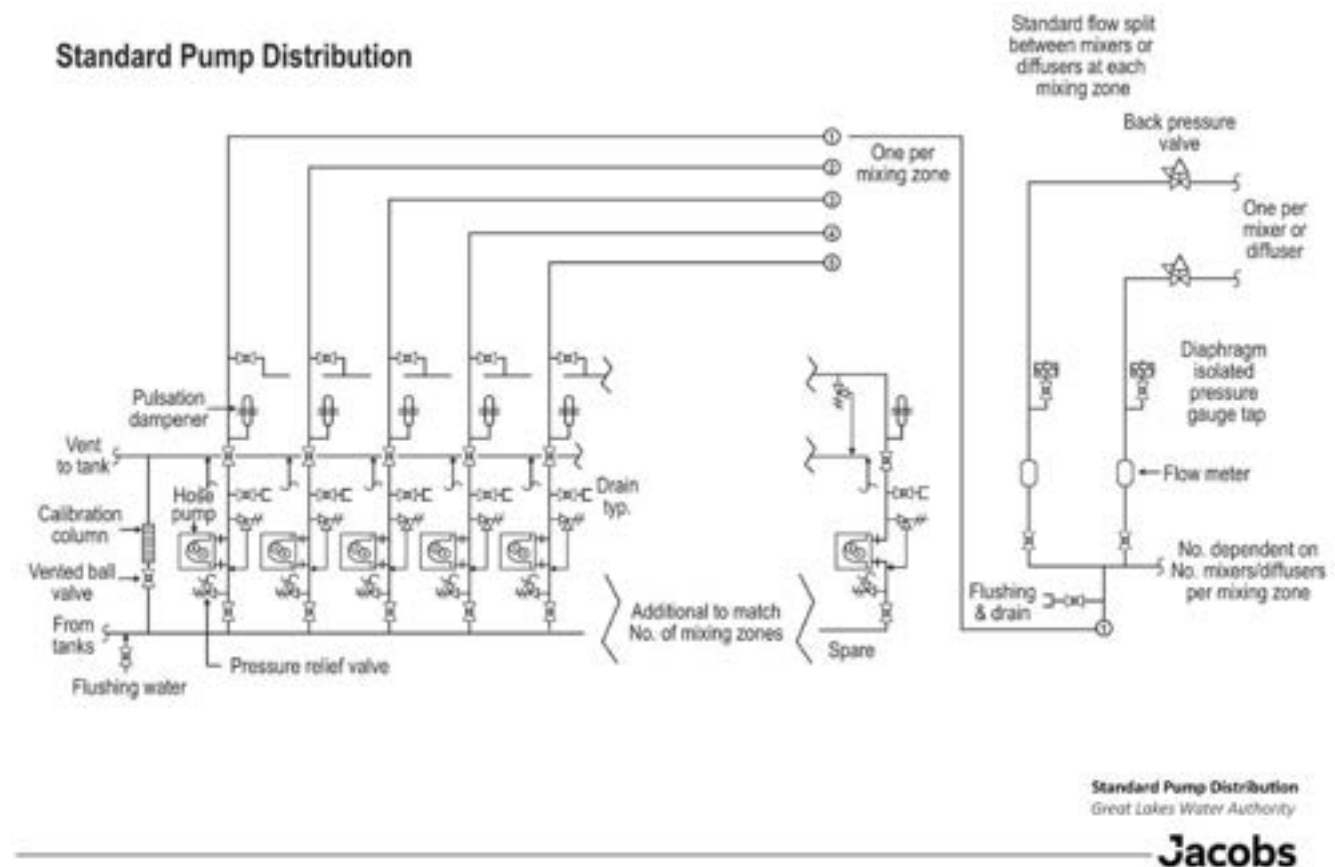


Figure 5-1. Standardized Pump Distribution

The advantages and disadvantages of this option are as follows:

Advantages:

- Simple and reliable control strategy with linear relationship between the pump speed and pump output (not reliant on flow meters due to the predictable speed vs. output relationship).
- Proven common approach for chemical dosing that will meet the permit requirements at each facility.
- Higher turndown ability than manifold option. Turndown ability is based on pump capabilities and not limited by instrumentation.
- If automated mode is not functional then manual mode would consist of manual pump speed adjustment for each pump in response to changing storm flow and TRC measurement.

Disadvantages:

- Higher number of pumps
 - Higher capital cost
 - Greater floor space required
 - More maintenance because pumps are higher maintenance than actuators in the manifold option
 - More equipment that could fail
 - More operations of equipment

Option 2 - Standardized Manifold Distribution

This option would be expected to allow a reduced number of pumps at facilities with a large number of mixing zones and would consist of the following: One or more pumps would pump to a manifold. Each pump would be controlled by a VFD. The pumps could be magnetic drive centrifugal or hose pumps. There would be one branch from the manifold for each mixing zone plus a spare connected to each to provide the same redundancy as the spare pump in Option 1. Every mixing zone would have its own flow meter and flow control valve. There would be a modulating pressure control valve on a recycle loop downstream of the manifold that is controlled to a pressure setpoint to ensure sufficient pressure to split flow in the manifold. The pumping rate is set sufficiently in excess of the desired sum of the feed rates to all feed points. Flow in excess of that distributed through the manifold is recycled to the feed pump suction header. The proposed configuration is illustrated in Figure 5-2.

Standard Manifold Distribution

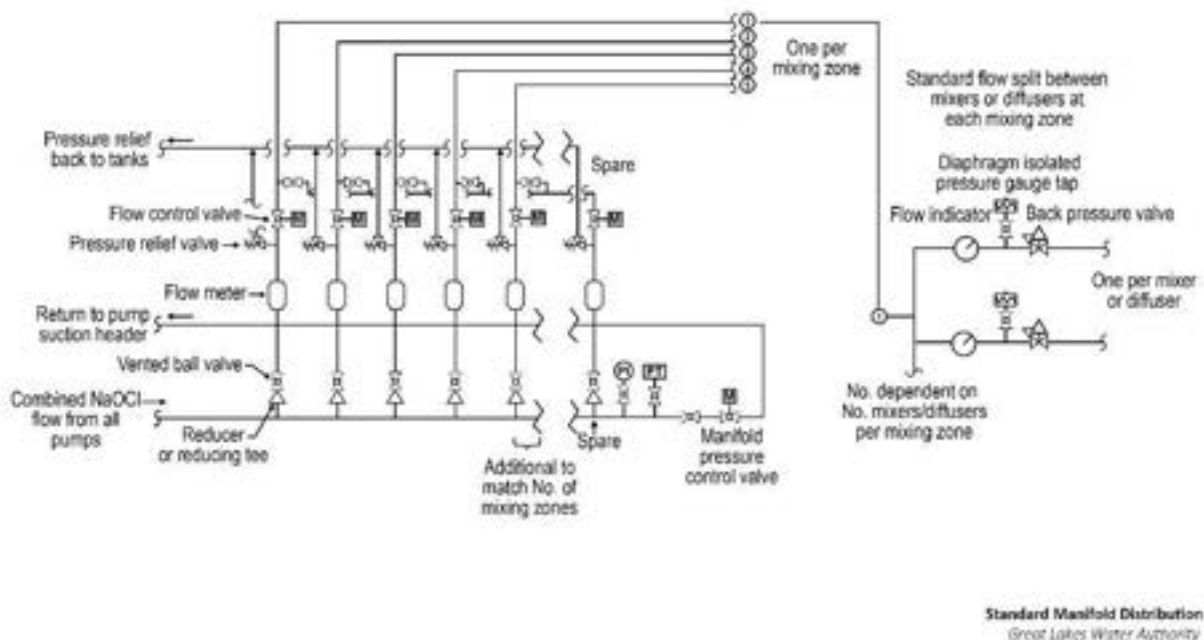


Figure 5-2. Standardized Manifold Distribution

Flow to each mixing zone would be split the same as Option 1, except given there will be a magnetic meter to each mixing zone the flow meters to each mixer or diffuser need not be sophisticated nor connected to SCADA. Therefore, a rudimentary visual flow indicator is recommended upstream of each back pressure valve. The flow indicators will allow a visual confirmation that hypochlorite is being provided to each location and an indication of equal flow splitting. Minimization of mixers and feed points is recommended as discussed herein to reduce the number of flow splits with back pressure valves, flow meters, and pressure gauge taps.

The advantages and disadvantages of this option are as follows:

Advantages:

- Minimizes number of pumps
- Proven approach to flow splitting.
 - Similar design by author has been in operation since the early 1990s at a WRRF.
 - There are many large WRRFs using a large number of flow control valve (FCV)/flow meter combinations to split air between aeration grids and multiple parallel aeration basins based on dissolved oxygen monitoring.
- A low number of pumps, and a flow control valve and flow meter combination per mixing zone, typically will have a lower capital and maintenance cost than a dedicated pump per mixing zone.
- Similar redundancy to a spare pump can be achieved with a spare branch from the manifold that ties into the discharge to each mixing zone from the manifold.

Disadvantages:

- Will require utilization of the number of mixing zones to match the storm flows. For example, a small storm event needs to be contained in one mixing zone while the peak storm event can utilize all mixing zones. This will ease the turndown requirements of the control instrumentation and the overall system.
- Lower turndown than possible with a dedicated peristaltic/hose pump approach. Minimum turndown of at least 16:1 and possibly as high as 26:1 per mixing zone.
 - The estimated maximum achievable turndown is based on a maximum allowable velocity of 8 ft/sec through a pipe and magnetic meter. Above this, noise and potential for cavitation in the flow control valve can become problematic.
 - The estimated maximum achievable turndown is based on a minimum velocity of 0.3 to 0.5 ft/sec. Below this, flow measurement can drop off to zero in magnetic meters and thus not be reliable.
 - Accommodating the required turndown from the infrequent design peak storm capacity to the more typical storm events could be problematic. The acceptability of the maximum achievable turndowns with this approach should be compared to ratios of peak design storm capacity to historical flows for each facility considering this approach.
- Must properly tune actuators at startup for steady valve operation.
- Even with well-tuned actuators, the valves must adjust frequently during a storm event to rapidly changing flows and chlorine demands, and to the influence of adjacent valves that are changing position.
- The pipe sizes required will result in small valves with large and heavy actuators that must be independently supported (i.e., pipe supports for the actuators).
- Must maintain multiple modulating actuators.
- If automated mode is not functional then manual mode would consist of manually adjusting the position of each of the flow control valves in response to changing storm flow and chlorine residual measurement, verifying adequacy and changing as necessary the pumping rate (but fewer pumps than the dedicated pump per mixing zone option), and verifying adequacy and changing as necessary the pressure control valve position to maintain sufficient pressure in the distribution manifold.

- Failure of the pressure control valve actuator would require manual valve adjustment that must be monitored and adjusted as necessary as the storm flow varies.
- Although not a high likelihood of failure, there is more length of common header piping than the dedicated pump option. This is because the hypochlorite is in a common header not only to the pumps but from the pumps to the manifold and on the return loop downstream of the pressure control valve. This common header length can be minimized by locating the manifold in the pump room. A failure in a common header would disrupt disinfection everywhere.

5.2.2.5 Pump Sizing for Capital Budgeting

As discussed herein, the original facility's design peak flow, an assumed dose of 20 mg/L chlorine for all but St. Aubin, and an assumed minimum sodium hypochlorite solution strength of 5 percent was assumed to size chemical feed pumps at each facility for soliciting budgetary pricing from the leading manufacturer of hose pumps for the two recommended options for feed distribution, as shown in Table 5-4 and Table 5-5.

Table 5-4. Option 1 – Pump Sizing for Standardized Pump Distribution

Facility	BC	BLI	CON	HS	Leib	OKW	PF	STA
Number of Prechlorination Pumps	0	0	0	0	1	0	2	1
Size of Each Prechlorination Pumps (gpm)	N/A	N/A	N/A	N/A	100	N/A	24	30
Number of Mixing Zone Pumps (includes one spare)	9	3	11	5	5	9	3	3
Size of Each Mixing Zone Pumps (gpm)	95	2	197	70	58	31	24	23

Table 5-5. Option 2- Pump Sizing for Standardized Manifold Distribution Using Hose Pumps

Facility	BC	BLI	CON	HS	Leib	OKW	PF	STA
Total Number of Pumps (includes one spare)	4	2	8	3	3	3	2	2
Size of Pumps (gpm)	253	5	282	164	115	124	48	47

The lack of turndown and resulting higher number of required pumps prevents the magnetic drive centrifugal pumps from being a recommended type of pump for Option 1. However, magnetic drive centrifugal pumps are a viable alternative for Option 2. Larger magnetic drive centrifugal pumps are available than with hose pumps. Therefore, budgetary pricing with fewer larger magnetic drive centrifugal pumps was solicited for Option 2 as shown in Table 5-6.

Table 5-6. Option 2- Pump Sizing for Standardized Manifold Distribution Using Magnetic Drive Centrifugal Pumps

Facility	BC	BLI	CON	HS	Leib	OKW	PF	STA
Total Number of Pumps (includes one spare)	3	2	6	2	2	2	2	2
Size of Pumps (gpm)	378	5	394	326	230	246	47	46

5.2.2.6 Chemical Feed System Alternative Costs for Identified Alternatives

The capital costs for the identified chemical feed system alternatives, including the replace in-kind alternative, are summarized in Table 5-7. Detailed cost estimates for each facility are provided in Volume 6 – Appendices, Appendix C under each facility.

Table 5-7. Capital Costs for the Pump Distribution and Pump Type Options

Identified Alternatives	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Facility	Replace In-Kind	Standardized Pump Distribution (Option 1) with Hose Pumps	Standardized Manifold Distribution (Option 2) with Magnetic Drive Centrifugal Pumps	Standardized Manifold Distribution (Option 2) with Hose Pumps
Baby Creek	\$1,657,000	\$3,325,000	\$1,237,000	\$2,388,000
Belle Isle	\$235,000	\$382,000	\$274,000	\$264,000
Conner Creek	\$2,919,000	\$5,409,000	\$2,300,000	\$4,369,000
Hubbell-Southfield	\$970,000	\$1,130,000	\$534,000	\$843,000
Leib	\$1,262,000	\$1,724,000	\$901,000	\$1,178,000
Oakwood	\$1,964,000	\$1,332,000	\$443,000	\$886,000
Puritan-Fenkell	\$340,000	\$687,000	\$383,000	\$545,000
Seven Mile	Not evaluated since facility will be converted to a Capture-Only			
St. Aubin	Evaluated under Sodium Hypochlorite Feed and Storage System Improvements. See Section 14.2.2.2.			
Total Capital Costs for All Facilities	\$9,348,000	\$13,989,000	\$6,072,000	\$10,473,000

It should be noted that Alternative 4 is not further included in the evaluation as it is nearly double the cost of Alternate 3 with no additional benefits or performance enhancements.

The following additional improvements to the sizing of the disinfection systems should be addressed for either Alternative 2 or 3, but are especially important if implementing the manifold alternative due to the lower turndown:

- Refine the maximum design flow once sufficient influent flow data is available from improved influent flow monitoring. While 10 years of reliable historical data will not be available in time for replacing the chemical feed systems, reliable influent flow data in conjunction with precipitation data should be used to better calibrate the collection system model. The model can then be used to determine an appropriate design flow once the model accurately predicts flow to a facility for a given precipitation event.
- Consider a lower design dose at peak flow. Monitoring influent bacterial counts versus flow and evaluating the probability of the peak dose being required concurrent with peak flow could further reduce the required pump sizing. A lower dose may be required at the design peak flow if bacterial counts decrease due to dilution with increasing flow. For example, if the required dose at the design peak flow was determined to be only 10 mg/L rather than 20 mg/L, this would allow the hypochlorite pump sizing to be half that assumed. This in turn would allow dosing at a much lower rate during small wet weather events and thereby help address the turndown limitation of the manifold compared to the pump distribution alternative.

5.2.3 Flow-Paced and TRC-Paced Automatic Chemical Feed

5.2.3.1 Introduction

Based on GLWA personnel input and observations during the site visits, the chemical feed systems do not operate in automatic as intended at any of the facilities. GLWA desires a simple, automated chemical feed system that will improve GLWA's ability to meet both fecal coliform criteria and TRC goals. Manual control is undesirable for the following reasons:

- Operation in manual requires frequent manual adjustments in response to varying storm flow.
- Operation in manual requires frequent sampling and analysis of TRC which is time consuming. This reduces available time for monitoring the facility and attending to other O&M needs.
- Except for extreme storm events at the facilities designed for 5 to 10 minutes contact time, the effluent sample points represent too long of a time delay between the hypochlorite dosing point and measuring point. Thus, adjustments in response to the TRC sampling and analyses at the effluent permit compliance point inherently results in poor control.

The considerations for automating chemical feed pacing are presented here and referenced in the facility-by-facility section because this section applies to most facilities.

5.2.3.2 Automated Sodium Hypochlorite Feed Approach

Consistent dosing in response to rapid changes in flow requires flow pacing, and refinement of the dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The control strategy would be as follows: The operator inputs a starting chlorine dose in terms of mg/L as Cl_2 . The chemical feed rate to that mixing zone would be controlled automatically to achieve that dose based on total facility flow and number of mixing zones in service. Flow splitting between mixers and or diffusers in a given mixing zone would be by non-automated means as described in Section 5.2.2.4 and thus would not be included in the control loop.

The operator will also input a target TRC. A new TRC analyzer sampling slightly downstream of the dose point (e.g., a certain number of minutes downstream at average flow) will be required for this control. The TRC setpoint would be what is desired after complete mixing and the initial rapid chlorine demand. If the measured TRC is less than the setpoint, then the operator entered target dose, still controlled by flow, would be automatically increased to eliminate the difference between the measured TRC and setpoint TRC (i.e., the primary control parameter will be flow pacing to maintain a target dose and the TRC analyzer will be used to adjust the target dose to account for CSO variability). Operator adjustable time delays would also be provided to allow for the adjusted dose to reach the TRC probe before the measurement is used to make the next adjustment to the dose. This approach is anticipated to control both effluent coliform and effluent TRC to a tighter range than possible based on the current manual approach to chemical dosing.

A second TRC analyzer is recommended at each CSO facility for the final discharge point. This will facilitate tweaking the setpoint for the upstream TRC analyzer discussed above and thereby improve compliance with the TRC goal at the discharge. The effluent TRC analyzer results can either be manually considered in tweaking the upstream TRC set point, or if GLWA prefers, it could be used automatically to adjust the upstream TRC setpoint. For example, if it is desired to target a 1 mg/L effluent TRC and the measured effluent TRC is 2 mg/L, and the upstream TRC setpoint was 5 mg/L, the upstream TRC setpoint could be automatically decreased by this 1 mg/L differential to 4 mg/L. And if the measured effluent TRC is 0 mg/L

the upstream TRC setpoint could be increased in increments (e.g., 0.5 or 1 mg/L) with adequate time delays between adjustments, until the effluent TRC reaches 1 mg/L.

Having online TRC analyzers will not only allow effluent coliform and effluent TRC to be controlled to a tighter range than is possible through manual measurements and feed rate adjustments but it will also free up time spent chemically analyzing TRC during a storm so that operators are able to spend their time attending to other needs and monitoring the facility.

Automated control systems require that the flow measurement and TRC analyzers be well maintained and calibrated. With eight active (i.e., excluding Seven Mile) CSO facilities and the recommendation for two TRC analyzers per facility, it is recommended that a single entity, whether internal or contracted, be responsible for maintaining the TRC analyzers to ensure these instruments are operating properly.

Operator training will be critical for successful transition to automated dosing. It is important that the training convey, and operators implement the following:

- The concept of dose being in terms of a concentration (i.e., mg/L) because of the correlation between dose and residual chlorine.
- Regular measurement and entry of sodium hypochlorite strength into the control system. This is important because twice the feed rate is required for the same TRC if the sodium hypochlorite has degraded from 10 percent to 5 percent. The degradation of sodium hypochlorite is unique compared to most other chemicals used in wastewater treatment.

Good operator training will also facilitate operation in manual mode should the TRC analyzer and or flow measurement be out of service. If the TRC analyzer is out of service, the automation system should be designed to allow the flow pacing control to continue. Manual adjustments of the dose should primarily be based on sampling at the upstream TRC sample point with the effluent TRC sample point being a secondary consideration due to the time delay issue discussed above.

5.2.3.3 Review of TRC Analyzer Manufacturers

There are multiple manufacturers with successfully operating TRC analyzers in wastewater applications. The primary types are colorimetric and amperometric. Some require reagents and some are reagent-less. The decision of which analyzer to choose should be based on consideration of some of the attributes of one analyzer versus another and discussions with personnel at other WRRFs or CSO facilities regarding their satisfaction with the equipment. The following are examples of manufacturers that GLWA may want to consider:

- Swan
- Evoqua Wallace & Tiernan
- Chemsan
- Hach
- Rosemount

GLWA may wish to pilot several to identify a preferred analyzer. Once an analyzer is proven at one facility, it is recommended that all the facilities standardize on this TRC analyzer to simplify calibration and maintenance, and to facilitate operators rotating between CSO facilities.

5.2.3.4 Identified Alternatives

Based on the discussion above, the identified alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

5.2.4 Reduce Cost Associated with Large Quantity of Chemical Induction Mixers

5.2.4.1 Introduction

Based on GLWA personnel input and observations during the site visits, reducing the quantity of induction mixers, especially at the facilities with a large number of induction mixers, is desired for the following reasons:

- The mixers are expensive to maintain and due to the sealed nature of submersible mixers they must be sent back to the manufacturer for maintenance
 - Manufacturer maintenance costs are higher than equipment that can be maintained in house
 - Shipping adds costs
 - Turnaround of the Evoqua induction mixers utilized at the majority of GLWA's CSO facilities takes months before the mixer is returned to service.
- Splitting chemical feed to multiple mixers complicates the chemical feed system (e.g., additional back pressure valves, flow metering, pressure monitoring, and piping)

For these reasons, a mixer evaluation was conducted under CS-299 that is applicable to multiple facilities. The importance is greatest at the facilities with the most mixers as follows:

- Conner Creek: 60 induction mixers
- Baby Creek: 32 induction mixers
- Leib: 18 induction mixers

The next largest number of mixers is St. Aubin with seven induction mixers. After that there are only two to four induction mixers per facility and thus the number of mixers at these facilities is not as significant.

The recommendations for facilities requiring a mixer evaluation are presented here and referenced in the facility-by-facility section because this section applies to multiple facilities.

The following alternatives for reducing costs of mixers at Conner Creek, Baby Creek and Leib are provided in the following list and described in the following sections:

- 1) Use an equivalent, less costly induction mixer (potentially Gas Mastrrr induction mixers) for all facilities
- 2) Reduce quantity of induction mixers
- 3) Use a different type of mixer (i.e., vertical shaft)

5.2.4.2 Comparison of Water Champ and Gas Mastrrr Induction Mixers

There are two manufacturers of induction mixers at the CSO facilities, Evoqua Water Champs and Mastrrr Company Gas Mastrrr induction mixers. There are 123 Water Champs at six CSO facilities compared to

only four Gas Mastrrr mixers at two CSO facilities, therefore the majority of GLWA's experience is with Water Champs. The Water Champs have had a higher purchase price, and it is desired to determine if the two manufacturers can be competitively bid when replacing mixers. Therefore, it was requested that the mixing intensity, as defined by the G-value, be compared for the Gas Mastrrr units versus the Water Champs for a given horsepower (hp) unit.

G-Value: Information was gathered on the cone of influence and corresponding mixing energy (referred to as "G-value") for both manufacturers and it was confirmed that Gas Mastrrr induction mixers provide similar G values to Water Champs for a given hp model.

Modifications for Installation of Gas Mastrrr Mixers: The local Gas Mastrrr representative visited a couple of the GLWA facilities where Water Champs are used and concluded the guide rails and controls would be reusable but new attachment brackets may be required.

Comparison of Maintenance Work Order History: Currently, GLWA has Gas Mastrrr induction mixers at Hubbell-Southfield (3) and Seven Mile (1). However, given the hydraulic issues limiting discharge from Seven Mile, the three Gas Mastrrr induction mixers at Hubbell-Southfield are the primary basis for forming opinions on relative reliability. For comparison there are a combined 123 Water Champ induction mixers at six of the CSO facilities. An evaluation of the number of maintenance work orders for the chemical induction mixers over the past five years is presented in Table 5-8 (as presented in the Maintenance Work Order Review for Facilities Assessment Task report). Although there is a large majority of Water Champ mixers, the annual average number of work orders per mixer is similar.

Table 5-8. Review of Chemical Induction Mixer Work Orders by CSO Facility

CSO Facility	Mixer Manufacturer and Model	Number of Installed Mixers	Total Number of WOs for Chemical Induction Mixers	Average Number of WOs per Mixer Over a 5-Year Period
Baby Creek	Evoqua (Water Champ)	32	38	1.2
Belle Isle	Evoqua (Water Champ)	4	0	0
Conner Creek	Evoqua (Water Champ)	60	51	0.9
Hubbell Southfield	Gas Mastrrr	3	5	1.7
Leib	Evoqua (Water Champ)	18	41	2.2
Puritan-Fenkell	Evoqua (Water Champ)	2	0	0
Seven Mile	Gas Mastrrr	1	0	0
St. Aubin	Evoqua (Water Champ)	7	15	2.1
Total		127	150	1.2

Repair Center: Another consideration for the mixers is the location of the repair center and the associated shipping costs. Gas Mastrrr indicated a local repair shop in Detroit area would be used, whereas Evoqua's repair center was historically located in Louisiana. As of late 2020, however, a repair facility is reportedly located in Belleville, Michigan.

Cost Comparison: Pricing was received from both manufacturers that varied with the number of units purchased, whether existing units were exchanged, and with and without explosion-proof motors. Table 5-9 provides a cost comparison of the two sizes for which explosion-proof motors were quoted by both manufacturers, assuming no existing units are exchanged, and using their bulk pricing discount assuming ten mixers are purchased at a time. The Gas Mastrrr mixers were quoted at 70 percent to 72 percent of the

Water Champ mixers. It is possible that Evoqua will improve their Water Champ pricing in a true competitive bid situation.

Table 5-9. Cost Comparison Between Water Champ and Gas Mastrrr Induction Mixers

Motor hp	Water Champ (\$/mixer)	Gas Mastrrr (\$/mixer)
15	\$37,000	\$26,300
20	\$40,000	\$29,300

Based on the G factor, the apparent interchangeable use of the existing guiderails and controls, work order history on reliability, and a comparison of quotes, GLWA can competitively bid Gas Mastrrr mixers and Water Champ mixers when replacing mixers going forward. The attachment brackets, and any other appurtenances as required to utilize the alternative manufacturer at a given location, can be specified to be included in the bid by that company to ensure all cost for switching to an alternative manufacturer are accounted for.

5.2.4.3 Reduce Quantity of Existing Mixers

This section evaluates the feasibility of reducing the number of mixers at each facility, now that many years of various storm events and operating experience has been obtained.

To understand the basis for the current number of mixers at each facility, it is helpful to review design documents. The basis of design for Conner Creek states:

"The number and size of the mixers was based on data collected during a mixing test conducted by Alden Research Laboratory, Inc in July 1999. The purpose of the test was to define the volume of water affected by the mixer at the design flow...

Mixing effectiveness was determined by measuring the concentration of a fluorescent tracer at two vertical planes, 10 feet (ft) and 58 ft downstream from the impeller of the mixers. The velocity and tracer concentration data were normalized by dividing the measured values by the theoretical average value. The theoretical channel velocity was 3 fps...

At the 10-ft vertical plane, a "uniform mix" was observed to occur within a cross-sectional area of approximately 24 square ft, which was equivalent to 33% of the total cross-sectional area. At the 58-ft vertical plane, the fluorescent tracer dye was observed throughout the 10-ft x 8.5-ft cross sectional flow path. Additionally, at the 58-ft vertical plane, there was an obvious gradation of tracer concentration, the highest concentration being at the water surface. The cross-sectional area of the test channel was approximately 1/6 of the full-scale channel, therefore, it is recommended to equip each of the screening/mixing channels with six, 20-hp induction-type mixers."

In summary, the mixer achieved non-uniform tracer dispersion across the entire cross-sectional area of the test channel at 58 ft and uniform dispersion across 33 percent of the cross-sectional area at 10 ft, the only two vertical planes tested. The basis, and significance if any, of the 58 ft vertical plane sampled is not explained. If one were to extrapolate the dispersion being across 33 percent of the cross-sectional area at 10 ft, then it is possible that dispersion occurred across the whole cross-sectional area at 30 ft. It is not apparent from the basis of design report that interpretation of the dispersion results was used in choosing the number of mixers for full-scale design. Instead, it appears that the determination of how many mixers to incorporate into the full-scale design at Conner Creek was simply a multiplication of the test channel cross-sectional area to the full-scale facility cross-sectional area. This raises the question that if they had instead chosen a pilot facility that was 1/4th the size of the full-scale facility, would they have designed four mixers rather than six mixers per mixing zone?

Computational Fluid Dynamics (CFD) is a powerful hydraulic analysis and design tool that was not available when the CSO facilities were designed. A primary issue with the physical model approach previously taken is how to interpret and apply the test results to design. With CFD modeling, the dispersion of chemical can be determined with relatively high certainty for any given number of mixers and mixer locations. Thus, the required number of mixers can be determined. A required input of CFD modeling is the mixing characteristics of each mixer to be modeled. Therefore, this information would be required from the mixer manufacturers.

CFD modeling is recommended for Baby Creek, Conner, Creek, and Leib, and if desired St. Aubin as well although only a two-mixer reduction would be anticipated there. The small number of mixers at the remaining facilities minimizes potential mixer reductions at those facilities, especially considering the benefit of some redundancy should a mixer become non-operational and not be available during a CSO event. For example, at a facility with only two, three, and four mixers, one mixer out of service represents a 50 percent, 33 percent, and 25 percent reduction in overall facility mixing capacity, respectively. The implications of one or two mixers being out of service at the three facilities with the largest number of mixers are much smaller.

Consultation with the CFD modeler should occur during scoping of the CFD modeling project to decide on the best modeling approach. It should also be determined whether the peak design capacity of the facility is the only condition to be modeled or whether any lower flow rates should also be modeled. The following is a preliminary list for consideration:

- Modeling of the existing number and size of mixers to develop a baseline.
- Modeling with fewer of the existing mixers in existing locations to determine what mixers if any could be eliminated.
- Modeling with fewer of the existing mixers but in optimized locations. Utilization of existing floor openings should be given first preference. If significant benefits are anticipated with alternative mixer locations then interferences and cost implications of a new floor penetration, hatch, and mixer removal infrastructure should be considered when selecting alternative locations to model.
- Modeling of larger (e.g., higher hp) induction mixers. This could be done in conjunction with one or both of the previous two bullets.

Although not recommended because it would rely more on trial and error and extensive sampling, an alternative to CFD modeling would be to remove mixers in one mixing zone and sample at enough points at the discharge end of the mixing zone to analyze the adequacy of chlorine dispersion. This could be accomplished by installing submersible sample pumps or sample pipes connected to self-priming sample pumps located on the operating level. A significant number of sample pumps or sample pipes would be required to adequately cover the cross section leaving the mixing zone. Initial testing could be conducted with the currently installed number of mixers to develop a baseline. Then testing could be conducted with one or more mixers removed. The intermittent and highly variable nature of CSOs make full-scale testing much more challenging than would be the case at a continuously operating wastewater treatment plant. Drawbacks of this approach compared to CFD modeling include:

- The design capacity of the facilities corresponds to a very infrequent event with a flow far in excess of typical peak storms. Therefore, testing at lower flows is unlikely to be fully indicative of the adequacy of mixing at peak design flow.
- The optimum positioning of mixers would be by trial and error and would be limited to positions on existing rails.
- Testing of each configuration would likely need to occur during multiple events, with an emphasis on capturing data during large events. This could require testing in one configuration (e.g., number of

mixers and mixer positioning) for a year or more depending on how soon a peak event occurs after setting a given configuration.

- The lack of access favors installing a matrix of sample points to provide adequate sampling. The associated piping would likely accumulate debris passing through screening and require periodic cleaning.

Without CFD modeling there is not a real basis for estimating whether the number of mixers can be reduced and by how much. Therefore, assumptions are required for estimating the costs of this alternative. Table 5-10 summarizes the assumptions for cost estimating this alternative.

Table 5-10. Reduced Number of Induction Mixers Alternative Summary

Facility	No. of Mixing Channels	Existing Number of Mixers Per Mixing Zone	Existing Total Number of Mixers	Assumed Number of Mixers Per Mixing Zone	Assumed Total Number of Mixers	Cost Per Mixer ^a	Cost Savings per Facility Using Reduced No. of Mixers
Baby Creek	8	4	32	2	16	\$50,000	\$800,000
Conner Creek	10	6	60	4	40	\$50,000	\$1,000,000
Leib	4	4	16 ^b	2	8 ^b	\$50,000	\$400,000

^a Based on existing Water Champ induction mixers with explosion-proof motors (Table 5-9), with a contingency and installation cost.

^b The two prechlorination mixers are not included in this evaluation and would remain.

5.2.4.4 Alternative Mixer Technology – Vertical Shaft Mixer

Vertical shaft mixers are a more common type of mechanical mixer at wastewater and water treatment plants than induction mixers. Vertical shaft mixers are typically very low maintenance and highly reliable. Figure 5-3 shows a vertical shaft mixer potentially applicable to Conner Creek.

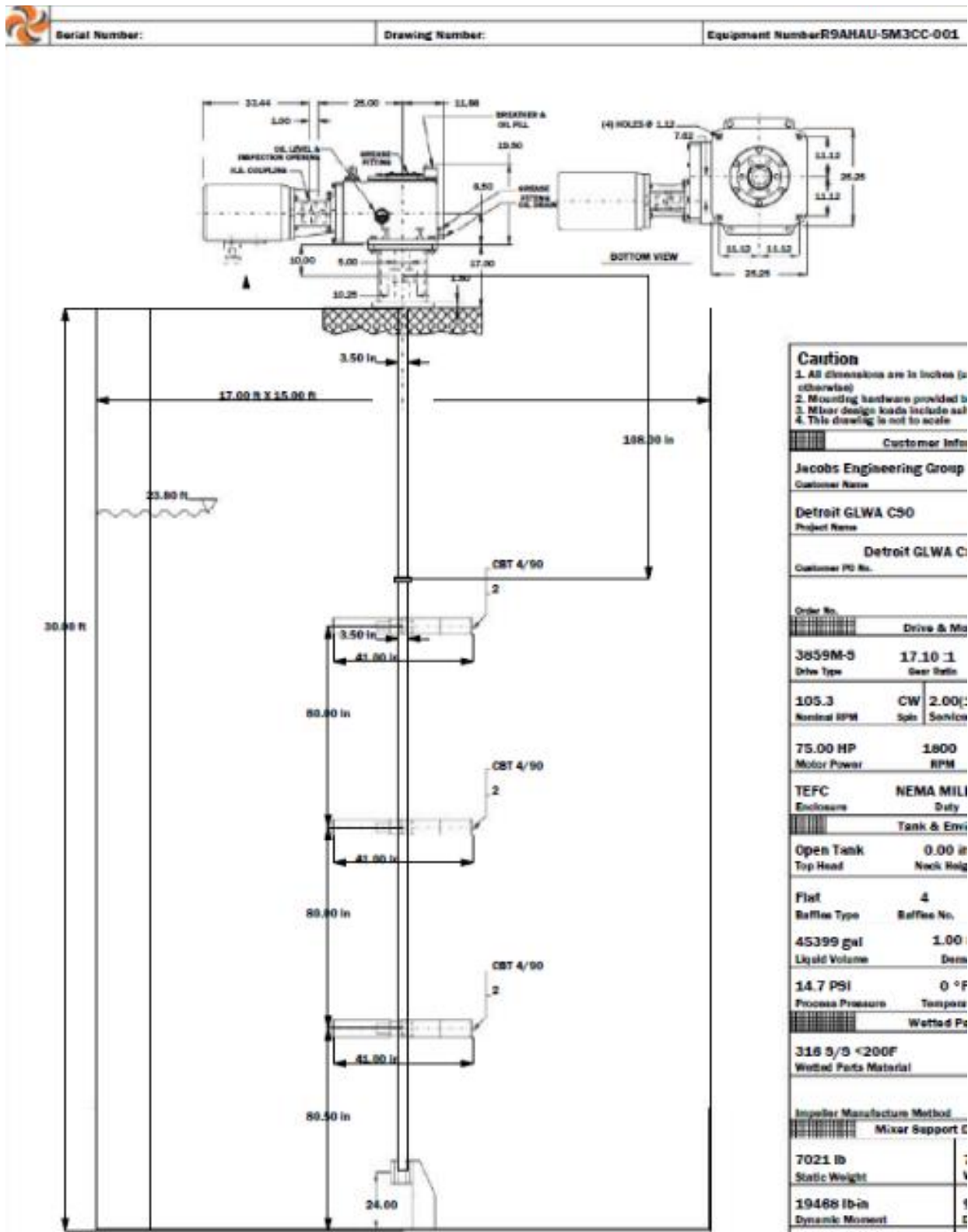
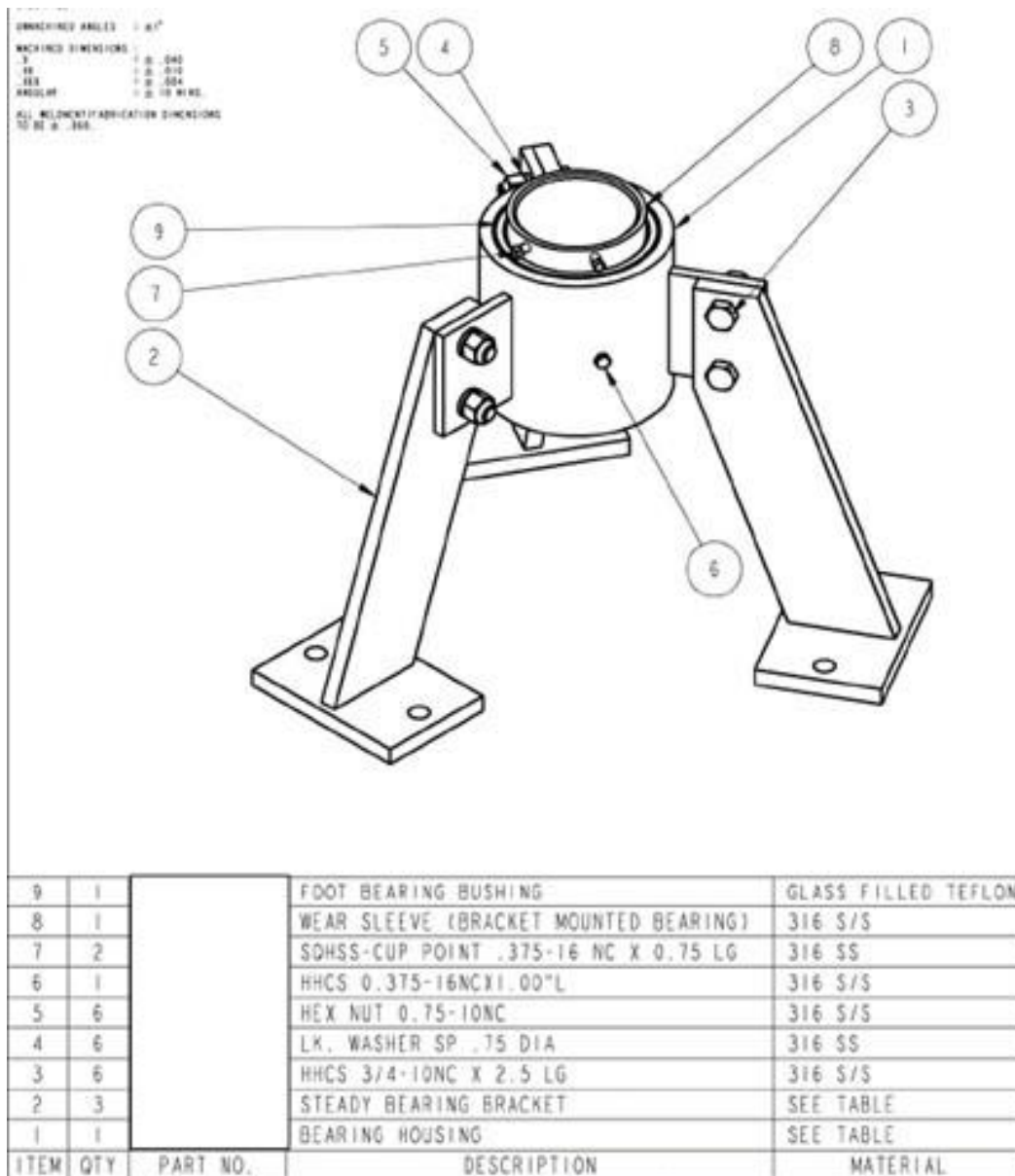


Figure 5-3. Vertical Shaft Mixer

The primary concern with this proven mixing technology if applied to a CSO facility is the potential for ragging and questions regarding whether that would cause damage to the mixer or result in significantly greater maintenance. Maintenance on vertical shaft mixers for this application would consist of:

- Change oil every 6 months to a year (potentially less frequent if the oil is sampled and analyzed).
- Grease bearings at the same time as oil changes. There is an upper and a lower bearing in the gearbox.
- Removal of rags from the shaft and impellers periodically. The amount of ragging will vary with CSO facility due to differences in screen openings and the quantity of screenings present in the CSO.
- Service the steady bearing every two years. This is a floor mounted bearing. Steady bearings are custom made for the application and their design will vary. An example of steady bearing is shown in Figure 5-4. Given the presence of solids, this application may involve a water flush to the lower bearing similar to pump seal water in order to maximize bearing life.



For the Leib facility, the belowground location of the mixer chamber and limited headspace would require significant structural modifications above the mixing chambers to allow the vertical shaft mixer to be installed and removed. Based on these constraints, the vertical shaft mixer is not further considered at the Leib facility and only induction mixer alternatives will be considered at Leib.

In addition to vertical shaft mixers typically being very low maintenance and highly reliable, another advantage of vertical shaft mixers over submersible mixers are the first two maintenance tasks noted above are on components located on the operations floor.

Drawings, facility design flows, and other relevant information were provided to Philadelphia Mixing Solutions and recommendations and budgetary pricing requested for the three facilities with the largest number of induction mixers. The three facilities were Conner Creek, Baby Creek, and Leib. The next largest number of mixers is St. Aubin with seven induction mixers. If successfully implemented at the facilities with the largest number of induction mixers, then replacement of six induction mixers with vertical shaft mixers downstream of screening could be considered at St. Aubin in the future. The seventh induction mixer at St. Aubin is a prechlorination mixer upstream of screening and would be assumed to remain. There are only one to four induction mixers per facility at the remaining facilities with induction mixers and thus the number of mixers at these facilities is not significant enough to warrant replacement with vertical shaft mixers.

- Philadelphia Mixing Solutions selected mixer sizes to rapid mix sodium hypochlorite based on the mixing zone size and configuration and the design peak flow of the facility. The proposed vertical shaft motor hp per mixing zone exceeds that of the existing induction mixers. The fact that the energy demand is concentrated in fewer larger motors will require changes to the power distribution thereby affecting capital cost. However, the intermittent nature of the CSO facilities is expected to minimize the life-cycle energy cost differences between the two technologies. Two features were proposed by Philadelphia Mixing Solutions to address the concerns about ragging:
 - 1) Steady bearing. This is provided to prevent shaft deflection from rag accumulation on the shaft and impeller and resulting stress on the upper bearings.
 - 2) Curved-blade turbine impeller intended to minimize ragging. The impeller is illustrated in Figure 5-5.

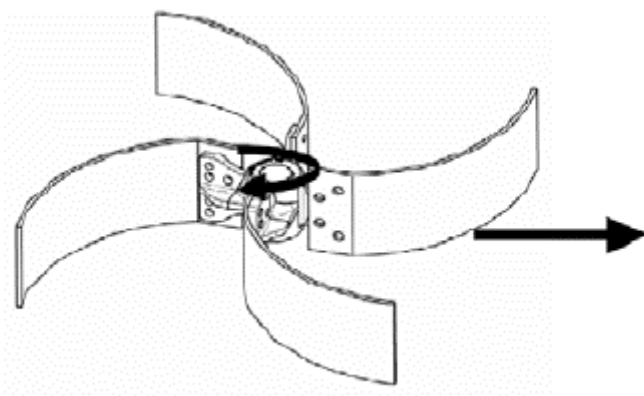


Figure 5-5. Curved-blade Turbine Impeller

- The mixers are designed to run during fill/drain operations, i.e., as the water level rises, or drops back down, through the level of the impeller(s). Although the mixer could run dry for short periods of time, the manufacturer does not recommend running them dry for any extended period of the time because

if solids are present in the steady bearing, the wear sleeve could be damaged. The mixers at Conner Creek and Baby Creek would have three impellers per shaft to provide rapid mixing at multiple depths. The mixers could run with any combination of impellers being above or below the water level due to water level variation during an event. Two mixers were proposed at each existing mixing zone for all three facilities. Table 5-11 summarizes the vertical shaft mixer concept for the two feasible facilities.

Table 5-11. Vertical Shaft Mixer Alternative

Facility	No. of Mixing Channels	Mixers Proposed Per Channel	Total Mixers Required	Cost Per Mixer	Mixer Equipment Cost Per Facility	Per Mixer Motor hp	Total Mixer Motor hp
Baby Creek	8	2	16	\$70,000	\$1,122,000	50	800
Conner Creek	10	2	20	\$79,000	\$1,578,000	75	1,500

- This alternative would cut the number of mixers from 60 to 20 at Conner Creek and from 32 to 16 at Baby Creek. Vertical baffling was recommended by the mixer manufacturer at each mixer location to facilitate turbulence rather than bulk laminar liquid rotation. Mixer locations (red) and proposed baffles (green) for each facility are illustrated in Figure 5-6, Figure 5-7 and Figure 5-8.

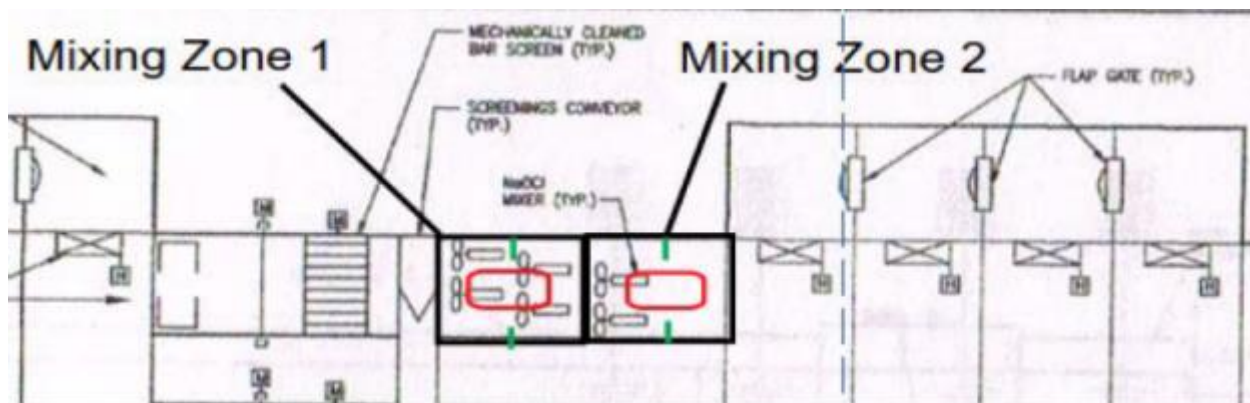


Figure 5-6. Vertical Shaft Mixers (Profile) Conceptual Implementation - Conner Creek

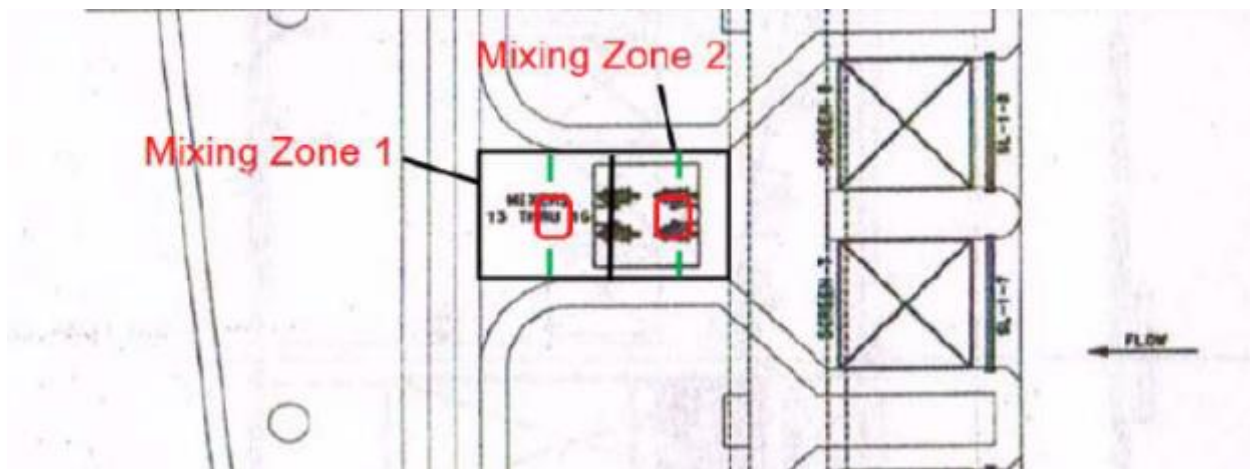


Figure 5-7. Vertical Shaft Mixers (Plan) Conceptual Implementation - Baby Creek

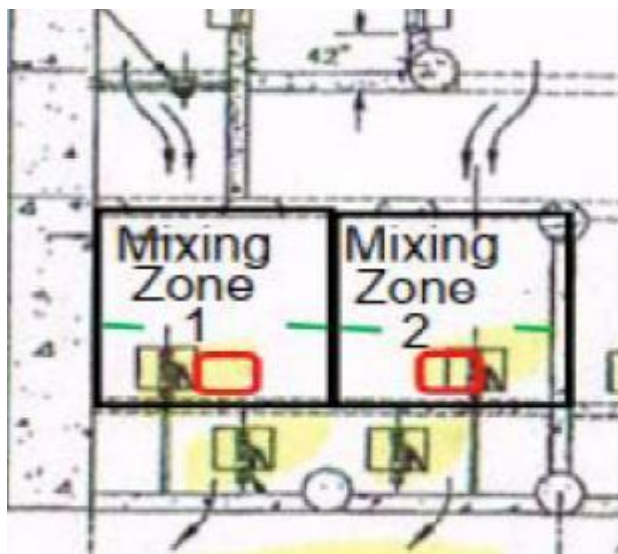


Figure 5-8. Vertical Shaft Mixers (Plan) Conceptual Implementation – Leib (Shown for reference only)

The in-series orientation at Conner Creek and Baby Creek would have the added advantage of providing partial redundancy because rapid mixing, at half the normal energy input, would continue to occur if there was a problem preventing operation of one mixer in that pair.

The advantages and disadvantages of the vertical shaft mixer is as follows:

Advantages:

- Typically very low maintenance
- Typically highly reliable
- Components requiring routine maintenance are located on the operations floor
- Cuts the number of mixers from 60 to 20 at Conner Creek and from 32 to 16 at Baby Creek
- Motor and gear drive are serviceable thereby minimizing the need to ship components to the manufacturer's maintenance facility
- Mixer can be run over the range of water levels during an event. This compares to the need to start and stop induction mixers installed at different elevations depending on water level.
- The in-series orientation at Conner Creek and Baby Creek would provide partial redundancy if one mixer were out of service (i.e., 50 percent mixing intensity)

Disadvantages:

- Requires steady bearing on the floor of the mixing zone due to the application. This is less typical for vertical shaft mixers and the associated maintenance requirements are site-specific and difficult to predict. Maintenance on these requires
- Steady bearing may require seal water to flush debris which could shorten the life of the bearing.
- Requires periodic removal of rags and debris from the shaft and impeller. CSO is not a typical application for vertical shaft mixers and the associated maintenance requirements are site-specific and difficult to predict.

- Requires some baffling additions. The head loss associated with these is anticipated to be insignificant but this should be verified during design.
- Higher total hp than the existing induction mixers. However, the intermittent nature of the CSO facilities is expected to minimize the life-cycle energy cost differences between the two technologies.

5.2.4.5 Alternative Evaluation

The 20-year life-cycle costs are presented in the alternatives evaluations contained in the Disinfection sections of the Baby Creek (Section 6.2.2) and Conner Creek (Section 8.2.2). These are the only two facilities where the vertical shaft mixer is considered feasible. The alternatives evaluation also includes the anticipated annual maintenance costs associated with each mixer.

It is recommended that CFD modeling be conducted as described herein to determine by how much the number of induction mixers can be reduced.

5.2.5 Total Chlorine Residual Reduction

TRC reduction (i.e., dechlorination) is currently not required for CSO discharges at any of the existing CSO facilities. However, the WWMP evaluated the size and location of dechlorination facilities in the section on potential future regulations. The capital cost estimates from the WWMP are presented in Table 5-12. GLWA does not anticipate a TRC requirement in the next 20 years while the Long Term CSO Control Plan is being executed because of finite resources to support other capital expenditures.

Table 5-12. TRC Reduction Capital Cost Estimates From the WWMP

CSO Facility	Estimated Capital Cost ^a (ENR CCI 11500 2019)
Baby Creek SDF	\$ 22.5 million
Conner Creek RTB	\$ 46.2 million
Hubbell Southfield RTB	\$ 16.5 million
Leib SDF	\$ 10.8 million
Puritan-Fenkell RTB	\$ 7.7 million
Oakwood RTB	\$ 10.6 million
Puritan-Fenkell RTB	\$ 7.7 million
Seven Mile RTB	\$ 7.3 million
St Aubin SDF	\$ 5.2 million

^a WWMP estimated TRC reduction capital costs, however these capital costs are not anticipated in the 20 year planning period of this report.

5.3 Electrical

5.3.1 CSO-Wide Lighting Replacement Project

A light-emitting diode (LED) Lighting Replacement project, conducted under Job Order Contract (JOC) No. 9, was completed in late 2020. The project consisted of replacing the originally installed fluorescent and sodium vapor light fixtures with new energy-efficient LED lighting fixtures at all CSO facilities. This project included a 7-year warranty on the new fixtures. Because of this recent project, the existing lighting at the facilities was not evaluated under CS-299.

New and additional lighting locations were discussed with O&M staff at each facility where lighting improvements are desired to better perform maintenance and daily operations activities. If applicable, the locations for additional lighting are presented in the Electrical section of each facility.

5.3.2 Power Quality Monitoring

GLWA currently has an ongoing power monitoring project for all CSO facilities. The project consists of installing a Schneider power monitoring system, which will enable GLWA to monitor the power quality of the electrical systems at each facility. The system will detect abnormal conditions, locate circuit insulation faults, and monitor the electrical equipment. It will allow GLWA to efficiently identify and track power event causes, patterns and system capacity to avoid overloads and failures. The power monitoring system has the ability to capture and record power monitoring data which can be used to troubleshoot and address current and future power issues at the facility.

5.4 Instrumentation and Control

5.4.1 Introduction

There are a number of I&C-related common improvements that could be made at the CSO facilities to standardize their operation, reduce maintenance costs and improve operations. The needs are described in this section and referenced, as appropriate, in the facility-by-facility assessments in the following bullets. The common needs include:

- Control System Improvements
- Evaluation of Level Measurement Technology – Ultrasonic vs Radar Instruments
- Chemical Fill Station Level Indicators
- Evaluation of Valve Control Philosophy – Valve Network (PakScan) vs Hardwired
- Fire Alarm System and Gas Monitoring Minimization
- Open Channel Flowmeter Alternatives
- Process Monitoring Cameras
- Additional Local Control
- Generator Run Status Signals to Historian
- Study for Disabled Motor Moisture Detection Capabilities

SCADA Data Review: In order to better understand the condition of level and flow signals generated from the numerous level sensors and flow meters throughout the nine CSO facilities, Jacobs conducted a detailed SCADA Data Review. This evaluation obtained and reviewed SCADA data from a recent 6-month period (August 2019 to February 2020). This evaluation was used to help determine whether some of the redundant instrumentation could be minimized (for example, see I&C sections of Baby Creek and Conner Creek). Furthermore, this evaluation was used to populate information in the CS-299 Condition Assessment related to whether the instrument “Performed Its Intended Function.”

5.4.2 Control System Improvements

Because the CSO facilities were constructed at various times over the last 25 years, the control systems vary. Table 5-13 provides a summary of the existing control systems at each facility. The table also provides the proposed and recommended upgrades for the control systems at all the facilities to standardize the systems and make operating these facilities more similar from one facility to another.

Table 5-13. Existing and Proposed SCADA Control Systems at Each CSO Facility

Facility	Existing Control System (Version)	Proposed and Recommended Upgrades
Baby Creek	Emerson Ovation (O.V.3.5.0)	Ovation System Upgrade to O.V.3.7 Replace local control panel at Sampling Building and provide control from Sample Building
Belle Isle	Emerson Ovation (O.V.3.5.0)	Ovation System Upgrade to O.V.3.7 Add root switch for network redundancy
Conner Creek	Emerson Ovation (O.V.3.5.0)	Ovation System Upgrade to O.V.3.7
Hubbell Southfield	Rockwell ControlLogix PLC's with Factory Talk software	Replace entire control system (proposed project under CS-299)
Leib	Rockwell PLC 5 with RSView software	Upgrade is ongoing through "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" project
Oakwood	Emerson Ovation (O.V.3.5.0)	Ovation System Upgrade to O.V.3.7
Puritan-Fenkell	Rockwell PLC 5 with RSView software	Replace entire control system (proposed project under CS-299)
Seven Mile	Rockwell PLC 5 with RSView software	Upgrade is ongoing through "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" project
St. Aubin	Rockwell PLC 5 with RSView software	Upgrade is ongoing through "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" project

Note:

PLC = programmable logic controller

During CS-299 Facilities Assessment meetings, GLWA personnel requested that the control systems and screen graphics be standardized across facilities so that staff could more easily understand the controls and operation from one facility to another. GLWA SCADA Governance Standards require that all CSO facilities use Ovation workstations with new high-performance graphics. Version 3.7 of Ovation should be used. The recommendations in the following paragraphs address these issues.

"Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" is a project that is intended to replace the control systems at the three facilities mentioned. The request for proposals (RFP) for this design/build project should be issued within the next few months (as of August 2020). A Jacobs team member was involved in the development of the RFP documents for this project and was able to convey the GLWA CSO team's desire for standardization. For this project, the workstations with high-performance graphics will be Ovation. The RFP will allow for either Ovation or Rockwell control system to be bid, so that it can be more competitively priced.

Replace Entire Control System: Hubbell Southfield and Puritan-Fenkell control systems and workstations are Allen Bradley programmable logic controller (PLC)-based systems that are obsolete and do not meet GLWA's Governance Standards. These systems should be replaced. The Facility assessments for Hubbell Southfield and Puritan-Fenkell provide project descriptions and recommendations for the replacement project.

Ovation Control System Upgrade: The Ovation Control System at the existing four facilities (Baby Creek, Belle Isle, Conner Creek and Oakwood) will provide GLWA reliable operation for many years. With the advances in technology and new operating systems, it is logical to upgrade the Ovation system to take

advantage of new capabilities to improve performance and ensure reliability of the system. For the Ovation system to have high-performance graphics and elements, the system needs to be upgraded to version O.V.3.7. Once upgraded, the system will be able to utilize the latest graphic elements in Ovation that GLWA is currently pursuing.

The potential control system upgrades are listed in the following paragraphs (and are subject to change during design phase):

- High-Performance Graphics: Provide use of new screen graphic macros to maximize the experience with high-performance graphics.
- Remote Node Interface: Ability to expand the system with Ethernet based remote nodes that have the capability to handle smart modules such as ELC, Profibus, or Fieldbus in remote locations.
- Machinery Health monitor: Vibration sensors to collect raw data and software to analyze and predict failures.
- Updated OCR1100 Controller: Updates to controller software and interfaces to handle high speed applications along with an enhanced set of control algorithms.
- Windows Server 2016 and Windows 10: Operating system obsolescence will no longer be an issue along with security patch availability.
- Trusted Domain capabilities: Allow all GLWA system credentials to be available for authentication at all sites and systems.
- HART capabilities enhancements: Allows the system to communicate to 254 HART variables via the wireless HART device.
- Enhance system viewer/analyzer: Provide the ability to troubleshoot by including the option to filter by message type or time. Additionally, the level of criticality can be selected to ensure only the most important items are viewed.
- Gigabit network communication capability and up to 500,000 tags.
- Upgrade Fiber Network to OM3 fiber to support greater distances with gigabit capabilities.

5.4.3 Evaluation of Level Measurement Technology – Ultrasonic vs Radar Instruments

Many different technologies exist for level measurement. The predominant methods for measuring liquid level in the water industry are through ultrasonic level measurement and radar level measurement. Both methods rely on transmitting a wave and tracking the time it takes to receive an echo from the reflected wave. With ultrasonic, the wave is acoustical and with radar, the wave is electromagnetic. When the CSO Facilities were originally designed and constructed, ultrasonic was the dominant technology for level measurement. Radar level instruments were just beginning to come to market and were much more expensive and not as accurate as ultrasonic level instruments. It was common to have the ultrasonic technology be the primary level instrument and the radar technology to be the secondary level instrument.

Today, the opposite is true. Radar level measurement has improved, and for many applications is superior to ultrasonic level measurement. The frequency of the electromagnetic wave has increased with each new version introduced which provides for a narrower beam spread with less chances of error introduced from waves reflecting off of different surfaces. In addition, the higher frequency allows for more accurate level measurement in water containing small particles of debris and/or foam. Radar level instruments are a 2-wire, loop powered device and do not require a separate 120-volt (V) power feed, unlike ultrasonic level instruments. This saves on installation costs by eliminating additional conduit and wire.

In the future, Jacobs recommends that new level instruments would be radar as the primary level and ultrasonic as the secondary (if secondary is required). Since the radar instruments are loop powered, an additional source of 120V power and the associated conduit and wire is not required. The radar level instruments tend to have a lower unit cost and slightly more accurate and reliable than ultrasonic. For existing installations where ultrasonic level instruments are successfully being used and it is time for replacement, the recommendation would be to re-install an ultrasonic level instrument, since 120V power and the associated conduit and wire is already present, and the mounting location is already set for ultrasonic.

5.4.4 Evaluation of Open Channel Flowmeter Technologies

At the CSO Facilities, Accusonic open channel flowmeters are commonly used to measure flow. The meters are expensive to purchase, expensive to maintain, and frequently have issues accurately measuring flow.

Two alternatives are available for flow measurement besides the Accusonic units. The alternatives are described in the following paragraphs.

Alternative 1 - Laser-Doppler Velocity Flow Measurement: The non-contact laser-doppler velocity sensor measures flow by using a combination of a laser beam to measure velocity in a pipe or channel and an ultrasonic level sensor to measure the level of the liquid in the pipe or channel. Once the level of the channel is known, the laser beam is focused on a specific point and the frequency shift is measured on the returned light. The flow is then calculated from the cross-sectional area of the pipe or channel (accounting for level) multiplied by the velocity. An example of this type of flowmeter is the TieNet 360 Laser Flowmeter.

Advantages:

- Non-contact with the liquid in the pipe or channel. This provides for better accuracy by not disturbing the flow of liquid and will also remain cleaner by not being exposed to debris in the liquid.
- Ability to be submerged and still measure flow (requires optional surcharge sensors).
- Less expensive than Accusonic.

Disadvantages:

- The 45-degree angle of the laser beam requires special mounting considerations. This involves using an opening in the pipe or channel to accommodate the geometry of the 45-degree beam along with the downward facing ultrasonic level sensor. An alternative is to use a remote mounted ultrasonic meter and use one opening where the 45-degree beam enters the channel, or use two smaller openings; one above the ultrasonic meter on the main unit, and one for the 45 degree beam.
- Generally, requires a larger structure to account for the special mounting.
- Distance limitations between the flow sensor and flow transmitter. The manufacturer supplied cable is limited to a maximum 150 ft. In order to increase this distance, an additional extender module is required, and larger cables are required to counteract the voltage drop in the cable.

Alternative 2 - Radar Velocity Flow Measurement: Similar to the laser-doppler velocity flowmeter, the non-contact radar velocity sensor measures flow by using a combination of a radar beam to measure velocity and an ultrasonic level sensor to measure the level of the liquid in the pipe or channel. The radar is pointed to the center of the flow stream to measure surface velocity by calculating the frequency shift of the returned radar beam (doppler effect). The flow is then calculated from the cross-sectional area of the pipe or channel (accounting for level) multiplied by the velocity. An example of this type of flowmeter is the Hach Flo-Dar.

Advantages:

- Non-contact with the liquid in the pipe or channel. This provides for better accuracy by not disturbing the flow of liquid and will also remain cleaner by not being exposed to debris in the liquid.
- Ability to be submerged and still measure flow.
- Less expensive than Accusonic.

Disadvantages:

- The mounting design of the radar velocity flow measurement is meant to be installed on a bracket located in the bottom of a manhole directly above the channel or pipe opening. Access to the meter would be limited unless a large manhole was used above the pipe or channel.
- Would require a larger structure similar to the laser-doppler velocity meter to provide access to the meter.

It is recognized that GLWA has recently replaced all of the Accusonic influent flow meters at the large CSO facilities (i.e., Baby Creek, Conner Creek, Hubbell Southfield, Leib and St. Aubin). These facilities have a contract for bi-annual maintenance of these meters. Given this current situation, it is recommended that the Accusonics continue to be used. As these units age and as technology continues to advance, alternative flow meters could be evaluated in the future.

Jacobs recommends one location (Conner Dewatering) where a new Laser-Doppler Velocity Flow Meter should be installed. This is further discussed in Section 8.2.7.3.

5.4.5 Chemical Fill Station Level Indicators

Level sensor indicators are necessary at the fill stations of all chemical storage tanks. This allows contractors to monitor tank level from outside the building while delivering sodium hypochlorite. GLWA staff are replacing level sensor indicators at St. Aubin and Leib, but replacement is required at Belle Isle. All other facilities require installation of new level sensor indicators.

For the CSO Facilities which require new level indication, it is recommended for the design to include a NEMA 4X enclosure, digital process display with large, red characters which are easy to read, panel heater, and an alarm horn or strobe to indicate when the tank is approaching a high level. The 4-20 milliamperes (mA) level signal used for the process display indication should be part of the 4-20 mA instrument loop between the level sensor and PLC analog input and should indicate how full the tank is and how close it is to overflow. The alarm horn or strobe should be powered through a relay from the process display and based on an adjustable setpoint through the process display setup. A reasonable level should be chosen for the setpoint, which might be 12 inches (in.) to 24 in. below the top level of the tank. If a horn is used for the level indication panel, a "test" and "alarm silence" pushbutton should be incorporated to the front of the panel.

5.4.6 Evaluation of Valve Control Philosophy – Valve Network (PakScan) vs Hardwired

The PakScan valve network is a proprietary networking system for use with Rotork electric actuators. The valve network utilizes a serial communication protocol to carry all valve actuator status and control signals over a two-wire system. Valve networks have advantages and disadvantages. For PakScan, the network can accommodate hundreds of individual valve actuators spanning over many miles apart. The valve network is capable of transmitting a multitude of status and control signals nearly instantaneously across the entire network. Some of the disadvantages of the PakScan valve network include losing status and control

of all valve actuators in the event of a cable malfunction and associated networking difficulties during power cycles (such as valve actuators losing IP addresses while the network is coming back online).

For the CSO Facilities which utilize PakScan valve networks (i.e., Baby Creek, Conner Creek, Puritan-Fenkell, and Seven Mile), Jacobs considered an alternative of maintaining the existing valve network for status monitoring, but converting to hardwired control for critical status and control functions. The addition of hardwired control would involve the addition of conduit and wire between the valve actuators and the nearest PLC panel. Any discrete status and control would be through No. 14 AWG wire. Additional I/O would likely be required in the PLC panels. If the PLC panel would not have space or capacity for additional valve actuator I/O, remote I/O panels would be required to collect the status and control signals and be tied into the local PLC panel. The major benefit of this alternative is that, in the event the valve network experiences issues or outages, the hardwired control would still remain as a backup to keep the CSO Facility in operation.

Construction costs (without Contractor overhead and profit or Engineering design) for this concept for all the actuators at the four CSO facilities was found to be fairly expensive, as follows:

- Baby Creek (60 actuators): \$204,000
- Conner Creek (107 actuators): \$355,000
- Puritan Fenkell (19 actuators): 68,000
- Seven Mile (15 actuators): 54,000

Based on this information and discussion with GLWA, the cost/benefit of this alternative was not considered to be favorable. The exception is the 16 effluent relief gates at Conner Creek, which could cause major flooding damage in the collection system if they do not open as programmed during a large storm event. As such, this alternative is not considered further, except for the Conner Creek effluent relief gates.

5.4.7 Fire Alarm System and Gas Monitoring Minimization

Minimization of Fire Alarm Systems: GLWA requested that Jacobs investigate potential locations where fire alarm and sprinkler systems could be eliminated. As part of this investigation, Jacobs recognizes that each facility was designed by professionals to meet current fire and safety requirements and codes. Furthermore, the designs and final installations were reviewed and approved by the City Fire Marshall. For these reasons, we do not recommend that the current fire safety systems be modified, unless further evaluated under a separate study.

Removal of Gas Monitors from Various Basins: GLWA also requested that Jacobs investigate the potential removal of gas monitors in the basins for Belle Isle and Oakwood CSO Facilities. When originally installed, the gas monitoring in the basin was the primary method to determine if dangerous gas levels were present and if it was safe for personnel to enter. Since then, the standard operating procedures have been updated to make personal meters worn by personnel the primary means for checking for dangerous gas levels. Per NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities, Table 4.2.2, Row 32, Fire Protection measure, which include combustible gas detection, is not required in wastewater holding basins.

For the gas monitoring equipment in the basins at Belle Isle and Oakwood, the recommendation is to remove the existing gas monitors to avoid the effort required to maintain the sensors. This recommendation is also based on the fact that entry into basin (confined space) requires individuals to have their own gas monitor, along with fans on. The existing conduit and wire should remain as spare and left for future use.

Gas monitors in the Headworks should remain for the same reasons as the fire alarm systems mentioned above.

5.4.8 Process Monitoring Cameras

During Facilities Assessment meetings with O&M staff, GLWA requested that Jacobs evaluate locations in which additional cameras would be beneficial to monitoring operations. With GLWA input, the locations of existing cameras and the number of new cameras required at the CSO facilities were identified. A summary of desired camera locations is presented in Table 5-14. For this report, the costs associated with cameras are included in the individual facility I&C Improvements project.

Table 5-14. Process Monitoring Camera Needs at Each CSO Facility

Facility	Location	Number of new cameras required	Notes
Baby Creek	Headworks	4	One camera for a group of four screens
	Influent Area	1	Focused on area upstream of the weir wall
	Chemical Room	2	PTZ ^a
Belle Isle	Headworks	1	Existing camera in the headworks needs updating
	Chemical Room	1	
Conner Creek	Headworks	3	
	Chemical Room	2	One camera inside and one camera outside. PTZ
	Outfall	0	Camera will be installed as part of ongoing security project
Hubbell-Southfield	Headworks	3	PTZ
	Chemical Room	1	PTZ
	Outfall	1	
Leib	Headworks	0	There is an existing camera in the headworks area
	Chemical Room	1	PTZ
Oakwood	Headworks	3	PTZ
	Chemical Room	2	PTZ
	Pump Room	2	PTZ
Puritan-Fenkell	Headworks	2	
	Chemical Room	1	PTZ
	Outfall	1	PTZ
Seven Mile	Headworks	No	
	Chemical Room	No	
St. Aubin	Headworks	1	Existing camera in headworks area needs updating
	Chemical Room	1	PTZ

^a PTZ is a point, tilt, zoom camera

5.4.9 Install Local Control Near Process Equipment

GLWA staff requested local control capability for some equipment to improve operability, for example submersible dewatering pumps and mixers at some locations. For areas where local control would provide a benefit, a standard approach would be taken for all CSO Facilities.

- In classified areas, local control stations should be added next to the equipment in NEMA 7 explosion-proof enclosures. Start and stop pushbuttons, local-off-remote selector switches and push-to-test indicating lights would be specified for the local control station. For applications involving VFDs, speed indication and speed control potentiometers should be included on the local control station.
- For non-classified areas, local control stations should be added next to the equipment in NEMA 4X stainless steel enclosures. Start and stop pushbuttons, local-off-remote selector switches and push-to-test indicating lights would be specified for the local control station. For applications involving VFDs, speed indication and speed control potentiometers should be included on the local control station.

The local control stations would require new conduit and wire back to the motor starters, typically located within MCC. The internal control circuits would need to be modified and updated to include the additional local control stations.

For typical applications, the multi-conductor exposed cables would route up through the wet-well to either quick-disconnect devices, or permanent terminal boxes. Seal-off fittings would be incorporated where required by code between the local control stations and terminal boxes/quick-disconnect devices.

The Instrumentation and Control sections of each facility provide the locations where remote control of equipment was recommended by O&M staff. These include:

- Baby Creek screens (see Section 6.2.7.3)
- Hubbell Southfield dewatering pumps (see Section 9.2.7.3)
- Leib fine screens (see Section 8.2.1.3)
- St. Aubin dewatering pumps (see Section 14.2.7.3)

5.4.10 Automatic Transfer Switch and Generators Controls Upgrade

Seven CSO facilities have standby generators (i.e., Belle Isle, Conner Creek, Hubbell-Southfield, Leib, Puritan-Fenkell, Seven Mile, and St. Aubin). The reliability of these generators and automatic transfer switches (ATS) has declined over recent years. During utility power outages when the standby generators are necessary, either the generators do not start automatically, or the ATSs do not transfer. In addition, the generator control panels and the ATSs do not report status or alarm signals to the operators through the SCADA Ovation control system.

The “Automatic Transfer Switch and Generators Controls Upgrade” project is an ongoing project that will address these issues. Under this project, the CSO facilities with standby generator systems will be upgraded to have a standardized, dedicated automatic transfer control system. In addition, the project will include the following:

- 1) The PLCs or other controller styles will be replaced with modern, standardized, microprocessor-based automatic transfer controllers.
- 2) The front panel of ATS panels not being fully replaced will be reconfigured to be standardized across all CSO facilities. A remote human-machine interface (HMI) screen dedicated for the automatic transfer system will be provided.
- 3) Local generator panels will be evaluated for compatibility and reliability.

- 4) Ovation displays will be standardized and useful inputs (alarms, configuration, status) will be included.

5.4.11 Study for Disabled Motor Moisture Detection Capabilities

Throughout many of the CSO Facilities, motor moisture detection used for mixers and dewatering pumps has been disabled using wire jumpers to bypass the shutdown control circuits. While this practice could be considered acceptable during emergency situations, the problem comes from not removing the wire jumpers after the CSO event and correcting the underlying moisture problem in the motors. As time goes on, these jumpers are forgotten about, as well as additional, new jumpers being added for other motors. Jacobs recommends a study of all facilities to identify the location of all existing jumpers used on the motor moisture detection circuits and then develop a plan to remove the jumpers and correct the motor moisture detection issues.

5.5 Structural

A Structural Rehabilitation Needs Assessment, dated August 2018, was conducted by NTH Consultants for all nine CSO facilities under a separate project. In this assessment, NTH assessed structural defects in aboveground buildings and belowground structures. The purpose of this assessment was to provide bridging documents for an upcoming CSO Structural Rehabilitation design/build project, which is scheduled to begin in early 2021. As such, it is not considered a complete list of all the structural defects. The selected design-build firm will be generating an updated, more complete list of defects at the start of their project. Because the structural assessment will be completed soon, structural rehabilitation capital costs are not presented in this report.

5.6 Building Roofs

A Roof Asset Condition Assessment, dated July 19, 2018, was conducted by NTH Consultants under a separate project for eight of the nine CSO facilities. (Puritan-Fenkell was not included in the assessment because a planned roof replacement was out for bid at the time of the inspections). The purpose of this assessment was "to visually examine the facility roofs, determine needs and priorities, and recommend optimal remedial roofing work strategies that will ensure a maximum return on investment and optimize the use of facility maintenance funds." The assessment included the size (in square ft) of each roof, roof membrane type or composition, slope, year installed, roofing contractor, roof system manufacturer, and roof condition/service projection. Each roof was rated good, fair, or poor. The results of the 2018 roof assessment are included in Volume 6 – Appendices, Appendix H.

The results of the roof condition assessments were used by the CS-299 team to populate the condition of the roofs for each facility in CS-299 Condition Assessment. In some cases, the roof has been replaced since the assessment; these scores have been adjusted accordingly.

5.7 Safety

5.7.1 CSO Facility Safety Inspection

Under CS-299, Jacobs conducted a safety inspection of all the CSO facilities in January 2020. The purpose of the safety inspection was to identify safety-related issues. The report identified whether the issue should be addressed through a future capital improvement or non-capital projects. The findings of the safety inspections were presented in the CSO Facility Safety Inspection Report, dated March 30, 2020, included in Volume 6 – Appendices, Appendix E.

5.7.2 Safety-Related Capital Improvement Projects for Each Facility

Safety-related capital improvement projects at the CSO facilities generally fall into one of the following categories:

- 1) Fall Protection Improvements – the approach for fall protection and recommended improvements are discussed in Section 5.7.3.
- 2) Eyewash and Emergency Shower Improvements – to be included in each facility Safety cost estimate.
- 3) Exit Sign Improvements – see discussion in the following paragraphs for proposed project to address these issues.
- 4) Conner Creek Conveyor Improvement – See Conner Creek Screening section (Section 8.2.1.2) for project that is addressing this issue.

Emergency Lighting: Emergency lighting issues identified in the Safety Inspection Report are not included in the capital improvement projects since it is understood by Jacobs that these issues will be addressed in the recently completed LED Lighting Project.

Exit Sign Improvement Project: Illuminated exit signs and emergency lighting were not functioning or not present at many locations. Emergency lighting is being addressed in the ongoing LED Lighting Project. The emergency lighting project may provide illumination of exits in various locations, thus affecting the exit locations that need to be addressed in this project. Also, some of the exit sign bulbs may simply need to be replaced. As such, it is recommended that Exit Sign Improvement projects include an exit route survey at each facility meeting NFPA 101 (Life Safety Code) requirements, Michigan Building Code requirements (2015 ver.) and MIOSHA regulations. This task is being addressed in a separate project under Task Order Engineering Services (TOES). As such, capital costs are not included in this section.

Safety-related capital improvement projects are recommended for each individual facility. The detailed cost estimates in Volume 6 – Appendices, Appendix C provide the safety-related items included for each facility.

5.7.3 Fall Protection Improvements

Using the information presented in the Safety Inspection Report, preliminary recommendations for improvements at each hatch opening were generated. These are included in Table E-1 in Volume 6 – Appendices, Appendix E. The purpose of this table is to provide a basis for the project cost associated with fall protection. Design of some of the safety recommendations will be required, and, therefore, the costs may change in the future.

The following general approach was used for the preliminary recommendation at each hatch opening:

- 1) In general, permanent railings are preferred since they provide the most reliable protection. This includes most roof access hatch locations. It also includes other locations where there are no traffic or access issues. However, permanent railing are not practical at all locations due to the need to maintain traffic or access. These locations need to consider some other form of fall protection.
- 2) For hatch openings for equipment removal, where permanent railings are not practical, GLWA O&M staff has requested that nets be provided.
 - For equipment openings with double leaves where each side is at least 3.5 ft high (42-in.) when opened, chains could be added to the existing leaves at the top and middle. This would provide fall protection for these hatch openings.

- For equipment openings where the hatch leaves are not 3.5 ft high, Jacobs recommends temporary/portable railings be provided to protect other staff at locations where the hatch could be left open and the net pulled back for equipment removal for an extended period of time. The temporary railings can be either custom-made railings from a local fabricator that slide into cored holes in the floor (for inside locations only), or they could be standard portable railings purchased from a handrail manufacturer.
 - If temporary railings are not acceptable for these equipment openings, Jacobs recommends that D-rings be used in conjunction with staff in a safety harness to provide fall protection for the worker while removing/installing equipment.
- 3) For hatch locations for ladder access into confined spaces (i.e., basins or vaults), a portable davit in conjunction with a worker safety harness is recommended, as the davit provides both fall protection and aids in personnel rescue, if needed. A ladder ratchet system could also be used for fall protection; however, it is not as effective for retrieval.
 - 4) All ladders should have retractable safety posts at the top of the ladder for improved safety when entering or exiting the opening.
 - 5) At Conner Creek at the time of the Jacobs safety walk-through, it was noted that many small (2 ft by 2 ft) hatches for lighting in the basin were left open. Netting is recommended at these locations as a permanent safety measure, as well as D-rings to provide fall protection during light bulb replacement.

In addition to fall protection, other modifications or enhancements are needed at some hatches to address various deficiencies. These issues are included in the “Additional Items” column of the spreadsheet and should be more thoroughly evaluated during the detailed design for modifications to the hatches at each facility. The most notable modifications include:

- 1) Replacing the 16 plates over the mixers at Leib with hatches.
- 2) Re-orienting the basin access hatches, as necessary, to make closing the hatch safer. See Figure 5-9 for an example at Belle Isle basin where staff must reach across opening to actuate the red handle to close the hatch.



Figure 5-9. Example of Need for Re-orienting the Basin Access Hatches

- 3) Replacement of the cylinders to aid hatch opening and closing should be evaluated at the time of replacement of all hatches.
- 4) Installation of a ladder safety system or personal fall arrest system for existing fixed ladders over 24 ft in height by November 18, 2036, for any section of the fixed ladder/cage/well that is replaced, or for any new fixed ladder exceeding 24 ft in height, per revised OSHA standard 1910.28(b)(9). Existing cages on ladders will require replacement with an alternate fall arrest system or ladder safety system to meet the revised standards.
- 5) A preliminary list of ladders with cages are presented in Table E-1 in Volume 6 – Appendices, Appendix E. It is recommended that the replacement of existing ladder cages be included in future capital improvement projects between now and 2036, and as such, cost estimates are not included in this assessment.

Other fall and trip hazards were present at several locations. These are listed in Table E-1 in Volume 6 – Appendices, Appendix E. Many of these hazards can be addressed with the addition of fall protection features such as temporary railings and are generally included in the cost estimates for each facility. Note, that since the safety inspection report was issued in March 2020, Jacobs was notified by GLWA that swing gates are current practice – chains are not acceptable fall protection. The project costs for fall protection for each individual facility are presented in the facility-by-facility Safety sections.

5.8 Maintenance Work Order Review

The CS-299 CSO Facilities Assessment scope of work required Jacobs to review historical maintenance work orders (WOs) as one component of the Facilities Assessment. The purpose of this review was to determine whether useful information can be obtained from the WOs to aid in the identification of future improvements to the assets, specifically related to capital improvements. For example, if there is evidence within an asset's work order history that pointed to recurring problems, this evaluation could potentially identify that asset to be a candidate for capital improvement to address the issue.

The WO review, included in Volume 6 – Appendices, Appendix F, presents the findings from the review of historical maintenance work orders from 2013-2018. As indicated in the summary, this review did not provide significant information that is useful to determine the need for capital improvements to assets. While there are several WOs that address asset repairs, these generally appear to be normal wear items and do not indicate an installation or performance concern. Information from this review was used to compare reliability of chemical induction mixers.

6. Baby Creek CSO Control Facility

6.1 Facility Description and Future Capacity Considerations

6.1.1 General Facility Description

The Baby Creek CSO facility is a SDF with 3 million gallons (MG) of storage, and a treatment capacity of 5,100 cfs. It was constructed in 2006. The facility has a nearly 1-mile long effluent conduit used for disinfection contact time before discharge into the Rouge River. The facility consists of one main building with a large Headworks, Chemical Room, utility support (two Electrical Rooms and a Mechanical Room), control room and other miscellaneous rooms. The facility also includes a small, off-site effluent sample building near the end of the effluent conduit and outfall access at the Rouge River (Miller Road Gates).

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

6.1.2 Future Capacity Considerations

Based on a review of the WWMP and discussions with GLWA, there were no future increased capacity considerations identified at this facility.

The high water levels in the Great Lakes and Lower Rouge River, however, have created the need for using the bypass gates during peak flows of larger wet weather events, before the design-rated capacity of the screens is reached. This issue is further discussed in the Screening and I&C in the following sections.

6.2 Facility Assessment

6.2.1 Screening

6.2.1.1 Description of Existing System

The Baby Creek CSO facility has 16 perforated panel screens that were installed in 2006. The influent weir to the first four screens is set one foot lower than the remaining 12 screens so that only the first four screens are used during smaller storm events and lower flow periods. This means flows are preferentially sent through the Elmer Ternes barrel of the Outfall.

Soon after startup of the facility, the screens significantly blinded during a large wet weather event due to heavy leaf load in the influent wastewater. Water backed up in the sewer system causing flooding issues in the community upstream of the facility. Modifications were made to the screens to address this issue including running the units at high speed (VFDs were provided for the original system and are still installed, but now they are only run at high speed) and eliminating the start/stop control of the screens based on differential level. Currently, the screens are operated when the water level spills over the influent weir wall. Furthermore, a bypass channel was constructed around the screening and disinfection portion of the facility. This bypass channel can be and has been used when there was reported blinding of the screens during high flow events or when levels in the influent sewer are high.

The operators report that they have used the bypass about four to five times during the past two years, which is more frequent than in the past due to the unprecedentedly higher water levels in the Great Lakes over the past year. When the bypass gates are opened, the bypassed flow does not receive screening or

disinfection, making this a significant issue. Bypasses are considered a violation of the NPDES permit by EGLE.

Screenings from the screens discharge into a sluice channel. The screens are equipped with a rotating brush and spray water to aid in the removal of the screenings from the screen. Flushing pumps pump raw wastewater to the sluice channel to convey the screenings to the Toward Treatment Sewer.

Table 6-1 provides an overview of the existing screening system at Baby Creek CSO facility.

Table 6-1. Overview of Existing Screening System at Baby Creek CSO facility

Parameter	Value
Treatment Capacity (cfs)	5,100
No. of Screens	16
Manufacturer	US Filter – John Meunier (now Veolia)
Screen Type	Perforated Panel Screen
Opening Size	6-mm perforation
Depth or Length / Width	26 ft 6 in / 10 ft 0 in
Screen Cleaning	Brush and high-pressure spray
Screening Removal	Conveyed through sluice trough to Toward Treatment Sewer and to WRRF

6.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Improve existing screens for blinding and reliability. Note that the evaluation of screen blinding is presented in the next section. It was determined that blinding was not a major issue and does not require a capital improvement. During the investigation, however, a potential improvement to the screen brushes was proposed and is evaluated under Replace Existing Screen Brushes (Project BC-SCR-1).
- Evaluate maintenance access to Screen 5. Unlike the other 15 screens, Screen 5 is unable to tilt up to Headworks floor due to interference by a large tipping bucket. Jacobs contacted Veolia to obtain input on maintenance procedures for this screen, given this constraint. They indicate that this screen needs to be only slightly pivoted to make the lateral doors near the bottom of the screen accessible and work on the bottom elements (i.e., sprockets, stub shafts, bushing, etc.) needs to be performed in the channel. Based on this input, this issue is not evaluated further.

6.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with a recommended alternative.

Improve existing screens for blinding and reliability. Operations staff reported that the screens blind about twice per year, once in the spring and once in the fall. If blinding is occurring, it may be increasing upstream water levels such that bypassing of the screens is required, which is a permit violation.

An assessment of screen blinding was conducted under CS-299. SCADA data was collected for seven storms between July 2017 through January 2020 for water levels upstream and downstream of the

screens. This information was used to evaluate the level differential (i.e., upstream level minus downstream level) through the screen during the entire storm event. If the screens blind, the level differential through the screen will increase significantly compared to the rest of the event.

Table 6-2 provides a summary of the storms and the level differentials.

Table 6-2. Peak Total Influent Flow and Screen Level Differential During Storm Events

Storm Date	Peak Total Influent Flow (cfs)	Level Differential Throughout Storm (inches)
11/18/17	952	5 – 8
4/15/18	614	5 – 8
5/12/18	878	5 – 9
10/2/18	405	5 – 8
7/7/19	872	19 – 31
10/27/19	1149	6 – 7
1/11/20	1444	6

Figure 6-1 and Figure 6-2 show water levels upstream and downstream of the screens as well as the river elevation and flow for the two storm events in October 2019 and January 2020, respectively. The upstream water level is shown in light and dark green and the downstream water level is shown in red and magenta. The screen differential levels in Figure 6-1 and Figure 6-2 are representative of all of the storms except for the July 7, 2019, storm as discussed below.

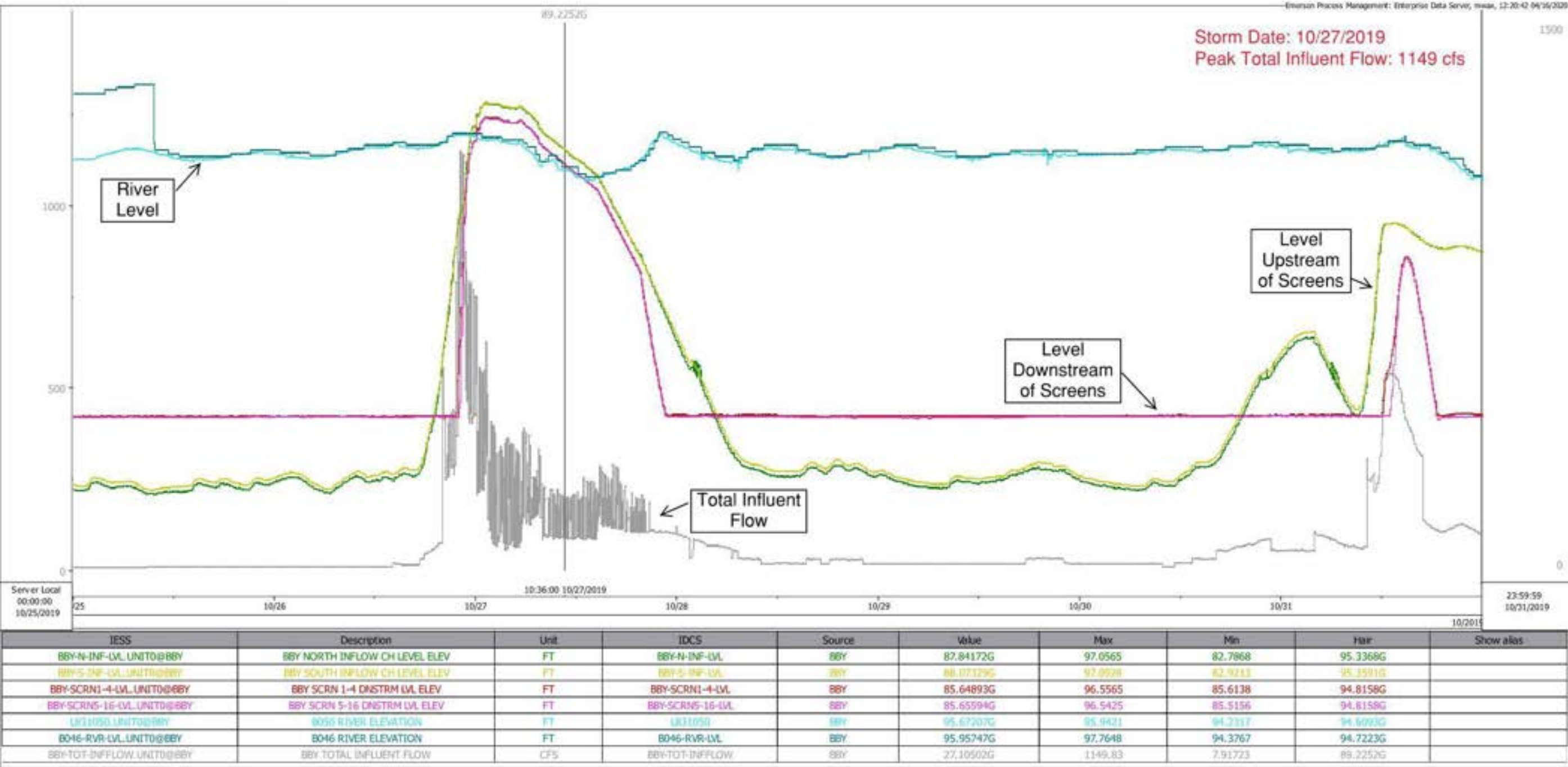


Figure 6-1. Screen Differential Level during October 27, 2019 Storm

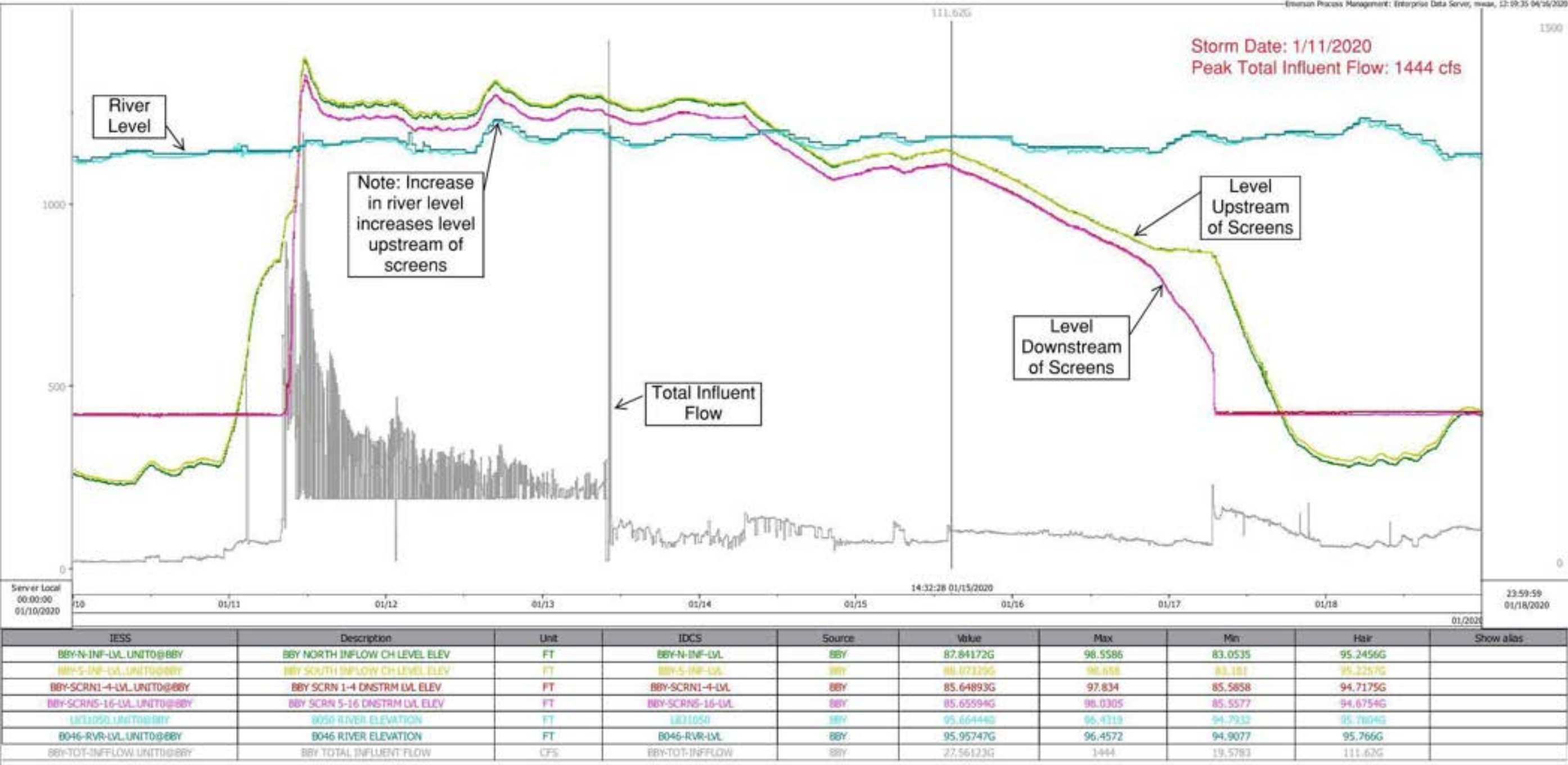


Figure 6-2. Screen Differential Level during January 11, 2020 Storm

Below are findings from analyzing the level differential data for all of the events.

- All events show a relatively constant differential across the screen during the entire storm event, regardless of flow rate throughout the storm. It should be noted that the differential through the screens should be greater during high flows and smaller during lower flows. The sensors should be checked for calibration as an annual recurring preventative maintenance (PM) activity.
- The differential varies from storm event to storm event; however, the value is nearly constant through an individual storm event. For example, differential was 6 in. for the entire January 11, 2020 storm and 6 to 7 in. for the October 27, 2019 storm. One storm (July 7, 2019), however, had differential of 19-31 in. throughout the storm event. This range was due to the fact that the influent level sensors had a 12- in. difference between the two readings for the entire event, which is not considered accurate.
- There are spikes in the level at the beginning of two events (May 11, 2018 [not shown] and January 11, 2020). These could be considered blinding caused by a first flush since the level rapidly increases, then decreases. In fact, for the January 11, 2020 storm, the bypass gates had to be opened at the beginning of the event. However, the downstream level shows the same spike. This indicates that blinding is not the cause of the spike in level. Rather, it is likely caused by the rapid increase in flow to the facility.
- The January 11, 2020 demonstrates that the river level affects the upstream levels. As noted on the figure (Figure 6-2) on January 12, 2020, an increase in the river level increases the downstream and the upstream screen levels.

Based on the constant level differential across the screens during large storm events, the screens do not show evidence of blinding. This issue was reviewed with GLWA on April 16, 2020. It was concluded that blinding was not occurring. As such, capital improvements intended to specifically reduce screen blinding will not be beneficial.

Replace Existing Screen Brushes (Project BC-SCR-1). During the investigation of the blinding issue and previous Veolia site visits, Veolia indicated that there is a new type of brush mechanism for the screens. The current mechanism is stationary, and a newer, current version of the mechanism is self-adjusting. All new screens of this type from Veolia have self-adjusting brush mechanisms. Reportedly, the self-adjusting brush maintains better contact with the screen panels at a constant pressure as the panels pass by the brush improving removal of screenings and extending brush life. The existing screen could be retrofitted with the new mechanism to potentially improve screenings removal and extend the life of the brush.

Due to the lack of supporting data related to the benefits of the newer brushes, GLWA could consider piloting the self-adjusting brush mechanism on two of the more frequently used screens (i.e., Screens 1 to 4) to compare its performance and the impact on brush life. Based on these results, GLWA would be able to determine whether to replace the brush mechanisms on the remaining screens. As such, there are two alternatives with this option:

- 1) **Alternative 1: Replace Existing Brushes In-Kind.** Replace with stationary brushes for two screens.
- 2) **Alternative 2: Pilot Self-Adjusting Brushes.** Replace with self-adjusting brushes for two screens.

The alternative evaluation is presented in Table 6-3. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 is based on brush costs from Veolia from a recent brush replacement order in 2019. Cost is for two brushes, installed by GLWA maintenance.

- The capital cost for Alternative 2 are included in Volume 6 – Appendices, Appendix C, under this project title, and are based on a quote for two brushes. Installation of the brushes is assumed to be performed by a contractor.

This analysis does not account for a potentially longer life of the brush, which would be determined through the pilot evaluation. Review of the NPV/Benefit costs, however, shows that the self-adjusting brushes would need a longevity of approximately four times longer than the existing brushes to be considered the Best Value Alternative. It is not anticipated that the self-adjusting brushes would have a longevity long enough to be considered the Best Value Alternative. As such, **Alternative 1: Replace Existing Brushes In-Kind is the recommended alternative.** Because this should be considered a wear item, it is not included in the capital improvement projects; rather, brush replacement should be included in a Capital Outlay for these screens.

Table 6-3. Alternative Evaluation for Replace Existing Screen Brushes (Project BC-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Screen Brushes In-Kind	Health and Safety	3	2.40	\$ 36,000	\$ -	\$ 36,000	\$ 15,000	Best Value Alternative
	<i>Definition:</i>	Replace existing screen brushes in-kind when they have worn	Water Quality & Compliance	2						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Shorter brush useful life due to higher wear rate. Not as effective at cleaning the screen.	Component Performance	2						
	<i>Comments:</i>	Brush costs from Veolia. Assumes GLWA labor for installation.	O&M Ease	2						
2	<i>Alt. Name:</i>	Pilot Self-Adjusting Brushes (Two Screen Pilot)	Health and Safety	3	3.00	\$ 173,000	\$ -	\$ 173,000	\$ 57,667	
	<i>Definition:</i>	Install higher performance self-adjusting brushes.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher cleaning performance. Longer life due to less wearing.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	Although new brushes may last longer than existing bushes, this evaluation assumes the new brushes have the same useful life.	O&M Ease	3						

6.2.2 Disinfection

6.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of four rubber-lined steel tanks, eight self-priming centrifugal pumps with VFD speed control, eight disinfectant rapid mix zones, and 32 induction mixers. There are 16 screens and the flow from each pair of screens is funneled into a disinfectant rapid mix zone. There are four induction mixers per disinfectant rapid mix zone consisting of two low level mixers and two high level mixers. The sodium hypochlorite pumps discharge to two headers, one smaller than the other, which run the length of the Headworks and each connect to the manifold feeding the four induction mixers at each rapid mix zone. Flow splitting between the four induction mixers is not metered and is dependent on functioning back pressure valves with equal upstream pressure settings.

Table 6-4 provides an overview of the existing disinfection system at Baby Creek CSO facility and the disinfection process flow diagram is included in Volume 6 – Appendices, Appendix G.

Table 6-4. Overview of Existing Disinfection System at Baby Creek CSO facility

Parameter	Value
Treatment Capacity (cfs)	5,100
Design Feed Strength (% hypochlorite)	5
Max. Dosage at Design Flow (mg/L as Cl ₂)	20
Disinfection Contact Time (min)	10
Storage Tanks	
Number	4
Volume of Each Tank (gal)	36,000
Type	Rubber-lined steel
Pumps	
Number	8 Total; 2 low-rate, 3 mid-rate, 3 high-rate
Capacity (gpm)	Low-rate: 0-50, Mid-rate: 0-150, High-rate: 0-400
Type	Centrifugal
Mixers	
Number / Type	32 / Chemical induction mixers
Model Number/ hp / Manufacturer	SWC15XPL/ 15 hp / Water Champ

6.2.2.2 Identified Needs and Issues

The needs and issues for Baby Creek were identified from meetings with O&M staff and Jacobs team site visit and investigations. The identified needs and issues are listed in the following bullets:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Baby Creek chemical feed system has the following issues:
 - The pumps and pipe supports in the vicinity of the pumps are corroding as a result of exposure to sodium hypochlorite.
 - A glued polyvinyl chloride (PVC) joint fails at an approximate rate of one every three months in the Chemical Room.

- The pumps have traditional drives requiring seal water, are reaching the end of their useful life, and include self-priming accessories adding to their complexity and increasing their footprint.
- The chemical piping is complex and congested.
- The back pressure valves controlling the chemical feed split between the four induction mixers at each disinfectant rapid mix zone are suspected of not functioning properly.

These issues are addressed in Replace Chemical Feed System (Project BC-DIS-1) in the next section.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Project BC-DIS-2) in the following bullet.
- There are 32 chemical induction mixers that require relatively frequent and costly maintenance. This issue is addressed in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project BC-DIS-3).
- Inefficient mixer removal system – includes evaluation of monorail vs. gantry cranes with electric hoist and electric trolley to replace existing hand chain hoist. This issue is addressed in Improve Mixer Removal System (Project BC-SUPP-1) at the end of this facility section.
- Modify floor slope in Chemical Room to drain to sump – This issue is addressed in the Architectural section (Section 6.2.9.3).
- Reline chemical storage tanks – Based on an inspection in 2020, the tanks are in need of relining to provide extended life. The repair/replacement of the liner is an ongoing project, so it is not included in the capital improvement projects for CS-299. The SRP model was manually adjusted to recognize the improvement of this ongoing project.
- Related to the relining of the storage tanks, GLWA requested that Jacobs review the historical and expected chemical usage compared to tank storage capacity to determine whether to reline all four tanks or only two or three tanks. Sodium hypochlorite usage for the four largest storms from 2016 through early 2019 was evaluated. The volume used was based on tank levels rather than flow meters because of suspicious flow meter data. The analysis indicated that the maximum used as a percent of total tank volume was 49 percent. This would indicate that the minimum number of tanks to be relined would be two. Had a larger storm occurred than the period analyzed then more than two tanks would be required assuming all other things equal (i.e., assuming the same dose and hypochlorite strength). Using more conservative assumptions of a 15 mg/L average dose and an assumed 5 percent hypochlorite strength, a volume in excess of the total four tank volume would be required. At an assumed dose of 15 mg/L and 9 percent hypochlorite strength three tanks would be fully consumed. Given the possibilities of a larger storm, hypochlorite degradation down to 5 percent, or the need for a higher dose, it is recommended that all four tanks be relined to retain the original design capacity at Baby Creek.
- Sump pump replacement in Chemical Room – This is an ongoing project. As such, it is not included in the capital improvement projects for CS-299.
- Chemical make-up water actuator replacement in Chemical Room – This is an ongoing project. As such, it is not included in the capital improvement projects for CS-299.

6.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project BC-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, BC-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

The alternative evaluation for these alternatives is presented in Table 6-5. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP and include pump replacement at Year 10.
- The capital costs for Alternative 2 and 3 are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 was developed based on GLWA experience of two pump rebuilds per year at a cost of \$13,000.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 6-5 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 6-5. Alternative Evaluation for Replace Chemical Feed System (Project BC-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System In-Kind	Health and Safety	3	2.08	\$ 1,657,301	\$ 26,000	\$ 2,205,631	\$ 1,058,703	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with feeding too much chemical. System is unique to Baby Creek.	Component Performance	1						
	<i>Comments:</i>	Capital costs include pump replacement at Year 10	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 3,325,000	\$ 44,550	\$ 4,264,543	\$ 1,184,595	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per disinfection channel. Utilize hose pumps.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual switchover.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 1,237,000	\$ 4,000	\$ 1,321,359	\$ 367,044	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps connected to all disinfection channels. Utilize centrifugal pumps.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily utilized.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each disinfection channel.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Project BC-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Operation in manual at Baby Creek is noted by operations as being extremely difficult. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

The sample point should be located approximately 15 minutes travel time downstream of the dosing point at average flow but peak flow travel time must also be considered. The exact location would be determined during design. Based on the evaluation of a few years of recent data, the average flow rate during storms at Baby Creek is about 108 cfs. This is a very small percent of the design storm and 15 minutes contact time at average flow will be only a short distance downstream of the dose point (approximately 500 ft). The sampling location needs to be upstream of storm sewer flows which would dilute the measurement. If there is an existing access point that meets the criteria, then this should be explored during design. However, the cost of a new manhole will be assumed to access the sampling pump.

The automatic chemical feed system should require less operator input during an event; however, this cost difference is not included in this analysis because GLWA O&M staff believe that manual sampling to confirm the auto sample result will still be necessary. There will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 6-6. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains ready for service.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be consistently met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 6-6. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project BC-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less efficient chemical feed and possible overdosing of chemical.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 201,000	\$ 4,860	\$ 303,496	\$ 87,970	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more efficient use of chemical.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult with infrequent CSO facility use.	Component Performance	4						
	<i>Comments:</i>	O&M to maintain analyzers based on 3 hrs/month.	O&M Ease	2						

Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project BC-DIS-3). Plant personnel reported that the mixers are expensive to maintain and due to the sealed nature of submersible mixers they must be sent back to the manufacturer for maintenance which adds shipping cost and takes months before the mixer is returned to service. These issues are exacerbated by having 32 mixers at Baby Creek, which is the second-highest of the nine CSO facilities. A reduction in the number of mixers would reduce maintenance and the associated expenses proportionate to the reduction. It would also reduce the complexity of equal flow splitting between mixers.

The alternatives to address this issue were identified previously in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Section 5.2.4). The alternatives include:

- 1) **Alternative 1. Replace Existing Chemical Induction Mixers In-Kind.** This alternative assumes replacement of the mixers in-kind.
- 2) **Alternative 2. Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers.** CFD modeling is assumed to be required to demonstrate to EGLE the adequacy of a lesser number of mixers. For illustration purposes, it is assumed that the number of mixers can be reduced by half (i.e., from four to two per channel) based on the fact that the latest model shows design flows are about half of the original design flows.
- 3) **Alternative 3. Install Vertical Shaft Mixers.** This alternative would replace the existing chemical induction mixers with new vertical shaft mixers. For Baby Creek, two mixers would be provided per channel.

The alternative evaluation is presented in Table 6-7. The sources of costs used in this evaluation are listed in the following bullet:

- The capital cost for Alternatives 1 and 2 includes mixer replacement in-kind at the number of mixers shown. Capital costs are based on the SRP replacement cost of \$50,000 per mixer and a 10-year life. Because the life-cycle period is 20 years, the capital costs assume replacement of the mixers twice during the 20-year period.
- For Alternative 2, the cost of the CFD model is assumed to be \$50,000.
- The O&M costs for mixer replacement in Alternatives 1 and 2 is based on current costs for repairing a chemical induction mixer. It is assumed the mixer needs to be repaired every 2.5 years at a cost of \$18,000 per mixer.
- The capital cost for Alternative 3 (vertical shaft mixers) is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 3 (vertical shaft mixers) are based on expected maintenance costs, including changing oil, greasing bearings, periodic rag removal from the shaft and servicing the steady bearing.

As shown in Table 6-7, Alternative 2 has a Total Benefit score about 0.4 higher than Alternative 1 because of the improved ease of maintaining fewer mixers. Alternative 3 has a Total Benefit score about 0.3 higher than Alternative 2 based on the anticipated improved performance of the vertical mixers and improved ease of maintenance, since the mechanical portion of above the water surface. **Alternative 2, however, has the lowest NPV/Benefit cost and therefore, is the recommended alternative.**

It should be noted that the cost of the reduced mixers is not a new capital cost for GLWA. Rather, it was used in this evaluation to compare alternatives. The cost for the CFD modeling would likely be included in a capital outlay, not a capital improvement project. If the CFD modeling does not prove that disinfection performance can be achieved, the vertical mixer alternative should be further explored, possibly through the pilot testing of this technology in one of the channels at Baby Creek or Conner Creek.

Table 6-7. Alternative Evaluation for Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project BC-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Induction Mixers In-Kind	Health and Safety	3	2.57	\$ 3,200,000	\$ 230,400	\$ 8,059,052	\$ 3,139,890	
	<i>Definition:</i>	Replace existing mixers as required.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, lots of redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Expensive and impacts operations and maintenance. Equipment installed in channels. Possible ragging issues.	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement 2 times during 20-year period.	O&M Ease	1						
2	<i>Alt. Name:</i>	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	Health and Safety	3	3.00	\$ 1,650,000	\$ 115,200	\$ 4,079,526	\$ 1,359,842	Best Value Alternative
	<i>Definition:</i>	Perform CFD modeling to simulate performance with fewer mixers (assumed 50% of existing).	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less expensive and less impacts to operations and maintenance. Equipment installed in channels. Possible ragging issues.	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement 2 times during 20-year period & CFD Modeling of \$50,000.	O&M Ease	3						
3	<i>Alt. Name:</i>	Install Vertical Shaft Mixers	Health and Safety	3	3.32	\$ 7,033,000	\$ 56,000	\$ 8,214,020	\$ 2,476,589	
	<i>Definition:</i>	Replace existing mixers with vertical shaft mixers.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less equipment to operate and maintain. Overall less install horsepower. Equipment is above the basin and accessible in a non-confined space environment. Maintains redundancy requirements.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Bearing in bottom of channel. Possible ragging issues.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

6.2.3 Odor Control

6.2.3.1 Description of Existing System

The Baby Creek odor control system is a Calgon Carbon PHOENIX automatic regeneration system, which utilizes radial flow canisters filled with Centaur HP carbon. Several years ago, Calgon Carbon sold its odor control equipment division to Continental Carbon along with the Centaur HP carbon. The unit consists of 26 compartments of five canisters each for a total of 130 canisters. Foul air is delivered from the Screening Building by the odor control fan and is uniformly distributed through the carbon canisters, bringing the air in direct contact with the carbon. Centaur HP carbon contains a catalyst that oxidizes hydrogen sulfide (H_2S) and converts it to sulfuric acid. As a result, the carbon can be restored for H_2S uptake by water washing. The regeneration process consists of filling a single compartment of canisters with water, letting the water sit for a period of time, and then draining and drying the carbon. The system was installed in 2006. The carbon has not been replaced since installation.

This odor control system operates under air permit requirements (Permit to Install No. 69-90). The emission limit is 0.04 pounds per hour of H_2S . At a design air flow of 26,000 cubic feet per minute (cfm), this equates to approximately 0.3 parts per million volume concentration of H_2S . The permit does not require sampling of emissions of carbon media unless the Michigan Department of EGLE specifically requests it.

Per GLWA, no odor complaints have been received for at least the past three years.

6.2.3.2 Identified Needs and Issues

During meetings with O&M staff related to the odor control system, no needs were identified. The recommendations in this section are based on the Jacobs team evaluation of the existing system.

Future Carbon Replacement Considerations. Carbon eventually needs to be replaced when the capacity to remove H_2S diminishes to the point that the discharge does not meet permit limits. Carbon replacement can be expensive, and the frequency and type of carbon should be carefully considered. This section presents considerations for carbon replacement.

The Centaur HP carbon loses capacity over time for several reasons. The main mechanism is loss of adsorption sites due to compounds other than H_2S . Other odorous compounds like organic sulfide compounds remain adsorbed to the carbon and are not removed during the regeneration process. Chlorine and other compounds that may be present in the regeneration water will adsorb to the carbon and remain. Another mechanism is residual sulfuric acid that does not get rinsed during the regeneration cycle and remains on the carbon occupying sites. Finally, carbon fines (i.e., tiny pieces of the carbon media) are lost over time as a result of the repeated washing process. The loss of fines reduces the carbon volume, which, correspondingly, reduces the carbon's overall capacity. One typically determines the need for carbon regeneration by measuring the H_2S concentration in the discharged air. When H_2S is still detected in the discharged air after a regeneration cycle, the carbon is spent and should be replaced. Centaur HP replacement is about every two years under typical municipal wastewater applications. GLWA facilities are not typical applications as the odor control systems are operated infrequently and are likely under low loads from H_2S and odorous compounds meaning the carbon will last a lot longer. According to O&M staff, the Baby Creek system is regenerated twice per year based on the recommended PM in the manufacturer's O&M manual. If this frequency has occurred since startup, the system has been washed about 24 times. Under extremely low odor loads, the carbon can be depleted faster due to compounds in the regeneration water like chlorine. Laboratory analysis of the carbon for H_2S capacity is likely the best

way to determine the remaining carbon life for the Baby Creek system. Sampling the discharged air for H₂S breakthrough likely will not be effective due to the likely low H₂S load.

Although the current carbon capacity may be significantly less than the original capacity, the lack of any odor complaints from the community means that any odors being discharged are either not noticeable, not objectionable or are masked by other odor sources in the area. It is recommended that GLWA sample the influent and discharge of the odor control system during at least two storm events in the summer months (i.e., the period with the highest odor potential) to better understand the magnitude of odors generated from the CSO facility and the performance of the current system relative to the existing air permit limits.

If the influent H₂S levels are below discharge permit limits, replacement of the carbon would not be needed. Further testing could then be performed to determine if the carbon could be removed and not replaced. If influent and discharge H₂S levels are greater than permit limits, carbon replacement should be performed in the near future. The following bullets provides considerations for the carbon replacement.

- The existing Centaur HP carbon in the PHOENIX system has an H₂S capacity of 0.09 g H₂S/cubic centimeter of carbon (15 percent by weight). The cost for replacement of the carbon is about \$88,400 (130 canisters at \$680 per canister). The cost includes a new canister, sealing and loading the canister with Centaur HP carbon, and delivery.
- ECS Environmental Solutions (ECS) manufactures a direct equivalent to Centaur HP carbon at a lower cost. ECS reuses the existing canisters. The cost for ECS's water regenerable catalytic carbon is about \$55,250 (130 canisters at \$425 per canister). The cost includes shipping the full canisters to ECS, disposal of the spent carbon, cleaning the canisters, charging the canisters with ECS water regenerable catalytic carbon, and delivery.

As noted above, an evaluation of influent and discharge H₂S concentrations is recommended prior to carbon replacement. When it is time to replace the Centaur HP carbon, GLWA should evaluate replacing it with either Centaur HP or ECS water regenerable catalytic carbon.

6.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement "needs".

6.2.4 Flushing and Dewatering

6.2.4.1 Description of Existing System

Dewatering System: After an overflow event, the effluent conduits and headworks area are dewatered by gravity by opening the sluice gates S-6-1 and S-6-2 to the Oakwood Interceptor. A 3,000 gpm dewatering pump is provided in the flushing pump area to fully dewater the Headworks area.

An alternate mode of dewatering is to allow the screening flushing pumps to continue to operate following an overflow event. This method of dewatering will allow dewatering flow into the Oakwood Interceptor even when the hydraulic grade line is relatively high.

Flushing System: A flushing system for the area in the Headworks upstream of the screens consists of two tipping buckets. There is one tipping bucket upstream of Screens 1-4 and one tipping bucket upstream of Screens 5-16.

It is noted that a flushing system is not currently provided for the effluent conduits. The nearly 1-mile long effluent conduits have an issue with significant quantities of solids accumulating in the channels (i.e., up to 5 ft deep in some locations). GLWA televised these conduits in 2019. GLWA plans to issue an RFP to address this issue in the near future. As such, this issue is not further addressed in this report.

Table 6-8 provides an overview of the existing flushing and dewatering system at Baby Creek CSO facility.

Table 6-8. Overview of Existing Flushing and Dewatering System at Baby Creek CSO facility

Parameter	Value
Headworks Dewatering and Flushing System	- One 3,000 gpm submersible pump for station dewatering (in Dewatering Sump) - Four 16,000 gpm submersible pumps - typically for screenings conveyance, but can be used to dewater area upstream of screens 2 tipping buckets for the area upstream of screens. Buckets flush toward Dewatering Sump, which pumps to Toward Treatment sewer
Effluent Conduit Dimensions	Three 17.5 ft × 14.5 ft barrel conduits
Effluent Conduit Dewatering and Flushing System	- Sluice gates at end of conduit are used to dewater effluent conduit to the Oakwood Interceptor after storm event. - There is no flushing system in the effluent conduit. <i>Project for a flushing system anticipated in the near future</i>

6.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- A significant amount of solids can accumulate in the influent channel area, immediately upstream of the weir wall at the Headworks. Significant solids buildup can cause hydraulic restrictions and impede inspection of influent flow meters. There is no flushing system at this location and solids removal must be performed periodically by a contractor. A contractor recently cleaned the influent channel area in 2019.
- S-2-1 sluice gate opening does not extend to the bottom of the influent channel to allow for complete dewatering (or solids flushing) of the influent area.
- Address sediment buildup in effluent disinfection conduits. Significant sediment occurs over time in the effluent conduits. An RFP for professional engineering services to minimize the buildup of sediments is planned in the near future to address this issue. As such, it is not included as a capital improvement project for CS-299.

6.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Flushing System in Influent Area (Project BC-FD-1). There are two alternatives for addressing the solids buildup in the influent area and the S-2-1 sluice gate opening. These alternatives include:

- Alternative 1: Do Nothing/ Contractor Clean-Out.**
- Alternative 2: Flushing System in Influent Area.** An identified alternative includes mounting a 6- in. high-density polyethylene (HDPE) flushing header along the backwall of the influent area

approximately 8 ft above the adjacent lower concrete surface. See Volume 6 – Appendices, Appendix B for figures (Figure BC-FD-1-ALT-2) showing conceptual layouts of this header. HDPE pipe is recommended for this application due to its corrosion resistance and its flexibility that imparts resistance to damage from impacts by heavy debris suspended in wet weather flows. The flushing header should be specified with an adequate wall thickness to allow for directionally drilled holes (up to 3/4- in. diameter) that create a water jet aimed in a specific direction toward the opening of Gate S-2-1. This gate is normally closed during dry-weather operation. A subsequent project to lower the invert of this opening is included in this set of recommendations.

The proposed hole spacing along the header is approximately 18 to 24 in. A total flow rate of at least 900 gpm is estimated to adequately remove sediment from the concrete shelf above the dry-weather flow channel and maintain adequate volume and velocity to carry the sediment into the dry-weather flow channel post event.

A second HDPE header mounted approximately 5 ft above the dry-weather flow channel with a similar spray hole distribution is recommended to provide additional flow and increase velocity during flushing. This will encourage faster removal and migration of sediment to the reconfigured Gate S-2-1 opening for pumping with the existing dewatering pump and discharge toward the WRRF with its better capacity for solids removal and disposal. A total flow rate of 1,200 gpm is estimated for initial sizing of this header. The benefit of the drilled hole approach to directing a jet of water is that no fittings are mounted on the exterior, and the pipe wall provides enough apparent length such that the hole directs the flow toward the intended surface.

Non-potable water (NPW) will be required. A 6-in. NPW line exists within the Headworks facility and is currently used for screen spray water and for chemical line flushing. The proposed flushing system connection could be made to this existing line within the facility. Flushing of the influent channel should occur after facility flows have significantly receded. As such, the influent flushing water use will not conflict with these other uses.

Following a CSO event, a motor operated solenoid/gate/ball control valve at the NPW pipe connection to the flushing water system will be opened to charge the flushing header. The control strategy assumes that solenoid is activated for a set duration (minimum of 15 minutes) after the level sensors in the influent channel record a water level rise above a pre-determined wet weather elevation and then a subsequent water level drop. A small valve is also recommended at the terminus end of each spray header with a rising stem and automated actuator mounted outside of the chamber. At the start of the cleaning cycle, these valves will automatically open for several minutes, allowing the potable water to flush any materials that have entered the header through openings out the open end. These terminus valves would close, and the header would pressurize and start spraying. Weekly automated cleaning during dry weather periods using this system will help reduce buildup of materials on the shelf and in the dry-weather flow channel.

During initial operation, onsite staff should visually inspect the shelf area to confirm sediment has been adequately removed and then adjust the control system timer to increase/decrease the flushing duration as needed until the system has been optimized. Integration with the facility's SCADA and PLC systems is necessary to achieve this functionality. A new electrical connection to the control valve is also required (110 V) and would be routed from the nearest internal junction box.

The opening for the S-2-1 gate does not extend to the floor of the influent channel. Making the bottom of this gate opening at a lower elevation would allow for flushed solids to enter the dewatering well and staff to be able to dewater the area without using sump pumps. The opening of sluice gate S-2-1 could be modified by removing the existing gate and frame, cutting approximately 2 ft of concrete from the bottom of the opening and remounting a new larger sluice gate.

The existing dry-weather flow channel will require addition of concrete topping to form a positive slope toward the expanded Gate S-2-1 opening, as shown in the drawings. The final designer should

collect and characterize site-specific sediment samples for grain size and density, and use a sediment fate/transport, CFD or scale model to finalize the performance criteria. This will be critical in evaluating and sizing this system to determine the required flow rate to direct sediment and the dry-weather base flow (20-30 cfs) toward the opening of Gate S-2-1.

The opening for the S-2-1 gate does not extend to the floor of the influent channel. Making the bottom of this gate opening at a lower elevation would allow for flushed solids to enter the dewatering well and staff to be able to dewater the area without using sump pumps. The opening of sluice gate S-2-1 could be modified by removing the existing gate and frame, cutting approximately 2 ft of concrete from the bottom of the opening and remounting a new larger sluice gate. Subsequent to the draft Facilities Assessment Report, another consultant (AECOM) analyzed this proposed flushing arrangement using CFD modeling and found that the proposed flow rate in the trough did not significantly suspend sediment within the influent trough. Based on this input, GLWA elected to postpone this project further into the future (at least 10 years out) and re-evaluate again after another round of manual cleaning.

For reference, the alternative evaluation for these alternatives is presented in Table 6-9. The sources of costs used in this evaluation are listed in the following bullets:

- Contractor clean-out of this area is estimated to be \$250,000 every 5 years, based on the cost and amount of solids buildup from the recent cleaning project at this location. This O&M cost is annualized to \$50,000.
- The capital cost for the flushing system (Alternative 2) is included in Volume 6 – Appendices, Appendix C under this project title. It should be noted that the capital cost includes an allowance of \$90,000 for cleaning the influent channel prior to installing the flushing system. The \$90,000 equates to about \$250,000 after contingencies, and standard markups for design, construction assistance and contractor overhead and profit have been applied.
- The O&M costs for the flushing system (Alternative 2) is based on water usage of 2,100 gpm for 15 min every week, for a total of about 1.6 MG per year and a unit cost of \$4,000 per MG.

Based on the results of recent CFD modeling of the flushing system by others showing that the sediment is not significantly suspended, **Alternative 1 – Contractor Clean Out is the recommended alternative.** Although Alternative 2 is not recommended at this time, it is included in the CIP to be reconsidered in about 10-15 years based on experienced gained from contracted cleaning the influent channel.

Table 6-9. Alternative Evaluation for Flushing System in Influent Area (Project BC-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Contractor Clean-Out	Health and Safety	2	2.50	\$ -	\$ 50,000	\$ 1,054,482	\$ 421,793	
	<i>Definition:</i>	Allow solids to build up and have a Contractor clean out the channel, as needed	Water Quality & Compliance	3						
	<i>Adv.:</i>	No system to maintain	Capacity Enhancement	3						
	<i>Disadv.:</i>	Significant build-ups can impact facility hydraulic capacity. Cleaning influent area is a high-risk activity. Requires a great deal of GLWA coordination.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Flushing System in Influent Area	Health and Safety	5	3.78	\$ 787,000	\$ 6,400	\$ 921,974	\$ 243,693	Best Value Alternative
	<i>Definition:</i>	Mount a flushing header along the backwall of the influent area and second flushing header above the dry weather flow channel	Water Quality & Compliance	3						
	<i>Adv.:</i>	Allows flushing after every event.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance of equipment and increased water usage.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

6.2.5 HVAC

6.2.5.1 Description of Existing System

The Baby Creek CSO facility was constructed in 2006. The facility consists of one main building with a large Headworks, Chemical Room, utility support (two Electrical Rooms and a Mechanical Room), control room and other miscellaneous rooms. The facility also includes a small, off-site effluent sample building about a mile from the main building. Table 6-10 provides a summary of the major HVAC equipment at this facility.

Plumbing services for the facility consist of city water service, sanitary system, natural gas-fired water heater, electric water cooler, emergency shower/eye wash, emergency eye wash, and bathrooms with lockers and shower. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 6.2.10.

Table 6-10. Major HVAC Equipment at Baby Creek CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	HV-1 & 2	2 × Heating and Ventilating Units	31,000 cfm and 1,760 MBH
	SF-1, 2, & 3	3 × Supply Fans	45,000 cfm
	EUH-1A to H	8 × Electric Unit Heaters	2,450 cfm and 51.2 MBH
Chemical Room	GUH-5A to 5E	5 × Gas Unit Heaters	1,100 cfm and 60 MBH
	IF-1	Exhaust Fan	2,110 cfm
	IF-2	Exhaust Fan	10,551 cfm
Electrical Room 1	WF-1	Wall Fan (Exhaust)	6,320 cfm
	EUH-2	Electric Unit Heater	700 cfm and 25.6 MBH
Electrical Room 2	WF-2	Wall Fan (Exhaust)	1,000 cfm
	EUH-3	Electric Unit Heater	400 cfm and 17.1 MBH
Control Room	HVAC-1	AHU with Split DX Cooling Coil and Natural Gas Furnace	1,610 cfm 74 MBH Heating 43.5 MBH Cooling
Office	HVAC-2	AHU with Split DX Cooling Coil and Natural Gas Furnace	1,480 cfm 74 MBH Heating 43.5 MBH Cooling

Notes:

AHU = air handling unit(s)

BTU = British thermal units

MBH = thousand British thermal units per hour

Table 6-11 provides a summary of the basis of design performance criteria for HVAC systems at Baby Creek and Table 6-12 provides the outdoor Basis of Design conditions.

Table 6-11. Baby Creek Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Headworks	Class I, Div 1, Group D	60	N/A	12 ACH (Occupied)
Chemical Room	Unclassified	60	100	6 ACH (Cooling Mode) 1 ACH (Continuous)
Electrical Room	Unclassified	70	100	Heat Relief
Control Room	Unclassified	72	72	5 cfm per person & 0.06 cfm/ft ²
Office	Unclassified	72 (Occupied) 50 (Unoccupied)	75	5 cfm per person & 0.06 cfm/ft ²

Notes:

ACH = air changes per hour

cfm/ft² = cubic feet per minute per square feet

Table 6-12. Baby Creek Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

6.2.5.2 Identified Needs and Issues

During discussions with GLWA O&M staff and GLWA's HVAC Contractor, the following HVAC issues were noted:

- Inadequate heating in Control Building: O&M staff noted that when outdoor air conditions are under 20 °F, the furnaces (HVAC-1 and HVAC-2) serving the main Control Building struggle to maintain a setpoint of 70 °F indoors.
- Abnormally short life for Electric Unit Heaters in Headworks Area: Per GLWA's HVAC Contractor, the Electric Unit Heaters in the Headworks Area have a life of 2 to 3 years. The typical expected life of unit heaters which are properly selected for their environment is about 15 years.
- Corrosion issues with Gas Unit Heaters in Chemical Room: GLWA's HVAC Contractor has observed corrosion issues with the gas unit heaters in the Chemical Room. Additionally, the location of one unit over the pump area was noted as making access for maintenance a major issue.

During site investigations (June 2020) the following observations were noted:

- The Chemical Room unit heaters are difficult to access. See Figure 6-3.



Figure 6-3. Chemical Room Unit Heater Located in Inaccessible Area

- Corrosion was visible on unit heaters in the Chemical Room.
- The Transformer Room supplied outside air for ventilation cooling high in the space and exhausted at a low level.
- The large overhead doors were open in the Headworks Area, the relief dampers were closed, and the make-up air unit (MAU) was not running.
- The thermostat on EUH-1 in the Headworks Area was out of calibration.
- Unit heater EUH-2 was turned on in the Headworks Area and it was about 75 degrees outside.
- Corrosion was visible on Trane unit heaters in the Headworks Area.
- Several of the motorized outside air intake dampers for SF-1, SF-2, and SF-3 were not functional. The fans showed signs of significant corrosion.

Improvements are currently ongoing under existing projects including:

- The installation of a new intake louver with integral motorized damper and exhaust fan in the Electrical Room
- Damper motor actuator replacements in the Chemical Room
- Damper and actuator replacements in the Headworks Area
- Various monitoring and control upgrades including control and monitoring of electric unit heaters, fans, dampers and HVAC units.

6.2.5.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Control Building HVAC Investigation and Improvements Study (Air Balance Study). Given that the winter outdoor design condition for the units was 3 °F and that they were designed to heat to 72 °F, the furnaces are not functioning as intended.

If the ongoing controls upgrade does not improve heating at the facility, Jacobs recommends an air balance of HVAC-1 and HVAC-2 to assess whether poor air distribution is the cause of the observed underheating.

If the air balance does not improve heating in the under-heated areas, electric duct heaters can be added to branches of the system requiring additional heat.

Chemical Room Unit Heaters and Ventilation System (Project BC-HVAC-1). The Trane GAND model unit heaters in the Chemical Room have aluminized steel heat exchangers. Sodium hypochlorite is known to have a severe corrosive effect on aluminum. The use of natural gas unit heaters in a sodium hypochlorite environment is generally not recommended due to the potential for corrosion of the unit heaters and subsequent natural gas leakage. There are two alternatives to address this issue:

- 1) **Alternative 1: Replace Chemical Room Unit Heaters and Ventilation System In-Kind.** This alternative assumes the units will be replaced in-kind. Because of the corrosive environment of this room, the units will be assumed to be replaced more frequently than typical unit heaters, as discussed further in the alternative evaluation in the following paragraph.
- 2) **Alternative 2: Replace Chemical Room Unit Heaters and Ventilation System with Air Handling Unit.** This alternative involves removing the gas unit heaters and installing an air handling unit (AHU) with a modulating gas heating section at ground level adjacent to the Chemical Room. The unit would be provided with a VFD to allow the AHU to work in conjunction with IF-1 to maintain a set differential pressure between the Chemical Room and ambient conditions. The AHU would run in conjunction with IF-1 and IF-2 in the summer to provide ventilation for cooling the Chemical Room. The AHU would run continuously at the minimum ventilation rate but would also be provided with a low leakage motorized damper which would close when the unit is not running (when the unit requires maintenance) to prevent backflow of air from the Chemical Room to the inside of the AHU potentially leading to corrosion issues. Locating the heating section in an AHU on the ground level has the added benefit of both reducing the number of pieces of equipment which need to be maintained and providing easier access to the equipment for maintenance personnel.

Figure BC-HVAC-1-ALT-2 in Volume 6 – Appendices, Appendix B, shows a potential location for the AHU. It also shows that the road next to the Chemical Room would need to be slightly relocated to allow adequate room for the AHU. Road modifications are included in the capital cost for this alternative.

The alternative evaluation is presented in Table 6-13. The sources of costs used in this evaluation are listed in the following bullets:

- Capital costs for the unit heaters and ventilation units in Alternative 1 were obtained from the SRP. The costs for the six unit heaters were multiplied by 2, assuming the units would need to be replaced twice during the life cycle of the AHU in Alternative 2.
- The annual O&M cost recognizes that there is less maintenance on the one AHU (Alternative 2) as opposed to the six unit heaters (Alternative 1).
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 is the Best Value Alternative. **As such, Alternative 2 Replace Chemical Room Unit Heaters and Ventilation System with Air Handling Unit is the recommended alternative.** Since Alternative 1 consists of in-kind replacement of the unit heaters and ventilation equipment, these units will be included in the SRP, not a CIP project.

Table 6-13. Alternative Evaluation for Replace Chemical Room Unit Heaters and Ventilation System (Project BC-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Chemical Room Unit Heaters and Ventilation System In-Kind	Health and Safety	3	2.78	\$ 73,400	\$ 5,760	\$ 194,876	\$ 70,015	Best Value Alternative
	<i>Definition:</i>	Replace unit heaters in Chemical Room in-kind, with material compatible with corrosive atmosphere	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Multiple units require increased maintenance	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement of unit heaters 2 times during 20-year period. O&M assumes annual maintenance of 6 hrs per unit.	O&M Ease	2						
2	<i>Alt. Name:</i>	Replace Chemical Room Unit Heaters and Ventilation System with Air Handling Unit	Health and Safety	4	3.60	\$ 236,000	\$ 2,400	\$ 286,615	\$ 79,615	
	<i>Definition:</i>	Replace unit heaters in Chemical Room with a make-up air unit outside Room at ground level	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier access for maintenance, fewer units to maintain, protected from corrosive atmosphere	Capacity Enhancement	3						
	<i>Disadv.:</i>	Tight site constraints for MAU	Component Performance	4						
	<i>Comments:</i>	O&M assumes annual maintenance of 20 hrs for AHU.	O&M Ease	4						

Headworks Building Electric Unit Heaters. The Trane UHXA unit heaters in the Headworks Building have an aluminum-finned tubular steel heat exchanger which is directly exposed to the air stream in the Headworks Building when the heaters are running. Steel has very poor H₂S resistance and is a poor choice of materials for the environment the unit heaters are in. It is recommended that as the unit heaters fail they are replaced by properly rated units that have a 316 stainless steel heat exchanger and cabinet body, aluminum or 316 stainless steel fins, fan blade, and control enclosure and a motor with a corrosion-resistant protective coating which has passed the ASTM B117 salt-spray test. Indeeco makes such a unit, which has been installed in other CSO facilities. Based on the information presented here, new unit heaters will not be a capital improvement project; rather they will be replaced as part of the SRP.

6.2.6 Electrical

6.2.6.1 Description of Existing System

The Baby Creek facility's electrical system consists of a double-ended unit substation with dual (redundant) utility feeds, primary metering and DTE Energy indoor dry type transformers. The substation has a tie-breaker and automatic source transfer controls. Circuit breakers in the substation then feed four motor control centers (MCCs). The MCCs then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Because of the redundant electrical feed, this facility does not have an emergency generator. Table 6-14 provides a summary of the major electrical equipment for this facility.

Table 6-14. Major Electrical Equipment at Baby Creek

Location	Major Electrical Equipment	Description
Electrical Room 1	Double-ended unit substation	2,000 kVA, 24 kV-480/277 V, 3 Phase
Electrical Room 1	MCC-1	1,200 A, 480/277 V, 3 Phase
Electrical Room 1	MCC-2	1,200 A, 480/277 V, 3 Phase
Electrical Room 2	MCC-3	800 A, 480/277 V, 3 Phase
Electrical Room 2	MCC-4	800 A, 480/277 V, 3 Phase

Note:

kVA= kilovolt-ampere(s)

6.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for less safe working conditions. These lighting needs are in addition to the recent LED lighting project. This issue is further described in the next section.

6.2.6.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project BC-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles, however it will be less safe when operating bypass gates at night and when accessing area downstream of screens.

2) **Alternative 2: Electrical Improvements.** Add Lighting and Exterior Power Receptacles at the following locations (and shown on the electrical drawings - Figure BC-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):

- Downstream of mixers – Add the required amount of ceiling and wall mounted LED lighting fixtures to provide sufficient lighting for O&M activities.
- Light pole by bypass gates - Add light pole and associated LED lighting fixture at the facility's bypass gates.
- Exterior power receptacles are needed about every 75 ft on the front and back wall of the facility to assist in the maintenance and operations of the facility. Receptacles should be accessible from ground level.

The alternative evaluation is presented in Table 6-15. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$38,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 6-15. Alternative Evaluation for Electrical Improvements (Project BC-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe when operating bypass gates at night and when accessing area downstream of screens.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 133,000	\$ -	\$ 133,000	\$ 38,000	Not Applicable
	<i>Definition:</i>	Add additional lighting and receptacles at identified locations	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Minor increased maintenance and energy usage with increased number of lights.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

6.2.7 I&C

6.2.7.1 Description of Existing System

Control System: The original Ovation control system was installed in 2005 under PC-748. The Ovation system was designed having two separate control systems – one for the CSO Facility and one for the Sampling Building. The CSO Facility's control system has the capability to control and monitor both systems; whereas the Sampling Building control system only monitors the outfall and controls the Miller gates. In 2015 under Job Order JB -173 the CSO Ovation system controllers and software were upgraded to O.V.3.5.0.

The existing CSO Facility Ovation system is composed of a typical Ovation control network with primary and backup network switches. The switches are connected to the GLWA AT&T wide area network via the system's router. It has three operator workstation stations, plus a database server. A redundant pair of Ovation controllers provides the station with controls and I/O capabilities. A 10 kilovolt-amperes (kVA) Liebert uninterruptible power supply is used to provide constant power to the network equipment and workstations. The network connections inside the facility are via copper Ethernet cables. The controller's connections are dual-homed, which means each controller has one connection to each of the network switches. Should one network fail, the backup, redundant network is available to provide station monitoring and control. The current system is equipped with a backup radio system to communicate critical monitoring points back to the System Control Center on wide area network failure.

The Sample Building's Ovation system consists of Ovation local I/O points, a controller, and a HMI that can only perform local control. Communications are via telephone line with radio backup to the CSO Facility. The local control panel is in poor condition and should be replaced in the near future due to reoccurring maintenance issues. The Sampling Building local control system was not updated in 2015 and is still operating on the old O.V.3.1. platform.

Flow and Level Sensors: Table 6-16 summarizes the level sensors and flow meters at the Baby Creek CSO facility used to monitor flows through the treatment system, chemical feed, and chemical storage.

Table 6-16. Summary of Flow Meters and Level Sensors at Baby Creek CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent (Elmer Ternes, East Barrel, West Barrel)	3	Transit-Time (AccuSonic)
CSO Level Sensors		
Influent (Elmer Ternes)	1	Ultrasonic
	1	Radar (Backup)
Influent (East Channel)	1	Ultrasonic
	1	Radar (Backup)
Influent (West Channel)	1	Ultrasonic
	1	Radar (Backup)
Screening Area (Upstream and downstream of screens)	6	Ultrasonic
	6	Radar (Backup)
Effluent Channel	1	Ultrasonic
	1	Radar (Backup)

Area	Quantity	Instrument Type
<i>Chemical System Flow Meters</i>		
Chemical Feed	2	Magnetic
Carrier Water	1	Magnetic
Service Water	1	Magnetic
<i>Chemical Storage Level Sensors</i>		
Chemical Storage Tanks	4	Ultrasonic

6.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- Address influent screen VFD failures
- Evaluate level sensors to determine redundancy and identify level sensors that could potentially be removed
- Need for additional flow meters and level sensors to improve monitoring and control of facility flows during wet weather and dewatering phases and level monitoring of tank levels at the Chemical Fill Station
- Need for process cameras at select locations to improve monitoring of facility during wet weather operation
- Replacement options for valve control network for the chemical feed system is discussed in detail in Section 5.4.6. The cost/benefit of the hardwired control was not favorable and therefore was not considered further.
- Update Ovation control system to the latest version and increased monitoring capabilities
- There is a lack of full monitoring and control of CSO facility from the Effluent Sample Building
- The facility bypass gates require manual operation. During large storm events, this takes on operator away from other activities. Providing remote control of these gates is an ongoing project. As such, it is not included in the capital improvement projects for CS-299.

6.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project BC-I&C-1). Due to the relatively small nature of some of the I&C-related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation control system upgrade and the full monitoring and control capability of the entire facility from the Effluent Sample Building, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. There are two alternatives for this project:

1) Alternative 1: Do Nothing/Replace In-Kind.

- Replace screen VFDs in-kind or leave VFDs in bypass mode
- Leave redundant level sensors in place

2) **Alternative 2: I&C Improvements** including,

- Address influent screen VFD failures
- Remove redundant level sensors
- Provide additional flow meters and level sensor
- Provide process cameras at select locations
- Provide local remote control for screens

Each of the I&C-related improvements listed above is described further in the following paragraphs:

Address influent screen VFD failures. Operations staff indicated the VFDs running the influent screens are subject to regular failures. The failures occur intermittently and cannot always be reset from the VFD. Operators have the option of bypassing the VFD to operate the screens, but without the ability to control the speed. It should be noted that, the screens operate at 100 percent speed constantly.

A short-term, temporary solution to bypass the VFDs after a fault is available. Each of the influent screens is equipped with a bypass contactor separate from the VFD. A selector switch on the front of the influent screen control panel is used to select the “bypass” mode. While operating in bypass mode, the influent screens will run in the forward direction at full speed. The reverse jog pushbutton located in a control station on the process floor near each influent screen, which is intended to momentarily reverse the screens in the event of a jam, will not function while the screens are in bypass mode. The VFD is used to provide the reversing feature and is not available while being bypassed. Operations has indicated the reverse jog feature is never used, so operating the influent screens in bypass mode is an acceptable, temporary option.

For a long-term solution, the influent screen manufacturer should be consulted to determine the path forward and if VFDs are necessary. If the influent screens do not require VFDs to operate, the VFDs should be removed and replaced with constant speed starters, similar to operation while in bypass mode. A second, reversing contactor should be included and interfaced with the reverse jog pushbutton located at the influent screens. Internal wiring modifications and as-built record drawings should be included. If the VFDs are necessary for long-term operation, the VFDs should be replaced with modern units to avoid the intermittent VFD failures.

Remove redundant level sensors. During the January 2020 Facilities Assessment meetings with O&M staff, GLWA requested that Jacobs investigate existing level sensors at all facilities to determine where there was redundancy and identify level sensors that could potentially be removed to minimize the number of instruments. The main focus of this investigation was the level sensors throughout the CSO treatment process.

There are two sets of level sensors in the influent channel at Baby Creek. Each set contains a primary ultrasonic and backup radar level sensor. One set is for the southern end of the channel (near Screen 2) where the influent weir is at El. 91 ft and the other is at the northern end (near Screen 11) where the influent channel is at El. 92 ft. Figure 6-4 shows the locations of these sensors. Review of the historical Ovation data for a recent six-month period shows that these two sets of level sensors have nearly identical readings, and as such, one set could potentially be removed. If removed, this would provide one ultrasonic level sensor as the primary sensor and one radar sensor as the backup for the influent channel.

There are also several redundant level sensors immediately upstream and downstream of the screens. Figure 6-4 highlights the locations of these level sensors in the Headworks. The original intent of these sensors, as depicted in the piping and instrumentation diagrams, was to provide the differential level readings for banks of screens to indicate when the screen should turn on and the speed of the screen. GLWA (and previously Detroit Water and Sewerage Department) have not used this feature since the major screen blinding/failure issues shortly after facility startup. Currently, the screens are

turned on at high speed when needed and then turned off after the wet weather event. Also, the jog feature is reportedly not used by operations staff. The removal of these differential level sensors (in accordance with Figure 6-4) would prevent the jogging feature of the screen and the speed adjustment, both of which are not used.

Provide additional flow meters and level sensors. Operations staff requested additional flow or level monitoring at the following locations:

- **Outfall Level Sensor:** GLWA requested a level sensor at the outfall. Consistent with the level measurement technology in Section 5.4.3, a radar level instrument is recommended.
- **Effluent Conduit Flowmeter:** The flowmeter should not be an Accusonic model but should be a laser-based flowmeter such as a TieNet 360 LaserFlow Velocity meter.
- **Bypass Conduit Flowmeter:** It should be noted that Jacobs performed a more detailed assessment of a laser-based flowmeter (TieNiet360 LaserFlow Velocity meter) for this location. Although the cost of the flow meter itself is significantly less than that of an Accusonic meter, the total project cost was greater than expected due to the significant cost for the structure above the conduit to provide adequate room for proper flow measurement. This flow meter is not included in the cost estimate.
- **Chemical Fill Station:** Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

Provide local remote control for screens. Provide local control for the screens in accordance with Section 5.4.9.

The alternative evaluation is presented in Table 6-17. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 includes VFD replacement for all screens and level sensors.
- The capital cost for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 1 include estimated annual maintenance of the valve control network. The O&M costs for Alternative 2 include estimated annual maintenance costs for the additional instrumentation provided.

This evaluation shows that Alternative 1, Do Nothing/Replace In-Kind, is the Best Value Alternative because the NPV/Benefit cost of Alternative 1 is approximately \$148,000 lower than that of Alternative 2. The total benefit score for Alternative 2, however, is 0.5 higher than Alternative 1 due to improved component performance and ease of O&M. **Since Alternative 2 provides increased performance and ease of O&M, it is the recommended alternative.** Due to the high NPV/benefit cost, however, it is not necessarily a high priority project if there are budget constraints.

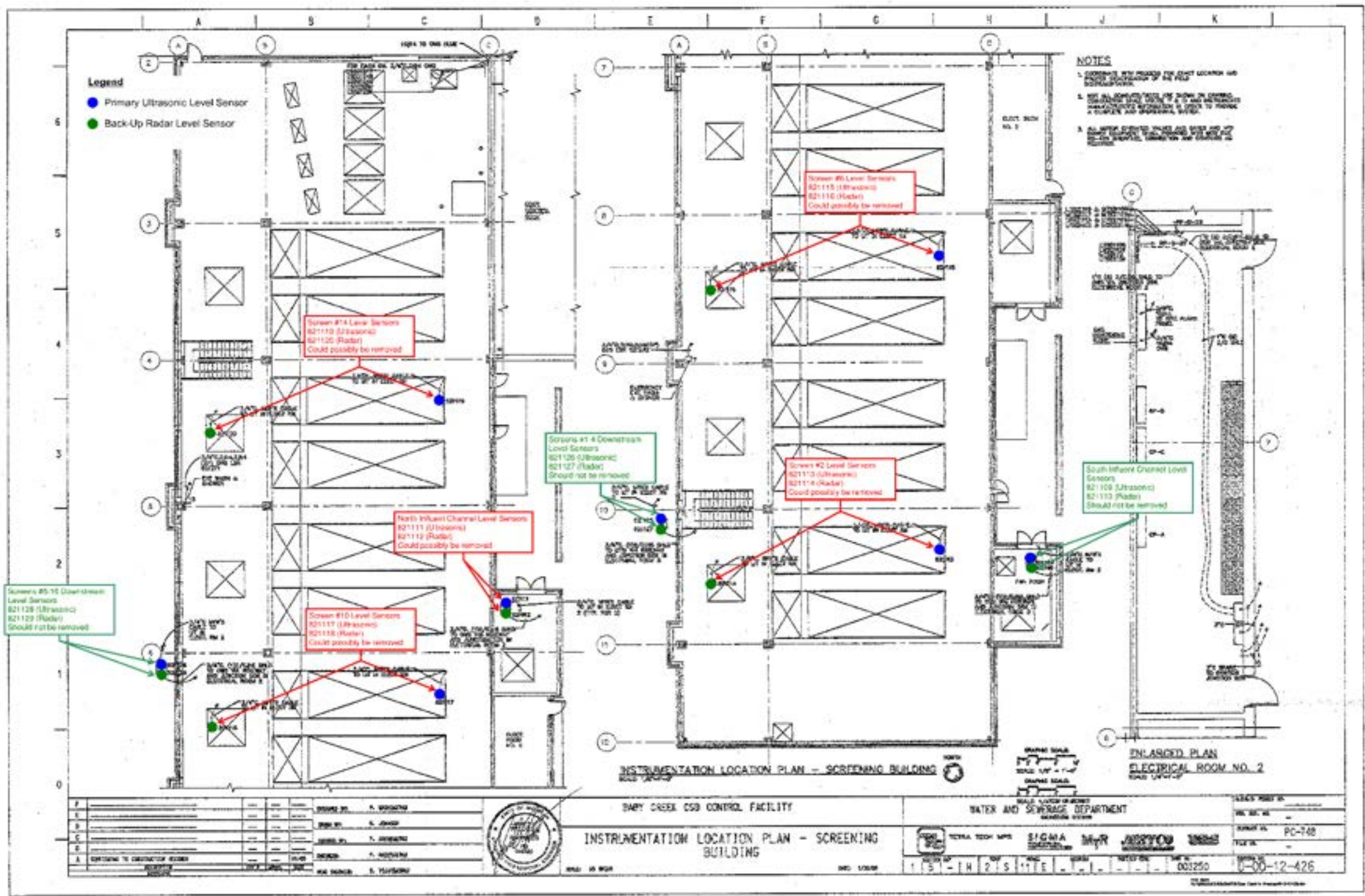


Figure 6-4. Baby Creek CSO Facility Level Sensor Identification

Table 6-17. Alternative Evaluation for I&C Improvements (Project BC-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	3	2.78	\$ 347,600	\$ 4,500	\$ 442,503	\$ 158,983	Best Value Alternative
	<i>Definition:</i>	Replace screen VFDs and level sensors in-kind.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	3						
	<i>Comments:</i>	O&M assumes annual maintenance of 5 hrs for level sensors; \$10,000 per year for valve network maintenance.	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 766,000	\$ 12,000	\$ 1,019,076	\$ 307,259	
	<i>Definition:</i>	Address VFD screen failures; removal of redundant level sensors; provide additional flow meters & sensors; provide process cameras; provide local control for screens	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	O&M assumes annual maintenance of 5 hrs for level sensors; 20 hrs for flow meter; 10 hrs for cameras.	O&M Ease	4						

Control System Upgrade (Project BC-I&C-2). This project updates the Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2. A full list of control system upgrades at the Baby Creek CSO facility is included in the following bullets:

- Update Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2.
- Replace the Sampling Building local control panel
- Update the Sample Building Ovation system to provide full control of the facility from the Sampling Building

Because the Ovation system is the only alternative for the control system upgrade, it is the only alternative considered. Table 6-18 provides the summary of the Control System Upgrade, which is the recommended alternative. Capital costs are included in Volume 6 – Appendices, Appendix C under this project title.

Table 6-18. Alternative Evaluation for Control System Upgrade (Project BC-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 1,337,000	\$ -	\$ 1,337,000	\$ 445,667	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Replace Sample Building local control panel. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Updates the control system to allow for enhanced performance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

6.2.8 Site

6.2.8.1 Description of Existing Site

The Baby Creek Control/Headworks Building site includes a 20-ft wide concrete paved access road off of Dix Rd on the west side of the facility. A concrete paved parking area is located on the northwest side of the Control Building. Site pavement on both sides of the building consists of 10- in. concrete and 6- in. aggregate base. Site runoff is collected by a storm sewer network in the parking areas and in grassy areas on the perimeter of the site. Then the flow is conveyed to the combined sewers onsite. Site security around the perimeter of the facility is provided by 8-foot-high ornamental fencing. Access to the facility is controlled by a sliding security gate located at the northwest corner of the Control Building.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's geographic information system (GIS). Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, Global Positioning System (GPS) date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this section.

6.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following sections.

- The fence is damaged in some locations due to lawn mower strikes.
- The existing access hatch to the Baby Creek sewer requires a crane to remove concrete planks. This is being addressed in an ongoing "Baby Creek Outfall Improvements" project (CIP 277001).
- An additional access point is needed downstream of the Screens 1-4.
- The stop logs are currently stored out-of-doors at the facility. The stop logs rubber seals are damaged by sunlight and, subsequently, are not effective when needed for flow isolation.
- The existing entrance gate is a 24-foot-wide cantilever sliding ornamental gate. The gate has experienced frequent electrical issues and has remained out of service for extended periods of time awaiting repair. During periods when the gate is out of service, it remains in an open position, which is a security concern particularly during hours of the day when there are fewer staff at the site. This was addressed in late 2020 under the GLWA-Contract No. 2001372 – Task 25 "Baby Creek Entrance Gate Repairs & Improvement" project.
- The following needs are generally PM items intended to ensure that the site features and utilities are serviceable throughout their expected service lives. These needs are listed in the following bullets and are not included in the capital improvement projects for CS-299. It is recommended that these issues be addressed by a GLWA-wide facilities maintenance contract. If not addressed.
 - Seal concrete pavement joints to prevent water infiltration

- Caulk expansion joint at the base of Control and Headworks Buildings between the walls/sidewalks along the north, south and west sides of the buildings
- Repair cracks in access drive and sidewalks

6.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Repair Security Fencing and Add Concrete Maintenance Strip (Project BC-SITE-1). The existing security fencing consists of 8-foot- tall powder coated aluminum fencing with 1- in. square fencing pickets. The total length of fencing is approximately 1,920 ft. The bottom of the fencing panels have experienced damage at several locations due to lawn mower strikes (example of damaged fencing shown in Figure 6-5). The impacts have left the bottom 6 to 8 in. of the pickets and posts severely bent or broken off. The fence is about 14 years old and, aside from the damaged pickets, remains in good condition. The damage sustained by the fencing does not currently impact security; however, because several fence posts have been damaged the fencing integrity in those areas has been compromised. There are two alternatives for addressing this issue. These alternatives include:

- 1) **Alternative 1: Do Nothing.** Repair bottom of fence, as necessary.
- 2) **Alternative 2: Repair Security Fencing and Add Concrete Maintenance Strip.** this alternative replaces the damaged fencing panels and posts. To avoid future damage by lawn mowing equipment, it is recommended that a maintenance strip be established 2 ft from each side of the fence line to avoid future strikes. The concrete maintenance strips beneath the fencing appear to have worked well at other sites.



Figure 6-5. Example of Damaged Fencing at Baby Creek CSO Facility

The alternative evaluation for these alternatives is presented in Table 6-19. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

Due to the limited extent of damage to the fence (i.e., only at the bottom), it is recommended that the fence be repaired, as necessary, and replaced when it has reached the end of its useful life. **As such, Alternative 1 is the recommended alternative.**

Table 6-19. Alternative Evaluation for Security Fencing (Project BC-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	3.00	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Replace fence in-kind at the end of useful life	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lowest cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Minor security concern	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Repair Fencing and Add Concrete Maintenance Strip	Health and Safety	3	3.20	\$ 226,000	\$ -	\$ 226,000	\$ 70,625	Not Applicable
	<i>Definition:</i>	Repair damaged fence and provide a concrete maintenance strip under fence to prevent future damage.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Addresses minor security concern	Capacity Enhancement	3						
	<i>Disadv.:</i>	Capital expenditure	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	3						

Stop Log Storage Shelter (Project BC-SITE-2). The stop logs are currently stored out-of-doors onsite at the Baby Creek CSO facility. The stop logs are equipped with compressible rubber seals that are susceptible to damage as a result of prolonged exposure to ultraviolet (UV) light. This results in their premature aging, impacting their ability to effectively prevent leakage when installed in the sewer stop log guides. The stop logs are currently stored in an area located between the Woodmere Pumping Station and the Baby Creek Headworks building, which has a footprint of approximately 60 ft by 20-ft. The stop logs are stored on grade and stacked next to each other. The stop logs rubber seals are damaged by sunlight and, subsequently are not effective and leak. There are two alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing.** Continue to store stop logs outside.
- 2) **Alternative 2: New Stop Log Storage Shelter and Racks.** The purpose of a new storage shelter is to provide protection for existing isolation stop logs. The storage shelter must provide protection from UV light and exposure to the elements, but its design must also remain open enough to allow equipment to access and move the stop logs in and out of the shelter. Per discussions with GLWA, the new shelter is to be located in the same general area as the existing storage area.

There are two potential styles of structure that could be used for a stop log shelter: a pavilion style pitched roofed structure or a semi-permanent canopy style structure. The pavilion style structure is generally a steel truss and post framed structure with a steel panel roof but generally without permanent sidewalls. The canopy structure can be a steel or aluminum framed structure with a heavy-duty PVC or polyethylene fabric cover that covers the entire framing structure to ground level. Either structure can be designed to meet Michigan Building Code requirements for snow and wind loads. The canopy style structure would provide additional UV protection with covered sidewalls extending to grade and is recommended for the storage of the stop logs. In addition, this option is less permanent than a pavilion structure, in the event that this structure might need to be moved around within the property. See Figure BC-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B, for the location of the proposed stop logs storage shelter. The figure also shows conceptual photos of what this type of semi-permanent low-tech structure would look like.

To avoid storage of stop logs directly on grade, it is also recommended that the shelter be placed on a concrete pad and the stop logs be stored in racks. These items are included in the cost estimate in BC-SITE-2 in Volume 6 – Appendices, Appendix C under this project title.

In addition, GLWA also requested that a new access hatch be provided to allow access for the area downstream of Screens 1 to 4. This hatch will be located outside of the facility near the existing concrete pavement above the channel (Figure BC-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B), provides the approximate location. Soils will be excavated above the existing roof near the outer channel wall to allow installation of a new 4-foot by 4-foot accessway and fall-restraint type ladder. The roof slab will be sawcut, and a precast utility vault section set and affixed. This opening size is required to accommodate the ladder assembly to the surface, clear space for personnel entering/exiting the lower facility and adequate space for personnel extraction connections to move freely between the lower facility and surface. A locking traffic-rated hatch (HS-20) is recommended. The existing pavement section will be extended to this new hatch location to provide a clean, paved working surface for topside activities while manned-entry into the lower area is underway.

The alternative evaluation for these alternatives is presented in Table 6-20. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – New Stop Log Storage Shelter and Racks has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and improved O&M provided by protecting the rubber seals on the stop logs. The NPV/Benefit cost for Alternative 2 is \$145,000, which is a relatively high cost compared to other projects

recommended in this assessment. Based on this information, **Alternative 2 - New Stop Log Storage Shelter and Racks** is recommended; however, it should be a relatively lower priority than other projects.

Table 6-20. Alternative Evaluation for Stop Log Storage (Project BC-SITE-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to store stop logs outside	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lowest cost.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Rubber seals may not properly hold back water when needed for projects.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	New Stop Log Storage Shelter and Racks	Health and Safety	3	3.42	\$ 497,000	\$ -	\$ 497,000	\$ 145,463	Not Applicable
	<i>Definition:</i>	New storage shelter will provide protection from UV light exposure.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Rubber seals should last longer.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost.	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	4						

6.2.9 Architectural

6.2.9.1 Description of Existing Facilities

The Baby Creek CSO facility consists of one main building with rooms for the process systems (screening and chemical feed/storage), odor control, utility support (electrical and mechanical), control room and other miscellaneous rooms. The facility also includes a small, off-site effluent sample building about a mile from the main building.

6.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a roof replacement evaluation and a detailed assessment of architectural issues, as described in the following paragraphs.

Evaluation of Type of Future Roof Replacement. The facility has a shingled roof. About one-third of the roof surface was replaced in 2017. A recent (2020) assessment by a roofing contractor (Schreiber) indicated that the remaining two-thirds was in “poor” condition and there have been leaks into the Electrical Room during recent rain events. GLWA requested that Jacobs perform a cost comparison of replacing the shingled roof with a metal roof.

Jacobs reviewed the results of the roof assessment and prepared a 60-year life-cycle cost analysis between shingled roof and metal roof. Based on the results of this evaluation, which shows a lower life-cycle cost for shingled roof, Jacobs recommended replacement of two-thirds of the roof with shingles. The analysis is presented in Table 6-21. Subsequently, GLWA requested that drawings and a roof replacement specification be developed to use in contracting for roof replacement. This project should be completed in 2021. As such, it is not included in this report as a future capital project. The SRP model was manually adjusted to recognize the improvement of this ongoing project.

Table 6-21. 60-Year Life-Cycle Cost Evaluation of Shingled vs. Metal Roof for Baby Creek Facility

	Shingle Roof	Metal Roof
Replacement Cost ^a	\$649,000	\$2,163,000
Replacement Interval	20 years	60 years
Number of Roof Replacements During 60 Years	3	1
Total Life-Cycle Cost (NPV) Discounted at 2.4%	\$1,762,000	\$2,163,000

^a Based on 43,250 ft² roof area; \$15/ ft² for shingle roof and \$50/ ft² for metal roof.

Note:

ft² = square feet

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities under CS-299. Jacobs used the architectural-related information in NTH’s Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the aboveground buildings as a starting point and included additional items, as observed during the assessments conducted under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff indicated that that the floor coating in the Chemical Room had been consumed by sodium hypochlorite spills and the floor was flat and did not slope toward the sump.

6.2.9.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (BC-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessment. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove and replace isolation/ cove joint sealant and around building perimeter
 - Repair and replace cracked guardrail member; make unstable base connections for FRP guardrail more rigid
 - Address door and door frame corrosion issues, and door hardware issues for various doors
 - Clean localized rusted areas of structural steel surface and recoat localized steel areas in Headworks
 - Clean rusted areas of steel bollards and recoat all exterior bollards
 - Remove and replace, in kind, disbonded tile and underlayment from concrete floor
 - Repair/ patch finish material and repaint ceiling of entryway exterior canopy
 - Clean corrosion in steel base/ steel column supporting the entryway exterior canopy and repaint

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings (Figure BC-ARCH-1-ALT-2) in Volume 6 – Appendices, Appendix B. Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 6-22. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the need to prevent more costly damage in the future from not addressing these issues, **Alternative 2 - Architectural Rehabilitation is the recommended alternative.**

Table 6-22. Alternative Evaluation for Architectural Rehabilitation (Project BC-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 596,000	\$ -	\$ 596,000	\$ 192,258	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

Slope Chemical Room Floors and Add Coating (Project BC-ARCH-2). GLWA requested Jacobs evaluate modifying the floor slope in the Chemical Room to drain to the sump. There are three alternatives evaluated:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Provide Corrosion-Resistant Floor Coating in Chemical Room** (on existing flat floor). This alternative only provides a floor coating which is currently being considered to address an immediate need for floor protection. Jacobs has successfully used the following highly chemical-resistant coating systems in sodium hypochlorite containment areas:
 - Surface Preparation: Meet requirements of Society for Protective Coating SP 13 and coating manufacturer's instructions.
 - Primer: 1 coat of the manufacturer's recommended concrete primer.
 - Filler/Surfacer: 1 coat as required to fill voids of trowel grade filler and surfacer designed for vinyl ester coating.
 - Finish: 2 coats of vinyl ester coating resistant to containment service of 12.5 percent sodium hypochlorite solution. Provide slip resistant surface on floors.
- 3) **Alternative 3: Provide Corrosion-Resistant Floor Coating and Slope Floor in Chemical Room.** This alternative includes sloping the floor before adding the coating described in Alternative 2. Sloping the floor would be accomplished by grouting over the existing floor. Grouting should be coordinated with the chemical feed system replacement project, if possible. Coating of the floor should be done after increasing the floor slope.

The alternative evaluation is presented in Table 6-23. The capital costs for Alternative 2 and 3 are included in Volume 6 – Appendices, Appendix C under this project title.

As shown in Table 6-23, Alternative 2 has a Total Benefit score about 1.0 higher than Alternative 1 because of the chemical resistant coating protecting the concrete floor. Alternative 3 has a Total Benefit score about 1.2 higher than Alternative 2 based on the improved health and safety, component performance, and ease of O&M with the chemical resistant coating and the sloped floor. Coating the floor is necessary to protect the concrete floor over the life of the facility. Examination of the NPV/benefit costs for the alternatives that provide a coating (Alternatives 2 and 3) shows that Alternative 3 has the lowest cost. **As such, Alternative 3 - Provide Corrosion-Resistant Floor Coating and Slope Floor in Chemical Room is the recommended alternative.**

This project should be scheduled with future improvements to the chemical feed system. If these improvements do not occur within the next two to three years, consideration should be given to coating the existing floor to preserve the condition of the concrete.

Table 6-23. Alternative Evaluation for Slope Chemical Room Floors and Add Coating (Project BC-ARCH-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	1	2.02	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Concrete floor continues to deteriorate.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Corrosion Resistant Floor Coating (on existing flat floor) in Chemical Room	Health and Safety	2	3.03	\$ 283,000	\$ -	\$ 283,000	\$ 93,297	Not Applicable
	<i>Definition:</i>	Provide corrosion resistant floor coating on existing floor	Water Quality & Compliance	3						
	<i>Adv.:</i>	Protects concrete floor from damage due to aggressive chemical	Capacity Enhancement	3						
	<i>Disadv.:</i>	Chemical still stays on the floor for extended period.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Provide Corrosion Resistant Floor Coating and Slope Floor in Chemical Room	Health and Safety	5	4.20	\$ 338,000	\$ -	\$ 338,000	\$ 80,476	Not Applicable
	<i>Definition:</i>	Slope floor toward sump and coat floor	Water Quality & Compliance	3						
	<i>Adv.:</i>	Spills will be conveyed to sump	Capacity Enhancement	3						
	<i>Disadv.:</i>	Highest cost	Component Performance	5						
	<i>Comments:</i>	Project should be combined with major disinfection project	O&M Ease	5						

6.2.10 Safety

6.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

6.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 6-24. The capital improvement project to address these issues is included in the table.

Table 6-24. Identification of Capital Improvements for Safety Issues

Location	Description	Proposed Corrective Action	Capital Improvement Project
Sample Room	Door needs illuminated exit sign	Add exit sign	Exit Sign Improvements ^a
Mechanical Room	No illuminated exit sign on exterior door	Add exit sign	Exit Sign Improvements ^a
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project BC-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

6.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section.

Safety Improvements (Project BC-SAFE-1). This project should address the safety issues identified above. These issues include:

- Fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 6-25 shows the one alternative.

Table 6-25. Alternative Evaluation for Safety Improvements (Project BC-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 236,000	\$ -	\$ 236,000	\$ 78,667	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection and eye washes.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

6.2.11 Supporting Infrastructure

6.2.11.1 Description of Existing System

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above.

6.2.11.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- Inefficient mixer removal system – includes evaluation of monorail vs. gantry cranes with electric hoist and electric trolley to replace existing hand chain hoist.
- Address inability of overhead crane to access dewatering pump.
- Address high iron sediment concentration in potable water lines. GLWA has experienced high iron concentrations in incoming potable water to the facility. In August 2020, flushing of the incoming 8-in. water mains servicing the facility conducted under CS-299 in an effort to remove the cause of the rust colored water within the facility. A few weeks after the flushing exercise, the operators reported rust colored water again. Based on the results of the flushing samples and the return of the rust color, the following recommendation were made to minimize the iron in these lines:
 - For the eye wash in the Chemical Room, it is recommended to install an automatic solenoid valve on a timer to routinely flush this line for a set period of time each day. The operators could do this over a few consecutive days to find out how long it takes to flush the line before the iron dissipates. If it takes a long time and there is a large amount water on the floor, there should be consideration to providing a permanent drain to the sump. However, the results seem to indicate the iron color may dissipate quickly, especially if it is flushed routinely.
 - For the kitchen, a point of use device could be installed specifically designed for iron removal.

These projects could be done by GLWA maintenance and are not included in the capital improvements.

6.2.11.3 Discussion and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Improve Mixer Removal System (Project BC-SUPP-1). The overhead bridge crane was not designed with adequate side-to-side reach for removal and installation of the induction mixers. Currently, portable A-frame gantry cranes with hand chain hoists are used for this purpose. An improved mechanism for removing and installing the induction mixers is desired.

Three alternatives are identified in the following list:

- 1) **Alternative 1: Do Nothing.** Continue to use gantry cranes with hand chain hoists.
- 2) **Alternative 2: Monorail System.** Provide two parallel monorails centered over the two pairs of induction mixers in each mixing zone. The monorails would run the length of the building (or shorter monorails could be provided serving one or more of the mixing zones). Two continuous monorails the

length of the building were assumed for estimating cost. One ¼ ton electric hoist with manual trolley on each of the two parallel monorails was assumed for estimating cost.

- 3) **Alternative 3: A-Frame Portable Gantry Cranes with Electric Hoists.** Provide two new portable A-frame gantry cranes with a ¼ ton electric hoist and trolley on each.

The alternative evaluation is presented in Table 6-26. Capital costs for each alternative are presented in Volume 6 – Appendices, Appendix C under this project title. The table shows that Alternative 3: A-Frame Portable Gantry Cranes with Electric Hoists provides a Total Benefit score of 1.0 higher than the Do Nothing alternative because of improvement safety and ease of O&M. The table also shows that the NPV/Benefit cost is more reasonable than the Alternative 2 – Monorail System. **As such, Alternative 3 is the recommended alternative.**

Table 6-26. Alternative Evaluation for Improve Mixer Removal System (Project BC-SUPP-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use gantry cranes with hand chain hoists	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Raising mixer out of channel for inspection is more difficult and less safe.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Monorail System	Health and Safety	5	4.00	\$ 998,000	\$ -	\$ 998,000	\$ 249,500	Not Applicable
	<i>Definition:</i>	Provide two parallel monorails centered over the two pairs of induction mixers in each mixing zone. One ¼ ton electric hoist with manual trolley on each of the two parallel monorails.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Raising mixer out of channel is easier and safer.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Highest cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						
3	<i>Alt. Name:</i>	A-Frame Portable Gantry Cranes with Electric Hoists	Health and Safety	4	3.50	\$ 266,000	\$ -	\$ 266,000	\$ 76,000	Not Applicable
	<i>Definition:</i>	Provide two new portable A-frame gantry cranes with a ¼ ton electric hoist and trolley on each.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Raising mixer out of channel is easier and safer than existing operation	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not as easy as monorail system.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

Overhead Crane Access for Dewatering Pump (Project BC-SUPP-2). O&M staff indicate that the existing building's overhead crane is unable to remove the dewatering pump. This is because the overhead crane travel does not reach the mid-point of the rails for the submersible dewatering pump. In order to use the overhead crane, the hook must be able to pull the dewatering pump straight up the rails, or the pump will not be able to be removed. Figure 6-6 illustrates this issue.

Two alternatives are identified in the following list:

- 1) **Alternative 1: Do Nothing.** Continue to use gantry crane. The gantry crane does not fit well into the space, making it difficult to remove the pump.
- 2) **Alternative 2: Add Trolley to Overhead Crane:** Jacobs contacted Crane Technologies, the original crane supplier for solutions to this issue. They recommended a 2-ton capacity electric chain hoist with motorized trolley. The hoist would be powered from a festoon track system that would have to be installed on the crane bridge. The hoist would be controlled from either a dedicated hard wire pendent, (which would have the concern for that pendent hanging down when the crane bridge is traveling down the runway), or from a dedicated radio control device, which would eliminate the corded pendent. The radio control system is recommended. The system would be explosion-proof rated.

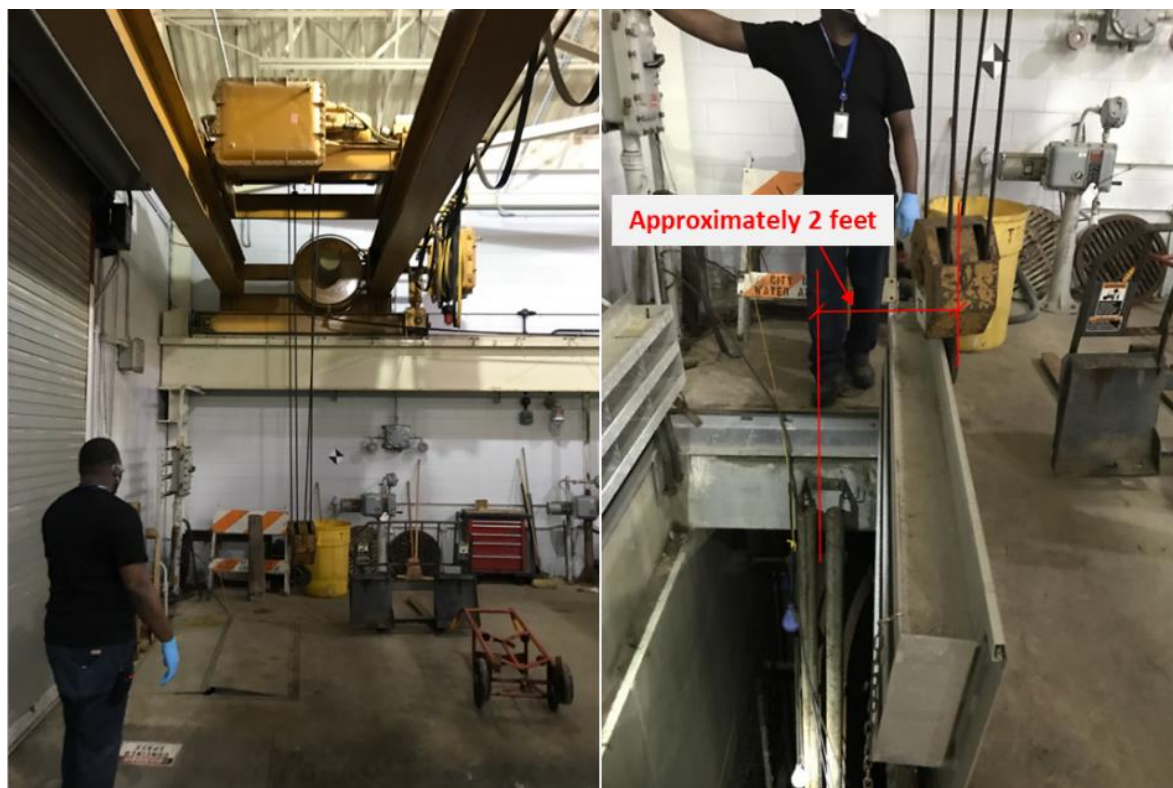


Figure 6-6. Overhead Crane Issue

The alternative evaluation is presented in Table 6-27. Capital costs for each alternative are presented in Volume 6 – Appendices, Appendix C under this project title. The table shows Alternative 2 has a Total Benefit score of 1.5 higher than the Do Nothing Alternative because of improved safety and ease of O&M. The NPV/Benefit cost for Alternative 2 is about \$22,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety and O&M with this alternative, Alternative 2 – Add Trolley to Overhead Crane is the recommended alternative.**

Table 6-27. Alternative Evaluation for Overhead Crane Access for Dewatering Pump (Project BC-SUPP- 2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to utilize gantry crane to remove dewatering pump	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Extremely tight site conditions make positioning the gantry crane difficult, and potentially unsafe.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Add Trolley to Overhead Crane	Health and Safety	5	4.00	\$ 90,000	\$ -	\$ 90,000	\$ 22,500	Not Applicable
	<i>Definition:</i>	Add a 2-ton capacity electric chain hoist with motorized trolley	Water Quality & Compliance	3						
	<i>Adv.:</i>	Simplified pump removal and install	Capacity Enhancement	3						
	<i>Disadv.:</i>		Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

6.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Baby Creek CSO facility, Table 6-28 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 6-28, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 6-28. Listing of Asset Condition Assessments for Baby Creek Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	40	40	0	100%
AHU	4	0	4	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	4	4	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	9	6	3	100%
BUILDING	2	1	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	0	0	0	N/A
COND-AIR	2	2	0	100%
CONVEYOR	0	0	0	N/A
CRANE	1	1	0	100%
CTRLPANEL	1	1	0	100%
DAM	0	0	0	N/A
DAMPER	16	16	0	100%
DISCONNECT	4	4	0	100%
DOOR	3	3	0	100%
DRIVE-ELEC	24	8	16	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
EYEWASHSTA	6	6	0	100%
FAN	1	0	1	100%
FANVENT	17	9	3	71% ^b
FENCE	2	2	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	1	0	100%
GASMONITOR	2	2	0	100%
GATE	10	10	0	100%
GEARBOX	48	0	48	100%
GENERATOR	0	0	0	N/A
GRINDER	0	0	0	N/A
GROUPS	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	2	0	0	0% ^c
MCC	4	0	4	100%
METER	8	8	0	100%
MIXER	32	32	0	100%
MOTOR	34	0	34	100%
PANEL	6	6	0	100%
PIPING	4	4	0	100%
PUMP	18	11	5	89% ^d
ROOF	1	1	0	100%
SAMPLER	1	1	0	100%
SCADA	2	2	0	100%
SCREEN	16	0	16	100%
SCRUBBER	1	0	1	100%
SENSOR	24	24	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	5	0	5	100%
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
TANK-STOR	4	4	0	100%
TIPBUCKET	2	2	0	100%
TRANSFRMR	3	0	3	100%
UNITHEATER	23	23	0	100%
UPS	3	3	0	100%
VALVE	56	56	0	100%
WATERHTR	2	2	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The five Roof Ventilators (non-motorized) on the roof were not accessible

^c The two Make Air Units are duplicates of the HV-1 and HV-2 Air Handling Units. These MAUs should be deleted in the future.

^d The two post-screening pumps are not in service and were not assessed.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Baby Creek Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

6.3 Capital Planning for Baby Creek CSO Facility

6.3.1 Summary of Capital Improvement Plan Projects

Table 6-29 provides a summary of the recommended CIP projects and associated capital costs for the Baby Creek CSO facility based on the alternative evaluations conducted for this facility.

Table 6-29. Summary of Recommended Projects at Baby Creek CSO Facility

Project No.	Alternative	Description	Total Project Cost
BC-DIS-1	3	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	\$ 1,237,000
BC-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 201,000
BC-DIS-3	2	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000
BC-FD-1 ^a	2	Flushing System in Influent Area	\$ 787,000
BC-ELEC-1	2	Electrical Improvements	\$ 133,000
BC-I&C-1	2	I&C Improvements	\$ 766,000
BC-I&C-2	1	Control System Upgrade	\$ 1,337,000
BC-SITE-2	2	New Stop Log Storage Shelter and Racks	\$ 497,000
BC-ARCH-1	2	Architectural Rehabilitation	\$ 596,000
BC-ARCH-2	3	Provide Corrosion-Resistant Floor Coating and Slope Floor in Chemical Room	\$ 338,000
BC-SAFE-1	1	Safety Improvements	\$ 236,000
BC-SUPP-1	3	A-Frame Portable Gantry Cranes with Electric Hoists	\$ 266,000
BC-SUPP-2	2	Add Trolley to Overhead Crane	\$ 90,000

Note:

^a Although this project is not recommended at this time, it is included in the CIP to be reconsidered based on experience gained from contractor cleaning of the influent channel.

6.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 6-30. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 6-30. Capital Improvement Plan Projects for Baby Creek CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
BC-1 Disinfection System Improvements	\$1,785,000	2033 <i>Timing based on existing asset condition</i>	BC-DIS-1	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	\$ 1,246,000
			BC-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 201,000
			BC-ARCH-2	Provide Corrosion-Resistant Floor Coating and Slope Floor in Chemical Room	\$ 338,000
BC-2 Influent Flushing System^a	\$ 787,000	2036 <i>Project to be re-evaluated after another cleaning cycle of the influent area</i>	BC-FD-1	Flushing System in Influent Area	\$ 787,000
BC-3 Facility-Wide Electrical and I&C Improvements	\$ 2,723,000	2025 <i>Timing based on asset condition</i>	BC-I&C-1	I&C Improvements	\$ 766,000
			BC-I&C-2	Control System Upgrade	\$ 1,337,000
			BC-ELEC-1	Electrical Improvements	\$ 133,000
BC-4 Facility-Wide Safety and Architectural Improvements	\$ 829,000	2023 <i>Project should be initiated as soon as possible</i>	BC-SAFE-1	Safety Improvements	\$ 229,000
			BC-ARCH-1	Architectural Improvements	\$ 600,000
BC-5 New Stop Log Storage Shelter	\$ 497,000	2030 <i>Timing based on best judgement</i>	BC-SITE-2	New Stop Log Storage Shelter and Racks	\$ 497,000
BC-10 Model Disinfection Performance	\$ 50,000	2021 <i>Timing based on potential for major maintenance cost reduction</i>	BC-DIS-3	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000

Note:

^a Although this project is not recommended at this time, it is included in the CIP to be reconsidered based on experience gained from contractor cleaning of the influent channel.

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 6-31 and Table 6-32 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 6-32 indicates that BC-DIS-1 project has two assets that need to be replaced immediately due to condition score of "5". These assets, however, have already been replaced/rebuilt since the Condition Assessment was conducted in Summer 2020. The remaining 40 assets that are included in this project have an average condition score of 1.55 and an average replacement date of 2034 (See Table 6-31). This information was used to propose a scheduled construction completion date of 2033.

Table 6-31. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
BC-DIS-1	40	1.35	1.55	2.43	21	2034	\$ 1,065,500
BC-DIS-3	29	1.29	1.24	2.08	10	2030	\$ 1,450,000
BC-HVAC-1	7	1.14	1.59	2.05	16	2032	\$ 39,801
BC-I&C-1	24	1.38	1.46	2.37	11	2031	\$ 329,307
BC-I&C-2	3	1.57	1.38	2.70	10	2030	\$ 803,097
BC-SAFE-1	2	1.71	1.29	2.82	10	2030	\$ 25,336
BC-SITE-1	1	1.29	1.33	2.14	20	2039	\$ 391,500

Table 6-32. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
BC-DIS-1	2	1.29	5.00	4.50	10	2021	\$ 102,000
BC-DIS-3	3	1.29	5.00	4.50	10	2021	\$ 150,000
BC-HVAC-1	1	1.14	5.00	4.00	15	2023	\$ 4,800
BC-I&C-1	1	1.43	5.00	5.00	10	2021	\$ 18,300
BC-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -
BC-SAFE-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
BC-SITE-1	0	0.00	0.00	0.00	N/A	N/A	\$ -

There are a number of recommended capital improvement projects presented in Table 6-29 that could be better delivered under capital outlay projects. These projects are listed in the following bullets:

- A-Frame Portable Gantry Cranes with Electric Hoists (BC-SUPP-1)
- Add Trolley to Overhead Crane (BC-SUPP-2)

For the CFD Modeling of Mixers (BC-DIS-3), it is ultimately recommended to include this project with similar modeling projects at the Conner Creek and Leib CSO Facilities. See Section 2 (Volume 1 – Project Introduction and Capital Improvement and Outlay Plans) for proposed bundling of this project.

6.3.3 20-Year Capital Outlay Plan

Table 6-33 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 6-33. 20-Year Capital Outlay Plan for Baby Creek CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 501,900	\$ 25,000	\$ -	\$ -	\$ 252,000	\$ -	\$ -	\$ 224,900	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 293,574	\$ -	\$ 293,574	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ 4,469	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2,546	\$ 1,923	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ 20,562	\$ -	\$ 20,562	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 3,033,298	\$ -	\$ -	\$ 3,004,620	\$ -	\$ -	\$ -	\$ 5,565	\$ 23,113	\$ -	\$ -	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 197,626	\$ 2,568	\$ -	\$ -	\$ 188,171	\$ -	\$ -	\$ 6,887	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,194,379	\$ -	\$ 131,141	\$ -	\$ 30,857	\$ -	\$ 38,003	\$ -	\$ -	\$ 994,379	\$ -	\$ -	\$ -
2030	\$ 2,353,820	\$ 19,572	\$ -	\$ -	\$ 2,235,076	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 99,172	\$ -	\$ -
2031	\$ 518,214	\$ 6,988	\$ -	\$ -	\$ 503,431	\$ -	\$ -	\$ 7,795	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 1,384	\$ -	\$ -	\$ -	\$ 1,384	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 256,028	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 256,028	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 4,789,716	\$ 986,965	\$ -	\$ 2,432,093	\$ 566,616	\$ -	\$ -	\$ 361,509	\$ -	\$ -	\$ 415,117	\$ -	\$ 27,416
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 2,567,530	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2,567,530	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 3,877,602	\$ 165,549	\$ -	\$ -	\$ -	\$ 2,619,091	\$ 40,007	\$ 386,452	\$ -	\$ -	\$ -	\$ 666,503	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 19,610,103	\$ 1,206,641	\$ 445,276	\$ 5,436,713	\$ 3,777,535	\$ 2,619,091	\$ 78,010	\$ 1,251,682	\$ 2,592,566	\$ 994,379	\$ 514,290	\$ 666,503	\$ 27,416

Notes:

Explanation of large capital outlays in first two years:

- Screening System: Screen No. 1 was out of service at the time of the Condition Assessment for major repair and received a score of 5. It has since been put back into service and could be reassessed.
- Disinfection System: Three mixers (\$50,000 each; \$150,000 total) were missing/out of service at the time of the Condition Assessment. Also, two chemical feed pumps (\$51,000 each; \$102,000 total) were missing.
- HVAC System: The Air Handling Unit (HV-2) was not operational two different times during the Condition Assessment. Unit was new in early 2020. It has since been fixed. Also, there was one unit heater in the Chemical Room that was out of service.

7. Belle Isle CSO Control Facility

7.1 Existing Facility Description and Future Capacity Considerations

7.1.1 General Facility Description

The Belle Isle CSO Facility is an RTB with 300,000 gallons of storage and a treatment capacity of 33 cfs. It was constructed in 2007. The facility consists of a headworks, chemical room, odor control room, electrical room, mechanical room, control room, sample room, and restrooms. The facility also includes an adjoining Belle Isle Pump Station, which is not included in this facility assessment.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

7.1.2 Future Capacity Considerations

Jacobs recommends an evaluation of sewer separation on Belle Isle be conducted in an effort to reduce or eliminate treatment of wet weather flows.

A review of the Belle Isle Basis of Design shows that sewer separation was considered as an alternative to constructing a regional treatment basin (RTB). In 1998, there was a concern that stormwater treatment at a single location may be required. As such, 8,100 ft of storm sewer piping was included in the cost comparison for the sewer separation alternative. Given the current movement toward green infrastructure, stormwater treatment does not appear to be a concern, particularly for a natural location such as Belle Isle.

A study of current wet weather flows and inflow and infiltration for the Belle Isle sewer system should be conducted to determine whether sewer separation and infiltration and inflow (I&I) control could reduce wet weather flows sufficiently to completely eliminate the need for the RTB (i.e., screening, disinfection, storage, and odor control). If I&I cannot be reduced enough to eliminate the need for the RTB, flows should be reduced enough so that the facility could operate as a complete capture facility. This would eliminate the need for disinfection, screening (potentially), and operator involvement during storm events.

7.2 Facility Assessment

7.2.1 Screening

7.2.1.1 Description of Existing System

The Belle Isle CSO Facility has two perforated horizontal band screens that were installed in 2007. Screenings that are captured by the screens are pumped by the Screenings Recirculation Pumps back to the Belle Isle Pump Station, where they are conveyed by the sanitary pumps to the Detroit River Interceptor (DRI), and ultimately to the WRRF.

Table 7-1 provides an overview of the existing screening system at Belle Isle CSO facility.

Table 7-1. Overview of Existing Screening System at Belle Isle CSO Facility

Parameter	Value
Treatment Capacity (cfs)	33
Number of Screens	2

Parameter	Value
Manufacturer	JWC Environmental
Screen Type	Horizontal Band Screen
Opening Size	6-mm perforation
Depth or Length / Width	7 ft 8 in. / 2 ft 8 in.
Screen Cleaning	Brush and high-pressure spray
Screening Removal	Screenings pumped to Pumping Station and conveyed to DRI and to WRRF

Note:

in. = inch(es)

7.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issue was identified related to the screens:

- Existing band screens are difficult to maintain due to tight site conditions

7.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Screen Replacement (Project BLI-SCR-1). The existing band screens perform well but maintenance is difficult due to their location under the grating and tight site conditions. The existing JWC Environmental horizontal band screens have 6-millimeter (mm) perforations. There are two alternatives:

- Alternative 1: Replace Existing Band Screens In-Kind.** This alternative would generally replace the existing band screens in-kind.
- Alternative 2: Replace Existing Screens with Fine Bar Screens.** A vertical fine bar screen was evaluated as a replacement. A vertical screen will provide adequate screening while being much more accessible for maintenance. Duperon's FlexRake FPFS-F fine bar screen was used as a representative screen and has 0.25- in. (approximately 6 mm) spacing. While a 6-mm perforation is finer than a 0.25-in. bar screen gap, both screens should provide equivalent screening. Michigan EGLE approval would be necessary for the 0.25-in. bar screen.

A vertical bar screen will require modifications to the existing channel. Currently, water enters the channel and flows up through the screen and over a weir as shown by the flow direction arrows on Figure 7-1. The existing screens extend approximately halfway across the channel. The vertical bar screen will extend across the full channel. Figure 7-2 shows the plan view of two vertical screening options. Option 1 positions the screen approximately halfway down the channel length while Option 2 positions the screen at the end of the channel where it leans up against the existing fiberglass screening retention baffle wall. A steel beam is needed to support the screen with both options. Duperon's screen may be completely vertical or at an angle of up to 45 degrees. The existing weir must be removed and filled in with concrete to prevent bypassing at high flows due to the long length of the existing weir. An opening downstream of the screen and cut into the concrete is necessary to convey the discharged flow. Option 2 requires an angled screen position and flow must discharge through a triangular opening.

Figure 7-2 also shows a 6-in. to 1-foot concrete bump out from the west wall extending the full channel depth for screen maintenance access. Positioning the screen at the end of the channel (Option 2) allows for screenings to discharge over the existing screening retention baffle wall into the screening wet well. Option 1 will require a screening sluice to convey screenings from the screens to the screening wet well. Figure 7-3 shows the sluice option. Headloss through the screen at the design flow of 16.5 cfs with 25 percent blinding is 0.04 in. Headloss through the existing JWC Environmental screen is unknown.

The alternative evaluation is presented in Table 7-2. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 1 were obtained from the screen replacement costs of the Scheduled Replacement Plan (SRP).
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C, under this project title.

This evaluation shows that Alternative 1 is the Best Value Alternative. Although maintenance would be easier for the proposed screen in Alternative 2, the difference in O&M costs were not calculated because the difference in capital costs is nearly \$1,000,000. Annualized over 30 years, this represents about \$51,000 (at 3 percent interest rate). It is unlikely the annual maintenance savings would be this high.

Because of the large difference in capital costs between the two alternatives, **Alternative 1 - Replace Existing Band Screens In-Kind is the recommended alternative**. As such, the replacement of these screens is not included in the CIP projects; rather it is included in the SRP.

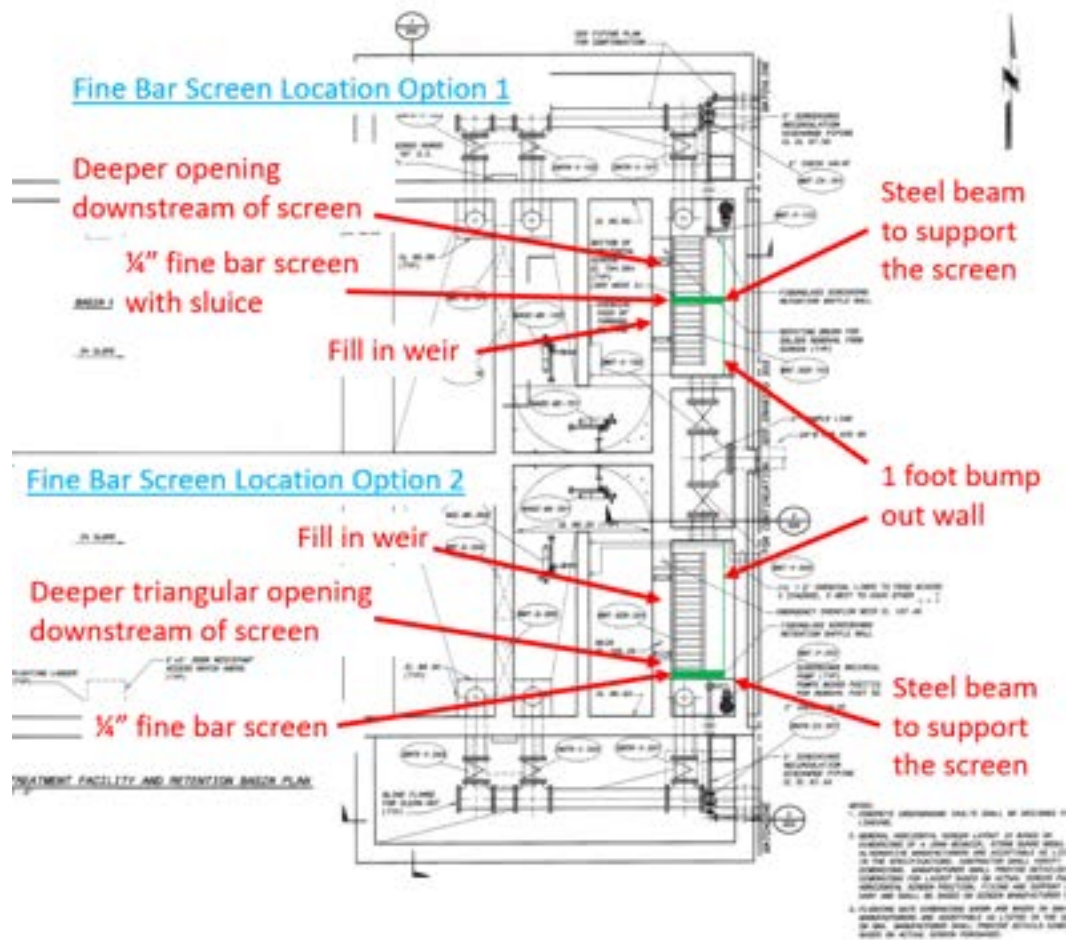


Figure 7-2. Belle Isle Screening Channel Modifications

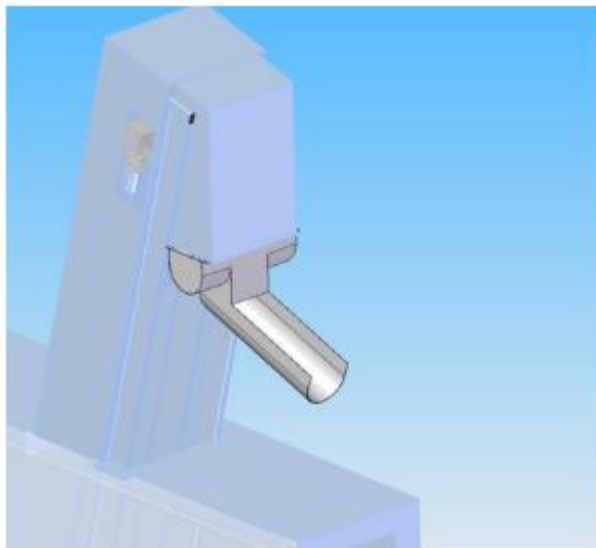


Figure 7-3. Illustration of a Screening Sluice for Belle Isle

Table 7-2. Alternative Evaluation for Screen Replacement (Project BLI-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Band Screens In-Kind	Health and Safety	3	2.78	\$ 978,000	\$ -	\$ 978,000	\$ 351,377	Best Value Alternative
	<i>Definition:</i>	Replace band screen in-kind	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system; has met permit	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance is difficult due to tight site conditions.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Replace Existing Screens with Fine Bar Screens	Health and Safety	3	3.43	\$ 1,960,000	\$ -	\$ 1,960,000	\$ 570,874	
	<i>Definition:</i>	Modify screen channel to allow for different type of screen that will allow better access for maintenance	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier maintenance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Retrofit of facility	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

7.2.2 Disinfection

7.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two fiber-reinforced plastic (FRP) tanks, three diaphragm pumps, two disinfectant rapid mix zones, and four induction mixers. There are two screens and each discharge into two disinfectant rapid mix zones in series. There are two induction mixers, one per disinfectant rapid mix zone in series, consisting of one low level mixer and one high level mixer. The sodium hypochlorite pumps discharge to a common header that splits to the two mixing zones and splits again to each induction mixer in that zone. The Basis of Design Report does not discuss sodium hypochlorite flow splitting. Flow splitting is not metered and there does not appear to be any basis for throttling the valves to individual induction mixers to achieve equal flow splitting. Table 7-3 provides an overview of the existing disinfection system at Belle Isle CSO facility.

Table 7-3. Overview of Existing Disinfection System at Belle Isle CSO Facility

Parameter	Value
Treatment Capacity (cfs)	33
Design Feed Strength (% hypochlorite)	6-8
Max. Dosage at Design Flow (mg/L Cl ₂)	25
Disinfection Contact Time (min)	10
Storage Tanks	
Number	2
Volume of Each Tank (gal)	1,334
Type	FRP
Pumps	
Number	3
Capacity (gpm)	10.43
Type	Diaphragm
Mixers	
Number / Type	4 / Chemical induction mixers
Model Number/ hp / Manufacturer	SWC15XP / 15 hp / Water Champ

7.2.2.2 Identified Needs and Issues

The needs and issues identified for Belle Isle were identified from meetings with O&M staff and Jacobs team site visit and investigations. These needs and issues are listed in the following bullets:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Belle Isle chemical feed system has the following issues:
 - The chemical piping is complex and congested. This is due to the available space being small for the three diaphragm-style pumps installed in a manufacturer's skid containing some potentially unnecessary pipe branches and components. Smaller footprint pumps and simplified piping could reduce complexity and congestion.
 - Chemical feed pumps are on large skids and removal of the skid would require significant pipe disassembly. A means of removing assemblies weighing more than 100 pounds is desired.

These issues are addressed in Replace Chemical Feed System (Project BLI-DIS-1) in the following bullets.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project BLI-DIS-2) in the following section.
- Complex recirculation pumps piping which makes it difficult to access pumps. This issue is addressed in Replace Chemical Recirculation System with Simplified System (Project BLI-DIS-3) below.

7.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project BLI-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities are included in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, BLI-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

The alternative evaluation for these alternatives is presented in Table 7-4. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 was obtained from the replacement costs of the SRP.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 1 were estimated based on manufacturer pump rebuilds at an average cost of \$20,000 per year and GLWA onsite rebuilds at an average cost of \$12,000 per year.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10 and routine maintenance. This frequency is based on GLWA's experience at Conner Creek.

Table 7-4 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 7-4. Alternative Evaluation for Replace Chemical Feed System (Project BLI-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System In-Kind	Health and Safety	3	2.08	\$ 234,619	\$ 32,000	\$ 909,487	\$ 436,554	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 382,000	\$ 2,340	\$ 431,350	\$ 119,819	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Small no. of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 274,000	\$ 3,000	\$ 337,269	\$ 93,686	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Project BLI-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue included in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-Paced and TRC-Paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

The automatic chemical feed system should require less operator input during an event; however, this cost difference is not included in this analysis because GLWA O&M staff believe that manual sampling to confirm the auto sample result will still be necessary. There will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation for these alternatives is presented in Table 7-5. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains ready for service.
- As noted above, this evaluation did not account for any reduction in operations labor using the automatic control system.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be consistently met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 7-5. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project BLI-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Replace existing chemical feed control system utilizing current level of controls and	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 220,000	\$ 4,860	\$ 322,496	\$ 93,477	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

Replace Chemical Recirculation System (Project BLI-DIS-3). The recirculation pumps' piping is unusually complex, which is readily apparent when compared to that at the Oakwood CSO facility. The area available for recirculation on the opposite side of the tanks from the feed pipes is small and the unnecessary complexity results in poor access to the pumps. The two alternatives are:

- 1) **Alternative 1: Do Nothing.** Maintain existing system.
- 2) **Alternative 2: Replace Chemical Recirculation System with Simplified System.** It is recommended that the complex recirculation pump and piping layout be replaced with a single pump per tank recirculation patterned after Oakwood (Figure 7-4).



Figure 7-4. Comparison of Complex Piping at Belle Isle (left) and Simplified Chemical Piping at Oakwood CSO Facility (right)

The alternative evaluation is presented in Table 7-6. Capital costs for each alternative are presented in Volume 6 – Appendices, Appendix C under this project title. This evaluation shows that Alternative 2 has a total benefit score about 0.4 higher than Alternative 1 based on the improved O&M provided by simplified piping. The NPV/Benefit cost for Alternative 2 is \$67,500, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the ease of O&M with this alternative, Alternative 2 – Replace Chemical Recirculation System with Simplified System, is the recommended alternative.**

Table 7-6. Alternative Evaluation for Replace Chemical Recirculation System (Project BLI-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Maintain existing system	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Poor access to pumps.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Replace Chemical Recirculation System with Simplified System	Health and Safety	3	3.22	\$ 217,000	\$ -	\$ 217,000	\$ 67,461	Not Applicable
	<i>Definition:</i>	Replace existing piping with straight-forward piping.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less pipe to maintain.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.3 Odor Control

7.2.3.1 Description of Existing System

The Belle Isle odor control system is a vertical flow, single dual-bed vertical carbon adsorber. The odor control fan pulls foul air from the screenings chamber, mixing chamber, and retention basin when liquid is detected in any of these areas. Carbon is replaced through the top and side access hatches on the vessel.

The system was installed in 2007. Overall, the system is in good condition. For a detailed condition assessment of individual odor control assets, see CS-299 Condition Assessment.

This odor control system operates under air permit requirements (Permit to Install No. 333-07). The emission limit is 0.0107 pounds per hour of hydrogen sulfide. At a design air flow of 8,800 cfm, this equates to approximately 0.23 ppm concentration of hydrogen sulfide. The carbon is tested for remaining bed life on a quarterly basis as required by the permit. Carbon was replaced in February 2019, which was the first time it was replaced since it was put into service.

Per GLWA, no odor complaints have been received for at least the past 3 years.

7.2.3.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified:

- The odor control vessel has a dome top which increases the risk of slipping during carbon replacement.
- Accessing the top bed of the media for sampling is not easily performed. Jacobs investigated this issue further for this evaluation and the findings and recommendations are presented in the following paragraphs.

Quarterly carbon samples are taken from the top bed so that the final layer of carbon media can be analyzed to test for breakthrough. The final layer of carbon media is not accessible in the bottom bed. Accessing the top bed requires two operations staff to safely hold the ladder against the cylindrical vessel while a third staff members scales the ladder and opens the top hatch to collect the sample.

During meetings with O&M staff, Jacobs suggested that the discharged air from the vessel could be sampled and analyzed for breakthrough of H₂S. Sampling of discharged air is safer and less labor intensive than carbon media sampling. However, air sampling also requires the facility to be in operation during a wet weather event. Due to the multiple other duties of O&M staff during a wet weather event, GLWA decided to continue sampling the carbon media, which can be done during dry weather periods.

As an alternative to sampling carbon through the top access hatch, carbon may be sampled from one of the six sample ports on the side of the carbon vessel. Three ports are provided for each carbon bed. Carbon should be sampled from one of the two ports shown on Figure 7-5. These ports are located near the discharge end of each carbon bed. The lower port may be sampled from ground level. A grain thief is necessary to obtain a sample from the ports. A grain thief (see Figure 7-5, <https://www.globalgilson.com/sampling-probes>) is a device used for obtaining a grain sample from a silo and can be constructed from PVC or purchased from agricultural supply stores and other online sources. Carbon analysis is a common service provided by most activated carbon suppliers or can also be performed by many analytical laboratories.

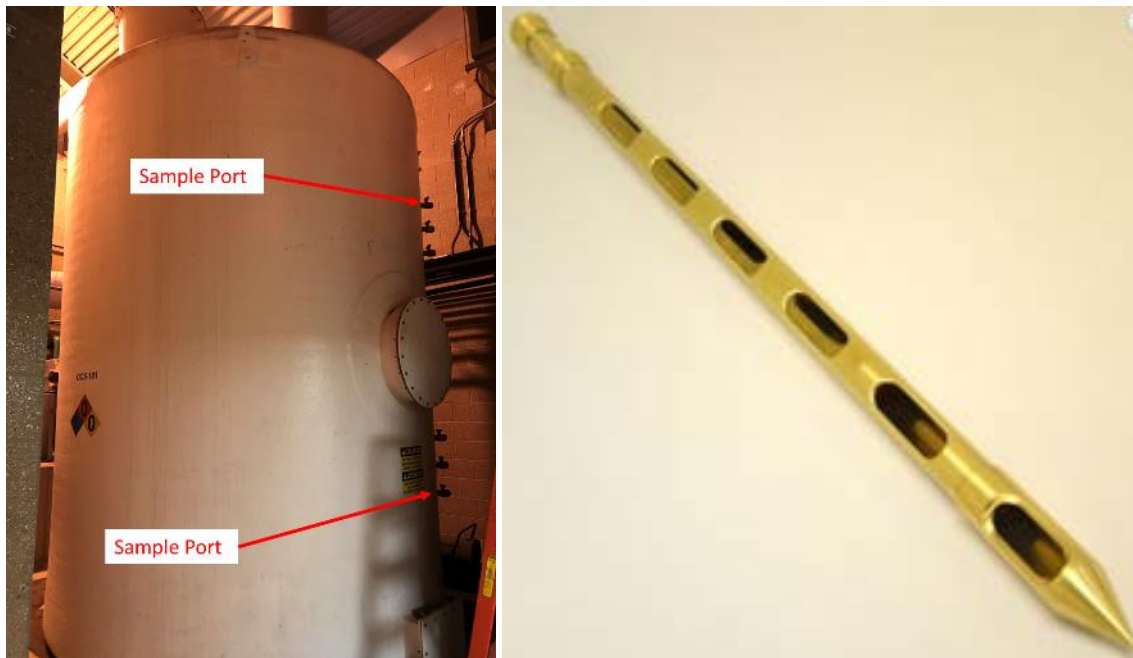


Figure 7-5. Carbon Sample Ports (left) and Grain Thief (right)

7.2.3.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative

Access to Odor Control Vessel (Project BLI-OC-1). Staff indicated that the recent carbon replacement at the facility required constructing scaffolding to safely access the top of the carbon vessel for replacing the top carbon bed. The vessel has a dome top increasing the risk of slipping.

Jacobs evaluated two alternatives that would make accessing the top of the carbon vessel safer for both sampling and carbon replacement and compared it to the current approach. Alternatives include:

- 1) **Alternative 1: Erect scaffolding for Carbon Replacement.** The O&M staff currently erects a scaffolding when replacing the carbon. The carbon needs to be replaced about every 10 years.
- 2) **Alternative 2: Ladder and Railing System.** Figure 7-6. shows a ladder and railing alternative. A contractor would field install fiberglass clips and receptacles to the existing fiberglass tank to secure the ladder and railing. The existing bolted hatch cover on the top of the vessel will be replaced with a hatch that has quick-opening clamps. The figure does not show a 6-in. toe rail, which is recommended, that should be installed at the bottom of the railing to help prevent a person's foot from slipping off the domed top along with tools and equipment.

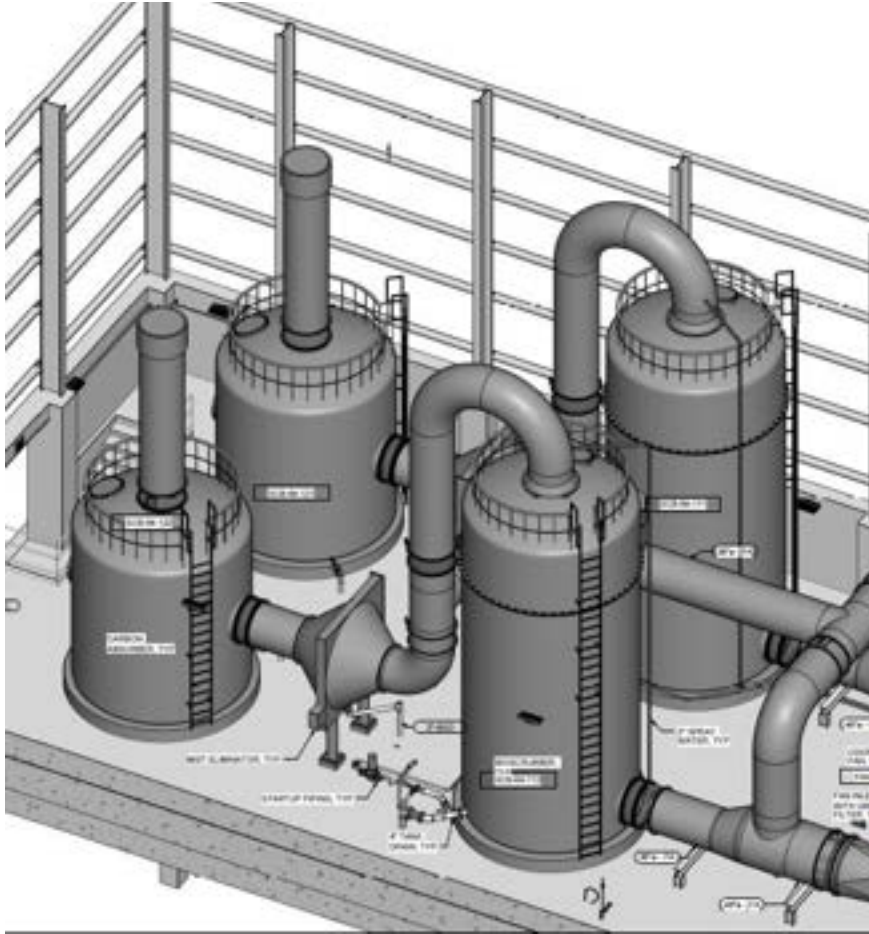


Figure 7-6. Example of Ladder and Railing (figure is not Belle Isle's odor control system)

- 3) **Alternative 3 - Ladder, Platform and Railing System:** Figure 7-7 shows an example of a ladder, platform, and railing on a horizontal tank. The platform provides a more stable working surface than the domed top. The option is a safer option because the platform provides a flat surface on which to stand. A contractor would field install fiberglass clips and receptacles to the existing fiberglass tank to secure the ladder, platform, and railing. Installation of the platform and rail option is more expensive than the railing only option (Option 1) as a crane is necessary to remove the metal roof and lower the platform from above. The existing bolted hatch cover on the top of the vessel will be replaced with a hatch that has quick-opening clamps.



Figure 7-7. Example of Ladder, Platform and Railing (figure is not Belle Isle's odor control system)

The alternative evaluation for these alternatives is presented in Table 7-7. The sources of costs used in this evaluation are listed below:

- The O&M cost for Alternative 1 is based on \$15,000 for erecting scaffolding. Because the carbon is replaced once every 10 years, the annual O&M cost is assumed to be \$1,500.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – Ladder and Railing System has a Total Benefit score 1.0 higher than Alternative 1 – Erecting Scaffolding due to the improved safety and the ease of O&M. Alternative 2 also has the lowest NPV/Benefit cost. **As such, Alternative 2 – Ladder and Railing System, is the recommended alternative.**

Table 7-7. Alternative Evaluation for Access to Odor Control Vessel (Project BLI-OC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Erect Scaffolding for Carbon Replacement	Health and Safety	2	2.50	\$ -	\$ 1,500	\$ 31,634	\$ 12,654	
	<i>Definition:</i>	Continue to use scaffolding when replacing carbon.	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Must be set up every time carbon is replaced.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Ladder and Railing System	Health and Safety	4	3.50	\$ 41,000	\$ -	\$ 41,000	\$ 11,714	Best Value Alternative
	<i>Definition:</i>	Provide a ladder on side of vessel and railing around top of vessel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Ladder provides improved access and railing provides safety during carbon change-out.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Surface of dome is still sloped and not as safe as a flat surface.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Ladder, Platform, and Railing System	Health and Safety	5	4.00	\$ 162,000	\$ -	\$ 162,000	\$ 40,500	
	<i>Definition:</i>	Provide a ladder on side of vessel and a platform and railing system on top of vessel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Platform provides more stable working surface of top of vessel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

7.2.4 Flushing and Dewatering

7.2.4.1 Description of Existing System

Dewatering System: After a wet weather event that fills the basin, the basin, screen channel, and mixing channels are dewatered by gravity back to the Belle Isle Pump Station, and subsequently pumped to the DRI and then to the WRRF.

Flushing System: Each basin contains a single flushing gate. After the basin is dewatered, the water in the flushing reservoirs (or NPW, if necessary) is used to flush the solids from the floor of the basins. The flushed solids flow by gravity to the Belle Isle Pump Station.

Table 7-8 provides an overview of the existing flushing and dewatering system at Belle Isle CSO facility.

Table 7-8. Overview of Existing Flushing and Dewatering System at Belle Isle CSO Facility

Parameter	Value
Total Basin Volume (MG)	0.3
Headworks and Basin Dewatering and Flushing System	- Each basin has one flushing gate - Flushed solids are routed by gravity to Belle Isle Pump Station

7.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- A significant amount of solids can accumulate in the corners of the mixing channels
- Local control of the valves in the two basin dewatering valve vaults requires confined space entry into the vaults. This issue is addressed in the I&C section (Section 7.2.7).

7.2.4.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Flushing System in Mixing Channel (Project BLI-FD-1). Review of the 3-D scanning results for CS-299 showed that there was a build-up of solids in the corners of the mixing channels. A means to spray these locations is needed. There are two alternatives for addressing the solids buildup in the corners of the mixing channels. These alternatives include:

- Alternative 1: Do Nothing/ Manual Flushing Build-Up Solids.** Allow solids to build-up and manually flush once every 3 months. One of the disadvantages of this alternative is that the solids in the mixing channels that are not removed after draining the basin may affect subsequent disinfection.
- Alternative 2: Flushing System in Mixing Channel.** The recommended improvement includes mounting a 4-in. HDPE header along the perimeter of the mixing channel approximately 3 ft above adjacent lower concrete surface. See Volume 6 – Appendices, Appendix B, for figures (Figure BLI-FD-1-ALT-2) showing conceptual layouts. The HDPE header should be specified with an adequate wall thickness to allow for directionally drilled holes (up to 0.75-in.-diameter) that create a water jet. The proposed hole spacing along the header is 18 to 24 in. A total flow rate of 250 gpm is required to adequately remove settled materials from the concrete shelf above the dry weather flow channel and

maintain adequate volume and velocity to carry materials into the dry weather flow channel following a CSO event.

Onsite NPW will be required. The final designer should confirm that the pressure in the existing water line is adequate (15 to 20 psi at the drilled hole) to meet the flushing requirements. The intent will be to use existing water pressure and not a booster pump. The 4-in. HDPE header should be connected to the interior NPW system piping. Following a wet-weather event, a motor operated solenoid/gate/ball control valve will be opened to charge the flushing header. The control strategy assumes that solenoid is activated for a set duration (minimum of 15 minutes) after the level sensors in the mixing channel record a water level rise above elevation 95.0 ft and subsequent water level drop.

A small valve is also recommended at the terminus end of each spray header with a rising stem and automated actuator mounted outside of the chamber. At the start of the cleaning cycle, these valves will automatically open for several minutes, allowing the potable water to flush any materials that have entered the header through openings out the open end. These terminus valves would close, and the header would pressurize and start spraying.

During initial operation, onsite staff should visually inspect the mixing channel area to confirm settled materials have been adequately removed and then adjust the control system timer to increase/decrease the flushing duration as needed until the system has been optimized. Provisions to flush the header pipe could be provided by adding another automatically operated valve at the terminal end of the header to open at the start of the flush event and flush any accumulated debris from the pipe. Integration with the facility's SCADA and LC) system is required to achieve this functionality. New electrical connections to the new control valve are also required (110 V).

The alternative evaluation for these alternatives is presented in Table 7-9. The sources of costs used in this evaluation are listed in the following bullets:

- The O&M cost for Alternative 1 assumes two personnel for 4 hours each day for manually flushing the mixing channels every 3 months.
- The O&M cost for water usage is assumed to be the same for the two alternatives, and therefore, not included in the O&M costs.
- The capital cost for the flushing system (Alternative 2) is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 1 – Do Nothing/ Manual Flushing Build-Up Solids, has the lowest NPV/Benefit cost and is considered the Best Value Alternative. **As such, Alternative 1 – Do Nothing/ Manual Flushing Build-Up Solids is the recommended alternative.**

Table 7-9. Alternative Evaluation for Flushing System in Mixing Channel (Project BLI-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Manual Flushing Solids Build-Up	Health and Safety	2	2.22	\$ -	\$ 3,200	\$ 67,487	\$ 30,445	Best Value Alternative
	<i>Definition:</i>	Allow solids to build-up and manually flush.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Known system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Solids in the mixing channels that are not removed after draining the basin may affect subsequent event water quality.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Flushing System in Mixing Channel	Health and Safety	4	3.50	\$ 151,000	\$ -	\$ 151,000	\$ 43,143	
	<i>Definition:</i>	Install a spray flushing system in each mixing channel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Solids are removed from the mixing channel after every storm.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased assets to maintain.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.5 HVAC

7.2.5.1 Description of Existing System

The Belle Isle facility consists of a headworks, chemical room, odor control room, electrical room, mechanical room, control room, sample room, and restrooms. The facility also includes an adjoining retention basin. Table 7-10 provides summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, sanitary system, electric water heater, electric water cooler and emergency shower/eye washes. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 7.2.10.

Table 7-10. Major HVAC Equipment at Belle Isle CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	WEF-2 and 3	Wall Exhaust Fans	3,350 cfm
	MAU-1	Make-up Air Unit	6,700 cfm
Basin	REF-1 and 2	2 × Roof Exhaust Fans	6,500 cfm
Chemical Room	WSF-1	Wall Supply Fan	1,600 cfm
	IEF-1	Inline Exhaust Fan	1,600 cfm
	EUH-1 and 2	Electric Unit Heater	2,450 cfm 25 kW
Electrical Room	IEF-2	Exhaust Fan	1,000 cfm
	IEF-3	Exhaust Fan	3,700 cfm
	EUH-5	Electric Unit Heater	580 cfm 5 kW
	EUH-6	Electric Unit Heater	5 kW

Notes:

kW = kilowatt(s)

Table 7-11 provides a summary of the basis of design performance criteria for HVAC systems at Belle Isle and Table 7-12 provides the outdoor Basis of Design conditions.

Table 7-11. Belle Isle Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (°F)	Summer (°F)	
Headworks Area	Class I, Div 2, Group D (Per As-Built Drawings)	60	N/A	12 ACH (Occupied)
Mechanical Room, Electrical Room	Unclassified	60	104	1 ACH (Mechanical Room) 1 ACH (Electrical Room)
Odor Control Area	Class I, Div 2, Group D (Per Basis of Design)	72	75	6 ACH (Occupied) 2 ACH (Unoccupied)

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (°F)	Summer (°F)	
Sample Room, Men's and Women's Washrooms, Control Room	Unclassified	72 (Occupied), 60 (Unoccupied)	75 F Dry Bulb, 50% Relative Humidity	1 ACH (Office) 6 ACH (Other Areas)
Chemical Room	Class I, Div 2, Group D (Per Basis of Design)	60	100	6 ACH (Occupied) 2 ACH (Unoccupied)

Table 7-12. Belle Isle Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb °F)	Summer (Wet Bulb °F)
3	91	73

7.2.5.2 Identified Needs and Issues

During discussions with GLWA O&M staff and GLWA's HVAC contractor, the following HVAC issues were noted:

- MAU-1 provides inadequate heat for Headworks Area: It was noted by O&M staff that this unit does not provide enough heat in the winter. However, no frozen pipe issues were noted in this area.
- Corrosion of Unit Heaters (UH-1 to UH-6). It was noted that half of Trane UHXA unit heaters at the facility have been recently replaced by GLWA's HVAC contractor due to corroding of copper soldering in the unit.
- Frequent failures of DX cooling coil in AHU-1. It was reported in the meetings that the Trane AC unit fails every year.
- Chemical room unit heater and exhaust fan are difficult to access due to the tight conditions in the room and the poor accessibility.
- The backflow preventer occasionally sprays water in the sample room.
- Occasional low water pressure at the facility: See Site Section 7.2.8.2 for discussion of this issue.
- Difficulty accessing chemical room HVAC equipment for maintenance: GLWA's HVAC contractor confirmed that accessing exhaust fan and unit heater in the chemical room for maintenance is very difficult. Routine maintenance has required the erection of scaffolding.

During site investigations (June 2020) the following observations were noted:

- Both Trane UHXA unit heaters in the chemical room had been replaced by Indeeco Ultra-Safe EXP unit heaters.
- The door between the electrical room and the adjacent Corridor was held open with a rope.
- Explosion proof unit heaters were provided throughout the facility including in spaces without explosion proof electrical equipment and lighting fixtures such as the electrical room and chemical room.
- The Trane UHXA unit heater in the electrical room had been replaced with an Indeeco Ultra-Safe EXP unit heater.

- The supply and exhaust fans in the odor control area were observed to be not running.
- The supply and exhaust fans in the chemical room are very difficult to access for maintenance due to their locations. See Figure 7-8. below.



Figure 7-8. Chemical Room Supply and Exhaust Fans Located in Inaccessible Area

- The exhaust fans were observed to not be running in the Headworks Area.
- Opening the Basin access hatches did not start either of the Basin exhaust fans. The fans should start when the hatch is opened.

7.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

HVAC Improvements (Project BLI-HVAC-1). Due to the relatively small nature of some of the HVAC related projects identified as improvements, all of the identified HVAC improvements are proposed to be in one project – HVAC Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) Alternative 1: Do Nothing/ Replace In-Kind.

- Replace MAU-1 in kind.

2) Alternative 2: HVAC Improvements including,

- Odor Control Area ventilation improvements
- Odor Control Area fan maintenance access
- Headworks ventilation

- Unit heater replacement
- Improved cooling for control room and sample room
- Improved access for chemical room HVAC equipment
- Water spray from backflow preventer

Each of the HVAC related improvements listed above are described further below:

Odor Control Area Ventilation Improvements. The 2003 Basis of Design report indicates that both the Chemical Room and the Odor Control Room were classified as Class I, Division 2 per NFPA 820; however, all other spaces aside from the Headworks Area and Basin were indicated as unclassified. Jacobs notes that chemical rooms are not Class I, Division 2 spaces. Rather, they are unclassified spaces, provided they are physically separated from classified spaces. The Chemical Room therefore does not require explosion-proof equipment such as the explosion-proof unit heaters currently installed in this space.

Per NFPA 820-2003, which was in effect when the facility was designed, the Odor Control Room is considered a Class I, Division 2 space if it is not continuously ventilated at 6 air changes per hour (ACH). However, the exhaust and supply fans in the odor control area were sized based on 6 ACH, which would make the area unclassified. Jacobs notes that the fans must run continuously and ventilation monitoring on both the supply and exhaust fan is required to detect no airflow. Ventilation failure and combustible gas in excess of 10 percent of the Lower Explosive Limit needs to be alarmed with visual and audible alarms at the entrance to the odor control area as well as inside the space.

It is recommended that the Odor Control Room be made unclassified by meeting the requirements noted above. Continuous ventilation of the odor control area and providing slight negative pressurization with respect to the atmosphere should have the added benefit of reducing H₂S levels in the electrical room, which was likely the cause of the need to replace the Trane UHXA unit heaters.

It should be noted that although it is not a code requirement, current best practice is to physically separate electrical rooms from spaces with corrosive conditions (e.g., the Odor Control Room) and to positively pressurize the space with respect to these areas. If the Odor Control Room is provided with negative pressurization with respect to adjacent spaces this most likely will not be necessary but if corrosion of the equipment in the electrical room becomes an issue it should be considered.

Odor Control Area Fan Maintenance Access. It is difficult to access WSF-2 and WEF-1 for maintenance purposes due to their locations high in the space and the proximity of conduit and piping restricting ladder access from below (Figure 7-9).



Figure 7-9. Odor Control Room Exhaust (left) and Supply (right) Fan Poorly Accessible

Access to WEF-1 could be provided by installing a platform which would be accessed from the landing outside of mechanical room on the second floor. This would effectively be an extension of the existing landing. WSF-1 could be provided with a platform with ladder access. This project should be coordinated with the Improved Access to Odor Control Vessel (Project BLI-OC-1) project.

Headworks Ventilation. Per the electrical record drawings, the Headworks area is electrically a Class I, Division 2 space which requires ventilation at a continuous rate of 12 ACH. Neither the odor control unit (which exhausts air from the Basin and Headworks Area), nor the Headworks Area exhaust fans were observed to be running during the site visit. This means the space is effectively a Class I, Division 1 environment containing equipment only rated for a Class I, Division 2 environment. It was also noted that Headworks Area exhaust fan WEF-3 is located only approximately 3 ft from odor control area supply fan WSF-2 (see excerpt from HVAC drawings below). When both fans are running, air being exhausted from the Headworks Area will be introduced into the odor control area by WSF-2 (Figure 7-10). This could have contributed to the corrosion which lead to the need to replace the Trane UHXA unit heaters.

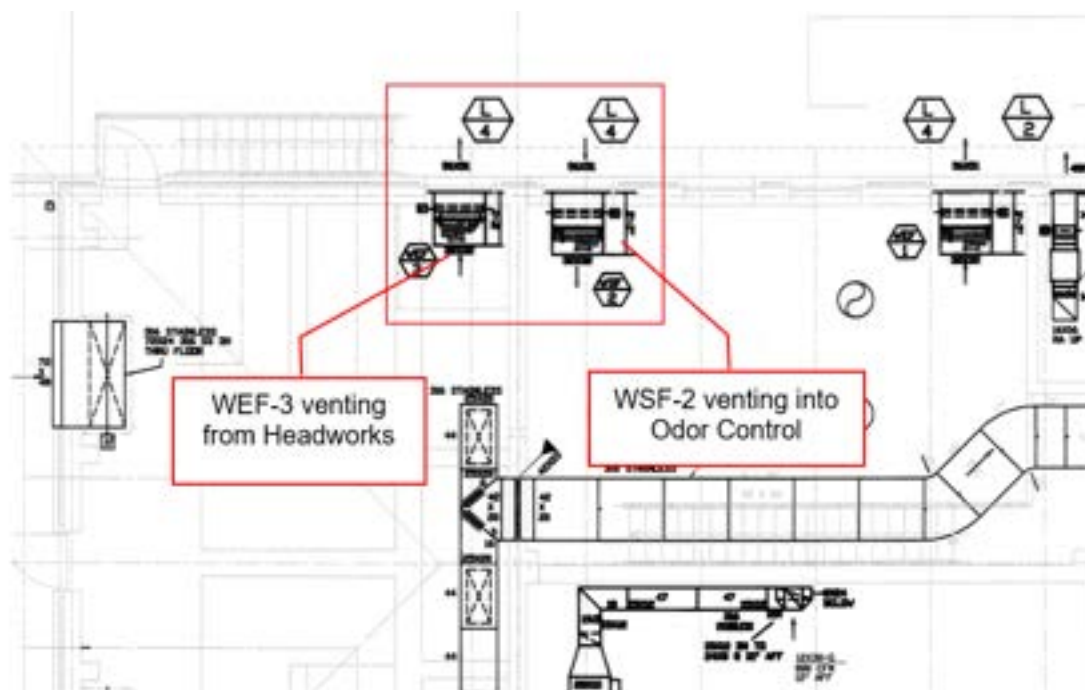


Figure 7-10. Short-Circuiting of Airstreams Between WEF-3 and WSF-2

In addition to issues with short-circuiting of the air streams between WEF-3 and WSF-2, MAU-1 has a duct which runs from the mechanical room through the odor control area to the headworks area (Figure 7-11). The ductwork between the classified Headworks Area and the unclassified mechanical room is a breach in physical separation as defined by NFPA 820 and effectively classifies the entire building with the same classification as the Headworks Area.

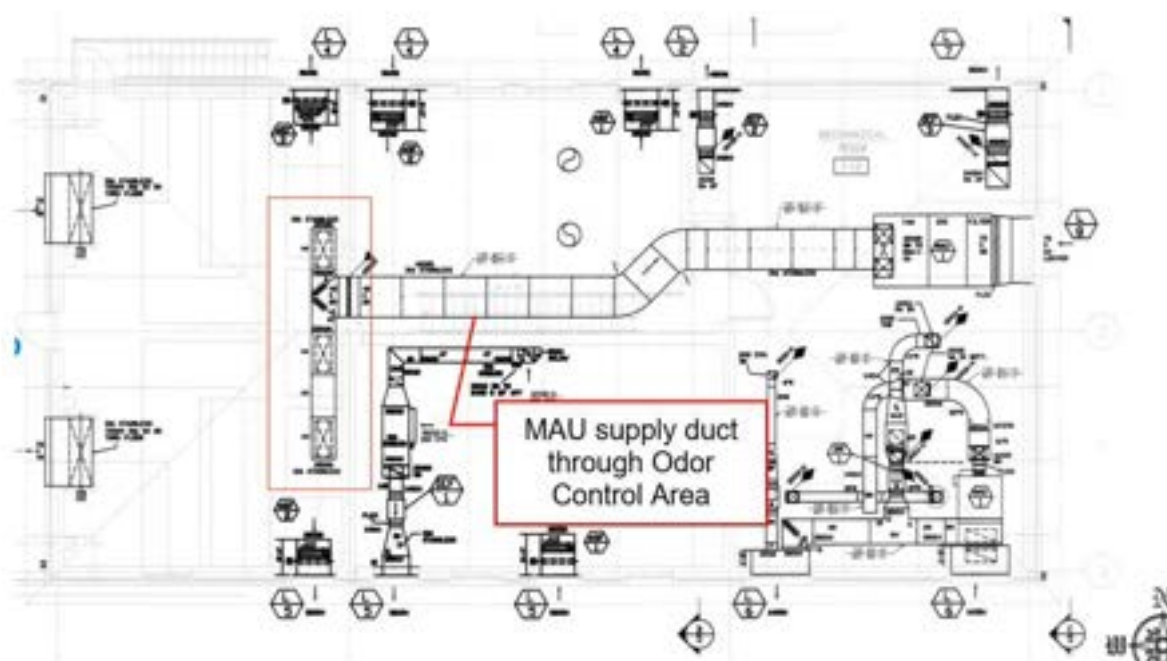


Figure 7-11. Ductwork Passing Between Classified and Unclassified Areas

It is recommended that MAU-1 be removed and replaced by either a MAU located at the ground level near the Headworks Area or a supply fan with the same capacity as MAU-1 and explosion proof unit heaters. For cost estimating purposes, a new supply fan and unit heaters are assumed. Locating the supply fans or MAU on the North side of the Headworks Area and relocating WEF-3 to the South side would have the benefit of eliminating the short-circuiting currently occurring between WEF-3 in the Headworks Area and WEF-2 in the odor control area.

Increased MAU-1 Heating Capacity (if necessary). MAU-1 serves the Headworks. It was noted by O&M staff that this unit does not provide enough heat in the winter. The basis of design dry bulb temperature for the Headworks area is 60°F, so it is possible that this area could be perceived as being cold in the winter. No pipes have frozen in the past in this area. If additional heating is desired in this space, a unit with increased heating capacity should be provided with the new MAU described in the project above.

Unit Heater Replacement. The Trane UHXA unit heaters at the facility have an aluminum-finned tubular steel heat exchanger which is directly exposed to the air stream when the heaters are running. Steel has very poor H₂S resistance and is a poor choice of materials for the environment the unit heaters are in. It is recommended that as the unit heaters fail, they are replaced by properly rated units that have a 316 stainless steel heat exchanger and cabinet body, aluminum or 316 stainless steel fins, fan blade, and control enclosure and a motor with a corrosion-resistant protective coating that has passed the ASTM International Method B117 salt-spray test. The Indeeco units are a good selection for the electrical room and odor control area. If the odor control area is unclassified, they are not required to be explosion-proof. Based on the recommendation to replace the units when they fail, their cost is not included in the capital cost estimate, rather, they are in the SRP.

The Indeeco units currently installed in the chemical room should last longer than the Trane UHXA units which they replaced; however, even 316 stainless steel is also susceptible to corrosion by sodium hypochlorite.

Improved Cooling for Control Room and Sample Room. GLWA's HVAC contractor noted that while there have been mechanical failures in AHU-1 in the past, the failures were not out of the ordinary in terms of frequency or severity and have been reportedly rectified.

It is likely that AHU-1 could appear to be under-performing in terms of cooling due to the fact that when the space is unoccupied, the setpoint is controlled to increase to 85°F. Operators visit the facility infrequently and in the short amount of time they are at the facility the temperature in the spaces served by AHU-1 (i.e., the sample room, control room, men's and women's restrooms, and corridor) may not reach the Basis of Design temperature of 72°F.

In order to improve operator comfort when the facility is occupied it is recommended that split direct expansion (DX) units be installed in the sample room and control room. The evaporator units in the split DX systems could be configured to discharge in locations where operators are likely to be located and would provide a faster response to occupancy than the current system configuration. The proposed split DX units would be provided in addition to the existing AHU-1 cooling coil and would be provided with their own thermostat.

Improved Access for Chemical Room HVAC Equipment. GLWA's HVAC contractor noted the need to erect scaffolding to perform maintenance on the unit heater and exhaust fan in the chemical room. Jacobs recommends either (1) installing a platform with ladder to allow for maintenance on the exhaust fan and relocating the unit heater to an area where ladder access is possible, or (2) evaluating and possibly repositioning the supply and exhaust fans closer to the floor when the chemical feed system is re-designed in the future (as described in the CS-299 Disinfection technical memorandum).

Water spray from backflow preventer. During the site visit water was noted on the floor near the backflow preventer with no drain near the unit (Figure 7-12). Jacobs recommends the installation of

an airgap fitting with hose attachment and running the hose to the nearest drain. This should address the water spray.



Figure 7-12. Water Spray Near Backflow Preventer

The alternative evaluation is presented in Table 7-13. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for MAU-1 in Alternative 1 was obtained from the SRP. It should be noted, however, that replacement of the MAU in its current location would likely not be code compliant.
- The O&M costs for Alternative 1 include scaffolding costs (to perform maintenance on the unit heater and exhaust fan in the chemical room).
- The capital costs for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 1 is the Best Value Alternative. However, replacement of the MAU in its current location would likely not be code compliant. In addition, Alternative 2 has a total benefit score about 1.0 higher than the Alternative 1 based on the improved health and safety and improved O&M. **As such, Alternative 2 - HVAC Improvements is the recommended alternative.**

Table 7-13. Alternative Evaluation for HVAC Improvements (Project BLI-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	2	2.50	\$ 63,500	\$ 2,000	\$ 99,591	\$ 39,836	Best Value Alternative
	<i>Definition:</i>	No improvements	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lack of code compliance, difficult, less safe, and more costly maintenance, corrosive gases entering building, and control room discomfort.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	4	3.50	\$ 293,000	\$ -	\$ 293,000	\$ 83,714	
	<i>Definition:</i>	Addition of Odor Control area ventilation monitoring to meet code requirements, replacement of MAU-1 with new system, improved fan access for maintenance, and supplemental air conditioning.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Code compliance, easier and safer maintenance, more comfortable control room conditions.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.6 Electrical

7.2.6.1 Description of Existing System

The Belle Isle electrical system consists of one DTE utility feed from a 1,000 kVA, 480 V, 3-phase outdoor transformer (primary metering) and one diesel generator feed from a 750 kilowatts (kW), 480 V, 3-phase stationary generator. The feeds are connected to a 1,200 A switchboard with electrically operated breakers and automatic source transfer controls. The switchboard then feeds a 1,200 A motor control center (MCC). The MCC then feeds the various pumps, valves, motors, transformers, panels, etc. at the facility. The Belle Isle Pump Station is fed from the CSO facility MCC; however, it is not included in this facility assessment, per the CS-299 Scope of Work. Table 7-14 provides a summary of the major electrical equipment for this facility.

Table 7-14. Major Electrical Equipment at Belle Isle

Location	Major Electrical Equipment	Description
Electrical Room	Main Switchboard/ATS	1,200 A, 480/277 V, 3-Phase
Outdoors	Generator (Diesel)	750 kW, 480 V, 3-Phase
Electrical Room	MCC	1,200 A, 480/277 V, 3-Phase

7.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the section below.

7.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project BLI-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting, however it will be less safe when operating at night and when accessing area downstream of screens.
- 2) **Alternative 2: Electrical Improvements.** Add lighting at the following location (and shown on the electrical drawings - Figure BLI-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Basin – Add additional external lighting on top and the riverside of the basin. Lighting foot-candles will meet the requirements of the local outdoor lighting ordinances.

The alternative evaluation is presented in Table 7-15. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting. The NPV/Benefit cost for Alternative 2 is \$16,500, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 7-15. Alternative Evaluation for Electrical Improvements (Project BLI-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe when operating at night.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 58,000	\$ -	\$ 58,000	\$ 16,571	Not Applicable
	<i>Definition:</i>	Add additional external lighting on top and the riverside of the basin.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.7 I&C

7.2.7.1 Description of Existing System

Control System: The original Ovation control system was installed in 2007 under PC-753. This project upgraded the existing Belle Isle Pump Station facility to include the new CSO basin facility. In 2014 under PC-773D, the Ovation system controllers and software were upgraded to version O.V.3.5.0.

The facility's Ovation network currently has only one primary network switch. The switch is connected to the GLWA AT&T wide area network via the system's router. The system has one database server and one operator workstation located in the control room. The system has a pair of Ovation controllers that provide the facility with redundant local controls and I/O capabilities. All network connections in the Belle Isle facility are via copper Ethernet cables. The controllers are connected to the network via a single-homed connection, which means each controller has only one connection to the network switch. Since there is only one network switch, the primary switch is a single point of failure for the overall system. The current system is equipped with a back-up radio system to communicate critical monitoring points back to SCC on wide area network failure.

Flow and Level Sensors: Table 7-16 summarizes the level sensors and flow meters at the Belle Isle CSO Facility used to monitor flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 7-16. Summary of Flow Meters and Level Sensors at Belle Isle CSO Facility

Area	Quantity	Instrument Type
CSO Level Sensors		
Screening Chambers	2	Ultrasonic
	2	Radar (Back-up)
Mixing Chambers	2	Ultrasonic
	2	Radar (Back-up)
Basin 1 and 2	2	Ultrasonic
	2	Radar (Back-up)
Flush Water Storage	2	Ultrasonic
	2	Radar (Back-up)
Chemical System Flow Meters		
Chemical Feed		
To upper mixers	2	Magnetic
To lower mixers	2	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Ultrasonic

7.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets:

- GLWA requested to have the ability to control the Belle Isle CSO Facility from Conner Creek to improve operational efficiency during CSO events.
- GLWA requested that Jacobs investigate the potential removal of gas monitors in the basins for Belle Isle to reduce instrumentation maintenance requirements.
- GLWA requested process cameras at select locations to improve monitoring of the facility during wet weather operation.
- Local control of the valves in the two basin dewatering valve vaults requires confined space entry into the vaults.
- Generator and ATS controls do not adequately report alarm signals into Ovation and are becoming less reliable. This issue is being addressed in an on-going project and is therefore not included in the capital improvement projects for CS-299.
- Update Ovation control system to the latest version and increased monitoring capabilities.
- Control system network lacks redundancy.

7.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project BLI-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, all of the identified I&C improvements, with the exception of the Ovation Control System Upgrade, are proposed to be in one project – I&C Improvements. This project could be split into multiple delivery projects, if needed. There are two alternatives for this project:

1) **Alternative 1: Do Nothing**

2) **Alternative 2: I&C Improvements including,**

- Provide remote operation of Belle Isle CSO Facility from Conner Creek CSO Facility
- Investigate need for gas monitoring in CSO basins
- Provide process cameras at select locations
- Provide local control capabilities of actuators in valve vaults

Each of the I&C related improvements listed above is described further below:

Provide remote operation of Belle Isle CSO Facility from Conner Creek CSO Facility. GLWA requested to have the ability to control the Belle Isle CSO Facility from Conner Creek to improve operational efficiency during CSO events. The physical infrastructure is in place to allow this to happen. It is recommended that GLWA investigate the programming through SCADA to determine if the code has already been written and activate if that is the case. If the existing programming in SCADA does not contain code for remote control of Belle Isle from Conner Creek, provide additional programming for this functionality.

Investigate need for gas monitoring in CSO basins. Eliminate gas monitoring equipment in accordance with Section 5.4.7.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

Provide local control for valves in valve vaults above ground (outside of vault). Local control of the valves requires confined space entry. Providing controls above ground, outside of the valve vault would improve safety, when local control of the valves may be needed.

The alternative evaluation is presented in Table 7-17. The sources of costs used in this evaluation are listed in the following bullets:

- The O&M costs for Alternative 1 assume that the lack of remote control of the Belle Isle facility requires additional operator time every wet weather event.
- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- O&M costs for Alternative 2 include an estimated annual cost for maintenance of the proposed cameras.

This evaluation shows that Alternative 1, Do Nothing/Replace In-Kind, is the Best Value Alternative because the NPV/Benefit cost of Alternative 1 is about \$7,000 lower than that of Alternative 2. The total benefit score for Alternative 2 is 1.3 higher than Alternative 1, due to improved health and safety, and ease of O&M. Based on the higher total benefit score and the small difference in NPV/Benefit cost, **Alternative 2 - I&C Improvements is the recommended alternative.**

Control System Upgrade (Project BLI-I&C-2). It is recommended to update the Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2. As part of this project, it is recommended to increase network switch redundancy. Adding a back-up network switch within the system will eliminate the single point of failure of the primary network switch. Once the back-up network switch is added, the connections to the network equipment and Ovation controllers will need to be converted to a dual-home configuration instead of single-home connections. This will provide full redundancy and should one of the networks fail, the second network will remain available for monitoring and control.

Capital costs are included in Volume 6 – Appendices, Appendix C under this project title. Because the Ovation system is the only alternative for the control system upgrade, it is the only alternative considered. Table 7-18 provides the summary of the **Control System Upgrade, which is the recommended alternative.**

Table 7-17. Alternative Evaluation for I&C Improvements (Project BLI-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ 4,000	\$ 84,359	\$ 33,743	Best Value Alternative
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Unexpected conditions may occur in the Headworks	Component Performance	3						
	<i>Comments:</i>	Annual O&M without remote control of basin: 10 events; 4 hrs per event; \$100/hr	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	5	3.78	\$ 112,000	\$ 2,000	\$ 154,179	\$ 40,752	
	<i>Definition:</i>	Provide local control of valves without entering valve vault, install cameras for monitoring of process areas, and eliminate gas monitoring in CSO basins.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance (with reduction of gas monitoring), and more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance (with addition of cameras)	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

Table 7-18. Alternative Evaluation for Control System Upgrade (Project BLI-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 922,000	\$ -	\$ 922,000	\$ 307,333	Best Value Alternative
	<i>Definition:</i>	Upgrade control system to latest version of Ovation.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Allows for use of high performance graphics and provides other benefits.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

7.2.8 Site

7.2.8.1 Description of Existing Site

The Belle Isle CSO Facility was constructed in 2009. The site includes the CSO facility and a sanitary pump station used to pump sanitary and retained storm flows from Belle Isle to the DRI on the west side of the Detroit River. The total area of the site is approximately 0.85 acres and includes an access road, parking area and fencing. The security fencing is 6-ft tall. There is a 24-ft wide sliding gate at the southern corner of the fenced-in area, as well as multiple smaller swing gates in other parts of the fence.

Site access/egress is by access road off of Sunset Drive. A parking area is located along the west side of the site to accommodate parking for O&M personnel and visitors. The access road and parking area consist of concrete pavement. The reinforced concrete sidewalk is 5 in. thick with 2 in. of aggregate base course. The rest of the reinforced concrete pavement on site is 10 in. thick with 9 in. of aggregate base course.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

7.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- Inadequate space or turning radius inside the site for the sodium hypochlorite tanker trucks to maneuver through the site.
- Water ponding near the entrance gates.
- GLWA Operations has experienced issues at the basin roof drain scupper outlets as they get plugged by leaves and debris resulting in ponding on the basin surface.
- Investigate occasional low water pressure. GLWA has experienced low pressure in the incoming potable water line to the Belle Isle CSO facility in the past. The watermain servicing the facility is 6-in.-diameter. Based on discussions with GLWA after the Needs Assessment meeting, GLWA staff believes the pressure issues may have been related to Detroit Water and Sewerage Department closing valves and changing flow paths during their operation of the system (now done by the State of Michigan). This may have resolved the issue. Pressure monitoring of the water pressure at the fire hydrant outside the facility could be performed over an extended period of time (i.e., a few months) to better determine the timing and magnitude of the issue, if this is still an issue in the future.
- Seal concrete pavement joints of service drive and parking area to ensure serviceability. This could be considered a preventative maintenance item; however, for this evaluation, costs have been included in the Site capital improvements to address any concrete pavement joints or other repairs.

7.2.8.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Site Improvements (Project BLI-SITE-1). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Site Improvements** including,
 - Tanker Truck Access
 - Address Ponding Near Service Drive Entrance
 - Improve Basin Surface Drainage

Each of the site related improvements listed above are described further below:

Tanker Truck Access: The sodium hypochlorite fill station is located on the south side of the facility. Tanker trucks must access this location several times a year for hypochlorite delivery. Currently, the trucks pull up on a temporary unpaved access drive next to the City's barricade storage yard outside of the fence line, and then run a hose through a manway gate to the fill station to offload the hypochlorite. There is not adequate space or road turning radius inside the site for the tanker trucks to maneuver through the site. Trucks accessing the truck fill station outside the fence is not ideal as trucks could get stuck in the soft grade while pulling up and turning on the site.

It is recommended that the concrete pavement be extended parallel to the existing drive from the entrance service drive to the truck fill location, and then extended southward with adequate paved area to provide adequate turning radii for the tanker truck to turn to the south and back up to the manway gate at the point of the truck fill (see Figure BLI-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B).

Address Ponding Near Service Drive Entrance: A low point in the existing site grading exists on the north side of the service drive near the entrance gate to the facility. This is an area where water encroaches on the service drive frequently and can be a nuisance, particularly in winter months when icing on the service drive is a concern. It is recommended that a catch basin be installed at this location and connected to the existing storm sewer near this low point.

Improve Basin Surface Drainage: The basin roof is sloped from south to north with drain scuppers located through a parapet wall that allow drainage through the wall to downspouts. GLWA Operations has experienced issues at the scupper outlets as they get plugged by leaves and debris resulting in ponding on the basin surface.

One alternative could be to remove the trees near the basin and replace them with a lower growing tree or shrub. Another alternative could be that the sizes and number of scuppers be evaluated, and appropriate modification be made to the scuppers to prevent leaves and debris from blocking the scupper outlets. Coring holes directly into the basin roof to provide additional drainage relief may also be considered as an alternative to work along with the existing scupper system.

The alternative evaluation is presented in Table 7-19. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than Alternative 1 based on the improved health and safety and improved O&M provided by the various site improvements. The NPV/Benefit cost for Alternative 2 is \$63,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Site Improvements is the recommended alternative.**

Table 7-19. Alternative Evaluation for Site Improvements (Project BLI-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Maintain current operation for hypo deliveries and do not address ponding.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Trucks could get stuck in the soft grade while accessing the site & safety issue with ponding water.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 220,000	\$ -	\$ 220,000	\$ 62,857	Not Applicable
	<i>Definition:</i>	Improved tanker truck access, address ponding near service drive entrance, and improve basin surface drainage.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved maneuverability and safety during hypo deliveries & improved safety for accessing facility.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.9 Architectural

7.2.9.1 Description of Existing Facilities

The Belle Isle CSO Facility includes the CSO facility and a sanitary pump station used to pump Belle Isle sanitary flows to DRI on the west side of the river. The treatment facility consists of a chemical room, odor control room, utility support (electrical and mechanical), control room, sampler room, screen room and other miscellaneous rooms. The facility also includes an adjoining retention basin.

7.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a roof replacement evaluation and a detailed assessment of architectural issues, as described in the following paragraphs.

Evaluation of Type of Future Roof Replacement. Jacobs reviewed the results of a roof assessment and prepared a 60-year life-cycle cost analysis between shingled roof and metal roof. Based on the results of this evaluation, which shows lower life cycle cost for shingled roof, Jacobs recommends replacement of the shingled roof with shingles when the roof is ready for replacement. The analysis is presented in Table 7-20. As such, the roof should be replaced in-kind and the costs and schedule for roof replacement will come from the SRP.

Table 7-20. 60-Year Life Cycle Cost Evaluation of Shingled vs. Metal Roof for Belle Isle Facility

	Shingle Roof	Metal Roof
Replacement Cost ^a	\$70,000	\$233,000
Replacement Interval	20 years	60 years
Number of Roof Replacements During 60 Years	3	1
Total Life Cycle Cost (NPV) Discounted at 2.4%	\$190,000	\$233,000

^a Based on 4,650 ft² roof area; \$15 ft² for shingle roof and \$50/ft² for metal roof.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because the items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

7.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (BLI-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control /expansion wall joints
 - Remove and replace isolation /cove joint sealant and around building perimeter
 - Clean concrete bollards, patch, prepare surface and coat
 - Repoint mortar joints
 - Remove damaged coating, prepare surface, patch and apply coating to coping.

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure BLI-ARCH-1-ALT-2). Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project. It should be noted that recoating of the floor in the Chemical Room was originally included in the architectural items, but moved to the Chemical Feed project (BLI-DIS-1).

The alternative evaluation is presented in Table 7-21. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, **Alternative 2 is the recommended alternative.**

Table 7-21. Alternative Evaluation for Architectural Rehabilitation (Project BLI-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 243,000	\$ -	\$ 243,000	\$ 78,387	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

7.2.10 Safety

7.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

7.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 7-22. The capital improvement project to address these issues is included in the table.

Table 7-22. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Chemical Room	Top and mid-rail fall protection needed at ladder access at top of tanks	Add swing gate (original recommendation was to add chain; however, this is no longer current GLWA practice)	Safety Improvements (Project BLI-SAFE-1)
Chemical Room	Emergency eyewash/shower is at different level from tank and pumps and it is partially obstructed by door	Relocate eyewash/shower	Safety Improvements (Project BLI-SAFE-1)
Odor Control Room	No illuminated exit signs	Add or replace exit signs	Exit Sign Improvements ^a
Odor Control Room	Concrete pad creates uneven exit access to exterior door	Remove section of concrete pad	Safety Improvements (Project BLI-SAFE-1)
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project BLI-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

7.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section.

Safety Improvements (Project BLI-SAFE-1). This project should address the safety issues identified above. These issues include:

- Add swing gate to access top of tanks in the chemical room
- Replace eyewash/shower in the chemical room
- Remove section of concrete pad in the odor control room
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 7-23 shows the one alternative.

Table 7-23. Alternative Evaluation for Safety Improvements (Project BLI-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	5	3.78	\$ 82,000	\$ -	\$ 82,000	\$ 21,674	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection, eye wash and exit signage.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

7.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at the Belle Isle CSO Facility.

7.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Belle Isle CSO facility, Table 7-24 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 7-24, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 7-24. Listing of Asset Condition Assessments for Belle Isle Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	15	15	0	100%
AHU	2	1	1	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	4	4	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	0	0	0	N/A
BUILDING	2	1	0	50% ^a
CAMERA	1	1	0	100%
COMPRESSOR	0	0	0	N/A
COND-AIR	0	0	0	N/A
CONVEYOR	0	0	0	N/A
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAMPER	15	15	0	100%
DISCONNECT	0	0	0	N/A
DOOR	2	2	0	100%
DRIVE-ELEC	3	3	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	4	4	0	100%
FAN	1	0	1	100%
FANVENT	13	13	0	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	0	0	0% ^b
GASMONITOR	8	8	0	100%
GATE	7	7	0	100%
GEARBOX	4	0	4	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	3	3	0	100%
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	1	1	0	100%
MCC	1	0	1	100%
METER	4	4	0	100%
MIXER	4	4	0	100%
MOTOR	7	3	4	100%
PANEL	8	8	0	100%
PIPING	4	4	0	100%
PUMP	8	8	0	100%
ROOF	1	1	0	100%
SAMPLER	1	1	0	100%
SCADA	0	0	0	N/A
SCREEN	2	0	2	100%
SCRUBBER	1	0	1	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SENSOR	18	18	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	1	1	0	100%
STRAINER	0	0	0	N/A
SWITCH	1	0	1	100%
SWITCHGR	1	0	1	100%
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	3	0	3	100%
UNITHEATER	6	6	0	100%
UPS	2	2	0	100%
VALVE	21	19	2	100%
WATERHTR	1	1	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is not an asset.

^b The one gas detector is a portable gas detector and was not assessed.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Belle Isle Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

7.3 Capital Planning for Belle Isle CSO Facility

7.3.1 Summary of Capital Improvement Plan Projects

Table 7-25 provides a summary of the recommended CIP projects and associated capital costs for the Belle Isle CSO facility based on the alternative evaluations conducted for this facility.

Table 7-25. Summary of Recommended Projects at Belle Isle CSO Facility

Project No.	Alternative	Description	Total Project Cost
BLI-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 274,000
BLI-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
BLI-DIS-3	2	Replace Chemical Recirculation System with Simplified System	\$ 217,000
BLI-OC-1	2	Ladder and Railing System	\$ 41,000
BLI-HVAC-1	2	HVAC Improvements	\$ 293,000
BLI-ELEC-1	2	Electrical Improvements	\$ 58,000
BLI-I&C-1	2	I&C Improvements	\$ 112,000
BLI-I&C-2	1	Control System Upgrade	\$ 922,000
BLI-SITE-1	2	Site Improvements	\$ 220,000
BLI-ARCH-1	2	Architectural Rehabilitation	\$ 243,000
BLI-SAFE-1	1	Safety Improvements	\$ 82,000

7.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 7-26. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 7-26. Capital Improvement Plan Projects for Belle Isle CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
BLI-1 Disinfection System Improvements	\$752,000	2028 <i>Timing based on asset condition</i>	BLI-DIS-1	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	\$ 274,000
			BLI-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
			BLI-DIS-3	Replace Chemical Recirculation System with Simplified System	\$ 217,000
			BLI-OC-1	Ladder and Railing System	\$ 41,000
BLI-2 HVAC Improvements	\$ 293,000	2033 <i>Timing based on asset condition</i>	BLI-HVAC-1	HVAC Improvements	\$ 293,000
BLI-3 Facility-Wide Electrical and I&C Improvements	\$ 1,092,000	2025 <i>Timing based on asset condition</i>	BLI-ELEC-1	Electrical Improvements	\$ 58,000
			BLI-I&C-1	I&C Improvements	\$ 112,000
			BLI-I&C-2	Control System Upgrade	\$ 922,000
BLI-4 Site Improvements	\$ 220,000	2030 <i>Timing based on best judgement</i>	BLI-SITE-1	Site Improvements	\$ 220,000
BLI-5 Facility-Wide Safety and Architectural Improvements	\$ 325,000	2023 <i>Project should be initiated as soon as possible</i>	BLI-ARCH-1	Architectural Rehabilitation	\$ 243,000
			BLI-SAFE-1	Safety Improvements	\$ 82,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 7-27 and Table 7-28 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 7-27 indicates that BLI-DIS-1 project has 13 assets that has an average condition score of 1.54 and an average replacement date of 2029. This information was used to propose a scheduled construction completion date of 2028.

Table 7-27. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
BLI-DIS-1	13	1.52	1.54	2.79	12	2029	\$ 234,619
BLI-HVAC-1	1	1.29	1.50	2.25	20	2034	\$ 63,500
BLI-SCR-1	1	2.00	1.70	3.70	30	2041	\$ 489,400

Table 7-28. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
BLI-DIS-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
BLI-HVAC-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
BLI-SCR-1	1	2.00	5.00	7.00	30	N/A	\$ 489,400

7.3.3 20-Year Capital Outlay Plan

Table 7-29 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 7-29. 20-Year Capital Outlay Plan for Belle Isle CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 44,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 19,500	\$ -	\$ -	\$ 14,500	\$ 10,000	\$ -
2022	\$ 504,082	\$ -	\$ 504,082	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ 8,555	\$ -	\$ -	\$ -	\$ 8,555	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 57,413	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 21,012	\$ -	\$ 36,401	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 354,204	\$ -	\$ -	\$ -	\$ 354,204	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 146,878	\$ -	\$ 61,713	\$ 61,713	\$ 23,452	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2030	\$ 171,867	\$ 37,838	\$ -	\$ -	\$ 83,138	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 50,890	\$ -	\$ -
2031	\$ 183,478	\$ -	\$ -	\$ -	\$ 159,120	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 24,358
2032	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 190,568	\$ -	\$ -	\$ 29,371	\$ -	\$ 18,603	\$ -	\$ 142,595	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 405,562	\$ 149,595	\$ -	\$ -	\$ -	\$ -	\$ 4,599	\$ 176,519	\$ -	\$ -	\$ 74,849	\$ -	\$ -
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 609,924	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 609,924	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 639,908	\$ 88,180	\$ -	\$ 291,140	\$ -	\$ 21,566	\$ 18,046	\$ 144,707	\$ -	\$ -	\$ -	\$ 76,269	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 3,316,439	\$ 275,614	\$ 565,795	\$ 382,224	\$ 628,468	\$ 40,169	\$ 22,644	\$ 483,321	\$ 630,936	\$ -	\$ 176,641	\$ 86,269	\$ 24,358

- Notes:
- Explanation of large capital outlays in first two years:
- Screening System: Screen in Basin 2 was out of service at the time of the Condition Assessment for major repair and received a score of 5. It has since been returned to service.

8. Connor Creek CSO Control Facility

8.1 Facility Description and Future Capacity Considerations

8.1.1 General Facility Description

The Connor Creek CSO Facility is an RTB with 30 MG of storage and a treatment capacity of 13,963 cfs. It was constructed in 2005. The facility consists of a headworks, chemical room, chemical storage area (outdoor), utility support (electrical, transformer and mechanical rooms), control room, sample room, hydraulic room, office space on the second floor, and other miscellaneous rooms.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

8.1.2 Future Capacity Considerations

There were no future capacity considerations identified at the time of this report.

8.2 Facility Assessment

8.2.1 Screening

8.2.1.1 Description of Existing System

The Connor Creek CSO Facility has 10 catenary bar screens that were installed in 2005. Channels 1-3 were originally designed to be always open (i.e., there are no influent slide gates upstream of these screens). Channels 4-10 have motorized double leaf slide type influent gates that were originally designed to open sequentially, first as a set of two (Numbers 4 and 6), and then as a final set of all remaining gates, based on increasing influent flow. During a large wet weather event in 2016, the gates did not open because there was no remote control, GLWA staff could not get to the basin, and the local area flooded. GLWA Operations decided to leave them open until all SCADA / controls can be restored for the facility.

Screenings are discharged onto one of two conveyor belts which transfer the screenings to a dumpster. One belt is provided for Bar Screens 1 through 5 and another belt is provided for Bar Screens 6 through 10. The screenings are disposed of in a landfill.

Table 8-1 provides an overview of the existing screening system at Connor Creek CSO facility.

Table 8-1. Overview of Existing Screening System at Connor Creek CSO Facility

Parameter	Value
Treatment Capacity (cfs)	13,963
No. of Screens	10
Manufacturer	US Filter
Screen Type	Catenary Bar Screen
Opening Size	1.5-in. slot
Depth or Length / Width	29 ft 8.5 in / 17 ft 0 in
Screen Cleaning	Mechanical Rake
Screening Removal	Conveyor belt to dumpster and landfilled

8.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Investigate conveyor belt improvements to address belt alignment issues and to address occasional buildup of screenings at start of the conveyor belt incline section.

Jacobs further investigated this issue with Custom Conveyor Corporation (the original belt manufacturer). It should be noted that Custom Conveyor will conduct a site investigation at a later date during CS-299 to assess the conveyor issues and provide recommendations.

Based on initial conversations, potential recommendations to address belt alignment issues include tightening the belt tension, installing training idlers, and replacing the belt. Tightening the belt tension by adjusting the tail pulley could prevent the belt from becoming misaligned. Installing training idlers approximately every 50-ft on the carry side of the belt can prevent the belt from walking off to the side. Over time, the belt may become stretched and exceed the ability of the tail pulley to provide further tension. The belt may also reach the end of its service life. In either case, the belt may need to be replaced.

Cleats may be recommended to prevent buildup of screenings at the start of the incline. Cleats prevent screenings from sliding down the belt. Cleats may be bolted onto existing belts. Cleats requires replacing the wiper used to clean the screens with a belt thumper. The belt thumper is slave driven off the discharge pulley.

No capital improvement costs have been provided to address this issue.

- GLWA O&M personnel requested improvements to access for screen maintenance, including for wear shoes and motor and gearbox. The motor and gearbox extend over the screenings channel and are difficult to reach from the walkway next to the screen. Currently, maintenance staff use a man-basket connected to the overhead crane to access the motor.

Jacobs further investigated this issue. One option would be to construct a walkway to provide better access; however, this will likely be a costly option. This issue has been added to the list of issues to be evaluated by E&I (original screen manufacturer) during their upcoming OEM screen assessment to determine if they have a better option. The results of E&I's evaluation will help determine the scope of any improvement.

During Jacobs safety inspection under CS-299, the following issue was identified in the Headworks Building:

- Eliminate low headspace between screenings dumpsters. During Jacobs Safety Inspection in January 2020, it was noted that the support beams for the screenings conveyor create a safety hazard for staff walking through the building due to their relatively low height. These beams support the head pulleys and discharge end of the screenings conveyors.

Jacobs contacted the original conveyor manufacturer (Custom Conveyor) to evaluate options for resolving this issue. Figure 8-1 shows a recommended modification that will eliminate the overhead safety concern. It involves providing a new drive-end conveyor support for each conveyor and relocating the drive motor. This is an on-going project being completed under a JOC.

8.2.1.3 Description and Evaluation of Alternatives

The issues above are either on-going or they do not require capital improvement at this time. As such, there are no alternatives identified as screening capital improvement "needs".

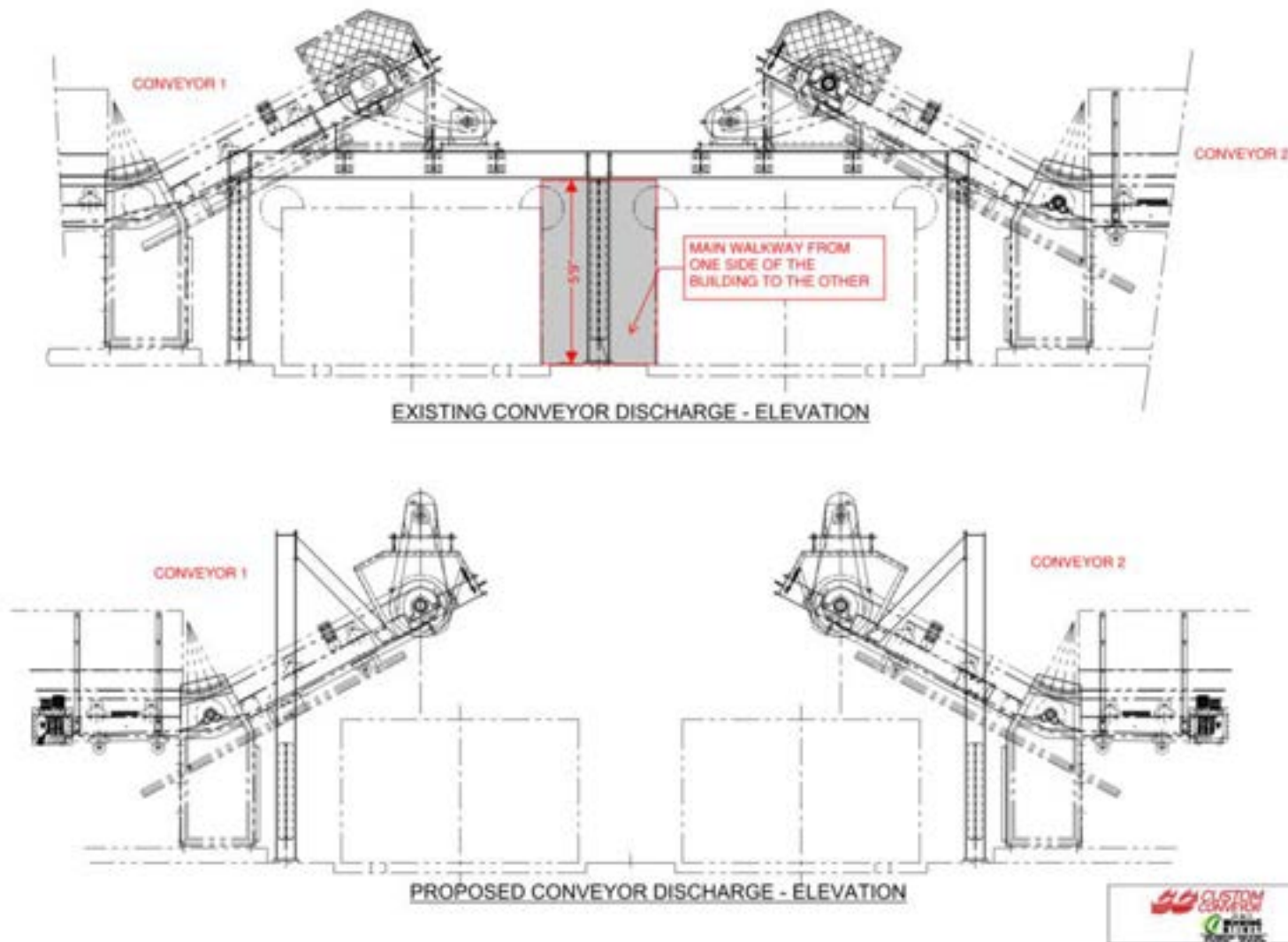


Figure 8-1. Conveyer Modifications to Improve Access through Headworks Building

8.2.2 Disinfection

8.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of four outdoor insulated rubber lined steel tanks, 10 constant speed magnetic drive centrifugal pumps, 10 disinfectant rapid mix zones, and 60 induction mixers. There are 10 screens and there is one disinfectant rapid mix zone immediately downstream of each screen. There is a diffuser at floor level immediately downstream of each screen to allow feeding sodium hypochlorite before the water level reaches the low-level induction mixers and to continue to provide disinfectant near floor level throughout an event. There are six induction mixers per disinfectant rapid mix zone consisting of two low-level mixers, two mid-level mixers, and two high-level mixers. Each sodium hypochlorite pump is paired to one disinfectant rapid mix zone. However, there is a valved crossover from each pump to one other pump. This provides less redundancy than a spare pump that could serve all disinfectant rapid mix zones. The sodium hypochlorite pumps each discharge to a manifold feeding the diffuser and 6 induction mixers at their paired rapid mix zone. There is a flow meter to the diffuser and each pair of low-level, mid-level, and high-level induction mixers. Flow splitting within each pair of mixers at a given level is assumed equal based on symmetry.

Table 8-2 provides an overview of the existing disinfection system at Connor Creek CSO facility and the disinfection process flow diagram is included in Volume 6 – Appendices, Appendix G.

Table 8-2. Overview of Existing Disinfection System at Connor Creek CSO Facility

Parameter	Value
Treatment Capacity (cfs)	13,262
Design Feed Strength (% hypochlorite)	10
Max. Dosage at Design Flow (mg/L Cl ₂)	25
Disinfection Contact Time (min)	5
Storage Tanks	
Number	4
Volume of Each Tank (gal)	95,000
Type	Rubber-lined steel
Pumps	
Number	10
Capacity (gpm)	197
Type	Centrifugal, magnetic drive
Mixers	
Number / Type	60 / Chemical Induction mixers
Model Number/ hp / Manufacturer	SWC20XP / 20 hp / Water Champ

8.2.2.2 Identified Needs and Issues

The needs and issues identified for Connor Creek were identified from meetings with O&M staff and Jacobs team site visit and investigations. The identified needs and issues are listed in the following bullets:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Connor Creek chemical feed system has the following issues:
 - The back-pressure valves controlling the chemical feed split between the three pairs of induction mixers and the diffuser at each disinfectant rapid mix zone are not functioning properly. Also, one

back pressure valve serves each pair of mixers at a given level. Therefore, flow splitting between each pair of mixers is assumed equal based on symmetry alone.

- The flow meters are in need of replacement due to age and some are showing significant signs of corrosion. Also, the vertical downflow orientation is poor as there is the potential for a non-full pipe.
- Similar to other facilities, it is desired to standardize on a flow splitting regime that considers such attributes as simplicity, reliability, and functionality.
- Currently, a hose must be moved and connected to each pump suction pipe to flush the hypochlorite solution from the feed system with NPW. A hard-piped flushing water connection is desired so that flushing could be accomplished by opening a valve to each pump.
- The pump area is located down four steps and there is no dedicated means to lower or lift the pumps and motors to or from this area. A mechanical means of getting pumps in and out of the room is desired.

These issues are addressed in Replace Chemical Feed System (Project CON-DIS-1) below.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project CON-DIS-2) below.
- There are 60 chemical induction mixers that require relatively frequent and costly maintenance. This issue is addressed in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project CON-DIS-3).
- Heat tracing on the outside chemical pipes occasionally fails putting the piping at risk of failing if it freezes. In fact, piping in this outdoor area for the eye wash / shower stations has previously frozen and ruptured. The heat tracing and insulation also hinders access to detect and replace leaking fittings and pipes. This issue is addressed in Freeze Protection for Chemical Storage Area Piping (Project CON-DIS-4).

8.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project CON-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, CON-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

Each of the alternatives above would include provisions to address the additional concerns specific to Conner Creek feed system:

- For cost estimating purposes, water piping and valving to each feed pump was assumed to allow water flushing for the entire chemical feed system from the feed pumps to the mixers.
- For cost estimating purposes, a mast type jib crane (also referred to as a base mounted jib crane – see Figure 8-2 for an example) for moving the pumps and motors up and down the flight of stairs. The base could be located approximately 4 ft from the bottom of the stairway so as to maintain sufficient egress to and from the stairway and to provide a set down area for the pump or motor. The beam would cantilever from the base over the stairway and the upper landing. An electric hoist and trolley could then be used to pick the pump or motor, raise it, convey it over the stairway, and set it down on the upper level. From there, a cart could be used to get the pump or motor out the door. This is the recommended alternative and was used for budgeting.



Figure 8-2. Example of Mast-Type Jib Crane

The alternative evaluation for these alternatives is presented in Table 8-3. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP and include pump replacement at Year 10.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 8-3 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 8-3. Alternative Evaluation for Replace Chemical Feed System (Project CON-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System in-kind	Health and Safety	3	2.08	\$ 2,919,000	\$ -	\$ 2,919,000	\$ 1,401,120	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with feeding too much chemical. System is unique to Conner Creek.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 5,409,000	\$ 109,670	\$ 7,721,900	\$ 2,144,972	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per disinfection channel. Utilize hose pumps.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	LOTS of pumps and valves, allows for an installed redundant pump but manual switchover.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 2,300,000	\$ 7,000	\$ 2,447,627	\$ 679,897	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps connected to all disinfection channels. Utilize centrifugal pumps.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily utilized.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each disinfection channel.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project CON-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the chemical dosing point to further adjust chemical feed flows.

The automatic chemical feed system should require less operator input during an event; however, this cost difference is not included in this analysis because GLWA O&M staff believe that manual sampling to confirm the auto sample result will still be necessary. There will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 8-4. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains ready for service.
- As noted above, this evaluation did not account for any reduction in operations labor using the automatic control system.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 8-4. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project CON-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 156,000	\$ 4,860	\$ 258,496	\$ 74,926	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

Reduce Cost Associated with Large Quantity of Chemical Induction Mixer (Project CON-DIS-3). Plant personnel report that the mixers are expensive to maintain and due to the sealed nature of submersible mixers they must be sent back to the manufacturer for maintenance which adds shipping cost and takes months before the mixer is returned to service. These issues are exacerbated by having 60 induction mixers at Conner Creek, which is the highest of the nine CSO facilities. A reduction in the number of mixers would reduce maintenance and the associated expense proportionate to the reduction. It would also reduce the complexity for equal flow splitting between mixers.

The alternatives to address this issue were identified previously in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Section 5.2.4). The alternatives include:

- 1) **Alternative 1. Replace Existing Chemical Induction Mixers In-Kind.** This alternative assumes replacement of the mixers in-kind.
- 2) **Alternative 2. Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers.** Computation fluid dynamic (CFD) modeling is assumed to be required to demonstrate to EGLE the adequacy of a lesser number of mixers. For illustration purposes, it is assumed that the number of mixers can be reduced by half (i.e., from six to three per channel). This needs to be confirmed by collection system modeling performed by others.
- 3) **Alternative 3. Install Vertical Shaft Mixers.** This alternative would replace the existing chemical induction mixers with new vertical shaft mixers. For Conner Creek, two mixers would be provided per channel.

The alternative evaluation is presented in Table 8-5. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternatives 1 and 2 includes mixer replacement in-kind at the number of mixers shown. Capital costs are based on the SRP replacement cost of \$50,000 per mixer and a 10-year life. Because the life-cycle period is 20 years, the capital costs assume replacement of the mixers twice during the 20-year period.
- For Alternative 2, the cost of the CFD model is assumed to be \$50,000.
- The O&M costs for mixer replacement in Alternatives 1 and 2 is based on current costs for repairing a chemical induction mixer. It is assumed the mixer needs to be repaired every 2.5 years at a cost of \$18,000 per mixer.
- The capital cost for Alternative 3 (vertical shaft mixers) is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 3 (vertical shaft mixers) are based on expected maintenance costs, including changing oil, greasing bearings, periodic rag removal from the shaft and servicing the steady bearing.

As shown in Table 8-5, Alternative 2 has a Total Benefit score about 0.4 higher than Alternative 1 because of the improved ease of maintaining fewer mixers. Alternative 3 has a Total Benefit score slightly higher than Alternative 2 based on the anticipated improved performance of the vertical mixers and improved ease of maintenance, since the mechanical portion of above the water surface. **Alternative 2, has the lowest NPV/Benefit cost and therefore, is the recommended alternative.**

It should be noted that the cost of the reduced mixers is not a new capital cost for GLWA. Rather, it was used in this evaluation to compare alternatives. The cost for the CFD modeling would likely be included in a capital outlay, not a capital improvement project. If the CFD modeling does not prove that disinfection

performance can be achieved, the vertical mixer alternative should be further explored, possibly through the pilot testing of this technology in one of the channels at Baby Creek or Conner Creek.

Table 8-5. Alternative Evaluation for Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project CON-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace Existing Mixers in-kind	Health and Safety	3	2.57	\$ 6,000,000	\$ 438,000	\$ 15,237,260	\$ 5,936,595	
	<i>Definition:</i>	Replace existing mixers as required.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, lots of redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Expensive and impacts operations and maintenance. Equipment installed in basins.	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement 2 times during 20-year period	O&M Ease	1						
2	<i>Alt. Name:</i>	Model Disinfection Performance and Replace/Utilize 2/3rds of the In-Kind Mixers	Health and Safety	3	3.00	\$ 3,050,000	\$ 219,000	\$ 7,668,630	\$ 2,556,210	Best Value Alternative
	<i>Definition:</i>	Perform computational fluid dynamics (CFD) model of basin and determine required number	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, maintains required redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less expensive and less impacts to operations and maintenance. Equipment installed in	Component Performance	3						
	<i>Comments:</i>	Capital costs are based on replacement 2 times during 20-year period & CFD Modeling of \$50,000.	O&M Ease	3						
3	<i>Alt. Name:</i>	Install Vertical Shaft Mixers	Health and Safety	3	3.32	\$ 9,239,000	\$ 70,000	\$ 10,715,274	\$ 3,230,736	
	<i>Definition:</i>	Install vertical shaft mixers throughout the basin.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less equipment to operate and maintain. Overall less install horsepower. Equipment is above the basin and accessible in a non-	Capacity Enhancement	3						
	<i>Disadv.:</i>	Bearing in bottom of basin. Possible ragging issues.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Freeze Protection for Chemical Storage Area Piping (Project CON-DIS-4). Conner Creek is the only facility with outdoor sodium hypochlorite storage. There are two alternatives:

- 1) **Alternative 1: Do Nothing – Continue to Use Heat Tracing and Replace at Regular Intervals.** Heat tracing with a monitoring system is currently used on chemical piping. Heat tracing, however, can fail and could cause the contents of an entire tank to spill into the containment area. This alternative assumes continued use of heat tracing with a monitoring system. Provisions for an improved system and, potentially replacement of the system before the end of its useful life should be considered to improve reliability.
- 2) **Alternative 2: Provide a New Building to Enclose Storage Area.** The existing structure surrounding the Chemical Storage Area consists of concrete masonry unit block wall with exterior brick. This wall is shorter than the tanks. While this wall could be integrated with a building to enclose the tanks, additional columns would be required to support the roof. A building would also require heating and ventilation, and possibly air conditioning, facility electrical (e.g., lighting and additional electrical outlets as needed), and fire protection (e.g., sprinklers). Air conditioning is often practiced with hypochlorite because the degradation rate is higher with higher temperature. Site glasses are also desired on the tanks.

For cost estimating purposes, a column supported roof and additional wall height necessary to enclose the tanks and integrate with the existing containment walls was the basis for the new structure. Provisions for HVAC, electrical and fire protection are included in the cost estimate.

The alternative evaluation is presented in Table 8-6. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 for heat trace system is included in Volume 6 – Appendices, Appendix C under this project title. It should be noted that the heat trace system useful life is assumed to be 10 years. To be consistent with the building life in Alternative 2 (60 years), the cost of the heat trace system is multiplied by 5.
- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title. The building life is assumed to be 60 years in this analysis.

As shown in Table 8-6, Alternative 2 has a Total Benefit score about 1.2 higher than Alternative 1 because of the improved health and safety, component performance, and ease of O&M. However, the NPV/Benefit is much larger for Alternative 2 compared to Alternative. Therefore, **Alternative 1 is the recommended alternative.**

Table 8-6. Alternative Evaluation for Freeze Protection for Chemical Storage Area Piping (Project CON-DIS-4)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing – Continue to Use Heat Tracing and Replace at Regular Intervals	Health and Safety	2	2.40	\$ 864,000	\$ -	\$ 864,000	\$ 360,000	Best Value Alternative
	<i>Definition:</i>	Replace/upgrade existing heat trace system	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Heat tracing can fail without notice or indication, causing pipe rupture	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide a New Building to Enclose Storage Area	Health and Safety	4	3.60	\$ 3,856,000	\$ -	\$ 3,856,000	\$ 1,071,111	
	<i>Definition:</i>	Enclose area around storage tanks and piping	Water Quality & Compliance	3						
	<i>Adv.:</i>	Enclosure provides temperature-controlled space, which would prevent freezing.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.3 Odor Control

8.2.3.1 Description of Existing System

The Conner Creek odor control system consists of four dual-bed vertical carbon adsorbers, one for each retention basin compartment, located near the effluent end of the retention basin. Air is pulled from the Headworks Building, down through the floor opening in the Retention Basin, and then up through the odor control vessels at the downstream end of the retention basin. Each system treats 25,000 cfm of air. Carbon is replaced through the top and side access hatches on the vessel.

The system was installed in 2005. Overall, the system was in fair condition with two systems out of service due to fan issues at the time of the Needs Assessment.

This odor control system operates under air permit requirements (Permit to Install No. 69-06). There is no H₂S emission limit but there is a six-minute average of 20 percent opacity limit. No testing of carbon for remaining bed life is required by the permit. The carbon has not been replaced since installation.

Per GLWA, no odor complaints have been received for at least the past three years.

8.2.3.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified:

- The odor control vessel has a dome top which increases the risk of slipping during carbon replacement.
- Jacobs odor control team notes that the majority of carbon systems are provided with simple differential pressure gauges for local monitoring. Regular monitoring of differential pressure gauges is not necessary as the pressure differential changes gradually over time and is not a critical operating parameter. SCADA monitoring is not necessary given the infrequency of operation. As such, remote monitoring of pressure drop across the carbon beds via SCADA is not recommended.
- During the site visit on 1/27/20, only Odor Control Unit 4 was in operation. The magnehelic pressure gauges showed no pressure loss through either vessel carbon bed in the dual bed vessel. The magnehelic pressure gauge across the grease filter indicated a pressure drop verifying air movement by the fan. Either the gauges are not operating, the magnehelic pressure gauge tubing is reversed, gauge ports are blocked, or there is no carbon in the vessel.

To address the lack of carbon bed pressure drop across Odor Control Unit 4, GLWA should inspect the vessel for carbon media. If the carbon media were removed at some point in the past and not replaced, there would be no pressure drop. If there is carbon in the vessel, check that the magnehelic pressure gauges are properly installed. If the gauges are installed properly, try an operating gauge from another vessel on Unit 4 to verify the pressure drop. Another possibility is the gauge ports are blocked by carbon or some component of the tank interior resin or coating. A pipe cleaner or compressed air can be used to check for blockage of the port connection and to remove loose obstructions.

8.2.3.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Access to Odor Control Vessel (Project CON-OC-1). Staff indicated that carbon replacement at the facility would require constructing scaffolding to safely access the top of the carbon vessel for replacing the top carbon bed. The vessel has a dome top increasing the risk of slipping.

Jacobs evaluated two alternatives that would make accessing the top of the carbon vessel safer for both sampling and carbon replacement.

- 1) **Alternative 1: Erect scaffolding for Carbon Replacement.** The O&M staff currently erects a scaffolding when replacing the carbon. The carbon needs to be replaced every 10 years.
- 2) **Alternative 2: Ladder and Railing System.** Figure 7-6. in the BLI facility section above shows a ladder and railing alternative. The figure does not show a 6-in. toe rail, which is recommended, that should be installed at the bottom of the railing to help prevent a person's foot from slipping off the domed top along with tools and equipment. A contractor would field install fiberglass clips and receptacles to the fiberglass tank to secure the ladder and railing. The existing bolted hatch cover on the top of the vessel will be replaced with a hatch that has quick-opening clamps.
- 3) **Alternative 3: Ladder, Platform and Railing System.** Figure 7-7 in the BLI facility section above shows an example of a ladder, platform, and railing on a horizontal tank. The platform provides a more stable working surface than the domed top. The option is a safer option because the platform provides a flat surface on which to stand. A contractor would field install fiberglass clips and receptacles to the fiberglass tank to secure the ladder, platform and railing. Installation of the platform and rail option is more expensive than the railing only option (Option 1) as a crane is necessary to remove the metal roof and lower the platform from above. The existing bolted hatch cover on the top of the vessel will be replaced with a hatch that has quick-opening clamps.

The alternative evaluation for these alternatives is presented in Table 8-7. The sources of costs used in this evaluation are listed below:

- The O&M cost for alternative 1 is based on \$10,000 per carbon column for erecting scaffolding. Since, the carbon is replaced once every 10 years, the annual O&M cost is assumed to be \$4,000.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C, under this project title. The standard markups for design, construction assistance and contractor overhead and profit have been applied.

This evaluation shows that Alternative 1 – Erect scaffolding for Carbon Replacement has the lowest NPV/Benefit ratio. **As such, Alternative 1 – Erect scaffolding for Carbon Replacement is the recommended alternative.**

Table 8-7. Alternative Evaluation for Access to Odor Control Vessel (Project CON-OC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Erect Scaffolding for Carbon Replacement	Health and Safety	2	2.50	\$ -	\$ 4,000	\$ 84,359	\$ 33,743	Best Value Alternative
	<i>Definition:</i>	Continue to use scaffolding when replacing carbon.	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Must be set up every time carbon is replaced.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Ladder and Railing System	Health and Safety	3	3.22	\$ 138,000	\$ -	\$ 138,000	\$ 42,902	
	<i>Definition:</i>	Provide a ladder on side of vessel and railing around top of vessel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Ladder provides improved access and railing provides safety during carbon change-out.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Surface of dome is still sloped and not as safe as a flat surface.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Ladder, Platform, and Railing System	Health and Safety	5	4.00	\$ 410,000	\$ -	\$ 410,000	\$ 102,500	
	<i>Definition:</i>	Provide a ladder on side of vessel and a platform and railing system on top of vessel.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Platform provides more stable working surface of top of vessel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

8.2.4 Flushing and Dewatering

8.2.4.1 Description of Existing System

Dewatering System: The basin and upstream hydraulic structures are dewatered mostly by gravity. Four submersible dewatering pumps located in a sump area in the central portion of the CSO basin (between Compartments 2 and 3) are used when gravity flow rates decline below pumping rate. The total volume of stored CSO after an overflow event is 62 MG, with 30 MG in the basin and 32 MG in the upstream structures. The volume of 62 MG was designed to be dewatered to the DRI in a 48-hour period. The rate of dewatering is controlled based on the level in the DRI.

Each pump discharges through a dedicated pipe to a junction chamber located next to the basin. All four pumps are intended to operate simultaneously. If one of the dewatering pumps is out of service, a flushing pump can be put into service.

Flushing System: A flushing gate system is used for cleaning solids from the bottom of the basin. Flushing gates with reservoirs were constructed at the following locations: 1) at each side of the screening distribution channel (upstream of the screens); 2) at each side of the basin distribution channel (i.e., the channel downstream of the screens); and 3) at the influent and effluent ends of the four basin compartments. The flushing reservoirs fill with wastewater as the facility fills during a wet weather event. Once the facility is dewatered, water remains in the reservoir. When the flushing gates are actuated, a surge of water is discharged down the channel, scouring solids and moving them into the sump areas. Flushing solids pumps are used to pump this water and solids mixture to the DRI. See Table 8-8 for the location and capacity of the pumps. If additional flushing is needed after the initial flush, NPW can be used to re-fill the reservoir.

The facility receives a significant amount of grit and large debris from the collection system. Because of the large accumulation of grit and heavy solids in the Screening Distribution Channel (upstream of the screens), the flushing gates and flushed solids pump (FSP-1) are ineffective in this area. In fact, FSP-1 has been removed and GLWA staff must use water hoses, vactor truck hoses and portable pumps to remove the solids from this channel.

For the influent sewer area ahead of the Screening Distribution Channel, a bobcat is lowered through a hatch to aid in moving the solids to the hatch area for subsequent removal. Solids are typically loaded into a small container to be lifted out through the hatch and loaded into a larger dumpster at ground level.

Table 8-8 provides an overview of the existing flushing and dewatering system at Connor Creek CSO facility.

Table 8-8. Overview of Existing Flushing and Dewatering System at Connor Creek CSO Facility

Parameter	Value
Total Basin Volume (MG)	30
Headworks and Basin Dewatering and Flushing System	- Flushing gates are installed in 1) Screening Distribution Channel; 2) Basin Distribution Channel; 3) Each Basin Compartment (4 total) 8 flushing gates for each channel or compartment (48 total) - FSPs are used to remove flushed solids from each compartment. - FSP-1 in the area ahead of the screens has been removed due to excessively high grit levels - FSP-2 in the Basin Distribution Channel is 735 gpm at 39.8 ft TDH - FSP-3 and 4 in the middle of the basins are 1,610 gpm at 51.5 TDH - Gravity dewatering can occur down to about 84 ft via in-system storage gates. - Four dewatering pumps. Capacity varies with water level in basin from 7,600 gpm at 12.3 ft TDH (basin full) to 4,475 gpm at 45.5 ft TDH (basin empty). Flow is routed to the DRI

Note:

TDH = total dynamic head

8.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- A significant amount of solids builds up in the Screening Distribution Channel (upstream of the screens). The removal of solids is labor intensive and costly, and some areas are inaccessible to the bobcat.
- Filling the flushing reservoirs after the first flush uses a significant amount of potable water, which is costly, and is a time consuming exercise. Also, water fills a group of four reservoirs by filling one reservoir and subsequently overflowing into the next three, one at a time. If one of the first flushing gates leaks, the downstream reservoirs do not get filled.
- Accumulation of sediment within the Conner Creek channel could potentially limit the discharge capacity of the facility.
- Many flushing gates do not function properly. Based on an inspection of each flushing gate in late 2019/early 2020 by a contractor, many of the gates do not function properly, making cleaning the basin difficult, if not completely ineffective, and time-consuming. GLWA is currently addressing this issue through rehabilitation of the existing gates through a JOC. As such, this project is not included in the capital improvement projects under CS-299.

8.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Screening Distribution Channel Improvements (Project CON-FD-1). A significant amount of grit builds up in the influent conduits to the Conner Creek Basin and in the Screening Distribution Channel. The build-up of solids (typically 3 to 6 ft high over time) prevents the flushing gates in the Screening Distribution Channel from being able to flush the solids to the sump area and it has overwhelmed FSP-1. Due to the significant quantity of grit, considerations to improve or modify the existing grit removal system were quickly dismissed.

The most effective method of grit removal for this CSO facility has proven to be using a bobcat to load the grit into dumpsters. In 2017, GLWA added a large (8-ft × 12-ft) equipment hatch to the influent conduit area to lower a bobcat into this area. This opening is also used to remove the grit from influent conduit area using a small container and dumping it into a larger dumpster located at the surface.

The flushing channels cannot be cleaned out by a bobcat since the channels are not accessible. To make them accessible, the leading alternative is to remove the training walls of the flushing channels, install ramps for the bobcat to access the channel area and fill the FSP-1 area with concrete. This concept is shown in several figures (Figure CON-FD-1-ALT-2) in Volume 6 – Appendices, Appendix B, and described further below.

There are two alternatives for addressing this issue:

1) **Alternative 1: Do Nothing/ Continue to Manually Clean Area**

2) **Alternative 2: Screening Distribution Channel Improvements.** This alternative includes the following:

Demolition of existing concrete and equipment. The recommended improvement involves demolition of the existing flushing gate channel training walls, flushing gate assemblies, and the front flushing gate reservoir walls. The anticipated demolition method is jackhammering, which will remove the concrete down to below the adjacent floor system. Rebar will be cut below the floor surface as well. High-strength concrete patching materials will be applied to create an overall smooth surface on the flushing floor. By removing this concrete, O&M staff will be able to maneuver around the area freely to collect sediment

Concrete Fill. The flushing wave collection channel will be filled in with concrete to be level with the floor surface. The FSP-1 sump will be cleaned and partially filled with concrete to result in a shallower sump, approximately 2 ft below the flushing floor edge.

Drain Pump System Reconfiguration and Reinstallation. The FSP-1 sump pump was previously removed by GLWA due to consistent pump fouling by sediment. Jacobs recommends constructing a more robust screen around the FSP-1 sump and reinstalling the pump and discharge piping. The benefit of reinstalling a protected pump is the ability to consistently dewater the influent channel area after all events, and to dewater the space more effectively prior to grit removal.

The more robust sump pump screen concept consists of a static screen installed around the existing sump. Four 6-in. bollards will be set inside the FSP-1 sump prior to concrete filling. A stainless-steel perforated screen will be fabricated with 2-mm openings (similar material and opening size to screens used for dewatering sumps in construction excavations). The screen fabrication will be approximately 10 ft high and will be positioned over the bollards, with the bollards serving to maintain the screen in its location. The screen unit will be sufficiently heavy to remain in place during inundation by CSO events but can be lifted from the surface to a height necessary to clean any debris that may accumulate inside the screen.

The FSP-1 sump pump will be reconfigured such that the pump suction intake is 2 ft above the sump floor with a welded stainless steel bracket. The operational setting for this pump will be reprogrammed to start operation once the minimum pump submergence level has been detected (requires level sensor element control) and will stay in operation for the duration of the event. A provision for a secondary water jet should be provided at the intake to support the dewatering. With the perforated screen in place, and the pump in continuous operation, the sediment loading inside the screened area will be significantly minimized, allowing the influent channel to be adequately dewatered following each event. The perforated screen can be lifted from the surface if needed to access the sump area.

Access to Screening Distribution Floor. To facilitate access to the floor from the influent conduit access hatch, two concrete ramps will be poured with a 12H:1V slope (approximately 8 degrees). Concrete bollards (6-in. diameter, 4 ft tall) will be set along the edge of the upper level at 6-foot spacings and along the edge of the ramp to the cleaning floor, effectively guiding equipment operators to the ramp during sediment removal and preventing driving over the edge.

At-Surface Sediment Removal. To support a more efficient removal of sediment from the area upstream of the bar screens, a series of 8 ft × 8 ft openings will be cut into the influent channel roof. A surface mounted conveyor unit will be extended into the opening down to the floor, where the bobcat operator can deposit sediment in a hopper. See Figure 8-3 for an example of a conveyor that could be used. The conveyor will lift the sediment to the surface and deposit the material into a dumpster or directly to a dump truck for off-site disposal. As the operator systematically cleans the area, the conveyor can be rotated to different positions using a crane from the surface as needed to minimize bobcat travel. Once a general area has been cleaned, the conveyor is retracted and relocated to another opening. The sequence is repeated until the entire upper level and floor has been adequately cleaned. Additionally, the openings through the roof slab facilitate easier access to the influent channel during construction. The conveyor used as a basis of the concept can be viewed online at www.interquip.net. When not in use, the conveyor belt unit would be disassembled and stored onsite. GLWA staff will need to identify a potential location where the stored unit does not interfere with day-to-day O&M. A covered storage structure (e.g., canopy cover, prefabricated metal shelter) and paved surfacing at a preferred storage location is not included in the capital cost estimate.



Figure 8-3. Example of Surface Mounted Conveyor Unit

Flow management during construction will be a major consideration for this option. Bypass pumping is not feasible, given the potentially large flows and isolating the areas of concrete addition will not be cost effective. Constructing concrete sections for the channel infill and the two concrete ramps above-ground and lowering into place should be considered. This issue will require much further evaluation during detailed design.

New Storage Building. A new 30-ft by 60-ft prefabricated metal building with a concrete slab-on-grade will be constructed near the existing building. The building will be used to store the conveyor, stop logs, and other spare parts for the facility.

The alternative evaluation for these alternatives is presented in Table 8-9. The sources of costs used in this evaluation are listed below:

- The O&M cost for Alternative 1 includes GLWA labor cost and water usage cost. The labor cost is based on 3 staff for 80 hours per week and 4 times per year, or about \$100,000 per year. Water usage assumes a water jet is needed to break-up the solids and convey them to the sump area. Water usage based on about 1 MGD needed for 8 hours per day during the 2 week period at \$4,000/MG, or about \$56,000 per year.
- The capital cost for the flushing system (Alternative 2) is included in Volume 6 – Appendices, Appendix C under this project title. It should be noted that the capital cost includes an allowance of \$200,000 for cleaning/re-cleaning the Screening area, and another \$200,000 allowance for wet weather interruptions/delays.
- The O&M costs for Alternative 2 is based on GLWA labor cost of 2 staff for 20 hours per week and 8 times per year, or about \$16,000 per year.
- Grit disposal costs are assumed to be similar for the two alternatives and, therefore, not included.

This evaluation shows that the Total Benefit score for Alternative 2 is 2.0 higher than Alternative 1 because of improved health and safety and ease of O&M. In addition, it is the best value alternative. **As such, Alternative 2 – Screening Distribution Channel Improvements is the recommended alternative.**

Table 8-9. Alternative Evaluation for Screening Distribution Channel Solids Build-Up (Project CON-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	1	1.72	\$ -	\$ 156,000	\$ 3,289,983	\$ 1,916,495	
	<i>Definition:</i>	Continue removing solids from portion of basin using bobcat and bucket	Water Quality & Compliance	2						
	<i>Adv.:</i>	Known system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Labor intensive, solids typically remain due to incomplete cleaning - thus solids could be scoured out of basin in a subsequent storm.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Screening Distribution Channel Improvements	Health and Safety	4	3.72	\$ 2,880,000	\$ 16,000	\$ 3,217,434	\$ 865,677	Best Value Alternative
	<i>Definition:</i>	Modify floor of channel to remove training walls and add ramps for bobcat; fill flushing wave collection channel with concrete; reconfigure and reinstall Flushing Solids Pump 1; provide removable solids removal conveyor.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Will make solids removal less labor intensive, less costly and safer.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

Flushing Water System Improvements (Project CON-FD-2). The flushing reservoirs in the basin and influent area are naturally filled with combined sewage during storms that fill at least one-quarter of the basin. The volume of water captured in the flushing reservoirs is used to flush the settled debris from the floor of the basin. If additional flushing is needed, NPW (i.e., City water that has gone through the backflow preventer) must be used. GLWA Operations personnel have noted that it takes about 10 hours to fill all the flushing reservoirs with water using the water lines. Based on the active reservoir volume of 0.4 MG, this implies that the average flow rate is about 700 gpm. Operations personnel also note that there is a drop in water pressure for hose washdown in the basin when the flushing reservoirs are being filled. The reservoir fill lines and hose drop connections are fed from the same service water system in the basin. The header for this system is an 8-in. diameter water line. The basin flushing water is fed from the facility's service water system that originates from a 12-in. connection on Freud Avenue.

There are three alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing/ Continue Using Potable Water**
- 2) **Alternative 2: Flushing Water System Improvements Using River Water.** This alternative involves using water from Conner Creek for flushing water. The gravity-fed system would consist of two 12-in. HDPE header pipes located across the basin to service the flushing reservoirs. See figures (Figure CON-FD-2-ALT-2) in Volume 6 – Appendices, Appendix B, for a plan view and section view, respectively, of this option. Each header would originate on the east side of the basin in the canal where the pipe would penetrate the basin wall. A screen (manually cleaned) is shown at the inlet of each pipe to prevent large objects from entering the header pipe. Platforms are provided at each inlet to allow for cleaning the screen, if necessary. The installation of this system will require intake structures, along with accompanying cofferdams, to be constructed at each intake into the basin from the canal.

The screened inlet must be located at an elevation below the Detroit River low water datum, which is approximately elevation 93.0 ft (City of Detroit Datum). At this river elevation, there would be a minimum of 12 ft of static head between the river elevation and the elevation of the discharge points at the flushing reservoirs. A motorized control valve would be located on the header pipe at each set of flushing reservoirs. After each valve, GLWA has requested piping to each individual reservoir, which allows for filling each reservoir even when there is a leak (i.e., a leak at the flushing gate) in the first reservoir. It is anticipated that each header could convey approximately 2,000 gpm, or nearly 3 million gallons per day (MGD). The influent and effluent flushing reservoirs could be filled independently. This modification, along with higher flows, would significantly reduce the time to fill the reservoirs.

The advantages of this gravity system, compared to a pumping system, are:

- City water savings (see alternative evaluation for details)
- Few moving parts to be maintained
- Lower maintenance cost
- Lower capital cost
- Ability to fill influent-end and effluent-end flushing reservoirs at the same time, thus significantly reducing the time to fill the reservoirs
- Ability to fill four reservoirs at a time, instead of filling one reservoir and allowing the water to overflow into subsequent reservoirs, by using a valve to control flow to the group of four reservoirs and extending a pipe with discharge to each of the four reservoirs.

The disadvantages of the gravity system, compared to a pumping system, are:

- Valve actuator being at the deck level will have 25 to 30 ft long stem requiring several braces spaced along the height of the valve stems.

- Potential blockage of screens due to zebra mussels

The attachment of zebra mussels on the intake screen or in the intake pipe will decrease screen inlet flow area and pipe diameter reducing flushing reservoir filling rates or completely restricting flows to the individual flushing reservoirs. Allowing zebra mussels to colonize the intake pipes will also provide them with an opportunity to enter the basin where further colonization may occur. For these reasons, it is recommended that a zebra mussel control strategy be implemented at each of the intake pipe locations for the gravity-feed system. There are a variety of mussel control measures ranging from treatments with chlorine and other oxidants, mechanical removal, and special pipe coatings. Sodium hypochlorite is commonly used to control zebra mussel growth. Extension of the Conner Creek CSO hypochlorite system to the raw water inlets may be the simplest approach as hypochlorite does not need to be applied continuously. Intermittent application of 1.0 mg/L hypochlorite during the breeding season in the summer is usually sufficient. Many utilities apply hypochlorite to the front edge of water intake pipes to prevent mussel colonization and to kill any mussels that have already attached. GLWA currently applies hypochlorite at the Belle Isle intake structure to control zebra mussels on the intake screens and within the intake structure and tunnel. Such practices are therefore recommended at the respective intake areas at the Connor Creek facility.

It should be noted that an application for water withdrawal from EGLE in excess of 2 MGD is required. The need for this permit will need to be further explored during detailed design phase. Water is not being diverted from the Great Lakes basin so obtaining a permit should not be a problem.

- 3) **Alternative 3: Flushing Water System Improvements Using Potable Water.** This alternative involves continued use of City water from Conner Creek, with the addition of the valves and piping to allow the groups of four reservoirs to fill at one time, as described in Alternative 2. Instead of tying into the river water piping, this proposed system would tie into the existing potable water system.

This alternative would have the advantage of being able to fill reservoirs downstream of leaking flushing gates. It would have the disadvantage of using a significant amount of City water and would still take a long time to fill all the reservoirs with water.

The alternative evaluation for these alternatives is presented in Table 8-10. The sources of costs used in this evaluation are listed below:

- The annual O&M cost for Alternative 1 and 3 is based on water usage of 800,000 gallons per event, 25 events a year, and a unit cost of \$4,000 per MG. The annualized cost of water is about \$80,000.
- The capital cost for the proposed flushing systems (Alternatives 2 and 3) are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 2 includes \$2,000 for equipment maintenance.

This evaluation shows that Alternative 1 – Do Nothing/Continue Using Potable Water, is the best value alternative. However, this alternative does not provide an acceptable level of cleaning when there are leaking flushing gates. Alternative 2 and 3 provides a solution to this issue. The NPV/Benefit cost for Alternative 3 is greater than Alternative 2. Because Alternative 2 provides the best value alternative compared to Alternative 3, **Alternative 2 – Flushing Water System Improvements Using River Water is the recommended alternative.**

Table 8-10. Alternative Evaluation for Flushing Water System Improvements (Project CON-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Continue Using Potable Water	Health and Safety	3	2.68	\$ -	\$ 80,000	\$ 1,687,171	\$ 628,759	Best Value Alternative
	<i>Definition:</i>	Continue to use potable water to fill reservoirs	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Significant amount of City water usage; time consuming	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Flushing Water System Improvements Using River Water	Health and Safety	3	3.32	\$ 2,692,000	\$ 2,000	\$ 2,734,179	\$ 824,376	
	<i>Definition:</i>	Use river water as source of flushing water	Water Quality & Compliance	3						
	<i>Adv.:</i>	Reduced potable water usage/cost; less time to fill reservoirs; lower maintenance cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Zebra mussel control	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Flushing Water System Improvements Using Potable Water	Health and Safety	3	3.32	\$ 1,332,000	\$ 80,000	\$ 3,019,171	\$ 910,303	
	<i>Definition:</i>	Continue to use potable water to fill reservoirs; add distribution to each reservoir	Water Quality & Compliance	3						
	<i>Adv.:</i>	All reservoirs can be filled even if there is a damaged gate	Capacity Enhancement	3						
	<i>Disadv.:</i>	Significant amount of City water usage; long time to fill reservoirs	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.5 HVAC

8.2.5.1 Description of Existing System

The Conner Creek CSO Facility consists of a Headworks, chemical room, chemical storage area (outdoor), utility support (electrical, transformer and mechanical rooms), control room, sample room, hydraulic room, office space on the second floor, and other miscellaneous rooms. The facility also includes adjoining retention basin. Table 8-11 provides summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, gas-heater water heater, electric water coolers, emergency shower/eye wash, and washroom shower. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 8.2.10.

Table 8-11. Major HVAC Equipment at Connor Creek CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	MAU-1 and 2	2 × Make-Up Air Units	44,000 CFM
Basin	ICEF-1 to 6	6 × Exhaust Fan (Influent Area)	50,200 CFM
	SF-1 to 24	24 × Supply Fan (Basin Deck)	45,000 CFM
Control Building	AHU-1	Air Handler	21,000 CFM
Chemical Room	EF-3	Exhaust Fan	4,140 CFM
	AHU-2	Air Handler	4,080 CFM
Electrical Room	EF-5	Exhaust Fan	2,893 CFM
	EUH-2	Electric Unit Heater	10.2 MBtu
Transformer Room	EF-4	Exhaust Fan	3,130 CFM

Note:

MBtu = million British thermal unit(s)

Table 8-12 provides a summary of the basis of design performance criteria for HVAC systems at Connor Creek and Table 8-13 provides the outdoor Basis of Design conditions.

Table 8-12. Connor Creek Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Headworks Building	Class I, Div 1, Group D (Per Basis of Design Report)	60	N/A	12 ACH (Occupied) 6 ACH (Unoccupied)
Mechanical and Electrical Rooms, Transformer Room, and Maintenance Shop	Unclassified	60	104	Heat Relief
Control Room	Unclassified	72 F Dry Bulb, 50% Relative Humidity	72 F Dry Bulb, 50% Relative Humidity	20 cfm per occupant
Office, Sample Room, Toilet Rooms and Hydraulic Room	Unclassified	72 (Occupied), 60 (Unoccupied)	75 F Dry Bulb, 50% Relative Humidity	50 cfm per flushing fixture (restrooms)

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
				20 cfm per occupant (Other Spaces)
Chemical Room	Unclassified	60	N/A	12 ACH (Occupied) 3 ACH (Unoccupied)

Table 8-13. Connor Creek Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

8.2.5.2 Identified Needs and Issues

During discussions with GLWA O&M staff and GLWA's HVAC contractor, the following HVAC issues were noted:

- Inadequate heating in maintenance shop and electrical room: O&M staff noted that the Maintenance Shop gets cold in winter months and electrical room to a lesser degree.
- Uneven heating was reported in the Control Building
- High temperatures in transformer room: Based on investigation by Jacobs, the basis of design summer dry bulb temperature for transformer room is 104°F. It is therefore not unusual that relatively high temperatures are observed in this space. During the site visit by Jacobs, exceedingly high temperatures were not noted in the transformer room; however, the door to the transformer room was open and the exhaust fan was observed to run at a low rpms, likely indicating a reduced airflow capacity. Additionally, the thermostat did not appear to be functional based on the fact that the exhaust fan remained on and the supply air damper remained open when the thermostat was adjusted to a setpoint above the space temperature. This is not considered a capital need.
- GLWA staff reported malfunctioning dampers in chemical room, maintenance room, electrical room, and transformer room. During the Jacobs site visit, the Maintenance Shop and electrical room motorized dampers were tested for functionality. The dampers responded to changes in the thermostat setpoint; however, there was a delay in the response. This delay is normal and does not require any corrective actions. The transformer room damper was observed to be open and the exhaust fan running; however, the damper and fan did not respond to changes in the thermostat setpoint. This issue should be investigated and corrected by maintenance staff and is not considered a capital need.
- Chemical room AHU-2 is difficult to replace due to limited size of door openings to the chemical room.
- O&M staff would like a shower in the upstairs men's and women's restrooms.

During the discussions with Dunbar Mechanical, GLWA's HVAC contractor, the following historical issues were noted:

- Heating Improvements in Control Building: GLWA's HVAC contractor noted that on/off control from the duct heaters in the Control Building was replaced with a controller that modulates the gas valves to maintain a minimum supply air temperature.
- Replacement of Duct Heater: GLWA's HVAC contractor noted that one of the three gas duct heaters had been recently replaced.

- Humidity Issues in exterior rooms: GLWA's HVAC contractor noted that major humidity issues had occurred in the North and East exterior room in the Control Building. Jacobs notes that several factors could be contributing to the humidity issues noted by GLWA's HVAC contractor. Major contributors include:
 - Insufficient cooling capacity of AHU-1's cooling coil. As noted below, the McQuay condensing unit appears to have a refrigerant leak which would result in a decrease in the ability of AHU-1 to remove humidity from the incoming outside air and return air streams. The recommended replacement of the condensing unit should eliminate cooling capacity as a contributing factor to high humidity levels.
 - Air infiltration into the space. During the site walkthrough it was noted that windows were left open in the Conference Area on the 2nd floor. Major sources of infiltration such as open windows would seriously contribute to the potential for condensation in air-conditioned spaces, particularly in the summer when the outside air dewpoint temperature is likely to be above the dewpoint temperature of interior surfaces.
 - Insufficient ventilation/poor air distribution (which would allow for the buildup of humidity in occupied spaces). The uneven heating noted by GLWA O&M staff could be an indicator of poor air distribution/ventilation. The recommended air balance should eliminate this as a potential contributing factor.

If the humidity issues persist after the recommended air balance study and replacement of the condensing unit, monitoring of the doors and windows using the direct digital controller (DDC) could be considered to determine if there is a correlation between open windows/doors and humidity issues.

During site investigations (June 2020) the following observations were noted:

- A new split DX system had recently been installed in the control room server area.
- The windows were open in the control building second floor conference room.
- The exhaust fan was off in the chemical room.
- Both roll-up doors were open in the headworks area.
- Oil was observed on the McQuay air-cooled condensing unit's (ACCU-1) condensing coil and the compressors were observed to be hissing (see Figure 8-4 below). This observation most likely indicates a refrigerant leak. The unit is 17-years old and a refrigerant leak would result in reduced cooling capacity, which could be contributing to the humidity issues in the control room noted by GLWA's HVAC contractor. Given that the unit is near the end of its useful life and a refrigerant leak is likely, it is recommended that the unit be replaced with a unit of the same capacity and added to the DDC system for monitoring and control. This replacement is included in the SRP.



Figure 8-4. Oil on McQuay Unit Condensing Coil

- The door to the transformer room was open.
- The transformer room exhaust fan appeared to be operating at low RPM.
- The actuator on the transformer room motorized damper appeared to have been recently installed.
- The electrical room overhead door was open.
- The electrical room exhaust fan intake is located very close to the air intake louver with motorized damper.
- The Maintenance Shop exhaust air ductwork is located close to its air intake louver.
- The duct for Basin supply fan SF-22 (located in the Maintenance Shop) is not enclosed in fire-rated walls as indicated on the design drawings (see Figure 8-5 and Figure 8-6).



Figure 8-5. Supply Duct for SF-22 Not Enclosed in Fire-Rated Wall

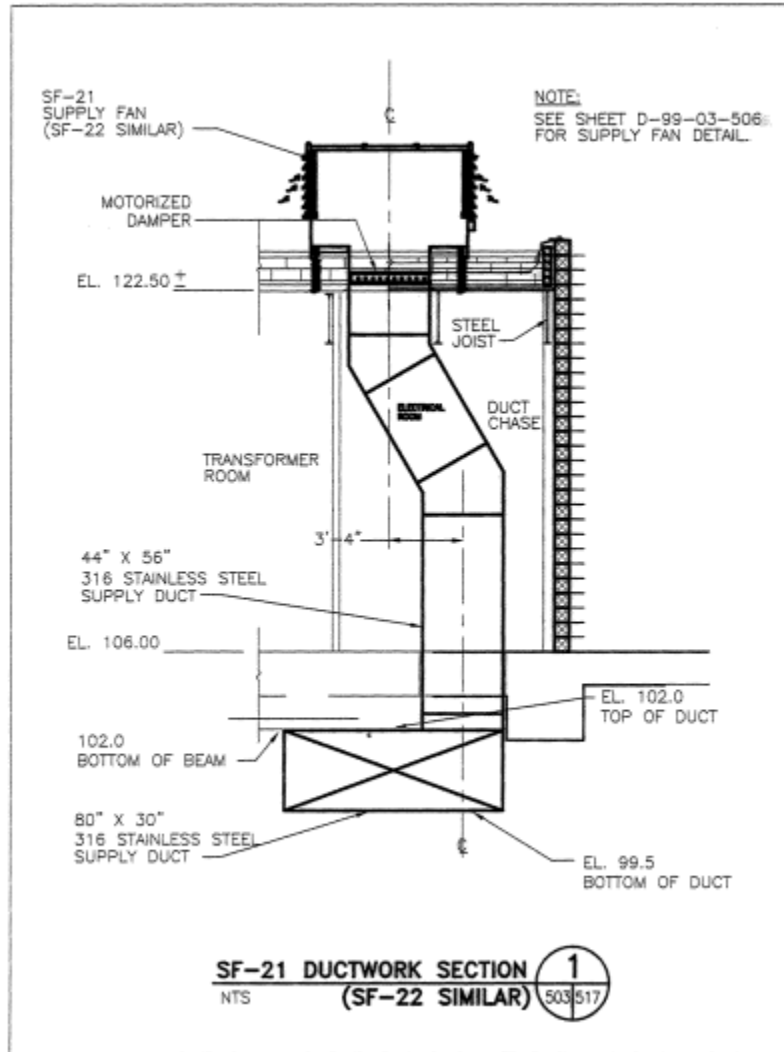


Figure 8-6. SF-22 Chase Detail (Per 02/06 Project Record Drawings)

8.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Control Building Air Balance Study. As noted in Section 8.2.5.2, the duct heaters in the Control Building have recently had a control upgrade to modulate the gas valves and maintain a minimum discharge temperature instead of being on-off and controlled by wall-mounted thermostats. If this change has not resolved the uneven heating experienced in the Control Building, an air balance study is recommended to determine if heated air is properly being distributed to spaces in the Control Building. If this does not resolve the issues, additional measures can be considered, such as additional duct heaters in spaces which are receiving inadequate heat. Jacobs recently prepared a scope to coordinate air balance study with a Testing and Air Balancing contractor.

HVAC Improvements (Project CON-HVAC-1). Due to the relatively small nature of some of the HVAC related projects identified as improvements, all of the identified HVAC improvements are proposed to be in one project – HVAC Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: HVAC Improvements** including,

- Maintenance Shop and Electrical Room Heating Improvements
- Chemical Room AHU Access Improvements
- Control Room Wall Extension
- Chase for SF-22 Basin Supply Air Duct
- Shower in Second Floor Men's and Women's Restrooms

Each of the HVAC related improvements listed above are described further below:

Maintenance Shop and Electrical Room Heating Improvements. The basis of design winter dry bulb temperature for the Maintenance Shop and electrical room is 60°F so it is possible that these areas could be perceived as being cold in the winter. Both the Maintenance Shop and electrical room are served by a single 3 kW electric unit heater. Jacobs noted that the unit heater in the Maintenance Shop and electrical room are located on the opposite side of the room from the outside doors, which likely makes for a big difference in temperature across the room during the winter months. It is recommended that an additional unit heater be added to each room.

Chemical Room AHU Access Improvements. To improve ability to remove this unit in the future, the single door to the hallway should be replaced with a double door.

Control Room Wall Extension. A new split DX system was recently added to the control room server area. This space is provided with conditioned air from AHU-1 and is not completely enclosed with a floor to ceiling partition (Figure 8-7). Thermal comfort in the occupied portion of the control room would be improved by extending the existing partition between the two spaces to the ceiling and extending the existing return air duct to the server room area in an appropriate location.



Figure 8-7. Low Wall in Control Room

Chase for SF-22 Basin Supply Air Duct. Per the design drawings, the supply air duct for SF-22 which runs through the Maintenance Shop to the Basin below was designed to be enclosed in a chase, which would create a physical separation between the Maintenance Shop and the supply air duct. A similar chase was constructed in the transformer room for SF-21's supply air ductwork. NFPA 820 requires a gas tight partition between classified spaces (such as the Basin, which is Class I, Division 1) and unclassified spaces, which was the reason the original design included the chase. Without the enclosure for the supply air duct, the Maintenance Shop, and by extension all spaces connected to it, are technically Class I, Division 1 spaces. It is recommended that a

chase be constructed in the Maintenance Shop per the original design drawings to create the required physical separation between the Basin and Maintenance Shop. See Figure 8-6 herein.

Shower in 2nd Floor Men's and Women's Restrooms. Space exists for the installation of showers in the 2nd Floor Washrooms. Although a complete design would require further assessment it seems likely that the drains, vents, and hot and cold water supplies could be connected to the existing plumbing system fairly easily.

During the evaluation of the existing plumbing assets it was discovered that the existing hot water tank only has a 100-gallon capacity. ANSI Z358.1 requires 20 gpm of tepid water for a period of 15 minutes for emergency showers. At the design mixed water temperature of 80°F, design storage temperature of 120°F, and recommended 47°F cold water design inlet temperature, the existing tank would only provide tepid water for 11 minutes. Jacobs recommends that the hot water tank should be replaced with one with a storage capacity of at least 150 gallons regardless of whether the shower upgrades are pursued.

The alternative evaluation is presented in Table 8-14. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- There is no measurable difference in O&M costs between the two alternatives.

This evaluation shows that Alternative 1 is the Best Value Alternative. Under Alternative 2, the chase for SF-22 air duct is a code compliance issue, so it should be implemented during a major project at the facility. Based on this need, **Alternative 2 is the recommended alternative.** However, it is noted that the remaining tasks are not high priority and could be performed at a later date.

Table 8-14. Alternative Evaluation for HVAC Improvements (Project CON-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do not address issues	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Worker discomfort	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	4	3.50	\$ 116,000	\$ -	\$ 116,000	\$ 33,143	Not Applicable
	<i>Definition:</i>	Maintenance Shop and Electrical Room heating improvements; Chemical Room AHU access improvements; Control Room wall extension; chase for SF-22 basin supply air duct; shower in 2nd floor men's and women's restrooms	Water Quality & Compliance	3						
	<i>Adv.:</i>	Code compliance and worker comfort	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.6 Electrical

8.2.6.1 Description of Existing System

The Conner Creek facility's electrical system consists of dual (redundant) 24 kV utility feeds for two unit substations with primary metering and DTE 3,000 kVA indoor dry type transformers. The facility also has one diesel generator feed from a 2 MW, 480/277 V, 3-phase stationary generator. The substations and generator feed into the double ended switchboard main distribution panel (MDP), which has a tie-breaker and automatic source transfer controls. Circuit breakers in the MDP then feed six MCCs and one power distribution panel (PDP). The MCCs and PDP then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 8-15 provides a summary of the major electrical equipment for this facility.

Table 8-15. Major Electrical Equipment at Connor Creek

Location	Major Electrical Equipment	Description
Transformers Room	Transformers T1 and T2 Substations	3,000 kVA, 24 kV-480/277 V, 3-Phase
Outdoors	Generator (Diesel)	2 MW, 480/277 V, 3-Phase
Electrical Room	Double ended switchboard main distribution panel (MDP)	3,200 A, 480/277 V, 3-Phase
Electrical Room	MCC-1	1,600 A, 480/277 V, 3-Phase
Electrical Room	MCC-2	1,600 A, 480/277 V, 3-Phase
Electrical Room	MCC-3	1,600 A, 480/277 V, 3-Phase
Electrical Room	MCC-4	1,600 A, 480/277 V, 3-Phase
Electrical Room	MCC-5	1,600 A, 480/277 V, 3-Phase
Chemical Room	MCC-6	1,600 A, 480/277 V, 3-Phase

8.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the section below.

8.2.6.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project CON-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles, however it will be less safe when operating at night and select locations within the basin.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure CON-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - FSP-2 access stairway – Relocate the existing LED wall mounted light fixtures to provide the required foot-candles and code requirements.

- Influent area ahead of Screens – Add LED lighting fixtures to meet the required foot-candles and code requirements for the area.
- Interior effluent end of Basin – Add interior LED wall mounted lighting fixtures to the area to address the required foot-candles and code requirement.
- Exterior effluent end of Basin – Add additional exterior LED lighting fixtures to supplement the current lighting within the area to address the required foot-candles and code requirements.
- Add power receptacles to assist in the maintenance and operations of the facility near the FSP-1 opening.

The alternative evaluation is presented in Table 8-16. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting. The NPV/Benefit cost for Alternative 2 is \$37,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 8-16. Alternative Evaluation for Electrical Improvements (Project CON-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe when operating at night and select locations within the basin	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 129,000	\$ -	\$ 129,000	\$ 36,857	Not Applicable
	<i>Definition:</i>	Add additional lighting in the at select locations in the basin and near the effluent.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.7 I&C

8.2.7.1 Description of Existing System

Control System: The original Ovation control system was installed in 2005 under GLWA project PC-739. During the same time period, stand-alone Ovation systems were being installed in the Freud Pump Station and Conner Creek Pump Station under PC-713. The Conner Creek CSO facility was designed to house the main control system for the region. In 2014 under PC-773D, the three facilities were combined into one overall Ovation control system. While the systems were being combined, the system controllers and software were upgraded to version O.V.3.5.0 for all three facilities.

The Conner Creek control system is comprised of primary and back-up network switches to provide the system complete network redundancy. The switches are connected to the GLWA AT&T wide area network via the system's router. These primary and back-up network switches are interfaced to three redundant networks, with one at the Freud Pump Station, one at the Conner Creek CSO facility, and one at the Conner Pump Station. The redundant network switches in the Conner CSO facility are connected to one database server and two operator workstations. All workstations are connected redundantly to the network switches via copper Ethernet cables. Additionally, it has two redundant Ovation controllers connected to the network switches in a dual-homed configuration to provide back-up for controls and I/O capabilities. The current system is equipped with a back-up radio system to communicate critical monitoring points back to SCC on wide area network failure.

The Freud Pump Station has redundant network switches connected to Conner Creek's main control systems primary and back-up network switches in the Conner Creek CSO facility. The networks are connected via fiber optic cables in underground ductbanks between the two facilities. There is a rack mounted workstation and one redundant Ovation controller pair for the station. The Ovation controllers and the workstation are connected in a dual-homed configuration via copper Ethernet cables. Additional local PLCs are connected to the Ovation control system via local system switches.

The Conner Pump Station has redundant network switches connected to Conner Creek's main control system primary and back-up network switches in the Conner Creek CSO facility, similar to the Freud Pump Station. The networks are connected via fiber optic cables in underground ductbanks between the two facilities. There is a rack mounted workstation and one redundant Ovation controller pair for the station. The Ovation controllers and the workstation are connected in a dual-homed configuration via copper Ethernet cables. Additional local PLCs are connected to the Ovation control system via local system switches.

Flow and Level Sensors: Table 8-17 summarizes the level sensors and flow meters at the Conner Creek CSO Facility used to monitor flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 8-17. Summary of Flow Meters and Level Sensors at Connor Creek CSO Facility

Area	Quantity	Instrument Type
CSO Influent Flow Meters		
Influent (East, central, and west influent channel flow, Freud Ashland Relief, Freud Fox Creek Relief)	5	Transit-Time (AccuSonic)
CSO Facility Level Sensors		
Mixing Chambers	2	Ultrasonic
	10	Ultrasonic (back-up)

Area	Quantity	Instrument Type
Flushed Solids Sumps (Dewatering sumps (2), Retention Basin Distribution Channel, Screening Distribution Dchannel)	4	Ultrasonic
Conner Creek	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed Pumps	10	Magnetic
Chemical Mixers and Diffusers		
High Mixers	10	Magnetic
Middle Mixers	10	
Low Mixers	10	
Diffusers	10	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	4	Ultrasonic

8.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section .

- Evaluate the existing level sensors and flow meters to determine redundancy and identify instruments that could potentially be removed. The evaluation and recommended removal of level sensors is presented in the next section.
- Operators have no way to determine whether the dewatering pumps are functioning properly. To address this issue, they requested a new flow meter downstream of the junction chamber to provide indication and rate of flow.
- Evaluate replacement options for valve control network
- Need for tank level indication at Chemical Fill Station
- Need for process cameras at select locations
- Update Ovation control system to the latest version and increased monitoring capabilities
- Generator and ATS controls do not adequately report alarm signals into Ovation and are becoming less reliable. This issue is being addressed in an on-going project and is therefore not included in the capital improvement projects for CS-299.
- Need accurate river level measurement. GLWA is currently planning to install a river level sensor through a JOC. This issue is not included in the capital improvement projects for CS-299.

8.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project CON-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation control system upgrade, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. There are two alternatives for this project:

1) Alternative 1: Do Nothing/Replace In-Kind.

- Leave level sensors in place

2) Alternative 2: I&C Improvements including,

- Remove redundant level sensors
- Provide new flow meter for dewatering flow downstream of the junction chamber
- Evaluate replacement options for valve control network
- Provide tank level indication at Chemical Fill Station
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Remove redundant level sensors. The Conner Creek CSO Facility has 12 level sensors in the chemical mixing chambers downstream of the screens. There are two primary ultrasonic level sensors, one in Mixing Chamber 3 and one in Mixing Chamber 8, and a level sensor in each of the ten chemical mixing chambers. See Figure 8-8 for the location of these sensors.

The level sensor signals are used to turn on and off the lower, middle and upper level mixers based on the water level in the channels. Since all the channels are interconnected downstream of the screens, the water level should be fairly similar between the mixing channels. The readouts for the individual channel level sensors are not available on the Ovation screens. However, while these level sensors act as back-up for the primary sensors in Mixing Chamber Nos. 3 and 8, current I&C configurations rely on the readings from level sensors in individual mixing chambers to run the high, mid-, and low-level mixers. As such, the ten level sensors can be removed, but only if the signal from the primary ultrasonic level sensors are retrofit with an output relay to replace this function provided by the individual channel level sensors.

Modifications to allow removal of these level sensors are included in the cost estimate. Removal of the 10 redundant level sensors will reduce I&C maintenance on these sensors.

Provide new flow meter for dewatering flow downstream of the junction chamber. Operations has expressed a desire to have flow measurement for the dewatered flow that is pumped from the basin to the sanitary sewer. The recommendation is to install a non-contact laser flowmeter downstream of the junction chamber in an existing manhole. This meter should provide accurate enough data in this 48-in. larger diameter sewer. Figure CON-I&C-1-ALT-2 in Volume 6 – Appendices, Appendix B, shows the plan and profile of the sewer and the area of interest where the flow meter should be installed.

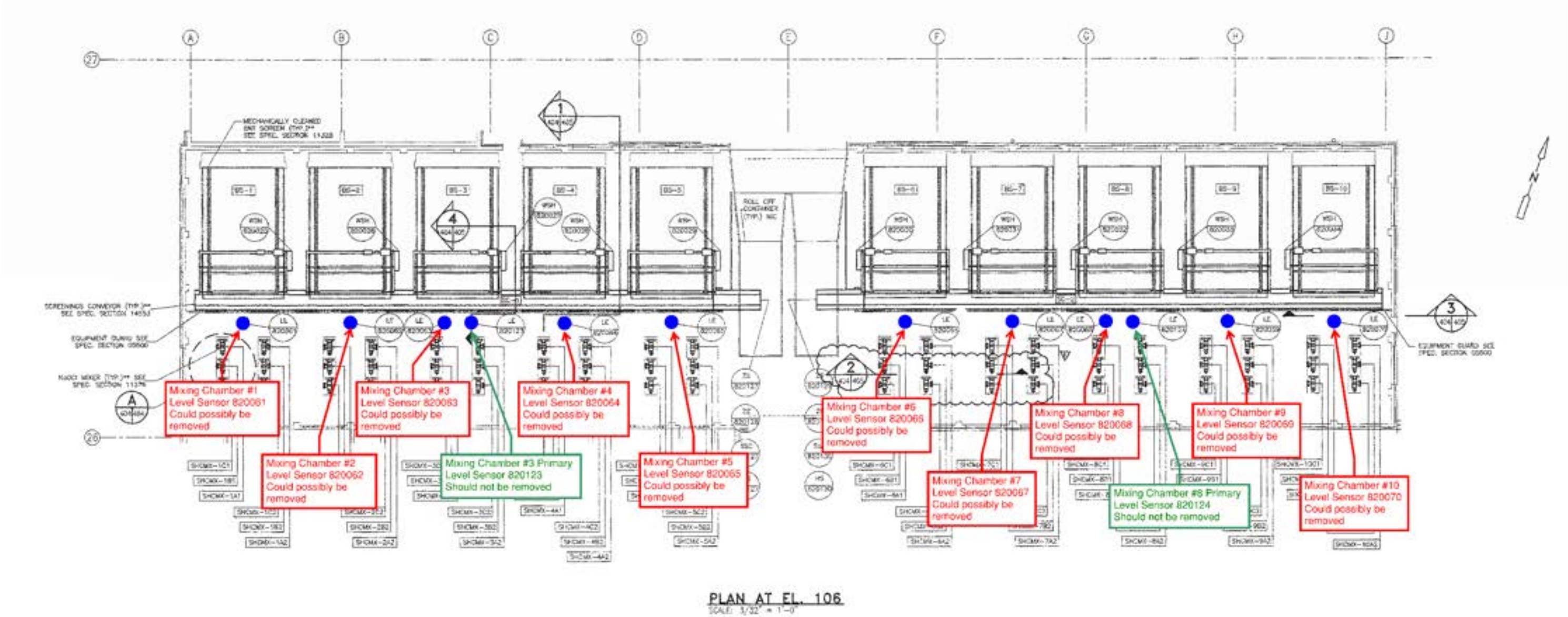


Figure 8-8. Conner Creek CSO Facility Level Sensor Identification

Evaluate replacement options for valve control network. See Section 5.4.6 for details of the Valve Control Philosophy – Valve Network (Pakscan) versus hardwired control. The recommendation is to continue the use of the Pakscan valve network for data and status while upgrading the 16 effluent relief gates valve controls to hardwired control.

Provide tank level indication at Chemical Fill Station. Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 8-18. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 includes the in-kind replacement for all level sensors.
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 1 include maintenance of the valve control network and the level sensors (downstream of the screens).
- The O&M costs for Alternative 2 include maintenance of the new instruments and cameras. It is difficult to quantify the monetary benefits of the improved operations through the improved monitoring and control.

This evaluation shows that Alternative 1, Do Nothing/Replace In-Kind, is the Best Value Alternative. The total benefit score for Alternative 2, however, is 0.6 higher than Alternative 1 due to improved component performance and ease of O&M. The NPV/benefit value of Alternative 2 is approximately \$157,000, which is a moderate cost compared to other projects recommended in this assessment. As such, **Alternative 2 - I&C Improvements, is the recommended alternative.**

Control System Upgrade (Project CON-I&C-2). It is recommended to update the Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2.

Because the Ovation system is the only alternative for the control system upgrade, it is the only alternative considered. Table 8-19 provides the summary of the Control System Upgrade, which is the recommended alternative. Capital costs are included in Volume 6 – Appendices, Appendix C under this project title.

Table 8-18. Alternative Evaluation for I&C Improvements (Project CON-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	3	2.68	\$ 60,900	\$ 10,000	\$ 271,796	\$ 101,291	Best Value Alternative
	<i>Definition:</i>	Replace level sensors in-kind.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 331,000	\$ 9,000	\$ 520,807	\$ 157,027	
	<i>Definition:</i>	Removal of redundant level sensors; addition of new flow meter for dewatering flow; provide tank level indication; upgrade effluent relief gate valves controls to hardwired control; and install process cameras.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Table 8-19. Alternative Evaluation for Control System Upgrade (Project CON-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 1,678,000	\$ 1	\$ 1,678,021	\$ 559,340	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved performance, standardized HMI screens, can have standardized redundant "on-the-shelf" parts.	Capacity Enhancement	3						
	<i>Disadv.:</i>	No performance related disadvantages.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

8.2.8 Site

8.2.8.1 Description of Existing Site

There is an access road to the site off Freud Avenue. The access entrance gate to the site is a 30-ft wide sliding vehicular gate across the 40-ft wide access road. Site security is provided by a 6-ft high ornamental fence along the north perimeter of the site. This includes the entrance gate located on the south side of Freud Avenue. The fence starting at the west end of the entrance gate extends easterly along the south right of way of Freud Avenue, extending around the stormwater detention pond and then ending at the creek. A 6-ft chain link fence is located at the west perimeter of the site facing the Federal Aviation Administration Tower Area. Site concrete sidewalks are 3 to 5 ft wide and approximately 4 in. thick. The site parking and drive areas are paved with 4.5 in. of asphalt on 10 in. of aggregate. The gravel drive farther south of the building is 8 in. thick.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

8.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- The entrance gate has reached the end of its useful service life
- Water ponds on top of the basin. In the winter, this water freezes and causes safety concerns
- Sidewalks have settled and heaved, causing safety issues and water infiltration next to building

8.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Site Improvements (Project CON-SITE-1). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) Alternative 1: Do Nothing.

2) Alternative 2: Site Improvements including,

- Replace Entrance Gate
- Address ponding on basin deck
- Replace Sidewalks in Select Areas

Each of the site related improvements listed above is described further below:

Replace Entrance Gate. The entrance gate at the Conner Creek CSO facility is a 30-ft wide automatic cantilever sliding gate. The gate has been subject to numerous recent mechanical failures. The gate has reached the end of its useful service life and is recommended to be replaced with a new similar style gate.

Address Ponding on Basin Deck. There are areas of significant ponding on the basin roof deck. Several of these areas are located on the east side of the deck adjacent to the Conner Creek canal. To remediate the ponding issue, it is recommended that holes be cored through the basin roof to allow discharge of ponded water to the basin. Recessed area drains would be installed in the cored holes to the basin. For those areas adjacent to the canal, scuppers through the basin parapet wall should be investigated to relieve ponded water directly to the canal.

Replace Sidewalks in Select Areas. The sidewalks next to the Control Building have settled, pulling away from the face of the building and allowing water to infiltrate the joints at the base of the building and sidewalks. This leads to heaving of sections of sidewalk and creates uneven sections, which is a safety concern. It is recommended that all damaged concrete sidewalk flags be demolished. In addition, the expansion joints at the face of the wall should be replaced and the joints caulked and sealed to prevent water infiltration.

The alternative evaluation is presented in Table 8-20. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Alternative 1 based on the improved health and safety and ease of O&M. The NPV/Benefit cost for Alternative 2 is \$24,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Site Improvements is the recommended alternative.**

Table 8-20. Alternative Evaluation for Site Improvements (Project CON-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Safety concerns uneven sidewalks and from ice buildup on the basin in winter.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 85,000	\$ -	\$ 85,000	\$ 24,286	Not Applicable
	<i>Definition:</i>	Replace entrance gate, sidewalks and core holes through deck at low points.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Restores sidewalks and removes water from top of basin.	Capacity Enhancement	3						
	<i>Disadv.:</i>		Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

8.2.9 Architectural

8.2.9.1 Description of Existing Facilities

The Conner Creek CSO Facility consists of a chemical room, chemical storage room, utility support (electrical and mechanical), control room, sample room, office area, hydraulic room, screen room and other miscellaneous rooms. The facility also includes adjoining retention basin.

8.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment, as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

8.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (CON-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove and replace isolation/ cove joint sealant and around building perimeter
 - Clean and coat bottom of all door frames
 - Remove corrosion from localized areas in roof framing, clean and coat
 - Apply skim coat and slope to redirect water to creek outside the Screening Building

- Provide flashing/ membrane system to protect column bases from ponding moisture to address pooling water between building/brick walls and to fix gap between brick and steel columns
- Clean and repaint surfaces where paint is debonding in Screening Building
- Remove and replace deteriorated ceiling tile in Control Building
- Remove and replace floor control joint sealant
- Investigate and repair water intrusion at door in Screening Building
- Address door hardware issues and door and door frame corrosion issues
- Clean rusted areas of structural steel column base of exterior Screenings Building

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings (Figure CON-ARCH-1-ALT-2) in Volume 6 – Appendices, Appendix B. Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project. It should be noted that recoating of the floor in the Chemical Room was originally included in the architectural items, but moved to the Chemical Feed project (CON-DIS-1).

The alternative evaluation is presented in Table 8-21. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, **Alternative 2 is the recommended alternative.**

Table 8-21. Alternative Evaluation for Architectural Rehabilitation (Project CON-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 361,000	\$ -	\$ 361,000	\$ 116,452	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

8.2.10 Safety

8.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

8.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 8-22. The capital improvement project to address these issues is included in the table.

Table 8-22. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Headworks – between bar screen No. 8 and No. 9 platforms	Railing does not extend over belt – fall hazard	Extend railing	Safety Improvements (Project CON-SAFE-1)
Stair B6 (Compartment 2) (Representative of all stair locations to basin)	No illuminated exit signs	Add or replace exit signs	Exit Sign Improvements ^a
Headworks – the “walkway” under the screenings conveyor and between grit rollofs	“Walkway” does not meet exit access width requirements – not adequate width, overhead hazard, column in center of walkway	Reroute personnel or the column/overhead horizontal beam will need to be moved	Conner Creek Conveyor Improvements ^b
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project CON-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

^b This project will be completed under the JOC.

8.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project CON-SAFE-1). This project should address the safety issues identified above. These issues include:

- Extend railing between bar screen #8 and #9 platforms to eliminate fall hazard
- Address fall protection

Because the importance of these issues relate to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 8-23 shows the one alternative.

Table 8-23. Alternative Evaluation for Safety Improvements (Project CON-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 358,000	\$ -	\$ 358,000	\$ 119,333	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection and fall hazard.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

8.2.11 Supporting Infrastructure

8.2.11.1 Description of Existing System

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above.

8.2.11.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- Dredging of the Conner Creek, based on analysis in the WWMP.

8.2.11.3 Discussion and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section.

Dredging of Conner Creek Channel (CON-SUPP-1). The WWMP investigated the accumulation of sediment within the Conner Creek channel that could potentially limit the discharge capacity of the Conner Creek CSO Facility. During peak wet weather events, it is necessary that the hydraulic capacity of the channel be sufficient to convey overflow from the facility to the Detroit River. Restrictions in the channel could reduce hydraulic capacity causing backup and potential surcharging within the RTB and collection system.

Section 8.8 of the WWMP presents the results of the physical investigation into the amount of sediment that has built up since the facility start-up in 2005. Based on the results of the survey, sediment deposition within the channel varies in depth from 0 to 3 ft, representing approximately 21,000 cubic yards (+/-20 percent) of sediment to be removed.

A cost estimate for dredging accumulated sediment within the Conner Creek channel was developed based on the assumption that the dredging operation will be performed using hydraulic dredging equipment similar to 2005. A material quantity of 35,000 CY was assumed for the estimate, assuming dredging will occur within the next 10 to 15 years. The total estimated cost of the project is \$11 million. For details are provided in Section 8.6 of the WWMP.

8.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Conner Creek CSO facility, Table 8-24 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table

8-24, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 8-24. Listing of Asset Condition Assessments for Conner Creek Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	110	110	0	100%
AHU	2	0	2	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	4	4	0	100%
BASIN	1	1	0	100%
BATTERY	1	1	0	100%
BREAKER	13	13	0	100%
BUILDING	4	2	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	0	0	0	N/A
COND-AIR	2	2	0	100%
CONVEYOR	2	0	2	100%
CRANE	2	2	0	100%
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A
DAMPER	4	4	0	100%
DISCONNECT	12	12	0	100%
DOOR	4	4	0	100%
DRIVE-ELEC	0	0	0	N/A
ELEVATOR	1	1	0	100%
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	7	7	0	100%
FAN	4	0	4	100%
FANVENT	37	37	0	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRSS	1	0	0	0% ^b
GASDETECTO	1	0	0	0% ^c
GASMONITOR	2	2	0	100%
GATE	111	59	6	59% ^d
GEARBOX	10	0	10	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	6	6	0	100%
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
MAU	2	2	0	100%
MCC	6	0	6	100%
METER	55	55	0	100%
MIXER	60	60	0	100%
MOTOR	26	10	16	100%
PANEL	30	30	0	100%
PIPING	4	4	0	100%
PUMP	22	14	8	100%
ROOF	2	2	0	100%
SAMPLER	2	1	0	50% ^e
SCADA	2	2	0	100%
SCREEN	10	0	10	100%
SCRUBBER	4	0	4	100%
SENSOR	22	22	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	4	4	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	3	0	3	100%
UNITHEATER	4	4	0	100%
UPS	5	5	0	100%
VALVE	79	79	0	100%
WATERHTR	1	1	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is not an asset. Another one of the building asset listed as "PLANNING - ORDERING PARTS/FILLING OUT WORK ORDER/COMPLETING INVENTORY OF PARTS ON HAND. (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is also not an asset.

^b The fire suppression was evaluated Simplex Grinnell in 2018 and not included in the ACES report.

^c The one gas detector is a portable unit and was not assessed.

^d The 46 individual flushing gates were not assessed. These were assessed as a group. The individual gates are being considered for removal from WAM.

^e The second sampler (ES-2) is listed as inactive and is being considered for removal from WAM.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the

Conner Creek Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

8.3 Capital Planning for Conner Creek CSO Facility

8.3.1 Summary of Capital Improvement Plan Projects Alternatives

Table 8-25 provides a summary of the recommended CIP projects and associated capital costs for the Conner Creek CSO facility based on the alternative evaluations conducted for this facility.

Table 8-25. Summary of Recommended Projects at Conner Creek CSO Facility

Project No.	Alternative	Description	Total Project Cost
CON-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 2,300,000
CON-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 156,000
CON-DIS-3	2	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000
CON-DIS-4	1	Do Nothing – Continue to Use Heat Tracing and Replace at Regular Intervals	\$ 144,000
CON-FD-1	2	Screening Distribution Channel Improvements	\$ 2,880,000
CON-FD-2	1	Flushing Water System Improvements Using River Water	\$ 2,692,000
CON-HVAC-1	2	HVAC Improvements	\$ 116,000
CON-ELEC-1	2	Electrical Improvements	\$ 129,000
CON-I&C-1	2	I&C Improvements	\$ 331,000
CON-I&C-2	1	Control System Upgrade	\$ 1,678,000
CON-SITE-1	2	Site Improvements	\$ 85,000
CON-ARCH-1	2	Architectural Rehabilitation	\$ 361,000
CON-SAFE-1	1	Safety Improvements	\$ 358,000
CON-SUPP-1	1	Dredging of Conner Creek Channel	\$ 11,000,000

8.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 8-26. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 8-26. Capital Improvement Plan Projects for Conner Creek CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
CON-1 Disinfection System Improvements	\$ 2,456,000	2035 <i>Timing based on asset condition</i>	CON-DIS-1	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 2,300,000
			CON-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 156,000
CON-2 Flushing System Improvements	\$ 5,572,000	2028 <i>Timing not dependent on existing asset condition</i>	CON-FD-1	Screening Distribution Channel Improvements	\$ 2,880,000
			CON-FD-2	Flushing Water System Improvements Using River Water	\$ 2,692,000
CON-3 HVAC Improvements	\$ 116,000	2033 <i>Timing based on priority of other needs</i>	CON-HVAC-1	HVAC Improvements	\$ 116,000
CON-4 Facility-Wide Electrical and I&C Improvements	\$ 2,138,000	2029 <i>Timing based on asset condition</i>	CON-ELEC-1	Electrical Improvements	\$ 129,000
			CON-I&C-1	I&C Improvements	\$ 331,000
			CON-I&C-2	Control System Upgrade	\$ 1,678,000
CON-6 Facility-Wide Safety and Architectural Improvements	\$ 719,000	2023 <i>Project should be initiated as soon as possible</i>	CON-ARCH-1	Architectural Rehabilitation	\$ 361,000
			CON-SAFE-1	Safety Improvements	\$ 358,000
CON-7 Dredging of Conner Creek Channel	\$ 11,000,000	2041 <i>Timing of project should be re-evaluated in about 2031</i>	CON-SUPP-1	Dredging of Conner Creek Channel	\$ 11,000,000
CON-10 Model Disinfection Performance	\$ 50,000	2021 <i>Timing based on potential for major maintenance cost reduction</i>	CON-DIS-3	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 8-27 and Table 8-28 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 8-28 indicates that CON-DIS-1 project has two assets that need to be replaced immediately due to condition score of "5". These assets, however, have already been replaced/rebuilt since the Condition Assessment was conducted in Summer 2020. The remaining 109 assets that are included in this project have an average condition score of 1.86 and an average replacement date of 2035. This information was used to propose a scheduled construction completion date of 2035.

Table 8-27. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
CON-DIS-1	109	1.19	1.86	2.28	22	2035	\$ 2,271,000
CON-I&C-2	2	2.29	1.57	4.08	12	2029	\$ 994,990

Table 8-28. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
CON-DIS-1	2	1.29	5.00	4.50	10	2021	\$ 108,000
CON-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -

There are recommended capital improvement projects presented in Table 8-26 that could be better delivered under capital outlay projects. These projects are listed in the following bullets:

- Continue to Use Heat Tracing and Replace at Regular Intervals (CON-DIS-4)
- Site improvements (CON-SITE-1) for the entrance gate replacement, sidewalk repair and basin drainage.

For the CFD Modeling of Mixers (CON-DIS-3), it is ultimately recommended to include this project with similar modeling projects at the Baby Creek and Leib CSO Facilities. See Section 2 (Volume 1 – Project Introduction and Capital Improvement and Outlay Plans) for proposed bundling of this project.

8.3.3 20-Year Capital Outlay Plan

Table 8-29 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 8-29. 20-Year Capital Outlay Plan for Conner Creek CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 751,200	\$ -	\$ -	\$ -	\$ 743,000	\$ -	\$ -	\$ 8,200	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 7,488,582	\$ -	\$ 16,962	\$ 2,867,520	\$ -	\$ -	\$ 4,604,100	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ 23,340	\$ -	\$ -	\$ -	\$ 23,340	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ 19,806	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 19,806	\$ -	\$ -	\$ -	\$ -
2025	\$ 6,854	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 6,854
2026	\$ 723,749	\$ -	\$ -	\$ -	\$ 637,601	\$ -	\$ -	\$ -	\$ 86,149	\$ -	\$ -	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 3,459,635	\$ 6,149	\$ -	\$ -	\$ 3,453,486	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,414,707	\$ -	\$ -	\$ 30,857	\$ 123,426	\$ -	\$ -	\$ -	\$ -	\$ 1,260,424	\$ -	\$ -	\$ -
2030	\$ 735,075	\$ 56,366	\$ -	\$ -	\$ 553,224	\$ -	\$ -	\$ -	\$ 9,786	\$ -	\$ 115,699	\$ -	\$ -
2031	\$ 1,743,475	\$ -	\$ -	\$ -	\$ 1,586,493	\$ -	\$ -	\$ 3,763	\$ -	\$ -	\$ 31,426	\$ -	\$ 121,792
2032	\$ 299,825	\$ 138,423	\$ -	\$ 122,920	\$ 7,752	\$ 30,730	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 1,261,697	\$ 49,572	\$ 213,376	\$ -	\$ -	\$ 330,420	\$ -	\$ 668,330	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 4,680,860	\$ 7,865	\$ -	\$ 460,886	\$ 2,989,482	\$ -	\$ -	\$ 16,638	\$ -	\$ -	\$ 105,276	\$ -	\$ 1,100,712
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 19,001,050	\$ 149,814	\$ 247,361	\$ 15,096,139	\$ -	\$ 1,266,355	\$ -	\$ 2,041,023	\$ 10,367	\$ -	\$ -	\$ 189,992	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 41,609,855	\$ 408,190	\$ 477,699	\$ 18,578,322	\$ 10,117,804	\$ 1,627,505	\$ 4,604,100	\$ 2,737,954	\$ 126,107	\$ 1,260,424	\$ 252,402	\$ 189,992	\$ 1,229,358

Notes:

Explanation of large capital outlays in first two years:

- Retention System: Flushing gate systems for basin distribution channel, screening distribution channel, and Compartment 1 to 4 received scores of 5 at the time of the Condition Assessment because some of the flushing gates were not functioning. A project to rehabilitate the gates is planned for late 2021.
- Disinfection System: One of the four mixers was covered in debris and the remaining three mixers were out of service at the time of the Condition Assessment (\$50,000 each; \$200,000 total) and received a score of 5. Two chemical feed pumps (\$54,000 each; \$108,000 total) were being repaired at the time of the Condition Assessment. The two Accusonic flow meters (\$217,500 each; \$435,000 total) were not installed at the time of the Condition Assessment.
- Odor Control System: Three scrubber systems (\$1,534,700 each) received scores of 5 since the motor (child of fan) was not functional at the time of the Condition Assessment.

9. Hubbell-Southfield CSO Control Facility

9.1 General Facility Description and Future Capacity Considerations

9.1.1 General Facility Description

The Hubbell Southfield CSO Facility is an RTB with 22 MG of storage, and a treatment capacity of 3,200 cfs. It was constructed in 1996. There are two buildings on site - a Headworks Building and a Control Building. The headworks building contains a headworks area, chemical room, mechanical room, and an odor control area. The control room building contains the control room, odor control room, work area, electrical room, basement area, restroom, locker room, and mechanical room.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

9.1.2 Future Capacity Considerations

There were no future capacity considerations identified at the time of this report.

9.2 Facility Assessment

9.2.1 Screening

9.2.1.1 Description of Existing System

The Hubbell-Southfield CSO Facility has six catenary bar screens that were installed in 1996. Screenings from the screens are discharged to a single conveyor belt, which conveys the screenings to a dumpster. The screenings are disposed in a landfill.

Table 9-1 provides an overview of the existing screening system at Hubbell-Southfield CSO facility.

Table 9-1. Overview of Existing Screening System Hubbell-Southfield CSO Facility

Parameter	Value
Treatment Capacity (cfs)	3,200
No. of Screens	6
Manufacturer	Jones and Atwood
Screen Type	Catenary Bar Screen
Opening Size	1.5-in. slot
Depth or Length / Width	22 ft 0 in / 9 ft 6 in
Screen Cleaning	Mechanical Rake
Screening Removal	Conveyor belt to dumpster and landfilled

9.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Provide a screening retention plate along entire conveyor to prevent screenings from falling off the conveyors at the back of the screens.

- O&M staff noted that the grating over the bar screen channel deflects when walking on it
- Prevent the edges of the bar screen rakes from dragging on concrete. This issue has been added to the scope of the OEM evaluation. This issue has been added to the scope of E&I's assessment, which has not occurred as of the time of this report. If there are capital costs associated with the retrofit to address this issue, it will be added based on OEM input.
- Prevent screens from swaying during operation. During higher flow events, the screens reportedly sway to some degree. The operators believe this is caused by the returning rake getting tossed by the rapid flow of water and affecting the rest of the screen. They noted that the Conner Creek screens (which is a similar screen but does not sway) has chain guide returns that extend closer to the floor of the channel. This issue was added to the scope of the OEM evaluation; however, the OEM was unable to see the swaying because flow did not occur during the site visit. If this issue causes problems in the future, it should be video-taped to document the issue.
- O&M staff noted that the overhead crane pendant is old and bulky.

9.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Screening Improvements (Project HS-SCR-1). Due to the relatively small nature of some of the screening-related projects identified as improvements, all of the identified screening improvements are proposed to be in one project – Screening Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Screening Improvements** including,
 - Screening Retention Plate Along Entire Conveyor
 - Walkway Grating Over Bar Screen Channels
 - Replace Overhead Crane Pendant

Each of the screening related improvements listed above are described further below:

Screening Retention Plate Along Entire Conveyor. Screenings from the screens occasionally fall off the conveyor at the back of the screens. A screenings retention plate would guide the discharged screenings to the middle of the conveyor belt. A cost for a screening retention plate (similar to screening retention plate at Conner Creek) is included in the capital cost estimate.

Walkway Grating Over Bar Screen Channels. O&M staff reported that grating does not feel sufficient (i.e., it deflects when walking on it). A cost for grating replacement is included in the capital costs.

Replace Overhead Crane Pendant. O&M staff indicated the current push-button, explosion-proof crane pendant is old and very bulky (Figure 9-1). Jacobs contacted Crane Technologies to obtain a replacement cost for a new pendant.



Figure 9-1. Existing Pendant for Overhead Crane at Hubbell-Southfield CSO Facility

The alternative evaluation is presented in Table 9-2. Capital costs for Alternative 2 are presented in Volume 6 – Appendices, Appendix C under this project title.

The total benefit score for Alternative 2, however, is about 1.0 higher than Alternative 1 due to improved health and safety, component performance, and ease of O&M. The NPV/Benefit cost for Alternative 2 is \$54,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the advantages with this alternative, Alternative 2 – Screening Improvements is the recommended alternative.**

Table 9-2. Alternative Evaluation for Screen Improvements (Project HS-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.62	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Some screenings fall off conveyor; walkway grating does not seem sufficient; pendant outdated.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Screening Improvements	Health and Safety	4	3.60	\$ 195,000	\$ -	\$ 195,000	\$ 54,167	Not Applicable
	<i>Definition:</i>	Addition of screening retention plate along entire conveyor; replace walkway grating over bar screen channels; replace overhead crane pendant.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Grating would be stronger; Cleaner screening operation	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.2 Disinfection

9.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP storage tanks, five gear pumps, and three induction mixers. There are six screens discharging into a common influent channel from which flow is directed to Basin Compartment 1 or to the Shunt Channel which can feed Basin Compartment 2. There are three induction mixers located upstream of the bar screens. The sodium hypochlorite pumps discharge to a common header with a flow meter that splits to the three induction mixers, the Shunt Channel, Basin 1, Basin 2, flushing, and odor control. During an event sodium hypochlorite is normally only fed to the three induction mixers. Flow splitting is not metered and there does not appear to be any basis for throttling the valves to individual induction mixers to achieve equal flow splitting. Table 9-3 provides an overview of the existing disinfection system at Hubbell-Southfield CSO facility.

Table 9-3. Overview of Existing Disinfection System at Hubbell-Southfield CSO Facility

Parameter	Value
Treatment Capacity (cfs)	2,200
Design Feed Strength (% hypochlorite)	5
Max. Dosage at Design Flow (mg/L Cl ₂)	10
Disinfection Contact Time (min)	20
Storage Tanks	
Number	2
Volume of Each Tank (gal)	15,000
Type	FRP
Pumps	
Number	5
Capacity (gpm)	10-55
Type	Gear
Mixers	
Number / Type	3 / Chemical induction mixers
Model Number/ hp / Manufacturer	Series 32 / 25 hp / Gas Mastrrr

9.2.2.2 Identified Needs and Issues

The needs and issues identified for Hubbell-Southfield were identified from meetings with O&M staff and Jacobs team site visit and investigations. The identified needs and issues are listed in the following bullets:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Hubbell Southfield chemical feed system has the following issue:
 - The feed pumps are in a confined basement are on short pump pads and as such at risk of being damaged if there was a spill or water leak.
 - The sump pumps in the feed pump area were not designed for corrosive or chemical service and have been damaged by exposure to sodium hypochlorite. Replacement with sump pumps suitable for corrosive chemical service is desired.

These issues are addressed in Replace Chemical Feed System (Project HS-DIS-1) below.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant,

overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project HS-DIS-2) below.

- Hypochlorite storage capacity is reportedly not enough for large storm events. GLWA requested that Jacobs investigate this issue. Jacobs found that the concrete containment area used for existing spill containment was the original sodium hypochlorite storage. The two existing 15,000 gallons FRP tanks installed in the original concrete storage tanks provide less chemical storage than the concrete tanks. Historical chemical usage from the four largest wet weather events from 2016 through 2018 was evaluated for all of the CSO facilities, including Hubbell Southfield. The data indicate that the volume of sodium hypochlorite fed exceeded the storage volume at Hubbell Southfield in one event. In that event 38,775 gallons was reportedly fed compared to 30,000 gallons storage volume. Chemical deliveries occurred during the event to address this. Based on the event above, additional hypochlorite storage is needed. This issue is addressed in Add New Chemical Storage Tank (Project HS-DIS-3).

9.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project HS-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel. Hose pumps will be larger than the existing gear pumps at Hubbell-Southfield and the need to enlarge the pump area was considered for this alternative. Although not all pumps may fit in the current row of pumps, there appears to be sufficient room to locate a couple of the pumps along the north wall under the stairway if necessary. The costs for demolishing the existing pads and adding new taller and larger pads was included in all alternatives and the cost will not substantially change with pump location. Details regarding pump layout are deferred to design.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

Each of the alternatives above would include provisions to address the additional concerns specific to the Hubbell Southfield feed system:

- **Sump Pump:** For cost estimating purposes, a chemically resistant sump pump is assumed for the sump in the chemical feed basement areas as well as hard-piped dilution water to the sump requested by plant personnel.
- **Spill Protection:** Jacobs evaluated two options to address the concern of sodium hypochlorite spill in the pump area, including:
 - **Option 1: Level sensors and raising pump pads.** This option would install a level sensor or contact switch in the pump area. The sensor would be programmed to close actuated valves from the tanks if a spill is detected. Also, this alternative includes raising the pump pads to 2 ft (from their current 4 in.) to further protect the pumps if a spill occurred.
 - **Option 2: Transfer Pump and Day Tank.** This option would include the sensor in Option 1 that would close the tank valves if a spill should occur. This option would also provide a transfer pump and day tank. However, the transfer pumps would remain a weak link in a flood. In order to address this, a vertical shaft

chemically resistant sump pump with the motor located above maximum flood level, as offered by Vanton Pumps, would serve as an emergency backup to a transfer pump. In a flood situation, the sump pump would serve as the transfer pump to the day tank or to return the sodium hypochlorite to one of the storage tanks after that tank's outlet valve is closed.

The cost for a level sensor in the pump area and programming to close actuated valves from the tanks if a spill is detected is a relatively low-cost alternative. As such it is included in Alternatives 2 and 3 above.

The alternative evaluation for these alternatives is presented in Table 9-4. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 was developed based on GLWA experience of pump rebuilds per year at a cost of \$30,000.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 9-4 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 9-4. Alternative Evaluation for Replace Chemical Feed System (Project HS-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System in-kind	Health and Safety	3	2.08	\$ 969,900	\$ 30,000	\$ 1,602,589	\$ 769,243	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 1,130,000	\$ 17,125	\$ 1,491,160	\$ 414,211	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per channel.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 534,000	\$ 3,000	\$ 597,269	\$ 165,908	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project HS-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

The sample point should be located approximately 15 minutes travel time downstream of the dosing point at average flow but peak flow travel time must also be considered. The exact location would be determined during design.

The automatic chemical feed system will require less operator input during an event. However, there will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 9-5. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains functional between storm events.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. Based on the improved ability to meet the NPDES permit TRC goal, **Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 9-5. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project HS-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less efficient chemical feed and possible overdosing of chemical.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 220,000	\$ 4,860	\$ 322,496	\$ 93,477	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more efficient use of chemical.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult with infrequent CSO facility use.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

Add New Chemical Storage Tank (Project HS-DIS-3). Based on the evaluation performed in the previous section, there is a need for additional chemical storage tank to ensure adequate chemical during larger events. There are two alternatives:

- 1) **Alternative 1: Do Nothing - Rely on Chemical Deliveries during Storm Event.** This approach was used during the large event that exceeded the existing chemical storage capacity. This alternative relies upon an outside contractor to deliver enough hypochlorite to make it through the storm event.
- 2) **Alternative 2: Add New Chemical Storage Tank.** The O&M staff requested a tank at grade to serve as a backup. They also requested the capability for gravity feed to the influent from the new tank in case the pump room floods. The lack of reliable influent flow measurement prevents sizing additional sodium hypochlorite storage based on influent flow, design doses, and assumed hypochlorite strength considering degradation potential. However, the installation of new flow meters in 2019 may help to inform tank sizing for design. For budgeting purposes, a third tank sized the same as the existing two 15,000 gallon tanks is assumed, inside a building with chemical containment, mechanical, electrical and I&C.

As requested by GLWA, the possibility of gravity feed from the chemical tanks with a meter and valve was evaluated. The effluent weir from the CSO basins into the effluent channel controls the hydraulic grade line at the influent induction mixers to above elevation 100 once the basin is filled. The bottom of a new at-grade sodium hypochlorite tank would be approximately elevation 111 and the maximum liquid depth is approximately 13 ft. Thus, there is approximately 11 ft of static head available with the tank empty and 24 ft with the tanks full. This corresponds to 4.8 pounds psig empty to 10.3 psig full available head. The induction mixers require back pressure valves to prevent siphoning chemical. Evoqua recommends a setting of 15 psig. Therefore, the available static head is inadequate for gravity feed before even accounting for friction loss and flow control valve loss. Thus, continued pumping as the means of chemical delivery is recommended.

The alternative evaluation is presented in Table 9-6. Capital costs for Alternative 2 are presented in Volume 6 – Appendices, Appendix C under this project title.

As shown in Table 9-6, Alternative 2 has a Total Benefit score about 1.5 higher than Alternative 1 because of the improved water quality and compliance (i.e., facility could run out of chemical during a storm and violate permit), and ease of O&M. Because of the risk of violating permit, **Alternative 2 is the recommended alternative.**

Table 9-6. Alternative Evaluation for Add New Chemical Storage Tank (Project HS-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/Rely on Chemical Deliveries during Storm Event	Health and Safety	3	2.00	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	1						
	<i>Adv.:</i>	Lower Cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	May run out of chemical during a large storm event, thereby violating permit.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Add a New Chemical Storage Tank	Health and Safety	3	3.50	\$ 753,000	\$ -	\$ 753,000	\$ 215,143	Not Applicable
	<i>Definition:</i>	Install new tank at grade to serve as a backup with capability for gravity feed	Water Quality & Compliance	4						
	<i>Adv.:</i>	Sufficient chemical for larger storm events.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.3 Odor Control

9.2.3.1 Description of Existing System

The Hubbell Southfield odor control system consists of two separate horizontal cross flow scrubber systems. Odorous air flows horizontally across the empty scrubber chamber and scrubbing solution is sprayed into the oncoming air from numerous spray nozzles. One system, located in the Headworks Building, treats air from the Headworks area and Basin No. 1. A second system, located in the Process Building, treats air from Basin No. 2. The systems were originally designed with the capability to spray a solution of sodium hypochlorite and sodium hydroxide to remove odorous gasses. However, the sodium hydroxide has not been used for some time. The chemical solution is recycled through the scrubber and recirculation tank, and fresh sodium hypochlorite is added as needed. Excess chemical solution overflows out of the recirculation tank into a drain.

The system was installed in 1996. Overall, the system is in good condition. The odor control system does not have an air permit.

Per GLWA, no formal odor complaints have been received for at least the past three years; however, the golf course has indicated that they can smell the facility.

9.2.3.2 Identified Needs and Issues

During meetings with O&M staff related to the odor control system, no needs were identified. The recommendation in this section is based on Jacobs evaluation of the existing system.

Potential Reduction of Odor Treatment during Operation. The facility does not have an air permit and is not required to operate the odor control system. The facility may not generate significant odors during wet weather events due to dilution of sewage with storm water. Storm water significantly reduces the concentration of sulfide and other odorous compounds in sewage. Odors may be more prevalent during the dewatering phase caused by odors from settled solids but may still be low. Due to the expected low odors from the facility, GLWA may want to consider operating the scrubber systems with water only and no sodium hypochlorite. Removal of H_2S is dependent on the H_2S concentration. Removal will be significantly less with only water, but there may be relatively low levels of H_2S to remove. Another option, which provides even less treatment, would be to operate the system without water and blow air through an empty scrubber system and out the stack. (This could be considered during the winter months when the golf course is not active, but is not recommended when the golf course is being used.)

Odor Study. Under both of these options, the discharged air may be non-odorous or sufficiently diluted with ambient air to render it non-odorous or non-detectable to receptors. Prior to implementing either one of these options, GLWA should conduct an odor study to sample influent air to the existing scrubber system for H_2S to determine if the H_2S concentration is sufficiently low. A non-detectable concentration of H_2S in the influent air means the systems can likely operate without sodium hypochlorite or water. The study would also sample the discharge when using water spray, to determine the measured effectiveness of such an operation.

9.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement "needs."

9.2.4 Flushing and Dewatering

9.2.4.1 Description of Existing System

Dewatering System: Basin dewatering can be accomplished by gravity or pumping. Gravity dewatering to the Northwest Interceptor (NWI) occurs by opening one of two flow control valves (BD-1 or BD-3). A control system regulates the valve position and corresponding flow from the basin to the NWI. The gravity discharge rate is controlled so as not to exceed the remaining capacity in the NWI as measured by a level sensor in the NWI. The Basin Compartments 1 and 2 can be dewatered from a basin water level of 99.5 ft down to about 94.75 ft. The basin could be dewatered by gravity down to 90.5 ft (if siphoning); however, at a water surface level below 94.75, the flow rate in the discharge line causes the velocity to drop below a recommended value of 3.5 ft/sec.

The remainder of volume in the basin must be removed by pumping. There are two 8,000 gpm pumps for each basin, for a total of four dewatering pumps. The system was designed for one pump as duty, with the other pump as backup. The dewatering pumps were designed to remove water down to about 74.5 ft, which is about 25 ft below the basin high water level.

The dewatering system originally included one 200 gpm sump pump for each compartment. These pumps have been removed. As noted below, Operators would like to see this pump replaced.

The basin was also designed to be decanted if there was no capacity in the NWI before a subsequent storm. The top 5 ft of water from the basin compartments could be decanted to the Rouge River. There are two decant gates located at the end of Basin 2: Basin Decant Slide Gate and Effluent Decant Gate. The Operators have not decanted flow and do not foresee the need to decant in the future. As such, these gates should remain closed and do not need to be replaced in the future. These gates could be removed in the future and the openings permanently filled with concrete.

Flushing System: The spray flushing system is intended to remove the remaining solids left on the floor of the basin and shunt channel after the basin has been dewatered. There are 22 flushing spray zones. Two submersible flushing water pumps are located in the effluent channel (referred to as the Pond) and a strainer is located in the Process Building dewatering pump room. If there is not enough effluent after a wet weather event in the effluent channel for the basin flushing, additional (City) water can be used to fill the effluent channel. The Pond fills at line pressure and there is no booster pump to help it fill faster.

The flushing system has not performed its intended function since it was originally installed. Solids accumulate across both basins and in the shunt channel. As such, the operators must lower a bobcat into the basin and use fire hoses to clean solids from the bottom of the basin. Due to the extraordinary difficulty of cleaning the basin, GLWA does not clean the basin after every event.

Table 9-7 provides an overview of the existing flushing and dewatering system at Hubbell-Southfield CSO facility.

Table 9-7. Overview of Existing Flushing and Dewatering System at Hubbell-Southfield CSO Facility

Parameter	Value
Total Basin Volume (MG)	22
Headworks and basin Dewatering and Flushing System	- Gravity dewatering can occur for the top portion of captured volume, but this is not typical operation - There are two 8,000 gpm dewatering pumps for Basin 1 and two 8,000 gpm dewatering pumps for Basin 2 - Two 5,000 gpm flushing pumps are located in the effluent channel. A strainer is provided in the Process Building Basement. - Flushing system consists of spray flushing system with 22 zones. System is largely ineffective at removing solids from the basins

9.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- There are significant issues with flushing solids from the floor of the basin and shunt channel.
- The dewatering pumps need to be upgraded and missing sump pumps need to be replaced. A fluidization system should be considered under the sump pumps to avoid large accumulations of solids in the sump
- There is no way to access to the effluent channel (Pond) area.

9.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Basin Flushing System (Project HS-FD-1). Flushing solids from the floor of the basin and shunt channel has been a problem since the facility was constructed. The existing flushing system using spray nozzles has been largely ineffective due to the large volume of solids that are generated during each storm and the fact that a subsequent storm may enter the facility before the entire contents have been cleaned. The configuration of the spray system (15 ft above the floor) also makes the spray system ineffective.

There are three alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing/ Continue Current Operation.** GLWA Operations staff to continue to manually clean the basin.
- 2) **Alternative 2: Contractor Clean Out.** Contractor to manually clean the basin. This alternative is similar to Alternative 1; however, it would include increased number of cleanings per year to meet the intent of the permit to have the basin ready for a subsequent storm event.
- 3) **Alternative 3: New Basin Flushing System.** Based on the poor performance of the existing spray flushing system at Hubbell Southfield and experience at another CSO basin in the Southeast Michigan region (Milk River CSO Basin), GLWA requested a completely new system. Jacobs initially considered both flushing gates and tipping buckets to replace the existing system. After consultations with several manufacturers and evaluating initial conceptual layouts, tipping buckets were removed from consideration due to the low head space inside of the basin areas and maximum flushing length limitation of only 200 ft. As such, the recommended flushing system involves flushing gates/reservoirs in the contact basins and an improved spray system in the shunt channel. This concept is shown in Figure HS-FD-1-ALT-3 in Volume 6 – Appendices, Appendix B.

Demolition. The demolition activities consist primarily of removing of the existing basin mixers and spray system components (pumps, pipes, fittings), concrete removal for construction and permanent access through the roof slab, and other equipment mounted inside of the tank to allow the extensive structural concrete placement. Temporary relocation of some equipment and piping/conduits on top of the tank to facilitate construction is assumed.

Flushing Gate Reservoir Configuration. The existing basin's semi-circular configuration, slope, alignment of the NWI dividing basin into two sections, and drainage channels create a challenging retrofit condition. Flushing gate reservoirs will be located along three lines in the upstream and downstream sections of the two basin compartments. The reservoir volume is determined by the length and slope of the surface that must be flushed by the flushing wave. The longest flushing length is along the northeastern wall of the facility is approximately 430 ft long. The average flushing reservoir volume for the conceptual configuration is approximately 15,000 gallons. The final design should validate and further refine the minimum volume requirement using a sediment fate-transport model (e.g., HEC-RAS) for each flushing lane based on length

and longitudinal channel slope. For 37 flushing reservoirs, the total flushing volume required is approximately 550,000 gallons.

Immediately downstream from the screens, an initial reservoir array will be constructed in Basin 1 with the flushing gate reservoirs suspended above the basin floor and with the gate openings directed towards the existing drainage channel in the upstream section. The suspended reservoirs, as shown in Figure HS-FD-1-ALT-3, allow low flows to continue underneath into the basin in a 2- to 3-foot high channel. As the water level continues to rise in the basin, the hydraulic gradient will build upstream of the suspended reservoirs and increase the velocity in the low-flow channel, effectively moving sediment into the basin sump and the dewatering pump station. Flows will eventually overtop the flushing gate reservoir walls (approximately 8 ft above the floor) and fill the reservoir volume.

A second array of flushing reservoirs is proposed in Basin 2 on the downstream side of the NWI alignment. The reservoirs of this array would be constructed on the existing basin floor with the gate openings directed towards the drainage channel that runs through the middle of Basin 2. The third and final array would be constructed along the finger weirs near the basin outlet. These reservoirs would also be constructed on the floor with the gate openings directed back towards the drainage channel in the middle of Basin 2.

Structural Retrofits. Flushing gates release a flushing wave that needs to be contained in a confined channel to maintain velocity and effectively carry resuspended sediment to a collection point. The basin floors will require concrete training walls along each flushing channel. Additionally, the existing floor will require concrete leveling across most of the entire basin to create level cross-sectional flushing channels. The conceptual design developed indicates that approximately 8,000 cy of concrete fill will be required to create adequate flushing wave channels and reservoirs. Additional concrete fill (structural and low-density concrete fill, approximately 1,000 cy) will be required throughout the basin as fillets and bulk fill to eliminate voids and areas where the flushing waves cannot remove sediment. The total displacement of the new concrete in the contact basin is approximately 1.82 million gallons.

A review of the existing facilities structural details indicate that the base slab could be susceptible to damage if any drainage channel realignments are made. The conceptual design avoids additional base slab structural improvements and subsurface improvements. Additionally, the facility's proximity to surface water and high groundwater would require extensive dewatering should any penetrations through the base slab be required. Additional modifications to the existing base slab, addition of concrete, and other improvements may negatively impact the structure and the foundation. A detailed analysis of the future condition live/dead loads should be completed during final design and structural/foundation improvements incorporated into the project by the final designer. These improvement could include additional piles, retrofitted structural supports, and use of higher strength concrete mixes.

Secondary Flushing Water Source. A secondary source of flushing water is recommended to provide additional flushing cycles for post-event cleaning. The base option for the concept development is to repurpose the existing flushing system water source and install a pipe network to fill the reservoirs in each array. A second option is to use a surface water source, similar to St. Aubin CSO Facility. The close proximity of the Rouge River at the outfall end of the facility allows for the installation of a pump intake, pump system and force main to provide water for a fill pipe network in the contact basin above the reservoirs. GLWA should consider large screens (4-in. bar-type or similar) to prevent floating debris from entering the effluent chamber. GLWA's experience with zebra mussel removal from other facilities in this area indicates that smaller screen openings should be avoided. Similarly, a small opening with a flap-gate opening inward to the effluent channel may help prevent floating debris from entering while ensuring adequate water is available for secondary flushing and shunt channel spray system operation.

The recommended alternative assumes each array of flushing gate reservoirs will be filled using surface water as the flushing water source, similar to the St. Aubin flushing system. Two 2,000-gpm submersible pumps will be mounted in the existing effluent channel. Each pump will discharge to separate 6-in. HDPE force mains that are mounted to the interior roof of the contact basin space (either at the centerline of the overall basin, or

along one wall). One pump will provide flushing water to the northernmost flushing reservoir array, and the other will provide flushing water to the other two arrays. At each array, a second run of 6-in. HDPE will extend over the top of the flushing reservoirs with a tee fitting. A concrete notch (3 ft long by 6 in. deep) cut into the walls between each reservoir would serve as a weir and will enable flows between the reservoirs to fill evenly as the pumps operate.

GLWA has noted that Basin 2 tends to accumulate more solids from wet weather events than Basin 1 and is expected to require more than one post-event flushing with the proposed flushing gate system. By dedicating one pump to the Basin 2 flushing gate arrays (closest to the finger weir), GLWA will be able to more quickly fill these reservoirs to provide a secondary cleaning of this area (estimated fill time at 2,000 gpm of 100 minutes). The other flushing reservoirs in the northern half of the basin will fill more slowly (approximately 180 minutes).

Alternative Gravity Filling System for Basin 2. A sub-alternative for filling the flushing gate reservoirs includes adding a new gated opening or repurposing an existing gated opening in the finger weirs between Basin 2 flushing chamber and the Pond. Each flushing reservoir will have a lower weir notched into the concrete walls between adjacent flushing reservoirs. Opening the gate will allow river water from the reservoir to quickly fill this array of flushing gate reservoirs from one source via overtopping the notched weirs and provide water for additional flushes. A screened and gated opening between the reservoir and the river channel is required to control flows into this space and limit floatable materials and larger aquatic organism from entering the facility. Pumping river water to the other flushing reservoirs using pumps would still be required with the conceptual configuration proposed. Extending a gravity pipe to the other arrays may be possible by adjusting or reconfiguring the elevations and layout of the proposed concept.

New Shunt Channel Flushing System. A new spray flushing system is proposed for the shunt channel. Two new flushing headers will be extended into the shunt channel on both sides of the conduit, and two new submersible pumps will draw river water from the effluent chamber near the secondary flushing gate water source pumps described above.

Each pump will provide water to one half of the shunt channel. Record drawings indicate a transverse slope in the channel's shelf of approximately 0.7 to 1.0 percent, draining from the exterior wall towards the low-flow channel next to the interior wall. The low-flow channel has a slope of approximately 0.5 percent and drains the northern and southern effluent channel sections towards the dewatering pumps. The northern (Basin 1) half of the channel will include two 590-foot, 8-in. HDPE (SDR 13.5) headers, mounted with stainless steel hardware approximately 6 ft from the floor, one above the top edge of the shelf and the other over the low-flow channel. Half-in. holes will be directionally drilled on 4-foot spacings to push solids towards the low flow channel, and along the low-flow channel towards the dewatering pumps. The pumping requirement for the northern half system is approximately 3,300 gpm. The southern (Basin 2) half of the channel includes two 280-foot, 8-in. HDPE headers mounted in a similar fashion and drilled accordingly. The pumping requirement for the southern half system is approximately 1,600 gpm. Similarly-sized pipe runs (approximately 560 ft) connect pumps to both headers.

The control strategy may require only running one half of the effluent channel cleaning system at a time in order to prevent overwhelming the dewatering pumps. Control valves to support pulsing may be required and are recommended to be installed on top of the facility or in new vaults installed in the roof. Flow rate, volume/pressure at application points and control strategy should be confirmed during final design using CFD or scale models.

Additional Mechanical Systems. The flushing gate hydraulic systems will require a new control room as the existing surface facilities at Hubbell Southfield do not have adequate space. Therefore, a new control room/building (occupied, declassified space) is assumed and will be constructed on top of the roof slab. The cost estimate assumes a stand-alone building rather than remodeling or adding to either of the existing buildings. An allowance for structural retrofits of the existing tank's roof slab and beams to support a new

surface structure is included in the costs. Hydraulic tubing would be routed inside of the basin along the ceiling to each gate actuator.

Advantages and Disadvantages of Alternative: This flushing gate option described above appears to be the most viable solution for improving the flushing of the basin using automated systems. The advantages of a flushing gate system at this facility include:

- Effective removal of sediment from the bottom of the basin: Currently, the sediment is only removed periodically due to the significant amount of time and effort. The new system should be able to flush the basins every time the basin is dewatered after a storm event.
- Improved NPDES permit compliance by being able to clean the basin after every event. Note that permit prohibits the discharge of sludge or residual accumulations from the basin to surface waters and requires the settled sludges to be promptly removed and disposed in accordance with procedures approved by EGLE.
- Improved safety for GLWA Operations staff: The flushing system eliminates the need for Operations personnel from entering and operating machinery in the confined space.
- Reduced O&M labor costs for sediment removal compared to current process: Currently, it takes about three personnel about one week to clean the entire basin and occurs about four times per year. This represents a cost of about \$50,000 per year.
- Potential reduction in flushing water usage: The existing spray system uses up to about 7 MG of City water after each event. The proposed flushing water system could eliminate the use of City water if river water can be used as the source of flushing water.
- Some other CSO basins in the area (i.e., Milk River) have removed flushing nozzle systems because they are ineffective.

The disadvantages of this system include:

- High capital cost. The cost estimate for the required modifications to the facility to construct a new flushing gate system is significant.
- Additional systems that require O&M: Adding about 37 flushing gates, hydraulic control system, and secondary flushing water system would add the number of assets that require preventative maintenance and replacement. Secondary flushing system pump operation power requirements would increase the facility's overall electrical consumption.
- New concrete used to construct the flushing system will displace approximately 1.8 million gallons of volume in the contact basin. This will reduce the contact time and may impact the CSO facility's ability to meet regulatory permit requirements. GLWA should assess this impact in more detail during final design of this improvement.
- Difficulty of Construction: Factors that make the construction of the flushing gates difficult include construction of the concrete flushing gates and training walls inside a covered basin, relatively tight site conditions, and the need to keep treating CSO flows. (It is noted that Basin 1 could be completely isolated during construction and allow treatment through Basin 2; however, it is not possible under current configuration to isolate Basin 2 and allow flow to be routed only through Basin 1)

The alternative evaluation for these alternatives is presented in Table 9-8. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 1 and 2 is based on the replacement cost of the piping and spray nozzle system in about 2014, inflated to 2021 dollars.

- The O&M costs for Alternative 1 includes GLWA labor cost for four cleanouts per year and associated water usage. The labor cost is based on GLWA labor cost of three staff for 40 hours per week and four times per year, or about \$48,000 per year. The water usage is estimated to be 7 MG per clean-out. At \$4,000 per MG, the cost is about \$112,000 per year.
- The O&M costs for Alternative 2 includes assumed Contractor labor cost for 12 cleanouts per year (average of one per month) and associated water usage. The labor cost is assumed to be about \$20,000 per clean-out, or about \$240,000 per year. This cost is an estimated cost to provide reliable cleaning of the basin on a periodic basis. The water usage is estimated to be 7 MG per clean-out. At \$4,000 per MG, the cost is about \$336,000 per year.
- The capital cost for the flushing system (Alternative 3) is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 3 includes \$10,000 for annual maintenance of the new equipment and electricity costs for the river water pumping.

This evaluation shows that Alternative 1 – Continue Current Operation has the lowest NPV/Benefit cost and is shown to be the Best Value Alternative. The poor health and safety conditions for GLWA operations personnel, however, are not properly conveyed in this analysis and the current four cleanings per year is not believed to be adequate to meet EGLE requirements to have the basin ready for subsequent storm events. Using contracted labor would allow GLWA to have the basin cleaned after most storm events; however, the NPV/Benefit cost is higher than Alternative 3. Alternative 3 provides the benefit of improved health and safety by not having to enter the basin for cleaning, and it is easily operated by the O&M staff after every storm. The Total Benefit score for Alternative 3 is about 2.0 points higher than Alternative 2. **As such, Alternative 3 – New Basin Flushing System is the recommended alternative.**

Table 9-8. Alternative Evaluation for Basin Flushing System (Project HS-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Continue Current Operation	Health and Safety	1	1.80	\$ 2,400,000	\$ 160,000	\$ 5,774,341	\$ 3,207,967	Best Value Alternative
	<i>Definition:</i>	Replace existing flushing system in-kind	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known approach; minimal mechanical equipment	Capacity Enhancement	3						
	<i>Disadv.:</i>	Labor intensive	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Contractor Clean out	Health and Safety	1	2.02	\$ 2,400,000	\$ 576,000	\$ 14,547,629	\$ 7,213,700	
	<i>Definition:</i>	Replace existing flushing system in-kind	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known approach; minimal mechanical equipment	Capacity Enhancement	3						
	<i>Disadv.:</i>	Relies on Contractor.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	2						
3	<i>Alt. Name:</i>	New Basin Flushing System	Health and Safety	5	3.98	\$ 24,800,000	\$ 10,000	\$ 25,010,896	\$ 6,278,886	
	<i>Definition:</i>	Flushing gates/reservoirs in the contact basins and an improved spray system in the shunt channel	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier maintenance. Safer operation.	Capacity Enhancement	2						
	<i>Disadv.:</i>	High capital cost; loss of treatment volume in basin	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	5						

Dewatering and Sump Pump Improvements (Project HS-FD-2). Sump pumps for Basin 1 and 2 were originally installed next to the basin dewatering pumps. Due to the large accumulations of solids in the sump, these pumps were routinely overwhelmed with solids. As such, O&M staff have removed them from both basins, but they indicated these pumps are beneficial for proper flushing and removal of solids.

There are two alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing/ Replace In-Kind.** Replace the dewatering and sump pumps in-kind.
- 2) **Alternative 2: Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System.** Two new 200 gpm, sump pumps should be installed. It is recommended that a solids fluidization system be installed under the intake of the new sump pumps and the dewatering pumps. This fluidization system could consist of a water jet to fluidize the accumulated grit before the pump turns on. The project should also provide a new base elbow, cleaning of the discharge pipes, replacement of valves on the discharge line, and replacement of the pump rail system.

O&M staff also requested that the type of dewatering pump be investigated to ones that better handle heavy grit loads. The existing four pumps are manufactured by Vaughan. The N-Series submersible pump by Flygt has replaced a number of dewatering pumps at other CSO facilities and are recommended at this location. Based on input from Kennedy Industries, a Flygt Model NP-3202 would be an appropriate replacement pump. The preliminary sizing indicated that these pumps have a slightly lower horsepower than the existing pumps. Detailed design is needed to confirm pump sizing. The elevation of each dewatering pumps should also be investigated (consider one higher than the other to avoid the heavy grit loads).

This project should be incorporated into the flushing gate project (Project HS-FD-1), if the new basin flushing system moves forward.

The alternative evaluation for these alternatives is presented in Table 9-9. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 is based on the pump replacement costs from the SRP.
- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title. It includes a new fluidizing system to allow the sump pumps to function properly. It also includes new piping to replace the existing and allow the pump elevations to be modified.

Alternative 1 is shown as the Best Value Alternative. The scope of Alternative 2 is generally similar to Alternative 1; however, there are additional improvements in Alternative 2 that are necessary to allow the system to function properly. As such, **Alternative 2 - Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System is the recommended alternative.**

Table 9-9. Alternative Evaluation for Dewatering and Sump Pump Improvements (Project HS-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	3	2.58	\$ 429,000	\$ -	\$ 429,000	\$ 166,065	Best Value Alternative
	<i>Definition:</i>	Replace the dewatering pumps and sump pumps in-kind.	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Difficulty with flushing and removal of solids.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System	Health and Safety	3	3.42	\$ 950,000	\$ -	\$ 950,000	\$ 278,049	
	<i>Definition:</i>	New dewatering and sump pumps and appurtenances will be installed. A solids fluidization system will be installed under the intake of the new sump pumps.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Proper flushing and removal of solids	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	4						

Access to Effluent Channel (Project HS-FD-3). There is no manned access to the effluent channel area (i.e., the area between the effluent weirs and the effluent flap-gates). GLWA needs to access this area to allow equipment to be lowered into this space for removal of settled solids from the floor.

There are two alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing**
- 2) **Alternative 2: Equipment Access to Effluent Channel.** A hatched opening is desired for this area in a location shown in Figure HS-FD-3-ALT-2 in Volume 6 – Appendices, Appendix B. One option is to cut an opening in one pre-stressed concrete plank and use removable covers, similar to the existing hatch shown in the photos in the Appendix. Another option that should be considered during design is providing an aluminum hatch opening, so that a boom truck is not needed to remove the cover.

This project should be incorporated into the flushing gate project (Project HS-FD-1), if the new basin flushing system moves forward.

The alternative evaluation for these alternatives is presented in Table 9-10. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

Due to need to access this location for solids clean-out, **Alternative 2 - Equipment Access to Effluent Channel is recommended.**

Table 9-10. Alternative Evaluation for Access to Effluent Channel (Project HS-FD-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Inability to access the effluent channel area	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Equipment Access to Effluent Channel	Health and Safety	3	3.22	\$ 126,000	\$ -	\$ 126,000	\$ 39,171	Not Applicable
	<i>Definition:</i>	Cut an opening in one pre-stressed concrete plank and use removable covers	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier access	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance of hatch	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.5 HVAC

9.2.5.1 Description of Existing System

The Hubbell-Southfield CSO Facility consists of a Headworks Building and a Process Building. The buildings contain a Headworks area, chemical room, utility support (electrical and mechanical rooms), control room, odor control rooms and other miscellaneous rooms. The facility also includes a retention basin. Table 9-11 provides a summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, emergency shower/eye wash and washroom regular shower. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 9.2.10.

Table 9-11. Major HVAC Equipment at Hubbell-Southfield CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	HVU-3	Heating Ventilating Unit	25,000 CFM
Basin 1	SF-1 to 6	6 × Supply Fans	50,000 CFM
Basin 2	SF-7 to 13	7 × Supply Fans	50,000 CFM
Chemical Room (Headworks Bldg)	EF-2	Exhaust Fan (Hypochlorite Rm)	2,200 CFM
	HVU-2	Heating Ventilating Unit	10,500 CFM
Process Control Bldg	PACU-1	Packaged Air Conditioning Unit	3,400 CFM

Note:

HVU = Heating Ventilation Unit

Table 9-12 provides a summary of the basis of design performance criteria for HVAC systems at Hubbell-Southfield and Table 9-13 provides the outdoor Basis of Design conditions.

Table 9-12. Hubbell-Southfield Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (°F)	Summer (°F)	
Odor Control Room – Process Building	Unclassified (Per As-Built Drawings)	70	N/A	12 ACH
Work Area, Electric Room, Toilet, Storage, etc., – Process Building	Unclassified	70 (Occupied) 60 (Unoccupied)	78	6 ACH
Dewatering Room – Process Building	Unclassified	70	N/A	3 ACH
Mechanical Room – Headworks Building	Unclassified	60	N/A	6 ACH
Odor Control Room – Headworks Building	Unclassified (Per As-Built Drawings)	70	N/A	12 ACH
NaOCl Room –Headworks Building	Unclassified	60	N/A	6 ACH
Headworks Room –Headworks Building	Class I, Div 1, Group D (Per As-Built Drawings)	70	N/A	12 ACH

Table 9-13. Hubbell-Southfield Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb °F)	Summer (Dry Bulb °F)	Summer (Wet Bulb °F)
3	91	73

9.2.5.2 Identified Needs and Issues

During discussions with GLWA O&M staff and GLWA's HVAC contractor, the following HVAC issues were noted:

- Heating in the dewatering room (basement of Process Building) was reported to be insufficient. No freezing of pipes was reported.

Jacobs further investigated this issue through review of design information and site visit. All spaces in the Process Building have a basis of design winter dry bulb temperature of 70°F. The dewatering room's HVU duct heater has a design capacity of 125,000 Btu/h which should be sufficient to heat the dewatering room to 70°F using 80 percent return air, as designed. EF-7 was not observed to be operating. Given the significant amount of corrosion that was observed on EF-7's motorized damper, it is very likely that the damper is seized. This could not be verified in the field due to the inaccessible location of the damper. The observed cold air temperatures in the dewatering room are most likely the result of HVU-4's outside air supply damper remaining fully open during heating mode and/or the return air damper remaining in its minimum position. Given the age of the equipment serving the dewatering room, a replacement in-kind of HVU-4, EF-7 and associated supply, return, and exhaust dampers is recommended and should resolve this issue. This project will come from the SRP.
- O&M staff requested that air conditioning in the Process Building odor control room. Upon further discussion, the main activity routinely performed in this area is sample preparation and analysis. Instead of air conditioning the entire odor control room, it was recommended to move the sample sink to the work area, which is already air conditioned. This is currently an on-going project to be completed by GLWA maintenance staff
- Heating and cooling issues in Process Building. Staff reported that improvements were needed.
- Historical Issues with Heating and Ventilation Units: GLWA's HVAC contractor noted there had been issues with the HVUs which had been resolved. They did not note any out of the ordinary wear or capacity issues with the units.

During Jacobs site investigations (June 2020) the following observations were noted:

- It was observed during the site visit that the air balance of PACU-1 in the Process Building had been adjusted since installation. It is very likely that this adjustment came from a desire to improve thermal comfort in occupied spaces. Additionally, it was noted that the supply air duct from PACU-1 runs from the West side to the East side of the Process Building; however, the return air duct terminates at the entrance to the odor control room (see Figure 9-2 below). This is likely to result in poor air quality as a result of a lack of air circulation in spaces on the East side of the Process Building.

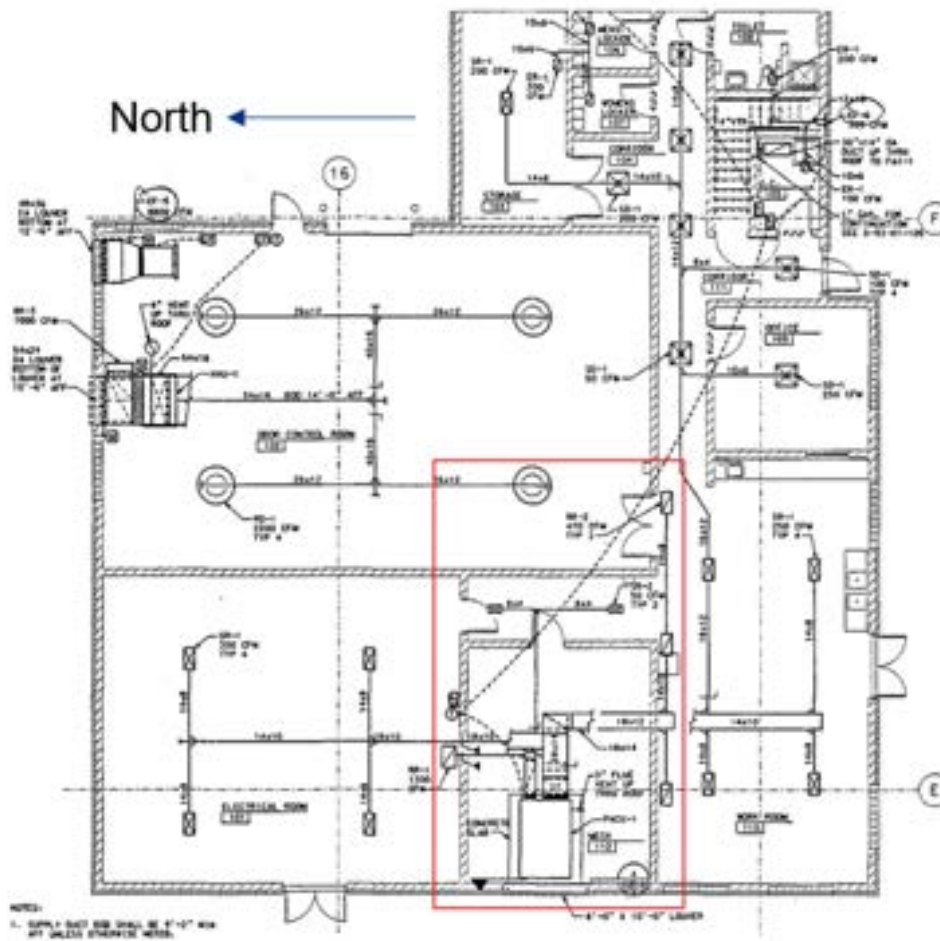


Figure 9-2. PACU-1 Return Air Ductwork

- The doors between the Process Building odor control room and the Work Area were observed to be open. Additionally, ventilation in the odor control room was switched off. Condensation was noted on the PACU-1 supply air duct directly in front of the Odor Control Room.
- Condensation was noted on the floor at the top of the dewatering room (basement) stairway. HVU-4, which serves the dewatering room was supplying ventilation air but EF-7 which provides relief for the air supplied to the dewatering room was not operating despite having its motorized damper in the open position. Additionally, significant corrosion was observed on the body of the dewatering room's duct mounted gas furnace (Figure 9-3).



Figure 9-3. Corrosion on EF-7 Ductwork

- HVU-2's supply fan, which provides ventilation to the odor control room in the Headworks Building, was observed to be running; however, EF-1, EF-2, EF-3 were not operating.

9.2.5.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Process Building Air Balance Study. An air balance is recommended for the Process Building to determine if the heating and cooling issues are the result of a poorly balanced system. It is noted that the operators occasionally leave the door to the odor control room open to cool this area, as observed during the site visit. This may be contributing to the issues related to poor cooling provided by PACU-1. Also, it should be noted that the spaces in the Process Building which are cooled are only designed to be cooled to 78°F.

If the air balance does not improve conditions in the Process Building, extending the return air to PACU-1 should be considered. This should improve air circulation and increase supply air flow to the spaces on the East side of the facility, including the Office.

Scheduled Replacement Plan: As noted in Section 9.2.5.2, many of the relatively small HVAC-related equipment at this facility is recommended to be replaced in-kind. Therefore, it is included in the SRP.

9.2.6 Electrical

9.2.6.1 Description of Existing System

The Hubbell Southfield facility's electrical system consists of one DTE utility feed from a 1,500 kVA, 480 V, 3-phase outdoor transformer (secondary metering) and one diesel generator feed from a 600 kW, 480 V, 3-phase stationary generator. The feeds are connected to a 2,500 A switchboard MDP with electrically operated breakers and automatic source transfer controls for a 1,200 A bus. The MDP switchboard also has a 2,000 A breaker before the ATS, which feeds a main circuit breaker panel switchboard (MCBP). The MDP and MCBP have breakers that

feed motor control centers (MCCs) and distribution panels. The MCCs and distribution panels then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 9-14 provides a summary of the major electrical equipment for this facility.

Table 9-14. Major Electrical Equipment at Hubbell-Southfield

Location	Major Electrical Equipment	Description
Electrical Room	Main Switchboard/ATS (MDP)	2,500 A, 480/277 V, 3-Phase
Outdoors	Generator (Diesel)	600 kW, 480 V, 3-Phase
Electrical Room	MCC-P1	600 A, 480/277 V, 3-Phase
Odor Control Room	MCC-H1	250 A, 480/277 V, 3-Phase
Electrical Room	MCC-P2	1,200 A, 480/277 V, 3-Phase
Odor Control Room	MCC-H2	600 A, 480/277 V, 3-Phase

9.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the next section.

9.2.6.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project HS-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles, however it will be less safe when operating at night and select locations within the basin.
- 2) **Alternative 2: Electrical Improvements.** Add Lighting and Exterior Power Receptacles at the following locations (and shown on the electrical drawings - Figure HS-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Basin Nos. 1 and 2—Add interior explosion-proof LED lighting fixtures to provide lighting within the basins.
 - Access road—Add light poles and associated LED light fixtures. Lighting foot-candles shall meet the requirements of the local outdoor lighting ordinances.
 - Outfall area—Add a light pole and overhead lighting at the facility's outfall. Lighting foot-candles shall meet the requirements of the local outdoor lighting ordinances.
 - External lighting on top of Basins—Add light poles and LED lighting fixtures on the facility's basins. Lighting foot-candles shall meet the requirements of the local outdoor lighting ordinances.
 - Add exterior power receptacles to assist in the maintenance and operations of the facility including receptacles every 75 ft on top of the basins for maintenance and operational needs.

This project should be incorporated into the flushing gate project (Project HS-FD-1,) if the new basin flushing system moves forward because of the amount of work on and in the basins.

The alternative evaluation is presented in Table 9-15. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$100,000, which is a moderate cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 9-15. Alternative Evaluation for Electrical Improvements (Project HS-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe when operating at night and when accessing select locations within the basin.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 349,000	\$ -	\$ 349,000	\$ 99,714	Not Applicable
	<i>Definition:</i>	Add additional lighting and receptacles at identified locations	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.7 I&C

9.2.7.1 Description of Existing System

Control System: The original control system at Hubbell Southfield was installed in 1996 under PC-694. Since then, several modifications to the original control system have taken place. In 2002 under PC-713, the facility's PLC control system was upgraded to interface with the Ovation system to enable remote monitoring and control the facility from SCC. In 2009, PC-761 replaced the control system and workstations with new Allen Bradley ControlLogix redundant PLCs and new operator workstations with Factory Talk View SE software. The existing hardwired back-up control panel and other miscellaneous PLCs and subsystems are incorporated into the overall control system. The current system is equipped with a back-up radio system to communicate critical monitoring points back to the SCC on wide area network failure.

The current PLC control system and back-up panels are obsolete and do not meet GLWA SCADA Governance standards, which stipulate that all CSO facilities use Ovation workstations with high-performance graphics.

Flow and Level Sensors: Table 9-16 summarizes the level sensors and flow meters at the Hubbell-Southfield CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 9-16. Summary of Flow Meters and Level Sensors at Hubbell-Southfield CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent channel (Upstream of inflatable dams)	2	Transit-Time (AccuSonic)
Shunt Channel (Shunt and bypass)	2	Transit-Time (AccuSonic)
Dewatering Flow	1	Magnetic
CSO Facility Level Sensors		
Influent channel (Upstream of inflatable dams)	2	Ultrasonic
Shunt Channel (Shunt and bypass)	2	Ultrasonic
Screening area (upstream and downstream of bar racks)	2	Ultrasonic
Basins	2	Ultrasonic
Dewatering Wells	2	Ultrasonic
Effluent Channel	1	Ultrasonic
Rouge River	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed	1	Ultrasonic

9.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- Evaluate level sensors and flow meters to determine redundancy and identify sensors or meters that could potentially be removed. Jacobs further evaluated this issue and found that the flow meter in the Shunt Channel is redundant to the flow meters for the Bypass Channel and Influent Channel and could possibly be eliminated. Under the current operation of first flush capture, the Shunt Channel flow meter provides the flow

rate for flow to Basin 2 (after Basin 1 is full) and flow to the Bypass Channel (when the Bypass gates are open). Since there is a flow meter on the influent and one on the Bypass, the Shunt Channel flow meter is redundant and could be removed. However, it does provide redundancy if the Influent flow meter fails and it was recently replaced. It is recommended that the Shunt Channel flow meter be considered for elimination when it is near the end of its useful life.

- Need for remote control capability of the Chemical Feed area from the Control Building
- Need for remote control of VR-8 gate. This need is scheduled to be addressed in Spring 2021 by SCC under CS-090A. This project will provide remote control of this gate from either the Hubbell Southfield CSO Basin or SCC.
- Need for local remote control for dewatering pumps
- Need for tank level indication at Chemical Fill Station
- Need for process cameras at select locations
- Update Ovation control system to the latest version and increased monitoring capabilities

9.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project HS-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, all of the identified I&C improvements, with the exception of the Ovation Control System Upgrade, are proposed to be in one project – I&C Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing**

2) **Alternative 2: I&C Improvements** including,

- Provide remote control capability of the Chemical Feed area from the Control Building
- Provide local remote control for dewatering pumps
- Provide tank level indication at Chemical Fill Station
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Provide remote control capability of the Chemical Feed area from the Control Building. A Remote I/O panel will be required at the Chemical Feed area which will be connected to the Control Building via a fiber optic cable. The Remote I/O panel will interface with the existing motor starter control circuits to be able to operate the equipment remotely.

Provide local remote control for dewatering pumps. Provide local control for the four Dewatering Pumps in accordance with Section 5.4.9.

Provide tank level indication at Chemical Fill Station. Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 9-17. The sources of costs used in this evaluation are listed in the following bullets:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

- The increased O&M costs for the remaining improvements in Alternative 2 are difficult to quantify and would not affect the alternative evaluation. Similarly, it is difficult to quantify the monetary benefits of the improved operations through the improved monitoring and control.

This evaluation shows that Alternative 2 – I&C Improvements has a total benefit score about 0.3 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and ease of O&M provided by the various I&C improvements. The NPV/Benefit cost for Alternative 2 is \$120,000, which is a moderate cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – I&C Improvements is the recommended alternative.**

Table 9-17. Alternative Evaluation for I&C Improvements (Project HS-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	3.00	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 274,000	\$ 7,000	\$ 421,627	\$ 127,124	Not Applicable
	<i>Definition:</i>	Provide local control capability of the Chemical Feed area from the Control Building; provide local remote control for dewatering pumps; provide tank level indication at Chemical Fill Station; provide process cameras at select locations.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Control System Upgrade (Project HS-I&C-2). The current facility's PLC control system, network, workstations and control system back-up panels are obsolete and should be replaced in the near future. The control system does not meet GLWA SCADA Governance standards, which require that all CSO facilities use Ovation workstations with new high-performance graphics. GLWA's standards for local CSO facility's control systems can be either the latest Allen Bradley PLC system with Ovation workstations or a complete Ovation system. This approach is being used on an ongoing project at Leib, Seven Mile, and St. Aubin.

Because of the approach used on the ongoing project, there is only one overall control system alternative considered. The project should include decommissioning and removal of the original hardwired back-up local control panels. These local panels are no longer required with today's redundant control system processors and local Operator Interface Terminal (OIT) as local back-up to the facility's workstations.

Table 9-18 provides the summary of the **Control System Upgrade, which is the recommended alternative**. Capital costs are included in Volume 6 – Appendices, Appendix C under this project title. Consideration should be given to replacing various field instruments; however, these are not included in the capital costs.

Table 9-18. Alternative Evaluation for Control System Upgrade (Project HS-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 2,457,000	\$ -	\$ 2,457,000	\$ 819,000	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved performance, standardized HMI screens, can have standardized redundant "on-the-shelf" parts.	Capacity Enhancement	3						
	<i>Disadv.:</i>	No performance related disadvantages.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

9.2.8 Site

9.2.8.1 Description of Existing Site

The Hubbell-Southfield CSO Facility was constructed in 1994. The Hubbell-Southfield facility has two buildings situated on top of the basin, namely the Headworks Building over the north influent end of the basin and the Process Building over the dewatering pumps at the center of the basin. The access entrance to the site is through a 24-ft wide sliding vehicular gate. Security around the perimeter of the site is provided by an 8-ft high chain link fence. Site pavement consists of 9-in. reinforced concrete on undisturbed earth. There are no sidewalks near the basin. The access road from Rotunda Dr. to the basin consists of 10-in. asphalt on 12 in. of gravel base.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

9.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the section below.

- The existing 2-in NPW header line for flushing the basins provides insufficient pressure for washdown after storm event.
- Poor condition of the service drive around the basin
- Localized ponding of water on the basin surface. In the winter, this water freezes and causes safety concerns
- Poor condition of security fencing
- The detention ponds drainage from the gold course discharged over the access road creates an issue for GLWA vehicles driving through
- The following needs are generally preventative maintenance items intended to ensure that the site features or utilities are serviceable throughout their expected service lives.
 - Remove vegetation from the fence line around the perimeter of the basin
 - Re-caulk expansion joints at the base of the exterior walls around the Headworks and Control Buildings
 - Replace expansion joint membranes and expansion joint cover plates on the basin service drive.

9.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Flushing Water Pressure in Headworks Area (Project HS-Site-1). A 6-in. watermain services the Headworks Building and supplies the NPW service to the hose bibs in the basin. The 6-in. watermain is tapped from an 8-in. watermain outside of Headworks Building. The NPW is supplied through a 2-in. header that runs through the length of the basin with drop connections at hose bibs spaced approximately 100 ft apart. GLWA Operations staff

indicate that there is little pressure in the 2-in. NPW line for hose washdown inside the basin after a storm event. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area.** To increase pressure in the NPW line, it is recommended to demolish and replace approximately 950-ft of the existing 2-in. header in the basin with a 4-in. header (See Figures HS-SITE-1-ALT-2). The size of this header should be confirmed during detailed design.

The alternative evaluation is presented in Table 9-19. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and ease of O&M. The NPV/Benefit cost for Alternative 2 is \$33,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area, is the recommended alternative.**

Table 9-19. Alternative Evaluation for Flushing Water Pressure in Headworks Area (Project HS-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Insufficient water pressure for washdown after storm event.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area	Health and Safety	3	3.42	\$ 112,000	\$ -	\$ 112,000	\$ 32,780	Not Applicable
	<i>Definition:</i>	To increase the pressure in the non-potable water line, it is recommended to replace the existing 2" header with a 4" header in the basin.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier washdown	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	4						

Site Improvements (Project HS-SITE-2). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Site Improvements** including,
 - Resurface Service Drive Around Basin
 - Improve Basin Roof Surface Drainage
 - Replace Security Fencing
 - Culvert for Golf Course Drainage

Each of the site related improvements listed above are described further below:

Resurface Service Drive Around Basin: The existing service drive around the basin is in poor condition. The service drive along the east side of the basin consists of reinforced concrete slab, which is the roof of the Dearborn Channel and Shunt Channel. The remaining portion of the service drive that runs across the basin and then along the west side of the basin to the headworks building consists of 4-in. concrete topping reinforced with welded wire fabric (WWF) on top of double tee beams of the basin roof.

To restore the service drive along the east side, it is recommended to hydro-demolish the top surface of the Dearborn and Shunt Channels roof slab up to 2 in. below the top layer of reinforcement and reconstruct the slab. To restore the service drive across the basin and along the west side of the basin, it is recommended to hydro-demolish the entire 4-in. thick concrete topping and replace it with new air entrained reinforced concrete topping. The reconstruction of the slab along the east and west sides of the service drive should be sloped to provide drainage away from the structure and towards grassy areas.

It is noted that the hydro-demolition and reconstruction activities will require a temporary support system from below to maintain the integrity of existing structural systems (roof slab/double Tees) during construction activities. Representative concrete core samples should be taken and tested by a material testing company to check the integrity of the slabs prior to any demolition activities.

Improve Basin Roof Surface Drainage: There are numerous areas on the basin roof surface where localized ponding of water occurs (See Figure HS-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B). Ponding of water can become a safety issue for personnel who must navigate around these areas to access equipment or facilities during winter months when the surfaces turn to ice. It is recommended at the larger areas of ponding water that cores be made through the basin roof to drain the area. Recessed plaza deck drains should be installed in the cored holes to drain ponded water directly to the basin. As an alternative, to prevent stormwater from entering the basin, consideration could be given to piping the ponded water drainage on the underside of the basin through the basin exterior walls and discharge to drainage swales on either side of the basin. It is estimated that there are 10 to 15 significant sites of ponded water on the basin surface.

Replace Security Fencing: There are two locations where fencing needs to be replaced because it is in disrepair:

- The fencing at the entrance to the service drive from Rotunda Drive (see Figure HS-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B, for location). The fencing extends on the south side of the service road from Rotunda Drive to the gate on the service drive at the Tournament Players Club golf course maintenance building. This includes 360 ft of 5-ft tall cyclone fencing.
- The fencing on the north side of the access road from Rotunda Drive to the facility access gate (also shown in Figure HS-SITE-2-ALT-2 in Volume 6 – Appendices, Appendix B). This includes approximately 2,300 ft of 5-ft tall cyclone fencing.

It should be noted that the as-built drawings for this facility (PC-694) do not include fencing. As such, it appears the fencing was existing when the facility was built and may not be the responsibility of GLWA.

Culvert for Golf Course Drainage: Periodically, the Tournament Players Club golf course must drain detention ponds located on the course. This is generally accomplished by pumping pond contents through hoses and discharging over the access road to allow the water to drain to the Rouge River. To minimize soil erosion from this method of pumping, GLWA has proposed to create a drainage culvert beneath the access road so that the pond water can be discharged beneath the road rather than across its surface where it is tracked by GLWA vehicles. The new drain should be located beneath the access road in the vicinity of the Tournament Players Club Maintenance Building and should include a catch basin on the north side of the road and a rip rapped discharge with a headwall (or spillway) on the Rouge River side of the access road.

The alternative evaluation is presented in Table 9-20. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety, and ease of O&M. The NPV/Benefit cost for Alternative 2 is \$258,000. **Because of the improved drainage and safety and restoration of the road with Alternative 2 – Site Improvements, Alternative 2 is the recommended alternative.**

Table 9-20. Alternative Evaluation for Site Improvements (Project HS-SITE-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>		Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 902,000	\$ -	\$ 902,000	\$ 257,714	Not Applicable
	<i>Definition:</i>	Resurface Service Drive Around Basin; improve basin roof surface drainage; replace security fencing; culvert for Golf Course drainage	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved drainage & improved safety for accessing facility.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.9 Architectural

9.2.9.1 Description of Existing Facilities

The Hubbell-Southfield CSO Facility consists of Headworks Building and Process Building. The Headworks Building includes a screen room, chemical room, a mechanical room and an odor control room. The Process Building includes a control room, utility support (electrical and mechanical), odor control room, and other miscellaneous rooms. The facility also includes the retention basin.

9.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a roof replacement evaluation and a detailed assessment of architectural issues, as described in the following paragraphs.

Evaluation of Type of Future Roof Replacement. Jacobs reviewed the results of a roof assessment and prepared a 60-year life-cycle cost analysis between shingled roof and metal roof. Based on the results of this evaluation, which shows lower life cycle cost for shingled roof, Jacobs recommends replacement of the shingled roof with shingles when the roof is ready for replacement. The analysis is presented in Table 9-21. As such, the roof should be replaced in-kind and the costs and schedule for the roof replacement will come from the SRP.

Table 9-21. 60-Year Life Cycle Cost Evaluation of Shingled vs. Metal Roof for Hubbell-Southfield Facility

	Shingle Roof	Metal Roof
Replacement Cost ¹	\$282,000	\$940,000
Replacement Interval	20 years	60 years
Number of Roof Replacements During 60 Years	3	1
Total Life Cycle Cost (NPV) Discounted at 2.4%	\$766,000	\$940,000

¹ Based on 18,800 ft² roof area; \$15 ft² for shingle roof and \$50/ft² for metal roof.

CS-299 Architectural Assessment: Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

9.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (HS-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove and replace isolation/ cove joint sealant and around building perimeter
 - Install floor expansion joint in Process Building
 - Paint wood truss and plywood roof deck in Process Building
 - Remove corrosion on bollards, and clean and coat
 - Remove existing paint, clean and paint wood roof deck and framing
 - Install vertical expansion joint and repair concrete and wall in Headworks Building
 - Replace damaged/stained/missing acoustic ceiling tiles in Process Building
 - Address door hardware issues
 - Caulk gap of fascia board on Process Building

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings (Figure HS-ARCH-1-ALT-2) in Volume 6 – Appendices, Appendix B. Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 9-22. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, Alternative 2 is the recommended alternative.

Table 9-22. Alternative Evaluation for Architectural Rehabilitation (Project HS-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 371,000	\$ -	\$ 371,000	\$ 119,677	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

9.2.10 Safety

9.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

9.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 9-23. The capital improvement project to address these issues is included in the table.

Table 9-23. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Headworks	Mid-rail missing between bar screen 2 and 3	Add mid rail	Safety Improvements (Project HS-SAFE-1)
Basin Odor Control Room	At top of ladders, mid-rail chain needed	Add swing gate (original recommendation was to add chain; however, this is no longer current GLWA practice)	Safety Improvements (Project HS-SAFE-1)
Process Building Odor Control Room	Eyewash 0922552 too low	Adjust height of eyewash	Eyewash/Shower Improvements (Project HS-SAFE-1)
Basin Odor Control Room	Eyewash 0947279 too low	Adjust height of eyewash	Eyewash/Shower Improvements (Project HS-SAFE-1)
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project HS-SAFE-1)

9.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project HS-SAFE-1). This project should address the safety issues identified above. These issues include:

- Extend railing between bar screen #2 and #3 to eliminate fall hazard
- Add swing gate at top of ladders in the basin odor control room
- Adjust height of eyewash in the Process Building odor control room and basin odor control room
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 9-24 shows the one alternative.

Table 9-24. Alternative Evaluation for Safety Improvements (Project HS-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	5	3.78	\$ 158,000	\$ -	\$ 158,000	\$ 41,762	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection, eye wash.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

9.2.11 Supporting Infrastructure

9.2.11.1 Description of Existing System

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above.

9.2.11.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the following section.

- The VR-8 Regulator upstream of the Hubbell-Southfield CSO Facility is located in the center median of Michigan Avenue east of the Southfield Freeway. The VR-8 Regulator consists of two stainless steel slide gates that are adjusted by SCADA control to regulate flow from the Hubbell-Southfield sewer to the NWI. A rehabilitation project was designed in 2013 by Metco, but not implemented. Rehabilitation of the VR-8 Regulator is still needed. It should be noted that the control system for the regulator is being upgraded in early 2021 under Project No. CS-090A. This upgrade will provide remote control of the two regulator gates from the Hubbell Southfield CSO Facility or SCC.

9.2.11.3 Discussion and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

VR-8 Regulator Rehabilitation (Project HS-SUPP-1). As described in the 2013 Final Basis of Design Report by Metco, the rehabilitation of the VR-8 Regulator included 1) Replacement of the slide gates and actuator; 2) SCADA system modifications; and 3) Access improvements in the median near the gates and control panel. As noted above, the SCADA system modifications are being addressed as part of a control system project. As such, Jacobs based the proposed rehabilitation on the cost estimate generated for this project (inflated to current dollars), excluding the SCADA system improvements. It was noted in the Metco report that the access improvements using geoblock units had not been approved by the Michigan Department of Transportation. These details would need to be resolved during detailed design.

The alternative evaluation is presented in Table 9-25. The capital cost is included in Volume 6 – Appendices, Appendix C under this project title. Since this is rehabilitation of an existing system, there is only one alternative considered. As such, **Alternative 1 is the recommended alternative.**

Table 9-25. Alternative Evaluation for VR-8 Regulator Rehabilitation (Project HS-SUPP-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	VR-8 Regulator Rehabilitation	Health and Safety	3	3.00	\$ 1,956,000	\$ -	\$ 1,956,000	\$ 652,000	Best Value Alternative
	<i>Definition:</i>	Replacement of the slide gates and actuator; and access improvements in the median.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Maintains system reliability and functionality.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

9.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Hubbell Southfield CSO facility, Table 9-26 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 9-26, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 9-26. Listing of Asset Condition Assessments for Hubbell Southfield Facility

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	45	45	0	100%
AHU	5	0	5	100%
AIRDRYER	1	1	0	100%
BACKFLOW	8	8	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	2	2	0	100%
BUILDING	4	2	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	3	3	0	100%
COND-AIR	2	2	0	100%
CONVEYOR	1	0	1	100%
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A
DAM	2	0	2	100%
DAMPER	3	3	0	100%
DISCONNECT	0	0	0	N/A
DOOR	3	3	0	100%
DRIVE-ELEC	5	5	0	100%
ELEVATOR	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	6	6	0	100%
FAN	2	0	2	100%
FANVENT	20	20	0	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	0	0	0% ^b
GASMONITOR	4	4	0	100%
GATE	26	26	0	100%
GEARBOX	7	0	7	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	0	0	0	N/A
MCC	6	0	6	100%
METER	7	7	0	100%
MIXER	23	23	0	100%
MOTOR	16	7	9	100%
PANEL	13	13	0	100%
PIPING	4	4	0	100%
PUMP	21	10	8	86% ^c
ROOF	2	2	0	100%
SAMPLER	0	0	0	N/A
SCADA	3	3	0	100%
SCREEN	6	0	6	100%
SCRUBBER	2	0	2	100%
SENSOR	12	12	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	1	1	0	100%
SWITCH	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	2	2	0	100%
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	1	0	1	100%
UNITHEATER	0	0	0	N/A
UPS	3	3	0	100%
VALVE	26	26	0	100%
WATERHTR	0	0	0	N/A

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is not an asset. Another one of the building asset listed as "PLANNING - ORDERING PARTS/FILLING OUT WORK ORDER/COMPLETING INVENTORY OF PARTS ON HAND. (FOR ELECTRICIANS, MILLWRIGHTS and PLUMBERS ONLY)", which is also not an asset.

^b The one gas detector is a portable unit and was not assessed.

^c Two pumps are listed in WAM - Basin 1 Sample Pump and Shunt Channel Sample Pump. These umps are being considered for removal from WAM.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Hubbell-Southfield Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

9.3 Capital Planning for Hubbell-Southfield CSO Facility

9.3.1 Summary of Capital Improvement Plan Projects

Table 9-27 provides a summary of the recommended CIP projects and associated capital costs for the Hubbell Southfield CSO facility based on the alternative evaluations conducted for this facility.

Table 9-27. Summary of Recommended Projects at Hubbell-Southfield CSO Facility

Project No.	Alternative	Description	Total Project Cost
HS-SCR-1	2	Screening Improvements	\$ 195,000
HS-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 534,000
HS-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
HS-DIS-3	2	Add a New Chemical Storage Tank	\$ 753,000
HS-FD-1	3	New Basin Flushing System	\$ 24,800,000
HS-FD-2	2	Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System	\$ 950,000
HS-FD-3	2	Provide Equipment Access to Effluent Channel	\$ 126,000
HS-ELEC-1	2	Electrical Improvements	\$ 349,000
HS-I&C-1	2	I&C Improvements	\$ 274,000
HS-I&C-2	1	Control System Upgrade	\$ 2,457,000
HS-HVAC	N/A	Process Building Air Balance Study	\$ 5,000
HS-SITE-1	2	Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area	\$ 112,000
HS-SITE-2	2	Site Improvements	\$ 902,000
HS-ARCH-1	2	Architectural Rehabilitation	\$ 371,000
HS-SAFE-1	1	Safety Improvements	\$ 158,000
HS-SUPP-1	1	VR-8 Regulator Rehabilitation	\$ 1,956,000

9.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 9-28. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 9-28. Capital Improvement Plan Projects for Hubbell-Southfield CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
HS-1 Disinfection System Improvements	\$ 1,507,000	2029 <i>Timing based on asset condition</i>	HS-DIS-1	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 534,000
			HS-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
			HS-DIS-3	Add a New Chemical Storage Tank	\$ 753,000
HS-2 Flushing System Improvements	\$ 27,239,000	2026 <i>Timing based on safety issues</i>	HS-FD-1	New Basin Flushing System	\$ 24,800,000
			HS-FD-2	Upgrade Basin Dewatering Pumps and Reinstall Sump Pumps and Fluidization System	\$ 950,000
			HS-FD-3	Provide Equipment Access to Effluent Channel	\$ 126,000
			HS-ELEC-1	Electrical Improvements ^a	\$ 349,000
			HS-SITE-1	Increase Flushing Water Pressure and Add Hose Bibs in Headworks Area	\$ 112,000
			HS-SITE-2	Site Improvements ^b	\$ 902,000
HS-3 Facility-Wide I&C Improvements	\$ 2,731,000	2029 <i>Timing based on asset condition</i>	HS-I&C-1	I&C Improvements	\$ 274,000
			HS-I&C-2	Control System Upgrade	\$ 2,457,000
HS-4 VR-8 Regulator Rehabilitation	\$ 1,956,000	2030 <i>Timing based on best judgment</i>	HS-SUPP-1	VR-8 Regulator Rehabilitation	\$ 1,956,000
HS-5 Facility-Wide Safety and Architectural Improvements	\$ 529,000	2023 <i>Project should be initiated as soon as possible</i>	HS-ARCH-1	Architectural Rehabilitation	\$ 371,000
			HS-SAFE-1	Safety Improvements	\$ 158,000

Notes:

^a Electrical Improvements were combined with Flushing System Improvements because most of electrical improvements are related to lighting within and on top of basin.

^b Site Improvements were combined with Flushing System Improvements because road around basin will likely need to be repaired after construction.

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 9-29 and Table 9-30 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 9-29 indicates that HS-DIS-1 project has 12 assets that has an average condition score of 1.57 and an average replacement date of 2029. This information was used to propose a scheduled construction completion date of 2029.

Table 9-29. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
HS-DIS-1	12	1.57	1.57	2.86	12	2029	\$ 969,900
HS-FD-2	3	1.57	1.20	2.51	20	2039	\$ 302,100
HS-I&C-1	4	1.14	1.23	1.85	14	2033	\$ 447,179
HS-I&C-2	3	2.29	1.57	4.08	12	2029	\$ 1,481,175

Table 9-30. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
HS-DIS-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
HS-FD-2	3	1.38	5.00	4.83	20	2021	\$ 126,900
HS-I&C-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
HS-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -

There is a recommended capital improvement project presented in Table 9-28 that could be better delivered under capital outlay projects. This project is listed in the following bullet:

- Screening Improvements (HS-SCR-1)

9.3.3 20-Year Capital Outlay Plan

Table 9-31 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 9-31. 20-Year Capital Outlay Plan for Hubbell-Southfield CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 461,382	\$ 7,482	\$ -	\$ -	\$ -	\$ 453,900	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 336,501	\$ -	\$ -	\$ 313,841	\$ 22,660	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 46,226	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 46,226	\$ -	\$ -	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 1,404,270	\$ -	\$ -	\$ -	\$ 1,285,218	\$ -	\$ 115,608	\$ 3,444	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,945,736	\$ -	\$ 15,428	\$ 53,999	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1,876,308	\$ -	\$ -	\$ -
2030	\$ 1,057,677	\$ 19,833	\$ -	\$ -	\$ 767,207	\$ -	\$ 171,466	\$ -	\$ -	\$ -	\$ 99,172	\$ -	\$ -
2031	\$ 498,895	\$ 19,218	\$ -	\$ 357,885	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 121,792
2032	\$ 551,340	\$ -	\$ -	\$ 25,288	\$ -	\$ -	\$ 526,052	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 1,383,384	\$ 13,217	\$ 399,963	\$ -	\$ -	\$ -	\$ -	\$ 970,204	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 1,433,863	\$ 56,420	\$ -	\$ 986,965	\$ 179,091	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 211,388	\$ -	\$ -
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 3,861,037	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,861,037	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 3,645,566	\$ 1,508,672	\$ -	\$ -	\$ -	\$ 1,227,138	\$ 136,195	\$ 285,133	\$ -	\$ -	\$ -	\$ 488,428	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 16,625,877	\$ 1,624,841	\$ 415,392	\$ 1,737,978	\$ 2,254,175	\$ 1,681,038	\$ 949,321	\$ 1,258,781	\$ 3,907,263	\$ 1,876,308	\$ 310,560	\$ 488,428	\$ 121,792

Notes:

Explanation of large capital outlays in first two years:

- Retention System: Influent slide gate (ISG-2) received a score of 5 at the time of the Condition Assessment since the actuator was on the ground and not mounted to the gate.
- Pumping System: Flushing Water Pump (FWP-2; \$327,000) received a score of 5 since the unit was out of service at the time of the Condition Assessment. Dewatering Pump No. 4 (\$100,700) was not functional during electrical testing at the time of the assessment. The two immersible sump pumps (ISMP-1 and 2; \$13,100 each) have been removed from service for some time.

10. Leib CSO Control Facility

10.1 General Facility Description and Future Capacity Considerations

10.1.1 General Facility Description

The Leib CSO Facility is an SDF with 9.9 MG of storage, and a treatment capacity of 1,550 cfs. It was constructed in 2002. The facility has a nearly 1-mile long effluent conduit used for disinfection contact time before discharge into the Detroit River. The facility consists of a Headworks area in the basement, chemical room, utility support (electrical, emergency generator and mechanical rooms), control room, sample room, supply fan room and other miscellaneous rooms. The facility also includes an underground outfall vault.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

10.1.2 Future Capacity Considerations

The WWMP recommended projects to increase wet weather flows to existing CSO facilities to maximize the use of the facilities and minimize the construction of additional facilities. Many of the CSO facilities do not reach their design flows, so there is an ability to accept additional flows, without exceeding their design capacity.

The Meldrum Diversion Sewer to the Leib CSO Facility is one of the recommended projects from the WWMP that will increase flows to the existing Leib CSO facility. The magnitude of the increased flows and the potential impact on screening and disinfection performance is described below.

This project originated from the WWMP and involves diverting the Meldrum sewer to the Leib CSO facility by constructing 350 ft of 5-ft diameter diversion sewer along Waterloo just upstream of the Leib facility. See Figure 10-1 for the layout of this new diversion sewer. The Leib CSO facility was designed to treat 1,550 cfs and hydraulically pass 2,000 cfs. The design hydraulic grade line (HGL) conditions are between elevation 110.5 and 111.5 ft, with a peak hydraulic capacity of 2,000 cfs, and a Toward Treatment Sewer capacity limited to 150 cfs.

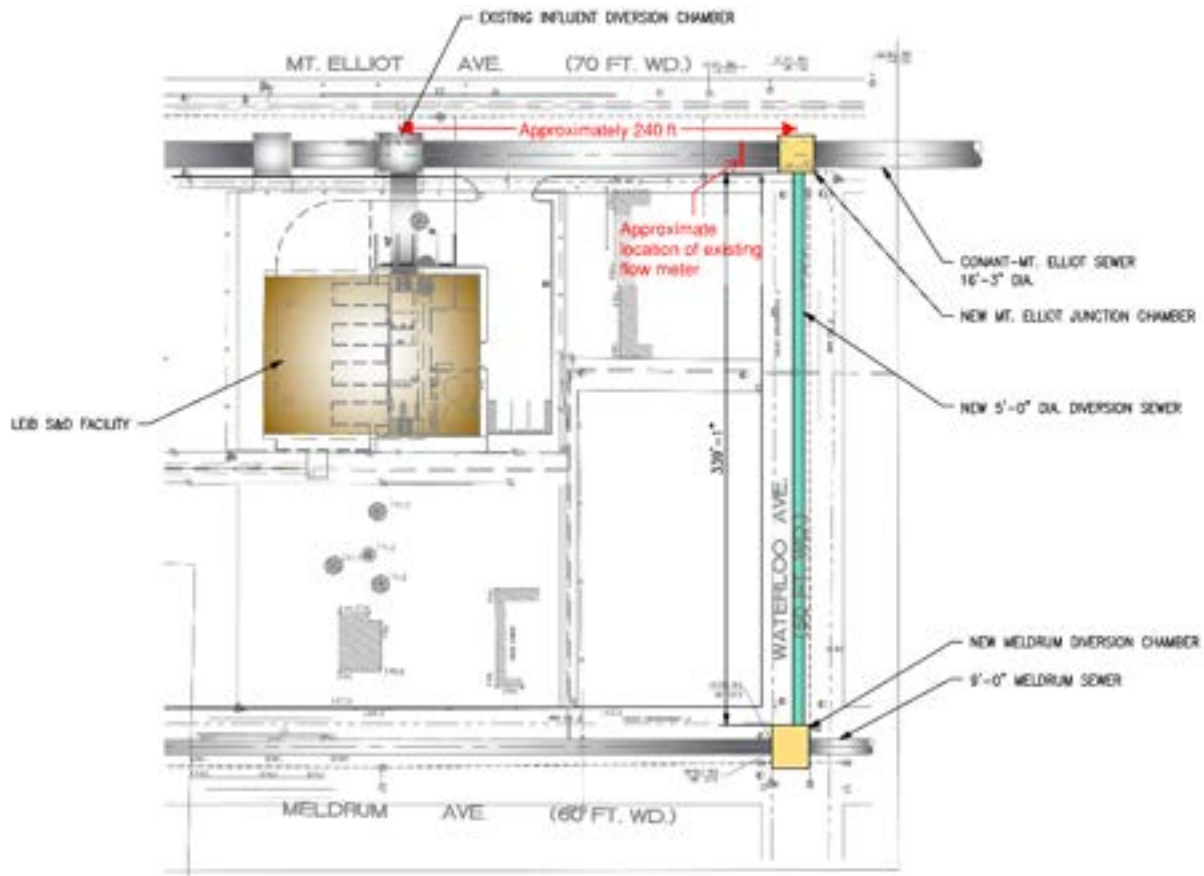


Figure 10-1. Layout of Proposed Meldrum Sewer Diversion near the Leib CSO Facility

The Regional Wastewater Collection System Model was used during the WWMP to predict the change in hydraulic grade line for the Leib facility for the 10-year 24-hour storm event. The WWMP reports that the 10-year 24-hour storm will add a peak flow of 427 cfs, and the HGL within the Leib CSO facility will stay within the critical elevation of El 589.72 (109.97 Detroit datum) at the crown of the Conant Mt. Elliot Sewer.

10.2 Facility Assessment

10.2.1 Screening

10.2.1.1 Description of Existing System

The Leib CSO Facility has two types of screens: 1) raked horizontal bar screen (original manufactured by COPA) and 2) raked vertical bar screens (manufactured by ROMAG). Constructed in 2002, the facility was intended to be a full-scale pilot facility for this type of fine screen. There are four screening channels in the facility, with a total of eight COPA screens and a total of four ROMAG screens.

During dry weather, raw sewage is routed through the facility and to the Toward Treatment Sewer. During wet weather events, the flow increases, and the flow enters the screening channels as the wet weather flow exceeds the capacity of the Toward Treatment Sewer.

Screenings are retained in the screening channels during the storm. After the storm event, the screenings are conveyed to the Toward Treatment Sewer and then the DRI for eventual removal at the WRRF.

The COPA screens recently received a complete overhaul in 2019. The existing ROMAG screens were also rebuilt in 2019; however, the control panels and power packs were not upgraded.

Table 10-1 provides an overview of the existing screening system at Leib CSO facility.

Table 10-1. Overview of Existing Screening System Leib CSO Facility

Parameter	Value	
Treatment Capacity (cfs)	1,550	
No. of Screens	4 (2 in each of 2 channels)	8 (4 in each of 2 channels)
Manufacturer	Westech ROMAG	COPA
Screen Type	Raked Vertical Bar Screen	Raked Horizontal Bar Screen
Opening Size	4-mm spacing	4-mm spacing
Depth or Length	29 ft 6 in	17 ft 0 in
Width	4 ft 0 in	4 ft 0 in
Screen Cleaning	Mechanical Comb	Mechanical Comb
Screening Removal	Conveyed to Toward Treatment Sewer and then to WRRF	

10.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issue was identified related to the screens:

- ROMAG screens are preferred over COPA for future screens: The screens at the facility are a combination of ROMAG vertical screens and COPA horizontal screens. Having dissimilar maintenance and operating characteristics presents a challenge for the GLWA O&M staff. In consideration that this facility was intended to be a "pilot" facility testing different technologies, it is reasonable to conclude, as it approaches 20-years in age, that some technologies should win out over others. In the case of the screens, the ROMAG screens present the simpler and easier O&M characteristics and therefore standardizing on these screens at this time, when major maintenance or rehabilitation is in the future for both screens, makes sense.
- The ROMAG screens offer a hydraulic benefit of allowing peak flows to overflow the top of the screen (this is not possible with the COPA screens). Although the portion that overflows does not receive screening, it does provide a hydraulic bypass for peak flows so that the screens are not overloaded or damaged. This is an important feature with the addition of the Meldrum Diversion Sewer in the near future.

10.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Screen Replacement (Project LIEB-SCR-1). The ROMAG screens present the simpler and easier O&M characteristics and therefore standardizing on these screens at this time makes sense. There are two alternatives with this option:

- Alternative 1: Replace Existing COPA Screens In-Kind.** This alternative would replace the existing eight COPA screens in-kind.

2) **Alternative 2: Replace Existing Screens with ROMAG Screens.** This project would replace the existing eight COPA screens with four ROMAG screens (Model RSW12x8/4) to make all the screens similar at the facility. The following modifications would be required for the replacement:

- **Structural Modifications:** A notch will need to be created in the channel concrete wall that the ROMAG screen will rest on, to match the existing ROMAG screen design.
- **Control Panel Upgrades:** The new ROMAG screens have new standard sequence of operations, updated electrical devices and controls. The controls for the existing ROMAG screens should be upgraded with these new items, as follows:
 - A touch screen operator interface to provide better functionality to adjust various setpoints.
 - New control functions including short stroke, blocked carriage, pressure settings in each direction, repeat cycle timer, park at home positioning, and level on and off settings.
 - The solenoid valve used on the carriage on the existing ROMAG screens should be replaced with an electrically actuated valve which changes the valve position according to the pressure setting that is seen by the cylinder. The new ROMAG screens will come with the electrically actuated valve used on the carriage.
 - The sequence of operation should be changed to eliminate the intermittent operation of the rake, which would maximize the cleaning frequency regardless of the liquid level once the screen is activated.
 - An ambient temperature thermostat should be installed and when the ambient temperature reaches less than 35°F, the control sequence to cycle the oil weekly would be disabled during periods of freezing temperatures. This will avoid a fault condition when the materials stuck to the screens freeze during winter months.

The alternative evaluation is presented in Table 10-2. The sources of costs used in this evaluation are listed below:

- Capital costs for Alternative 1 were obtained from the screen replacement costs of the SRP.
- Capital costs for Alternative 2 are presented in Volume 6 – Appendices, Appendix C under this project title.
- Although there are O&M benefits to having all the same screens (i.e., similar spare parts and needed familiarity with only one screen type), the difference in O&M costs for the COPA and ROMAG is difficult to monetize. As such, O&M costs are not included in this analysis. This issue, however, is reflected in the Ease of O&M scores.

This evaluation shows that Alternative 1 is the Best Value Alternative. Because of the large difference in capital costs between the two alternatives, **Alternative 1 - Replace Existing COPA Screens In-Kind is the recommended alternative.**

Table 10-2. Alternative Evaluation for Screen Replacement (Project LEIB-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace COPA Screens In Kind	Health and Safety	3	2.78	\$ 3,524,000	\$ -	\$ 3,524,000	\$ 1,266,108	Best Value Alternative
	<i>Definition:</i>	Replace In Kind	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Need to maintain two different types of screens.	Component Performance	3						
	<i>Comments:</i>	Note: This is only replacing the COPA screens with COPA screens. The existing ROMAG screens are not included.	O&M Ease	2						
2	<i>Alt. Name:</i>	Replace Existing COPA Screens with ROMAG Screens	Health and Safety	3	3.55	\$ 6,224,000	\$ -	\$ 6,224,000	\$ 1,753,239	
	<i>Definition:</i>	Replace Existing COPA Screens with ROMAG Screens	Water Quality & Compliance	3						
	<i>Adv.:</i>	ROMAG screens offer a hydraulic benefit of allowing peak flows to overflow the top of the screen. Also, all screens would be identical, making maintenance and spare parts more efficient	Capacity Enhancement	4						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	Note: This is only replacing the COPA screens. The existing ROMAG screens are not included.	O&M Ease	5						

10.2.2 Disinfection

10.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP tanks, six low-rate diaphragm pumps, two high-rate centrifugal pumps, four disinfectant rapid mix zones, and 18 induction mixers. There are two channels with four ROMAG screens and two channels with Copa screens discharging into a screened effluent channel. From there screened effluent flows to four disinfectant rapid mix zones. There are four induction mixers per disinfectant rapid mix zone consisting of one pair of mixers upstream and one pair of mixers downstream of a concrete baffle wall that directs all flow down and past the mixers. There are also two induction mixers in the influent channel upstream of screening referred to as prechlorination mixers. Four of the low-rate sodium hypochlorite pumps are each paired to a disinfectant rapid mix zone. Flow is metered from each pump and then flow is split in a manifold to the four induction mixers in each disinfectant rapid mix zone. The manifold includes a solenoid valve, manual valve, and a sight flow indicator to each induction mixer. Flow splitting between induction mixers is primarily dependent on equal back pressure valve settings to the induction mixers. The other two low-rate sodium hypochlorite pumps are each paired to one of the influent channel mixers. The two high-rate pumps discharge to a four-way manifold with flow metering on each branch. These tie into the discharge from the four low-rate pumps upstream of the manifold to each disinfectant rapid mix zone. There are also valved connections allowing the high-rate pumps to be used for the influent channel induction mixers.

The design which was intended to provide redundancy and flexibility is atypically complex and results in the manifolds including valves and sight flow indicators to be inaccessible due to their height on the wall. Table 10-3 provides an overview of the existing disinfection system at Leib CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G

Table 10-3. Overview of Existing Disinfection System at Leib CSO Facility

Parameter	Value
Treatment Capacity (cfs)	1,550
Design Feed Strength (% hypochlorite)	7.5
Max. Dosage at Design Flow (mg/L Cl ₂)	38
Disinfection Contact Time (min)	10
Storage Tanks	
Number	2
Volume of Each Tank (gal)	10,450
Type	FRP
Pumps	
Number	8 Total; 6 low-rate, 2 high-rate
Capacity (gpm)	Low-rate: 7.6, High-rate: 112
Type	Low-rate: Diaphragm, High-rate: Centrifugal
Mixers	
Number / Type	18 / Chemical induction mixers
Model Number / hp / Manufacturer	SWC15FX / 15 hp / Water Champ

10.2.2.2 Identified Needs and Issues

The needs and issues identified for Leib were identified from meetings with O&M staff and Jacobs team site visit and investigations. These needs and issues are listed in the following bullets :

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Leib chemical feed system has the following issues:
 - Pumps are expensive to maintain and replace
 - Complex piping with a high number of components
 - Inaccessible manifold components due to height on wall
 - The VFDs and electrical equipment are located in the corrosive environment of the chemical room
 - The chemical feed pump and motor are difficult to remove from the containment area
 - Currently, a hose must be moved and connected to each pump suction pipe to flush the hypochlorite solution from the feed system with NPW. A hard-piped flushing water connection is desired so that flushing could be accomplished by opening a valve to each pump.
 - The chemical room floor has been damaged due to a chemical leak from one of the storage tanks.

These issues are addressed in Replace Chemical Feed System (Project LEIB-DIS-1) below.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project LEIB-DIS-2) below.
- There are 18 chemical induction mixers that require relatively frequent and costly maintenance. This issue is addressed in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project LEIB-DIS-3).

10.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project LEIB-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, LEIB-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

Each of the alternatives above would include provisions to address the additional concerns specific to the Leib feed system:

- For cost estimating purposes, water piping and valving to each feed pump was assumed to allow water flushing for the entire chemical feed system from the feed pumps to the mixers.
- Move VFDs and electrical equipment out of the chemical room.
- For cost estimating purposes, a mast type jib crane (similar to the one described for Conner Creek) is assumed for moving the pumps and motors up and down the flight of stairs. The actual configuration should be included in the detailed design of a modified chemical feed system.

The alternative evaluation for these alternatives is presented in Table 10-4. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP and include pump replacement at Year 10.
- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 were estimated based on manufacturer pump rebuilds at a cost of \$20,000 per year and GLWA onsite rebuilds at a cost of \$24,000 per year.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 10-4 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 10-4. Alternative Evaluation for Replace Chemical Feed System (Project LEIB-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System In-Kind	Health and Safety	3	2.08	\$ 1,262,400	\$ 44,000	\$ 2,190,344	\$ 1,051,365	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 1,724,000	\$ 26,750	\$ 2,288,148	\$ 635,597	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 901,000	\$ 3,000	\$ 964,269	\$ 267,852	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project LEIB-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Operation in manual at Leib is noted by operations as being extremely difficult. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose through the use of an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The influent flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on influent flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the facility to analyze TRC concentrations to further adjust chemical feed flows.

The sample point should be located approximately 15 minutes travel time downstream of the dosing point at average flow but peak flow travel time and the future additional flow from Meldrum diversion must also be considered. The exact location would be determined during design. The original design included a sample pump about 50 ft from the mixing chamber. The appropriateness of this location should be evaluated during design. However, the operability of this pump is not known because it is not currently used for sampling. Given the uncertainties regarding whether this sample point and the condition of the sample pump, the cost for a new manhole to access a sampling pump in the effluent conduit was included. A buried pipe was assumed in the cost estimate to convey the sample flow into the existing building where the TRC analyzer would be located.

The automatic chemical feed system will require less operator input during an event. However, there will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 10-5. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains functional between storm events.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 10-5. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project LEIB-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less efficient chemical feed and possible overdosing of chemical.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 220,000	\$ 4,860	\$ 322,496	\$ 93,477	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more efficient use of chemical.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common at CSO facilities, but TRC-pacing is difficult with infrequent CSO facility use.	Component Performance	4						
	<i>Comments:</i>	O&M to maintain analyzers based on 4 hrs/month.	O&M Ease	2						

Reduce Cost Associated with Large Quantity of Chemical Induction Mixer (Project CON-LEIB-3). Plant personnel report that the mixers are expensive to maintain and due to the sealed nature of submersible mixers they must be sent back to the manufacturer for maintenance which adds shipping cost and takes months before the mixer is returned to service. The Leib facility has 16 chemical induction mixers in the mixing channels (and 2 pre-chlorination mixers, which would remain). A reduction in the number of mixers would reduce maintenance and the associated expense proportionate to the reduction. It would also reduce the complexity for equal flow splitting between mixers.

The alternatives to address this issue were identified previously in Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Section 5.2.4); however, due to facility constraints, vertical shaft mixers would not be feasible at this location, so that option is not included. The alternatives include:

- 1) **Alternative 1. Replace Existing Chemical Induction Mixers In-Kind.** This alternative assumes replacement of the mixers in-kind.
- 2) **Alternative 2. Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers.** Computation fluid dynamic (CFD) modeling is assumed to be required to demonstrate to EGLE the adequacy of a lesser number of mixers. For illustration purposes, it is assumed that the number of mixers can be reduced by half (i.e., from four to two per channel). This needs to be confirmed by collection system modeling performed by others. Capital and O&M costs per mixer are identical to Alternative 1.

The alternative evaluation is presented in Table 10-6. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternatives 1 and 2 includes mixer replacement in-kind at the number of mixers shown. Capital costs are based on the SRP replacement cost of \$50,000 per mixer and a 10-year life. Because the life-cycle period is 20 years, the capital costs assume replacement of the mixers twice during the 20-year period.
- For Alternative 2, the cost of the CFD model is assumed to be \$50,000.
- The O&M costs for mixer replacement in Alternatives 1 and 2 is based on current costs for repairing a chemical induction mixer. It is assumed the mixer needs to be repaired every 2.5 years at a cost of \$15,500 per mixer.

This evaluation shows that Alternative 2 – Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers is the Best Value Alternative. As such, **Alternative 2 – Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers is the recommended alternative.**

It should be noted that the cost of the reduced number of mixers is not a new capital improvement cost for GLWA. Rather, it was used in this evaluation to compare alternatives. The cost for the CFD modeling would likely be included in a capital outlay, not a capital improvement project. If the CFD modeling does not prove that disinfection performance can be achieved, the number of mixers would remain the same as the current number.

Table 10-6. Alternative Evaluation for Reduce Cost Associated with Large Quantity of Chemical Induction Mixers (Project LEIB-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace Existing Mixers in-kind	Health and Safety	3	2.57	\$ 1,600,000	\$ 84,800	\$ 3,388,401	\$ 1,320,156	
	<i>Definition:</i>	Replace existing mixers as required.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, lots of redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Expensive and impacts operations and maintenance. Equipment installed in basins.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	Health and Safety	3	3.00	\$ 850,000	\$ 42,400	\$ 1,744,200	\$ 581,400	Best Value Alternative
	<i>Definition:</i>	Perform computational fluid dynamics (CFD) model of basin and determine required number	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system, maintains required redundancy.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less expensive and less impacts to operations and maintenance. Equipment installed in	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

10.2.3 Odor Control

There is no odor control system at the Leib facility. Building space for a carbon adsorber system, space in the electrical room for the fan motor, and a duct penetration to the screening facility below grade were provided, if odor control is needed in the future. However, odor complaints have not been received for this facility since it has been in operation. Therefore, an odor control system is not needed and, therefore, there are no associated "needs."

10.2.4 Flushing and Dewatering

10.2.4.1 Description of Existing System

The Leib CSO Facility does not have a dedicated dewatering or flushing system for the screening and disinfection area. The facility drains by gravity and, due to the limited use, solids accumulation has not been a major issue at this facility, with the exception of the screening channels, which are discussed in the next section.

The outfall conduit has dewatering pumps to dewater the lower portion of the effluent conduit. These pumps are located near the Outfall Sample Building. The dewatered flow is pumped to the DRI.

Table 10-7 provides an overview of the existing flushing and dewatering system at Leib CSO facility.

Table 10-7. Overview of Existing Flushing and Dewatering System at Leib CSO Facility

Parameter	Value
Headworks Dewatering and Flushing System	Headworks (basin) area is dewatered by gravity to the Toward Treatment sewer or disinfection conduit.
Effluent Conduit Dimensions	16-ft-dia. effluent sewer to Junction Chamber, two 11-ft-dia. pipes to dewatering gate, two 10 ft × 10.5 ft box conduits to Detroit River
Effluent Conduit Dewatering and Flushing System	- Two 1,500 gpm dewatering pumps located near Effluent Sample Building are used to dewater lower end of effluent conduit. Flow is pumped to the DRI - There is no flushing system in the effluent conduit.

10.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Flushing the screening channels after every storm event is difficult and time-consuming.
- The existing four screening channels cannot be isolated from the influent flow during rehabilitation or extensive maintenance activities. Jacobs reviewed options to install stop logs or sluice gates at the influent end of each channel. Although there is space for new slots to be constructed for either a new gate or stop logs, the lack of isolation of each screen channel from another channel downstream of the proposed gate would not provide the desired isolation. As such, there does not appear to be a feasible way to isolate channels. The current practice of installing scaffolding in the screen channels appears to be the best alternative.

10.2.4.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Screening Chamber Flushing (Project LEIB-FD-1). The screening channels must be manually sprayed down after every event. Flushing from the surface is somewhat difficult and time-consuming. There are two alternatives for addressing this issue:

- 1) **Alternative 1: Do Nothing.** Continue manual flushing.
- 2) **Alternative 2: Screening Chamber Flushing System.** A new flushing system piped from the existing NPW line, extending down to the screen channel floors and drilled with holes through the HDPE pipe is recommended to address this issue. Figure LEIB-FD-1-ALT-2, included in Volume 6 – Appendices, Appendix B, show the conceptual layout of this improvement.

The alternative evaluation for these alternatives is presented in Table 10-8. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 includes GLWA labor cost. It is based on 2 hours per event and 25 events per year, at \$100 per hour rate.
- It is assumed that the cost of water is similar between the two alternatives, so it is not included in this evaluation.

This evaluation shows that Alternative 2 – Screening Chamber Flushing System, is the Best Value Alternative. **As such, Alternative 2- Screening Chamber Flushing System is the recommended alternative.**

Table 10-8. Alternative Evaluation for Screening Chamber Flushing (Project LEIB-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.57	\$ -	\$ 5,000	\$ 90,228	\$ 35,154	
	<i>Definition:</i>	Do Nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>		Capacity Enhancement	3						
	<i>Disadv.:</i>	Flushing from the surface is somewhat difficult and time-consuming	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Screening Chamber Flushing System	Health and Safety	3	3.43	\$ 16,000	\$ -	\$ 16,000	\$ 4,660	Best Value Alternative
	<i>Definition:</i>	A new flushing system piped from the existing NPW line, extending down to the screen channel floors and drilled with holes through the HDPE pipe	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less time to clean channel	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

10.2.5 HVAC

10.2.5.1 Description of Existing System

The Leib CSO facility consists of a Headworks area in the basement, chemical room, utility support (electrical, emergency generator and mechanical rooms), control room, sample room, supply fan room and other miscellaneous rooms. The facility also includes an underground influent channel. Table 10-9 provides summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, and emergency eyewash shower. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 10.2.10.

Table 10-9. Major HVAC Equipment at Leib CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks (Screening Chamber)	SF-1	Supply Fan	59,000 CFM
Chemical Room	HV-2	AHU	2,700 CFM 300 MBH
	EF-2	Exhaust Fan	3,010 CFM
Electrical Room	HV-1	AHU	2,700 CFM 300 MBH
	EF-3	Exhaust Fan	4,650 CFM

Table 10-10 provides a summary of the basis of design performance criteria for HVAC systems at Leib and Table 10-11 provides the outdoor Basis of Design conditions.

Table 10-10. Leib Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (°F)	Summer (°F)	
Headworks	Class I, Group D, Div 1	N/A	N/A	12 ACH (Occupied)
Mechanical Spaces	Unclassified	60	96	Heat Relief
Office, Sampling Room, and Toilet Rooms	Unclassified	70	78 F Dry Bulb, 50% Relative Humidity	15 cfm per occupant

Table 10-11. Leib Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb °F)	Summer (Dry Bulb °F)	Summer (Wet Bulb °F)
3	91	73

10.2.5.2 Identified Needs and Issues

During the CS-299 Needs Assessment meetings with GLWA O&M staff, the following HVAC issues were noted:

- Odor issue in Basin and Garage area. The louvered penthouses next to the stairwells had been seized closed and the supply air to the Headworks Area was not able to be relieved through the penthouses. This may have caused odorous air to be pushed out of the large blind flange for a potential future odor control system. It was noted after the meeting that the on-going CIP project HVAC Improvements, CIP 260611, GLWA Contract No. 1803718 will be restoring the louvers in the penthouses and installing new gasketing for the blind flange in the garage area. This should reduce odors in the garage.
- Access to SF-1 for maintenance and repair is difficult: There is very little clearance to service belts and bearings in the supply fan room.
- The Headworks is not provided with any heat: O&M staff noted that water has to be turned off after about November to prevent pipes from freezing and that humidity in the air can cause major condensation in the Headworks.
- Jacobs further evaluated this issue. The Headworks area was not originally designed to be a conditioned space. Adding heating/dehumidifying to prevent frozen pipes and condensation would be prohibitively expensive. Insulating and heat tracing pipes to prevent freezing was considered; however, heat tracing can fail without warning and then pipes could still freeze. Keeping a small flow of water through the pipes during the extreme winter cold periods could be explored. No capital costs have been applied to this issue.
- Improved cooling is needed in the control room. Jacobs further investigated this issue. GLWA's HVAC contractor noted that there have been major control issues at the facility in the past and control installations are taking place presently which should help improve operator comfort. It is recommended that the impact of the control changes on operator comfort be assessed after they are completed, and recommendations can be made for proposed changes if conditions do not improve. It should also be noted that the cooling equipment serving the office, sampling room, and toilet rooms was sized to provide a summer indoor temperature of 78°F. Because an operator routinely occupies the control room, consideration should be given to sizing the next AC unit for 72°F. No capital costs have been applied to this issue. The AC unit will be replaced.

During the discussions with GLWA's HVAC contractor the following historical issues were noted:

- Dampers on HV-1 and HV-2 mixing boxes are not completely functional: GLWA's HVAC contractor noted although the actuators on the dampers are being replaced as part of an on-going project, the dampers may be in poor shape. Currently, they manually actuate the dampers.

During site investigations (June 2020) the following observations were noted:

- A roof has been constructed over both Entrance Courtyards: The as-built drawings show that these areas had no roof when they were originally constructed. Roofs have since been constructed over these areas with screens to keep out birds and insects. See discussion and photos below for further details.
- The on-going HVAC-related upgrade project (CIP No. 260611) will be upgrade the HVAC control system with DDC, replace dampers and actuators in the penthouse and within the indoor HVAC system, and replace the actuator and damper for the supply air to the basement.

10.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

HVAC Improvements (Project LEIB-HVAC-1). Due to the relatively small nature of some of the HVAC related projects identified as improvements, all of the identified HVAC improvements are proposed to be in one project – HVAC Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: HVAC Improvements** including,
 - Entrance courtyard modifications
 - Improved access to SF-1 for maintenance

Each of the HVAC related improvements listed above is described further below:

Entrance courtyard modifications. Another potential source of odors and a code compliance issue are the stairwells which are currently connected to the interior unclassified areas of the facility via the Entrance Courtyards on the East and West sides of the facility (Figure 10-2). The as-built drawings (Figure 10-3) show these areas as having no roof. This design does not constitute an enclosed space under NFPA 820 because it is open to the atmosphere. The building has been modified since construction to include a roof over both Entrance Courtyards and has been enclosed with bird screen between the existing wall and newly constructed roof.



Figure 10-2. Existing West (left) and East (right) Entrance Courtyard



Figure 10-3. As-Built Entrance Courtyard Design – Section through Building

NFPA 820 defines a space with a roof as “Not Enclosed” if 50 percent of its wall area is open to the atmosphere. This is clearly no longer the case with either of the Entrance Courtyards (Figure 10-4).

Due to their connection to the Headworks Area, the stairwells are technically Class I, Division 1 spaces per NFPA 820. The fact that they are connected to other areas of the facility via man doors, through the now enclosed Entrance Courtyards, effectively classifies the rest of the facility as Class I, Division 1. Although the Entrance Courtyards have combustible gas detection and some relief to the atmosphere, current versions of NPA 820 make it clear that such connections between unclassified and classified areas are only allowed via a pressurized airlock, with combustible gas detection monitoring and alarm, positive pressurization monitoring and alarm, and alarm if the airlock door is open for more than 20 seconds. This is not a feasible solution for the West Entrance Courtyard due to the intake for the Emergency Generator room in this area, but may be feasible for the East Entrance.

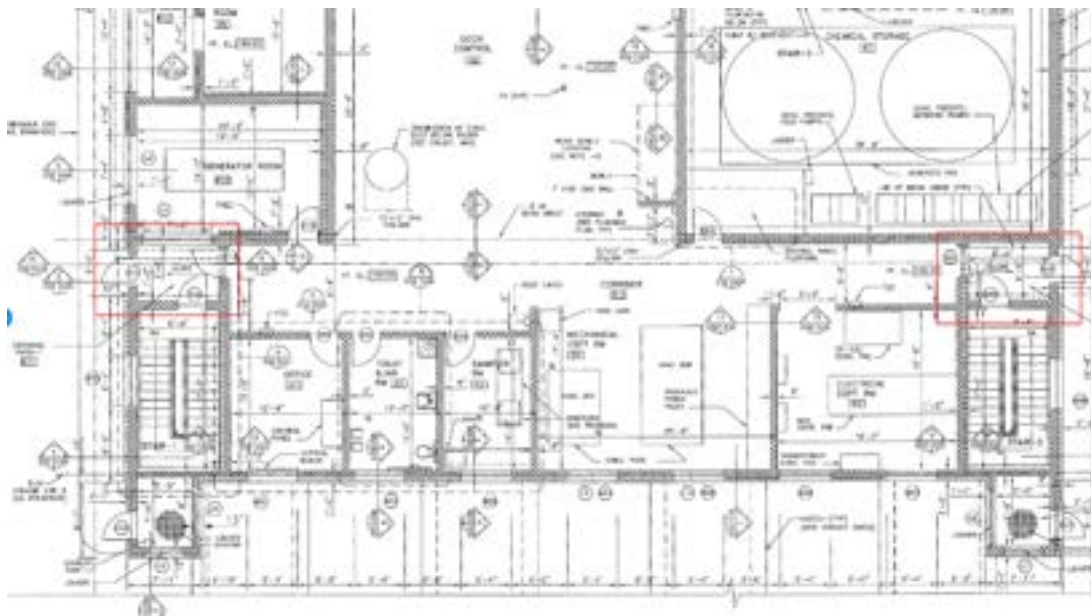


Figure 10-4. Entrance Courtyards – Plan view

To comply with NFPA 820 and ensure that hazardous gasses cannot enter the facility through the Entrance Courtyards in the future, Entrance Courtyard roofs should be removed.

Improved access to SF-1 for maintenance. SF-1 supplies ventilation air to the Headworks area and therefore the supply fan room is also a Class I, Division 1 area. Creating openings in either the generator room or garage area to improve access were considered; however, these would violate the physical separation between the classified supply fan room and unclassified generator room and garage area. One option would be to demolish the east wall of the supply fan room and move it further east with man door access added in the north wall, if necessary. See Figure 10-5 below.

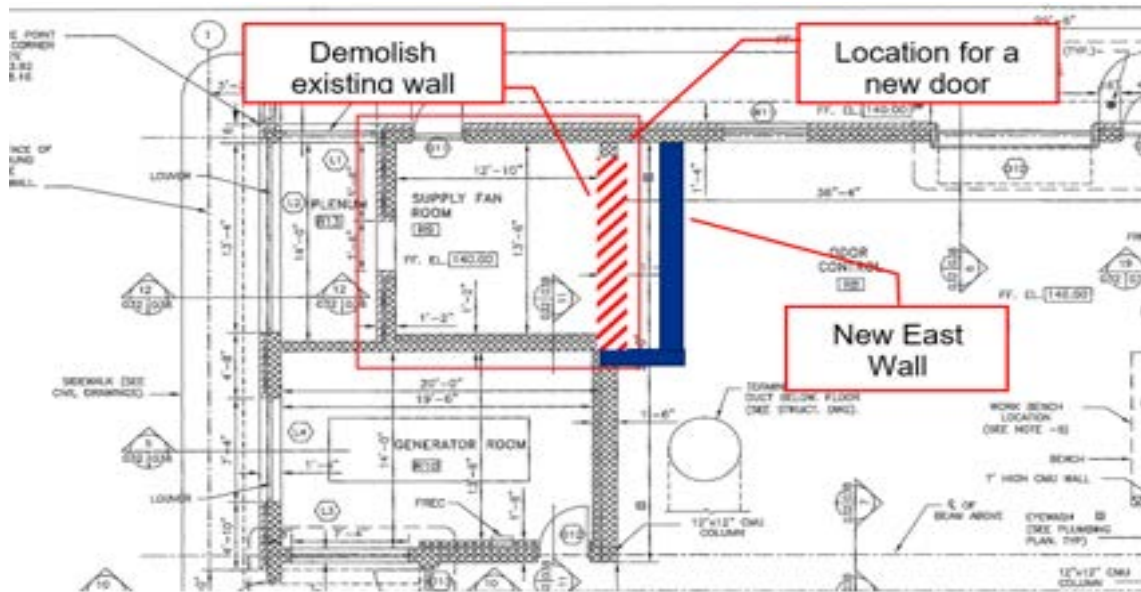


Figure 10-5. Supply Fan Room – Plan view

The alternative evaluation is presented in Table 10-12. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- Although the access to maintain SF-1 would be improved by moving the wall, it is difficult to monetize this benefit. As such, there is no measurable difference in O&M costs between the two alternatives.

Alternative 2 is recommended based on the need for code compliance. This project should be conducted when a major upgrade is performed at the facility.

Table 10-12. Alternative Evaluation for HVAC Improvements (Project LEIB-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Does not meet current code and very difficult access to SF-1 for maintenance	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	4	3.72	\$ 126,000	\$ -	\$ 126,000	\$ 33,901	Not Applicable
	<i>Definition:</i>	Improved access to SF-1 and address code issues.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved access for maintenance and improved safety.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

10.2.6 Electrical

10.2.6.1 Description of Existing System

The Leib facility's electrical system consists of one DTE utility feed from a 480 V, 3-phase outdoor transformer (secondary metering) and one diesel generator feed from a 350 kW, 480 V, 3-phase stationary generator. The utility feed is connected to a 600 A motor control center (MCC-B) with a 600 A sub-feed connection to a 600 A ATS. The ATS then feeds a distribution panel with two 600 A breakers, which feeds two MCCs (MCC-A and MCC-C). The MCCs feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 10-13 provides a summary of the major electrical equipment for this facility.

Table 10-13. Major Electrical Equipment at Leib

Location	Major Electrical Equipment	Description
Generator Room	Generator (Diesel)	350 kW, 480/277 V, 3-Phase
Electrical Room	MCC-A	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-B	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-C	600 A, 480/277 V, 3-Phase

10.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The operators need to call an electrician to reset the mixer units, which is time consuming.

10.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project LEIB-ELEC-1). The operators need to call an electrician to reset the mixer units, which is time consuming. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Continue calling the electrician to reset the mixer units.
- 2) **Alternative 2: Electrical Improvements.** Add Reset Buttons to the outside of the MCC buckets for each chemical induction mixer motor. See Figure LEIB-ELEC-1-ALT-2 in Volume 6 – Appendices, Appendix C for location. The reset buttons will enable Operations to reset the mixers themselves when a trip occurs instead of contacting electricians to reset the mixer unit.

The alternative evaluation is presented in Table 10-14. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved O&M. The NPV/Benefit cost for Alternative 2 is only \$6,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.**

Table 10-14. Alternative Evaluation for Electrical Improvements (Project LEIB-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	The operators need to call electricians to reset the mixer units, which usually takes a long time.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	3	3.43	\$ 19,000	\$ -	\$ 19,000	\$ 5,534	Not Applicable
	<i>Definition:</i>	Add reset buttons to the outside of the MCC buckets for each chemical induction mixer motor	Water Quality & Compliance	3						
	<i>Adv.:</i>	The operators do not need to call electricians to reset the mixer units	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

10.2.7 I&C

10.2.7.1 Description of Existing System

Control System: The original control system was installed in 2002 under PC-732. In 2004 the system was upgraded and interfaced into GLWA's overall SCADA Ovation control system. This upgrade provided the ability to remotely monitor the operations of the facility and the local collection system at SCC.

The existing control system contains an Allen Bradley-based PLC system consisting of an Allen-Bradley redundant PLC-5 with local I/O controls that are installed in the facility's local control system panel. The operator workstation software has a Rockwell RSVIEW operating platform and is located in the control room. The existing hardwired local back-up control panel and other miscellaneous subsystems that are incorporated into the overall control system are outdated and need replacement. The control system network and switches are obsolete and do not meet GLWA SCADA Governance standards on redundant networks and switches, and that all CSO facilities use Ovation workstations with new high-performance graphics. The current system is equipped with a back-up radio system to communicate critical monitoring points back to GLWA System Control on wide area network failure.

Flow and Level Sensors: Table 10-15 summarizes the level sensors and flow meters at the Leib CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 10-15. Summary of Flow Meters and Level Sensors at Leib CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent Sewer (Larger Sewer)	1	Transit-Time (AccuSonic)
Influent Sewer (Smaller Sewer)	1	Transit-Time (AccuSonic)
Towards Treatment Sewer	1	Transit-Time (AccuSonic)
Outfall	1	Transit-Time (AccuSonic)
CSO Facility Level Sensors		
Influent (Sewer and channel)	2	Ultrasonic
Mixing Chamber	1	Ultrasonic
Dewatering (Pumping station and control gate)	2	Ultrasonic
Effluent (Outfall, Towards Treatment Sewer)	2	Ultrasonic
DRI Discharge Regulator Chamber	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed Pumps	8	Magnetic

10.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Install an Outfall OIT

- Evaluate repair or replacement of the DRI level sensor
- Need for remote control of the regulator gates
- Ensure influent flow meter is properly positioned with new Meldrum connection
- Need for process cameras at select locations
- Evaluate influent flow meter will be properly positioned with new Meldrum connection. Based on GLWA's WWMP, a new diversion sewer is proposed to connect the Meldrum Sewer to the Conant-Mt. Elliot Sewer, which will divert flow from Meldrum to the Leib CSO Facility during wet weather events. GLWA staff expressed concern that the proposed location of the new junction chamber may impact the accuracy of the existing multi-path flow meter. The approximate location of the existing flow meter, as well as the proposed location of the new diversion sewer was shown previously in Figure 10-1.

The existing meter will likely be in a zone of higher turbulence near the new sewer connection, which will result in less accurate flow measurement. It is recommended that the flow meter be about 10 pipe diameters, or 160 ft, from the proposed junction chamber to ensure that the meter functions reliably. The proposed junction chamber is approximately 240 ft upstream of the existing influent diversion chamber to the CSO facility. As such, there is sufficient pipe length to relocate the meter downstream. In discussions with GLWA, Jacobs recognizes that the flow meter will be replaced in the near future. It would be most efficient to relocate the meter to a point that would account for the future diversion flow. Because a new influent flow meter is going to be installed at this location, costs are not provided in this report for relocation to address this issue.

- Need to replace the regulator gate limit switches. Replacement of the switches will likely require dewatering and flow diversion in the regulator structure, which could be a significant effort and cost. As such, this work should be considered for combination with other upcoming work at or near this location.
- The control system should be upgraded. GLWA is currently developing an FP) for qualified design-build contractors to provide professional engineering and construction services for control system improvements at the Seven Mile CSO Facility under "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities." The project will replace the existing PLC-5 control system and back-up local control panels with a new control system, provide new Ovation workstations with high-performance graphics, and replace some of the field instruments. This is an on-going project that has already been included in the CIP.
- The screen graphics are very difficult to understand and should be updated to match other facilities. This improvement is included in the Control System Improvements project described in the previous bullet.
- Evaluate regulator gate limit switches. Remote control of the regulator gates is included under the "Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities" project. No further improvements are recommended.

10.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project LEIB-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation Control System Upgrade and the Automatic Transfer Switch and Generator Controls Upgrade, are

proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: I&C Improvements** including,

- Install an Outfall Operator Interface Terminal (OIT)
- Evaluate DRI level sensor
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Install an Outfall Operator Interface Terminal (OIT). In order to assist operations during CSO events, Operators requested an OIT at the Outfall. The OIT should be consistent with other OIT panels being installed throughout other CSO Facilities under the I&C Systems Project.

Evaluate DRI level sensor. It is recommended to replace the DRI level sensor.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 10-16. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the remaining improvements in Alternative 2 are difficult to quantify and would not affect the alternative evaluation. Similarly, it is difficult to quantify the monetary benefits of the improved operations through the improved monitoring and control.

This evaluation shows that Alternative 2 – I&C Improvements has a total benefit score about 0.9 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and O&M. The NPV/Benefit cost for Alternative 2 is \$49,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – I&C Improvements is the recommended alternative.**

Table 10-16. Alternative Evaluation for I&C Improvements (Project LEIB-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.53	\$ 109,000	\$ 3,000	\$ 172,269	\$ 48,755	Not Applicable
	<i>Definition:</i>	Install higher performance I&C instruments including Outfall OIT, level sensor, regulator gate limit switches, and process cameras. Project may be able to be split into multiple delivery projects if needed.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	5						

Control System Upgrade. The following control system improvements are recommended:

- Update Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2.

GLWA is currently developing an RFP for qualified design-build contractors to provide professional engineering and construction services for control system improvements at the Leib CSO Facility under *"Control System Improvements – St. Aubin, Leib and Seven Mile CSO Facilities"*. The project will replace the existing PLC-5 control system and back-up local control panels with a new control system, provide new Ovation workstations with high-performance graphics, and replace most of the field instruments.

The alternative evaluation table is not provided because this is an on-going project that has already been included in the CIP.

10.2.8 Site

10.2.8.1 Description of Existing Site

The Leib CSO facility was built in 2002. The site includes a 6-ft high security fence along the perimeter of the site. A sliding cantilever entrance gate is provided at the Mt. Elliott entrance. The parking lot consists of 8-in thick reinforced pavement with 8-in. crushed limestone base. There is a 5-ft wide, 4-in. thick sidewalk along the building entrances and 10-in. aggregate site pavement along the perimeter of the facility. Site utilities include potable water, natural gas, electrical, telephone services, stormwater, and sanitary sewer connections.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

10.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the section below.

- There are safety concerns for those accessing the Leib CSO facility through the sliding cantilever entrance gate off of Mt. Elliot St.
- Need for additional space to store outside summer/winter site maintenance equipment. Jacobs evaluated this issue. All the equipment required for outside summer/winter site maintenance is stored inside the Leib facility in the space originally planned for the odor control room outside the control room. GLWA has requested additional space to store this extraneous equipment outside of the building. There is limited space for a permanent structure on the site without locating it over the treatment basin or influent/effluent conduits. One available location is at the south side of the property where there is an approximately 15-ft wide strip inside the fence line. The available area will depend on the required size of the storage building. While there is limited space on the current facility site to construct a permanent storage structure, it may be possible to locate a new storage building if

property is acquired for the new access drive entrance and the security fence and new gate alignment can be realigned to accommodate a secure area for a new storage building.

- Based on our understanding of the equipment to be stored, it appears that a small commercial secure garden shed style structure would be adequate; however, a more secure option would be to continue to utilize the existing space inside the Leib facility and plan for a storage facility outside as a new larger space may become available. As such, no capital costs have been provided for this issue.
- The Leib facility influent and effluent diversion junction chambers are located in Mt Elliott St. outside the facility boundary extending across two lanes of north bound traffic (approximately 20 ft in width). The diversion chambers were constructed on piles. The concrete junction chambers extend to the surface in Mt. Elliott St. Settlement of the asphalt-surfaced road has occurred around these structures. The settlement issue is more pronounced at the effluent diversion structure. We recommend that the roadway around the structures be reconstructed with a modified engineered fill that can help stabilize the roadway surface around the structures. As Mt. Elliott is a city-owned road, road reconstruction should be performed by the City of Detroit. However, a line item is included in the New Access from Meldrum Street project to address this issue.

GLWA is currently addressing some of the site needs at the facility. These on-going projects are described below and are not included in the capital improvement projects for CS-299:

- There are significant water infiltration issues at the Leib Outfall Sampling Vault near the Detroit River. The Sampling Vault shares a common wall with the east barrel of the outfall. A number of conduits carrying power and control wiring and cables penetrate the common wall near the base of the vault that corresponds with the elevation of the base of the outfall. The existing conduits service dewatering and sampling pumps, level sensors, proximity switches on backwater gates and a multi-path transit time flowmeter located upstream of the Sampling Vault. When wet weather events occur, infiltration into the conduits flows back into the Sampling Vault, flooding the base of a floor mounted control panel.

To prevent the backflow of treated water into the Sampling Vault, it is recommended to realign the penetrations of the existing conduits to an elevation above the waterline in the outfall conduits. The existing conduit penetration should be demolished, removed and the openings grouted shut. There are six 1.25- in. conduit penetrations and two 2-in. conduit penetrations that would have to be relocated. This is an on-going project and will be completed through a JOC.

- The following issues were addressed under GLWA-CON-1902040 "Site Improvements at P-F Detention Facility and Leib Screening and Disinfection Facility" Contract.
 - Address Facility Drainage. The surface of grade over the treatment facility is very flat and as a result water ponded on it.
 - Repair Concrete Sidewalk. The 4-ft wide access sidewalk around the perimeter of the Leib CSO facility has been impacted by settlement issues that have caused the sidewalk to pull away from the building and crack.
 - Caulk joints at expansion joint between base of wall/sidewall – all sides of building.
 - Seal all control joints and cracks in the concrete parking lot pavement.
 - Repair collapsing catch basin.

10.2.8.3 Description and Evaluation of Alternatives

A project to address the need identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

New Site Access from Meldrum Street (Project LEIB-SITE-1). The existing site access through the sliding cantilever entrance gate off of Mt. Elliott St. creates safety concerns for those accessing the Leib CSO facility site. The existing site fence line and security gate on the west side of the facility is located immediately behind the street sidewalk. As a consequence, there is not enough space for vehicles to completely pull forward onto the drive approach to the site without the vehicle remaining partially in the lane of traffic on Mt. Elliott. As a result, some drivers exit their vehicles while in traffic to swipe security access cards to open the gate. Furthermore, some drivers park their vehicle in the turn lane and cross the traffic to open the gate. This poses a slip and fall safety concern, especially in the winter in inclement weather. Several alternatives have been investigated to address this issue, including realigning the fence and gate location off Mt. Elliott so that vehicles can pull fully out of the traffic lane to access the card reader and wait for the gate to open. This alternative, however, does not appear to be practical due to the significant encroachment on the existing parking lot necessary to create space for cars and trucks to pull off Mt. Elliott Street. In addition, realigning the gate would not allow proper maneuverability for vehicles in the parking lot.

There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: New Site Access from Meldrum Street.** This alternative includes relocating the site entrance to the east side of the site off Meldrum Street. See Figure LEIB-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, for the conceptual layout. There are several parcels of vacant property immediately adjacent to the east side of the Leib facility. Three of these parcels align with the existing Leib parking lot on the north side of the facility. An access road could be constructed off Meldrum to allow an alternative entrance to the Leib facility. This alternative would include construction of a new 24-ft wide access driveway. The length of the drive would be approximately 175-ft off Meldrum. The facility's existing east fence line would be modified to accommodate a new sliding cantilever gate and access card reader. The Detroit GIS parcel database indicates the vacant properties on the east side of the site are owned by the Detroit Water and Sewerage Department.

This alternative includes the paving of Mt. Elliot in front of the Leib facility.

The alternative evaluation is presented in Table 10-17. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.15 higher than the Do Nothing Alternative (Alternative 1) based on the improved safety and component performance. The NPV/Benefit cost for Alternative 2 is \$65,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 - New Site Access from Meldrum Street, is the recommended alternative.**

Table 10-17. Alternative Evaluation for Site Access (Project LEIB-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	1	2.23	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Safety concerns remain	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	New Site Access from Meldrum Street	Health and Safety	4	3.38	\$ 220,000	\$ -	\$ 220,000	\$ 65,025	Not Applicable
	<i>Definition:</i>	Relocate the site entrance to the east side of the site off Meldrum St.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Increased safety for personnel accessing the facility.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

10.2.9 Architectural

10.2.9.1 Description of Existing Facilities

The Leib CSO facility consists of chemical room, utility support (electrical, emergency generator and mechanical), control room, odor control room, screen room, sampler room and other miscellaneous rooms. The facility also includes an underground influent channel.

10.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment, as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff indicated the leak from the chemical storage tank damaged the floor coating in the chemical room. The recoating of the floor is included in LEIB-DIS-1 project.

10.2.9.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (LEIB-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:

- Remove and replace sealant around doors, windows and other wall penetrations
- Remove and replace sealant at all control/ expansion wall joints
- Remove and replace isolation/ cove joint sealant and around building perimeter
- Clean and coat bottom of all door frames
- Clean corrosion and coat underside of roof deck

- Clean and coat localized areas of roof beams and framing members
- Remove debonding roof deck paint, clean and replace with new paint
- Replace cracked limestone windowsill and caulk on the southeast side of the building

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings (Figure LEIB-ARCH-1-ALT-2) in Volume 6 – Appendices, Appendix B. Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project. It should be noted that recoating of the floor in the Chemical Room was originally included in the architectural items, but moved to the Chemical Feed project (LEIB-DIS-1).

The alternative evaluation is presented in Table 10-18. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, Alternative 2 is the recommended alternative.

Table 10-18. Alternative Evaluation for Architectural Rehabilitation (Project LEIB-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 246,000	\$ -	\$ 246,000	\$ 79,355	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

10.2.10 Safety

10.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

10.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 10-19. The capital improvement project to address these issues is included in the table.

During the Needs Assessment meeting for Disinfection, O&M staff noted the tanks lack fall protection to allow safe access to appurtenances and valves above the tank. Fall protection is desired for safety.

It is recommended that either the handrail style fall protection, similar to Belle Isle and Oakwood, or the solid style fall protection similar to Hubbell-Southfield be added to the top of the two hypochlorite tanks. This will require a technician skilled in working with FRP to bond the fall protection to the tank. FRP tank manufacturers offering field repair services would be able to do this work.

Table 10-19. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Garage	No exit sign	Add exit sign	Exit Sign Improvements ^a
Chemical Room	No guardrails on tanks	Add guardrails	Safety Improvements (Project LEIB-SAFE-1)
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project LEIB-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

10.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project LEIB-SAFE-1). This project should address the safety issues identified above. These issues include:

- Extend guardrails on tanks in the chemical room to eliminate fall hazard
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 10-20 shows the one alternative.

Table 10-20. Alternative Evaluation for Safety Improvements (Project LEIB-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 211,000	\$ -	\$ 211,000	\$ 70,333	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

10.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at Leib CSO Facility.

10.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Leib CSO facility, Table 10-21 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 10-21, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 10-21. Listing of Asset Condition Assessments for Leib Facility

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	9	9	0	100%
AHU	1	0	1	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	3	3	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	1	0	1	100%
BUILDING	4	4	0	100%
CAMERA	1	1	0	100%
COMPRESSOR	0	0	0	N/A
COND-AIR	1	1	0	100%
CONVEYOR	0	0	0	N/A
CRANE	0	0	0	N/A
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
DAMPER	14	14	0	100%
DISCONNECT	0	0	0	N/A
DOOR	1	1	0	100%
DRIVE-ELEC	8	8	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	4	4	0	100%
FAN	0	0	0	N/A
FANVENT	5	4	1	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	1	0	0	0% ^a
GASDETECTO	1	0	0	0% ^b
GASMONITOR	2	2	0	100%
GATE	12	12	0	100%
GEARBOX	0	0	0	N/A
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	12	12	0	100%
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	2	2	0	100%
MCC	3	0	3	100%
METER	13	13	0	100%
MIXER	18	18	0	100%
MOTOR	1	0	1	100%
PANEL	4	4	0	100%
PIPING	4	4	0	100%
PUMP	13	10	2	92% ^c
ROOF	2	2	0	100%
SAMPLER	1	1	0	100%
SCADA	2	2	0	100%
SCREEN	12	0	12	100%
SCRUBBER	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	# of Visual Condition Assessments	# of Detailed Condition Assessments	% of Assets with Condition Assessment
SENSOR	22	22	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	3	0	3	100%
UNITHEATER	0	0	0	N/A
UPS	3	3	0	100%
VALVE	4	4	0	100%
WATERHTR	1	1	0	100%
^a The fire suppression was evaluated Simplex Grinnell in 2018 and not included in the ACES report. ^b The gas detector is a portable unit and was not assessed. ^c The one pump not evaluated was a sample pump originally in the in the disinfection channel, which is no longer used.				

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Leib Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

10.3 Capital Planning for Leib CSO Facility

10.3.1 Summary of Capital Improvement Plan Projects

Table 10-22 provides a summary of the recommended CIP projects and associated capital costs for the Leib CSO facility based on the alternative evaluations conducted for this facility .

Table 10-22. Summary of Recommended Projects at Leib CSO Facility

Project No.	Alternative	Description	Total Project Cost
LEIB-DIS-1	3	Chemical Feed utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 901,000
LEIB-DIS-2	2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
LEIB-DIS-3	2	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000
LEIB-FD-1	2	Screening Chamber Flushing System	\$ 16,000
LEIB-HVAC-1	2	HVAC Improvements	\$ 126,000
LEIB-ELEC-1	2	Electrical Improvements	\$ 19,000
LEIB-I&C-1	2	I&C Improvements	\$ 109,000
LEIB-I&C-2	1	Control System Upgrade	Ongoing Project
LEIB-SITE-1	2	New Site Access from Meldrum Street	\$ 220,000
LEIB-ARCH-1	2	Architectural Rehabilitation	\$ 246,000
LEIB-SAFE-1	1	Safety Improvements	\$ 211,000

10.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 10-23. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 10-23. Capital Improvement Plan Projects for Leib CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
LEIB-1 Disinfection System Improvements	\$ 1,206,000	2026 <i>Timing based on implementation of projects before Meldrum diversion to ensure reliable operation with increased flows.</i>	LEIB-DIS-1	Chemical Feed utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 901,000
			LEIB-DIS-2	Provide Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
			LEIB-DIS-3	Model Disinfection Performance and Replace/Utilize Half of the In-Kind Mixers	\$ 50,000
			LEIB-FD-1	Screening Chamber Flushing System	\$ 16,000
			LEIB-ELEC-1	Electrical Improvements	\$ 19,000
LEIB-2 Facility-Wide Safety and Architectural Improvements	\$ 583,000	2023 <i>Project should be initiated as soon as possible</i>	LEIB-HVAC-1	HVAC Improvements	\$ 126,000
			LEIB-ARCH-1	Architectural Rehabilitation	\$ 246,000
			LEIB-SAFE-1	Safety Improvements	\$ 211,000
LEIB-3 I&C Improvements	\$ 109,000	2030 <i>Timing based on best judgement</i>	LEIB-I&C-1	I&C Improvements	\$ 109,000
LEIB-4 Site Improvements	\$ 220,000	2026 <i>Timing based on need to address safety issue</i>	LEIB-SITE-1	New Site Access from Meldrum Street	\$ 220,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 10-24 and Table 10-25 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 10-24 indicates that LEIB-DIS-1 project has 28 assets that has an average condition score of 1.29 and an average replacement date of 2032. However, this project should be completed before the Meldrum diversion and therefore, the project was proposed a scheduled construction completion date of 2026 instead of 2032.

Table 10-24. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
LEIB-DIS-1	28	1.36	1.29	2.27	13	2032	\$ 904,400

Table 10-25. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
LEIB-DIS-1	0	0.00	0.00	0.00	N/A	N/A	\$ -

10.3.3 20-Year Capital Outlay Plan

Table 10-26 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 10-26. 20-Year Capital Outlay Plan for Leib CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 300,900	\$ -	\$ -	\$ 217,500	\$ 59,200	\$ -	\$ -	\$ 24,200	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 1,814,757	\$ -	\$ 1,814,757	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ 3,961	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 3,961	\$ -	\$ -	\$ -	\$ -
2025	\$ 21,112	\$ -	\$ -	\$ 6,854	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 14,258	\$ -	\$ -
2026	\$ 781,158	\$ -	\$ -	\$ 779,057	\$ -	\$ -	\$ -	\$ -	\$ 2,101	\$ -	\$ -	\$ -	\$ -
2027	\$ 56,120	\$ 56,120	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 54,606	\$ -	\$ -	\$ -	\$ 54,114	\$ -	\$ -	\$ 492	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,924,056	\$ -	\$ 30,857	\$ 38,571	\$ 84,856	\$ -	\$ -	\$ -	\$ -	\$ 1,769,773	\$ -	\$ -	\$ -
2030	\$ 1,215,181	\$ 39,143	\$ -	\$ -	\$ 1,142,981	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 33,057	\$ -	\$ -
2031	\$ 204,007	\$ 26,610	\$ -	\$ -	\$ 177,397	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 8,429	\$ -	\$ -	\$ 8,429	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 318,726	\$ -	\$ -	\$ -	\$ -	\$ 129,231	\$ -	\$ 189,495	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 1,805,282	\$ -	\$ -	\$ 1,579,749	\$ 89,545	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 108,572	\$ -	\$ 27,416
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 1,372,234	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1,372,234	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 254,817	\$ 44,126	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 106,402	\$ 41,469	\$ -	\$ -	\$ 62,820	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 10,135,347	\$ 165,999	\$ 1,845,614	\$ 2,630,160	\$ 1,608,094	\$ 129,231	\$ -	\$ 320,589	\$ 1,419,765	\$ 1,769,773	\$ 155,887	\$ 62,820	\$ 27,416

Notes:

Explanation of large capital outlays in first two years:

- Screening System: Screen #3, #5, and #7 received a score of 5 as the screens failed to start at the time of the Condition Assessment.
- Retention System: One Accusonic flow meter (FM-3; \$217,500) was not functional based on SCADA review in 2019 and 2020.
- Disinfection System: One chemical storage tank #2 (\$59,200 each) received a score of 5 as it had a small leak and had been taken out of service until repaired.

11. Oakwood CSO Control Facility

11.1 General Facility Description and Future Capacity Considerations

11.1.1 General Facility Description

The Oakwood CSO Facility is an RTB with 9 million gallons (MG) of storage and a treatment capacity of 1,660 cfs. It was constructed in 2012. There are three buildings. The main building contains the Storm Pump Station, Sanitary Pump Station, chemical room, control room, utility support (electrical and mechanical rooms), odor control room, sample room, shipping and receiving and miscellaneous other rooms. The Headworks Building contains the headworks, headworks control room, MAU room and hydraulic room. The basin odor control room contains the odor control systems for the East and West Basins.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

11.1.2 Northwest Interceptor Diversion to Oakwood CSO Facility

The WWMP proposed projects to increase wet weather flows to existing CSO facilities to maximize the use of the facilities and minimize the construction of additional facilities. Many of the CSO facilities do not reach their design flows, so there is capacity to accept additional flows, without exceeding their design flow.

The NWI Diversion to Oakwood CSO Facility is one of the recommended projects from the WWMP that will increase flows to the existing Oakwood CSO Facility. The magnitude of the increased flows and the potential impact on screening and disinfection performance is described in the following sections.

This project originated from the WWMP and involves diverting NWI flows to the Oakwood Storm Pump Station and CSO facility whenever the Detroit WRRF is overloaded, and capacity is available at the Oakwood facility. Based on information presented in the WWMP, the predicted peak wet weather flow rate expected at the Oakwood Pumping Station (PS) for the 10-year 24-hour storm event is about 1,100 cfs. The firm capacity of the Oakwood PS and the design flow for the CSO facility is 1,660 cfs. This leaves about 560 cfs of unused capacity at the Oakwood facility at design conditions.

The NWI diversion involves construction of a new control gate chamber on the NWI at Bayside and Sanders. About 3,100 ft of 10-ft-diameter tunnel is required to convey the peak wet weather flows from the NWI control gate chamber to a new diversion chamber at Liddesdale and Pleasant Streets, near the Oakwood influent junction chamber.

11.2 Facility Assessment

11.2.1 Screening

11.2.1.1 Description of Existing System

The Oakwood CSO Facility has six perforated plate screens that were installed in 2012. Raw wastewater is pumped to the screens from the Oakwood Storm Pump Station. Screened flow enters either one or both of the CSO basins via the Screen Outlet Chamber.

Screened material is removed from the screens using a rotating brush and high-pressure spray and discharged into a screw conveyor. The conveyor transports the screenings to a dumpster for eventual disposal in a landfill. A washer/compactor was originally installed at the end of the conveyor, prior to discharge to the dumpster.

The sanitary pump station has two manually cleaned bar screens upstream of the sanitary pumps. Space was provided in the Sanitary Pump Station for a monorail system and bucket that could be used to manually clean the screens if it were determined necessary in the future.

Table 11-1 provides an overview of the existing screening system at Oakwood CSO facility.

Table 11-1. Overview of Existing Screening System Oakwood CSO Facility

Parameter	Value	
Type	Retention Treatment Basin	Sanitary PS
Treatment Capacity (cfs)	1,660	NA
No. of Screens	6	2
Manufacturer	Andritz	Not known
Screen Type	Perforated Panel Screen	Manual Bar Rack
Opening Size	6-mm perforation	3-in.
Depth or Length	21 ft 6 in.	41 ft
Width	10 ft 0 in.	5 ft 0 in.
Screen Cleaning	Brush and high-pressure spray	Manual
Screening Removal	Screw conveyor to dumpster and landfilled	Manually cleaned (currently by washing screenings through the screens to the sanitary pumps)

11.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Provide a better means of cleaning the two bar racks at the sanitary pump station: The bar racks have 3-in. spacing to protect the sanitary pumps by capturing large debris. The sanitary pump station bar racks, however, become frequently blinded. During Jacobs Condition Assessment in June 2020, the differential through the screens was about 10 ft. The screens reportedly had not been cleaned for a prolonged period due to accessibility issues. The current method of cleaning involves lowering a worker in a man-basket into the wet well to manually remove the debris, which poses considerable safety risks. Alternatives to address this issue are discussed in the following section.
- Resolve water carry-over into screenings dumpster and onto floor near dumpster: Screenings and spray water from the screens are conveyed by the screw conveyor directly into the dumpster at ground floor. There is a significant amount of water that completely fills the dumpster during an event and spills onto the floor around the dumpster. A portable screenings washer/compactor was provided in the original system and can be moved into place to wash and compact the screenings. The washer/compactor has a drain that can divert the excess water to a drain line. The compactor, however, has been problematic because screenings fill the compactor chute, dry in place, and are unable to be pushed out of the chute during the subsequent storm. As such, the washer/compactor is bypassed.

- Jacobs recommends replacing the inclined discharge chute with a minimally modified chute. This will minimize compaction of the screenings and, most importantly, will allow the excess water to drain from the screenings prior to discharge into the dumpster below. This should significantly reduce the amount of water transferred to the dumpster. Jacobs contacted the washer/compactor manufacturer (JWC) to confirm this approach. The GLWA millwrights could construct and install a new horizontal section. The capital expenditure for this modification is minimal and not included in the capital outlay.
- Potential impact of higher flows on screening performance. The screens have not experienced peak design flows, and there is a concern that they may blind at the higher flows with the NWI diversion. It should be noted that the screens have emergency bypasses built-in to the screening channels to allow flows around the screens if the screens should become blinded. If screen blinding should become a problem in the future, potential modifications to the existing screens, including speeding up the screen, could be investigated. There is no room for additional screens at the facility.

11.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Sanitary Pump Station Screen Improvements (Project OKW-SCR-1). The existing manually raked bar screens excessively blind over time and cleaning them is a safety concern. There are four alternatives:

- 1) **Alternative 1: Do Nothing/Keep Existing Manual Bar Rack**
- 2) **Alternative 2: Remove Bar Racks.** The bar racks were installed to protect the sanitary pumps. Due to the excessive blinding of the bar racks, GLWA recently temporarily removed the bar racks. This will allow observation of pump performance without screening. If the pumps can convey most of the debris, this could be the long-term alternative. GLWA should observe this performance for at least a year to determine the impacts on the pumps and the material that remains in the wet well.
- 3) **Alternative 3: Monorail and Clamshell.** The facility was originally designed for a monorail and clamshell to remove the screenings from the manual bar racks, but it was not installed. A clamshell could be used to clean bar racks with 3-in. openings as the captured debris is usually large/heavy. A clamshell would be faster and safer to use than the man-basket that was previously used. However, GLWA subsequently requested a mechanical bar screen in lieu of continuing to use the manual bar racks based on operational experience with clamshells being unreliable.
- 4) **Alternative 4: Mechanical Bar Screen.** The bar racks could be replaced with mechanical bar screens with the same 3-in. bar spacing that extend the full depth of the channel. Duperon's FlexRake FP-F bar screen was evaluated and would perform well (see Figure OKW-SCR-1-ALT-4 in Volume 6 – Appendices, Appendix B). It was used as a representative screen for cost estimating purposes. A smaller bar spacing of 1.5-in. is an option but will result in additional screenings to manage. The spacing of a new screen, if this option is selected, should be further evaluated during detailed design.

Several options for screenings handling were evaluated for the mechanical screens in Alternative 4:

- **Screenings Handling Option 1: Rolling Dumpster:** A rolling dumpster with a drain should be adequate for screenings from a 3-in. bar screen. The portable dumpster could be moved just outside the roll-up door and picked up by a trash truck. Screenings captured with a 3-in. bar screen are not expected to be odorous.
- **Screenings Handling Option 2: Grinder After Mechanical Screen:** Rather than disposing of screenings at the Oakwood facility, screenings could be ground and returned to the screened wastewater and conveyed to the WRRF. Screens at the Detroit WWTP would remove the ground screenings. The grinder teeth can be set to grind the screenings to the desired size, so they are mostly removed by the treatment plant screens. Conversations with a Jacobs' screening expert

and Duperon indicated that maintenance on the grinder will be intensive due to the large material that will be ground. The likelihood and frequency of jammed grinders is high, and a rolling dumpster is a better disposal option.

- Based on the evaluation above, a rolling dumpster (Screenings Handling Option 1) is recommended as a grinder has a higher potential for future maintenance problems than its apparent overall value.

The alternative evaluation is presented in Table 11-2. The sources of costs used in this evaluation are listed the following bullets:

- O&M costs for Alternative 1 assume the manual bar rack is cleaned twice per year.
- Alternative 3 – Monorail and Clamshell is not considered a viable alternative by GLWA because of unfavorable experiences with this type of system at other facilities.
- Capital costs for Alternative 4 are presented in Volume 6 – Appendices, Appendix C under this project title.
- Screenings disposal costs are not included in Alternative 4 because the cost difference is so large between Alternative 2 and Alternative 4.

This evaluation shows that Alternative 2 – Remove Bar Racks is the Best Value Alternative. **As such, Alternative 2 is the Recommended Alternative.**

Table 11-2. Alternative Evaluation for Sanitary Pump Station Screen Improvements (Project OKW-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	Alt. Name:	Do Nothing.	Health and Safety	1	1.80	\$ -	\$ 3,200	\$ 67,487	\$ 37,493	
	Definition:	Do nothing.	Water Quality & Compliance	3						
	Adv.:	Known system	Capacity Enhancement	3						
	Disadv.:	Cleaning the screens requires manned-entry/suspension into channel, which is unsafe.	Component Performance	1						
	Comments:	None	O&M Ease	1						
2	Alt. Name:	Remove Bar Racks	Health and Safety	4	3.72	\$ -	\$ -	\$ -	\$ -	Best Value Alternative
	Definition:	Remove Bar Racks.	Water Quality & Compliance	3						
	Adv.:	No blinding	Capacity Enhancement	3						
	Disadv.:	Pumps may be unable to handle large debris	Component Performance	3						
	Comments:	None	O&M Ease	5						
3	Alt. Name:	Monorail and Clamshell	Health and Safety	3	2.47	No cost estimate prepared. GLWA has had unfavorable experience with clamshells				
	Definition:	A clamshell can be used to clean bar racks with 3-inch openings as the captured debris is usually large/heavy	Water Quality & Compliance	3						
	Adv.:	A clamshell would be faster and safer to use than a man-basket.	Capacity Enhancement	3						
	Disadv.:	Unfavorable experience at another location.	Component Performance	2						
	Comments:	None	O&M Ease	1						
4	Alt. Name:	Mechanical Bar Screen	Health and Safety	5	4.20	\$ 3,243,000	\$ -	\$ 3,243,000	\$ 772,143	
	Definition:	Replace existing sanitary pump station bar racks with mechanical bar screens with the same 3-inch bar spacing or smaller.	Water Quality & Compliance	3						
	Adv.:	Mechanically cleaned on a continuous basis, which is continuous and safer.	Capacity Enhancement	3						
	Disadv.:	Higher capital cost. Need for screenings disposal.	Component Performance	5						
	Comments:	Does not include screenings handling	O&M Ease	5						

11.2.2 Disinfection

11.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP tanks, 10 gear pumps, and multiport injection on the discharge of the eight stormwater vertical turbine pumps. The storm pumps pump stormwater into the CSO facility and are further described in Section 11.2.12.1. Three of the sodium hypochlorite pumps are low-rate and seven are high-rate. Sodium Hypochlorite Pumps 1 through 8 inject on the discharge of Storm Pumps 1 through 8, respectively. Sodium Hypochlorite Pump 9 is a high-rate pump serving as the backup to high-rate pumps 3 through 8. Sodium Hypochlorite Pump 10 is a low-rate pump serving as the backup to low-rate pumps 1 and 2. Each pump has a VFD to adjust chemical feed flow based on storm pumping rate. Flow is metered from each pump.

Table 11-3 provides an overview of the existing disinfection system at the Oakwood CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G.

Table 11-3. Overview of Existing Disinfection System at Oakwood CSO Facility

Parameter	Value
Treatment Capacity (cfs)	1,660
Design Feed Strength (% hypochlorite)	7.5
Max. Dosage at Design Flow (mg/L Cl ₂)	12
Disinfection Contact Time (min)	6 min w/ 1 basin, 12 min w/ 2 basins in service
Storage Tanks	
Number	2
Volume of Each Tank (gal)	11,500
Type	FRP
Pumps	
Number	10 Total; 3 low-rate, 7 high-rate
Capacity (gpm)	Low-rate: 0-26, High-rate: 151
Type	Gear
Mixers	
Number / Type	Hypo added to pump discharge
Model Number/ hp / Manufacturer	Not Applicable (Hypo added to pump discharge)

11.2.2.2 Identified Needs and Issues

The needs and issues for Oakwood were identified from meetings with O&M staff and Jacobs team site visit and investigations. These needs and issues are summarized as follows:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Oakwood chemical feed system has the following issue:
 - The gear pumps are expensive to replace and repair
 - The gear pumps vibrate despite efforts to eliminate vibration
 - The chemical feed pumps are on skids. The skid frames reduce access to the pumps and components and do not aid in the removal of the pumps.

These issues are addressed in Replace Chemical Feed System (Project OKW-DIS-1) in the following bullets.

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project OKW-DIS-2) in the following bullet.
- Provide ability to sample basin at two levels. The basin effluent sample pump requires the water level to reach a certain level before chlorine residual can be determined. There is concern that it could be too late to adjust the sodium hypochlorite feed rate in response to variable influent conditions affecting chlorine demand by not being able to sample sooner. Therefore, it is desired to sample at two levels, one at low level in addition to the high level at end of basin. It should be noted that this capability will be provided in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project OKW-DIS-2) by installing a new pump well upstream of the effluent end of the CSO basins. As such, a separate capital improvement is not needed to address this issue.
- Feed piping overpressure alarms. There is a pressure sensor and associated alarm setpoint on the discharge of each pump. Over-pressurization alarms occur indicating the need to investigate whether the pressure relief valves are functioning properly or whether the pressure sensor is causing false alarms.

This should not be an issue after the chemical feed system is replaced, as recommended in the following bullet. In the interim, however, the pressure relief valves could be investigated to verify they are functioning properly and that the pressure sensors be checked to determine if they are causing false alarms. This can be done by installing a calibrated pressure gauge on the discharge of a pump and monitoring pressure concurrently with someone monitoring SCADA for an alarm. GLWA maintenance staff could perform this investigation or a mechanical contractor. Given that the system should be replaced in the near future, capital costs have not been included in this evaluation to address this issue.

- Investigate corrosion concern at chemical injection points on pump discharge. During meetings related to disinfection, GLWA expressed concern that corrosion could be occurring in the vicinity of where the hypochlorite is injected into the discharge pipes of each pump. Closed-circuit television (CCTV) results of the discharge pipes for each pump (conducted under another project) were reviewed for this evaluation. See Figure 11-1 for CCTV results from the chemical injection points of one pump (Pump 2) used to illustrate the condition. The CCTV did not show any serious corrosion. Based on these results, it is recommended to re-investigate the piping again in about 5 years.

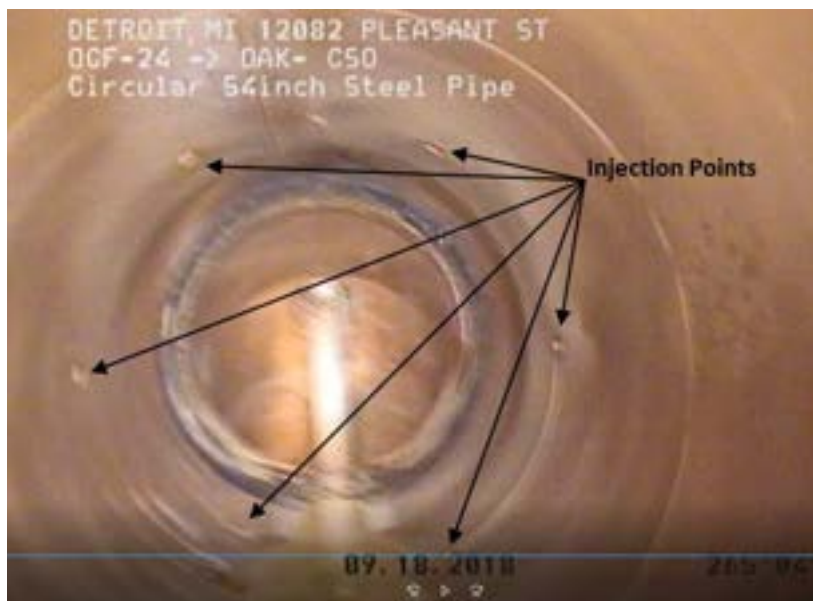


Figure 11-1. CCTV Inspection of Oakwood Storm Pump Discharge Piping Showing Chemical Injection Points

- Provide side access manway on hypochlorite tanks for improved ease of inspection and future relining.
- Provide backup storm pump flow measurement, for when the storm pump flow meter is not working properly—this issue is addressed in the Oakwood I&C section (Section 11.2.7).

11.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project OKW-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to each discharge point (i.e., pump discharge pipe).
- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

The alternative evaluation for these alternatives is presented in Table 11-4. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP.

- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 were estimated based on average annual costs of \$66,000 for manufacturer rebuilds and \$57,000 for GLWA on-site rebuilds (includes GLWA labor) for a total of \$123,000.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on rebuild of \$20,000 per pump for three pumps at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 11-4 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Table 11-4. Alternative Evaluation for Replace Chemical Feed System (Project OKW-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System In-Kind	Health and Safety	3	2.08	\$ 1,964,300	\$ 123,000	\$ 4,558,325	\$ 2,187,996	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 1,332,000	\$ 13,275	\$ 1,611,965	\$ 447,768	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a discharge pipe.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 443,000	\$ 5,000	\$ 548,448	\$ 152,347	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project OKW-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose using an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The storm pump flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on storm pump flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the chemical dosing point to further adjust chemical feed flows. The sampling location would be near the influent end of the basin and near the bottom portion of the basin (to be able to measure TRC concentrations before the effluent sample point). Another sampling point can be provided at an intermediate level.

The automatic chemical feed system should require less operator input during an event; however, this cost difference is not included in this analysis because GLWA O&M staff believe that manual sampling to confirm the auto sample result will still be necessary. There will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 11-5. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains functional between storm events.
- As noted above, this evaluation did not account for any reduction in operations labor using the automatic control system.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Table 11-5. Alternative Evaluation for Provide Flow-paced and TRC-paced Automated Chemical Feed (Project OKW-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Continue Manual Adjustment of Chemical Feed	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less efficient chemical feed and possible overdosing of chemical.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 156,000	\$ 4,860	\$ 258,496	\$ 74,926	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing. Also, provide sampling at two levels, one at low level and one at an intermediate level, in addition to the high level at end of basin.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more efficient use of chemical.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common of CSO facilities, but TRC-pacing is difficult with infrequent CSO facility use.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

Reline and Provide Side Access Manway on Hypochlorite Tanks (OKW-DIS-3). The hypochlorite storage tanks lack side entry manways making FRP repair significantly more difficult. A side entryway manhole near the bottom of each existing tank is recommended. This should be performed when the tank requires relining or a major repair. To determine the condition of the tanks, Jacobs reviewed a 2020 inspection by GHD and found that there was a only a small chip on the exterior of one tank and evidence of leakage from a drain valve (exterior to the FRP tank and not part of the tank).

Based on the limited extent of any defects to the existing tanks, it is recommended that the installation of the manways be done when the tanks near the end of their useful life and require relining. The costs for relining and adding manways to the existing tanks are included in the capital costs for this project. There is no alternative to this option. Table 11-6 provides the summary of **Reline and Provide Side Access Manway, which is the recommended alternative.**

Table 11-6. Alternative Evaluation for Reline and Provide Side Access Manway on Hypochlorite Tanks (OKW-DIS-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Reline and Provide Side Access Manways	Health and Safety	3	3.00	\$ 289,000	\$ -	\$ 289,000	\$ 96,333	Best Value Alternative
	<i>Definition:</i>	Reline and Provide Side Access Manways on Hypochlorite Tanks	Water Quality & Compliance	3						
	<i>Adv.:</i>	Re-use existing chemical tanks	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.3 Odor Control

11.2.3.1 Description of Existing System

There are three odor control systems at the Oakwood facility. One system, located in the Odor Control Building next to the sanitary pump station, treats air from the east and west storm wet wells, the sanitary wet wells, and the sanitary pump station room. The second and third systems, both located in the Basin Odor Control Building, treat air from the East and West Retention Basins. Each of the retention basin odor control systems also serves the headworks, as it is connected to both CSO basins.

The system serving the pump stations consists of a grease filter/mist eliminator, an odor control fan, and a single bed vertical activated carbon vessel. The system also includes a bypass ventilation fan, which allows foul air to be removed from the pump stations and bypass the carbon column. Carbon is replaced through the top access hatch on each vessel.

The systems serving the retention basins operate in parallel. Each system consists of an odor control fan and an activated carbon vessel (there are no grease filter/mist eliminators). Each system also has a bypass ventilation fan.

These odor control systems operate under air permit requirements (Permit to Install No. 91-06). The emission limit for the Pump Station system is 0.0043 pounds per hour (pph) of hydrogen sulfide. At a design air flow of 30,000 cfm, this equates to approximately 0.028 parts per million volume (ppmv) concentration of hydrogen sulfide. The emission limit for the CSO basin systems is 0.0031 pph. At a design air flow rate of 22,000 cfm (each), this equates to approximately 0.028 ppmv concentration of hydrogen sulfide. The carbon is tested for remaining bed life on a quarterly basis as required by the permit. Carbon was replaced in all three carbon vessels in Spring 2018, which was the first time it was replaced since it was put into service in 2012.

Per GLWA, no odor complaints have been received for at least the past three years.

11.2.3.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified:

- Improve odor control for the sanitary pump station.
- Provide improved access and safety for carbon replacement for both the sanitary and basin scrubbers.
- Provide improved access and safety for carbon sampling for both the sanitary and basin scrubbers.
- West basin odor control fan was out of service due to vibration. Vibration monitoring was not installed properly resulting in frequent fan shutdown when vibration is not excessive.

These issues are discussed below.

Oakwood HVAC Improvements Project (CIP No. 260619). The Oakwood HVAC project, currently in the design stage, will include 1) improvements to odor control for the sanitary pump station; 2) improvements for access and safety for carbon replacement for both the sanitary and basin scrubbers; and 3) improvements for access and safety for carbon sampling for both the sanitary and basin scrubbers. Capital costs are not provided because this is an ongoing project.

Vibration Sensor Modifications. Install vibration monitoring closer to the frame of the fan. This will be done as part of the Oakwood HVAC Improvements (CIP No. 260619).

11.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement “needs”.

11.2.4 Flushing and Dewatering

11.2.4.1 Description of Existing System

Dewatering System: The Oakwood screening facility and CSO basins (East and West) are largely dewatered by gravity through drain lines that discharge to the NWI force main. The CSO drain system has sufficient capacity to allow both CSO basin drain valves to be opened simultaneously; however, there is a flow control valve and magnetic flow meter provided on the drain line to the NWI to control the flow to the NWI to prevent overflows in the collection system between the CSO Basin and the WRRF. Also, there is a Surge Chamber on the gravity drain lines that will direct flow back to the head of the plant if the basin dewatering flow rate exceeds the available capacity in the line to the NWI.

Due to system hydraulics, the water in the lowest levels of the basins that cannot be discharged to the NWI by gravity is instead routed back to the Oakwood Pump Station, where flow is pumped by the sanitary wastewater pumps to the NWI.

Flushing System: A flushing gate system is used for cleaning solids from the floor of the basin following dewatering. There are 20 total flushing gates—eight in each of the two CSO basins, and two in each of the two basin influent channels. The flushing gates in each basin are arranged in two groups of four. The flushing gates operate in a latch-unlatch manner and are controlled by a common hydraulic power pack.

The flushing reservoirs are filled as the basins fill during a wet weather event. When the basin and screening facilities dewater, flushing water remains behind the flushing gates. Flushing is initiated by sequentially unlatching two basin flushing gates (one in each basin) at a time in the first basin reservoir until all are open. Then, if the last of the four reservoirs was full prior to its gate opening, the second set of flushing gates will sequentially open. Once basin flushing is completed, one gate is opened in each influent channel. The flushing sequence only allows one gate in each channel to be open at a time.

Table 11-7 provides an overview of the existing flushing and dewatering system at Oakwood CSO facility.

Table 11-7. Overview of Existing Flushing and Dewatering System at Oakwood CSO Facility

Parameter	Value
Total Basin Volume (MG)	9
Headworks and Basin Dewatering and Flushing System	- Basins are dewatered by gravity by opening the Drain Valve to the NWI - There are 20 flushing gates; 8 in each basin and 2 in each basin distribution channel - Flushed solids are routed to the Oakwood Pump Station for pumping to the NWI

11.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed in the following bullets and further described in the next section.

- Air-operated pinch valve intended to isolate the two sides of the Storm Pump Station during dry weather are encased in sand, making them extremely difficult to access, and the air lines that actuate them are underground and have a leak, which cannot be found.
- Flushing valves are hard to reach during maintenance activities and scaffolding needs to be setup to reach the valves, which is difficult due to steep slope on the floor
- Significant grit accumulation at the flushing sumps in the basin leads to plugging of the 12-in. drainage pipeline at the effluent end of the basin

11.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Influent Junction Chamber Isolation (Project OKW-FD-1). The existing influent chamber has two 18-ft diameter sewers from the junction chamber to the Oakwood Storm Pump Station. Within the junction chamber, at the bottom of each 18-ft diameter pipe, there is a 30-in. diameter pipe with an air-operated pinch valve intended to isolate the two sides of the Storm Pump Station during dry weather. These pinch valves are encased in sand, making them extremely difficult to access, and the air lines that actuate them are underground and have a leak, which cannot be found. As such, they have not been repaired after they failed. A means to isolate the two sides of the Storm Pump Station is still needed. A previous study (Oakwood CSO Pump Station Investigative Study, Brown and Caldwell, January 15, 2019) identified several alternatives that included replacement of the existing pinch valves and new stop logs. Jacobs reviewed this study and discussed cost effective options with GLWA. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.** Contractor to install isolation, when needed.
- 2) **Alternative 2: Influent Junction Chamber Isolation Improvements.** This alternative includes removal/replacement of the existing dry weather flow pinch valves with new small hand-pull slide gates. Figure OKW-FD-1-ALT-2 in Volume 6 – Appendices, Appendix B, shows the conceptual layout of this improvement. Following removal of the pinch valves and demolition of the concrete boxes, brackets for a 36-in. by 36-in. hand-pull slide gate will be mounted on the rehabilitated concrete face of the 30-in. pipe in each channel. The hand-pull gates (two service and one spare) could be stored in the upper part of this structure. Flow bypassing is assumed during modifications.

This project should be coordinated with the NWI Diversion project to coordinate and minimize shutdowns and bypass pumping requirements.

The alternative evaluation for these alternatives is presented in Table 11-8. The sources of costs used in this evaluation are listed in the following bullets:

- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 includes the estimated cost of isolation, which is based on \$60,000 per event and frequency of use is assumed to be once every 5 years, for an annual O&M cost of \$12,000.
- The O&M costs for Alternative 2 includes the estimated cost of isolation, which is based on \$2,000 per event and frequency of use assumed to be once every 5 years, for an annual O&M of \$400.

The total benefit score for Alternative 2 is about 0.8 greater than Alternative 1. Also, the NPV/Benefit cost for Alternative 2 is less than Alternative 1. As such, **Alternative 2 - Influent Junction Chamber Isolation Improvements is the recommended alternative.**

Table 11-8. Alternative Evaluation for Influent Junction Chamber Isolation (Project OKW-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.58	\$ -	\$ 12,000	\$ 253,076	\$ 97,965	
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Unable to isolate the two sides of the Storm Pump Station during dry weather.	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Influent Junction Chamber Isolation Improvements	Health and Safety	3	3.42	\$ 289,000	\$ 400	\$ 297,436	\$ 87,054	Best Value Alternative
	<i>Definition:</i>	Removal/replacement of the existing dry weather flow pinch valves with new small hand-pull slide gates.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Simple system to isolate storm pump wet well.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Still requires manned entry into junction chamber, when needed	Component Performance	5						
	<i>Comments:</i>	None	O&M Ease	4						

Reservoir Flushing Valves and Basin Sump Flushing (Project OKW-FD-2). The O&M staff noted that the flushing valves are hard to reach during maintenance activities and scaffolding needs to be setup to reach the valves, which is difficult due to steep slope on the floor.

O&M staff also report that significant grit accumulation at the flushing sump leads to plugging of the 12-in. drainage pipe at the effluent end of the basin. Frequent jetting of this pipe is difficult due to the configuration of the pipes below the facility's slab and the depth to the flushing sump below the adjacent finger weir. There are also two 10-in. drain lines on the influent end that plug, but at a lesser frequency.

There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.** Continue to jet-rod the pipe, when necessary.
- 2) **Alternative 2: Reservoir Flushing Valves Relocation and Basin Sump Flushing.** This alternative relocates the reservoir flushing valves and piping to downstream of flushing gates, where the slope of the floor is less steep. Figure OKW-FD-2-ALT-2 in Volume 6 – Appendices, Appendix B, show the conceptual layout of this improvement.

Improvements to mitigate the pipe clogging include installing submersible solids handling pumps (4-in. discharge) at each sump to recirculate effluent near the sump drains and resuspend accumulated materials. A 4-in. ductile iron discharge manifold mounted around the sump with two or three nozzles pointed toward the sump opening would support more complete resuspension while the basin is use. See Figure OKW-FD-2-ALT-2 in Volume 6 – Appendices, Appendix B for conceptual illustration. As the facility comes into operation, the pumps would start operating and continue operation for the duration of the event and as the facility is drained. By preventing a large accumulation at the sump, the draining process can more effectively dewater the facility and gradually remove settled materials. Pumps would be rail-mounted and removable to the surface through new hatched openings in the top of the structure.

The alternative evaluation for these alternatives is presented in Table 11-9. The sources of costs used in this evaluation are listed in the following bullets:

- The O&M cost for Alternative 1 includes the estimated cost of setting up scaffolding and jetrodding. The cost of scaffolding is based on \$15,000 per event and frequency of use to be once every 10 years. The cost of jetrodding is based on \$10,000 per event and frequency of use to be once every year.
- The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 2 includes the estimated cost of setting up scaffolding. The cost of scaffolding is based on \$10,000 per event and frequency of use to be once every 10 years.

The total benefit score for Alternative 2 is two times higher than Alternative 1 because of the significant improvement to health and safety and ease of operation. Although the NPV/benefit cost is slightly higher for Alternative 2, the type of improvements make **Alternative 2 - Reservoir Flushing Valves Relocation and Basin Sump Flushing the recommended alternative.**

Table 11-9. Reservoir Flushing Valves and Basin Sump Flushing (Project OKW-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	1	2.00	\$ -	\$ 11,500	\$ 242,531	\$ 121,265	Best Value Alternative
	<i>Definition:</i>	Continue to jet-rod the pipe, when necessary.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system	Capacity Enhancement	3						
	<i>Disadv.:</i>	Difficult to set-up scaffolding in basin to reach valves. Unsafe conditions for jetrodding drain line	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Reservoir Flushing Valves Relocation and Basin Sump Flushing	Health and Safety	5	4.00	\$ 536,000	\$ 1,000	\$ 557,090	\$ 139,272	
	<i>Definition:</i>	Relocate the reservoir flushing valves (RFVs) and piping to downstream of flushing gates and install sump flushing system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Easier to reach RFVs for maintenance; Sump flushing system should eliminate need to access basin when it is partially filled to jet-rod drain lines.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher capital cost.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

11.2.5 HVAC

11.2.5.1 Description of Existing System

The Oakwood CSO facility consists of three buildings. The main building contains the Storm Pump Station, Sanitary Pump Station, chemical room, control room, utility support (electrical and mechanical rooms), odor control room, sample room, shipping and receiving and miscellaneous other rooms. The Headworks Building contains the headworks, headworks control room, MAU room and hydraulic room. The Basin Odor Control Room contains the odor control systems for the East and West Basins. Table 11-10 provides summary of the major HVAC equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, gas-fired water heater, emergency shower/eye wash, emergency eye wash, sump pumps, pressure booster pumping system, compressed air system etc. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 11.2.10.

Table 11-10. Major HVAC Equipment at Oakwood CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Main Pump Station	SF-1 to 2	Supply Fan	5,000 CFM
Headworks	MAU-3	MAU	35,800 CFM 3,000 MBH
Basin	EF-20 to 22	3 × Exhaust Fan (East Basin)	52,800 CFM
	EF-23 to 26	3 × Exhaust Fan (West Basin)	52,800 CFM
	SF-5 to 7, SF-10	4 × Supply Fan (East Basin)	52,800 CFM
	SF-5, SF-8 to 10	4 × Supply Fan (West Basin)	52,800 CFM
Chemical Room	AC-2	Air Conditioning Unit	315 CFM 1.25 ton
	MAU-4	MAU	5,000 CFM 400 MBH
	EF-18	Exhaust Fan	2,500 CFM
Electrical Room	AHU-1	AHU	25,000 CFM, Cooling Capacity (125 tons), Heating Capacity (353 MBH)
	EF-35	Exhaust Fan	13,880 CFM
	EUH-8	Electric Unit Heater	1,700 CFM 15 KW
Mechanical Room	AHU-1A	AHU	2,700 CFM
Make-up Air Room	MAU-3	MAU	35,800 CFM
Odor Control Room	EF-28, EF-29	Exhaust Fan	3,000 CFM
	EF-33, EF-34	Exhaust Fan	22,000 CFM
	EUH-6 to 7	Electric Unit Heater	1,700 CFM 15 KW

Table 11-11 provides a summary of the basis of design performance criteria for HVAC systems at Oakwood and Table 11-12 provides the outdoor Basis of Design conditions.

Table 11-11. Oakwood Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Control Building				
Restroom/ Locker	Unclassified	70	78	10 ACH
Electrical Equipment	Unclassified	70	78	6 ACH
Corridor	Unclassified	70	78	4 ACH
Sampling Room	Unclassified	70	78	6 ACH
Control Room	Unclassified	70	78	6 ACH
Conference/ Reference/ Lunch Room	Unclassified	70	78	6 ACH
Shipping/ Receiving Room	Unclassified	50	N/A	Negatively Pressurized
Mechanical/ HVAC Equipment Room	Unclassified	50	N/A	6 ACH
Instrumentation/Phone/ Communications Room	Unclassified	N/A	78	6 ACH
Storage	Unclassified	50	N/A	Negatively Pressurized
Janitor Closet	Unclassified	50	N/A	6 ACH
Pump Station				
Storm and Sanitary Wet Wells (Lower Level)	Class I, Div 1, Group D	N/A	N/A	2 ACH (Unoccupied) 30 ACH (Occupied)
Bearing Floor (Intermediate Level)	Unclassified	50	N/A	6 ACH
Motor or Ground Floor Level (Upper Level)	Unclassified	50	N/A	Ventilation Cooling
Sanitary Screen Room (Upper Level)	Class I, Div 1, Group D (Per Electrical Drawings)	50	N/A	12 ACH
Elevators and Stairwells	Class I, Div 1, Group D	N/A	N/A	30 ACH (Occupied)
Odor Control Room	Class I, Div 1, Group D (Per Electrical Drawings)	50	N/A	6 ACH
Chemical Facility				
Chemical Feed Room	Unclassified	50	N/A	6 ACH
Mechanical Room	Unclassified	50	N/A	4 ACH
Chem. Instrument Rm.	Unclassified	70	78	6 ACH
Stair	Unclassified	50	N/A	4 ACH
Corridor	Unclassified	50	N/A	4 ACH
Headworks				
Screening Room	Class I, Div 2, Group D	50	N/A	12 ACH
CSO Basins	Class I, Div 1, Group D	N/A	N/A	1.4 ACH (Unoccupied) 12 ACH (Occupied)

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Basin Odor Control Building	Class I, Div 2, Group D	50	N/A	Negatively Pressurized

Table 11-12. Oakwood Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
0	90	73

11.2.5.2 Identified Needs and Issues

During the CS-299 Needs Assessment meetings with GLWA O&M staff, the following HVAC issues were noted:

- Insufficient heating capacity in Headworks Area (served by MAU-3): Upon further investigation, the assessment of insufficient heating was based on the fact that a NPW pipe to one of the screens had burst during a cold period last year. It was determined that this issue was related to a problem with the booster pump system.
- Failed Basin supply air fans and exhaust air fans require replacement: this issue is part of the ongoing HVAC Improvements project (CIP No. 260619).

During the discussions with GLWA's HVAC contractor the following historical issues were noted:

- AHU-1 compressor failures: GLWA's HVAC contractor noted that there have been 4 compressor failures with the AHU-1 DX cooling coil in the past 5 years.
- Abnormally short life of Electric Unit Heaters: Per GLWA's HVAC Contractor, the Trane Electric Unit Heaters at Oakwood have a life of 2 to 3 years. The typical expected life of unit heaters that are properly selected for their environment is about 15 years.

Jacobs investigated this issue further. The Trane UHXA unit heaters in the Headworks Area have an aluminum-finned tubular steel heat exchanger that is directly exposed to the air stream in the Headworks Building when the heaters are running. Steel has very poor H₂S resistance and is a poor choice of materials for the environment the unit heaters are in. It is recommended that as the unit heaters fail they are replaced by properly rated units that have a 316 stainless steel heat exchanger and cabinet body, aluminum or 316 stainless steel fins, fan blade, and control enclosure and a motor with a corrosion-resistant protective coating that has passed the ASTM International Standard B117 salt-spray test. As such, this issue should be covered in the SRP.

- Failed Basin supply air fans, maintenance issues, and signs of advanced wear: Several basin supply air fans have failed. There have been bearing failures in the units but there is no access for bearing maintenance. The bearings are greased remotely but there is no way to verify if the grease is getting to the bearings. Despite the fact the units are only 10 years old, the bodies of the units are showing advanced signs of age. GLWA's HVAC contractor does not believe the bases of the units were properly installed; however, the manufacturer provided an inspection in 2020 and concluded that the apparent base settlement was not a concern. As noted above, these fans are being replaced as part of the HVAC Improvements project (CIP No. 260619).

During site investigations (June 2020), the following observations were noted:

- AHU-1 only had one compressor running: Although the weather on the day of the site visit was hot and humid, only one compressor was observed to be running. This underscores that most of the cooling load is driven by the heat generated by electrical equipment, which was not in service on the day of inspection. The main contributors to the cooling load in the space are the VFDs for the stormwater pumps, which rarely run. Jacobs confirmed, however, that the cooling capacity is correctly sized for the predicted heat generated by the electrical equipment when it is in service.
- MAU-4 for the Chemical Room has a complex burner control scheme: Heating output is controlled on MAU-4 by relay packs on each burner. This system is overly complicated and maintenance intensive as each relay represents a potential failure point in the system. GLWA's HVAC contractor noted that they recently had to replace the controller on the unit.

When MAU-4 fails or if maintenance issues become too costly, Jacobs recommends replacement of the unit with one that has a simpler mechanism to modulate the burner output. More efficient units with simpler control schemes are currently available. As such, this issue will be covered in the SRP.

- The Electrical Room was negatively pressurized: The Electrical Room has differential pressure control; however, the area was noted to be negatively pressurized. Electrical rooms are typically positively pressurized to reduce the ingress of dust and corrosive gases into the space. At some facilities, the incoming outside air is filtered with an activated carbon unit to remove H₂S and other corrosive airstream gases.
- MAU-1 has extensive corrosion: Extensive corrosion was noted on the interior of MAU-1. This is most likely the result of backflow of air from the Sanitary Pump Station Room. This MAU is being addressed under the ongoing HVAC Improvement project (CIP No. 260619).

11.2.5.3 Description and Evaluation of Alternatives

As noted above, the major existing HVAC issues and needs are being addressed by the ongoing HVAC capital improvement project. One issue remains and is discussed below. At this time, it is believed that this issue does not require a capital improvement.

AHU-1 Compressor Issues. The extremely high frequency of compressor replacement would suggest that AHU-1 is experiencing abnormal equipment operation. Given the dependence of the peak cooling load on stormwater VFD operation, which occurs rarely, it is likely that the compressors are short-cycling. Jacobs recommended monitoring the compressors using current transformers to determine if this is occurring. As a result of this recommendation, GLWA's mechanical contractor installed a monitoring system in August 2020. Based on review of this data, Jacobs observed that only one of the four compressors (Compressor No. 3) was operating and that it experienced occasions with extremely short cycle times where it was off for less than a minute or only ran for a minute. During the site walkthrough Jacobs noted a compressor was running when the temperature in the electrical room was 75°F despite the fact that the specified sequence of operations calls for AHU-1 to run only if the space temperature exceeds 87°F and that the sequence of operations calls for free cooling to be provided by outside air between a space temperature of 75°F and 87°F. Because AHU-1 was not operating in accordance with the sequence of operations, Jacobs recommended resetting AHU-1 to original factory settings as a next step to potentially reduce short cycle times.

Resetting the AHU did not result in a reduction in short cycle times. Jacobs then contacted Trane, which advised that minimum compressor runtimes and lockout times could be programmed into the unit.

As next steps Jacobs advises GLWA to:

- 1) Work with the mechanical maintenance provider to ensure AHU-1 is functioning as intended per the sequence of operations. As noted above, AHU-1 should economize before running any compressors.
- 2) Verify the cooling temperature setpoint in the space to determine if it has been set to an unreasonably low temperature (outside of the sequence of operations). If the temperature setting is lower than design, Jacobs recommends limiting which users can adjust the cooling setpoint.
- 3) Work with their mechanical maintenance provider to program the unit's compressors to run for a minimum of 15 minutes followed by a minimum lockout time of 15 minutes.

11.2.6 Electrical

11.2.6.1 Description of Existing System

The Oakwood facility's electrical system consists of double ended 4.8 kV, 3,000 A switchgear with dual (redundant) utility feeds, metering of the 4.8 kV feeds and an adjacent DTE substation with two 15 MVA outdoor transformers. The switchgear has a tie-breaker and automatic source transfer controls. Circuit breakers in the switchgear then feed eight storm pumps and two 2,500 kVA outdoor pad mount transformers. The 2,500 kVA transformers then feed a double ended 480 V, 3,200 A switchboard with a key interlocked tie-breaker. Circuit breakers in the switchboard then feed four MCCs and four 125 hp sanitary pumps. The MCCs then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 11-13 provides a summary of the major electrical equipment for this facility.

Table 11-13. Major Electrical Equipment at Oakwood

Location	Major Electrical Equipment	Description
Electrical Room	Double ended 4.8 kV switchgear w/ automatic source transfer	3,000 A, 4.8 kV, 3-Phase
Electrical Room	VFD (Storm Pumps)	(4) 4.8 kV, 3-Phase
Storm Pump Motor Room	Vertical turbine pumps	(2) 1,500 hp, (6) 2000 hp, 4.8 kV, 3-Phase
Outdoors	Pad Mount Transformers	(2) 2,500 kVA, 4.8 kV-480 V, 3-Phase
Electrical Room	Double ended switchboard w/ tie-breaker	3,200 A, 480 V, 3-Phase
Electrical Room	VFD (Sanitary Pumps)	(4) 480 V, 3-Phase
Sanitary Pump Room	Sanitary Pumps	(4) 125 hp, 480 V, 3-Phase
Electrical Room	MCC-1	1,200 A, 480/277 V, 3-Phase
Electrical Room	MCC-2	1,200 A, 480/277 V, 3-Phase
Screening Facility Control Room	MCC-3	1,200 A, 480/277 V, 3-Phase
Screening Facility Control Room	MCC-4	1,200 A, 480/277 V, 3-Phase

11.2.6.2 Identified Need and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the section below.

11.2.6.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project OKW-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure OKW-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Near drain vaults and effluent end of Basin – Add LED lighting fixtures to meet the required foot-candles per IES standards and meet the requirements of the local outdoor lighting ordinances for the areas.
 - Interior Basin at effluent channel – Add interior LED ceiling and wall mounted lighting fixtures within the area to address the required foot-candles and code requirements.
 - External lighting on top of Basin - Add additional light poles and LED lighting fixtures on the facility's basin, lighting foot-candles will meet the requirements of the local outdoor lighting ordinances.
 - Add power receptacles every 100 ft around the exterior of the basin at ground level.
 - Add power receptacles on the top of the basin.

The alternative evaluation is presented in Table 11-14. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$75,000, which is a relatively low cost compared to other projects recommended in this assessment.

Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.

Table 11-14. Alternative Evaluation for Electrical Improvements (Project OKW-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 262,000	\$ -	\$ 262,000	\$ 74,857	Not Applicable
	<i>Definition:</i>	Add additional lighting near drain vaults and effluent end of basin, interior basin at effluent channel, and top of basin; add power receptacles to assist workers.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

11.2.7 I&C

11.2.7.1 Description of Existing System

Control System: The original Ovation control system was installed in 2012 under PC-755. In 2015 under PC -773D, the Ovation control system controllers and software were upgraded to version O.V.3.5.0.

The existing Ovation system includes remote I/O cabinets located in the Headworks/CSO Basins that are networked to the Ovation controller/I/O cabinets and data concentrator cabinet located in the Communication Room. The system currently has one dual screen operator workstation, plus a database server with wall mounted displays and printers in the Control Room. The Ovation redundant pair of controllers provides the facility with a redundant network, controls and I/O capabilities. A 10 kVA Liebert uninterruptible power supply is used to provide constant power to the Ovation system and network. The Ovation network is equipped with primary and backup network switches. The switches are connected to the GLWA AT&T wide area network via the facility's router. The network connections inside the station are via copper Ethernet cables. All workstations and controller connections have redundant networks. The controller connections are dual-homed to provide system redundancy. Should one network fail, the backup, redundant network is available to provide station monitoring and control. The Ovation system is equipped with a backup radio system to communicate critical monitoring points back to the SCC on wide area network failure.

Flow and Level Sensors: Table 11-15 summarizes the level sensors and flow meters at the Oakwood CSO Facility and Sanitary Pump Station for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 11-15. Summary of Flow Meters and Level Sensors at Oakwood CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Storm Pump Flow Meters	8	Area Velocity
Drain to NWI Meter Vault	1	Magnetic
CSO Facility Level Sensors		
Screening Area	1	Ultrasonic
	1	Radar
Basin Influent (East and West)	2	Ultrasonic
	2	Radar
Basins (East and West)	2	Ultrasonic
	2	Radar
Basins Flush Gates (Gates 7, 8, 10, and 11)	4	Ultrasonic
NWI	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed	10	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Ultrasonic
Sanitary Pump Station Flow Meters		

Area	Quantity	Instrument Type
Pump Meter Vault (East and West)	2	Magnetic
<i>Sanitary Pump Station Level Sensors</i>		
Sanitary Wet Wells (East and West, Upstream and Downstream)	4	Ultrasonic
Sanitary Surge Relief Chamber	1	Ultrasonic

11.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Operators have indicated the human interface modules (HIMs) for the Chemical Feed Pump VFDs are difficult to operate locally.
- Eliminate basin gas monitoring.
- Minimize fire alarm systems. Elimination of fire alarm systems is not recommended at Oakwood based on the discussion in Section 5.4.7.
- Need for tank level indication at the Chemical Fill Station
- Need for process cameras at select locations to improve monitoring of facility during wet weather operation.
- Update Ovation control system
- Investigate cause of storm pump flow meter failures. Jacobs further investigated this issue. The storm pump flow meters (Teledyne Isco Inc Pro20 HotTap Insertion Meters) have experienced frequent, random outages. Jacobs investigated the issue with the manufacturer Teledyne and with technicians from PCI, who had investigated these meters. According to the Teledyne Isco Inc Pro20 HotTap installation instructions, the meter is suitable for a wide range of pipe sizes, pipe geometries, and varying hydraulic conditions. All of these installation conditions are met, which indicates the meter is being used in the proper application, but an underlying issue is still present, which is causing the random outages. In order to determine the root cause of the issue, a deeper evaluation from an instrumentation contractor familiar with these meters will be required. An allowance of \$50,000 is included in the capital cost estimate to further study this issue.
- Investigate backup flow measurement for each storm pump if the flow meter is not working properly. GLWA requested that Jacobs consider as a backup creating a programmed lookup table to estimate flow based on wet well level and pump curves. Jacobs discovered that this type of backup flow measurement was actually specified to be programmed into the control system according to the 2007 contract documents (Specification 17500 page 12) and may already exist in the software. If it is not included, it could be added by a controls system contractor. Based on this information, a capital improvement is not provided to address this issue.

11.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

I&C Improvements (Project OKW-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation

Control System Upgrade, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. There are two alternatives for this project:

1) **Alternative 1: Do Nothing/ Replace In-Kind**

- Replace Storm Pump flow meters in-kind
- Leave HIM modules for the Chemical Feed Pump VFDs in place

2) **Alternative 2: I&C Improvements** including,

- Improve local operation capabilities of chemical feed pump HIM
- Eliminate basin gas monitoring
- Provide tank level indication at Chemical Fill Station
- Provide process cameras at select locations
- Resolve existing storm pump flow meter reliability issues

Each of the I&C related improvements listed above is described further below:

Improve local operation capabilities of chemical feed pump HIM. Operators have indicated the HIMs for the chemical feed pump VFDs are difficult to operate locally. The buttons are small and navigating through the LCD screens is not intuitive or easy to use. The recommendation is to provide local control stations similar to the approach to add local control in Section 5.4.9. The VFD HIM modules would remain for troubleshooting, but operation of the chemical feed pumps will be from the local control stations.

Eliminate basin gas monitoring. Eliminate gas monitoring equipment in accordance with Section 5.4.7.

Provide tank level indication at Chemical Fill Station. Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

Resolve existing storm pump flow meter reliability issues. This issue should be further investigated by an instrumentation contractor.

The alternative evaluation is presented in Table 11-16. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 includes replacement of the Storm Pump flow meter.
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M costs for Alternative 2 include estimated annual O&M for the new cameras and new tank level indicators.

This evaluation shows that Alternative 1 – Do Nothing is the Best Value Alternative. **However, because of the improved reliability, control and operations associated with the I&C improvements, Alternative 2 is the recommended alternative.**

Control System Upgrade (OKW-I&C-2). It is recommended to update the Ovation control system to latest version (O.V.3.7), as described in Section 5.4.2.

Because the Ovation system is the only alternative for the control system upgrade, it is the only alternative considered. Table 11-17 provides the summary of the **Control System Upgrade, which is the recommended alternative.**

Table 11-16. Alternative Evaluation for I&C Improvements (Project OKW-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Replace In-Kind	Health and Safety	3	2.40	\$ 145,600	\$ -	\$ 145,600	\$ 60,667	Best Value Alternative
	<i>Definition:</i>	Replace Storm Pump flow meter in-kind.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to operation - flows and volumes, alarms, system status, etc.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.60	\$ 347,000	\$ 8,000	\$ 515,717	\$ 143,255	
	<i>Definition:</i>	Improve local operation capabilities of Chemical Feed Pumps; eliminate basin gas monitoring; provide tank level indication; and provide process cameras.	Water Quality & Compliance	4						
	<i>Adv.:</i>	Higher performance, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Table 11-17. Alternative Evaluation for Control System Upgrade (Project OKW-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 1,003,000	\$ -	\$ 1,003,000	\$ 334,333	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Replace Sample Building local control panel. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Updates the control system to allow for enhanced performance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.8 Site

11.2.8.1 Description of Existing Site

Access to the site is off Pleasant Street through a 26-ft wide sliding vehicular gate. The parking lot consists of 8-in. thick reinforced concrete pavement. Roads onsite consist of 26 ft wide, 9 in. thick reinforced concrete pavement with 8-in. aggregate base designed to support HS-20 loading. There is also a gravel road going around the basin building consisting of 8 in. of aggregate. Concrete sidewalks are 4 to 5 ft wide and 4 in. thick with a 2-in. sand base. Site security is provided by a perimeter fence comprised of an 8-ft ornamental iron fence and an 8-ft chain-link fence. Stormwater runoff from the site is collected and conveyed to the storm junction chamber upstream of the pump station.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's geographic information system (GIS). Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GP) date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

11.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the following bullets.

- The current road around the basin is gravel and susceptible to potholing .
- There are areas around the basin with poor drainage, including electrical and instrumentation vaults.
- There are several locations around the perimeter of the Control Building where the concrete access sidewalk has settled, leaving uneven cracked flags of sidewalk.
- The following needs are generally preventative maintenance items intended to ensure that the site features or utilities are serviceable throughout their expected service lives.
 - Clear vegetation overgrowth from Surge Relief Basin
 - Seal joints in concrete pavement drive to ensure serviceability

11.2.8.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Site Improvements (Project OKW-SITE-1). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: Site Improvements** including,

- Add paved road around the basin
- Address drainage around the basin
- Address drainage in electrical and instrumentation vaults
- Replace settled concrete sidewalk

Each of the site related improvements listed above is described further below:

Add Paved Road Around the Basin. The access service road around the perimeter of the Control and Pump Station Buildings includes reinforced concrete pavement and gutter. However, the access road around the CSO basin is a gravel surface. A number of areas around the perimeter of the basin have experienced poor drainage, that has impacted the service drive, resulting in potholing and reducing accessibility around the CSO basin. It is recommended that the gravel service road be replaced with new reinforced concrete pavement that will extend around the perimeter of the basin connecting with the existing concrete service road on either side of the basin. See Figure OKW-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, for the location of new pavement. The concrete pavement should have a minimum 16-ft width.

Address Drainage Around CSO Basin. There are areas around the CSO basin that are poorly drained. Runoff from the CSO basin roof is collected at six scupper/downspout locations on either side of the basin and discharged to grassy areas at grade between the basin and service road on either side of the basin. These areas do not have significant slope, so basin roof discharge during wet weather tends to accumulate at grade at the base of the basin. The west side of the basin is particularly poorly drained. This may be an area that could benefit from a Green Stormwater Infrastructure solution that would feature a bioswale to collect runoff from the poorly drained grassy area between the basin and service drive. On the basin's west service drive, there is a shallow drainage swale with dimensions of approximately 360 ft by 30 ft. The area tributary to this swale includes areas surrounding its immediate perimeter.

It is recommended that the swale be excavated to increase its volume to accept the flow that is discharged from the west side of the basin roof during wet weather. Figure OKW-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, presents the proposed layout for these improvements. The flat area between the basin and existing service drive is recommended to be regraded away from the basin, and new catch basins and a storm sewer be added to capture the surface runoff and direct the flow under the service drive to discharge into the new bioswale.

Address Drainage in Electrical and Instrumentation Vaults. In the past, the basin electrical/I&C vaults on the west side of the basin had experienced flooding through electrical conduits, allowing groundwater to flow into the vaults. Per discussion with GLWA, the damaged duct-banks have been replaced and the issue of water infiltration into the vaults has been fixed. Having inspected the ground surfaces around the basin, this area should be regraded and the top of the vaults should be adjusted to avoid any surface drainage from going into these vaults. If there is still infiltration into these vaults and there is a desire to keep them free of water, a permanent sump pump should be installed in each vault.

Replace Settled Concrete Sidewalk. There are several locations around the perimeter of the Control Building where the concrete access sidewalk has settled, leaving uneven cracked flags of sidewalk. It is recommended that the damaged sections of sidewalk be removed and replaced to mitigate the potential tripping hazard created by the uneven surfaces. Expansion joints at the base of the building wall should be replaced and caulked to prevent water infiltration.

The alternative evaluation is presented in Table 11-18. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – Site Improvements has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved O&M. The NPV/Benefit cost for Alternative 2 is \$209,000, which is a moderate cost compared to other projects recommended in this assessment. However, because of the improved drainage and safety with **Alternative 2 – Site Improvements, Alternative 2 is the recommended alternative.**

Table 11-18. Alternative Evaluation for Site Improvements (Project OKW-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Potholing of gravel road; ponding water around basin; submerged electrical and instrumentation vaults; settled sidewalk.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 732,000	\$ -	\$ 732,000	\$ 209,143	Not Applicable
	<i>Definition:</i>	Replace gravel road with new reinforced concrete pavement around the basin and improve drainage around CSO Basin and drainage into electrical and instrumentation vaults. Replace settled concrete sidewalk.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Smoother road; proper drainage around basin and better access to vaults.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

11.2.9 Architectural

11.2.9.1 Description of Existing Facilities

The Oakwood facility consists of chemical room, utility support (electrical and mechanical), control room, odor control room, screen room, sampler room, storm pump room, sanitary pump room, hydraulic room, make-up air room, shipping and receiving and miscellaneous other rooms. The facility also includes the retention basins.

11.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment, as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/coverings systems
- Stairways
- Corrosion on visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

11.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (OKW-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove and replace isolation/ cove joint sealant and around building perimeter
 - Remove failed concrete floor coating, clean floor and reseal floor in Headworks and Odor Control Rooms

- Clean rust/ corrosion and coat localized areas in roof framing and beams in the Sanitary Pump Station and Headworks
- Clean and coat corroded areas of vehicle barriers and bollards
- Investigate and repair cause of water intrusion at skylight, between roof decking and skylight installation
- Remove and replace various door hardware and address corrosion on door hardware
- Clean and coat debonding paint from wall
- Clean corrosion of column base plate and apply moisture resistant coat in Pump Station Odor Control Room
- Fasten and replace damaged face brick façade flashing

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure OKW-ARCH-1-ALT-2).

The alternative evaluation is presented in Table 11-19. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, **Alternative 2 is the recommended alternative.**

Table 11-19. Alternative Evaluation for Architectural Rehabilitation (Project OKW-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 880,000	\$ -	\$ 880,000	\$ 283,871	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.10 Safety

11.2.10.1 Description of Existing System

Safety related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

11.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 11-20. The capital improvement project to address these issues is included in the table.

Table 11-20. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Storm Pump Station	Stairway to lower level has excessive gap at landing	Extend railing	Safety Improvements (Project OKW-SAFE-1)
Top of basin	Conduit posing a trip hazard (multiple locations)	Install conduit ramps	Safety Improvements (Project OKW-SAFE-1)
Storm Pump Station lower level	No eyewash and shower present on this level, yet there are containment jugs for hypochlorite, one of which was full and had recently overflowed onto the floor	Add eyewash and shower	Safety Improvements (Project OKW-SAFE-1)
Effluent Sample Room	Eyewash is out of service	Replace eyewash	Safety Improvements (Project OKW-SAFE-1)
Sanitary Pump Room	Illuminated exit sign not working	Replace exit sign	Exit Sign Improvements ^a
Basin Odor Control Room	Illuminated exit signs not working	Replace exit signs	Exit Sign Improvements ^a
Chemical Room	Gaps between ladder and tanks 1 and 2 at top of ladders are too large	Install step platform	Safety Improvements (Project OKW-SAFE-1)
Storm Pump Station	Gaps between ladder and motors at top of ladders are too large	Install step platform	Safety Improvements (Project OKW-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

11.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of project alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project OKW-SAFE-1). This project should address the safety issues identified above. These issues include:

- Extend railing on the stairway in the Storm Pump Station to eliminate fall hazard
- Install conduit ramps at the top of basin to eliminate trip hazard
- Replace eyewash/shower in the Storm Pump station, Effluent Sample Room, and Sanitary Pump Room
- Install step platform between ladder and tanks 1 and 2 at top of the ladder in the Chemical Room

- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency, the Table 11-21 showing the one alternative is presented below.

Table 11-21. Alternative Evaluation for Safety Improvements (Project OKW-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 338,000	\$ -	\$ 338,000	\$ 112,667	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address tripping hazards, fall protection, and eye wash.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at Oakwood CSO Facility.

11.2.12 Storm Pump Station

11.2.12.1 Description of Existing System

The storm water pump station consists of eight vertical mixed flow pumps. Design criteria is presented in Table 11-22. The pump station is divided into two equal sized wet wells. Each wet well contains one smaller pump and three larger pumps. The storm pumps are equipped with an external flushing water system for bearing cooling and lubrication. The seal water system consists of potable water piping with a dedicated seal water booster pump for each storm pump. As the wet wells fill, the storm pumps start based on the wet well levels and control system logic. The station was designed for operation using a constant-level control strategy. Features of this control strategy include narrow wet well operating range, pump speed ramping up and down, and pumps turning on/off to match a set level. This requires pumps with VFDs and a high degree of turn-down capability for the pumps.

Table 11-22. Design Criteria for Oakwood Storm Pump Station

Storm Pump No.	Design Capacity, MGD	Total Dynamic Head, ft	Drive Type
1 and 2	97	48	VFD
3, 4, 7, and 8	178	48	Constant Speed
5 and 6	178	48	VFD

11.2.12.2 Identified Needs and Issues

For the Storm Pump Station, Jacobs examined existing conditions and obtained information from O&M staff members. Many of the stormwater pumping issues were evaluated separately in a report by Brown and Caldwell dated January 15, 2019. Jacobs confirmed in June 2020 that it appeared the recommendations for the stormwater pumps had not yet been implemented.

SP1 and SP2 (small pumps) were found to have an unstable operating zone below 60 MGD at typical wet well levels and motor speeds below approximately 85 percent. Currently, the majority of SP1 and SP2 operating time is at a motor speed of 75 percent within this unstable zone. SP5 and SP6 have an unstable zone below 110 MGD (motor speeds below 80 percent). SCADA data documents significantly increased pump vibration levels and rapidly fluctuating discharge flowrates while operating in this unstable zone. Pump operation outside of the preferred operating range (POR) and especially in the unstable zone will lead to diminished reliability. Anticipated consequences include increased rate of failure of bearings and seals. The low annual runtime of the pumps may mask reliability issues related to the poor operating conditions. The recommended discharge-flowrate turn-down range for SP1, SP2, SP5 and SP6 is significantly less than the original design intent. Pumps SP3, SP4, SP7, and SP8 operate in a stable zone at all normal operating conditions.

The storm pumps operate within a narrow range of wet well levels. The pump net positive suction head (NPSH) margin was analyzed, and based on the analysis performed, it may be possible to start pump operations at a lower wet well level.

Based on this information, it was recommended that the operating setpoints be modified and tested. The potential setpoint modifications include the following:

- Operate SP1 and SP2 within a speed range of 85 to 100 percent to avoid unstable operating zones. Jacobs confirmed that, as of June 2020, this modification had not yet been made.
- Operate SP5 and SP6 within a speed range of 85 to 100 percent to avoid unstable operating zones. Jacobs confirmed that, as of June 2020, this modification had not yet been made for SP6.
- Lower lead pump shut-off WSE from EL 71-ft to EL 65-ft to reduce pump cycling on/off. Prior to implementing this recommendation, at a minimum, the submergence should be calculated for the large pumps using the equation in ANSI/HI 9.8 (Pump Intake Design) to determine if the proposed minimum WSE is feasible. A more robust study would be to perform physical model tests for low water level for the large storm pumps.
- For the near term, modify controls to provide continuous seal/lube water to all storm pumps to prevent clogging of seal water lines. Note that the facility SOP indicates that the "seal water system" is to be run continuously if the storm pump wet well level is above the bell of the storm pumps. Consider whether the modified controls will allow the seal water to run at a lower than advised wet well level, implications, and modifications to run seal water continuously under appropriate conditions. Jacobs confirmed that, as of June 2020, the seal water pumps run continuously.

The seal water systems for the storm water pumps were found to experience various operational issues. Previously, tripping of the seal water booster pump circuit breakers frequently caused failure of the storm pumps. This issue was addressed by replacing the breakers. Recently, the seal water lines have become plugged and proved difficult to clear. These events coincided with the blinding of bar rack in the sanitary PS. Because the racks were blinded, the sanitary sewage level in the storm wet well raised to nearly EL 70-ft. Exposure of the storm pump bearings to sanitary sewage floatables may have plugged the bearing flushing lines.

11.2.12.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Rehabilitate Storm Pumps (Project OKW-PUMP-1). This project would include removal of each pump for inspection in the factory and necessary rehabilitation of all eight storm pumps. The conversion of the water bearing lubrication system with a grease bearing lubrication system would be included to alleviate the plugging problems experienced in the past. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.** Continue to operate pumps in existing condition and rehabilitate at some time in the future.
- 2) **Alternative 2: Rehabilitate Storm Pumps.** This alternative includes removal of all pump rotating assemblies for inspection and rehabilitation, as necessary. The alternative also includes conversion of all pumps from a water bearing lubrication system to a grease lubrication system. This task should include: Confirm details of required modifications with pump manufacturer (Xylem/Flygt); identify the recommended type of grease; determine where the excess water for motor bearing cooling and seal water services would be conveyed (enclosing tube typically fills with grease); modifications required to seal the bottom of enclosing tube around the shaft to prevent wastewater/ grease mixing in tube; and, obtain state regulator buy-in for this modification.

This task should also evaluate and recommend the feasibility of lowering the lead pump shut-off water surface elevation from EL 71-ft to EL 65-ft in an effort to reduce pump cycling on/off. This task may require physical model tests for the large storm pumps.

The alternative evaluation for these alternatives is presented in Table 11-23. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

Due to the importance of reliable storm pumping after the diversion of additional flow from the NWI in the near future, **Alternative 2 – Rehabilitate Storm Pumps is the recommended alternative.**

Table 11-23. Alternative Evaluation for Rehabilitate Storm Pumps (Project OKW-PUMP-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.80	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do not rehabilitate pumps	Water Quality & Compliance	3						
	<i>Adv.:</i>	Same as existing	Capacity Enhancement	3						
	<i>Disadv.:</i>	Potential pump failures (i.e., plugging of seal water lines, bearing and seal failures)	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Rehabilitate Storm Pumps with Grease Lubrication System	Health and Safety	3	3.10	\$ 4,100,000	\$ -	\$ 4,100,000	\$ 1,322,581	Not Applicable
	<i>Definition:</i>	Rehab Storm Pumps and convert water bearing with grease bearing lube system	Water Quality & Compliance	3						
	<i>Adv.:</i>	More reliable operation	Capacity Enhancement	3						
	<i>Disadv.:</i>	Regulatory concerns with grease in wastewater	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

11.2.13 Sanitary Pump Station

11.2.13.1 Description of Existing System

The Sanitary Pump Station of the Oakwood CSO Facility consists of two separate wet wells (east and west) and an enclosed sanitary pump station room located at ground level. Each wet well includes a manual bar screen and two submersible sanitary sewage pumps for a total of four pumps. Even number pumps (SN2 and SN4) are located in the east wet well, while odd numbered pumps (SN1 and SN3) are located in the west wet well.

11.2.13.2 Identified Needs and Issues

For the Sanitary Pump Station, Jacobs examined existing conditions and obtained information from O&M staff members. Many of the sanitary pumping issues were evaluated separately in a report by Brown and Caldwell dated January 15, 2019.

The manual bar screen frequently become blinded, resulting in differential water levels of 12-15 ft from upstream to downstream of the bar racks. This can contribute to submergence of the storm pump intakes during dry weather flow. This issue is evaluated in the Screening section above and removal of the bar racks is recommended.

In general, the pumps have normal annual pump runtimes. Operation of east and west wells is imbalanced due to failure of the Influent Junction Chamber isolation pinch valves. Modifications to the Influent Junction Chamber are discussed in the Dewatering and Flushing section above.

The new Flygt pumps are expected to run over a range of static head that spans wet well elevation 78 down to wet well elevation 43.6, a static head range of 34.5-ft between low wet well elevation and high wet well elevation. These pumps are operating without VFDs. The Flygt pumps operate to the right side of the best efficiency point (BEP) for most operating conditions. At low wet well elevations, the pumps operate most efficiently at approximately 83 percent speed. At high wet well levels, the pumps run well to the right of the POR (nearly off of pump curve) under all speeds. At target dry weather wet well elevations, the pumps run between the minimum and maximum POR only at a pump speed of 75 to 85 percent.

When the storm pumps are operating and there is no wet weather capacity in the downstream sewer to the NWI, the control system should automatically operate the sanitary pumping system in recirculation mode, to minimize settling of grit and solids within the sanitary pump wet wells. (It is currently operated in manual.) Recirculating sanitary flow during wet weather events may be delaying the time it takes to empty the wet well and wasting energy. However, the cost/down time associated with unclogging pumps may outweigh the energy utilized to recirculate flow.

The maximum firm capacity from Sanitary PS is approximately 15 to 20 MGD. The minimum recommended flowrate for the Storm PS is approximately 65 to 75 MGD. The dead band between these two capacities significantly limits ease-of-operations for small and intermediate sized storm events based on current operating strategies.

11.2.13.3 Recommendations

The following actions are recommended to address issues identified with the sanitary pumps:

- Modify operating setpoints and test new operation. Testing would include the further development of proposed new operating procedures and setpoints, coordination with GLWA Oakwood CSO O&M staff

GLWA field Services O&M staff and execution on one or more storm events. Update O&M manual with the new operating procedures

- It is recommended that the manual operated bar racks be removed to prevent sewage backup into the storm pump intakes. See Screening Section 11.2.1 above for further discussion.

11.2.14 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Oakwood CSO facility, Table 11-24 and Table 11-25 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 11-24 and Table 11-25, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 11-24. Listing of Asset Condition Assessments for Oakwood CSO (CSO-OKW) Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	52	52	0	100%
AHU	2	0	2	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	18	18	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	4	0	4	100%
BUILDING	5	3	0	60%
CAMERA	1	1	0	100%
COMPRESSOR	1	1	0	100%
COND-AIR	7	7	0	100%
CONVEYOR	2	0	2	100%
CRANE	6	6	0	100%
CTRLPANEL	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAM	0	0	0	N/A
DAMPER	8	8	0	100%
DISCONNECT	2	2	0	100%
DOOR	7	5	2	100%
DRIVE-ELEC	0	0	0	N/A
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	4	4	0	100%
FAN	4	2	2	100%
FANVENT	39	11	28	100%
FENCE	1	1	0	100%
FIREALARM	2	2	0	100%
FIRESUPRES	1	0	0	0% ^b
GASDETECTO	1	0	0	0% ^c
GASMONITOR	5	5	0	100%
GATE	9	9	0	100%
GEARBOX	15	1	14	100%
GENERATOR	0	0	0	N/A
GRINDER	1	1	0	100%
GROUNDS	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	1	1	0	100%
MAU	3	2	1	100%
MCC	4	0	4	100%
METER	12	12	0	100%
MIXER	0	0	0	N/A
MOTOR	33	13	20	100%
PANEL	17	17	0	100%
PIPING	3	3	0	100%
PUMP	21	17	2	90% ^d
ROOF	3	3	0	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SAMPLER	1	1	0	100%
SCADA	1	1	0	100%
SCREEN	6	0	6	100%
SCRUBBER	2	0	2	100%
SENSOR	15	15	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	1	0	1	100%
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	6	0	6	100%
UNITHEATER	11	11	0	100%
UPS	5	5	0	100%
VALVE	49	49	0	100%
WATERHTR	2	2	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The fire suppression was evaluated Simplex Grinnell in 2018.

^c The one gas detector is a portable unit and was not assessed.

^d There are two sump pumps SMP-1 and SMP-2, listed in the WAM data, which were not found at the facility. These assets are being considered to be removed from the WAM data.

Table 11-25. Listing of Asset Condition Assessments for Oakwood Sewage Pump Station (SPS-OKW)

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	7	7	0	100%
AHU	1	0	1	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	0	0	0	N/A
BASIN	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
BATTERY	0	0	0	N/A
BREAKER	8	0	8	100%
BUILDING	1	0	0	0% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	1	1	0	100%
COND-AIR	0	0	0	N/A
CONVEYOR	0	0	0	N/A
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A
DAMPER	9	9	0	100%
DISCONNECT	1	1	0	100%
DOOR	3	3	0	100%
DRIVE-ELEC	12	0	12	100%
ELEVATOR	2	2	0	100%
EMERGLIGHT	0	0	0	N/A
EYEWASHSTA	0	0	0	N/A
FAN	0	0	0	N/A
FANVENT	8	1	7	100%
FENCE	0	0	0	N/A
FIREALARM	0	0	0	N/A
FIRESUPRES	0	0	0	N/A
GASDETECTO	0	0	0	N/A
GASMONITOR	0	0	0	N/A
GATE	0	0	0	N/A
GEARBOX	0	0	0	N/A
GENERATOR	0	0	0	N/A
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	0	0	0	N/A
MANHOLE	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
MAU	2	2	0	100%
MCC	0	0	0	N/A
METER	11	11	0	100%
MIXER	0	0	0	N/A
MOTOR	25	0	25	100%
PANEL	2	2	0	100%
PIPING	1	1	0	100%
PUMP	32	4	28	100%
ROOF	0	0	0	N/A
SAMPLER	0	0	0	N/A
SCADA	0	0	0	N/A
SCREEN	0	0	0	N/A
SCRUBBER	1	0	1	100%
SENSOR	6	6	0	100%
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	0	0	0	N/A
SYSTEM	5	0	0	0%
TANK-PROC	0	0	0	N/A
TANK-STOR	0	0	0	N/A
TIPBUCKET	0	0	0	N/A
TRANSFRMR	0	0	0	N/A
UNITHEATER	8	8	0	100%
UPS	0	0	0	N/A
VALVE	12	12	0	100%
WATERHTR	0	0	0	N/A
^a The Oakwood – Pumping Station Building was not evaluated.				

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near

future. Based on the review of the Oakwood Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

11.3 Capital Planning for Oakwood CSO Facility

11.3.1 Summary of Capital Improvement Plan Projects

Table 11-26 provides a summary of the recommended CIP projects and associated capital costs for the Oakwood CSO facility based on the alternative evaluations conducted for this facility.

Table 11-26. Summary of Recommended Projects at Oakwood CSO Facility

Project No.	Alternative	Description	Total Project Cost
OKW-SCR-1	2	Remove Bar Racks	Capital Outlay
OKW-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 443,000
OKW-DIS-2	2	Install Flow-paced and TRC-paced Chemical Feed Control System	\$ 156,000
OKW-DIS-3	1	Reline and Provide Side Access Manways	\$ 289,000
OKW-FD-1	2	Influent Junction Chamber Isolation Improvements	\$ 289,000
OKW-FD-2	2	Reservoir Flushing Valves Relocation and Sump Flushing	\$ 536,000
OKW-ELEC-1	2	Electrical Improvements	\$ 262,000
OKW-I&C-1	2	I&C Improvements	\$ 347,000
OKW-I&C-2	1	Control System Upgrade	\$ 1,003,000
OKW-SITE-1	2	Site Improvements	\$ 732,000
OKW-ARCH-1	2	Architectural Rehabilitation	\$ 880,000
OKW-SAFE-1	1	Safety Improvements	\$ 338,000
OKW-PUMP-1	2	Rehabilitate Storm Pumps	\$ 4,100,000

11.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 11-27. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 11-27. Capital Improvement Plan Projects for Oakwood CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
OKW-1 Disinfection System Improvements	\$ 1,424,000	2026 <i>Timing based on implementation of projects before NWI diversion to ensure reliable operation with increased flows.</i>	OKW-DIS-1	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 443,000
			OKW-DIS-2	Install Flow-paced and TRC-paced Chemical Feed Control System	\$ 156,000
			OKW-DIS-3	Reline and Provide Side Access Manways	\$ 289,000
			OKW-FD-1	Influent Junction Chamber Isolation Improvements	\$ 289,000
			OKW-FD-2	Reservoir Flushing Valves Relocation and Sump Flushing	\$ 536,000
OKW-3 Facility-Wide Electrical and I&C Improvements	\$ 1,612,000	2029 <i>Timing based on asset condition</i>	OKW-ELEC-1	Electrical Improvements	\$ 262,000
			OKW-I&C-1	I&C Improvements	\$ 347,000
			OKW-I&C-2	Control System Upgrade	\$ 1,003,000
OKW-4 Site Improvements	\$ 732,000	2030 <i>Timing based on best judgement</i>	OKW-SITE-1	Site Improvements	\$ 732,000
OKW-5 Facility-Wide Safety and Architectural Improvements	\$ 1,218,000	2023 <i>Project should be initiated as soon as possible</i>	OKW-ARCH-1	Architectural Rehabilitation	\$ 880,000
			OKW-SAFE-1	Safety Improvements	\$ 338,000
OKW-6 Rehabilitate Storm Pumps	\$ 4,100,000	2022 <i>Timing based on condition</i>	OKW-PUMP-1	Rehabilitate Storm Pumps	\$ 4,100,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 11-28 and Table 11-29 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 11-28 indicates that OKW-DIS-1 project has 52 assets that have an average condition score of 1.15 and an average replacement date of 2041. However, this project should be completed before the NWI diversion to ensure reliable operation with increased flows and therefore, the project was proposed a scheduled construction completion date of 2026 instead of 2041.

Table 11-28. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
OKW-DIS-1	52	1.24	1.15	1.95	23	2041	\$ 1,819,300
OKW-DIS-3	2	2.14	1.00	3.21	15	2035	\$ 118,400
OKW-I&C-1	8	1.14	1.91	2.24	15	2031	\$ 145,600
OKW-I&C-2	1	2.29	1.57	4.08	12	2029	\$ 580,725

Table 11-29. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
OKW-DIS-1	1	1.29	5.00	4.50	10	2021	\$ 145,000
OKW-DIS-3	0	0.00	0.00	0.00	N/A	N/A	\$ -
OKW-I&C-1	0	0.00	0.00	0.00	N/A	N/A	\$ -
OKW-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -

11.3.3 20-Year Capital Outlay Plan

Table 11-30 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 11-30. 20-Year Capital Outlay Plan for Oakwood CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 671,213	\$ 20,010	\$ 30,000	\$ -	\$ 145,000	\$ -	\$ -	\$ 429,435	\$ -	\$ -	\$ 46,768	\$ -	\$ -
2022	\$ 1,574,631	\$ -	\$ -	\$ 26,883	\$ -	\$ -	\$ 1,534,700	\$ -	\$ -	\$ -	\$ 13,048	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ 59,417	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 59,417	\$ -	\$ -	\$ -	\$ -
2025	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 4,499,155	\$ -	\$ -	\$ 4,405,601	\$ -	\$ -	\$ -	\$ 9,506	\$ 84,047	\$ -	\$ -	\$ -	\$ -
2027	\$ 37,493	\$ 37,493	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 234,006	\$ 6,149	\$ -	\$ -	\$ 205,389	\$ -	\$ -	\$ 6,887	\$ -	\$ -	\$ 15,580	\$ -	\$ -
2029	\$ 851,357	\$ -	\$ -	\$ 100,284	\$ 15,428	\$ -	\$ -	\$ -	\$ -	\$ 735,645	\$ -	\$ -	\$ -
2030	\$ 2,015,008	\$ 58,715	\$ -	\$ -	\$ 1,923,236	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 33,058	\$ -	\$ -
2031	\$ 205,384	\$ 6,988	\$ -	\$ -	\$ -	\$ 65,583	\$ -	\$ 11,020	\$ -	\$ -	\$ -	\$ -	\$ 121,792
2032	\$ 9,274	\$ -	\$ -	\$ 9,274	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 1,890,027	\$ 89,945	\$ 343,637	\$ -	\$ -	\$ -	\$ -	\$ 1,456,445	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 720,327	\$ 73,209	\$ -	\$ -	\$ 179,091	\$ -	\$ -	\$ 146,419	\$ -	\$ -	\$ 321,608	\$ -	\$ -
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 1,831,683	\$ 302,378	\$ 919,060	\$ -	\$ -	\$ -	\$ 150,961	\$ 364,288	\$ -	\$ -	\$ -	\$ 94,996	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 14,598,975	\$ 594,888	\$ 1,292,697	\$ 4,542,042	\$ 2,468,144	\$ 65,583	\$ 1,685,661	\$ 2,424,000	\$ 143,464	\$ 735,645	\$ 430,062	\$ 94,996	\$ 121,792

Notes:

Explanation of large capital outlays in first two years:

- Screening System: The screen spray water booster pump in the makeup air room was out of service at the time of the Condition Assessment. GLWA has repaired this asset since then.
- Retention System: Two reservoir fill valves (Nos. 3 and 5) in the West Basin (\$6,900 each) received a score of 5 because the valves may not open again if they are closed. One drain valve (DV-7; \$13,000) received a score of 5 because the valve body was removed from the pipeline.
- Disinfection System: One chemical feed pump (No. 6) received a score of 5 since the pump had been removed from the skid at the time of the Condition Assessment.
- Odor Control System: One carbon scrubber in the basin Odor Control Room received a score of 5 because the unit was not in service at the time of the Condition Assessment.
- HVAC System: Three exhaust fans (EF-5, EF-20, and EF-24) and four supply fans (SF-7 to 10) received a score of 5 since they have been out of service for some time. An ongoing HVAC project is addressing these units.

12. Puritan-Fenkell CSO Control Facility

12.1 General Facility Description and Future Capacity Considerations

12.1.1 General Facility Description

The Puritan-Fenkell CSO Facility is an RTB with 2.8 MG of storage and a treatment capacity of 845 cfs. It was constructed in 1996. The facility has not experienced the originally anticipated level of flows, in fact, the facility did not discharge from 2016-2018 and only a few times in 2019 and 2020. For this reason, Section 12.1.2 describes potential modifications to make this facility into a "Capture-Only" facility. A similar recommendation is made for Seven Mile CSO Facility.

The facility consists of a headworks area, chemical room, odor control room, electrical room, control room, metering room in the basement, and miscellaneous other rooms and a courtyard.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

12.1.2 Modifications to Make Puritan-Fenkell Facility into a Capture-Only Facility (PF-WWMP-1)

The WWMP recognized that "GLWA has developed a protocol to operate the Puritan-Fenkell and Seven Mile basins in capture-only mode (no treatment or discharge) for flows up to the 10-year 1-hour design storm. This finding provides a significant water quality benefit because the 1,114-acre service area can be captured, stored, and returned to the WRRF following a storm event preventing release of an estimated 700 million gallons of CSO each year."

Operating these two facilities in capture mode would allow for the cost avoidance of operating and maintaining the hypochlorite feed and storage systems and it would likely not require operations labor to be onsite during a storm event. Screening the influent flow is still recommended, particularly since the screens are already installed, to prevent large debris from entering the capture basin.

Wade Trim conducted a study ("Puritan-Fenkell and Seven Mile CSO Retention and Treatment Basins Basin Collection System and Hydraulic Analysis", dated August 29, 2019). This hydraulic study included an analysis "to evaluate the potential of operating the basins in capture-only mode as a possible operational protocol for the system. Capture basin operation was evaluated to understand the impacts on untreated overflow from the 17 Main Rouge River outfalls on the Detroit West Side system, flooding impacts of the utility tunnels within the two basins, and the risk of upstream basement flooding."

The findings of the study included:

- Limited (approximately 2 percent) increase in untreated overflow from the 17 Main Rouge River outfalls as a result of capture mode operation.
- Impact to the utility tunnels when operating in capture mode is expected for design storms between the 10-year, 24-hour and the 25-year, 24-hour storm at the Puritan-Fenkell basin. At the Seven Mile basin, design storms slightly smaller than the 10-year, 24-hour storm will begin to impact the utility tunnel.
- The evaluation of basement flooding risk shows the basins can be operated in capture mode for the 10-year, 24-hour storm without risk of basement flooding. However, during the 25-year, 24-hour storm significant basement flooding can be expected.

The report concluded that operating the basins in capture-only mode in their current configuration is not recommended due to the risk of basement flooding. The report indicated, however, that capture-only mode may be possible if high level emergency overflows are added to the basins to relieve the system during extreme events to protect basements from flooding.

To aid in the analysis of operating both Puritan-Fenkell and Seven Mile as capture-only basins, conceptual cost estimates have been generated under CS-299 for both facilities including capital improvements listed below. The Wade Trim hydraulic study provided some details regarding these issues, which are included in the description of the conceptual cost estimate; however, additional study and design will be needed.

- 1) Emergency overflow relief. The current weir wall is about 12 ft high at both facilities. A new weir wall about 20 ft high and associated structural modifications are needed at the effluent end of the basin to construct a taller weir wall (see Figure 12-1). The length of weir was not reported and should be included in the future study.
- 2) Utility tunnel flooding protection. Water-tight doors are recommended where there is access to the basin from the utility tunnel and at the influent end of the utility tunnel. The proposed doors can withstand 20-ft of static head.
- 3) Replace the existing effluent butterfly gates with flap gates. The Wade Trim report evaluated two different locations for these gates at each facility, which would prevent backflow into the facility (see Figure 12-2). Additional study should be performed to determine if these flap gates are still needed with the taller proposed weir wall.

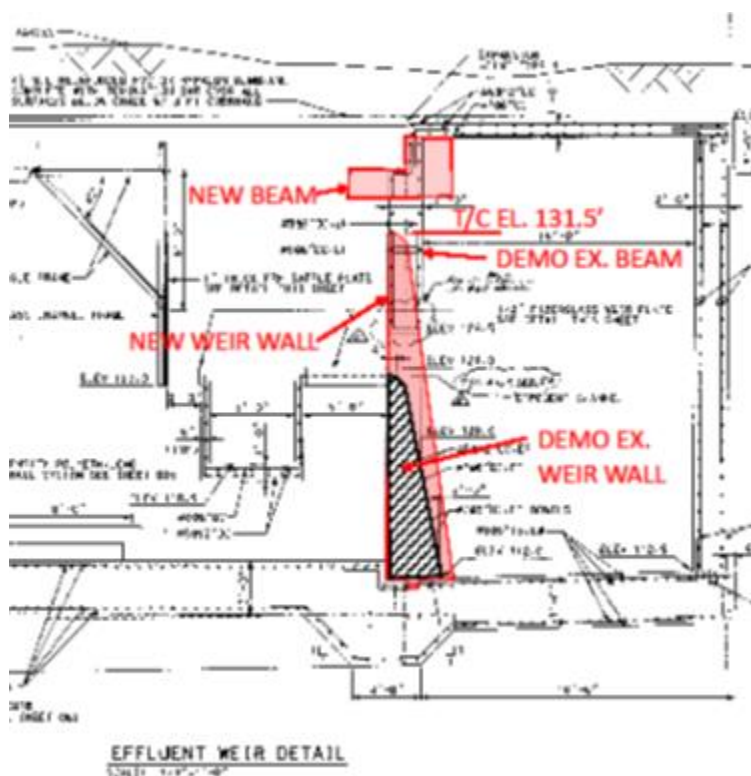


Figure 12-1. Proposed Modification to Effluent Weir Wall for Emergency Overflow Relief

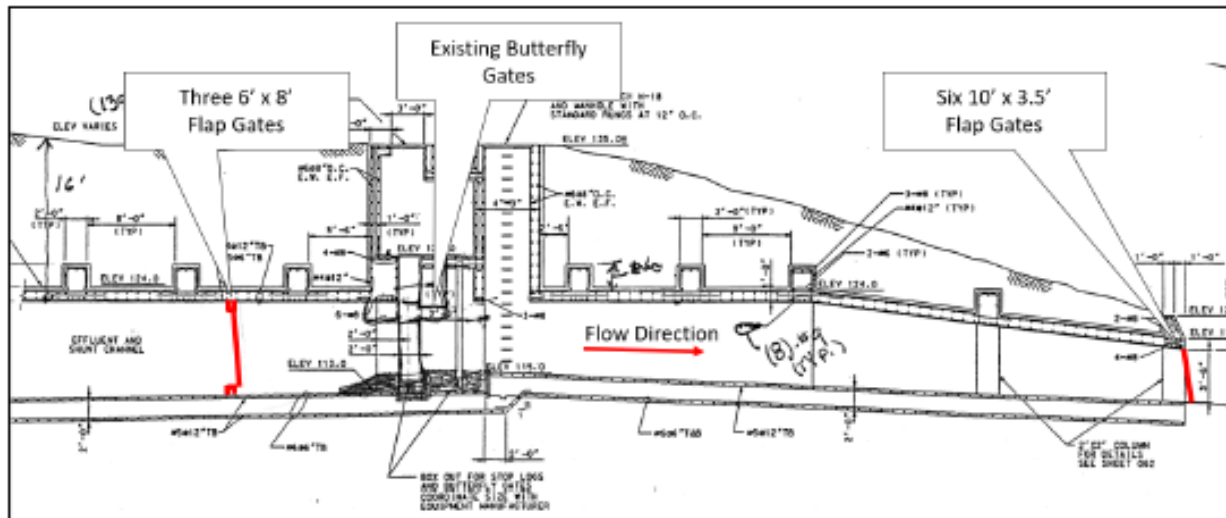


Figure 12-2. Potential Options for Flap Gate Retrofit – Puritan-Fenkell (from Wade Trim Report)

A preliminary life-cycle comparison is presented in Table 12-1. Alternative 1 represents the scenario where the facility continues to operate as an RTB. Alternative 2 represents a scenario where the facility operates in the complete capture mode. The intent of this comparison is to present the cost of the emergency overflow weirs and flap gates compared to the avoided costs associated with maintaining the disinfection system and flow meters for the flow-through treatment mode of operation. The following costs are used in this evaluation:

- The period of evaluation is assumed to be 50 years, which represents an approximate remaining life of the basin.
- For Alternative 1, the capital costs were obtained from the SRP replacement costs and include the chemical feed pumps, drives, piping, and storage tanks. It also includes the flow meters for the effluent and shunt channel. It is assumed for this analysis that all of these assets would be replaced twice during the period of evaluation.
- For Alternative 1, the O&M costs include those items that are currently needed, but would no longer be needed under a complete capture mode. These costs include Operations labor before and during storm events to make the facility ready for discharge, if necessary (assumed to be 8 storm events per year and 10 hours per storm event). Costs also include hypochlorite usage or degradation of the hypochlorite in one tank (4,000 gallons) every six months at a unit cost of \$0.90 per gallon.
- For Alternative 2, the total project cost for the modifications described for the emergency weirs and flap gates is provided in Volume 6 – Appendices, Appendix C, under PF-WWMP-1. The costs also include permitting and modeling to demonstrate and coordinate the modifications with Michigan EGLE.

As shown in Table 12-1, the Best Value Alternative is Alternative 2 – Convert to Complete Capture Basin. As such, it is recommended that this alternative be pursued through additional modeling to confirm water levels in the collection system during peak storm events and coordination with Michigan EGLE.

Table 12-1. Alternative Evaluation for Puritan-Fenkell Convert to Complete Capture Basin

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.50	\$ 2,836,400	\$ 15,200	\$ 3,702,286	\$ 1,480,914	
	<i>Definition:</i>	Do nothing. Continue to operate as an RTB	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system; no new regulatory issues	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher level of operator attention during storm events. Must maintain hypochlorite storage and feed system.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Convert to Complete Capture Basin	Health and Safety	4	3.72	\$ 2,600,000	\$ -	\$ 2,600,000	\$ 699,552	Best Value Alternative
	<i>Definition:</i>	Convert to Complete Capture Basin	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less operator attention during storm events. No O&M for hypochlorite system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires regulatory approval; Modeling confirmation of acceptability	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	5						

12.2 Facility Assessment

12.2.1 Screening

12.2.1.1 Description of Existing System

The Puritan-Fenkell CSO Facility has three mechanically cleaned bar screens that were installed in 1996. Influent wastewater from a 12-ft diameter influent sewer enters the headworks area of the facility and flows through the screens into the basin compartments. Material collected by the screens is mechanically raked from the bar screens and deposited into a dumpster to be hauled to the landfill.

Table 12-2 provides an overview of the existing screening system at Puritan-Fenkell CSO facility.

Table 12-2. Overview of Existing Screening System at Puritan-Fenkell CSO Facility

Parameter	Value
Treatment Capacity (cfs)	845
No. of Screens	3
Manufacturer	Jones and Attwood
Screen Type	Catenary Bar Screen
Opening Size	0.5-in. spacing
Depth or Length / Width	29 ft 1 in / 9 ft 4 in
Screen Cleaning	Mechanical Rake
Screening Removal	Conveyor belt to dumpster and landfilled

12.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the screens:

- Provide screening retention plate along entire conveyor. Screenings from the screens occasionally fall off the conveyor at the back of the screens. A screenings retention plate would guide the discharged screenings to the middle of the conveyor belt.
- Replace conveyor belt as corrugated sidewall part of belt has torn off from large sections of the belt.
- Need for automatic start for screens and belt.
- Change location of screen controls.
- Prevent screens from swaying during operation. During higher flow events, the screens reportedly sway to some degree. The operators believe this is caused by the returning rake getting tossed by the rapid flow of water and affecting the rest of the screen. They noted that the Conner Creek screens (which is a similar screen but does not sway) has chain guide returns that extend closer to the floor of the channel. This issue was added to the scope of the OEM evaluation; however, the OEM was unable to see the swaying because flow did not occur during the site visit. If this issue causes problems in the future, it should be video-taped to document the issue.

- Address worn teeth on screen rakes. The OEM condition assessment assessed the condition of the screen components. They noted some rakes had a significant amount of corrosion, but they did not indicate the need for replacement.
- Provide improved means to install stop logs in influent area. GLWA requested a means for installing the stop logs with a permanent type of system. The channels for the stop logs for each screen are very close to Headworks building wall (see drawing in Figure 12-3). The reach of the overhead crane is unable to lower the logs directly into place.

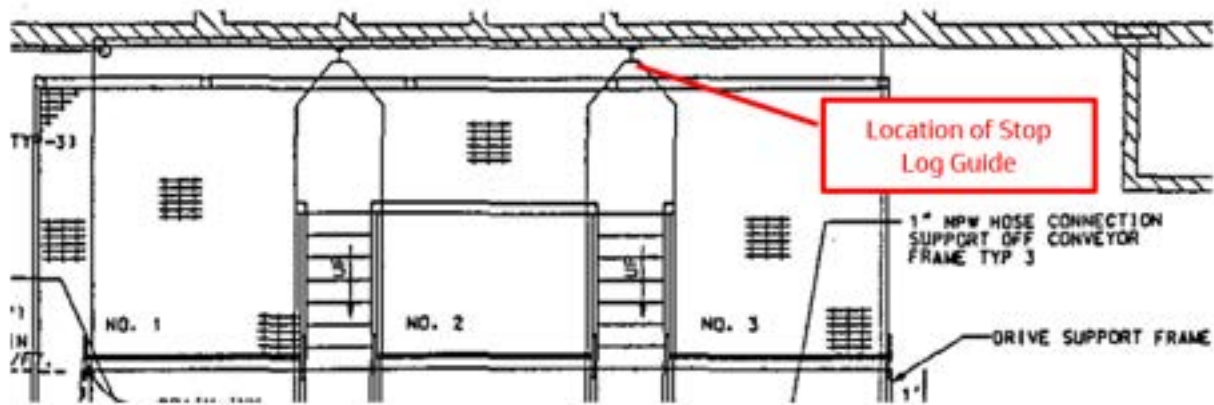


Figure 12-3. Location of Stop Log Guides at Puritan-Fenkell Headworks

It should be noted that a sluice gate is proposed upstream of the sanitary pumps (and downstream of the screens) in the Flushing and Dewatering section (Section 12.2.4). This will allow isolation of the sanitary wet well from the rest of the facility.

It should also be noted that one of the screen channels has the influent channel running through the bottom of the opening. It is not clear how the existing stop log were intended to stop flow, given the 2 ft by 2 ft channel running through the bottom of the channel floor. Furthermore, all of the stop logs would need to be installed (and the channel properly isolated) to isolate the screen channel during a wet weather event because there is no stop log on the downstream side of the screen.

Jacobs investigated installing sluice gates. Based on the hydraulic profile, gates with 18 ft height and 10 ft width would be needed. This size would require two leaf gates; however, there is not enough room for two leaves. The gates could be shorter height if designed for a smaller storm event. Then, one gate could be used. The proposed gates would normally reside in the “up” position, out of the water channel and be lowered using an actuator when needed.

Given the infrequent need for installing the stop logs and the redundancy of the screens, it is suggested that a temporary means of installing the stop logs should be utilized when screen replacement or major rehabilitation is required.

12.2.1.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Screening Improvements (Project PF-SCR-1). Due to the relatively small nature of some of the screening-related issues identified as improvements, all of the identified screening improvements are proposed to be in one project – Screening Improvements. This project could be split into multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: Screening Improvements** including,

- Screening retention plate along entire conveyor
- New conveyor belt
- Provide programming modifications for automatic start for screens and belt
- Relocate screen controls.

Each of the screening related improvements listed above is described further below:

Screening Retention Plate Along Entire Conveyor. Screenings from the screens occasionally fall off the conveyor at the back of the screens. A screenings retention plate would guide the discharged screenings to the middle of the conveyor belt. A cost for a screening retention plate (similar to screening retention plate at Conner Creek) is included in the capital cost estimate.

New conveyor belt. A new conveyor belt is recommended, as opposed to rehabilitating the existing belt. The cost estimate includes a new belt.

Provide programming modifications for automatic start for screens and belt. Programming modifications to provide automatic start of the screen and conveyor belt based on influent water level (for the screens) and start of screens (for the conveyor belt).

Relocate screen controls. The screen control box is located on the wall next to the conveyor. During screening operation, access to this location requires the operator to stand by a discharging screen. Although the screening plate may reduce splatter, it may still occur.

The alternative evaluation is presented in Table 12-3. The sources of costs used in this evaluation are listed below:

- Capital costs for Alternative 2 are presented in Volume 6 – Appendices, Appendix C under this project title.
- The difference in O&M costs between the two alternatives will be negligible.

This evaluation shows that Alternative 2 has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M. The NPV/Benefit cost for Alternative 2 is \$66,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – Screening Improvements is the recommended alternative.**

Table 12-3. Alternative Evaluation for Screen Improvements (Project PF-SCR-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Operator needs to be present to start screen.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Screening Improvements	Health and Safety	4	3.50	\$ 230,000	\$ -	\$ 230,000	\$ 65,714	Not Applicable
	<i>Definition:</i>	Provide screening retention plate, new conveyor belt, automatic screen and conveyor	Water Quality & Compliance	3						
	<i>Adv.:</i>	Operator does not need to be present to start screen, cleaner/safer operation	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

12.2.2 Disinfection

12.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP tanks, four gear pumps, two induction mixers, and two in basin mixers. There are three screens discharging into a common influent channel to Basins 1 or 2. There are two induction mixers located upstream of the bar screens and two submersible mixers with chemical feed, one in each basin. The sodium hypochlorite pumps discharge to a common header with a flow meter that splits to the two induction mixers, Basin 1 mixer, and Basin 2 mixer. Although there are flow indicators after the split to the two induction mixers, flow splitting is not metered and there does not appear to be any basis to achieve equal flow splitting. Currently, operations primarily feed to the basin mixers and if they suspect a strong chlorine demand in the influent, they will also feed to the two induction mixers in the influent.

Table 12-4 provides an overview of the existing disinfection system at Puritan-Fenkell CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G.

Table 12-4. Overview of Existing Disinfection System at Puritan-Fenkell CSO Facility

Parameter	Value
Treatment Capacity (cfs)	845
Design Feed Strength (% hypochlorite)	5
Max. Dosage at Design Flow (mg/L Cl ₂)	10 @ 845 cfs
Disinfection Contact Time (min)	20
Storage Tanks	
Number	2
Volume of Each Tank (gal)	4,000
Type	FRP
Pumps	
Number	4
Capacity (gpm)	20
Type	Gear
Mixers	
Number / Type	2 / Chemical induction mixers
Model Number/ hp / Manufacturer	SWC5R / 5 hp / Water Champ
Number/Type	2 / Submersible mixers
Model Number / hp / Manufacturer	4600-Series / 20 / Flygt

12.2.2.2 Identified Needs and Issues

The needs and issues identified for Puritan-Fenkell were identified from meetings with O&M staff and Jacobs team site visit and investigations. These needs and issues are summarized as follows:

- Chemical feed system. In addition to the desire to standardize on one or two types of chemical feed pumps between facilities and the desire to simplify chemical feed where possible, the Puritan-Fenkell chemical feed system has the following issues:
 - No flow metering to individual feed points to control the feed split
 - Consider need to enlarge area to accommodate alternative type of pumps.
 - Evaluate possibility of gravity feed from the chemical tanks with a meter and control valve. Jacobs evaluated the possibility of this type of feed system. The effluent weir from the CSO basins

controls the hydraulic grade line at the influent induction mixers to above elevation 124 once the basin is filled. The bottom of the sodium hypochlorite tanks are at approximately elevation 142 and the maximum liquid depth is approximately 8 ft. Thus, there is approximately 18 ft of static head available with the tanks empty and 26 ft with the tanks full. This corresponds to 7.8 pounds per square in. gauge (psig) empty to 11.2 psig full available head. The induction mixers require back pressure valves to prevent siphoning chemical. Evoqua recommends a setting of 15 psig. Therefore, the available static head is inadequate for gravity feed before even accounting for friction loss and flow control valve loss. Thus, continued pumping as the means of chemical delivery is recommended.

The first two issues are addressed in Replace Chemical Feed System (Project PF-DIS-1).

- Lack of flow-paced and TRC-paced automated chemical feed. Chemical feed system controls are O&M intensive and have performance issues with feeding appropriate levels of chemical. To stay compliant, overfeeding chemical is common. This issue is addressed in Provide Flow-paced and TRC-paced Automated Chemical Feed (Project PF-DIS-2) below.

12.2.2.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Replace Chemical Feed System (Project PF-DIS-1). The alternatives to address the common chemical feed system issues among most of the CSO facilities were presented in Replace Chemical Feed System (Section 5.2.2). It should be noted that the project, PF-DIS-1, would address the additional chemical feed system issues identified in the previous section. Alternatives include:

- 1) **Alternative 1: Replace Existing Chemical Feed System In-Kind.** This alternative would generally replace the existing feed system in-kind. If this alternative were to be selected, minor improvements to address some identified issues could be considered; however, Jacobs did not specifically evaluate any individual improvements to the existing system; rather, the focus was on the identified alternatives.
- 2) **Alternative 2: Chemical Feed Utilizing Standardized Pump Distribution and Hose Pumps.** The major advantage of this alternative is that it is easier to control as one pump is dedicated to a channel.

It should be noted that hose pumps will be larger than the existing gear pumps and the need to enlarge the pump area was considered to verify the feasibility of this alternative. The Bredel 65 pumps have a base of 29 in. by 28 in. The pump and motor cantilever beyond the base plate and pad and have maximum dimensions of 42 in. by 46 in. The existing pump area is about 5 ft wide and 18 ft long excluding the doors. If one pump were provided per feed point using the pump distribution alternative, then there would be 5 pumps including a spare. This would fully consume the approximate 18 foot length with no space between the pumps for maintenance or access. Thus, the pump area would need to be expanded for this alternative. The separate pump containment could be eliminated, and the pumps located on pads at a sufficient height for spill protection. This is reflected in the cost estimate for this alternative.

- 3) **Alternative 3: Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps.**

The alternative evaluation for these alternatives is presented in Table 12-5. The sources of costs used in this evaluation are listed below:

- The capital cost for Alternative 1 were obtained from the replacement costs of the SRP.

- The capital cost for Alternative 2 and 3 is included in Volume 6 – Appendices, Appendix C under this project title.
- The O&M cost for Alternative 1 were estimated based on manufacturer pump rebuilds at a cost of \$7,500 per year.
- O&M costs for Alternative 2 were developed based on input from hose pump manufacturer for annual lubrication and hose replacement, and rebuild of the pumps at Year 10.
- O&M costs for Alternative 3 were estimated based on pump rebuild cost of \$20,000 per pump at Year 10. This frequency is based on GLWA experience at Conner Creek.

Table 12-5 shows that the Total Benefit score of Alternatives 2 and 3 are 1.5 higher than Alternative 1 (Do Nothing) due to improved ease of O&M and improved component performance, which should lead to more consistent and reliable water quality compliance. Based on having the lowest NPV/Benefit cost, **Alternative 3 - Chemical Feed Utilizing Standardized Manifold Pump Distribution and Centrifugal Pumps is the Best Value Alternative. As such, this is the recommended alternative.**

Note that this project would not be recommended if the basin is converted to complete capture.

Table 12-5. Alternative Evaluation for Replace Chemical Feed System (Project PF-DIS-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed System in-kind	Health and Safety	3	2.08	\$ 340,000	\$ 7,500	\$ 498,172	\$ 239,123	
	<i>Definition:</i>	Replace existing chemical feed system.	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Existing system is difficult to operate and maintain and has performance issues with	Component Performance	1						
	<i>Comments:</i>	None	O&M Ease	1						
2	<i>Alt. Name:</i>	Chemical Feed utilizing Standardized Pump Distribution and Hose Pumps	Health and Safety	3	3.60	\$ 687,000	\$ 4,410	\$ 780,005	\$ 216,668	
	<i>Definition:</i>	Upgrade chemical feed system to individual pump distribution system with one pump per	Water Quality & Compliance	4						
	<i>Adv.:</i>	Easier control as one pump is dedicated to a channel.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Lots of pumps and valves, allows for an installed redundant pump but manual	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						
3	<i>Alt. Name:</i>	Chemical Feed utilizing Manifold Pump Distribution and Centrifugal Pumps	Health and Safety	3	3.60	\$ 383,000	\$ 3,000	\$ 446,269	\$ 123,964	Best Value Alternative
	<i>Definition:</i>	Upgrade chemical feed system to manifold pump distribution system with multiple pumps	Water Quality & Compliance	4						
	<i>Adv.:</i>	Less pumps and valves for easier maintenance. Redundant pump is installed and easily	Capacity Enhancement	3						
	<i>Disadv.:</i>	Not quite as energy efficient. Maintenance of flow control devices to equalize flows to each	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Provide Flow-paced and TRC-paced Automated Chemical Feed (Project PF-DIS-2). As with the other CSO facilities, the chemical feed system does not work in automatic. Consistent dosing in response to rapid changes in flow requires flow pacing. Refinement of the hypochlorite dose in response to changes in chlorine demand requires automated adjustment of the target dose using an online TRC analyzer.

The alternatives to address this issue were presented in Provide Flow-Paced and TRC-Paced Automated Chemical Feed (Section 5.2.3). The alternatives include:

- 1) **Alternative 1: Continue Manual Adjustment of Chemical Feed.** This alternative would continue to use the existing level of controls and automation for the chemical feed system in which the operators manually adjust chlorine feed. The storm pump flow meter readings would continue to be used by the operator to adjust the chlorine feed rates.
- 2) **Alternative 2: Provide Flow-paced and TRC-paced Chemical Feed Control System.** This alternative would automatically adjust chemical flow based on storm pump flow rate and also utilize the sampling and analysis of wastewater from a point a relatively short distance downstream of the chemical dosing point to further adjust chemical feed flows. The sampling location would be near the influent end of the basin and near the bottom portion of the basin (to be able to measure TRC concentrations before the effluent sample point).

The automatic chemical feed system will require less operator input during an event. However, there will be increased maintenance of the TRC system by GLWA staff (either lab technicians or operators) during the storm and during dry weather. The annual O&M cost includes costs for maintaining the TRC monitors.

The alternative evaluation is presented in Table 12-6. The sources of costs used in this evaluation are listed in the following bullet:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The annual O&M cost for Alternative 2 assumes that a lab technician or operator would need to perform inspection/maintenance of the TRC analyzers on a routine basis to make sure it remains functional between storm events.

Although Alternative 1 does not require any additional capital or O&M, it does not address the fact that the TRC goal may not be met every event. Alternative 2 provides the best opportunity to meet the effluent TRC goals in the NPDES permit. **Based on the improved ability to meet the NPDES permit TRC goal, Alternative 2 – Provide Flow-paced and TRC-paced Chemical Feed Control System is the recommended alternative.**

Note that this project would not be recommended if the basin is converted to complete capture.

Table 12-6. Alternative Evaluation for Provide Flow-paced and TRC-paced Chemical Feed Control System (Project PF-DIS-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Replace Existing Chemical Feed Control System	Health and Safety	3	2.40	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Replace existing chemical feed control system utilizing current level of controls and	Water Quality & Compliance	2						
	<i>Adv.:</i>	Less maintenance. Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires more operator input to monitor disinfection performance. May result in less	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Install Flow-paced and TRC-paced Chemical Feed Control System	Health and Safety	3	3.45	\$ 220,000	\$ 4,860	\$ 322,496	\$ 93,477	Not Applicable
	<i>Definition:</i>	Upgrade chemical feed control system utilizing flow-pacing and TRC-pacing.	Water Quality & Compliance	5						
	<i>Adv.:</i>	Less operator input during a rain event. Better control of chemical feed resulting in more	Capacity Enhancement	3						
	<i>Disadv.:</i>	Maintenance intensive. Flow pacing is common of CSO facilities, but TRC-pacing is difficult	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	2						

12.2.3 Odor Control

12.2.3.1 Description of Existing System

The Puritan-Fenkell odor control system consists of two separate odor control systems. One system treats foul air from the Headworks and pump station wet well area and the other treats foul air from the basins. Each system includes a scrubber tower, recirculation pump, caustic feed system, hypochlorite feed system, and an odor control fan. The original system was designed to feed sodium hydroxide and sodium hypochlorite; however, the sodium hydroxide has not been used for some time. The scrubber tower contains 5.5 ft of plastic media with a chemical spray section located above the media.

The system was installed in 1996. Overall, the system is in good condition. The odor control system does not have an air permit.

Per GLWA, no odor complaints have been received for at least the past 3 years.

12.2.3.2 Identified Needs and Issues

During meetings with O&M staff related to the odor control system, no needs were identified. The recommendation in this section is based on Jacobs evaluation of the existing system.

Potential Reduction of Odor Treatment during Operation. The facility does not have an air permit and is not required to operate the odor control system. The facility may not generate significant odors during wet weather events due to dilution of sewage with storm water. Storm water significantly reduces the concentration of sulfide and other odorous compounds in sewage. Odors may be more prevalent during the dewatering phase caused by odors from settled solids but may still be low. Due to the expected low odors from the facility, GLWA may want to consider operating the scrubber systems with water only and no sodium hypochlorite. Removal of H_2S is dependent on the H_2S concentration. Removal will be significantly less with only water, but there may be relatively low levels of H_2S to remove. Another option, which provides even less treatment, would be to operate the system without water and blow air through an empty scrubber system and out the stack.

Under both of these options, the discharged air may be non-odorous or sufficiently diluted with ambient air to render it non-odorous. Prior to implementing either one of these options, GLWA could sample influent air to the existing scrubber system for H_2S to determine if the H_2S concentration is sufficiently low. A non-detectable concentration of H_2S in the influent air means the systems can likely operate without sodium hypochlorite or water.

12.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement "needs."

12.2.4 Flushing and Dewatering

12.2.4.1 Description of Existing System

Dewatering System: Water from the basin can be dewatered by gravity after a storm event. There are also three dewatering pumps used to dewater the basin. Dewatered flow is conveyed to the NWI.

Flushing System: There are a total of 16 tipping buckets on the side walls of both basin compartments and the influent channels. City water is used to fill the tipping buckets.

Table 12-7 provides an overview of the existing flushing and dewatering system at Puritan-Fenkell CSO facility.

Table 12-7. Overview of Existing Flushing and Dewatering System at Puritan-Fenkell CSO Facility

Parameter	Value
Total Basin Volume (MG)	2.8
Headworks and basin Dewatering and Flushing System	- There are three 3,200-4,500 gpm dewatering pumps 7 tipping buckets for each basin (14 total) 2 tipping buckets in influent distribution channel

12.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- There is no way to achieve positive isolation between the dry weather and wet weather wet wells
- The bearing assemblies for the tipping buckets are inaccessible for periodic inspection
- A number of actuators on the flushing lines have been removed and not replaced
- The dewatering force main from the CSO facility to the NWI is inaccessible but may require future inspection and cleaning
- O&M staff noted that a water spray system is needed near the influent and dewatering pumps to clean the platform and grating around the area

12.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Isolation of Sanitary and Dewatering Wet Well (Project PF-FD-1). The Puritan-Fenkell CSO facility continuously functions as a lift station for dry weather flows using two dry weather submersible pumps. These pumps and associated wet well are fed through a low-flow trough in the influent channel and they are adjacent to the basin dewatering pumps and their associated wet well. Currently, there is no secure way to achieve positive isolation between the dry weather and wet weather wet wells and GLWA O&M staff requested this be provided.

There are two alternatives for this project:

- Alternative 1: Do Nothing.**
- Alternative 2: Wet Well Improvements.** In 2013, Metco prepared a basis of design report, with a figure and cost estimate to provide a new 30-in. by 30-in. stainless steel gate on the influent to the dry weather wet well. See Volume 6 – Appendices, Appendix B, for figures (Figure PF-FD-1-ALT-2) of the proposed layout.

O&M staff noted that a water spray system is needed near the influent and dewatering pumps to clean the platform and grating around the area. An NPW line running from the Control Building to the hypochlorite storage room could be tapped and routed to the catwalk area located below the

Headworks floor. Multiple water cannons could be arranged to adequately clean the area. See Volume 6 – Appendices, Appendix B, for figures (Figure PF-FD-1-ALT-2) for a conceptual layout.

The alternative evaluation for these alternatives is presented in Table 12-8. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.5 higher than the Do Nothing Alternative (Alternative 1) based on the increased ease of O&M and component performance provided by the added wet well isolation and spray system. The NPV/Benefit cost for Alternative 2 is \$24,000, which is a relatively low cost compared to other projects recommended in this assessment. As such, **Alternative 2 – Wet Well Improvements is the recommended alternative.**

Access to Tipping Buckets (Project PF-FD-2). O&M staff noted that the bearing assemblies for the tipping buckets are inaccessible; however, they require periodic inspection. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Provide Access to Tipping Buckets for Maintenance.** This alternative consists of constructing manhole openings above each adjoining set of rotating groups. A total of 19 manhole openings are required, including one over each bearing assembly on the end tipping buckets.

The bearing assemblies are located in an unpaved area atop of the basins. Installation requires excavating to the top of the existing roof slab. A 24-in. opening will be cored through the roof, and manhole grade rings set/doweled over the opening and extended to 6 in. above the existing ground surface to prevent runoff intrusion. A standard 24-in. manhole ring and lid will be set and bolted to the grade rings, and the excavation backfilled around the new access point. Final restoration will include lawn seeding.

The costs include extending a 0.5-in. metal grease tube and grease gun fitting from each bearing assembly to within 6 in. of the surface at the nearest new manhole opening (two zerks per manhole, one each at the end tipping buckets). After consultation with the tipping bucket gate manufacturer, regular greasing of the bearings is not required for the model of tipping buckets installed at the Puritan-Fenkell CSO Facility. GLWA may elect to install the access for better visual confirmation of tipping bucket condition and operation and better access to limit switches at each bearing assembly. Figures PF-FD-2-ALT-2, included in Volume 6 – Appendices, Appendix B, show the conceptual layout of this improvement.

Finally, a number of actuators have been removed and not replaced. The replacement of these actuators has been included in the cost estimate.

The alternative evaluation for these alternatives is presented in Table 12-9. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and increased ease of O&M provided by the improved access to the tipping bucket bearings. The NPV/Benefit cost for Alternative 2 is \$27,000, which is a relatively low cost compared to other projects recommended in this assessment. **As such, Alternative 2 – Provide Access to Tipping Buckets for Maintenance is the recommended alternative.**

Table 12-8. Alternative Evaluation for Wet Well Improvements (Project PF-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Unable to isolate between the dry weather and wet weather wet wells.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Wet Well Improvements	Health and Safety	3	3.32	\$ 79,000	\$ -	\$ 79,000	\$ 23,819	Not applicable
	<i>Definition:</i>	Provide a sluice gate on the influent to wet well. Install water spray system	Water Quality & Compliance	3						
	<i>Adv.:</i>	Simple system to provide isolation of Sanitary and Dewatering wet well.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Table 12-9. Alternative Evaluation for Access to Tipping Buckets (Project PF-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Inaccessible bearing assemblies for the tipping buckets.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Access to Tipping Buckets for Maintenance	Health and Safety	4	3.50	\$ 95,000	\$ -	\$ 95,000	\$ 27,143	Not applicable
	<i>Definition:</i>	Construct 19 manhole openings, including one over each bearing assembly on the end tipping buckets	Water Quality & Compliance	3						
	<i>Adv.:</i>	Access for better visual confirmation of tipping bucket condition and operation and better access to limit switches at each bearing assembly	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

Access to Dewatering Force Main (Project PF-FD-3). GLWA noted that the dewatering force main from the CSO facility to the NWI is inaccessible but will require future inspection and cleaning. There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Access to Dewatering Force Main for Inspection and Cleaning.** This alternative consists of the installation of cleanouts at the following locations: 1) at the end of the force main, southwest of the siphon head chamber in Manhole No. 1 for cleaning of the force main, 2) northeast of the Manhole No. 1 before the inverted siphon, and 3) on the east side of the Rouge River, just before Manhole No. 2. (See Figure PF-FD-3-ALT-2 included in Volume 6 – Appendices, Appendix B.)

The alternative evaluation for these alternatives is presented in Table 12-10. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.6 higher than the Do Nothing Alternative (Alternative 1) based on the increased ease of O&M and improved component performance provided by the ability to access the force main. The NPV/Benefit cost for Alternative 2 is \$27,000, which is a relatively low cost compared to other projects recommended in this assessment. **As such, Alternative 2 –Access to Dewatering Force Main is the recommended alternative.**

Table 12-10. Alternative Evaluation for Access to Dewatering Force Main (Project PF-FD-3)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.68	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Dewatering forcemain from the CSO facility to the NWI remains inaccessible.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Access to Dewatering Force Main for Inspection and Cleaning	Health and Safety	3	3.32	\$ 90,000	\$ -	\$ 90,000	\$ 27,136	Not applicable
	<i>Definition:</i>	Install cleanouts at a number of locations.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Access to the dewatering forcemain from the CSO facility to the NWI for future inspection	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

12.2.5 HVAC

12.2.5.1 Description of Existing System

The Puritan-Fenkell CSO facility consists of a headworks area, chemical room, odor control room, electrical room, control room, metering room in the basement, and miscellaneous other rooms and a courtyard. The facility also includes the retention basins. Table 12-11 provides summary of the major equipment for this facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, emergency shower/eye wash, regular shower, and drinking fountain. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 12.2.10.

Table 12-11. Major HVAC Equipment at Puritan-Fenkell CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	HVU-2	Heating and Ventilating Unit	11,100 CFM
	EF-5	Exhaust Fan	10,000 CFM
Basin	SF-1 and 2	2 × Supply Fans (Basin Ventilation)	97,000 CFM
	SF-3	Supply Fan (Shunt Valve Chamber)	2,300 CFM
	SF-4	Supply Fan (Effluent Valve Chamber)	2,300 CFM
	EF-7	Exhaust Fan (Shunt Channel Valve Chamber)	400 CFM
	EF-8	Exhaust Fan (Effluent Valve Chamber)	400 CFM
	UH-1	Unit Heater (Shunt Channel Valve Chamber)	400 CFM 17.0 MBH
	UH-2	Unit Heater (Effluent Valve Chamber)	400 CFM 17.0 MBH
Odor Control Room	HVU-1	Heating Ventilating Unit	4,700 CFM
	EF-5	Exhaust Fan	4,700 CFM
Electrical Room	PACU-1	Heating Ventilating Unit	2,200 CFM

Table 12-12 provides a summary of the basis of design performance criteria for HVAC systems at Puritan-Fenkell and Table 12-13 provides the outdoor Basis of Design conditions.

Table 12-12. Puritan-Fenkell Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Retention Basin	Class I, Group D, Div 1	N/A	N/A	10 ACH
Headworks and Pump Room	Class I, Group D, Div 1	60	N/A	12 ACH
Odor Control Room	Unclassified for areas greater than 3 ft from odor control vessel. Class I, Group D, Div 2 for areas closer than 3 ft.	70	N/A	10 ACH
Electrical Room, Work Room, Office, Toilet, Etc.	Unclassified	70	78	2 cfm/ft ²
Basement (Magnetic Meter Room)	Unclassified	70	N/A	6 ACH
NaOCl Storage Room	Unclassified	60	N/A	6 ACH

Table 12-13. Puritan-Fenkell Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

12.2.5.2 Identified Needs and Issues

During the Needs Assessment meetings with GLWA O&M staff, the following HVAC issues were noted:

- PACU-1 requires replacement.
- HVU-1 in Odor Control Room requires replacement.
- Supply and exhaust fans in Shunt Channel and Effluent Channel require replacement.

During the discussions with GLWA's HVAC contractor the following historical issues were noted:

- PACU-1 requires constant maintenance to keep running: GLWA's HVAC contractor noted that PACU-1 has had a multitude of problems including damper problems, actuator problems, refrigerant leaks and wiring issues.
- HVU-1 locks out at least once a week.
- HVU-3 is very difficult to service due to location.

During site investigations (June 2020), the following observations were noted:

- PACU-1 was down for repair and GLWA's HVAC contractor staff were working on it on the day the site investigation took place.
- The exhaust fan was off in the Headworks Area

- Improvements are needed for code compliance in the Odor Control and Headworks Areas
- SF-1 and SF-2 were functional but had corroded bases

12.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

HVAC Improvements (Project PF-HVAC-1). Due to the numerous HVAC-related assets that require replacement in-kind and the additional need to provide monitoring for code compliance in the Odor Control Room and Headworks, all of the identified HVAC improvements are proposed to be in one capital improvement project – HVAC Improvements. As such, there is only one alternative for this project, which includes:

- PACU-1 Replacement
- Improvements to Enhance Safety in Odor Control Area
- Improvements to Enhance Safety in Headworks Area
- HVU-1 and 2 Replacement
- HVU-3 Replacement (with improved access)
- SF-1 and SF-2 Replacement
- Exhaust Fan Replacement
- Removal of Shunt Channel and Effluent Channel HVAC Equipment

Each of the HVAC-related improvements listed above are described further below:

PACU-1 Replacement. Given the age of PACU-1 (24 years), the lengthy history of various issues, and the fact that the unit was undergoing repair the day of site walkthrough, replacement of PACU-1 with a more efficient modern unit and controls is recommended.

Improvements to Enhance Safety in Odor Control Area. The Odor Control area is classified as a Class I, Division 2 space under NFPA 820 if it is not continuously ventilated at a rate of 6 ACH. The space does not meet the 6 ACH ventilation requirement and does not currently have electrical equipment rated for a Class I, Div 2 environment. HVU-1 is designed to provide 10 ACH of ventilation air in cooling mode but was sized to provide only 2 ACH of outside air in heating mode. Additionally, EF-2 is only designed to operate in cooling mode at 10 ACH. NFPA 820 requires both supply and exhaust fans to operate continuously to declassify odor control areas.

Given the age of HVU-1 and EF-2 and the problems HVU-1 is exhibiting, Jacobs recommends replacement of both units. HVU-1 and EF-2 could be replaced with units with two-speed fans or VFDs to provide 6 ACH continuously during ventilation and heating and 10 ACH in cooling mode.

Regardless of whether the space is unclassified by providing 6 ACH of outside air, NFPA 820 requires the installation of combustible gas detection in the Odor Control area with audible and visible alarms at all entrances to the Odor Control area and within the space.

If ventilation is used to declassify the space as described above, ventilation flow monitoring of both the supply and exhaust fan is required with visible and audible alarms of a low or no flow condition required at entrances and within the space.

Improvements to Enhance Safety in Headworks Area. HVU-2 serves the Headworks Area, which is classified as a Class I, Division 1 space per the design drawings. Given its age, and general condition, it should be replaced. Because the electrical equipment in the space is rated for a Class I, Division 1

environment continuous ventilation and ventilation flow monitoring are not required. NFPA 820 does, however, require combustible gas detection with visible and audible alarms at the entrances to the Headworks area and inside the space, which the Headworks area currently does not have. Jacobs recommends making this change to comply with NFPA 820.

HVU-3 Replacement (relocated with improved access). HVU-3 is currently mounted high in the Metering Room in the basement making access for maintenance very difficult (Figure 12-4). Placing HVU-3 lower in the space would make access to the magnetic meter and associated piping very difficult, which is likely the reason the decision to mount the unit high in the space was made. Jacobs recommends replacing HVU-3 with a unit mounted on a concrete pad on the North side of the building when HVU-3 requires replacement. There is an existing opening for the Meter Room supply air duct, which could be utilized by the outdoor unit. This approach would allow ample space for maintenance and would make removal much easier. Currently, HVU-3 will need to be removed in sections when replacement is necessary.



Figure 12-4. HVU-3 Located in Difficult to Access Location Located in Inaccessible Area

SF-1 and SF-2 Replacement. SF-1 and 2 are functional despite having corroded bases (Figure 12-5). These units will require replacement in the near future.



Figure 12-5. Corroded Supply Fan Bases – View from Above (left) and View from Below (right)

Exhaust Fan Replacement. There are five relatively small exhaust fans that are original to the facility and should be included in the replacement project.

Removal of Shunt Channel and Effluent Channel HVAC Equipment. The unit heater, supply and exhaust fans in the Shunt Channel and Effluent Channel are not used and are inoperable. These units could be retired. Portable ventilation could be utilized, if necessary, when operators need to enter these areas.

The alternative evaluation is presented in Table 12-14. **The capital cost for Alternative 1, which is the recommended alternative,** is included in Volume 6 – Appendices, Appendix C under this project title.

Table 12-14. Alternative Evaluation for HVAC Improvements (Project PF-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	3	3.00	\$ 810,000	\$ -	\$ 810,000	\$ 270,000	Best Value Alternative
	<i>Definition:</i>	Facility-wide HVAC Improvements	Water Quality & Compliance	3						
	<i>Adv.:</i>	Code compliance, less emergency maintenance, improved asset reliability.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.6 Electrical

12.2.6.1 Description of Existing System

The Puritan-Fenkell electrical system consists of one DTE utility feed from a 750 kVA, 480/277 V, 3-Phase outdoor transformer (secondary metering) and diesel generator feed from a 400 kW, 480/277 V, 3-Phase stationary generator. The feeds are connected to a 1,200 A MDP with electrically operated breakers and automatic source transfer controls for a 1,200 A bus. The MDP has breakers that feed MCCs and distribution panels. The MCCs and distribution panels then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 12-15 provides a summary of the major electrical equipment for this facility.

Table 12-15. Major Electrical Equipment at Puritan-Fenkell

Location	Major Electrical Equipment	Description
Electrical Room	Main distribution panel with ATS	1,200 A, 480/277 V, 3-Phase
Courtyard	Generator (Diesel)	400 kW, 480/277 V, 3-Phase
Electrical Room	MCC-1	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-2	600 A, 480/277 V, 3-Phase

12.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the following section.

12.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project PF-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure PF-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Wet Well Chamber Area – Add LED lighting fixtures within the area to address the required foot-candles and code requirements.
 - Effluent channel – Add interior LED ceiling and wall mounted lighting fixtures within the area to address the required foot-candles and code requirements.
 - Basin – Add additional basin interior explosion-proof LED lighting fixtures to provide lighting within the Basins. Lighting to meet the required foot-candles and codes for the area.
 - Add exterior power receptacles to assist in the maintenance and operations of the facility including receptacles every 100 ft on the backside exterior of the facility at ground level.

The alternative evaluation is presented in Table 12-16. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$59,000, which is a relatively low cost compared to other projects recommended in this assessment.

Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.

Table 12-16. Alternative Evaluation for Electrical Improvements (Project PF-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe due to poorer lighting at night	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 205,000	\$ -	\$ 205,000	\$ 58,571	Not applicable
	<i>Definition:</i>	Add additional lighting in wet well chamber area, effluent channel, and basins. Provide exterior power receptacles.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

12.2.7 I&C

12.2.7.1 Description of Existing System

Control System: The original Allen Bradley control system was installed in 1996 under PC-697. Since then, several modifications to the original system have taken place. These upgrades provided the ability to locally and remotely monitor the operations of the facility and the overall collection system, including from the SCC. The control system and workstation software are Allen Bradley PLC-5 redundant PLCs with Rockwell RSView software. The existing hardwired backup control panel and other miscellaneous PLCs and subsystems were also incorporated into the overall control system. The current PLC-5 control system, workstations and backup panels are obsolete, and do not meet GLWA SCADA Governance standards, which stipulate that all CSO facilities use Ovation workstations with new high-performance graphics. The current system is equipped with a backup radio system to communicate critical monitoring points back to SCC on wide area network failure.

Flow and Level Sensors: Table 12-17 summarizes the level sensors and flow meters at the Puritan-Fenkell CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 12-17. Summary of Flow Meters and Level Sensors at Puritan-Fenkell CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent (Storm sewer)	1	Transit-Time (AccuSonic)
Shunt Channel	1	Transit-Time (AccuSonic)
Effluent Overflow Weir	2	Ultrasonic ^a
Basin Dewatering	1	Magnetic
CSO Level Sensors		
Influent (Storm Sewer)	1	Ultrasonic
Shunt Channel	1	Ultrasonic
Screening Area (Upstream and downstream of bar racks)	2	Ultrasonic
Basins	2	Ultrasonic
Wet Well	1	Ultrasonic
	1	Radar
Effluent	1	Ultrasonic
River	1	Ultrasonic
Chemical System Flow Meters		
Process Water	1	Magnetic
Chemical Feed	1	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Pressure

^a Ultrasonic level sensor readings are used to measure height of water to allow calculation of effluent flow rate.

12.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Replacement options for valve control network for the chemical feed system is discussed in detail in Section 5.4.6. The cost/benefit of the hardwired control was not favorable and therefore was not considered further.
- Need for tank level indication at Chemical Fill Station
- Need for process cameras at select locations
- Update Ovation control system

12.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

I&C Improvements (Project PF-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the Ovation Control System Upgrade, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: I&C Improvements** including,

- Provide tank level indication at Chemical Fill Station
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Provide tank level indication at Chemical Fill Station. Tank level indication is described and recommended in Section 5.4.5.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 12-18. The sources of costs used in this evaluation are listed below:

- The O&M costs for Alternative 2 include estimated annual maintenance costs for the additional instrumentation provided.
- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 – I&C Improvements, has a total benefit score about 0.3 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and ease of O&M provided by the various I&C improvements. The NPV/Benefit cost for Alternative 2 is \$53,000, which is a relatively lost cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – I&C Improvements is the recommended alternative.**

Table 12-18. Alternative Evaluation for I&C Improvements (Project PF-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	3.00	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Known existing system.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Performance isn't met with regards to safety and compliance - flows and volumes, alarms, disinfection, system status, etc.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 70,000	\$ 5,000	\$ 175,448	\$ 52,899	Not applicable
	<i>Definition:</i>	Install tank level indication and process cameras.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Higher performance, improved safety, improved compliance control, more efficient operations.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased complexity and higher maintenance.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

Control System Upgrade (Project PF-I&C-2). The current facility's PLC control system, network, workstations and control system backup panels are obsolete and should be replaced in the near future. The control system does not meet GLWA SCADA Governance standards, which require that all CSO facilities use Ovation workstations with new high-performance graphics. GLWA's standards for local CSO facility's control systems can be either the latest Allen Bradley PLC system with Ovation workstations or a complete Ovation system. This approach is being used on an ongoing project at Leib, Seven Mile, and St. Aubin.

Because of the approach used on the ongoing project, there is only one overall control system alternative considered. The project should include decommissioning and removal of the original hardwired backup local control panels. These local panels are no longer required with today's redundant control system processors and local Operator Interface Terminal (OIT) as local backup to the facility's workstations.

Table 12-19 provides the summary of the **Control System Upgrade, which is the recommended alternative**. Capital costs are included in Volume 6 – Appendices, Appendix C under this project title. Consideration should be given to replacing various field instruments during this project; however, these are not included in the capital costs.

Table 12-19. Alternative Evaluation for Control System Upgrade (Project PF-I&C-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Control System Upgrade	Health and Safety	3	3.00	\$ 2,323,000	\$ -	\$ 2,323,000	\$ 774,333	Best Value Alternative
	<i>Definition:</i>	Install current technology, higher performing control system hardware and software that is standardized across all CSO facilities. Ovation is the recommended system.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved performance, standardized HMI screens, can have standardized redundant "on-the-shelf" parts.	Capacity Enhancement	3						
	<i>Disadv.:</i>	No performance related disadvantages.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.8 Site

12.2.8.1 Description of Existing Site

Access to the site is off of Five Mile Road through a 25-ft wide swing gate. Site security is provided by a perimeter fence comprised of an 8-ft chain-link fence. The parking lot consists of 4-in. thick asphalt pavement with 8-in. gravel base. Sidewalks are 5 ft wide and consist of 4 in. of concrete with a 4-in. sand base. Site utilities include watermain, gas, sanitary and electric.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

12.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the section below.

- Removal and installation of effluent stop logs is difficult.
- Rain gutters and downspouts are not installed, causing roof runoff to pond around the sidewalk, creating a safety issue for personnel accessing the building.
- Entrance Gate. The existing entrance security gate at the site is a 25-ft wide swing gate. This gate has been experiencing recurring maintenance issues recently and has reached the end of its useful service life. The gate should be replaced with a rolling gate.
- Repair cracks in asphalt parking lot surface.

The following issues were addressed under "*GLWA-CON-1902040 Site Improvements at P-F Detention Facility and Leib Screening and Disinfection Facility*" Contract and are not included in the capital improvement projects for CS-299.

- Extend Security Fence. The existing security fencing only extends around three sides of the Control Headworks Building and Basin. The river side of the site is not fenced.
- Address Drainage on Basin. The overburden cover on top of the basin roof is poorly drained and typically remains saturated for several days following a rain event. Service trucks with equipment have trouble navigating the basin roof while the soil is saturated.

12.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Stop Log Removal System for Effluent Gates (Project PF-Site-1). Removal and installation of stop logs is difficult. There are two alternatives for this project:

1) **Alternative 1: Do Nothing.**

- 2) **Alternative 2: Stop Log Removal System for Effluent Gates.** A davit arm crane is recommended at the three hatch openings of the effluent gates and stop logs to assist in removal of hatch covers, the installation and removal of stop logs and other equipment from the effluent butterfly gate vault. A small area in the vicinity is recommended to be paved with concrete for temporary storage of stop logs.

Additionally, construction of a service road would assist access to the effluent gate vault site. Because the Puritan-Fenkell facility is located in a City park, the appearance of the service drive must blend in with the grass covered surroundings. It is recommended that the installed service road consist of an engineered fill base that will support a grass paver surface that will eventually support vegetation growth to better blend in with the natural surroundings, while giving vehicles access to the effluent gates. The service drive will extend from the existing Eliza Howell office parking lot and will be about 16 ft wide and approximately 265 ft long. Since this is in City park, it will likely require an easement. See Figure PF-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, for the conceptual layout.

The alternative evaluation is presented in Table 12-20. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.4 higher than the Do Nothing Alternative (Alternative 1) based on the improved O&M. The NPV/Benefit cost for Alternative 2 is \$75,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – Stop Log Removal System for Effluent Gates, is the recommended alternative.**

Table 12-20. Alternative Evaluation for Stop Log Removal System for Effluent Gates (Project PF-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Removal and installation of stop logs is difficult.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Stop Logs Removal System for Effluent Gates	Health and Safety	3	3.22	\$ 240,000	\$ -	\$ 240,000	\$ 74,611	Not applicable
	<i>Definition:</i>	A davit arm crane is recommended at the three hatch openings of the effluent gates and stop logs to assist in removal of hatch covers, the installation and removal of stop logs and other equipment from the effluent butterfly gate vault.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Ease of removal and installation of stop logs.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

General Site Improvements (Project PF-SITE-2). The roof on the Puritan-Fenkell Control and Headworks Buildings was recently replaced. However, rain gutters and downspouts were not installed. Roof runoff currently runs to the front of the Control Building and drops to grade where it tends to pond around the sidewalk, creating icy conditions during the winter and a safety issue for personnel accessing the building.

The Courtyard in the Headworks area has an open roof and is exposed to rain and snow falling on its floor surface. There are scuppers in the base of the south wall of the Courtyard to allow runoff to drain through the Courtyard wall onto the basin roof surface outside the wall. The Courtyard floor, however, does not provide adequate slope for the runoff to flow to the scuppers and consequently ponds on the floor surface.

This project also includes replacement of the entrance gate and restoration of the pavement.

There are two alternatives to address these issues:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: General Site Improvements:** It is recommended that a rain gutter and downspouts be added to the Control and Headworks Buildings to capture roof runoff and funnel it away from the building at grade. The Courtyard in the Headworks area has an open roof and is exposed to rain and snow falling on its floor surface. There are scuppers in the base of the south wall of the Courtyard to allow runoff to drain through the Courtyard wall onto the basin roof surface outside the wall. The Courtyard floor, however, does not provide adequate slope for the runoff to flow to the scuppers and consequently ponds on the floor surface. To alleviate the water ponding on the Courtyard floor, it is recommended that holes be cored through the courtyard floor to the basin below. Recessed area drains can be installed in the cored holes to funnel floor drainage to the basin.

This alternative also includes replacement of the entrance gate and restoration of the pavement.

The alternative evaluation is presented in Table 12-21. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.7 higher than the Do Nothing Alternative (Alternative 1) based on the improved O&M. The NPV/Benefit cost for Alternative 2 is \$34,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved O&M with this alternative, Alternative 2 – General Site Improvements, is the recommended alternative.**

Table 12-21. Alternative Evaluation for General Site Improvements (Project PF-SITE-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.62	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Safety concern related to ponding water and security issue with non-functioning gate	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	General site Improvements	Health and Safety	4	3.28	\$ 112,000	\$ -	\$ 112,000	\$ 34,112	Not applicable
	<i>Definition:</i>	Install rain gutter and downspouts; repair pavement	Water Quality & Compliance	3						
	<i>Adv.:</i>	Safety concern with ponding is eliminated	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.9 Architectural

12.2.9.1 Description of Existing Facilities

The Puritan-Fenkell CSO facility consists of chemical room, utility support (electrical), control room, odor control room, screen room, miscellaneous other rooms and a courtyard. The facility also includes retention basins.

12.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment, as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the ongoing Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff raised the following issues:

- It was identified that the existing basin access is through a 4 ft by 6 ft hatch with temporary wooden stairs and these stairs are not code-compliant.
- There is no access to the Headworks area and the Courtyard during a power outage.

These two issues are being addressed in an ongoing project under a JOC.

12.2.9.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (PF-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

1) **Alternative 1: Do Nothing.**

2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:

- Remove and replace sealant around doors, windows and other wall penetrations
- Remove and replace sealant at all control/ expansion wall joints

- Remove and replace isolation/ cove joint sealant and around building perimeter
- Remove and replace cracked façade limestone panels
- Replace damaged/stained/missing acoustic ceiling tiles in Control Building
- Address door hardware issues
- Clean, prepare surface and coat stained CMU walls in the Headworks

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure PF-ARCH-1-ALT-2). Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 12-22. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, Alternative 2 is the recommended alternative.

Table 12-22. Alternative Evaluation for Architectural Rehabilitation (Project PF-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 351,000	\$ -	\$ 351,000	\$ 113,226	Not applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.10 Safety

12.2.10.1 Description of Existing System

Safety-related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

12.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 12-23. The capital improvement project to address these issues is included in the table.

Table 12-23. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Odor Control Room	No tempering valve on eyewash/shower	Provide tempering valve	Safety Improvements (Project PF-SAFE-1)
Chemical Room	Emergency eyewash/shower outside containment	Add eyewash/shower inside tank containment	Safety Improvements (Project PF-SAFE-1)
Chemical Room	Emergency eyewash/shower 0943390 outside containment	Add eyewash/shower inside tank containment	Safety Improvements (Project PF-SAFE-1)
Basement stairwell	No illuminated exit signs	Add exit signs	Exit Sign Improvements ^a
Headworks	Illuminated exit signs not working	Replace exit signs	Exit Sign Improvements ^a
Utility tunnel	Illuminated exit signs not present	Add exit signs	Exit Sign Improvements ^a
Utility Tunnel Access	Illuminated exit signs are out. Exit signs missing in locations.	Add or replace exit signs.	Exit Sign Improvements ^a
Utility Tunnel	Ladder at end of tunnel has an exit sign but hatch is locked.	Add placard to fixed ladder "Not An Exit." Replace existing exit sign with directional exit sign away from ladder access.	Exit Sign Improvements ^a
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project PF-SAFE-1)

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

12.2.10.3 Description and Evaluation of Needs and Issues

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project PF-SAFE-1). This project should address the safety issues identified above. These issues include:

- Provide tempering valve on eyewash/shower in the Odor Control Room
- Add eyewash/shower outside containment in the Chemical Room
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 12-24 shows the one alternative.

Table 12-24. Alternative Evaluation for Safety Improvements (Project PF-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 126,000	\$ -	\$ 126,000	\$ 42,000	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection, and eye wash.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

12.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at Puritan-Fenkell CSO Facility.

12.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Puritan-Fenkell CSO facility, Table 12-25 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 12-25, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 12-25. Listing of Asset Condition Assessments for Puritan-Fenkell Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	34	34	0	100%
AHU	3	0	3	100%
AIRDRYER	1	1	0	100%
BACKFLOW	2	2	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	0	0	0	N/A
BUILDING	2	1	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	1	1	0	100%
COND-AIR	1	1	0	100%
CONVEYOR	1	0	1	100%
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAM	0	0	0	N/A
DAMPER	6	6	0	100%
DISCONNECT	0	0	0	N/A
DOOR	3	3	0	100%
DRIVE-ELEC	4	4	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	2	2	0	100%
FAN	2	0	2	100%
FANVENT	11	9	2	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	0	0	0% ^b
GASMONITOR	2	2	0	100%
GATE	15	15	0	100%
GEARBOX	4	0	4	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUND	0	0	0	N/A
HYDPACK	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	0	0	0	N/A
MCC	3	0	3	100%
METER	8	8	0	100%
MIXER	6	6	0	100%
MOTOR	8	0	8	100%
PANEL	7	7	0	100%
PIPING	4	4	0	100%
PUMP	19	11	5	84% ^c
ROOF	2	2	0	100%
SAMPLER	2	1	0	50% ^d
SCADA	2	2	0	100%
SCREEN	3	0	3	100%
SCRUBBER	2	0	2	100%
SENSOR	12	12	0	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	2	2	0	100%
TANK-STOR	2	2	0	100%
TIPBUCKET	1	1	0	100%
TRANSFRMR	2	0	2	100%
UNITHEATER	3	3	0	100%
UPS	1	1	0	100%
VALVE	27	27	0	100%
WATERHTR	1	1	0	100%

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The one gas detector is a portable unit and was not assessed.

^c Three inactive pumps are listed in WAM - Basin 1 Sample Pump, Basin 2 Sample Pump, and Shunt Channel Sample Pump. These pumps are being considered for removal from WAM.

^d The Shunt Sampler 1 is listed in WAM. This sampler is being considered for removal from WAM.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Puritan-Fenkell Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

12.3 Capital Planning for Puritan-Fenkell CSO Facility

12.3.1 Summary of Capital Improvement Plan Projects

Table 12-26 provides a summary of the recommended CIP projects and associated capital costs for the Puritan-Fenkell CSO facility based on the alternative evaluations conducted for this facility.

Table 12-26. Summary of Recommended Projects at Puritan-Fenkell CSO Facility

Project No.	Alternative	Description	Total Project Cost
PF-WWMP-1	2	Convert to Complete Capture Basin	\$ 2,600,000
PF-SCR-1	2	Screening Improvements	\$ 230,000
PF-DIS-1	3	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 383,000
PF-DIS-2	2	Install Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
PF-FD-1	2	Wet Well Improvements	\$ 79,000
PF-FD-2	2	Provide Access to Tipping Buckets for Maintenance	\$ 95,000
PF-FD-3	2	Access to Dewatering Force Main for Inspection and Cleaning	\$ 90,000
PF-HVAC-1	1	HVAC Improvements	\$ 810,000
PF-ELEC-1	2	Electrical Improvements	\$ 205,000
PF-I&C-1	2	I&C Improvements	\$ 70,000
PF-I&C-2	1	Control System Upgrade	\$ 2,323,000
PF-SITE-1	2	Stop Log Removal System for Effluent Gates	\$ 240,000
PF-SITE-2	2	General Site Improvements	\$ 112,000
PF-ARCH-1	2	Architectural Rehabilitation	\$ 351,000
PF-SAFE-1	1	Safety Improvements	\$ 126,000

12.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 12-27. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 12-27. Capital Improvement Plan Projects for Puritan-Fenkell CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
PF-1 Convert to Complete Capture Basin	\$ 2,600,000	2030 <i>Timing based on general CSO project priorities</i>	PF-WWMP-1	Convert to Complete Capture Basin	\$ 2,600,000
PF-2 Disinfection System Improvements	\$ 603,000	2032 <i>Timing based on asset condition</i>	PF-DIS-1	Chemical Feed Utilizing Manifold Pump Distribution and Centrifugal Pumps	\$ 383,000
			PF-DIS-2	Install Flow-paced and TRC-paced Chemical Feed Control System	\$ 220,000
PF-3 Flushing System Improvements	\$ 616,000	2032 <i>Timing based on best judgement</i>	PF-FD-1	Wet Well Improvements	\$ 79,000
			PF-FD-2	Provide Access to Tipping Buckets for Maintenance	\$ 95,000
			PF-FD-3	Access to Dewatering Force Main for Inspection and Cleaning	\$ 90,000
			PF-SITE-1	Stop Log Removal System for Effluent Gates	\$ 240,000
			PF-SITE-2	General Site Improvements	\$ 112,000
PF-4 HVAC Improvements	\$ 810,000	2027 <i>Timing based on asset condition</i>	PF-HVAC-1	HVAC Improvements	\$ 810,000
PF-5 Facility-Wide Electrical and I&C Improvements	\$ 2,598,000	2029 <i>Timing based on asset condition</i>	PF-ELEC-1	Electrical Improvements	\$ 205,000
			PF-I&C-1	I&C Improvements	\$ 70,000
			PF-I&C-2	Control System Upgrade	\$ 2,323,000
PF-6 Facility-Wide Safety and Architectural Improvements	\$ 477,000	2023 <i>Project should be initiated as soon as possible</i>	PF-ARCH-1	Architectural Rehabilitation	\$ 351,000
			PF-SAFE-1	Safety Improvements	\$ 126,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 12-28 and Table 12-29 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 12-29 indicates that PF-DIS-1 project has one asset that needs to be replaced immediately due to condition score of "5". This asset, however, has already been replaced/rebuilt since the Condition Assessment was conducted in Summer 2020. The remaining nine assets that are included in this project have an average condition score of 1.27 and an average replacement date of 2032 (See Table 12-28). This information was used to propose a scheduled construction completion date of 2032.

Table 12-28. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
PF-DIS-1	9	1.67	1.27	2.75	12	2032	\$ 311,400
PF-HVAC-1	10	1.19	1.47	2.06	20	2039	\$ 306,011
PF-I&C-2	2	2.29	1.57	4.08	12	2029	\$ 1,397,075
PF-SCR-1	1	1.43	1.89	2.78	20	2034	\$ 146,071

Table 12-29. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
PF-DIS-1	1	1.29	5.00	4.50	10	2021	\$ 29,000
PF-HVAC-1	1	2.57	5.00	9.00	20	N/A	\$ 63,500
PF-I&C-2	0	0.00	0.00	0.00	N/A	N/A	\$ -
PF-SCR-1	0	0.00	0.00	0.00	N/A	N/A	\$ -

12.3.3 20-Year Capital Outlay Plan

Table 12-30 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 12-30. 20-Year Capital Outlay Plan for Puritan-Fenkell CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 142,700	\$ -	\$ -	\$ -	\$ 29,000	\$ -	\$ -	\$ 113,700	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 314,150	\$ -	\$ -	\$ 314,150	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 42,024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 42,024	\$ -	\$ -	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 29,886	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 29,886	\$ -
2029	\$ 1,842,719	\$ 34,375	\$ 7,714	\$ 15,428	\$ -	\$ 15,428	\$ -	\$ -	\$ -	\$ 1,769,773	\$ -	\$ -	\$ -
2030	\$ 668,481	\$ 109,601	\$ -	\$ 260,955	\$ 243,993	\$ -	\$ 20,876	\$ -	\$ -	\$ -	\$ 33,057	\$ -	\$ -
2031	\$ 891,017	\$ 14,111	\$ -	\$ 876,905	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 33,718	\$ -	\$ 8,429	\$ 25,288	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 475,484	\$ 13,217	\$ 214,511	\$ -	\$ -	\$ -	\$ 19,238	\$ 228,519	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 841,458	\$ 34,790	\$ -	\$ 579,615	\$ 90,453	\$ -	\$ -	\$ 12,403	\$ -	\$ -	\$ 96,782	\$ -	\$ 27,416
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 2,185,352	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2,185,352	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 1,060,565	\$ 16,292	\$ -	\$ -	\$ -	\$ 558,909	\$ 216,549	\$ 268,814	\$ -	\$ -	\$ -	\$ -	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 8,527,553	\$ 222,386	\$ 230,654	\$ 2,072,341	\$ 363,445	\$ 574,337	\$ 256,664	\$ 623,437	\$ 2,227,376	\$ 1,769,773	\$ 129,839	\$ 29,886	\$ 27,416

Notes:

Explanation of large capital outlays in first two years:

- Retention System: Two influent slide gate (SG-1 and SG-5; \$157,000 each) received a score of 5 since they were locked out of service at the time of the Condition Assessment.
- HVAC System: One AHU (HV-1, \$63,500) was out of service at the time of inspection. Two electric unit heaters (\$19,500 each) , two supply fans (SF-3 and SF-4; \$3,000 each), and two exhaust fans (EF-7 and EF-8; \$2,600 each) received a score of 5 due to severe corrosion on the units and have been out of service for some time.

13. Seven Mile CSO Control Facility

13.1 General Facility Description and Future Capacity Considerations

13.1.1 General Facility Description

The Seven Mile CSO Facility is an RTB with 2.2 MG of storage and a treatment capacity of 655 cfs through the treatment system. It was constructed in 1997. Since it was constructed, the facility has rarely discharged, with one recorded event of 490,000 gallons of discharge in 2014 from a nearly 6-in. rain event. For this reason, Section 13.1.2 describes potential modifications to make this facility into a "Capture-Only" facility. A similar recommendation is made for the Puritan-Fenkell CSO Facility.

The facility consists of a headworks area, chemical room, odor control room, electrical room, control room, metering room in the basement, and miscellaneous other rooms and a courtyard.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

13.1.2 Modifications to Make Seven Mile Facility into a Capture-Only Facility (SM-WWPM-1)

The WWMP recognized that "GLWA has developed a protocol to operate the Puritan-Fenkell and Seven Mile basins in capture-only mode (no treatment or discharge) for flows up to the 10-year 1-hour design storm. This finding provides a significant water quality benefit because the 1,114-acre service area can be captured, stored, and returned to the WRRF following a storm event preventing release of an estimated 700 million gallons of combined sewer overflow each year."

Operating these two facilities in capture mode would allow for the cost avoidance of operating and maintaining the hypochlorite feed and storage systems, and it would likely not require operations labor to be onsite during a storm event.

Wade Trim conducted a study ("Puritan-Fenkell and Seven Mile CSO Retention and Treatment Basins Basin Collection System and Hydraulic Analysis", dated August 29, 2019). This hydraulic study included an analysis "to evaluate the potential of operating the basins in capture-only mode as a possible operational protocol for the system. Capture basin operation was evaluated to understand the impacts on untreated overflow from the 17 Main Rouge River outfalls on the Detroit West Side system, flooding impacts of the utility tunnels within the two basins, and the risk of upstream basement flooding."

The findings of the study included:

- Limited (approximately 2 percent) increase in untreated overflow from the 17 Main Rouge River outfalls as a result of capture mode operation.
- Impact to the utility tunnels when operating in capture mode is expected for design storms between the 10-year, 24-hour and the 25-year, 24-hour storm at the Puritan-Fenkell basin. At the Seven Mile basin, design storms slightly smaller than the 10-year, 24-hour storm will begin to impact the utility tunnel.
- The evaluation of basement flooding risk shows the basins can be operated in capture mode for the 10-year, 24-hour storm without risk of basement flooding. However, during the 25-year, 24-hour storm significant basement flooding can be expected.

The report concluded that operating the basins in capture-only mode in their current configuration is not recommended due to the risk of basement flooding. The report indicated, however, that capture-only

mode may be possible if high level emergency overflows are added to the basins to relieve the system during extreme events to protect basements from flooding.

To aid in the analysis of operating both Puritan-Fenkell and Seven Mile as capture-only basins, conceptual cost estimates have been generated under CS-299 for both facilities including capital improvements listed below. The Wade Trim hydraulic study provided some details regarding these issues, which are included in the description of the conceptual cost estimate; however, additional study and design will be needed.

- 1) Emergency overflow relief. The current weir wall is about 12 ft high at both facilities. A new weir wall about 20 ft high and associated structural modifications are needed at the effluent end of the basin to construct a taller weir wall. The length of weir was not reported and should be included in the future study.
- 2) Utility tunnel flooding protection. Water-tight doors are recommended where there is access to the basin from the utility tunnel and at the influent end of the utility tunnel. The proposed doors can withstand 20 ft of static head.
- 3) Replace the existing effluent butterfly gates with flap gates. The Wade Trim report evaluated two different locations for these gates at each facility, which would prevent backflow into the facility (see Figure 13-1 below showing one of the locations, which was used for the cost estimate). Additional study should be performed to determine if these flap gates are still needed with the taller proposed weir wall.

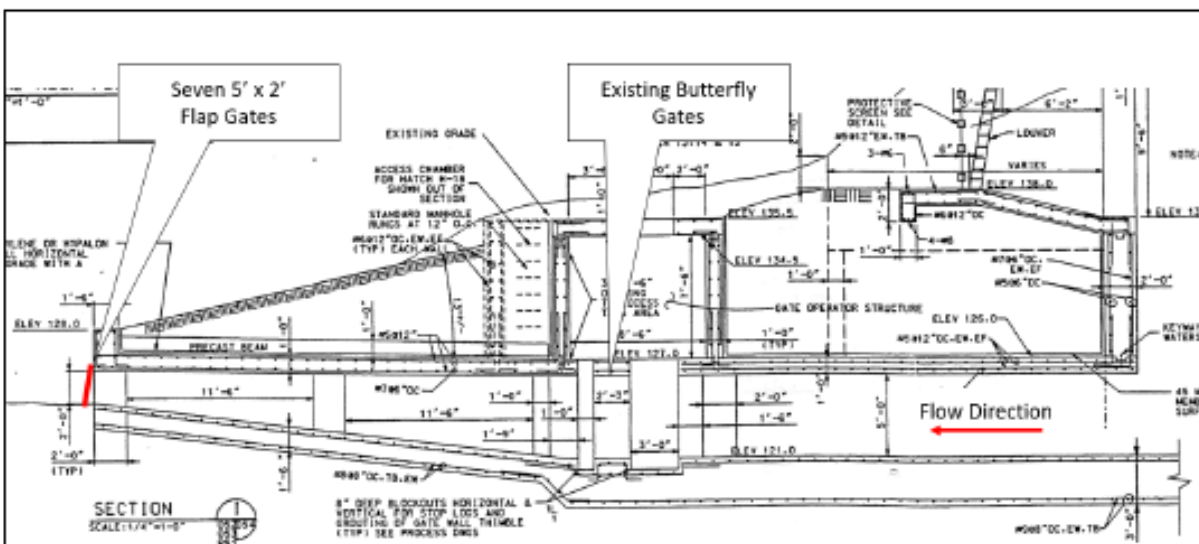


Figure 13-1. Potential Options for Flap Gate Retrofit – Seven Mile (from Wade Trim report)

A preliminary life-cycle comparison is presented in Table 13-1. Alternative 1 represents the scenario where the facility continues to operate as an RTB. Alternative 2 represents a scenario where the facility operates in the complete capture mode. The intent of this comparison is to present the cost of the emergency overflow weirs and flap gates compared to the avoided costs associated with maintaining the disinfection system and flow meters for the flow-through treatment mode of operation. The following costs are used in this evaluation:

- The period of evaluation is assumed to be 50 years, which represents an approximate remaining life of the basin.
- For Alternative 1, the capital costs were obtained from the SRP replacement costs and include the chemical feed pumps, drives, piping, and storage tanks. It also includes the flow meters for the

effluent and shunt channel. It is assumed for this analysis that all of these assets would be replaced twice during the period of evaluation.

- For Alternative 1, the O&M costs include those items that are currently needed, but would no longer be needed under a complete capture mode. These costs include Operations labor before and during storm events to make the facility ready for discharge, if necessary (assumed to be 8 storm events per year and 10 hours per storm event). Costs also include hypochlorite usage or degradation of one tank (2,400 gallons) every six months at a unit cost of \$0.90 per gallon.
- For Alternative 2, the total project cost for the modifications described for the emergency weirs and flap gates is provided in Volume 6 – Appendices, Appendix C, under SM-WWMP-1. The costs also include Permitting and Modeling to demonstrate and coordinate the modifications with Michigan EGLE (assumed to be \$100,000).

As shown in Table 13-1, the Best Value Alternative is Alternative 2 – Convert to Complete Capture Basin. As such, it is recommended that this alternative be pursued through additional modeling to confirm water levels in the collection system during peak storm events and coordination with Michigan EGLE.

Table 13-1. Alternative Evaluation for Seven Mile to Convert to Complete Capture Basin

Alt.	Description			Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.		Health and Safety	2	2.50	\$ 2,531,000	\$ 12,320	\$ 3,232,823	\$ 1,293,129	
	<i>Definition:</i>	Do nothing. Continue to operate as an RTB		Water Quality & Compliance	3						
	<i>Adv.:</i>	Known system; no new regulatory issues		Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher level of operator attention during storm events. Must maintain hypochlorite storage and feed system.		Component Performance	3						
	<i>Comments:</i>	None		O&M Ease	2						
2	<i>Alt. Name:</i>	Convert to Complete Capture Basin		Health and Safety	4	3.72	\$ 2,500,000	\$ -	\$ 2,500,000	\$ 672,646	Best Value Alternative
	<i>Definition:</i>	Convert to Complete Capture Basin		Water Quality & Compliance	3						
	<i>Adv.:</i>	Less operator attention during storm events. No O&M for hypochlorite system.		Capacity Enhancement	3						
	<i>Disadv.:</i>	Requires regulatory approval; Modeling confirmation of acceptability		Component Performance	3						
	<i>Comments:</i>	None		O&M Ease	5						

13.2 Facility Assessment

13.2.1 Screening

13.2.1.1 Description of Existing System

The Seven Mile CSO Facility has two bar screens that were installed in 1997. Influent wastewater enters the facility from the Seven Mile Sewer and is routed through the screens to the basin compartments. Material collected by the screens is mechanically raked from the bar screens and deposited into individual dumpsters to be hauled to a landfill.

It should be noted that this facility is planned to become a complete capture facility with emergency overflow to prevent basement flooding based on the recommendations from the WWMP. It is recommended that the screens remain at the facility to prevent large debris from entering the facility.

Table 13-2 provides an overview of the existing screening system at Seven Mile CSO facility.

Table 13-2. Overview of Existing Screening System at Seven Mile CSO Facility

Parameter	Value
Treatment Capacity (cfs)	655
No. of Screens	2
Manufacturer	E & I Corporation
Screen Type	Catenary Bar Screen
Opening Size	0.5-in. spacing
Depth or Length / Width	23 ft 0 in. /9 ft 6 in.
Screen Cleaning	Mechanical Rake
Screening Removal	Conveyor belt to dumpster and landfilled

13.2.1.2 Identified Needs and Issues

There were no needs identified by GLWA or the Jacobs team.

13.2.1.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no screening-related issues that that would be classified as capital improvement "needs."

13.2.2 Disinfection

13.2.2.1 Description of Existing System

This facility was constructed in 1996 and has rarely discharged. Recent studies have been conducted under the WWMP recommending that this basin be modified from a treatment basin to a complete capture basin. Under this scenario, the disinfection system would not be used. As such, it is recommended that the disinfection system be removed or moth-balled at this site.

Table 13-3 provides an overview of the existing disinfection system at Seven Mile CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G.

Table 13-3. Overview of Existing Disinfection System at Seven Mile CSO Facility

Parameter	Value
Treatment Capacity (cfs)	655
Design Feed Strength (% hypochlorite)	5
Max. Dosage at Design Flow (mg/L Cl ₂)	10 @ 655 cfs
Disinfection Contact Time (min)	30
Storage Tanks Number Volume of Each Tank (gal) Type	2 2,400 FRP
Pumps Number Capacity (gpm) Type	4 20 Gear
Mixers Number / Type Model Number/ hp / Manufacturer	1 / Chemical induction mixers Series 32 / 10 hp / Gas Mastrrr

13.2.2.2 Identified Needs and Issues

The disinfection system should ultimately be demolished and removed from this facility. This includes the chemical storage tanks, chemical feed pumps, piping and associated electrical and instrumentation components. These costs are included in the conversion to a complete capture basin.

13.2.2.3 Description and Evaluation of Alternatives

There were no disinfection-related issues identified by the GLWA or the Jacobs team that would be classified as capital improvements “needs”.

13.2.3 Odor Control

13.2.3.1 Description of Existing System

The Seven Mile odor control system consists of one cross-current vertical scrubber vessel that treats air from the Headworks area and basins. The system includes a scrubber tower, recirculation pump, caustic addition system, sodium hypochlorite addition system and an odor control fan. The scrubber tower contains 5.5 ft of plastic media with a chemical spray section located above the media. The original system was designed to feed sodium hydroxide and sodium hypochlorite; however, the sodium hydroxide has not been used for some time.

The system was installed in 1997. Overall, the system is in good condition. The odor control system does not have an air permit.

Per GLWA, no odor complaints have been received for at least the past three years.

13.2.3.2 Identified Needs and Issues

During meetings with O&M staff related to the odor control system, no needs were identified. The recommendation in this section is based on Jacobs evaluation of the existing system.

Potential Reduction of Odor Treatment during Operation. The facility does not have an air permit and is not required to operate the odor control system. The facility may not generate significant odors during wet weather events due to dilution of sewage with storm water. Storm water significantly reduces the concentration of sulfide and other odorous compounds in sewage. Odors may be more prevalent during the dewatering phase caused by odors from settled solids but may still be low. Due to the expected low odors from the facility, GLWA may want to consider operating the scrubber systems with water only and no sodium hypochlorite. Removal of H_2S is dependent on the H_2S concentration. Removal will be significantly less with only water, but there may be relatively low levels of H_2S to remove. Another option, which provides even less treatment, would be to operate the system without water and blow air through an empty scrubber system and out the stack.

Under both of these options, the discharged air may be non-odorous or sufficiently diluted with ambient air to render it non-odorous. Prior to implementing either one of these options, GLWA could sample influent air to the existing scrubber system for H_2S to determine if the H_2S concentration is sufficiently low. A non-detectable concentration of H_2S in the influent air means the systems can likely operate without sodium hypochlorite or water.

13.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement “needs”.

13.2.4 Flushing and Dewatering

13.2.4.1 Description of Existing System

Dewatering System: There are three dewatering pumps and one sump pump used to dewater the basin after a storm event. Dewatered flow is pumped to the NWI.

Flushing System: There are 14 tipping buckets on the side walls of both basin compartments and the influent channels. City water is used to fill the tipping buckets.

Table 13-4 provides an overview of the existing flushing and dewatering system at Seven Mile CSO facility.

Table 13-4. Overview of Existing Flushing and Dewatering System at Seven Mile CSO Facility

Parameter	Value
Total Basin Volume (MG)	2.2
Headworks and basin Dewatering and Flushing System	- There are three 2,000 gpm dewatering pumps 6 tipping buckets for each basin (12 total) 2 tipping buckets in influent distribution channel

13.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Provide access to tipping buckets for inspection
- Provide access to dewatering force main for inspection and cleaning

13.2.4.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Access to Tipping Buckets (Project SM-FD-1). O&M staff noted that the bearing assemblies for the tipping buckets are inaccessible; however, they require periodic inspection and greasing.

There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Provide Access to Tipping Buckets for Maintenance.** This alternative provides access for visual inspection of the tipping bucket bearing assemblies consists of constructing manhole openings above each adjoining set of rotating groups. A total of 17 manhole openings would be required, including one over each bearing assembly on the end tipping buckets.

Installation will require removing pavement and excavating to the top of the existing roof slab. A 24-in. opening will be cored through the roof, and manhole grade rings set/doweled over the opening and extended to the existing surface. A standard 24-in. manhole ring and lid will be set flush with the pavement, and the excavation backfilled around the new access point. Final restoration will include pavement repairs and patching to the concrete parking area.

The costs include extending a 0.5-in. metal grease tube and grease gun fitting from each bearing assembly to within 6 in. of the surface at the nearest new manhole opening (2 zerks per manhole, 1 each at the end tipping buckets). After consultation with the tipping bucket gate manufacturer, regular greasing of the bearings is not required for the model of tipping buckets installed at the Seven Mile CSO Facility. GLWA may elect to install the access for better visual confirmation of tipping bucket condition and operation and better access to limit switches at each bearing assembly. Figures (Figure SM-FD-1-ALT-2) included in Volume 6 – Appendices, Appendix B, show the conceptual layout of this improvement.

The alternative evaluation for these alternatives is presented in Table 13-5. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and increased ease of O&M provided by the improved access to the tipping bucket bearings. The NPV/Benefit cost for Alternative 2 is \$36,000, which is a relatively low cost compared to other projects recommended in this assessment. **As such, Alternative 2 –Access to Tipping Buckets is the recommended alternative.**

Table 13-5. Alternative Evaluation for Access to Tipping Buckets (Project SM-FD-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Inaccessible bearing assemblies for the tipping buckets	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Access to Tipping Buckets for Maintenance	Health and Safety	4	3.50	\$ 125,000	\$ -	\$ 125,000	\$ 35,714	Not Applicable
	<i>Definition:</i>	Construct manhole openings over each bearing assembly of tipping buckets	Water Quality & Compliance	3						
	<i>Adv.:</i>	Access for better visual confirmation of tipping bucket condition and operation and better	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

Access to Dewatering Force Main (Project SM-FD-2). GLWA noted that the force main from the CSO facility to the NWI is inaccessible but will require future inspection and cleaning.

There are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Access to Dewatering Force Main for Inspection and Cleaning.** this alternative consists of the installation of cleanouts at the following locations: 1) at the end of the force main, southwest of the siphon head chamber in Manhole No. 1 for cleaning of the force main, 2) just to the northeast of the Manhole No. 1 before the inverted siphon, and 3) east side of the Rouge River, just before Manhole No. 2. (see Figure SM-FD-2-ALT-2 included in Volume 6 – Appendices, Appendix B)

The alternative evaluation for these alternatives is presented in Table 13-6. The capital cost for Alternative 2 is included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.4 higher than the Do Nothing Alternative (Alternative 1) based on the increased ease of O&M provided by the ability to access the force main. The NPV/Benefit cost for Alternative 2 is \$28,000, which is a relatively low cost compared to other projects recommended in this assessment. **As such, Alternative 2 –Access to Dewatering Force Main is the recommended alternative.**

Table 13-6. Alternative Evaluation for Access to Dewatering Force Main (Project SM-FD-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Dewatering forcemain from the CSO facility to the NWI remains inaccessible.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Provide Access to Dewatering Force Main for Inspection and Cleaning	Health and Safety	3	3.22	\$ 90,000	\$ -	\$ 90,000	\$ 27,979	Not Applicable
	<i>Definition:</i>	Install cleanouts at a number of locations.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Access to the dewatering forcemain from the CSO facility to the NWI for future inspection and cleaning.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

13.2.5 HVAC

13.2.5.1 Description of Existing System

The Seven Mile CSO facility consists of a headworks area, chemical room, odor control room, electrical room, control room, metering room in the basement, and miscellaneous other rooms and a courtyard. The facility also includes the retention basins. Table 13-7 provides summary of the major HVAC equipment for the facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, multiple emergency shower/eye wash, regular shower, and sump pump. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 13.2.10.

Table 13-7. Major HVAC Equipment at Seven Mile CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	HVU-2	Heating and Ventilating Unit	12,190 CFM
	EF-5	Exhaust Fan	11,480 CFM (Pump Area)
Basin	SF-1 and 2	Supply Fan (for Basin)	102,420 CFM
	SF-3	Supply Fan (Utility Tunnel)	1,472 CFM
	SF-4	Supply Fan (Shunt Channel)	2,600 CFM
	EF-7	Exhaust Fan (Shunt Channel)	500 CFM
	EF-8	Exhaust Fan (Effluent Channel)	500 CFM
	UH-1 and 2	Unit Heater (Shunt Chamber)	400 CFM 17.0 MBH
Odor Control Room	HVU-1	Heating and Ventilating Unit	2,400 CFM 65 MBH
	EF-6	Exhaust Fan	2,000 CFM
Basement (Meter Vault)	HVU-3	Heating Ventilation Unit	1,200 cfm
Electrical Room	PACU-1	Packaged Air Conditioning Unit	2,200 CFM 51.2 MBH

Table 13-8 provides a summary of the basis of design performance criteria for HVAC systems at Seven Mile and Table 13-9 provides the outdoor Basis of Design conditions.

Table 13-8. Seven Mile Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Retention Basin	Class I, Div 1, Group D	N/A	N/A	10 ACH
Headworks and Pump Room	Class I, Div 1, Group D	60	N/A	12 ACH
Odor Control Room	Unclassified for areas greater than 3 ft from odor control vessel. Class I, Div 2, Group D	70	N/A	10 ACH

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
	for areas closer than 3 ft.			
Electrical Room, Work Room, Office, Toilet	Unclassified	70	78	2 cfm/ft ²
Basement (Magnetic Meter Room)	Unclassified	70	N/A	6 ACH
NaOCl Storage Room	Unclassified	60	N/A	6 ACH

Table 13-9. Seven Mile Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

13.2.5.2 Identified Needs and Issues

During the Needs Assessment meetings with GLWA O&M staff, the following HVAC issues were noted:

- PACU-1 requires replacement.

During the discussions with GLWA's HVAC contractor the following historical issues were noted:

- PACU-1 requires frequent maintenance to keep running: GLWA's HVAC contractor noted that PACU-1 at Seven Mile has had issues very similar to unit at Puritan-Fenkell, including damper problems, actuator problems, refrigerant leaks and wiring issues.
- SF-1 and SF-2 motorized dampers are not fully functional.
- SF-2 has audible motor bearing problems.

During site investigations (June 2020), the following observations were noted:

- SF-1 and SF-2 were functional but had damaged duct connections.
- The motorized dampers for SF-1 and SF-2 were seized and not fully open.
- HVU-3 is difficult to access for maintenance.

13.2.5.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

HVAC Improvements (Project SM-HVAC-1). Due to the numerous HVAC-related assets that require replacement and the additional need to provide monitoring for code compliance in the Odor Control Room and Headworks, all of the identified HVAC improvements are proposed to be in one project – HVAC Improvements. As such, there is only one alternative for this project, which includes:

- PACU-1 Replacement
- Improvements to Enhance Safety in Odor Control Area

- Improvements to Enhance Safety in Headworks Area
- HVU-1 and 2 Replacement
- HVU-3 Replacement (with improved access)
- SF-1 and SF-2 Replacement
- Exhaust Fan Replacement
- Removal of Shunt Channel and Effluent Channel HVAC Equipment

Each of the HVAC-related improvements listed above are described further below:

PACU-1 Replacement. Given the age of PACU-1 (24 years) and the lengthy history of various issues, replacement of PACU-1 with a more efficient modern unit and controls is recommended.

Improvements to Enhance Safety in Odor Control Area. The Odor Control area is classified as a Class I, Division 2 space under NFPA 820 if it is not continuously ventilated at a rate of 6 ACH. The space does not meet the 6 ACH ventilation requirement and does not currently have electrical equipment rated for a Class I, Div 2 environment. HVU-1 is designed to provide 10 ACH of ventilation air in cooling mode but was sized to provide only 2 ACH of outside air in heating mode. Additionally, EF-2 is only designed to operate in cooling mode at 10 ACH. NFPA 820 requires both supply and exhaust fans to operate continuously to unclassify odor control areas.

Given the age of HVU-1 and EF-2 and the problems HVU-1 is exhibiting, Jacobs recommends in-kind replacement of both units. HVU-1 and EF-1 could be replaced with two-speed fans or VFDs to provide 6 ACH continuously during ventilation and heating and 10 ACH in cooling mode.

Regardless of whether the space is unclassified by providing 6 ACH of outside air, NFPA 820 requires the installation of combustible gas detection in the Odor Control area with audible and visible alarms at all entrances to the Odor Control area and within the space.

If ventilation is used to unclassify the space as described above, ventilation flow monitoring of both the supply and exhaust fan is required with visible and audible alarms of a low or no flow condition required at entrances and within the space.

Improvements to Enhance Safety in Headworks Area. HVU-2 serves the Headworks Area, which is classified as a Class I, Division 1 space per the design drawings. Given its age and general condition, HVU-2 should be replaced. Because the electrical equipment in the space is rated for a Class I, Division 1 environment continuous ventilation and ventilation flow monitoring are not required. NFPA 820 does, however, require combustible gas detection with visible and audible alarms at the entrances to the Headworks area and inside the space, which the Headworks area currently does not have. Jacobs recommends making this change to comply with NFPA 820.

HVU-3 Replacement (relocated with improved access). HVU-3 is currently mounted high in the Metering Room space making access for maintenance very difficult (Figure 13-2). Placing HVU-3 lower in the space would make access to the magnetic meter and associated piping very difficult. Jacobs recommends replacing HVU-3 with a unit mounted on a concrete pad on the North side of the building when HVU-3 requires replacement. There is an existing opening for the Meter Room supply air duct, which could be utilized by the outdoor unit. This approach would allow ample space for maintenance and would make removal much easier. Currently, HVU-3 will need to be removed in sections when replacement is necessary.



Figure 13-2. HVU-3 Located in Inaccessible Area Difficult to Access Location

SF-1 and SF-2 Replacement. SF-1 and 2 are functional despite having damaged duct connections. These units will require replacement in the near future. The motorized dampers on the units have seized and will need to be removed or replaced. It is worth noting that the design documents for the Puritan-Fenkell facility (which is very similar to Seven Mile Road) indicated the Basin ventilation units had motorized dampers, which were not seen during the site walkthrough and presumably have since been removed. Motorized dampers are not necessary for this application and add a potential failure point as well as increased maintenance and repair costs. The selection of fans with corrosion-resistant construction should negate the need to have motorized dampers.

Exhaust Fan Replacement. There are five relatively small exhaust fans that are original to the facility and should be included in the replacement project.

Removal of Shunt Channel and Effluent Channel HVAC Equipment. The unit heater, supply and exhaust fans in the Shunt Channel and Effluent Channel are not used and are inoperable. These units could be retired. Portable ventilation could be utilized, if necessary, when operators need to enter these areas.

The alternative evaluation is presented in Table 13-10. **The capital cost for Alternative 1, which is the recommended alternative,** is included in Volume 6 – Appendices, Appendix C under this project title.

Table 13-10. Alternative Evaluation for HVAC Improvements (Project SM-HVAC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	HVAC Improvements	Health and Safety	3	3.00	\$ 858,000	\$ -	\$ 858,000	\$ 286,000	Best Value Alternative
	<i>Definition:</i>	Facility-wide HVAC Improvements	Water Quality & Compliance	3						
	<i>Adv.:</i>	Code compliance, less emergency maintenance, improved asset reliability.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

13.2.6 Electrical

13.2.6.1 Description of Existing System

The Seven Mile facility's electrical system consists of one DTE utility feed from a 750 kVA, 480/277 V, 3-Phase outdoor transformer (secondary metering) and one diesel generator feed from a 350 kW, 480/277 V, 3-Phase stationary generator. The feeds are connected to a 1,200 A MDP with electrically operated breakers and automatic source transfer controls for a 1,200 A bus. The MDP has breakers that feed MCCs and distribution panels. The MCCs and distribution panels then feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 13-11 provides a summary of the major electrical equipment for this facility.

Table 13-11. Major Electrical Equipment at Seven Mile

Location	Major Electrical Equipment	Description
Electrical Room	Main distribution panel with ATS	1,200 A, 480/277 V, 3-Phase
Courtyard	Generator (Diesel)	350 kW, 480/277 V, 3-Phase
Electrical Room	MCC-1	400 A, 480/277 V, 3-Phase
Electrical Room	MCC-2	400 A, 480/277 V, 3-Phase

13.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for unsafe working conditions. This issue is further described in the section below.

13.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project SM-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure SM-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Basin – Add additional basin interior explosion-proof LED lighting fixtures to provide lighting within the basins. Lighting to meet the required foot-candles and codes for the area.
 - Add exterior power receptacles to assist in the maintenance and operations of the facility including additional power receptacles at the facility's outfall.

The alternative evaluation is presented in Table 13-12. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$39,000, which is a relatively low cost compared to other projects recommended in this assessment.

Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.

Table 13-12. Alternative Evaluation for Electrical Improvements (Project SM-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 136,000	\$ -	\$ 136,000	\$ 38,857	Not Applicable
	<i>Definition:</i>	Add additional lighting in basins. Provide exterior power receptacles.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

13.2.7 I&C

13.2.7.1 Description of Existing System

Control System: The original PLC control system and hardwired backup control system were installed in 1996 under PC-696. The system has the ability to remotely monitor the operations of the facility and the overall area collection system at SCC.

The existing control system consists of Allen Bradley redundant PLC-5 processors with local I/O for monitoring and control of the facility processes. The system has hardwired backup capabilities to control the facility on an overall control system failure. The PLC's control system network communicates via an Ethernet network to the facility's control system and operator workstation. The workstation currently uses the Rockwell RSView software package that provides the existing operator workstation the additional software applications to provide historical data storage and retrieval, reporting, as well as other functions to monitor and control the system. The local hardwired backup control panel is obsolete and with new redundant control systems, this type of backup hardwired control panel is no longer used. The current system is equipped with a backup radio system to communicate critical monitoring points back to SCC on wide area network failure.

Flow and Level Sensors: Table 13-13 summarizes the level sensors and flow meters at the Seven Mile CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 13-13. Summary of Flow Meters and Level Sensors at Seven Mile CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Shunt Channel	1	Transit-Time (AccuSonic)
Effluent Weir	2	Ultrasonic
Dewatering	1	Magnetic
CSO Level Sensors		
Influent	1	Ultrasonic
Screening Area (Downstream of bar racks)	1	Ultrasonic
Basin	2	Ultrasonic
Effluent Channel	1	Ultrasonic
Dewatering Well	1	Ultrasonic
NWI	1	Ultrasonic
River	1	Ultrasonic
Chemical System Flow Meters		
Secondary Water	1	Magnetic
Chemical Feed	1	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Ultrasonic

13.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- Replacement options for valve control network for the chemical feed system is discussed in detail in Section 5.4.6. The cost/benefit of the hardwired control was not favorable and therefore was not considered further.
- Update control system. GLWA is currently developing a RFPs for qualified design-build contractors to provide professional engineering and construction services for control system improvements at the Seven Mile CSO Facility under "Control System Improvements – St. Aubin, Leib and Seven Mile CSO Facilities." The project will replace the existing PLC-5 control system and backup local control panels with a new control system, provide new Ovation workstations with high-performance graphics, and replace some of the field instruments. This is an ongoing project that has already been included in the CIP.

13.2.7.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no I&C related issues that that would be classified as capital improvement "needs."

13.2.8 Site

13.2.8.1 Description of Existing Site

The Seven Mile CSO Facility was constructed in 1994. Access to the site is off of Shiawassee St. through a 25-ft wide sliding gate. Site security is provided by perimeter fencing comprised of a 6-ft high chain-link fence along the west side of the CSO building along Shiawassee St. The parking lot consists of 4-in. thick asphalt pavement with 8-in. gravel base. Concrete sidewalks are 5 ft wide and 4 in. thick with 4-in. sand base. The top of most of the basin roof area is used as a parking lot by the nearby church.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

13.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the section below.

- There is no security fencing around the north, south and east sides of the Seven Mile CSO Control/Headworks Building.
- The Courtyard floor does not provide adequate slope for the rain/snow runoff to flow to the scuppers and consequently ponds on the floor surface.
- The existing hatch cover plates are heavy and difficult to remove.

13.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section, by potential project, along with the recommended alternative.

Security Fencing (Project SM-Site-1). There is currently no security fencing around the north, south and east sides of the Seven Mile CSO Control/Headworks Building. Painted chain-link fencing exists on the west side of the CSO building along Shiawassee St. There are two alternatives to address this issue:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Extend Security Fencing Around Entire Building.** It is recommended that security fencing be installed along the remainder of the building site to secure building operations.

The alternative evaluation is presented in Table 13-14. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 0.9 higher than the Do Nothing Alternative (Alternative 1) based on the improved safety. Because of the importance of this issue related to safety, **Alternative 2 – Extend Security Fencing Around Entire Building is the recommended alternative.**

Table 13-14. Alternative Evaluation for Security Fencing (Project SM-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Security issue.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Extend Security Fencing Around Entire Building	Health and Safety	5	3.57	\$ 347,000	\$ -	\$ 347,000	\$ 97,290	Not Applicable
	<i>Definition:</i>	Security fencing to be installed along the remainder of the building site.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Secure building operations	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

Site Improvements (Project SM-SITE-2). Due to the relatively small nature of some of the site related projects identified as improvements, all of the identified site improvements are proposed to be in one project – Site Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Site Improvements** including,
 - Improve Drainage in the Courtyard
 - Replace Existing Effluent Gate and Shunt Channel Hatches

Each of the site related improvements listed above is described further below:

Improve Drainage in the Courtyard. The Courtyard at the Headworks of the Seven Mile CSO Basin has an open roof and is exposed to rain and snow falling on the floor surface. There are scuppers in the base of the east wall of the Courtyard to allow runoff to drain through the Courtyard wall onto the basin roof surface outside the wall. The Courtyard floor, however, does not provide adequate slope for the runoff to flow to the scuppers and consequently ponds on the floor surface. To alleviate the water ponding, it is recommended that holes be cored through the courtyard floor to the basin below. Recessed area drains can be installed in the cored holes to funnel floor drainage to the basin.

Replace Existing Effluent Gate and Shunt Channel Hatches. There are three hatch openings over the three existing effluent butterfly gates and their corresponding stop log guides. The hatch openings at the effluent gates have dimensions of 8 ft by 3 ft. The existing hatch cover plates are heavy and difficult to remove. GLWA would like to replace cover plates with an alternative plate design that improves accessibility to the gates and stop log guides below.

There are also two hatch openings over the two shunt channel butterfly gates and their corresponding stop log guides. These hatch openings also have dimensions of 8 ft by 3 ft. These hatch covers have been recently replaced and are not included in the cost estimate.

The improvements at these locations should be coordinated with the potential modification of this basin to a complete capture facility, described in Section 13.1.2.

The alternative evaluation is presented in Table 13-15. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M. The NPV/Benefit cost for Alternative 2 is \$35,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Site Improvements is the recommended alternative.**

Table 13-15. Alternative Evaluation for Site Improvement (Project SM-SITE-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Safety issues.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Site Improvements	Health and Safety	4	3.50	\$ 122,000	\$ -	\$ 122,000	\$ 34,857	Not Applicable
	<i>Definition:</i>	Improve drainage in the Courtyard and replace existing effluent gate and shunt channel hatches.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved drainage and ease of O&M.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

13.2.9 Architectural

13.2.9.1 Description of Existing Facilities

The Seven Mile Road CSO facility consists of chemical room, utility support (electrical), control room, work room, odor control room, screen room, miscellaneous other rooms and a courtyard.

13.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a roof replacement evaluation and a detailed assessment of architectural issues, as described in the following paragraphs.

Evaluation of Type of Future Roof Replacement. Jacobs reviewed the results of a roof assessment and prepared a 60-year life-cycle cost analysis between shingled roof and metal roof. Based on the results of this evaluation, which shows lower life cycle cost for shingled roof, Jacobs recommends replacement of the shingled roof with shingles when the roof is ready for replacement. The analysis is presented in Table 13-16. As such, the roof should be replaced in-kind and the costs and schedule for the roof replacement will come from the SRP.

Table 13-16. 60-Year Life-Cycle Cost Evaluation of Shingled vs. Metal Roof for Seven Mile Facility

	Shingle Roof	Metal Roof
Replacement Cost ^a	\$93,000	\$311,000
Replacement Interval	20 years	60 years
Number of Roof Replacements During 60 Years	3	1
Total Life-Cycle Cost (NPV) Discounted at 2.4%	\$252,000	\$311,000

^a Based on 6,225 ft² roof area; \$15 ft² for shingle roof and \$50/ ft² for metal roof.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering systems
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff indicated that that there is no access to the Headworks area and the Courtyard during a power outage.

13.2.9.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (SM-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address this issue:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Architectural Rehabilitation.** Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation includes the following:
 - Remove and replace sealant around doors, windows and other wall penetrations
 - Remove and replace sealant at all control/ expansion wall joints
 - Remove corrosion at bottom of man door and coat steel framing
 - Remove paint debonding from wall, clean and coat
 - Address door hardware issues
 - Remove painted debonding from roof framing, clean and coat

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure SM-ARCH-1-ALT-2). Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 13-17. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, Alternative 2 is the recommended alternative.

Table 13-17. Alternative Evaluation for Architectural Rehabilitation (Project SM-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 156,000	\$ -	\$ 156,000	\$ 50,323	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

Access to Courtyard and Headworks (Project SM-ARCH-2). If there is a power outage and the generator does not kick on, there would be no access to the Headworks area and the Courtyard. There are two alternatives to address this issue:

- 1) **Alternative 1: Do Nothing.**
- 2) **Alternative 2: Additional Access to Courtyard and Headworks.** GLWA requested access doors be provided from the Courtyard to the outside. Two 3-ft by 7-ft heavy-duty hollow metal double doors and frame with commercial grade stainless steel hardware is recommended to provide emergency access.

The alternative evaluation is presented in Table 13-18. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M. The NPV/Benefit cost for Alternative 2 is \$10,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved safety with this alternative, Alternative 2 – Additional Access to Courtyard and Headworks is the recommended alternative.**

Table 13-18. Alternative Evaluation for Access to Courtyard and Headworks (Project SM-ARCH-2)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None.	Capacity Enhancement	3						
	<i>Disadv.:</i>	No access to the Headworks and Courtyard, during a power outage.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Additional Access to Courtyard and Headworks	Health and Safety	4	3.50	\$ 34,000	\$ -	\$ 34,000	\$ 9,714	Not Applicable
	<i>Definition:</i>	Install door into Courtyard.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Provides emergency access to the Headworks and Courtyard during a power outage.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

13.2.10 Safety

13.2.10.1 Description of Existing System

Safety-related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

13.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 13-19. The capital improvement project to address these issues is included in the table.

Table 13-19. Identification of Capital Improvements for Safety Issues

Location	Description	Corrective Action from Safety Inspection Report	Capital Improvement Project
Chemical Room	Emergency eyewash/shower 0943390 outside containment	Add eyewash/shower inside tank containment	Safety Improvements (Project SM-SAFE-1)
Utility Tunnel	Ladder at end of tunnel has an exit sign but hatch is locked.	Add placard to fixed ladder "Not An Exit." Replace existing exit sign with directional exit sign away from ladder access.	Exit Sign Improvements ^a

^a This task is being addressed in a separate project under TOES. As such, capital costs are not included.

13.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project SM-SAFE-1). This project should address the safety issues identified above. These issues include:

- Add eyewash/shower outside containment in the Chemical Room
- Address fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency, the Table 13-20 showing the one alternative is presented below.

Table 13-20. Alternative Evaluation for Safety Improvements (Project SM-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	3	3.00	\$ 92,000	\$ -	\$ 92,000	\$ 30,667	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection, and eye wash.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						

13.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at Seven Mile CSO Facility.

13.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the Seven Mile CSO facility, Table 13-21 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 13-21, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 13-21. Listing of Asset Condition Assessments for Seven Mile Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	29	29	0	100%
AHU	4	0	4	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	3	3	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	0	0	0	N/A
BUILDING	2	1	0	50% ^a
CAMERA	0	0	0	N/A
COMPRESSOR	1	1	0	100%
COND-AIR	0	0	0	N/A
CONVEYOR	0	0	0	N/A
CRANE	1	1	0	100%
CTRLPANEL	0	0	0	N/A
DAM	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAMPER	6	6	0	100%
DISCONNECT	0	0	0	N/A
DOOR	3	3	0	100%
DRIVE-ELEC	4	4	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	3	3	0	100%
FAN	0	0	0	N/A
FANVENT	12	8	4	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	0	0	0	N/A
GASDETECTO	1	0	0	0% ^b
GASMONITOR	2	2	0	100%
GATE	6	6	0	100%
GEARBOX	2	0	2	100%
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUND	0	0	0	N/A
HYDRANT	0	0	0	N/A
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	0	0	0	N/A
MCC	5	0	5	100%
METER	6	6	0	100%
MIXER	5	5	0	100%
MOTOR	5	0	5	100%
PANEL	7	7	0	100%
PIPING	4	4	0	100%
PUMP	16	9	4	81% ^c
ROOF	2	2	0	100%
SAMPLER	1	1	0	100%
SCADA	2	2	0	100%
SCREEN	2	0	2	100%
SCRUBBER	1	0	1	100%
SENSOR	10	10	0	100%
SMOKE	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	0	0	0	N/A
SWITCHGR	1	0	1	100%
SYSTEM	0	0	0	N/A
TANK-PROC	1	1	0	100%
TANK-STOR	2	2	0	100%
TIPBUCKET	1	1	0	100%
TRANSFRMR	3	0	3	100%
UNITHEATER	0	0	0	N/A
UPS	2	2	0	100%
VALVE	27	27	0	100%
WATERHTR	0	0	0	N/A

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The one gas detector is a portable unit and was not assessed.

^c Three inactive pumps are listed in WAM - Basin 1 Sample Pump, Basin 2 Sample Pump, and Shunt Channel Sample Pump. These pumps are being considered for removal from WAM.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the Seven Mile Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

13.3 Capital Planning for Seven Mile CSO Facility

13.3.1 Summary of Capital Improvement Plan Projects

Table 13-22 provides a summary of the recommended CIP projects and associated capital costs for the Seven Mile CSO facility based on the alternative evaluations conducted for this facility.

Table 13-22. Summary of Recommended Projects at Seven Mile CSO Facility

Project No.	Alternative	Description	Total Project Cost
SM-WWMP-1	2	Convert to Complete Capture Basin	\$ 2,500,000
SM-FD-1	2	Provide Access to Tipping Buckets for Maintenance	\$ 125,000
SM-FD-2	2	Access to Dewatering Force Main for Inspection and Cleaning	\$ 90,000
SM-HVAC-1	1	HVAC Improvements	\$ 858,000
SM-ELEC-1	2	Electrical Improvements	\$ 136,000
SM-I&C-1	1	Control System Upgrade	Ongoing Project
SM-SITE-1	2	Extend Security Fencing Around Entire Building	\$ 347,000
SM-SITE-2	2	Site Improvements	\$ 122,000
SM-ARCH-1	2	Architectural Rehabilitation	\$ 156,000
SM-ARCH-2	2	Additional Access to Courtyard and Headworks	\$ 34,000
SM-SAFE-1	1	Safety Improvements	\$ 92,000

13.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 13-23. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 13-23. Capital Improvement Plan Projects for Seven Mile CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
SM-1 Flushing Improvements	\$ 337,000	2032 <i>Timing based on Best judgement</i>	SM-FD-1	Provide Access to Tipping Buckets for Maintenance	\$ 125,000
			SM-FD-2	Access to Dewatering Force Main for Inspection and Cleaning	\$ 90,000
			SM-SITE-2	Site Improvements	\$ 122,000
SM-2 HVAC Improvements	\$ 858,000	2027 <i>Timing based on asset condition</i>	SM-HVAC-1	HVAC Improvements	\$ 858,000
SM-3 Electrical Improvements	\$ 136,000	2032 <i>Timing based on best judgement</i>	SM-ELEC-1	Electrical Improvements	\$ 136,000
SM-4 Facility-Wide Safety and Architectural Improvements	\$ 629,000	2023 <i>Project should be initiated as soon as possible</i>	SM-SITE-1	Extend Security Fencing Around Entire Building	\$ 347,000
			SM-ARCH-1	Architectural Rehabilitation	\$ 156,000
			SM-ARCH-2	Additional Access to Courtyard and Headworks	\$ 34,000
			SM-SAFE-1	Safety Improvements	\$ 92,000
SM-5 Convert to Complete Capture Basin	\$ 2,500,000	2030 <i>Timing based on general CSO project priorities</i>	SM-WWMP-1	Convert to Complete Capture Basin	\$ 2,500,000

The scheduling of projects that are replacing existing assets is influenced by the condition and remaining life of the existing assets. Table 13-24 and Table 13-25 provide information related to the assets in these projects to aid in the scheduling of these projects. For example, Table 13-24 indicates that SM-HVAC-1 project has 12 assets that has an average condition score of 1.61 and an average replacement date of 2034. Although the average replacement date suggests 2034, the SM-HVAC-1 project was moved up to 2027 due to equipment age and performance.

Table 13-24. Information for Assets with Condition 1-4 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 1-4)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
SM-HVAC-1	12	1.19	1.61	2.15	20	2034	\$ 224,880

Table 13-25. Information for Assets with Condition 5 in Capital Improvement Projects

NA PROJECT NUMBER	TOTAL NO. OF ASSETS (Condition 5)	AVG CoF SCORE	AVG CONDITION SCORE	AVG RISK SCORE	AVG LIFE EXPECTANCY	AVG REPLACEMENT DATE	TOTAL REPLACEMENT COST
SM-HVAC-1	0	0.00	0.00	0.00	N/A	N/A	\$ -

13.3.3 20-Year Capital Outlay Plan

Table 13-26 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 13-26. 20-Year Capital Outlay Plan for Seven Mile CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2022	\$ 335,368	\$ -	\$ -	\$ 322,802	\$ -	\$ -	\$ -	\$ -	\$ 12,566	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ 19,806	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 19,806	\$ -	\$ -	\$ -	\$ -
2025	\$ 112,551	\$ -	\$ -	\$ 112,551	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 18,911	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2,101	\$ -	\$ 16,809	\$ -	\$ -
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 228,757	\$ 6,149	\$ -	\$ 61,494	\$ 161,113	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,831,486	\$ 7,714	\$ 15,428	\$ 23,142	\$ 15,428	\$ -	\$ -	\$ -	\$ -	\$ 1,769,773	\$ -	\$ -	\$ -
2030	\$ 200,940	\$ 37,838	\$ -	\$ -	\$ 103,077	\$ -	\$ 10,438	\$ -	\$ -	\$ -	\$ 49,586	\$ -	\$ -
2031	\$ 584,604	\$ -	\$ -	\$ 292,302	\$ -	\$ 292,302	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 853,103	\$ -	\$ 278,369	\$ 574,734	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 471,031	\$ 14,054	\$ -	\$ -	\$ -	\$ 161,098	\$ 55,809	\$ 240,070	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 954,856	\$ 21,630	\$ -	\$ 657,977	\$ 90,453	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 157,381	\$ -	\$ 27,416
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 813,118	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 813,118	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 521,153	\$ 18,877	\$ -	\$ -	\$ 68,097	\$ 356,888	\$ 22,302	\$ 54,989	\$ -	\$ -	\$ -	\$ -	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 6,945,682	\$ 106,262	\$ 293,797	\$ 2,045,001	\$ 438,169	\$ 810,288	\$ 88,549	\$ 295,060	\$ 847,591	\$ 1,769,773	\$ 223,776	\$ -	\$ 27,416

Notes:

Explanation of large capital outlays in first two years:

- Retention System: Two influent slide gate (SG-1 and SG-5; \$157,000 each) received a score of 5 because the gates were locked out at the time of the Condition Assessment. Two flushing water ball valve (FW-1 and FW-8; \$4,000 each) received a score of 5 because the actuator for the valve was not functional or had been removed.

14. St. Aubin CSO Control Facility

14.1 General Facility Description and Future Capacity Considerations

14.1.1 General Facility Description

The St. Aubin CSO Facility is an SDF with 2.4 MG of storage, and a treatment capacity of 250 cfs. It was constructed in 2002. The facility has a nearly 1/3-mile long effluent conduit used for disinfection contact time before discharge into the Detroit River. The facility consists of an underground headworks, chemical room, odor control area, supply fan room, control room, and utility support (electrical, emergency generator, and mechanical rooms) and a restroom. The facility has an offsite sample building at the end of the outfall.

Schematics of the facility, including a process flow diagram, are included in Volume 6 – Appendices, Appendix G.

14.1.2 Future Capacity Considerations

Based on a review of the WWMP, there were no future increased capacity considerations identified at this facility.

14.2 Facility Assessment

14.2.1 Screening

14.2.1.1 Description of Existing System

The St. Aubin CSO Facility has two vertical ROMAG screens that were installed in 2002. Screenings are retained in the influent chamber during the storm. After the storm event, the screenings are pumped to the Detroit River Interceptor for eventual removal at the WRRF.

Table 14-1 provides an overview of the existing screening system at St. Aubin CSO facility.

Table 14-1. Overview of Existing Screening System at St. Aubin CSO Facility

Parameter	Value
Treatment Capacity (cfs)	250
No. of Screens	2
Manufacturer	Westech ROMAG
Screen Type	Raked Vertical Bar Screens
Opening Size	4-mm spacing
Depth or Length / Width	3 ft 7 in. /22 ft 0 in.
Screen Cleaning	Mechanical Comb
Screening Removal	Pumped to Toward Treatment Sewer and to WRRF

14.2.1.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issue was identified related to the screens:

- Evaluate potential improvements to existing screening system to remove screenings during wet weather.

14.2.1.3 Description and Evaluation of Alternatives

The evaluation of the need identified above is presented in this section.

Replace Screens with Improved Screens. Due to the configuration of the St. Aubin CSO Facility, the screenings accumulate during a wet weather event in the influent chamber in front of the screens. Although each screen has a mechanically operated comb that cleans the screens during a wet weather event, the screenings continue to accumulate in front of the screens. Some provisions were made in the original system to direct the screens to the dewatering well; however, these were found to be ineffective.

Jacobs investigated a new type of screen by Enviro-Care (SAVI Overflow Spillway – Model VSE-700/6) that could transport the screenings away from the influent chamber and convey them using an integral screw conveyor to the dewatering chamber (see Figure 14-1). The manufacturer developed a layout within the existing facility that would allow the screenings to discharge near the dewatering chamber. A short connection would be required to connect the discharge end to the facility's Dewatering Chamber.



Figure 14-1. Enviro-Care SAVI Overflow Spillway Screen

There are a number of concerns with the Enviro-Care screen and the retrofit of this screen into the St. Aubin facility:

- The proposed screen, within the given facility layout, only has a capacity of 217 cfs, which is less than the facility capacity of 250 cfs.
- The proposed screen has 8-mm openings. The other GLWA SDF with perforated openings (Baby Creek) has perforations of 6-mm. The Enviro-Care screen is available in 6-mm; however, the capacity of a screen with 6-mm perforations would be further reduced. Although the perforation size could potentially be negotiated with Michigan EGLE, there is a risk that EGLE would require 6-mm perforations.

Given the fact that the screen does not meet facility's design capacity of 250 cfs, it is not recommended for further consideration.

14.2.2 Disinfection

14.2.2.1 Description of Existing System

The sodium hypochlorite disinfection system consists of two FRP tanks, two low-rate diaphragm pumps, three high-rate diaphragm pumps, two rapid mix zones, and seven induction mixers. There are two ROMAG screens discharging into a screened effluent channel. From there screened effluent flows to two disinfectant rapid mix zones. There are three induction mixers per disinfectant rapid mix zone consisting of one pair of mixers upstream and one mixer downstream of a concrete baffle wall that directs all flow down and past the mixers. There is also one induction mixer in the influent channel upstream of screening referred to as prechlorination and the influent channel mixer. The discharges of Low-rate Pump 1 and High-rate Pump 2 combine and serve disinfectant rapid Mix Zone 1. The discharges of Low-rate Pump 3 and High-rate Pump 4 combine and serve disinfectant rapid Mix Zone 2. Sodium Hypochlorite Pump 5 serves the prechlorination mixer or as a backup to either rapid mix zone. Flow is metered from each pump and then flow is split in a manifold to the three induction mixers in each disinfectant rapid mix zone. The manifold includes a solenoid valve, manual valve, and a sight flow indicator to each induction mixer. Flow splitting between induction mixers is primarily dependent on equal back pressure valve settings to the induction mixers. Some valves are inaccessible due to their height on the wall.

Table 14-2 provides an overview of the existing disinfection system at St. Aubin CSO facility and the disinfection process flow diagrams are included in Volume 6 – Appendices, Appendix G.

Table 14-2. Overview of Existing Disinfection System at St. Aubin CSO Facility

Parameter	Value
Treatment Capacity (cfs)	250
Design Feed Strength (% hypochlorite)	10
Max. Dosage at Design Flow (mg/L Cl ₂)	38
Disinfection Contact Time (min)	10
Storage Tanks	
Number	2
Volume of Each Tank (gal)	5,200
Type	FRP
Pumps	
Number	5 Total; 2 low-rate, 5 high-rate
Capacity (gpm)	Low-rate: 7.6, High-rate: 22.8
Type	Hydraulic diaphragm
Mixers	
Number / Type	7 / Chemical induction mixers
Model Number/ hp / Manufacturer	SWC7.5FX / 7.5 hp / Water Champ

14.2.2.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations.

This facility, however, will be treated differently in this project because Hazen performed a Sodium Hypochlorite Storage and Feed System Assessment, dated October 15, 2019, for disinfection system improvements and AECOM is developing scope for an upcoming design project for facility improvements, including chemical feed pumps, relocation of pump control panels, mixer modifications, and building storage improvements.

Sodium Hypochlorite Feed and Storage System Improvements (Project STA-DIS-1). The recommendations from the Hazen report, although not identical, are similar to the chemical feed system improvements recommended in CS-299. Chemical feed pumps as peristaltic (hose) pumps or mag drive centrifugal pumps were recommended for further consideration during detailed design. It is recommended that the firm selected for detailed design consider the improvements from this CS-299 Facilities Assessment evaluation of the disinfection systems to best standardize this system with the other future systems. Other disinfection-related improvements were recommended as part of this project, including operation in automatic mode and provisions to flush the feed system piping.

14.2.2.3 Description and Evaluation of Alternatives

Because this is an upcoming project (CIP 260617), an alternative evaluation was not conducted, and capital costs are not included in this report.

14.2.3 Odor Control

14.2.3.1 Description of Existing System

The St. Aubin odor control system consists of a Calgon Carbon PHOENIX automatic regeneration system, which utilizes radial flow canisters filled with Centaur HP carbon. Several years ago, Calgon Carbon sold its odor control equipment division to Continental Carbon along with the Centaur HP carbon. The unit consists of 30 canisters and an odor control fan, which delivers air through the carbon filters or directly to the exhaust stack. Air is pulled from the screening and disinfection chambers by the odor control fan and is uniformly distributed through the carbon canisters, bringing the air in direct contact with the carbon. The regeneration process consists of programmed filling of a single compartment of canisters with water, letting the water sit for a period of time, and then draining and drying the carbon.

The system was installed in 2002. The carbon has not been replaced since installation. Overall, the system is in good condition. The odor control system does not have an air permit.

Per GLWA, no odor complaints have been received for at least the past three years.

14.2.3.2 Identified Needs and Issues

The identified needs for the St. Aubin CSO facility are included in the following sections. The following issue was identified:

- Evaluate improvements to enhance safety around odor control system inside building, if needed.

Improvements to Enhance Safety Around Odor Control System. Hazen prepared a preliminary design report for the St. Aubin CSO Facility entitled *Sodium Hypochlorite Storage and Feed System Assessment*, dated October 15, 2019. In this report, they investigated the facility's current compliance with NFPA 820. Based on this evaluation, the following deficiencies were noted:

- Air flow monitoring
- Horns and strobes
- Backup power supply for horns/strobes and flow monitoring.

The Hazen report recommends that these items be included in the upcoming facility improvement project. This issue is being addressed in an upcoming project (CIP 260617).

The recommendations related to the odor control system below are based on the Jacobs team evaluation of the existing system.

Future Carbon Replacement Considerations. Centaur HP carbon contains a catalyst that oxidizes H_2S and converts it to sulfuric acid. As a result, the carbon can be restored for H_2S uptake by water washing. As discussed for the Baby Creek CSO Facility in Section 6.2.3.2, the Centaur HP carbon loses capacity over time. One typically determines the need for carbon regeneration by measuring the H_2S concentration in the discharged air. When H_2S is still detected in the discharged air after a regeneration cycle, the carbon is spent and should be replaced. Centaur HP replacement is about every two years under typical municipal wastewater applications. GLWA CSO facilities are not typical applications as the odor control systems are operated infrequently and are likely under low loads from H_2S and odorous compounds meaning the carbon will last a lot longer. According to O&M staff, the St. Aubin system is regenerated every two months based on the recommended PM in the manufacturer's O&M manual. The system may not need to be regenerated that frequently given the light load. The existing practice of carbon regeneration every two months may continue, but carbon capacity may decrease with each washing due to compounds in the regeneration water that adsorb to the carbon and that less than 100 percent of the sulfuric acid generated during the adsorption process is removed. Laboratory analysis of the carbon for H_2S capacity is likely the best way to determine the remaining carbon life for the St. Aubin system. Sampling the discharged air for H_2S breakthrough likely will not be an effective indicator due to the likely low H_2S load.

Although the current carbon capacity may be significantly less than the original capacity, the lack of any odor complaints from the community suggests that any odors being discharged are either not noticeable, not objectionable or are masked by other odor sources in the area. It is recommended that GLWA sample the influent and discharge of the odor control system during at least two storm events in the summer months (i.e., the period with the highest odor potential) to better understand the magnitude of odors generated from the CSO facility.

If the influent H_2S levels are low, replacement of the carbon would not be needed. Further testing could then be performed to determine if the carbon could be removed and not replaced. A non-detectable concentration of H_2S in the influent air means the system can likely operate without carbon. The following bullets provides considerations for the carbon replacement.

- The existing Centaur HP carbon in the PHOENIX system has an H_2S capacity of 0.09 g H_2S /cubic centimeter of carbon (15 percent by weight). The cost for replacement of the carbon is about \$20,400 (30 canisters at \$680/canister). The cost includes a new canister, sealing and loading the canister with Centaur HP carbon, and delivery.
- ECS manufactures a direct equivalent to Centaur HP carbon at a lower cost. ECS reuses the existing canisters. The cost for ECS's water regenerable catalytic carbon is about \$12,750 (30 canisters at \$425/canister). The cost includes shipping the full canisters to ECS, disposal of the spent carbon, cleaning the canisters, charging the canisters with ECS water regenerable catalytic carbon, and delivery.

As noted above, an evaluation of influent and discharge H_2S concentrations is recommended prior to carbon replacement. When it is time to replace the Centaur HP carbon, GLWA should evaluate replacing it with either Centaur HP or ECS water regenerable catalytic carbon.

14.2.3.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no odor control-related issues that that would be classified as capital improvement "needs".

14.2.4 Flushing and Dewatering

14.2.4.1 Description of Existing System

Dewatering System: The Headworks (screening and disinfection) area and the effluent conduits are dewatered after a storm event using three dewatering pumps located in the Headworks Dewatering Well.

The dewatering of the effluent conduit also relies on two submersible dewatering pumps located at the end of the effluent conduit. These pumps convey any water remaining at the end of the effluent conduit (after the Headworks Dewatering Pumps have removed as much of the water as possible) back to the Headworks Dewatering Well.

Flushing System: The original facility did not include a flushing system for the effluent conduits. Around 2010, a flushing system for the final one-third of the effluent conduits was installed. This system consists of two 100 gpm flushing pumps located at the outfall, just downstream of the backwater gates. These pumps use Detroit River water to pump to two locations in the effluent conduit with spray nozzles.

A manually operated, gravity flushing system consisting of a pipe with nozzles is provided for the area upstream of screens. This system uses water captured in the disinfection chambers as flushing water. The area upstream of the screens is dewatered first, while water remains in the mixing chambers. The head pressure from the water in the mixing chambers provides the pressure in the flushing pipe to provide a sufficient flush of the floor area.

Table 14-3 provides an overview of the existing flushing and dewatering system at St. Aubin CSO facility.

Table 14-3. Overview of Existing Flushing and Dewatering System at St. Aubin CSO Facility

Parameter	Value
Headworks Dewatering and Flushing System	- Headworks (screening and disinfection) area is dewatered using three 1,100 gpm dewatering pumps located in the Headworks Dewatering Well. - Manually operated flushing system consisting of a pipe with nozzles for area upstream of screens.
Effluent Conduit Dimensions	10 ft. × 10 ft.
Effluent Conduit Dewatering and Flushing System	- Effluent conduit is dewatered using three 1,100 gpm dewatering pumps located Headworks Dewatering Well. - There are two 200 gpm submersible dewatering pumps located at the end of the effluent conduit, which pump back to the Headworks Dewatering Well. - There are two 100 gpm flushing pumps that provide water to a spray flushing system for the second half of the effluent conduit.

14.2.4.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The following issues were identified related to the flushing and dewatering system:

- Settled solids buildup in the 10-ft by 10-ft effluent conduit for this facility. A flushing system was installed since the facility was constructed; however, this system has not proved effective at removing the solids buildup.
- Provide flushing system in mixing chambers to flush accumulated solids from the floor.

14.2.4.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

New Effluent Conduit Flushing System (Project STA-FD-1). There are two alternatives for addressing the solids buildup in the effluent conduits and the chemical mixer chambers. These alternatives include:

- 1) **Alternative 1: Do Nothing/ Contractor Cleanout**
- 2) **Alternative 2: New Effluent Conduit Flushing System.** This alternative includes mounting a 6-in. HDPE flushing header along both sides of the effluent conduit approximately 2 ft above adjacent lower concrete surface. See Volume 6 – Appendices, Appendix B, for Figure STA-FD-1-ALT-2 showing conceptual layouts. HDPE pipe is recommended for this application due to its corrosion resistance and its flexibility that imparts resistance to damage from impacts by heavy debris suspended in wet weather flows. The flushing header should be specified with an adequate wall thickness to allow for directionally drilled holes (up to 0.75-in.-diameter) that create a water jet aimed in a specific direction. The proposed hole spacing along the header will be approximately 18 to 24 in. A cursory analysis based on channel dimensions, slopes and anticipated grit sizes indicates that a minimum total flow rate of 3,500 gpm is required to adequately resuspend sediment from the floor of the square conduit and maintain adequate volume and velocity to carry the sediment to the terminus ends.

A small valve is also recommended at the terminus end of each spray header with a rising stem and automated actuator mounted outside of the chamber. At the start of the cleaning cycle, these valves will automatically open for several minutes, allowing the potable water to flush any materials that have entered the header through openings out the open end. These terminus valves would close, and the header would pressurize and start spraying.

Two new flushing pumps (approx. 5,200 gpm, 100 ft total dynamic head) will be installed at the end of the conduit and the existing flushing pumps removed. The pump size has been selected to provide a 1.5 safety factor on flushing anticipated grit volumes and particle sizes. The existing flushing system will also be removed. The new flushing pumps will be manifolded with a control valve to allow flushing of one-half of the conduit at a time. The existing flushing pump electrical system is assumed to have adequate load capacity for the new pumps; however, an allowance is included for rewiring and new conduits in the cost estimate. An allowance is also included for SCADA and PLC/human-machine interface programming.

Existing dewatering pumps may be overwhelmed by the large flushing flows generated by continuous post-event cleaning. The costs for this improvement include replacing the existing 100 gpm and 200 gpm dewatering pumps with larger pumps (1,000 gpm) and allowances for replacing some of the exposed discharge piping and valves. To avoid replacing the dewatering pumps, the flushing system could be operated in 15-minute intervals with adequate time between to drain the flushing water and sediment. Preliminary analysis indicates a total of 2 hours of flushing per pump unit should be considered as a starting point for operations. GLWA staff may increase or decrease the number of intervals over time as the effectiveness of the cleaning system is observed. The final designer should evaluate and refine the flushing volumes and generated header nozzle velocities using a sediment fate/transport model, CFD or lab scale model. Grit characterization is strongly recommended for proper sizing.

The likely flow management scenario assumed for construction will be to isolate the facility structurally or using existing controls. Seasonal restrictions are also assumed such that much of the work will take place in the dry season to minimize inundation risk during construction.

GLWA O&M staff also requested that a dedicated flushing system be provided for the two chemical mixing channels to flush accumulated solids from the floor after a storm event. A new flushing system

pipled from the existing NPW line in the “basin” area, extending down to the mixing chamber floors and drilled holes through HDPE pipe is recommended to address this issue. Figures (Figure STA-FD-1-ALT-2) that show the conceptual layout of this improvement are included in Volume 6 – Appendices, Appendix B.

The alternative evaluation for these alternatives is presented in Table 14-4. The sources of costs used in this evaluation are listed below:

- Contractor cleanout of this area is estimated to be \$400,000 every 5 years, based on costs at other screening and disinfection facilities. This O&M cost is annualized to \$80,000.
- The capital cost for the flushing system (Alternative 2) is included in Volume 6 – Appendices, Appendix C under this project title. It should be noted that the capital cost includes an allowance of \$90,000 for cleaning the influent channel prior to installing the flushing system. The \$140,000 equates to about \$400,000 after contingencies, and standard markups for design, construction assistance and contractor overhead and profit have been applied.
- The O&M costs for the current and proposed flushing system (Alternatives 1 and 2) are based on using Detroit River water, so there is no cost for water usage.
- Alternative 2 will provide the benefit of improved effluent water quality and hydraulic capacity because the conduit will be cleaned after every event. This will prevent the scouring of built up solids accumulation and will maintain hydraulic capacity of the effluent conduits.

This evaluation shows that Alternative 2 has the lowest NPV/Benefit cost and is the Best Value Alternative. Because of the improved health and safety, effluent water quality and hydraulic capacity, **Alternative 2 – New Effluent Conduit Flushing System is the recommended alternative.**

Table 14-4. Alternative Evaluation for New Effluent Conduit Flushing System (STA-FD-1)

Alt.	Description			Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing/ Contractor Clean-out	Health and Safety		2	2.10	\$ -	\$ 80,000	\$1,687,171	\$ 803,415	
	<i>Definition:</i>	Allow solids to build up and have a Contractor clean out the conduit, as needed	Water Quality & Compliance		2						
	<i>Adv.:</i>	No system to maintain	Capacity Enhancement		2						
	<i>Disadv.:</i>	Significant build-ups can impact facility hydraulic capacity. Cleaning effluent area is a high-risk activity, which requires significant GLWA coordination. Solids build-up may scour out of basin and negatively affect effluent water quality.	Component Performance		3						
	<i>Comments:</i>	None	O&M Ease		2						
2	<i>Alt. Name:</i>	New Effluent Conduit Flushing System	Health and Safety		5	4.18	\$ 2,472,000	\$ -	\$2,472,000	\$ 590,916	Best Value Alternative
	<i>Definition:</i>	Provide flushing system in effluent conduit using river water and provide a flushing system in the chemical mixing area.	Water Quality & Compliance		4						
	<i>Adv.:</i>	Minimizes solids from being scoured from floor and affecting effluent water quality. No confined space entry to clean conduit.	Capacity Enhancement		4						
	<i>Disadv.:</i>	Increased maintenance of equipment.	Component Performance		3						
	<i>Comments:</i>	None	O&M Ease		4						

14.2.5 HVAC

14.2.5.1 Description of Existing System

The St. Aubin CSO facility consists of an underground headworks, chemical room, odor control area, supply fan room, control room, and utility support (electrical, emergency generator, and mechanical rooms) and a restroom. The facility has an offsite sample building. Table 14-5 provides a summary of the major equipment for the facility.

Plumbing services for the facility consist of city water service, natural gas service, sanitary system, electric water heater, and emergency shower/eye wash. Emergency shower/eye washes are addressed, if safety issues were discovered, in Section 14.2.10.

Table 14-5. Major HVAC Equipment at St. Aubin CSO Facility

Location	Unit No.	Description	Capacity (Per Unit)
Headworks	SF-1	Supply Fan (Basin)	9,555 CFM
Chemical Room	HV-1	Heating Ventilating Unit (Mech Rm)	2,710 CFM
	EF-2	Exhaust Fan	3,010 CFM
Electrical Room	HV-2	Heating Ventilating Unit (Mech Rm)	4,665 CFM
	EF-3	Exhaust Fan (Odor Control Rm)	3,720 CFM

Table 14-6 provides a summary of the basis of design performance criteria for HVAC systems at St. Aubin and Table 14-7 provides the outdoor Basis of Design conditions.

Table 14-6. St. Aubin Original Indoor Basis of Design Performance Criteria Summary

Location	Area Electrical Classification	Basis of Design		
		Indoor Design Temperature		Ventilation Design Criteria
		Winter (F)	Summer (F)	
Headworks	Class I, Div 1, Group D	N/A	N/A	12 ACH (Occupied)
Mechanical Spaces	Unclassified	60	96	Heat Relief
Office, Sampling Room, and Toilet Room	Unclassified	70	78 F Dry Bulb, 50% Relative Humidity	15 cfm per occupant
Odor Control Room	Unclassified for areas greater than 3 ft from odor control vessel. Class I, Div 2, Group D for areas closer than 3 ft.	60	96	6 ACH

Table 14-7. St. Aubin Original Outdoor Basis of Design Conditions

Outdoor Design Temperature		
Winter (Dry Bulb F)	Summer (Dry Bulb F)	Summer (Wet Bulb F)
3	91	73

report, they investigated the facility's current compliance with NFPA 820. Based on this evaluation, the following ventilation related deficiencies were noted:

- Air flow monitoring
- Horns and strobes
- Backup power supply for horns/strobes and flow monitoring

The Hazen report recommended these items should be included in the upcoming facility improvement project. Jacobs agrees with the proposed recommendations and would add that in addition to the Hazen recommendations, combustible gas detection and alarm of gas in excess of 10 percent of the lower explosion limit is also required by NFPA 820 in the Odor Control Area. These recommendation are being addressed in an upcoming project (CIP 260617).

14.2.5.3 Description and Evaluation of Alternatives

Based on discussion in the previous section, there were no HVAC-related issues that that would be classified as capital improvement “needs”.

14.2.6 Electrical

14.2.6.1 Description of Existing System

The St. Aubin electrical system consists of one DTE utility feed from a 480 V, 3-Phase outdoor transformer (secondary metering) and one generator feed from a 175 kW, 480 V, 3-Phase stationary diesel generator. The utility feed is connected to a 600 A motor control center (MCC-B) with a 200 A sub-feed connection to a 225A ATS. The ATS then feeds a distribution panel with one 200 A breaker and one 150 A breaker, which feeds two MCCs (MCC-A and MCC-C, respectively). The MCCs feed the various pumps, valves, motors, transformers, panels, etc. at the facility. Table 14-8 provides a summary of the major electrical equipment for this facility.

Table 14-8. Major Electrical Equipment at St. Aubin

Location	Major Electrical Equipment	Description
Generator Room	Generator (Diesel)	175 kW, 480/277 V, 3-Phase
Electrical Room	MCC-A	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-B	600 A, 480/277 V, 3-Phase
Electrical Room	MCC-C	600 A, 480/277 V, 3-Phase

14.2.6.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. The lighting is poor or non-existent in some locations, making for less safe working conditions. These lighting needs are in addition to the recent LED lighting project. This issue is further described in the next section.

14.2.6.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Electrical Improvements (Project STA-ELEC-1). The lighting is poor or non-existent in some locations, making for less safe conditions. There are two alternatives to address the issue:

- 1) **Alternative 1: Do Nothing.** Do not add the lighting or receptacles.
- 2) **Alternative 2: Electrical Improvements.** Add lighting and exterior power receptacles at the following locations (and shown on the electrical drawings - Figure STA-ELEC-1-ALT-2 - included in Volume 6 – Appendices, Appendix B):
 - Basin Interior – Add additional basin interior explosion-proof LED lighting fixtures to provide lighting within the basin area to meet operational needs.
 - Outfall area – Add additional lighting at the facility's outfall.
 - Exterior power receptacles are needed on the wall of the facility near the basin to assist in the maintenance and operations of the facility.

The alternative evaluation is presented in Table 14-9. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the lighting is assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.8 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M provided by the added lighting and receptacles. The NPV/Benefit cost for Alternative 2 is \$41,000, which is a relatively low cost compared to other projects recommended in this assessment.

Because of the improved safety with this alternative, Alternative 2 – Electrical Improvements is the recommended alternative.

Table 14-9. Alternative Evaluation for Electrical Improvements (Project STA-ELEC-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	2	2.72	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Less maintenance and energy usage	Capacity Enhancement	3						
	<i>Disadv.:</i>	Less safe	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Electrical Improvements	Health and Safety	4	3.50	\$ 144,000	\$ -	\$ 144,000	\$ 41,143	Not Applicable
	<i>Definition:</i>	Add additional lighting in basin interior and outfall area.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased maintenance and energy usage	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

14.2.7 I&C

14.2.7.1 Description of Existing System

Control System: The original control system was installed in 1999 under PC-731. In 2002 the system was upgraded and interfaced into GLWA's overall SCADA Ovation control system. This upgrade provided the ability to remotely monitor the operations of the facility and the local collection system at SCC.

The existing control system contains an Allen Bradley-based PLC system consisting of an Allen Bradley redundant PLC-5 with local I/O controls that are installed in the facility's local control system panel. The operator workstation has a Rockwell RSVIEW operating software platform and is located in the Control Room. The existing hardwired local backup control panel and other miscellaneous subsystems that are incorporated into the overall control system are outdated and need replacement. The control system network and switches are obsolete and do not meet GLWA SCADA Governance standards on redundant networks and switches stipulates and that all CSO facilities use Ovation workstations with new high-performance graphics. The current system is equipped with a backup radio system to communicate critical monitoring points back to the SCC on wide area network failure.

Flow and Level Sensors: Table 14-10 summarizes the level sensors and flow meters at the St. Aubin CSO Facility for monitoring flows through the treatment system, chemical dosing, and chemical storage tanks levels.

Table 14-10. Summary of Flow Meters and Level Sensors at St. Aubin CSO Facility

Area	Quantity	Instrument Type
CSO Flow Meters		
Influent	1	Transit-Time (AccuSonic)
Effluent	1	Transit-Time (AccuSonic)
Toward Treatment Dewatering	1	Magnetic
CSO Level Sensors		
Dubois Diversion Chamber	1	Ultrasonic
Influent Channel	1	Ultrasonic
Mixing Chamber	1	Ultrasonic
Dewatering Chamber	1	Ultrasonic
Effluent Channel	1	Ultrasonic
Chemical System Flow Meters		
Chemical Feed	5	Magnetic
Chemical Storage Level Sensors		
Chemical Storage Tanks	2	Ultrasonic

14.2.7.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- The outfall level sensor level fluctuates significantly when the levels are high during discharge.

- GLWA staff note that local control of the equipment is needed, including dewatering pumps, flushing valve, and regulator gates) to improve maintenance. (It is noted that remote control of the regulator gates is included under the “Control System Upgrade – St. Aubin, Leib and Seven Mile CSO Facilities” project, so they are not further addressed in this report.)
- Process cameras are needed to observe process performance from the Control Room during a wet weather event
- The control system should be upgraded. GLWA is currently developing an RFP for qualified design-build contractors to provide professional engineering and construction services for control system improvements at the Seven Mile CSO Facility under “Control System Improvements – St. Aubin, Leib and Seven Mile CSO Facilities.” The project will replace the existing PLC-5 control system and backup local control panels with a new control system, provide new Ovation workstations with high-performance graphics, and replace some of the field instruments. This is an ongoing project that has already been included in the CIP.
- The screen graphics are very difficult to understand and should be updated to match other facilities. This improvement is included in the Control System Improvements project described in the previous bullet.

14.2.7.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

I&C Improvements (Project STA-I&C-1). Due to the relatively small nature of some of the I&C related projects identified as improvements, the identified I&C improvements, with the exception of the control system upgrade and simplifying the screen graphics, are proposed to be in one project – I&C Improvements. This project could be split into separate multiple delivery projects, if needed. As such, there are two alternatives for this project:

1) **Alternative 1: Do Nothing**

2) **Alternative 2: I&C Improvements** including,

- Address outfall level sensor fluctuations
- Provide remote control of:
 - Flushing and dewatering pumps at outfall
 - Flushing valve for influent channel
- Provide process cameras at select locations

Each of the I&C related improvements listed above is described further below:

Address outfall level sensor fluctuations. During wet weather, the level sensor signal fluctuates. To remedy, it is recommended to ensure at least 18-in. are clear between the water surface and the level sensor element. Modify the installation, as necessary, to raise the level sensor element to be a minimum of 18 in. above the surface of the highest expected water level. This should be a maintenance issue that gets addressed before this I&C project; however, it is included as a capital improvement in case it is not completed before this project.

Provide remote control of flushing and dewatering pumps at outfall and flushing valve for influent channel. Outfall Flushing and Dewatering Pumps: Provide remote control of the Flushing and Dewatering Pumps at the outfall from the CSO facility. The recommendation is to install a dedicated fiber optic cable from the CSO facility to a control panel located at the outfall.

Influent Channel Flushing Valve: It is recommended to provide remote control of the influent channel flushing valve to allow operations more flexibility when operating the facility during CSO events.

Provide process cameras at select locations. A list of the desired locations for process cameras is included in Section 5.4.8.

The alternative evaluation is presented in Table 14-11. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the remaining improvements in Alternative 2 are difficult to quantify and would not affect the alternative evaluation. Similarly, it is difficult to quantify the monetary benefits of the improved operations through the improved monitoring and control.

This evaluation shows that Alternative 2 – Electrical Improvements has a total benefit score about 0.5 higher than the Do Nothing Alternative (Alternative 1) based on the improved component performance and improved O&M. The NPV/Benefit cost for Alternative 2 is \$67,000, which is a relatively low cost compared to other projects recommended in this assessment. **Because of the improved control and maintainability associated with the I&C improvements, Alternative 2 is the recommended alternative.**

Table 14-11. Alternative Evaluation for I&C Improvements (Project STA-I&C-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.78	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	None	Capacity Enhancement	3						
	<i>Disadv.:</i>	Someone needs to be in Control Room to operate pump remotely during maintenance.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	I&C Improvements	Health and Safety	3	3.32	\$ 170,000	\$ 2,500	\$ 222,724	\$ 67,153	Not Applicable
	<i>Definition:</i>	Add local control to pumps and valves; add process cameras.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved ease of maintenance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Increased instrumentation to maintain.	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	4						

14.2.8 Site

14.2.8.1 Description of Existing Site

The St. Aubin facility was constructed in 1999. Access to the site is off of Atwater Street. The access entrance gate is a 25-ft wide sliding vehicular gate. Site security is provided by a 6-ft high security fence around the perimeter of the site. The parking lot consists of 8-in. reinforced concrete pavement with 8-in. crushed limestone base. Concrete sidewalk widths vary from 5 to 14 ft and are approximately 4 in. thick.

The St. Aubin outfall site includes the Sampling Building and access hatch opening to the outfall conduit. The Sampling Building and outfall discharge site are secured by cyclone fencing on all four sides of the site. A 12-ft cantilever sliding gate is located on the west fence line to provide access to the secured area. The secured outfall site is located approximately 340 ft off Atwater Street. A gravel drive extends from Atwater Street to the entrance gate.

Under a separate task of CS-299, all site utilities have been located and included in GLWA's GIS. Site utilities include water, sewer (sanitary, storm and combined sewer), process, natural gas, electric, and communications. The information provided in the GIS includes attributes for each asset type within each utility such as unique identification (ID), name, ownership, horizontal location (coordinates), vertical elevation and depth, utility type, size (diameter, length, dimensions, etc.), material type, the type of surface at the utility (i.e., asphalt, concrete, grass, etc.), installation year, as-built reference drawing number, contract number, section map number, GPS date, and location accuracy.

The information from the GIS is being used to develop the SRP under CS-299 for horizontal assets at all nine CSO facilities. As such, renewal needs related to underground site utilities are not included in this report.

14.2.8.2 Identified Needs and Issues

The needs and issues were identified from meetings with O&M staff and Jacobs team site visit and investigations. These issues are listed below and further described in the next section.

- There are several site issues at the St. Aubin outfall site including: 1) poor drainage in the access drive area between Atwater St. and the fenced area; 2) fencing in disrepair; 3) difficulty in removing hatch plates; and 4) access to the backwater gates. The poor drainage of the access drive has damaged the road surface and has created issues with accessibility to the secured area.
- The concrete surface at the northwest corner of the St. Aubin CSO facility has cracked due to settlement, causing runoff to flow back toward the building.
- At the St. Aubin CSO Control and Headworks Building, are stored in the Odor Control Room or outdoors. There is insufficient space inside the existing building to efficiently store all of the O&M equipment, as well as the equipment to maintain the site, in the main building. A storage building is needed to protect this equipment from ultraviolet light degradation and the elements. This building is currently planned to be installed under a separate project (CIP 260617).
- There are cracks in the sidewalks on the south and east sides of the Control Building.

14.2.8.3 Description and Evaluation of Alternatives

Projects to address the needs and issues identified above are presented in this section. The evaluation of project alternatives is also included in this section along with the recommended alternative.

Outfall Site Improvements (Project STA-Site-1). There are two alternatives to address the issues identified at the St. Aubin outfall:

- 1) **Alternative 1: Do Nothing**
- 2) **Alternative 2: Outfall Site Improvements**

At the outfall site area, which is approximately 340 ft by 75 ft, regrading of the site is included in this alternative to direct the drainage north to the exiting channel to help alleviate poor drainage in this area. Additionally, the gravel drive in this area could be replaced with an alternative design featuring a grass paver surface supported on a new engineered support base. The grass pavers could be for the full width of the access drive, replacing the existing gravel drive. This will also complement the Detroit Riverwalk area in the vicinity. Figure STA-SITE-1-ALT-2 in Volume 6 – Appendices, Appendix B, shows the location of these issues and suggested improvements.

The cyclone fencing around the site is in disrepair. The fencing includes approximately 400 ft of 8-ft-tall cyclone fencing. The fencing should be replaced to maintain security. Since the facility is located in a city park in a high visibility location, it is suggested that the cyclone fencing on the west, east and south sides of the site be replaced with ornamental fencing. The existing 12-ft wide automatic cantilever sliding gate has experienced numerous recent breakdowns. This equipment has likely reached the end of its useful service life and should be replaced.

The hatch openings over the two outfall backwater gates have dimensions of 8 ft by 10.5 ft. The openings over the two stop log guides are 10.25 ft by 3 ft. The hatch plates over the outfall gate openings are 0.5-in. thick stainless steel plates. These cover plates are very cumbersome to remove due to their weight. It is suggested that the outfall cover plate design be changed to a lighter weight cover plate. The cover plates over the stop log gates are Bilco style hatch covers – these gates should be considered for replacement due to their age.

Accessing the outfall backwater gates and stop logs within the secured fence line can be difficult as the area is all grass surface. It is suggested that the grass paver system identified for the entrance access road to the site be extended within the site so that trucks and equipment can access the outfall structure and gate and stop log hatch openings.

The minor repair to the concrete surface at the facility is included in this project. It is suggested that that this portion of the slab be removed, the subsurface regraded, and the concrete slab replaced to provide proper drainage away from the building.

The alternative evaluation is presented in Table 14-12. The sources of costs used in this evaluation are listed below:

- The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.
- The increased O&M costs for the added features are assumed to be negligible and would not affect the alternative evaluation.

This evaluation shows that Alternative 2 has a total benefit score about 1.0 higher than the Do Nothing Alternative (Alternative 1) based on the improved health and safety and improved O&M. **However, because of the improved accessibility, security and maintenance with the Outfall Site Improvements, Alternative 2 is the recommended alternative.**

Table 14-12. Alternative Evaluation for Outfall Site Improvements (Project STA-SITE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing.	Health and Safety	2	2.50	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do nothing.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lowest cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Site issues remain a concern.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	2						
2	<i>Alt. Name:</i>	Outfall Site Improvements	Health and Safety	4	3.50	\$ 806,000	\$ -	\$ 806,000	\$ 230,286	Not Applicable
	<i>Definition:</i>	Site improvements at the outfall area to address accessibility, security, and ease of maintenance.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved accessibility, security and maintenance.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

14.2.9 Architectural

14.2.9.1 Description of Existing Facilities

The St. Aubin CSO facility consists of chemical room, utility support (electrical, emergency generator and mechanical), control room, odor control room and miscellaneous other rooms. The facility has an separate sample building at the end of the outfall.

14.2.9.2 Identified Needs and Issues

The needs and issues for architectural issues were identified by a detailed assessment as described in the following paragraphs.

CS-299 Architectural Assessment. Jacobs conducted an assessment of the architectural-related defects at the CSO facilities. Jacobs used the architectural-related information in NTH's Structural Rehabilitation Needs Assessment (referenced in Section 5.5) for the above-ground buildings as a starting point and included additional items, as observed during the assessments conducted in January 2021 under CS-299. The architectural assessments included:

- Doors
- Windows, including sealant
- Room finishes
- Floors and ceiling coating/covering system
- Stairways
- Corrosion of visible steel members

The architectural assessment did not include structural related defects, such as cracks in walls, spalling concrete, roofs and roofing system, because these items will be accounted for in the on-going Structural Rehabilitation project and the condition of the roofs was assessed recently by NTH. It also does not include assessment of furnishings, such as office furniture, desks, built-in cabinets, audio/video equipment, etc.

Specific O&M Staff Concerns during Facility Assessment Meetings. O&M staff indicated that that additional storage is desired at the St. Aubin facility. Since the meeting, the GLWA Program Management team generated a proposal for a new storage building to be located along the west side of the building, near the existing electrical room. This building is intended to be added during the upcoming capital improvement project (CIP 260617).

14.2.9.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above are presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Architectural Rehabilitation (STA-ARCH-1). Jacobs identified numerous architectural-related defects that should be addressed within the next five years. There are two alternatives to address these issues:

1) Alternative 1: Do Nothing.

2) Alternative 2: Architectural Rehabilitation. Perform the architectural repairs identified under the NTH and CS-299 assessments. The major rehabilitation include the following:

- Remove and replace sealant around doors, windows and other wall penetrations
- Remove and replace sealant at all control/ expansion wall joints
- Remove and replace isolation/ cove joint sealant and around building perimeter

- Remove failed concrete floor coating, clean floor, and reseal floor with chemical resistant coating
- Remove corrosion at bottom of man door and coat steel framing

The detailed list of rehabilitation items are included in the capital cost estimate for this project and are shown in drawings in Volume 6 – Appendices, Appendix B (Figure STA-ARCH-1-ALT-2). Consideration should be given to making some or all of these repairs under the Structural Rehabilitation project.

The alternative evaluation is presented in Table 14-13. The capital costs for Alternative 2 are included in Volume 6 – Appendices, Appendix C under this project title.

Because of the benefit of preventing more costly damage in the future from not addressing these issues, **Alternative 2 is the recommended alternative.**

Table 14-13. Alternative Evaluation for Architectural Rehabilitation (Project STA-ARCH-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Do Nothing	Health and Safety	3	2.90	\$ -	\$ -	\$ -	\$ -	Not Applicable
	<i>Definition:</i>	Do Nothing	Water Quality & Compliance	3						
	<i>Adv.:</i>	Lower cost	Capacity Enhancement	3						
	<i>Disadv.:</i>	Repairs may become more costly in the future.	Component Performance	2						
	<i>Comments:</i>	None	O&M Ease	3						
2	<i>Alt. Name:</i>	Architectural Rehabilitation	Health and Safety	3	3.10	\$ 136,000	\$ -	\$ 136,000	\$ 43,871	Not Applicable
	<i>Definition:</i>	Architectural Rehabilitation	Water Quality & Compliance	3						
	<i>Adv.:</i>	Repairs building defects before they become more severe and costly issues.	Capacity Enhancement	3						
	<i>Disadv.:</i>	Higher cost	Component Performance	4						
	<i>Comments:</i>	None	O&M Ease	3						

14.2.10 Safety

14.2.10.1 Description of Existing System

Safety-related items include fall protection, exit signage, hatch access, and other miscellaneous safety-related issues.

14.2.10.2 Identified Needs and Issues

The safety issues identified during Jacobs Safety Inspection, described in Section 5.7, are listed in Table 14-14. The capital improvement project to address these issues is included in the table.

Table 14-14. Identification of Capital Improvements for Safety Issues

Location	Description	Proposed Corrective Action	Capital Improvement Project
Basin	Seal-off fittings for mixer electrical feed is bypassed (typical of some other mixers also) and open junction box	Incorporate seal-off fitting into electrical wiring.	I&C Improvements
Dewatering Chamber	Exposed power wires in junction box and bypass of explosion-proof seal-off fitting in dewatering pump chamber	Enclose junction box and incorporate seal-off fitting into electrical wiring.	I&C Improvements
Fall Protection	Fall Protection	See Section 5.7.3 and Volume 6 – Appendices, Appendix E	Safety Improvements (Project STA-SAFE-1)

14.2.10.3 Description and Evaluation of Alternatives

A project to address the needs and issues identified above is presented in this section. The evaluation of alternatives is also included in this section, along with the recommended alternative.

Safety Improvements (Project STA-SAFE-1). This project should address the safety issues identified above. These issues include:

- Fall protection

Because the importance of these issues related to safety, it is the only alternative considered. As such, it is the recommended project. For consistency in this report, Table 14-15 shows the one alternative.

Table 14-15. Alternative Evaluation for Safety Improvements (Project STA-SAFE-1)

Alt.	Description		Benefit Category	Benefit Score	Total Benefit	Capital Costs	Annual O&M	NPV	NPV/Benefit (prefer low value)	Best Value Alternative
1	<i>Alt. Name:</i>	Safety Improvements	Health and Safety	5	3.78	\$ 79,000	\$ -	\$ 79,000	\$ 20,881	Best Value Alternative
	<i>Definition:</i>	Safety improvements to address fall protection.	Water Quality & Compliance	3						
	<i>Adv.:</i>	Improved safety for staff and workers.	Capacity Enhancement	3						
	<i>Disadv.:</i>	None.	Component Performance	3						
	<i>Comments:</i>	None	O&M Ease	4						

14.2.11 Supporting Infrastructure

Supporting infrastructure refers to equipment or needs that may not fit into one of the processes or discipline-specific sections above. There were no needs or issues identified related to supporting infrastructure at St. Aubin CSO Facility.

14.2.12 Confirmation of Asset Replacement in Capital Planning

This section includes a review of the CS-299 Asset Assessment to confirm that any assets that requires replacement or rehabilitation are addressed through a capital outlay or capital improvement project.

As described in Section 4, one of the goals of the CS-299 Facilities Assessment is to develop the capital replacement and rehabilitation needs for the assets at each facility. The sections above have evaluated performance enhancement improvement alternatives to address regulatory compliance, safety, or enhance the operability or maintainability of the assets. For recommended alternatives, any assets included in the alternative would be replaced in a CIP project at some time during the expected useful life of the assets.

To ensure that all the assets are being addressed in a capital outlay or improvement project at the St. Aubin CSO facility, Table 14-16 provides a listing of the asset types and the number of assets in each asset type. The table also provides the number of condition assessments (visual or detailed) performed under CS-299 for these assets and the overall percentage of assets that received condition assessments. (The reader is referred to the CS-299 Asset Assessment Report in Volume 3, Section 15 for the results of these assessments.) As shown in the Table 14-16, all of the assets in each asset type were assessed either visually or in detail, with explanation of minor exceptions included in the footnotes. The condition rating and the expected useful life of the assets are used to develop the schedule for replacement of these assets in the SRP.

Table 14-16. Listing of Asset Condition Assessments for St. Aubin Facility

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
ACTUATOR	5	5	0	100%
AHU	5	2	3	100%
AIRDRYER	0	0	0	N/A
BACKFLOW	1	1	0	100%
BASIN	1	1	0	100%
BATTERY	0	0	0	N/A
BREAKER	1	1	0	100%
BUILDING	4	3	0	75% ^a
CAMERA	1	1	0	100%
COMPRESSOR	0	0	0	N/A
COND-AIR	0	0	0	N/A
CONVEYOR	0	0	0	N/A
CRANE	0	0	0	N/A
CTRLPANEL	0	0	0	N/A

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
DAM	1	0	1	100%
DAMPER	11	10	1	100%
DISCONNECT	0	0	0	N/A
DOOR	1	1	0	100%
DRIVE-ELEC	5	5	0	100%
ELEVATOR	0	0	0	N/A
EMERGLIGHT	1	1	0	100%
EYEWASHSTA	6	6	0	100%
FAN	1	0	1	100%
FANVENT	5	4	1	100%
FENCE	1	1	0	100%
FIREALARM	1	1	0	100%
FIRESUPRES	1	0	0	0% ^b
GASDETECTO	1	0	0	0% ^c
GASMONITOR	1	1	0	100%
GATE	8	8	0	100%
GEARBOX	0	0	0	N/A
GENERATOR	1	0	1	100%
GRINDER	0	0	0	N/A
GROUNDS	0	0	0	N/A
HYDPACK	2	2	0	100%
HYDRANT	0	0	0	N/A
LIGHTING	1	1	0	100%
MANHOLE	0	0	0	N/A
MAU	0	0	0	N/A
MCC	3	0	3	100%
METER	8	8	0	100%
MIXER	8	8	0	100%
MOTOR	1	0	1	100%
PANEL	5	5	0	100%
PIPING	4	4	0	100%
PUMP	16	8	7	94% ^d
ROOF	2	2	0	100%
SAMPLER	1	1	0	100%
SCADA	2	2	0	100%
SCREEN	2	0	2	100%
SCRUBBER	1	1	0	100%
SENSOR	9	9	0	100%

Asset Type	Total No. of Assets in Asset Type	No. of Visual Condition Assessments	No. of Detailed Condition Assessments	% of Assets with Condition Assessment
SMOKE	0	0	0	N/A
SPRINKLER	0	0	0	N/A
STRAINER	0	0	0	N/A
SWITCH	1	0	1	100%
SWITCHGR	0	0	0	N/A
SYSTEM	0	0	0	N/A
TANK-PROC	0	0	0	N/A
TANK-STOR	2	2	0	100%
TIPBUCKET	0	0	0	N/A
TRANSFRMR	3	0	3	100%
UNITHEATER	2	2	0	100%
UPS	3	3	0	100%
VALVE	5	5	0	100%
WATERHTR	0	0	0	N/A

^a One of the building assets listed as "EQUIPMENT - TRAVEL/INSPECTION/TROUBLESHOOT (FOR ELECTRICIANS, MILLWRIGHTS & PLUMBERS ONLY)", which is not an asset.

^b The fire suppression system was assessed independently by Simplex Grinnell and not included in the ACES report.

^c The one gas detector is a portable unit and was not assessed.

^d The one pump not assessed was the Disinfection Sample Pump No. 2, which was inactive.

Jacobs also reviewed all the assets with a condition rating of 3, 4 or 5 for this facility based on the CS-299 Asset Assessment to determine if there were assets that required capital outlay or a capital improvement. Recall, that the intent of the SRP is to develop capital replacement schedules based on asset condition. Therefore, all the assets that were rated in poor condition will be scheduled to be replaced in the near future. Based on the review of the St. Aubin Asset Assessment results, there are no additional capital projects to address the assets in the WAM database.

14.3 Capital Planning for St. Aubin CSO Facility

14.3.1 Summary of Capital Improvement Plan Projects

Table 14-17 provides a summary of the recommended CIP projects and associated capital costs for the St. Aubin CSO facility based on the alternative evaluations conducted for this facility.

Table 14-17. Summary of Recommended Projects at St. Aubin CSO Facility

Project No.	Alternative	Description	Total Project Cost
STA-FD-1	2	New Effluent Conduit Flushing System	\$ 2,472,000
STA-ELEC-1	2	Electrical Improvements	\$ 144,000
STA-I&C-1	2	I&C Improvements	\$ 170,000
STA-I&C-2	1	Control System Upgrade	Ongoing Project
STA-SITE-1	2	Outfall Site Improvements	\$ 806,000
STA-ARCH-1	2	Architectural Rehabilitation	\$ 136,000
STA-SAFE-1	1	Safety Improvements	\$ 79,000

14.3.2 Capital Improvement Project Bundling and Scheduling

Initial bundling of the recommended capital improvement projects for this facility is presented in Table 14-18. The goal of the bundling is to optimize the efficiency of the project delivery by grouping similar discipline work or work in similar areas together, thus optimizing design and construction activities for GLWA operations and engineering staff. A new project title and Project ID are provided for each project. These projects will be rolled up into the overall CIP for the CSO facilities, and may be further bundled with similar projects from other CSO facilities. Some of the recommended capital projects for this facility are recommended to be capital outlay projects, and are presented later in this section.

Table 14-18. Capital Improvement Plan Projects for St. Aubin CSO Facility

Bundled Capital Improvement Project	Total Project Cost (Sum of Individual Projects)	Proposed Year of Construction Completion	Capital Improvement Project		
			Project ID	Project Total	Project Cost
STA-1 Flushing System Improvements	\$ 2,472,000	2028 <i>Timing based on need to clean effluent channel in 10 years from last cleaning in</i>	STA-FD-1	New Effluent Conduit Flushing System	\$2,472,000
STA-2 Facility-Wide Electrical and I&C Improvements	\$ 314,000	2035 <i>Timing based on best judgement</i>	STA-ELEC-1	Electrical Improvements	\$144,000
			STA-I&C-1	I&C Improvements	\$170,000
STA-3 Outfall Site Improvements	\$ 806,000	2028 <i>Timing based on best judgement</i>	STA-SITE-1	Outfall Site Improvements	\$806,000
STA-4 Facility-Wide Safety and Architectural Improvements	\$ 215,000	2023 <i>Project should be initiated as soon as possible</i>	STA-ARCH-1	Architectural Rehabilitation	\$136,000
			STA-SAFE-1	Safety Improvements	\$79,000

Unlike the other sections, there are no existing assets in the projects listed above. As such, the Asset Information tables shown for the other facilities are not included here.

14.3.3 20-Year Capital Outlay Plan

Table 14-19 provides a summary of the recommended 20-Year Capital Outlay Plan for this facility, based on SRP results from the CS-299 condition assessment ratings and existing life of the assets, and based on the recognition that the assets included in any CIP project would be replaced as part of that project. Note, the table below is representative of the results based on WAM data available at the time of this report. WAM data is constantly evolving and the SRP model should be used with the most current WAM data set to continuously update results.

Table 14-19. 20-Year Capital Outlay Plan for St. Aubin CSO Facility

CSO Facility and SRP Year	Annual Total	Common Support Systems	Screening Systems	Retention System	Disinfection System	Pumping System	Odor Control System	HVAC System	Electrical Distribution System	SCADA System	Safety and Security System	Road and Grounds System	Infrastructure System
2021	\$ 113,300	\$ 23,500	\$ -	\$ 48,800	\$ -	\$ 22,300	\$ -	\$ 4,200	\$ -	\$ -	\$ 14,500	\$ -	\$ -
2022	\$ 176,144	\$ -	\$ -	\$ 176,144	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2023	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2024	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2025	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2026	\$ 27,315	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 6,304	\$ -	\$ -	\$ -	\$ 21,012
2027	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2028	\$ 202,929	\$ 30,747	\$ -	\$ -	\$ 172,182	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2029	\$ 1,831,486	\$ 7,714	\$ -	\$ 38,571	\$ 15,428	\$ -	\$ -	\$ -	\$ -	\$ 1,769,773	\$ -	\$ -	\$ -
2030	\$ 524,523	\$ 2,610	\$ -	\$ -	\$ 472,328	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 49,585	\$ -	\$ -
2031	\$ 332,485	\$ -	\$ -	\$ 292,302	\$ 40,183	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2032	\$ 8,429	\$ 8,429	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2033	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2034	\$ 842,645	\$ -	\$ -	\$ 632,938	\$ -	\$ 65,056	\$ -	\$ 144,651	\$ -	\$ -	\$ -	\$ -	\$ -
2035	\$ 425,483	\$ -	\$ -	\$ 328,988	\$ 45,226	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 51,269	\$ -	\$ -
2036	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2037	\$ 508,199	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 508,199	\$ -	\$ -	\$ -	\$ -
2038	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
2039	\$ 409,967	\$ 74,025	\$ -	\$ -	\$ -	\$ 150,325	\$ 40,007	\$ 95,847	\$ 49,762	\$ -	\$ -	\$ -	\$ -
2040	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ 5,402,905	\$ 147,025	\$ -	\$ 1,517,743	\$ 745,348	\$ 237,681	\$ 40,007	\$ 244,698	\$ 564,265	\$ 1,769,773	\$ 115,354	\$ -	\$ 21,012

- Notes:
- Explanation of large capital outlays in first two years:
- Retention System: St. Aubin “basin” (\$176,000) received a score of 5 based on the NTH structural assessment. One magnetic flow meter (FM-2; 49,000) received a score of 5 because the meter was not functioning properly based on SCADA data review in early 2020.

Appendix F: Geotechnical Report



DRAFT REPORT ON GEOTECHNICAL INVESTIGATION

GREAT LAKES WATER AUTHORITY (GLWA)
DESIGN SERVICES FOR COMBINED SEWER OUTFALL
IMPROVEMENTS PROJECTS— CONTRACT NO. 2101475
GLWA LEIB CSO FACILITY
DETROIT, MICHIGAN

Owner:
Great Lakes Water Authority (GLWA)
Detroit, Michigan

Prepared for:
CDM Smith
535 Griswold Street, Suite 930
Detroit, Michigan 48226

December 31, 2022
2022136A



December 31, 2022
2022136A

Mr. Ali Khraizat, P.E.
CDM Smith
535 Griswold St., Suite 930
Detroit, Michigan 48226

RE: Draft Report on Geotechnical Investigation
Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO) Improvements Project
GLWA Leib CSO Facility - Contract Number 2101475
Detroit, Michigan

Dear Mr. Khraizat:

We have completed the Draft Report on Geotechnical Investigation for the GLWA Leib CSO Facility Project in the City of Detroit, Michigan. This report presents the results of our observations and results of the geotechnical. The report is draft pending the surveying data at the probe locations and pending your review comments.

The soil samples collected during our field investigation will be retained in our laboratory for 90 days from the date of the final report, at which time these samples will be discarded unless otherwise directed by you.

It was a pleasure working with you on this project. If you have any questions regarding this report, please do not hesitate to contact us 313-963-2721.

Sincerely,
Somat Engineering, Inc.

Sean Panetta
Staff Geologist

Jane M. Abadir, P.E. LEED A.P
Principal Engineer

SP/JA/aer

**DRAFT REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA LEIB CSO FACILITY
DETROIT, MICHIGAN**

REPORT SUMMARY

A general summary of the report conclusions is provided below:

1. The field exploration program consisted of performing a total of 2 soil borings for the GLWA Leib CSO Facility Project in Detroit, Michigan. The borings extended to a depth of 10 feet below existing grades.
2. Generalized soil profile: Fill soils was encountered in boring Leib-02 and extended to a depth of 1.3 feet below existing grades.
3. The long-term groundwater table is estimated to be situated at about 7 feet (EL. XXX) below existing grades. Perched groundwater trapped in the granular fill soils within close proximity of any excavations should also be expected.
4. We recommend undercutting the upper topsoil and underlying granular fill soils to a minimum depth of about 1.5 feet below existing grades and replacing with engineered granular fill soils (such as MDOT 21AA or Class II sand), new base course, and pavement. Based on our analysis we checked that the proposed pavement section design consisting of 9 inches of Portland cement concrete over a minimum of 8 inches of new aggregate base course that is similar in gradation to MDOT 21AA over the compacted new engineered fill subgrade soils prepared as noted in this report; should be adequate to support the proposed HS-20 traffic loading for the access drive.

The summary presented above is general in nature and should not be considered apart from the entire text of the report with all the qualifications and considerations mentioned therein. Details of our findings and recommendations are discussed in the following sections and in the appendices of this report.

REPORT PREPARED BY:

Sean Panetta
Staff Geologist

REPORT REVIEWED BY:

Jane M. Abadir, P.E. LEED A.P.
Principal Engineer, Geotechnical Services



**DRAFT REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA LEIB CSO FACILITY
DETROIT, MICHIGAN**

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**DRAFT REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA LEIB CSO FACILITY
DETROIT, MICHIGAN**

1.0 INTRODUCTION

1.1 GENERAL

Upon authorization from CDM Smith, Somat Engineering, Inc. (Somat) has completed the geotechnical investigation for the development of the Great Lakes Water Authority (GLWA) Design Services for Combined Sewer Outfall (CSO) Improvements Project at the Leib CSO Facility in the City of Detroit, Wayne County, Michigan.

Somat was retained by CDM Smith to perform a pre-design geotechnical investigation for the referenced project within the project limits. The geotechnical investigation was performed in general accordance with Somat Proposal No. P210314B dated January 12, 2022. The results of the investigation will be used to support the design of the project and development of construction specifications.

1.2 PROJECT INFORMATION

The overall project includes design services required to implement a series of improvements at the Leib CSO Screening and Disinfection (SDF) facility located at 2200 Mt. Elliott, Detroit, Michigan. The site improvements include constructing a new alternate access road shall be about 176 feet long and 24 feet wide, and will require minimal reconfiguration of the existing parking lot.

The following sections of this report provide a description of our field investigation, the results of the field and laboratory tests, the logs of auger probes, our interpretation of subsoil and groundwater conditions, recommendations related to the proposed construction.



2.0 SUBSURFACE INVESTIGATION

2.1 FIELD EXPLORATION

The field exploration program consisted of performing a total of two (2) soil borings. Borings LEIB-01 and LEIB-02 were performed along the grass covered parcel on the east side of the Leib gated facility. The borings extended to a depth of 10 feet below existing grades.

The soil borings were drilled using Geoprobe 3126GT drill rig. The soil borings were drilled by advancing hollow stem augers to the termination depths of the soil borings. Upon completion, all the boreholes were backfilled with soil cuttings to the surface. The soil boring logs are presented as logs of test borings in Appendix B. Soil boring coordinates and the ground surface elevations (included in the soil boring logs) were provided by the Project Surveyor.

2.2 STANDARD PENETRATION TEST

Soil samples collected during the field portion of the subsoil exploration were labeled with the soil boring designation and a unique sample number. Soil samples were obtained from the soil borings by Standard Penetration Tests (SPT) in accordance with ASTM D1586 procedures, whereby a conventional 2-inch O.D. split-spoon sampler is driven into the soil with a 140-pound hammer repeatedly dropped through a free-fall distance of 30 inches. The sampler is generally driven three successive 6-inch increments, with the blows for each 6-inch increment being recorded. The number of blows required to advance the sampler through 12 inches after an initial penetration of 6 inches is termed the Standard Penetration Test resistance (N-value) and is presented graphically on the individual Logs of Test Borings. As added information, the number of blows for each 6-inch increment is also presented on the boring logs.

The N-values reported on the Logs of Test Borings are the direct blow counts from the field and are uncorrected. The efficiency of each specific hammer is dependent on many factors, including type (auto vs. manual), material quality, regularity of maintenance, drill rig mechanics, etc., and can change with time. As such, SPT hammers on each drill rig are required to be calibrated. Certificates are provided to us indicating each hammer's measured energy transfer



ratio. For this project, the geotechnical driller (DLZ American Drilling) used a Geoprobe 3126GT drill rig (serial number: 52110001). Based on the current certificate for this drill rig, the energy transfer ratio for the SPT hammer is 101.3%.

2.3 SAMPLING

Soil boring samples were recovered using split-spoon sampling procedures in accordance with ASTM Standard D1586 (“Standard Method for Penetration Tests and Split Barrel Sampling of Soils”). In general, the samples were obtained continuously to a depth of 5 feet and every 2.5 feet intervals to the termination depth of the borings. The samples were sealed in glass jars in the field to protect the soil and maintain the soil’s natural moisture content.

2.4 GROUNDWATER LEVEL OBSERVATION PROCEDURES

Whenever possible, groundwater level observations were made during the drilling operations and are shown on the individual Logs of Test Borings. During drilling, the depth at which free water was observed, where drill cuttings became saturated or where saturated samples were collected, was indicated as the groundwater level during drilling. In granular, pervious soils, the indicated water levels are considered relatively reliable when solid or hollow-stem augers are used for drilling. However, in cohesive soils, groundwater observations are not necessarily indicative of the static water table due to the low permeability rates of the soils, and due to the sealing off of natural paths of groundwater flow during drilling operations.

It should be noted that seasonal variations and recent precipitation conditions may influence the level of the groundwater table significantly. Groundwater observation wells are generally used if precise groundwater table information is needed, however the installation of groundwater monitoring wells was not included in the scope of the investigation. Therefore, the discussion and recommendations provided within the report are based on our knowledge of the soil and groundwater conditions in this area, as well as the reported design water levels of water bodies located at the bridge locations, which should provide for a reasonable approximation of the groundwater level.



2.5 GEOTECHNICAL LABORATORY TESTING

All soil samples were classified in accordance with the Unified Soil Classification System (USCS). Cohesive soil samples were subjected to laboratory tests consisting of moisture content determinations, and hand penetrometer tests. Loss-on-ignition (LOI) tests are performed on any samples that appear to contain significant organic content.

The results of the soil classifications and the laboratory tests are included on the respective logs in Appendix B. All laboratory tests were performed in accordance with their applicable ASTM procedures.

2.6 LIMITATIONS

The scope of our services was strictly geotechnical and did not include environmental investigation. Our scope of services did not include investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on, below or around this site.

Somat has made no observations or recommendations with regard to the presence or absence of mold or other biological contaminants (such as spores, fungi, bacteria, viruses, and the byproducts of such organisms), now or in the future, on this site or within or on any structures to be constructed on this site. Any consideration with regard to the presence of mold, or the possibility of mold growth in or on the structure to be constructed on this site are not within our scope of services on this project.

Some soils have been identified on the Logs of Test Borings as “fill” or “possible fill” if a soil deposit is suspected to have been placed by human activity, versus having been deposited by natural means. These designations were based on our professional engineering judgment considering factors such as our visual classification, the presence of foreign materials (i.e., bricks, concrete, plastic, etc.), and/or site topography, among many other possibilities. As such, the “fill” or “possible fill” descriptions should be considered as secondary information to the standardized soil classification. Due to the large variation of types of fill, methods of fill



placement, potential changes of historical use of the site, and soil sample size, it is difficult to discern whether the subject soil sample is native to this site, or fill material based on visual classification alone. As such, the designation of “fill” may not be reliable and hence should be considered as informational only. Conversely, where a soil is not designated as “fill” on the boring logs, it does not necessarily mean it is not a fill soil, only that there were no apparent observations indicating a fill material. Therefore, we cannot guarantee that our description of “fill” soils is accurate, or that we have identified all types of fill material encountered with our sampling on the site.

3.0 SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

Soil conditions encountered at the boring locations have been evaluated and presented in the form of logs of auger probes. The logs of auger probes include approximate soil stratification with detailed soil descriptions and selected physical properties for each stratum encountered in the auger probes. In addition to the observed subsoil stratigraphy, the auger logs present information relating to sample data, groundwater level conditions observed in the probing, personnel involved, and other pertinent data. For information, and to aid in understanding the data as presented on the auger logs, General Notes defining nomenclature used in soil descriptions are presented immediately following the Logs of Test Borings. It should be noted that the Logs of Test Borings included with this report have been prepared on the basis of laboratory classifications and testing as well as field logs of the soils encountered.

A generalized description of the soils and pavement encountered in the six (6) auger probes beginning at the existing ground surface and proceeding downward, is provided below:

Stratum 1: Surface Material:

- **Topsoil:** Clayey topsoil was encountered at the surface of LEIB-01 and 02 and had a thickness of 6 inches.

Stratum 2: Fill Soils:



- **Granular Fill:** Granular fill soils consisting of sand with silt was encountered below the topsoil in boring LEIB-02 and extended to a depth of 1.3 below existing grades. The apparent density of the fill soils was dense.

Stratum 3: Native Cohesive Soils

- Native sandy lean clay was encountered below the topsoil or fill soils in both borings and extended to a depth of 2 to 3.5 feet below existing grades. The consistency of the clay was hard and had a moisture content ranging between 9 and 14%.

Stratum 4: Native Granular Soils

- Native granular soils consisting of sand and silty sand were encountered below the native clays in both borings and extended to the termination depth of 10 feet in boring LEIB-01 and to a depth of 8 feet in boring LEIB-02. The apparent density of the native granular soils ranged between medium dense and very dense.

Stratum 5: Native Cohesive Soils

- Native lean clay was encountered below the native granular soils in boring LEIB-02 and extended to the explored depth of 10 feet below existing grades. The consistency of the clay was very stiff and had a moisture content of 15%.

The logs of soil borings are presented in Appendix B and the soil boring location diagram is presented in Appendix A. It is emphasized that the stratification lines shown on the logs are approximate indications of change from one soil type to another at the locations of the boreholes. The actual transition from one stratum to the next may be gradual and may vary within the area represented by the test boring.

3.2 GROUNDWATER LEVEL OBSERVATIONS

Groundwater was not encountered in boring LEIB-01. Groundwater was encountered at a depth of 7 feet during drilling and 8.5 feet after completion of drilling in boring LEIB-02.

A lack of groundwater in some of the auger holes, does not necessarily mean there is no groundwater in this area, due to the sealing off of natural flow paths during the drilling process. Oftentimes, a change in color from brown to gray in cohesive soils is a good indication of the long-



term groundwater level (indicating oxidation). As such the long-term groundwater table is estimated to be situated at about 7 feet below existing grades (EL. XXX).

Perched groundwater within the granular and fill soils above the less permeable clay layers should be expected and the Contractor should be prepared to handle. Water trapped in existing utility trenches in the area, which are often sand backfill within the native clay soils, should be expected.

It should be noted that the elevation of the long-term groundwater table is likely to vary throughout the year depending on the amount of precipitation, runoff, evaporation, and percolation in the area, as well as on the water level in any surface water bodies in the vicinity affecting the groundwater flow pattern.

4.0 GEOTECHNICAL RECOMMENDATIONS

4.1 PROPOSED ACCESS DRIVE

The project includes the construction of a new paved alternate access road that is about 176 feet long and 24 feet wide. The proposed pavement section will be Portland cement concrete and gutter and the thickness of the pavement is anticipated to consist of 9-inch-thick reinforced concrete pavement over a minimum of 8-inch-thick aggregate base in conformance to MDOT 21AA gradation. The pavement will be designed to support HS-20 loading.

4.1.1 Subgrade Preparation and Groundwater Control Recommendations

Based on the soil borings, the subgrade soils consist of existing granular fill soils over native hard lean clay. We do not recommend constructing new pavement on undocumented fill soils. As such we recommend undercutting the upper topsoil and underlying granular fill soil to a minimum depth of about 1.5 feet below existing grades and replacing with engineered granular fill soils (similar in gradation to MDOT 21AA or Class II sand), new base course, and Portland cement concrete pavement.



Once a rough subgrade has been achieved, the exposed pavement subgrade along the entire sections of access drive to be constructed should be visually checked for the presence of debris, organic matter, and other unsuitable material.

If unsuitable or highly organic subgrade soils (organic contents greater than 4%) are encountered during construction, the material should be assessed by the on-site geotechnical engineer to determine the depth and extent of the material and whether it should be fully undercut.

All of the pavement subgrade areas should be thoroughly proof rolled before placement of the new base course and pavement. The purpose of the proof rolling is to locate overly loose or soft areas as well as to uniformly compact the subgrade surface. In granular soils, proof rolling should be performed with a heavy (minimum 30 ton) self-propelled vibratory roller. Loose or soft areas revealed during compaction or during the proof rolling should either be suitably compacted and aerated if necessary. Any areas that exhibit excessive pumping or yielding should be stabilized, scarified, and re-compacted, if weather conditions permit, or by the removal of the yielding soils and their replacement with engineered fill.

The pavement subgrade will need to be compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D-1557 (Modified Proctor). It may be necessary in some areas to undercut unsuitable soils and replace them with a stabilization layer of engineered fill.

The long-term groundwater table is estimated to be situated at a depth of about 7 feet below existing grades (EL. XXX). Perched groundwater within the granular and fill soils above the less permeable clay layers should be expected and the Contractor should be prepared to handle. Water trapped in existing utility trenches in the area, which are often sand backfill within the native clay soils, should be expected. We do not expect the excavations required to construct the access drive would extend below the estimated long-term groundwater. As such, we believe the groundwater should be adequately controlled using standard sump pits and pumping methods.



4.1.2 Drainage Considerations

The effects of frost heave are anticipated to be more significant in areas where water is not allowed to drain freely either due to subsoil conditions, site grades, or other factors. We recommend including a new drainage system within the new base course to drain water away from the pavement. The pavement and subgrade will need to be positively graded towards these drainage features or away from the center of the roadway to allow for gravity flow of groundwater.

For all new pavements, final pavement elevations should be designed to provide positive surface drainage. The minimum surface slope of 2 percent is recommended. The pavement surface should be smooth, free of roller marks or depressions, and should not contain any irregularities which would pond or impede water flow

4.1.3 Pavement Design Recommendations

4.1.3.1 Subgrade Design Values

We anticipate the subgrade soils for the proposed pavement construction will consist of existing fill soils. The recommended subgrade resilient modulus (M_R) and vertical subgrade reaction (K_v) provided below assumes the soil conditions encountered in the auger probes are representative of the soil conditions within the proposed pavement construction areas. This also assumes the recommended earthwork operations will have been incorporated into the project specifications and that the subgrade soils will have been compacted. If during construction, the subgrade is found to vary from the expected soil conditions, we should be contacted so we may re-evaluate our soil design parameters.

For Portland cement concrete pavement design, based on our experience with similar soil conditions and the results of the in-situ SPT tests, we recommend the following coefficients of subgrade reaction (K_v), subgrade resilient moduli (M_R), and CBR's be used as representation for the conditions of the soils at the new base course and subgrade levels compacted to project specifications.



Table 4.1.3.1 Recommended Pavement Subgrade Design Parameters

Soil Type	Coefficient of Vertical Subgrade Reaction, (K_v)	Subgrade Resilient Moduli (M_R)	CBR
Existing Native Clay Soils	85 pci	6,000 psi	4
New Engineered Sand Fill (MDOT Class II)	235 pci	22,500 psi	15
New Engineered Aggregate Base (MDOT 21AA)	340 pci	37,500 psi	25

Other factors should also be considered in the final pavement design, in addition to the subgrade modulus values. These factors may include, but are not limited to, adequate subgrade preparation, adequate placement of engineered fill and pavement layers, and surface and subsurface drainage.

4.1.3.2 Pavement Section Design Recommendations

As we understand, the proposed pavement section will be Portland cement concrete and gutter and the thickness of the pavement is anticipated to consist of 9-inch-thick reinforced concrete pavement over a minimum of 8-inch-thick aggregate base in conformance to MDOT 21AA gradation. The pavement will be designed to support HS-20 loading.

We performed pavement analysis utilizing the AASHTO 1993 Guide for Design of Pavement Structures and the associated design charts and nomographs. The following list summarizes our input parameters and assumptions based on AASHTO guidelines and our observations:

Pavement Design Life	20 years (7 days per week)
Loading	HS-20 (8,000 lb/ front axle and two 32,000 lb/ rear axles (Given)
Load Equivalent Factor (LEF)	2.985 (calculated based on HS-20 loading using AASHTO LEF tables for terminal serviceability of 2.5)
Maximum Average Daily Traffic (ADT)	185 vehicles per day with HS-20 loading criteria (Back calculated)
Maximum Design ESAL's:	4,000,000 ESAL (Back calculated)
Percent Trucks:	100 %



Reliability:	90 % (Arterial road)
Standard Deviation:	0.35 (Rigid pavement)
Drainage Coefficient:	1.0
Initial Serviceability:	4.5 (Rigid pavement)
Terminal Serviceability:	2.5 (Major collectors)
Growth Rate	3%
Load Transfer Coefficient	2.7 (Dowel and mesh)
Concrete Elastic Modulus	6,000,000 psi (Assumed)
Effective Modulus of Subgrade Reaction of new base course (MDOT 21AA)	340 pci (CBR =25)
Effective Modulus of Subgrade Reaction of clay subgrade	85 pci (CBR =4)
Mean Concrete Modulus of Rapture	650 psi

Based on our analysis we checked that the proposed pavement section design consisting of 9 inches of Portland cement concrete over a minimum of 8 inches of new aggregate base course that is similar in gradation to MDOT 21AA over the compacted existing granular fill soils prepared as noted in this report; should be adequate to support the proposed traffic loading for the access drive.

5.0 GENERAL QUALIFICATIONS

All construction activities should be monitored under the direction of a qualified Geotechnical Engineer to verify conditions as interpreted in this report. This report and the attached Logs of Soil Borings are instruments of service, which have been prepared in accordance with generally accepted soil and foundation engineering practices. We make no other warranties either expressed or implied as to the professional advice included in this report.

The contents of this report have been selected in order to aid in the evaluation of expected subsoil properties to assist the Engineer in the design of this project. In the event that any changes are made in the geotechnical aspects of this project, however slight, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and the conclusions of this report are modified in writing by our office.



Since the information obtained from auger probes is specific to the exact test locations, soil and water information could be different from those occurring at other locations of the site. This report does not reflect variations which may occur between the test holes. The nature and extent of these variations may not become evident until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate the recommendations provided in this report.

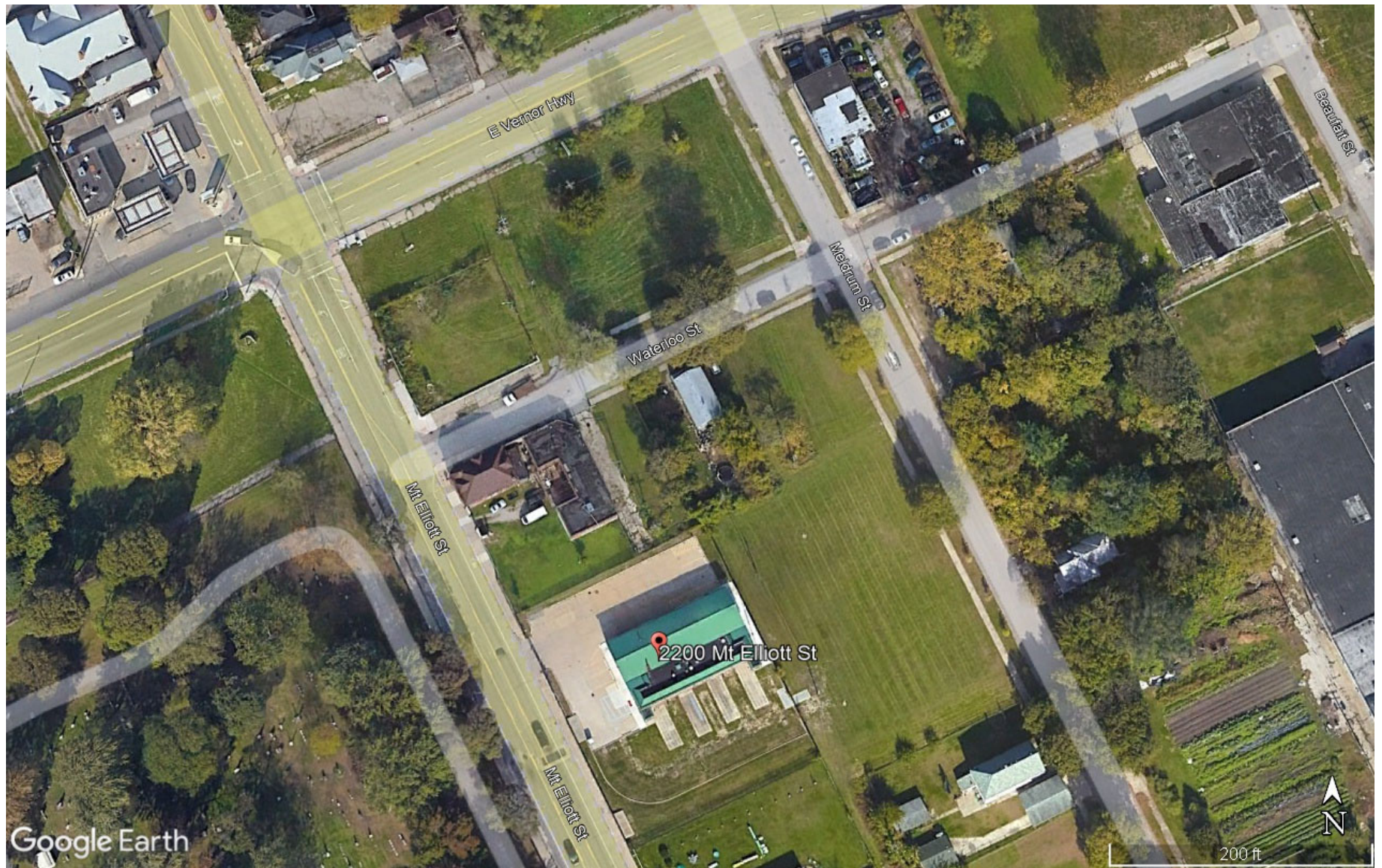
This report and the associated soil logs should be made available to bidders prior to submitting their proposals and to the successful Contractor and subcontractors for their information only, and to supply them with facts relative to the subsurface investigation, laboratory tests, etc.

The discussions and recommendations submitted in this report are based on the soil information contained in the Logs of Soil Borings and test results appended to this report. We expect that the logs of auger probes, test results, and the soil profiles included in this report along with our discussions and conclusions will assist you in designing the proposed pavement. Please refer to Appendix C for important information about this geotechnical investigation report. If you have any questions regarding this report, please contact us.



APPENDIX A

SOIL BORING LOCATION DIAGRAM



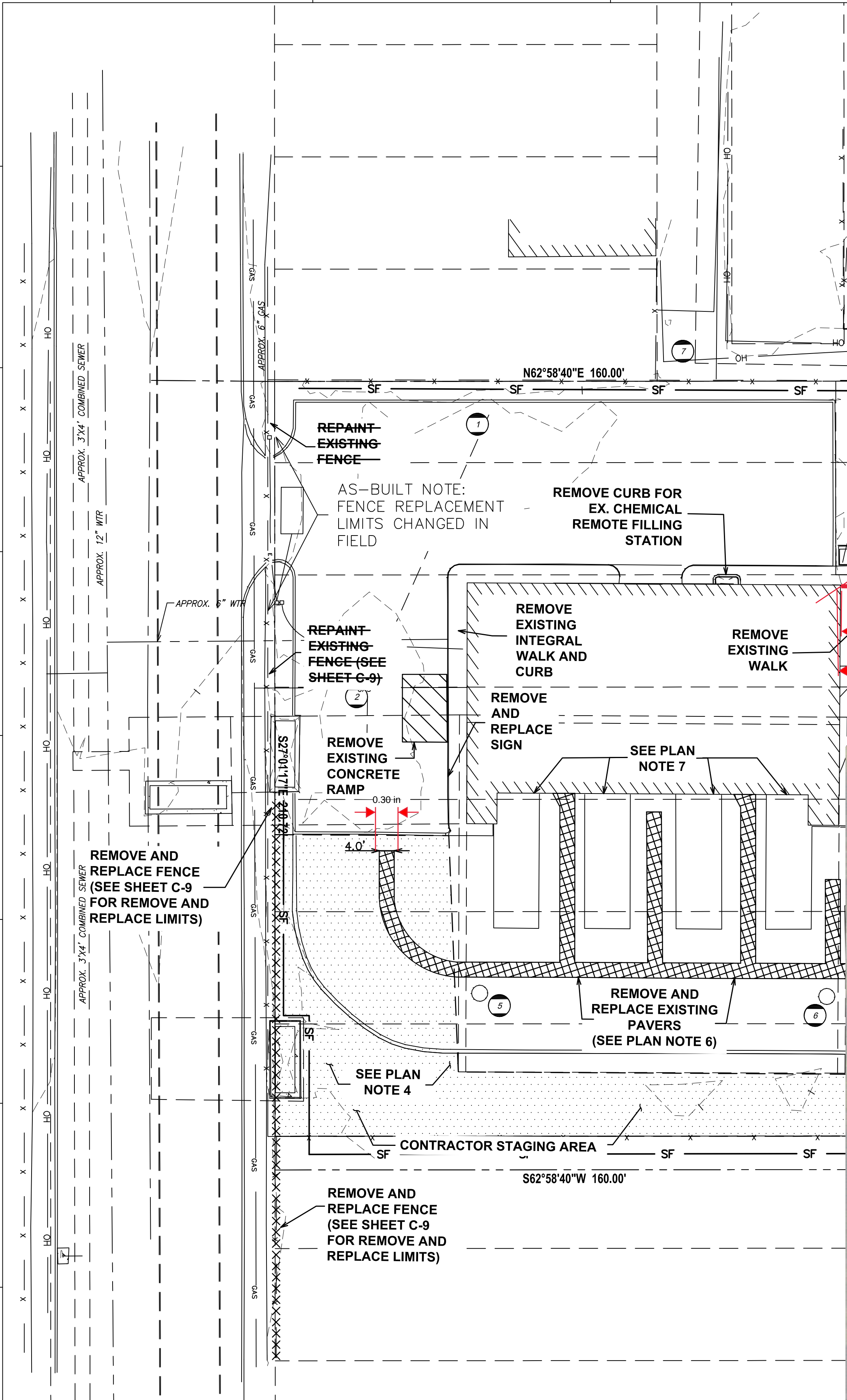
Adapted from Google Earth satellite imagery

Drawing Scale as noted



Project Site – Vicinity Map

Great Lakes Water Authority (GLWA)
GLWA Leib CSO Facility
Detroit, Michigan



SOIL EROSION AND SEDIMENTATION CONTROL GENERAL NOTES AND REQUIREMENTS:

1. CONTRACTOR SHALL NOTIFY THE WAYNE COUNTY SOIL EROSION OFFICE 48 HOURS BEFORE WORK IS TO BEGIN AT 734-326-3936.
2. ALL SOIL EROSION AND SEDIMENTATION CONTROL WORK SHALL CONFORM TO THE STANDARDS AND SPECIFICATIONS OF WAYNE COUNTY. THE CONTRACTOR SHALL OBTAIN THE SOIL EROSION CONTROL PERMIT FROM WAYNE COUNTY, AND SHALL MAINTAIN COMPLIANCE WITH THE PERMIT THROUGHOUT CONSTRUCTION.
3. CONTRACTOR SHALL PROVIDE A DETAILED SCHEDULE SHOWING DATES AND DURATION FOR EACH PHASE OF EARTH DISTURBANCE TO THE WAYNE COUNTY SOIL EROSION OFFICE FOR APPROVAL.
4. EROSION AND ANY SEDIMENT FROM WORK ON THIS SITE SHALL BE CONTAINED ON THE SITE AND NOT ALLOWED TO COLLECT ON ANY OFF-SITE AREAS OR IN WATERWAYS. WATERWAYS INCLUDE BOTH NATURAL AND MAN-MADE OPEN DITCHES, STREAMS, STORM DRAINS, LAKES, AND PONDS.
5. CONTRACTOR SHALL PROVIDE AND INSTALL SOIL EROSION AND SEDIMENTATION CONTROL (SESC) DEVICES, AS SHOWN, BEFORE PROCEEDING WITH ANY OTHER SITE WORK. CONTRACTOR SHALL MAINTAIN ALL SESC DEVICES FOR THE DURATION OF THE CONSTRUCTION. AT THE END OF CONSTRUCTION, CONTRACTOR SHALL RESTORE ALL DISTURBED AREAS. ONCE GRASS IS ESTABLISHED, CONTRACTOR SHALL REMOVE AND DISPOSE OF ALL TEMPORARY SESC DEVICES AND COLLECTED DEBRIS. TEMPORARY CONTROLS SHALL BE REMOVED ONLY AFTER GETTING APPROVAL BY THE WAYNE COUNTY SOIL EROSION INSPECTOR.
6. CONTRACTOR SHALL INSPECT AND MAINTAIN SESC DEVICES ON A WEEKLY BASIS AND WITHIN 24 HOURS AFTER A STORM EVENT. THE CONTRACTOR SHALL REMOVE ACCUMULATED DEBRIS AND MAKE NECESSARY REPAIRS AS-DIRECTED BY THE ENGINEER.
7. CONTRACTOR IS TO MAINTAIN DRAINAGE OF THE SITE FOR THE DURATION OF CONSTRUCTION. DRAINAGE MATERIALS AND COLLECTED DEBRIS ARE REMOVED AT THE END OF CONSTRUCTION AND THE AREA RESTORED. ALL EXCESS EXCAVATED MATERIALS SHALL BE REMOVED FROM THE SITE AND DISPOSED OF PROPERLY. OWNER SHALL BE INFORMED OF THE DISPOSAL AREA(S), PRIOR TO ANY MATERIALS LEAVING THE SITE.
8. ALL STORM SEWERS USED TO CONVEY DISCHARGES FROM EXCAVATION DE-WATERING SYSTEMS SHALL BE FLUSHED AND CLEANED.
9. CONTRACTOR SHALL SWEEP ROADWAYS AT LEAST ONCE PER DAY OF EACH WORKDAY THROUGHOUT THE PROJECT WHILE EARLY CONSTRUCTION IS IN PROGRESS. ANY MUD/DIRT TRACKED ONTO EXISTING CITY/COUNTY/STATE ROAD SHALL BE PROMPTLY REMOVED BY THE CONTRACTOR. THIS WORK SHALL BE INCLUDED IN THE UNIT BID COSTS FOR SESC.
10. CONTRACTOR SHALL MAINTAIN SAFE, DUST FREE CONDITION ON EXISTING STREETS WHICH SHALL REQUIRE DAILY REMOVAL OF EARTH TRACKED OR SPILLED ON ROAD SURFACE, AND OTHER DUST CONTROL MEASURES AS REQUIRED BY THE PROJECT ENGINEER. EXCESSIVE DUST WILL NOT BE TOLERATED AT ANY TIME DURING CONSTRUCTION. NO ADDITIONAL PAYMENT WILL BE ALLOWED FOR THIS WORK.
11. WHEN THE SITE IS READY FOR FINAL GRADING, RE-GRADE THE SITE AND COMPLETE ALL PAVEMENT WORK, THEN PERMANENTLY STABILIZE THE SITE PER CONTRACT REQUIREMENTS BY SEEDING.
12. PERMANENT SOIL EROSION AND SEDIMENTATION CONTROL MEASURES FOR ALL SLOPES, CHANNELS, DITCHES, OR ANY DISTURBED LAND AREA SHALL BE COMPLETED WITHIN 5 CALENDAR DAYS AFTER FINAL GRADING OR THE FINAL EARTH CHANGE HAS BEEN COMPLETED. WHEN IT IS NOT POSSIBLE TO PERMANENTLY STABILIZE A DISTURBED AREA AFTER AN EARTH CHANGE HAS BEEN COMPLETED OR WHERE SIGNIFICANT EARTH CHANGE ACTIVITY CEASES, TEMPORARY SOIL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE IMPLEMENTED WITHIN 30 CALENDAR DAYS. ALL TEMPORARY SOIL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE MAINTAINED UNTIL PERMANENT SOIL EROSION AND SEDIMENTATION CONTROL MEASURES ARE IMPLEMENTED.
13. DITCHES, GULLIES, AND OTHER AREAS THAT WILL CHANNEL CONCENTRATED RUNOFF MUST BE STABILIZED.

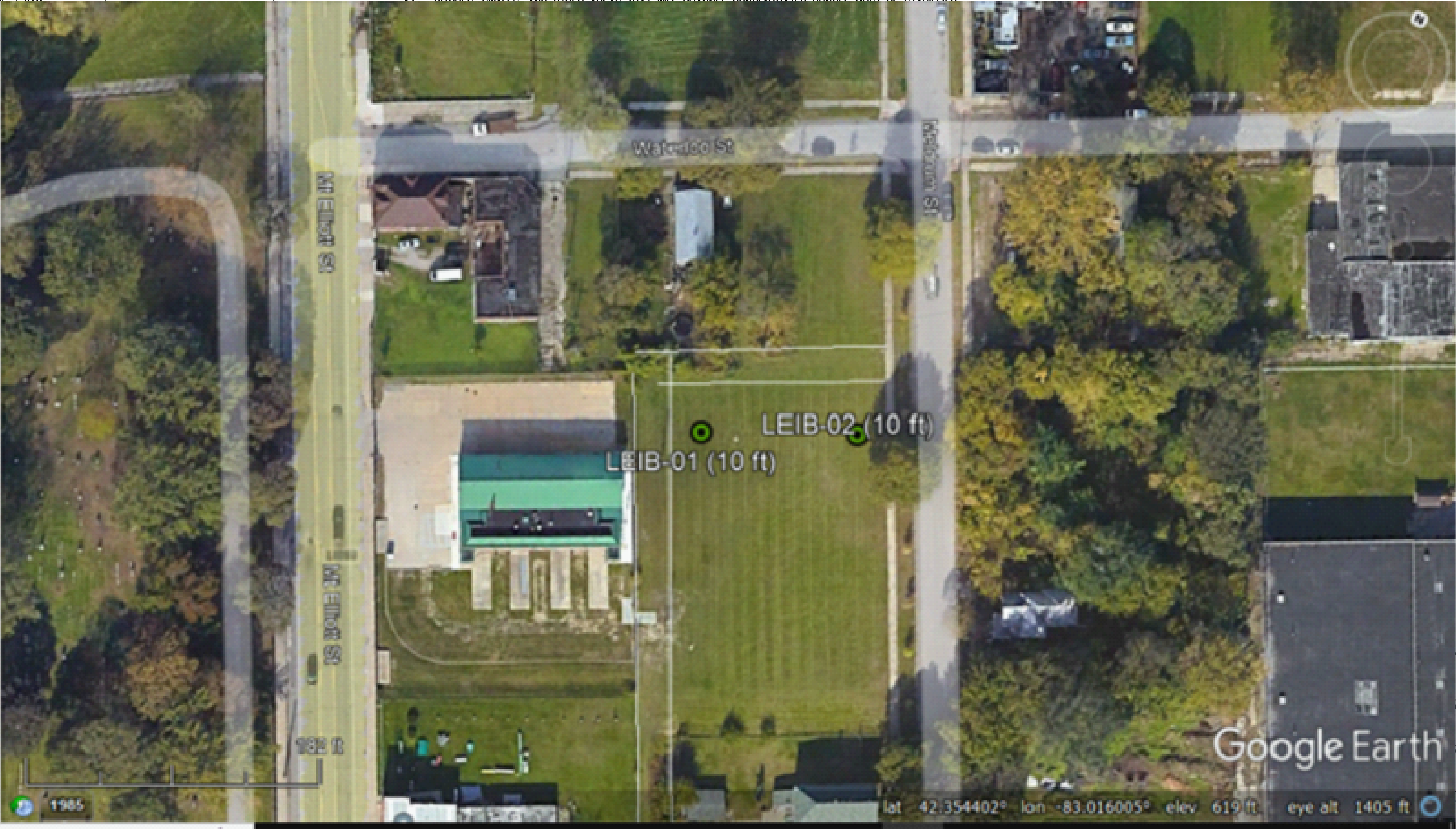
REMOVAL LEGEND

	REMOVE SIDEWALK
	REMOVE BRICK PAVERS
	REMOVE FENCE
	REMOVE CONCRETE PAVEMENT
	REMOVE ASPHALT
	CSO BASIN LIMITS

PLAN NOTES:

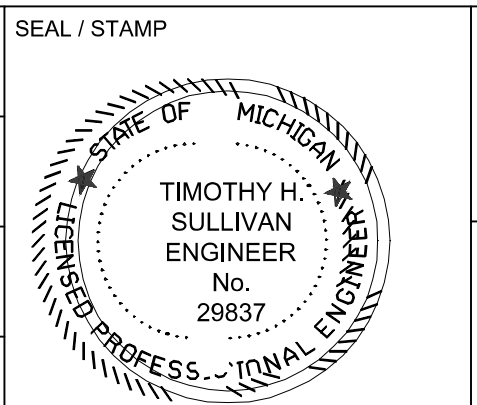
1. REFER TO SME ALTA SURVEY PLAN SHEET 2-LEIB FOR EXISTING ONSITE STORM SEWER INFORMATION.
2. EXISTING SITE INFORMATION NOT FOUND ON THIS SHEET CAN BE FOUND IN ALTA SURVEY PLAN SHEETS 2-LEIB AND 3-LEIB.
3. THE CONTRACTOR SHALL CONFINE ALL CONSTRUCTION OPERATIONS TO THE STAGING AREAS SHOWN ON THIS SHEET.
4. THE EXISTING UNDERGROUND CSO BASIN LIMITS ARE SHOWN ON THIS SHEET. MAXIMUM LOAD LIMIT ON THE BASIN TOP SLAB IS 300 PSF. THIS INCLUDES COMBINATIONS OF LOADS AT ANY ONE POINT IN TIME- EQUIPMENT, SOIL, ETC. THE CONTRACTOR IS RESPONSIBLE FOR THE EVALUATION OF THE EFFECTS OF ALL LOADS DUE TO CONSTRUCTION-RELATED ACTIVITIES ON THE BASIN AND OTHER EXISTING STRUCTURES ON THE SITE. SEE STRUCTURAL CAPACITY EVALUATION SPECIAL PROVISION FOR REQUIREMENTS.
5. SITE MUST BE SECURE AT THE END OF EACH WORK DAY. CONTRACTOR SHALL ONLY REMOVE AS MUCH FENCE AS HE CAN REPLACE THAT DAY. TEMPORARY FENCE SHALL MATCH OR EXCEED EXISTING FENCE.
6. UNDAMAGED BRICK PAVERS ARE TO BE SALVAGED WHERE POSSIBLE. DAMAGED BRICK PAVERS ARE TO BE REPLACED.
7. CONTRACTOR SHALL NOT EXERT ANY LOAD ON CONCRETE AREA INCLUDING ANY EQUIPMENT, DEBRIS, DIRT, ETC.

Legend
Soil Borings



AND DEMOLITION PLAN-LEIB

F				DESIGNED BY:	AKJ
E				DRAWN BY:	EJP
D	AS-BUILTS	AJ	APPR	10/15/21	
C	100% SUBMITTAL	THS	APPR	8/14/19	
B	90% REVIEW	THS	APPR	7/2/19	
A	50% REVIEW	THS	APPR	5/29/19	
No.	DESCRIPTIONS / REVISIONS	CHK'D	APPR	DATE	APPROVED BY:
					THS



FACILITY:
PROJECT:
SCALE: AS NOTED
DATE: August, 2019

SECTION MAP	TOWN	RANGE	STATION	PORTION CODE	DRAWING No.
- - - -	1 S	10 E	- - - -	- - - -	C-6

811
CALL MISS DIG
72 HOURS
(3 WORKING DAYS)
BEFORE YOU DIG
1-800-482-7171
or 811
LL811.COM (TOLL FREE)
EQ PERMIT No. N/A
WA CONTRACT No. GLWA-CO-1902040
E No. 20181156

APPENDIX B

LOGS OF TEST BORINGS AND GENERAL NOTES

PROJECT NO. 2022136A

DATE STARTED: 12/14/2022

DATE COMPLETED: 12/14/2022

LOG OF TEST BORING
LEIB-01

ELEVATION ft		LOG OF SOIL PROFILE	DEPTH (ft)	FIELD DATA					LABORATORY DATA							▼ SPT N VALUE ▼			
				SAMPLE NO.	SAMPLE RECOVERY (in)	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	● MOISTURE CONTENT (%) ●				
															10 20 30 40				
															■ UCC STRENGTH (psf) ■				
				2000 4000 6000 8000															
		Ground Surface Elevation	0																
		Approximate 6 inches of brown sandy TOPSOIL	0.5																
		Hard SANDY LEAN CLAY, trace gravel, gray-brown (CL)	2.0	SS1	24	6-14-14-12	28	2.0	9000+*	8.8									
		Dense to medium dense SILTY FINE SAND sand, trace gravel, frequent sandy clay seams, gray-brown, moist (SM)		SS2	18	12-14-12	26	3.5											
			SS3	14	6-7-7	14	5.0												
			SS4	18	11-17-18	35	7.5												
		Dense to very dense poorly graded fine SAND with silt, trace gravel, brown, moist (SP-SM)																	
			SS5	18	8-15-38	53	10.0												
		End of Boring at 10 feet	10																

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed SampleDrilling Company: DLZ American Drilling
Drill Rig: Geoprobe 3126GT (Rig 10001)
Logged By: P. Cody
Drilling Method: 3 1/4 inch HSA
Method Notes: ---
Hammer Type:
Backfilled With: Cuttings
Checked By: ALOG
QA/QC By: JA
Remarks:

Somat Engineering Inc.

Great Lakes Water Authority (GLWA)
Combined Sewer Outfall (CSO) Improvements
Project
Leib CSO Facility
Detroit, Michigan

PROJECT NO. 2022136A

DATE STARTED: 12/14/2022

DATE COMPLETED: 12/14/2022

LOG OF TEST BORING
LEIB-02

ELEVATION ft		LOG OF SOIL PROFILE		DEPTH (ft)		FIELD DATA					LABORATORY DATA						▼ SPT N VALUE ▼																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
						SAMPLE NO.	SAMPLE RECOVERY (in)	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	10 20 30 40																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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GROUNDWATER READINGS

First Encountered: 7 feet
Upon Completion: 8.5 feet

BORING LOCATION INFORMATION

Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed SampleDrilling Company: DLZ American Drilling
Drill Rig: Geoprobe 3126GT (Rig 10001)
Logged By: P. Cody
Drilling Method: 3 1/4 inch HSA
Method Notes: ---
Hammer Type:
Backfilled With: Cuttings
Checked By: ALOG
QA/QC By: JA
Remarks:

Somat Engineering Inc.

Great Lakes Water Authority (GLWA)
Combined Sewer Outfall (CSO) Improvements
Project
Leib CSO Facility
Detroit, Michigan



GENERAL NOTES

Unified Soil Classification System (USCS) ASTM D2488 (Modified)

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon – 1 3/8" I.D., 2" O.D. (standard)	BS:	Bulk Sample	RC:	Rock Core with diamond bit, NX size, (unless otherwise noted)
S:	Split Spoon – non-standard size, as noted	HSA:	Hollow Stem Auger	RB:	Rock Bit/Roller Bit
ST:	Thin-Walled Tube – 3" O.D., (unless otherwise noted)	DP:	Direct Push	WR:	Wash Rotary
LS:	Liner Sample	PS:	Piston Sample	NR:	No Recovery
PA:	Power Auger	PT:	Pitcher Sample	VS:	Vane Shear Test
HA:	Hand Auger	WS:	Wash Sample	ER:	Hammer Energy Ratio
AU:	Auger Sample				

Standard Penetration Test Resistance, N-Value: Sum of 2nd and 3rd 6-inch increments, in blows per foot of a 140-pound hammer falling 30 inches and driving an 18-inch to 30-inch long, 2-inch OD split spoon.

WATER LEVEL MEASUREMENT:

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. In pervious soils, the indicated levels may reflect the location of a groundwater table. In low permeability soils (clays and silts), the accurate determination of groundwater levels may not be possible with only short-term observations. Groundwater levels at times and locations other than when and where individual borings were performed could vary.

DESCRIPTIVE SOIL CLASSIFICATION:

Soil classification is based on the Unified Soil Classification (USC) System and ASTM Standards D-2487 and D-2488. Coarse-grained soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are generally described as: clays, if they are plastic, and silts, if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their apparent in-place density and fine-grained soils on the basis of their apparent in-place density (silty soils) or consistency (clayey soils).

CONSISTENCIES OF COHESIVE SOILS:

The pocket penetrometer, pocket torvane, and in-situ vane shear tests are converted into an estimated unconfined compressive strength, in pounds per square feet (psf), for presentation on the logs. The unconfined compressive strength is estimated to be about two times the shear strength.

DESCRIPTORS OF MINOR CONSTITUENTS

Primary Constituent	Fine-Grained (Silt & Clay)	Coarse-Grained (Sand & Gravel)	
Descriptor of Other Constituents	Relative Portion of Coarse Grained Soils as a % of Dry Weight	Relative Portion of Fine Grained Soils as a % of Dry Weight	Relative Portion of Coarse Grained Soils as a % of Dry Weight
Trace	<5%	<5%	<5%
Few	≥5% - <15%	N/A	≥5% - <15%
With	≥15% - <30%	≥5% - 12%	≥15%
Modifier	≥30%	>12%	N/A

FINE-GRAINED SOILS

Unconfined Compressive Strength Q_u , psf	Consistency	N-Value	Apparent Density
< 500	Very Soft	0 – 4	Very Loose
500 - <1,000	Soft	5 – 9	Loose
1,000 - <2,000	Medium	10 – 29	Medium Dense
2,000 - <4,000	Stiff	30 – 49	Dense
4,000 - <8,000	Very Stiff	50 – 80	Very Dense
≥ 8,000	Hard	>80	Extremely Dense

COARSE-GRAINED SOILS

DEFINITIONS OF STRUCTURAL AND DEPOSITIONAL FEATURES

Term	Definition
Parting	≤ 1/16 inch (1.6 mm) thick
Seam	> 1/16 inch (1.6 mm) → 1/2 inch (12.7 mm) thick
Layer	> 1/2 inch (12.7 mm) to ≤ 12 inches (305 mm) thick
Pocket	Small, erratic deposits of limited lateral extent
Lens	Lenticular deposit
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Varved	Alternating partings or seams (1 mm – 12 mm) of silt and/or clay and sometimes fine sand
Stratified	Alternating layers of varying material or color with layers ≥ 6 mm thick
Laminated	Alternating layers of varying material or color with layers < 6 mm thick
Fissured	Contains shears or separations along planes of weakness
Slickensided	Shear planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Homogeneous	Same color and appearance throughout
Occasional	One or less per foot (305 mm) of thickness
Frequent	More than one per foot (305 mm) of thickness
Interbedded	Applied to strata of soil lying between or alternating with other strata of a different nature

DEFINITIONS OF PAVEMENT CONDITION

Condition	Description
Good	ACC Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks and transverse cracks (open 1/4 inch). No patching or very few patches in excellent condition.
	PCC Moderate scaling in several locations. A few isolated surface spalls. Shallow reinforcement causing cracks. Several corner cracks, tight or well sealed. Open (1/4 inch wide) longitudinal or transverse joints.
Fair	ACC Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (1/2 inch deep or less).
	PCC Severe polishing, scaling, map cracking, or spalling over 50% of the area. Joints and cracks show moderate to severe spalling. Pumping and faulting of joints (1/2 inch with fair ride). Several slabs have multiple transverse or meander cracks with moderate spalling.
Poor	ACC Alligator cracking (over 25% of surface). Severe distortions (over 2 inches deep) Extensive patching in poor condition. Potholes.
	PCC Extensive slab cracking, severely spalled and patched. Joints failed. Patching in very poor condition. Severe and extensive settlement or frost heaves.

GRAIN SIZE TERMINOLOGY

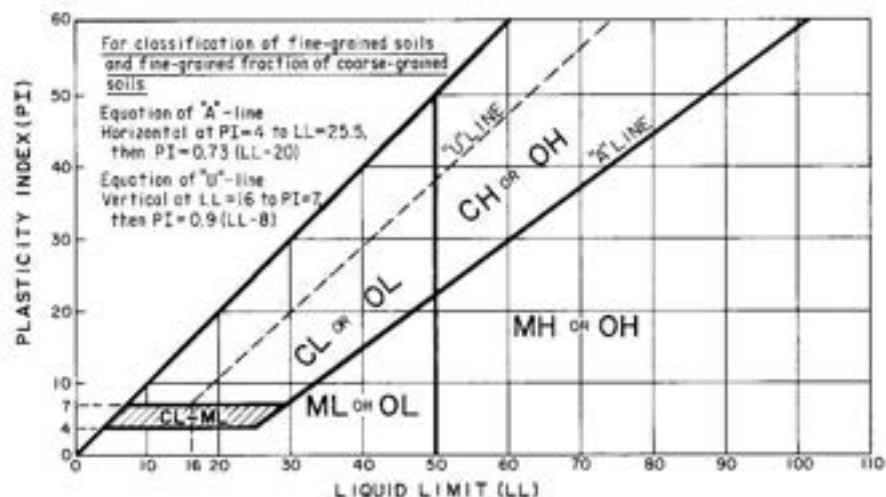
Major Component of Sample	Size Range
Boulders	≥ 12" (300 mm)
Cobbles	< 12" - 3" (300 mm – 75 mm)
Gravel - Coarse	< 3" - 3/4" (75 mm – 19 mm)
Gravel - Fine	< 3/4" - #4 (19 mm – 4.75 mm)
Sand - Coarse	< #4 - #10 (4.75 mm – 2 mm)
Sand - Medium	< #10 - #40 (2 mm - 0.425 mm)
Sand - Fine	< #40 - #200 (0.425 mm - 0.074 mm)
Silt	< 0.074 mm - 0.005 mm
Clay	< 0.005 mm



GENERAL NOTES

Unified Soil Classification System (USCS) ASTM D2487

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	Group Name <i>B</i>
COARSE-GRAINED More than 50 % retained on No. 200 sieve	Gravels (More than 50 % of coarse fraction retained on No. 4 sieve)	Clean Gravels	$Cu \geq 4$ and $1 \leq Cc \leq 3^D$	GW	Well-graded gravel ^E
		(Less than 5% fines ^C)	$Cu < 4$ and/or $[Cc < 1 \text{ or } Cc > 3]^D$	GP	Poorly graded gravel ^E
		Gravels with Fines	Fines classify as ML or MH	GM	Silty gravel ^{E,F,G}
		(More than 12 % fines ^C)	Fines classify as CL or CH	GC	Clayey gravel ^{E,F,G}
	Sands (50 % or more of coarse fraction passes No. 4 sieve)	Clean Sands	$Cu \geq 6$ and $1 \leq Cc \leq 3^D$	SW	Well-graded sand ^I
		(Less than 5 % fines ^H)	$Cu < 6$ and/or $[Cc < 1 \text{ or } Cc > 3]^D$	SP	Poorly graded sand ^I
		Sands with Fines	Fines classify as ML or MH	SM	Silty sand ^{F,G,I}
		(More than 12 % fines ^H)	Fines classify as CL or CH	SC	Clayey sand ^{F,G,I}
FINE-GRAINED SOILS 50 % or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line ^J	CL	Lean clay ^{K,L,M}
			PI < 4 or plots below "A" line ^J	ML	Silt ^{K,L,M}
		organic	(Liquid Limit - oven dried) / (Liquid Limit - not dried) < 0.75	OL	Organic clay ^{K,L,M,N}
					Organic silt ^{K,L,M,O}
	Silts and Clays Liquid limit more than 50	inorganic	PI plots on or above "A" line	CH	Fat clay ^{K,L,M}
			PI plots below "A" line	MH	Elastic silt ^{K,L,M}
		organic	(Liquid Limit - oven dried) / (Liquid Limit - not dried) < 0.75	OH	Organic clay ^{K,L,M,P}
					Organic silt ^{K,L,M,Q}
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			Pt	Peat
^A Based on the material passing the 3-in. (75-mm) sieve. ^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name. ^C Gravels with 5 to 12 % fines require dual symbols: GW-GM well-graded gravel with silt GW-GC well-graded gravel with clay GP-GM poorly graded gravel with silt GP-GC poorly graded gravel with clay ^D $Cu = D_{60}/D_{10}$ $Cc = (D_{30})^2 / (D_{10} \times D_{60})$ ^E If soil contains ≥ 15 % sand, add "with sand" to group name. ^F If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM. ^G If fines are organic, add "with organic fines" to group name.				^H Sands with 5 to 12 % fines require dual symbols: SW-SM well-graded sand with silt SW-SC well-graded sand with clay SP-SM poorly graded sand with silt SP-SC poorly graded sand with clay ^I If soil contains ≥ 15 % gravel, add "with gravel" to group name. ^J If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay. ^K If soil contains 15 to <30 % plus No. 200, add "with sand" or "with gravel," whichever is predominant. ^L If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name. ^M If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name. ^N $PI \geq 4$ and plots on or above "A" line. ^O $PI < 4$ or plots below "A" line. ^P PI plots on or above "A" line. ^Q PI plots below "A" line.	



Order of Classification: 1) Consistency or Apparent Density, 2) Type of Soil, 3) Minor Soil Type(s), 4) Inclusions, 5) Layered Soils, 6) Color, 7) Water Content, 8) USCS Symbol, 9) Geological Name

Description of Frequently Used Laboratory Testing Procedures

Visual Engineering Classification

Visual classification was performed on all samples (though other means of refining the classification may also be used). The General Notes provided immediately following the Logs of Test Borings include a brief discussion of the general method used to visually classify the soil, which is based on the visual-manual procedure (ASTM D2488). The visual classification is used to assign an appropriate Unified Soil Classification System (USCS) group symbol. The USCS symbol is shown in parentheses following the textural description of the various strata on the boring logs.

Where more laboratory testing is performed (requiring both grain size and Atterberg limit tests), the classification may also be refined further based on USCS ASTM D2487.

Moisture Content (ASTM D2216)

Moisture content determination tests were performed in accordance with ASTM D2216. Samples were sealed in the field to retain the natural moisture content of the soil specimen. Samples were then dried at a constant temperature (approximately 110° C) overnight in an oven. After drying, the samples were weighed to determine the dry weight of the sample (and the loss in weight representing the water contained in the original sample). The moisture content of the specimen is expressed as a percent and is the weight of the water compared to the dry weight of the specimen.

Hand Penetrometer

A hand/pocket penetrometer was used to estimate the unconfined compressive strength of cohesive (clay) samples. In the hand penetrometer test, the shear strength of a cohesive soil sample is estimated by measuring the resistance of the sample to the penetration of a small, calibrated spring-loaded cylinder. The maximum capacity of the penetrometer is 4.5 tons per square foot. The shear strength is doubled and reported on the soil boring logs as an estimate of the unconfined compressive strength.

Grain Size Analyses (ASTM D6913, D7928, and/or D422-2017)

Grain size analyses were performed in accordance with ASTM D6913, D7928, and/or D422-2017 on selected soil samples to evaluate the gradation of the soil represented by the sample. The distribution of particle sizes larger than 75 micrometers (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 micrometers is determined by a sedimentation process using a hydrometer.

Atterberg Limits Tests (ASTM D4318)

Determination of the Liquid Limit, Plastic Limit, and Plasticity Index of cohesive soils (known as Atterberg Limits) were performed in accordance with ASTM D4318. Fine-grained soils are tested to determine the Liquid Limit (LL) and Plastic Limits (PL), which are moisture contents that define boundaries between material consistency states. The LL and PL values define the transitional boundaries between non-plastic, plastic, and viscous fluid states. The plasticity index (PI) defines the complete range in water content for the plastic state.

Description of Frequently Used Laboratory Testing Procedures (continued)

Organic Content (Loss-On-Ignition) Tests (ASTM D7348)

The organic content of a soil is determined through a Loss-On-Ignition test performed in accordance with ASTM D2974 on soil samples suspected to contain significant organics. After the sample has been oven-dried, the soil sample is super-heated in a 440°C muffle furnace as a means to burn off all present organic matter. The weight of the remaining ash is used to calculate the percentage of organic matter as compared to the dry weight of the sample.



APPENDIX F

GEO-PROFESSIONAL BUSINESS ASSOCIATION (GBA) MESSAGE

Important Information about This Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual site-wide subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists.*



**GEOPROFESSIONAL
BUSINESS
ASSOCIATION**

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DRAFT REPORT ON GEOTECHNICAL INVESTIGATION

GREAT LAKES WATER AUTHORITY (GLWA)
DESIGN SERVICES FOR COMBINED SEWER OUTFALL
IMPROVEMENTS PROJECTS— CONTRACT NO. 2101475
GLWA OAKWOOD CSO FACILITY
DETROIT, MICHIGAN

Owner:
Great Lakes Water Authority (GLWA)
Detroit, Michigan

Prepared for:
CDM Smith
535 Griswold Street, Suite 930
Detroit, Michigan 48226

December 19, 2022
2022136A



December 19, 2022
2022136A

Mr. Ali Khraizat, P.E.
CDM Smith
535 Griswold St., Suite 930
Detroit, Michigan 48226

RE: Draft Report on Geotechnical Investigation
Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO) Improvements Project
GLWA Oakwood CSO Facility - Contract Number 2101475
Detroit, Michigan

Dear Mr. Khraizat:

We have completed the Draft Report on Geotechnical Investigation for the GLWA Oakwood CSO Facility Project in the City of Detroit, Michigan. This report presents the results of our observations and results of the geotechnical. The report is draft pending the surveying data at the probe locations and pending your review comments.

The soil samples collected during our field investigation will be retained in our laboratory for 90 days from the date of the final report, at which time these samples will be discarded unless otherwise directed by you.

It was a pleasure working with you on this project. If you have any questions regarding this report, please do not hesitate to contact us 313-963-2721.

Sincerely,
Somat Engineering, Inc.

Sean Panetta
Staff Geologist

Jane M. Abadir, P.E. LEED A.P
Principal Engineer

SP/JA/aer

**DRAFT REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA OAKWOOD CSO FACILITY
DETROIT, MICHIGAN**

REPORT SUMMARY

A general summary of the report conclusions is provided below:

1. The field exploration program consisted of performing a total of 6 hand auger probes for the GLWA Oakwood CSO Facility Project in Detroit, Michigan. The auger probes extended to depths ranging between 5 and 6 feet below existing grades.
2. Generalized soil profile: Fill soils were encountered in 4 of the 6 auger probes and extended to depths ranging between 2 and 5.5 feet below existing grades. The fill soils generally consisted of roadway gravel and granular soils. Native soils consisting of lean clay or sandy lean clay were encountered below the fill or below the topsoil and extended to the exploration depths of the borings. The consistency of the native clays was stiff to very stiff and the moisture content ranged between 15 and 45%.
3. Groundwater was not encountered during augering or upon completion of augers in any of the hand auger probes. Based on the change from brown to gray in the cohesive soils of OAK-04 and 06, the long-term groundwater table is estimated to be situated at about 3.3 to 4 feet (EL. XXX) below existing grades. Perched groundwater trapped in the granular fill soils within close proximity of any excavations should also be expected.
4. The gravel service road will be replaced with new reinforced concrete pavement that will extend around the perimeter of the basin connecting with the existing concrete service road on either side of the basin. The current pavement design calls for a total length of about 1,000 lineal feet and a width of 16 feet. The proposed pavement section will be Portland cement concrete and gutter and the thickness of the pavement is anticipated to consist of 9-inch-thick reinforced concrete pavement over a minimum of 8-inch-thick aggregate base (MDOT 21AA gradation) designed to support HS-20 loading.
5. The existing gravel road consisted of 10 to 18 inches of crushed aggregate with silty sand over granular fill soils. The fines content of the existing gravel road material ranged between 11 and 25% which is higher than the allowable limit of fines content of MDOT 21AA aggregate. The excessive fines in the base course will reduce the permeability of the base and increase its susceptibility to detrimental frost action. As such, we recommend removal and replacement with new clean and compacted aggregate base material. Based on our analysis we checked that the proposed pavement section design consisting of 9 inches of Portland cement concrete over a minimum of 8 inches of new aggregate base course that is similar in gradation to MDOT 21AA over the compacted existing granular fill subgrade soils prepared as noted in this report; should be adequate to support the proposed HS-20 traffic loading for the service drive.
6. A total of 3 auger probes were performed within the existing bioswale located on the west side of the basin. The general soil profile consisted of topsoil over granular fill soils over native clays. The layer of the granular fill soils consisted of clayey sand and ranged in



**DRAFT REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA OAKWOOD CSO FACILITY
DETROIT, MICHIGAN**

thickness between 4 and 18 inches. These fill soils had 43% of fines (silt and clay) which is considered elevated and will not promote positive drainage. Based on the in-situ falling head permeability tests performed at a depth of 4 to 6 feet below existing grades, the mean hydraulic conductivity of the existing native clay soils ranged between 0.007 and 0.025 inch/hour which is considered almost impermeable. For the proposed bioswale, we recommend undercutting the existing fill and some of the native clay soils and replacing with drainable engineered fill with gradation in accordance with the GSI design specifications. The width, length, and depth of the proposed bioswale will be designed by others to accommodate the anticipated volume surface water surface runoff during the wet seasons, and taking into consideration the anticipated long-term groundwater table at the site.

The summary presented above is general in nature and should not be considered apart from the entire text of the report with all the qualifications and considerations mentioned therein. Details of our findings and recommendations are discussed in the following sections and in the appendices of this report.

REPORT PREPARED BY:

Sean Panetta
Staff Geologist

REPORT REVIEWED BY:

Jane M. Abadir, P.E. LEED A.P.
Principal Engineer, Geotechnical Services



**DRAFT REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA OAKWOOD CSO FACILITY
DETROIT, MICHIGAN**

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**DRAFT REPORT ON GEOTECHNICAL INVESTIGATION
GREAT LAKES WATER AUTHORITY (GLWA)
GLWA OAKWOOD CSO FACILITY
DETROIT, MICHIGAN**

1.0 INTRODUCTION

1.1 GENERAL

Upon authorization from CDM Smith, Somat Engineering, Inc. (Somat) has completed the geotechnical investigation for the development of the Great Lakes Water Authority (GLWA) Design Services for Combined Sewer Outfall (CSO) Improvements Project at the Oakwood CSO Facility in the City of Detroit, Wayne County, Michigan.

Somat was retained by CDM Smith to perform a pre-design geotechnical investigation for the referenced project within the project limits. The geotechnical investigation was performed in general accordance with Somat Proposal No. P210314B dated January 12, 2022. The results of the investigation will be used to support the design of the project and development of construction specifications.

1.2 PROJECT INFORMATION

The overall project includes design services required to implement a series of improvements at the Oakwood CSO Retention Treatment Basin (RTB) and storm/sanitary pumping station located at 12220 Pleasant Street, Detroit, Michigan. The site improvements include constructing a new access service drive that will extend around the perimeter of the basin connecting with the existing concrete service road on either side of the basin and expanding the existing bioswale on the west side of the basin to improve drainage conditions.

The following sections of this report provide a description of our field investigation, the results of the field and laboratory tests, the logs of auger probes, our interpretation of subsoil and groundwater conditions, recommendations related to the proposed construction.



2.0 SUBSURFACE INVESTIGATION

2.1 FIELD EXPLORATION

The field exploration program consisted of performing a total of six (6) hand auger probes, designated OAK-01 through OAK-06. Borings OAK-01, 02, and 03 were performed along the existing gravel access road and extended to a depth ranging between 5 and 5.5 feet below existing grades. In-situ Dynamic Cone Penetrometer (DCP) tests were performed at each of these probes to assess the strength of the subgrade soils and support the pavement section design of the access road.

Hand auger probes OAK-04, 05, and 06 were performed along the existing bioswale that is located on the west side of the basin. These probes extended to depths ranging between 4 and 6 feet below existing grades. In-situ infiltration tests were performed near each of these probes at depths ranging between 4 and 6 feet below existing grades.

Soil boring coordinates and the ground surface elevations (included in the soil boring logs) were provided by the Project Surveyor. A schematic of the approximate soil boring locations and the corresponding infiltration test locations can be found in Appendix A. The Logs of Test Borings are included in Appendix B.

2.1.1 Drilling Operations

The drilling operations were performed on December 1 and December 2, 2022. The hand auger probes were performed using a 3-inch hand auger bucket. Upon completion, all boreholes were backfilled with soil cuttings and the site was restored to the best of our ability.

2.1.2 Geotechnical Sampling

Bulk soil samples were collected from each hand auger probe at every apparent stratum change. The samples were sealed in plastic zip lock bags in the field to protect the soil and maintain the soil's natural moisture content. All samples were identified with unique information on hand auger



number, sample number, and sample depth. The samples were transported to Somat's laboratory in Romulus, Michigan.

All soil samples for the geotechnical investigation were transported to Somat's laboratory for further analysis and testing and will be retained in our laboratory for a period of 90 days after the date of the final report, after which they will be discarded unless we are notified otherwise.

2.1.3 In-Situ Dynamic Cone Penetrometer (DCP) Tests

A dual-mass Dynamic Cone Penetrometer (DCP) test was performed in general accordance with ASTM D6951 at probes OAK-01, 02, and 03. The test was performed starting at the surface material, and extended to depths of about 4 feet below existing grade, approximately. The DCP test is utilized to estimate the California Bearing Ratio (CBR) values from 0.1 to 100. A CBR value is an index commonly used in pavement design, indicative of base and subgrade support characteristics for granular soils. The test procedure involves dropping a 17.6-pound hammer from a distance of 22.6 inches onto an anvil/coupler assembly that drives the graduated drive rod with a disposable cone or tip. The cone has a 60° angle with a maximum diameter of 0.79 inches. The rate of cone penetration per blow is measured at selected penetration or hammer drop intervals. The analysis was performed based on relationships developed by USACE to estimate the California Bearing Ratio (CBR) value from the results of the DCP test. The correlated CBR values ranged between 10 and 100 (an outlier CBR of 4.8 was eliminated). The DCP test results and correlated CBR values are presented in Appendix C.

2.1.4 Groundwater Level Observation Procedures

Whenever possible, groundwater level observations were made during the augering operations and are shown on the individual Logs of Auger Probes. During augering, the depth at which free water was observed, where soil cuttings became saturated or where saturated samples were collected, was indicated as the groundwater level during drilling. In granular, pervious soils, the indicated water levels are considered relatively reliable when hand auger probes are used. However, in cohesive soils, groundwater observations are not necessarily indicative of the static water table



due to the low permeability rates of the soils, and due to the sealing off of natural paths of groundwater flow during augering operations.

It should be noted that seasonal variations and recent precipitation may influence the level of the groundwater table significantly. Groundwater observation wells are generally used if precise groundwater table information is needed, however, the installation of groundwater monitoring wells was not included in the scope of the investigation. Therefore, the discussion and recommendations provided within the report are based on our knowledge of the soil and groundwater conditions in this area, which should provide for a reasonable approximation of the groundwater level.

2.1.5 In-Situ Falling Head Permeability Test

The falling head in-situ permeability testing was performed in accordance to the Stormwater Management Design Manual of the City of Detroit Water and Sewerage Department (2018 which is adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015). The permeability tests consisted of the following steps:

1. Advance a borehole to the required depth of the proposed infiltration interface depth of 4 to 6 feet using a 6-inch hand auger bucket. The augured hole diameter is at least two inches larger than the outer diameter of the inner casing. The inner casing will consist of a PVC pipe with minimum inner diameter of four inches.
2. Push the inner casing within the augured hole to the infiltration interface and firmly set into the bottom of the borehole. Measure the depth from the top of casing to the bottom of the hole to the nearest 0.1 feet.
3. Place two inches of fine gravel or coarse sand in the bottom of the borehole to prevent scour during filling of the casing. Place gravel or sand uniformly to obtain an even depth within the hole. Re-measure the depth from the top of casing to the gravel or sand surface to the nearest 0.1 feet.
4. Presoak test holes immediately prior to testing to simulate saturated conditions. Fill casing with water at a very low rate so as not to disturb the bottom sediments. Place water to a depth of at least six inches above the bottom and readjust every 30 minutes for one hour. The drop in the water level during the last 30 minutes of the presoaking period to be applied to the following standard to determine the time interval between readings:
 - a. If water level drop is two inches or more, use ten-minute measurement intervals.



- b. If water level drop is less than two inches, use 30-minute measurement intervals.
5. After the presoaking, the water level is measured using an approved method per the ASTM standard, where the water level remains at least 12 inches above the bottom of the bottom of the hole. All water added was recorded as a volume along with the time of addition.
6. Measurements of water level were made from the top of casing and continued at the interval determined until a minimum of eight readings are completed or until a stabilized rate of drop was obtained, whichever occurred first. A stabilized rate of drop means a difference of about 0.25 inch or less of a drop between the highest and lowest readings for four consecutive readings.
7. Calculate the infiltration rate as described in ASTM D6391.

The results of the permeability tests and the graphic presentation of the calculated mean hydraulic conductivity, K_1 , versus the elapsed time at each test location are discussed in Section 3.3 and presented in Appendix D.

2.2 GEOTECHNICAL LABORATORY TESTING

All soil samples were classified in accordance with the Unified Soil Classification System (USCS). Cohesive soil samples were subjected to laboratory tests consisting of moisture content determinations, hand penetrometer tests, grain size analysis, and Atterberg Limits tests. Loss-on-ignition (LOI) tests were performed on any samples that appear to contain significant organic content.

The results of the soil classifications and the laboratory tests are included on the respective Logs of Auger Probes in Appendix B and/or tabulated or presented graphically in Appendix E. All laboratory tests were performed in accordance with their applicable ASTM procedures. A general description of each test method is presented in Appendix E, immediately following the result sheets.

2.3 LIMITATIONS

The scope of our services was strictly geotechnical and did not include environmental investigation. Our scope of services did not include investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on, below or around this site.



Somat has made no observations or recommendations with regard to the presence or absence of mold or other biological contaminants (such as spores, fungi, bacteria, viruses, and the byproducts of such organisms), now or in the future, on this site or within or on any structures to be constructed on this site. Any consideration with regard to the presence of mold, or the possibility of mold growth in or on the structure to be constructed on this site are not within our scope of services on this project.

Some soils have been identified on the Logs of Test Borings as “fill” or “possible fill” if a soil deposit is suspected to have been placed by human activity, versus having been deposited by natural means. These designations were based on our professional engineering judgment considering factors such as our visual classification, the presence of foreign materials (i.e., bricks, concrete, plastic, etc.), and/or site topography, among many other possibilities. As such, the “fill” or “possible fill” descriptions should be considered as secondary information to the standardized soil classification. Due to the large variation of types of fill, methods of fill placement, potential changes of historical use of the site, and soil sample size, it is difficult to discern whether the subject soil sample is native to this site, or fill material based on visual classification alone. As such, the designation of “fill” may not be reliable and hence should be considered as informational only. Conversely, where a soil is not designated as “fill” on the boring logs, it does not necessarily mean it is not a fill soil, only that there were no apparent observations indicating a fill material. Therefore, we cannot guarantee that our description of “fill” soils is accurate, or that we have identified all types of fill material encountered with our sampling on the site.

3.0 SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

Soil conditions encountered at the boring locations have been evaluated and presented in the form of logs of auger probes. The logs of auger probes include approximate soil stratification with detailed soil descriptions and selected physical properties for each stratum encountered in the auger probes. In addition to the observed subsoil stratigraphy, the auger logs present information relating to



sample data, groundwater level conditions observed in the probing, personnel involved, and other pertinent data. For information, and to aid in understanding the data as presented on the auger logs, General Notes defining nomenclature used in soil descriptions are presented immediately following the Logs of Test Borings. It should be noted that the Logs of Test Borings included with this report have been prepared on the basis of laboratory classifications and testing as well as field logs of the soils encountered.

A generalized description of the soils and pavement encountered in the six (6) auger probes beginning at the existing ground surface and proceeding downward, is provided below:

Stratum 1: Surface Material:

- **Topsoil:** Clayey topsoil was encountered at the surface of OAK-04, OAK-05, and OAK-06 and had a thickness of 6 inches.
- **Roadway Materials:** Fill soils consisting of a mixture of crushed aggregate and silty sand were encountered at the surface of OAK-01, OAK-02, and OAK-03. These fill soils extended to depths ranging between 0.8 and 1.5 feet below existing grades and had fines content ranging between 11 and 25% (silt and clay).

Stratum 2: Fill Soils:

- **Granular Fill:** Silty sand and clayey sand fill soils with varying amounts of silt and gravel were encountered below the topsoil in OAK-04 and 05, and below the roadway gravel in OAK-01, 02, 03. The fill soils extended to depths ranging between 2 and 5.5 feet below existing grades. The granular fill extended to the termination depths of auger probes OAK-01 and OAK-03. The fines content ranged between 11 and 43%. Few organics were encountered in the granular fill soils in OAK-03 at a depth of about 3 feet below existing grades. Based on the Loss-On-Ignition (LOI) test the organic content was 7.2%.

Stratum 3: Native Cohesive Soils

- Native brown and gray lean clay or sandy lean clay soils were encountered generally below the fill soils in OAK-02 and OAK-05, and below the topsoil in OAK-06 and extended to the explored depths of the auger probes at 4 to 6 feet below existing grades. The consistency of the clay was stiff to very stiff. The moisture content of the native clays ranged between 15 and 45%. Based on the Atterberg limits test result on the clay sample obtained from a depth of 5 feet at probe OAK-01 the liquid limit was 38% and the plasticity Index (PI) was 18%. Graphical presentation of the Atterberg Limits results plotted on the Casagrande chart shows that the clay is classified as lean clay (CL). The chart is presented in Appendix E.



The Logs of Auger Probes are presented in Appendix B and the Hand Auger Probe Location Diagram is presented in Appendix A. It is emphasized that the stratification lines shown on the Logs of Test Borings are approximate indications of change from one soil type to another at the locations of the boreholes. The actual transition from one stratum to the next may be gradual and may vary within the area represented by the test boring.

3.2 GROUNDWATER LEVEL OBSERVATIONS

Groundwater was not encountered during drilling or upon completion of any of the hand auger probes.

A lack of groundwater in some of the auger holes, does not necessarily mean there is no groundwater in this area, due to the sealing off of natural flow paths during the drilling process. Oftentimes, a change in color from brown to gray in cohesive soils is a good indication of the long-term groundwater level (indicating oxidation). Based on the change from brown to gray in the cohesive soils of OAK-04 and OAK-06, the long-term groundwater table is estimated to be situated at about 3.3 to 4 feet below existing grades (EL. XXX).

Perched groundwater within the granular and fill soils above the less permeable clay layers should be expected and the Contractor should be prepared to handle. Water trapped in existing utility trenches in the area, which are often sand backfill within the native clay soils, should be expected.

It should be noted that the elevation of the long-term groundwater table is likely to vary throughout the year depending on the amount of precipitation, runoff, evaporation, and percolation in the area, as well as on the water level in any surface water bodies in the vicinity affecting the groundwater flow pattern.

3.3 IN-SITU FALLING HEAD PERMEABILITY TEST RESULTS

The in-situ falling head permeability testing was performed in accordance to the Stormwater Management Design Manual of the City of Detroit Water and Sewerage Department (2018 which



is adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015).

Per the request of CDM Smith, the infiltration tests were performed at about 4 to 6 feet below existing grades in the native soils. The mean hydraulic conductivity, K_1 , is defined as the average rate of water movement through a saturated soil mass, as tested for the in-situ permeability testing using the falling water level method. The mean hydraulic conductivity was calculated based on the equation adopted from ASTM D6391-11.

The equation is as follows:

$$K_1 = R_T G_1 \frac{\ln\left(\frac{Z_1}{Z_2}\right)}{(t_2 - t_1)}$$

Where:

K_1 is the mean hydraulic conductivity in inch/hour and in cm/sec

G_1 is the test setup parameter

R_T is the temperature coefficient

t_1 and t_2 are the time interval in seconds

Z_1 and Z_2 are the head measurements in cm, measured from the bottom of the borehole to the water level.

The results of the hydraulic conductivity, in equivalent inches per hour, at each testing location were then compared to soil textures of the U.S. Department of Agriculture (USDA) textural triangle presented in Table 3.3-1 to identify the general soil texture and the corresponding hydrologic soil grouping. The following table is an excerpt of the USDA Classification Table:



Table 3.3-1 - Summary Table of Hydraulic Soil properties Classified by Soil Texture

Texture class	Minimum Infiltration Rate (Hydraulic Conductivity) (Inch/hour)	Hydrologic Soil Grouping
Sand	8.27	A
Loamy Sand	2.41	A
Sandy Loam	1.02	A
Loam	0.52	B
Silt Loam	0.27	B
Sandy Clay Loam	0.17	C
Clay Loam	0.09	D
Silty Clay Loam	0.06	D
Sandy Clay	0.05	D
Silty Clay	0.04	D
Clay	0.02	D

The following Table 3.3-2 summarizes the mean hydraulic conductivity measured at each borehole and interpretation for the corresponding soil texture and hydrologic group based on the referenced USDA soil group. The results of the in-situ falling head tests and the graphic presentation of the mean hydraulic conductivity (in cm/sec) versus the elapsed time (in seconds) at each test location are presented in Appendix D.

Table 3.3-2 Summary Table of the In-Situ Falling Head Permeability Tests Results

Hand Auger Probe ID	Mean Hydraulic Conductivity, K_1 (cm/sec)	Mean Hydraulic Conductivity, K_1 (inch/hour)	General Soil Texture and the Corresponding Hydrologic Soil Grouping*	
			Texture Class	Hydrologic Soil Grouping
OAK-04	7.062E-06	0.01	Clay	D
OAK-05	1.736E-05	0.025	Clay	D
OAK-06	5.181E-06	0.007	Clay	D

*Based on soil textures of the U.S. Department of Agriculture (USDA) Textural Triangle

Based on the in-situ falling head permeability tests performed at a depth of 4 to 6 feet below existing grades, the mean hydraulic conductivity of these soils ranged between 0.007 and 0.025 inch/hour (1.7E-05 – 5.2E-06 cm/sec).



4.0 GEOTECHNICAL RECOMMENDATIONS

4.1 PROPOSED ACCESS SERVICE DRIVE

The project includes the construction of a new paved access service drive around the perimeter of the basin connecting with the existing concrete service road on either side of the basin. The current design calls for a total length of about 1,000 lineal feet and a width of 16 feet. The proposed pavement section will be Portland cement concrete and gutter and the thickness of the pavement is anticipated to consist of 9-inch-thick reinforced concrete pavement over a minimum of 8-inch-thick aggregate base in conformance to MDOT 21AA gradation. The pavement will be designed to support HS-20 loading.

4.1.1 Existing Subgrade Conditions

Based on the hand auger probes, the existing access road consists of 10 to 18 inches of a mixture of gravel and silty sand (road gravel) over granular fill soils. Based on the laboratory grain size analysis performed on the surface gravel layer, the fines content ranged between 11 and 25% which is considered excessive. Also, the gradation does not conform with the gradation of MDOT 21AA because the percent finer by weight was exceeded for the ½ inch, #8, and #200 sieves. As such, we do NOT recommend re-using the existing road gravel material as a base course below the new pavement because the excessive fines may reduce the ability of the material to effectively allow drainage below the pavement and may pose a risk of detrimental frost action.

The existing granular fill soils below the gravel layer consisted of poorly graded sand with silt and silty sand which extended to a depth of 4.5 to 5.5 feet below existing grades. Native stiff clay was encountered at a depth of 4.5 feet in boring OAK-02 and extended to the explored depth of 5 feet.

A pocket of organics was encountered at a depth of about 3 feet at the location of probe OAK-03. Loss-On-Ignition (LOI) test performed on that soil sample showed an organic content of 7.2% which is considered excessive. We recommend undercutting the soils at that location and removing the organics to avoid settlement under the new pavement due to the decomposition of the organic material.



Typically, we do not recommend constructing new pavement on undocumented fill soils. However, except as noted in OAK-03, the existing fill soils do not appear to contain excessive organic material or debris, and given the density of the sand fill, these existing subgrade soils are considered suitable for the direct support of new pavement. However, it must be noted that the risk of premature pavement cracking, faulting or uneven settlement should be considered when placing a pavement on a non-engineered fill material. If the risk of this type of distress is not tolerable, then it may be necessary to remove some of the existing non-engineered fill and replace it with engineered fill. We recommend a geotechnical engineer or qualified technician confirm the suitability of the subgrade soils in the field at the time of construction.

4.1.2 Subgrade Preparation and Groundwater Control Recommendations

Once a rough subgrade has been achieved, the exposed pavement subgrade along the entire sections of access service drive to be constructed should be visually checked for the presence of debris, organic matter, and other unsuitable material.

If unsuitable or highly organic subgrade soils (organic contents greater than 4%) are encountered during construction, the material should be assessed by the on-site geotechnical engineer to determine the depth and extent of the material and whether it should be fully undercut.

All of the pavement subgrade areas should be thoroughly proof rolled before placement of the new base course and pavement. The purpose of the proof rolling is to locate overly loose or soft areas as well as to uniformly compact the subgrade surface. In granular soils, proof rolling should be performed with a heavy (minimum 30 ton) self-propelled vibratory roller. Loose or soft areas revealed during compaction or during the proof rolling should either be suitably compacted and aerated if necessary. Any areas that exhibit excessive pumping or yielding should be stabilized, scarified, and re-compacted, if weather conditions permit, or by the removal of the yielding soils and their replacement with engineered fill.



The pavement subgrade will need to be compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D-1557 (Modified Proctor). It may be necessary in some areas to undercut unsuitable soils and replace them with a stabilization layer of engineered fill.

Based on the change from brown to gray in the cohesive soils encountered at OAK-04 and OAK-06, the long-term groundwater table is estimated to be situated at a depth of about 3.3 to 4 feet below existing grades (EL. XXX). Perched groundwater within the granular and fill soils above the less permeable clay layers should be expected and the Contractor should be prepared to handle. Water trapped in existing utility trenches in the area, which are often sand backfill within the native clay soils, should be expected. We do not expect the excavations required to construct the access service drive would extend below the estimated long-term groundwater. As such, we believe the groundwater should be adequately controlled using standard sump pits and pumping methods.

4.1.3 Drainage Considerations

The effects of frost heave are anticipated to be more significant in areas where water is not allowed to drain freely either due to subsoil conditions, site grades, or other factors. We recommend including a new drainage system within the new base course to drain water away from the pavement. The pavement and subgrade will need to be positively graded towards these drainage features or away from the center of the roadway to allow for gravity flow of groundwater. As we understand, the storm runoff from the site will be collected and conveyed to the storm junction chamber upstream of the Oakwood CSO.

For all new pavements, final pavement elevations should be designed to provide positive surface drainage. The minimum surface slope of 2 percent is recommended. The pavement surface should be smooth, free of roller marks or depressions, and should not contain any irregularities which would pond or impede water flow



4.1.4 Pavement Design Recommendations

4.1.4.1 Subgrade Design Values

We anticipate the subgrade soils for the proposed pavement construction will consist of existing fill soils. The recommended subgrade resilient modulus (M_R) and vertical subgrade reaction (K_v) provided below assumes the soil conditions encountered in the auger probes are representative of the soil conditions within the proposed pavement construction areas. This also assumes the recommended earthwork operations will have been incorporated into the project specifications and that the subgrade soils will have been compacted. If during construction, the subgrade is found to vary from the expected soil conditions, we should be contacted so we may re-evaluate our soil design parameters.

For Portland cement concrete pavement design, based on our experience with similar soil conditions and the results of the in-situ DCP tests, we recommend the following coefficients of subgrade reaction (K_v), subgrade resilient moduli (M_R), and CBR's be used as representation for the conditions of the soils at the new base course and subgrade levels compacted to project specifications.

Table 4.1.4.1 Recommended Pavement Subgrade Design Parameters

Soil Type	Coefficient of Vertical Subgrade Reaction, (K_v)	Subgrade Resilient Moduli (M_R)	CBR
Existing Granular Fill subgrade compacted in place	175 pci	15,000 psi	10 (lowest CBR value shown in the in-situ DCP tests)
Existing Native Clay Soils	85 pci	6,000 psi	4
New Engineered Sand Fill (MDOT Class II)	235 pci	22,500 psi	15
New Engineered Aggregate Base (MDOT 21AA)	340 pci	37,500 psi	25



Other factors should also be considered in the final pavement design, in addition to the subgrade modulus values. These factors may include, but are not limited to, adequate subgrade preparation, adequate placement of engineered fill and pavement layers, and surface and subsurface drainage.

4.1.4.2 Pavement Section Design Recommendations

As we understand, the proposed pavement section will be Portland cement concrete and gutter and the thickness of the pavement is anticipated to consist of 9-inch-thick reinforced concrete pavement over a minimum of 8-inch-thick aggregate base in conformance to MDOT 21AA gradation. The pavement will be designed to support HS-20 loading.

We performed pavement analysis utilizing the AASHTO 1993 Guide for Design of Pavement Structures and the associated design charts and nomographs. The following list summarizes our input parameters and assumptions based on AASHTO guidelines and our observations:

Pavement Design Life	20 years (7 days per week)
Loading	HS-20 (8,000 lb/ front axle and two 32,000 lb/ rear axles (Given)
Load Equivalent Factor (LEF)	2.985 (calculated based on HS-20 loading using AASHTO LEF tables for terminal serviceability of 2.5)
Maximum Average Daily Traffic (ADT)	200 vehicles per day with HS-20 loading criteria (Back calculated)
Maximum Design ESAL's:	4,200,000 ESAL (Back calculated)
Percent Trucks:	100 %
Reliability:	90 % (Arterial road)
Standard Deviation:	0.35 (Rigid pavement)
Drainage Coefficient:	1.0
Initial Serviceability:	4.5 (Rigid pavement)
Terminal Serviceability:	2.5 (Major collectors)
Growth Rate	3%
Load Transfer Coefficient	2.7 (Dowel and mesh)
Concrete Elastic Modulus	6,000,000 psi (Assumed)
Effective Modulus of Subgrade Reaction of new base course (MDOT 21AA)	340 pci (CBR =25)
Mean Concrete Modulus of Rapture	650 psi



Based on our analysis we checked that the proposed pavement section design consisting of 9 inches of Portland cement concrete over a minimum of 8 inches of new aggregate base course that is similar in gradation to MDOT 21AA over the compacted existing granular fill soils prepared as noted in this report; should be adequate to support the proposed traffic loading for the service drive.

4.2 PROPOSED BIOSWALE

As we understand, there are areas around the CSO basin that are poorly drained. On the basin's west side, there is an existing shallow drainage swale with dimensions of approximately 360 feet by 30 feet. The current plan calls for expanding and improving this swale to increase its volume to accept the flow that is discharged from the west side of the basin roof during wet weather.

A total of three (3) hand auger probes were performed along the existing bioswale. These probes were OAK-04, 05, and 06 and each extended to a depth of 6 feet, 4 feet, and 5 feet, respectively.

Based on the findings of the hand auger probes, the soils consisted of 6 inches of topsoil over a granular fill layer over the native clay. The granular fill layer encountered in probes OAK-04 and OAK-05 consisted of silty sand and clayey sand soils, and had a thickness of 4 and 18 inches, respectively. Laboratory grain size analysis performed in accordance with ASTM D6913 indicated that the fines content of this granular layer was 43%, which is considered excessive.

In-situ falling head permeability tests were performed in the native clay soils at the termination depths near the probes. The infiltration tests were performed in offset boreholes within 2 feet from the locations of the sampling probes per the guidelines of the City of Detroit stormwater manual. Based on the in-situ infiltration tests the mean hydraulic conductivity (K1) of the native clay ranged between 0.007 and 0.025 inch per hour, which is considered almost impermeable.

Based on the findings of the infiltration tests, we recommend undercutting the existing granular fill soils and some of the native clays and replacing with drainable engineered fill in conformance



to the Green Infrastructure Solution (GIS) design. The geometry of the new expanded swale (length, width, depth, and thickness of the granular soils) shall be designed by the GIS Engineer based on the maximum anticipated surface water runoff at the site.

The GIS design engineer should also consider the level of the anticipated long-term groundwater at the site during the design of the bioswale and the associated drainage systems. Based on the findings at the time of the geotechnical investigation (December 2022), the long-term groundwater table is estimated to be situated at a depth of about 3.3 to 4 feet below existing grades (EL. XXX).

5.0 GENERAL QUALIFICATIONS

All construction activities should be monitored under the direction of a qualified Geotechnical Engineer to verify conditions as interpreted in this report. This report and the attached Logs of Auger Probes are instruments of service, which have been prepared in accordance with generally accepted soil and foundation engineering practices. We make no other warranties either expressed or implied as to the professional advice included in this report.

The contents of this report have been selected in order to aid in the evaluation of expected subsoil properties to assist the Engineer in the design of this project. In the event that any changes are made in the geotechnical aspects of this project, however slight, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and the conclusions of this report are modified in writing by our office.

Since the information obtained from auger probes is specific to the exact test locations, soil and water information could be different from those occurring at other locations of the site. This report does not reflect variations which may occur between the test holes. The nature and extent of these variations may not become evident until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate the recommendations provided in this report.



This report and the associated soil logs should be made available to bidders prior to submitting their proposals and to the successful Contractor and subcontractors for their information only, and to supply them with facts relative to the subsurface investigation, laboratory tests, etc.

The discussions and recommendations submitted in this report are based on the soil information contained in the Logs of Auger Probes and test results appended to this report. We expect that the logs of auger probes, test results, and the soil profiles included in this report along with our discussions and conclusions will assist you in designing the proposed pavement. Please refer to Appendix F for important information about this geotechnical investigation report. If you have any questions regarding this report, please contact us.



APPENDIX A

SOIL BORING LOCATION DIAGRAM



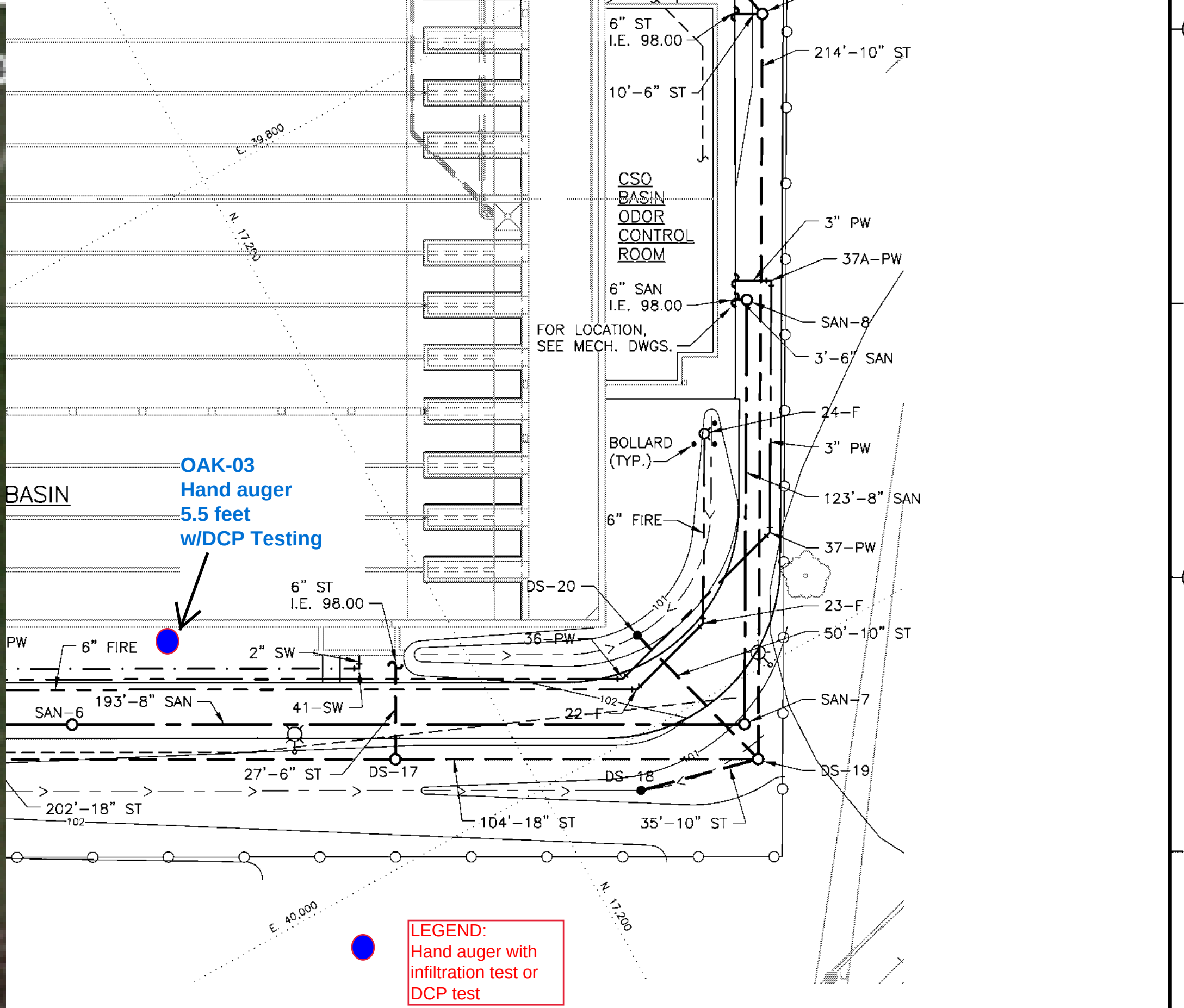
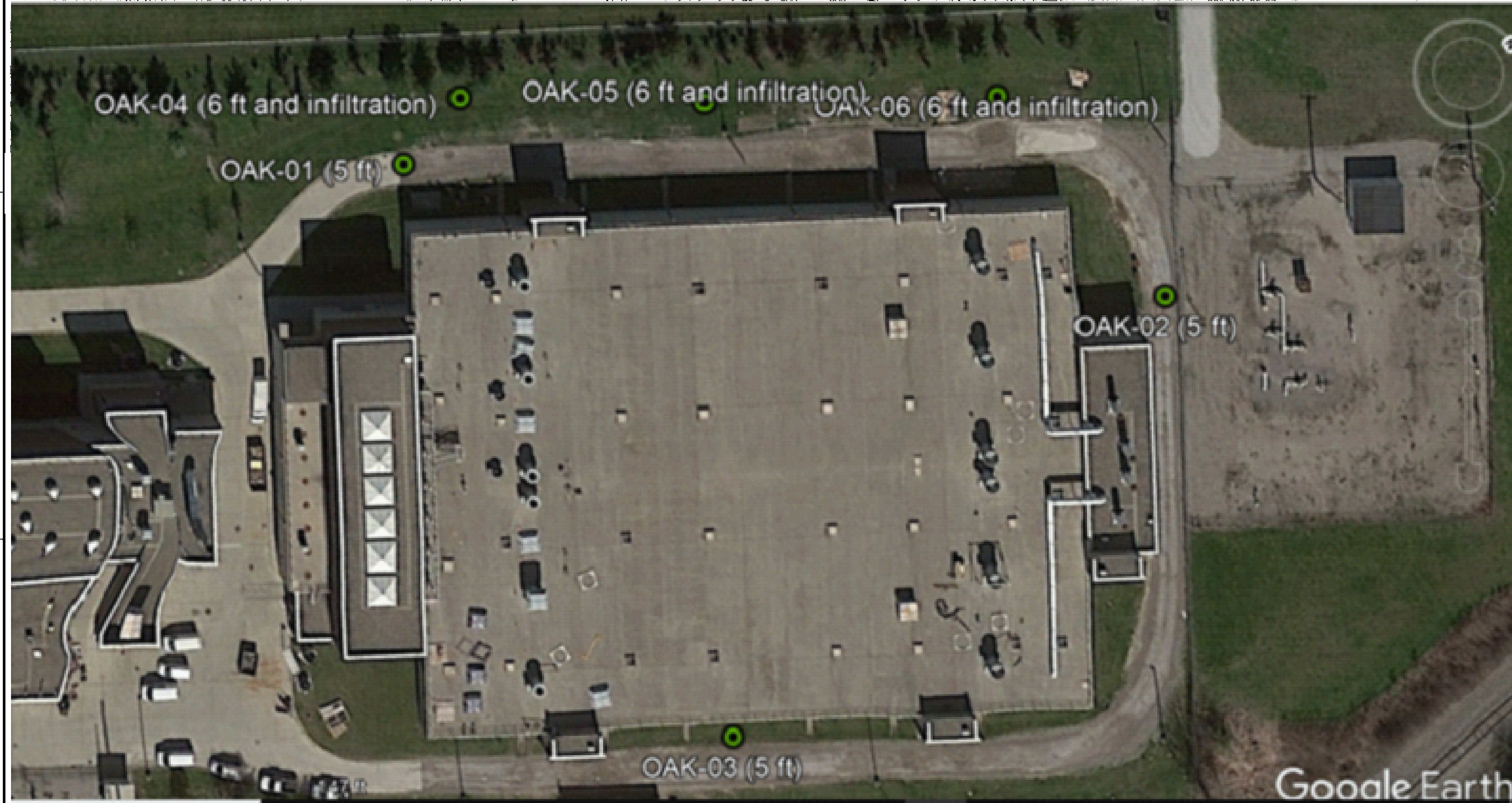
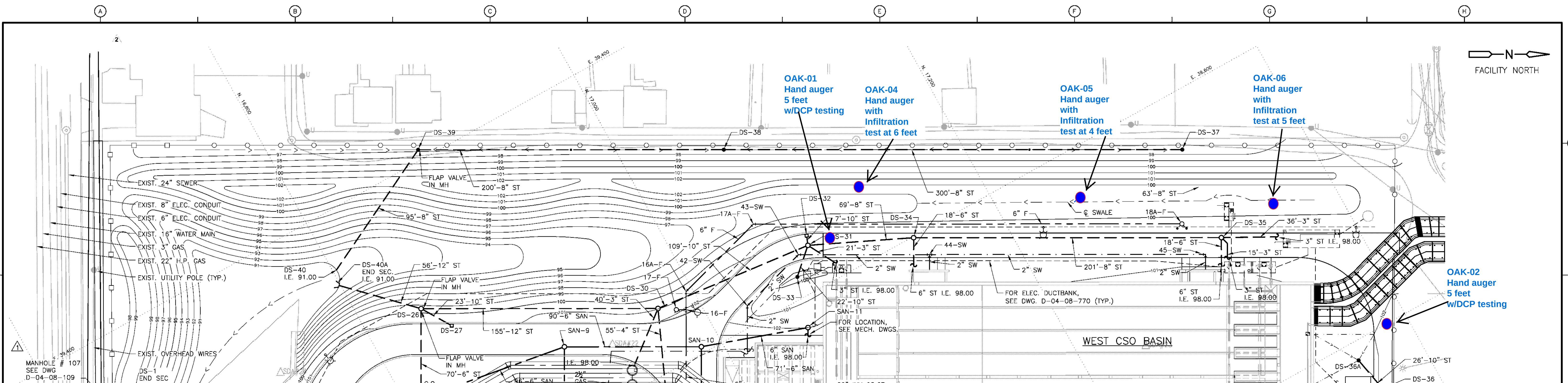
Adapted from Google Earth satellite imagery

Drawing Scale as noted



Project Site – Vicinity Map

Great Lakes Water Authority (GLWA)
GLWA Oakwood CSO Facility
Detroit, Michigan



3 WORKING DAYS BEFORE YOU DIG CALL MISS DIG. 1-800-482-7171

For free location of public utility lines.

ALTERNATE NUMBER (810) MISS-DIG

COLOR CODES FOR UTILITY LOCATING:

Yellow	OIL & GAS	Blue	WATER
Orange	PHONES & CATV	Green	STORM DRAIN
Red	ELECTRIC	Brown	SEWER
		Pink	SURVEYING

IF YOU ARE GOING TO WORK NEAR OVERHEAD WIRES ... CALL MISS DIG

LEGEND:
Hand auger with infiltration test or DCP test

RECORD DRAWING

THIS RECORD DRAWING HAS BEEN PREPARED BASED ON A COMBINATION OF INFORMATION PROVIDED BY OTHERS AND BY CDM SMITH. THEREFORE, THE ENGINEER HAS NOT VERIFIED THE ACCURACY OF ALL THE INFORMATION. TO THE BEST OF THE ENGINEER'S BELIEF AND KNOWLEDGE, THE INCLUDED RECORD INFORMATION IS REASONABLY ACCURATE.

By DUANE D. DeDENE Date 08/2012

CDM Smith

NO.	DESCRIPTION	NO.	DATE	APPROVED
1	REVISED PER BULLETIN NO. 1	1	1/07	AG
2	REVISED PER BULLETIN NO. 2	2	2/07	AG
3	REVISED PER BULLETIN NO. 3	3	3/07	AG
4	LP-2 LOCATION FIELD CHANGE	4	8/12	DDD
5	RFI # 00544	5	8/12	DDD
6	CDM DIRECTIVE	6	8/12	DDD
7	PCS-79	7	8/12	DDD
8	FIELD CHANGE	8	8/12	DDD
9	REVISED FOR RECORD	9	8/12	DDD

DESIGN	KJ
DRAFTING	MV
CHECKED	BB
APPROVED	AG

DETROIT WATER AND SEWERAGE DEPARTMENT

OAKWOOD CSO CONTROL FACILITY AND PUMP STATION

SITE UTILITY PLAN

SCALE: 1" = 30'

DATE: DECEMBER 15, 2006

CDM CDM Michigan Inc. One Woodward Avenue, Suite 1500 Detroit, MI 48226 TEL: (313) 963-1313 FAX: (313) 963-1313 WWW.CDMMICHIGAN.COM	hamiltonanderson Hamilton Anderson Associates 1430 Franklin Suite 200, Detroit, Michigan 48226 P: 313.964.0270 F: 313.964.0170 www.hamilton-anderson.com	Applied Science, Inc. 300 West River, Suite 5400, Detroit, MI 48207 Phone: (313) 967-2600 Fax: (313) 967-2700	TUCKER, YOUNG, JACKSON, TULL, INC. CONSULTING ENGINEERS PLANNERS 200 E. LAMAR SUITE 300, DETROIT, MICHIGAN 48226 TEL: (313) 963-0812 FAX: (313) 963-2166	Associates Inc. 150 W. Congress St., Suite 410 Detroit, MI 48226 Phone: 313-954-7765 Fax: 313-954-7782	SUPERIOR ENGINEERING ASSOC., INC. 6500 Woodward Ave., Suite 2101, Detroit, MI 48202 TEL: (313) 964-2700 FAX: (313) 964-2701 WWW.SUPERIORENGINEERING.COM	SOMAT Engineering, Inc. SOMAT Engineering, Inc. is a subsidiary of "SOMAT GROUP" a national firm 600 Woodward Ave., Suite 1245, Detroit, Michigan (313) 963-2700 Fax: (313) 963-2701	SIGMA CONSULTING ENGINEERS Sigm Associates Inc. 300 Woodward Ave., Suite 1700 Detroit, MI 48226 Tel: 313.963.2700 Fax: 313.963.2701	CITY OF DETROIT WATER AND SEWERAGE DEPARTMENT ENGINEERING DIVISION	M.D.P.H./D.N.R. PERMIT NO. FAMIS NO. CONTRACT NO. PC-755 FILE NO. CSTPL107A.DWG DRAWING NO. D-04-08-107A
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APPENDIX B

LOGS OF TEST BORINGS AND GENERAL NOTES

12/18/22

PROJECT NO. 2022136A DATE STARTED: 12/1/2022 DATE COMPLETED: 12/1/2022 LOG OF TEST BORING OAK-02

ELEVATION ft		LOG OF SOIL PROFILE	DEPTH (ft)	FIELD DATA			LABORATORY DATA						▼ SPT N VALUE ▼					
				SAMPLE NO.	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	10 20 30 40				
														● MOISTURE CONTENT (%) ●				
														10 20 30 40				
												■ UCC STRENGTH (psf) ■						
												2000 4000 6000 8000						
		Ground Surface Elevation ft	0															
<																		

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company:

Drill Rig:

Engineer on Rig: A. Patil

Drilling Method: Hand Auger

Method Notes: ---

Hammer Type:

Backfilled With: Cuttings

Checked By: ALOG

QA/QC By: JA

Remarks:



Somat

DRAFT

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwood CSO Facility
Detroit, Michigan

PROJECT NO. 2022136A DATE STARTED: 12/2/2022 DATE COMPLETED: 12/2/2022 LOG OF TEST BORING OAK-03

ELEVATION ft		LOG OF SOIL PROFILE	DEPTH (ft)	FIELD DATA			LABORATORY DATA						▼ SPT N VALUE ▼						
				SAMPLE NO.	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	10 20 30 40					
														● MOISTURE CONTENT (%) ●					
														10 20 30 40					
												■ UCC STRENGTH (psf) ■							
												2000 4000 6000 8000							
		Ground Surface Elevation ft	0																

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company: NA
Drill Rig: NA
Engineer on Rig: A. Patil
Drilling Method: Hand Auger
Method Notes: ---
Hammer Type:
Backfilled With: Cuttings
Checked By: ALOG
QA/QC By: JA
Remarks:



DRAFT
Somat Engineering Inc.

**Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwood CSO Facility
Detroit, Michigan**

PROJECT NO. 2022136A DATE STARTED: 12/1/2022 DATE COMPLETED: 12/1/2022 LOG OF TEST BORING OAK-04

ELEVATION ft	LOG OF SOIL PROFILE	DEPTH (ft)	FIELD DATA			LABORATORY DATA						▼ SPT N VALUE ▼																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company: NA

Drill Rig: NA

Engineer on Rig: A. Patil

Drilling Method: Hand Auger

Method Notes: ---

Hammer Type:

Backfilled With: Cuttings

Checked By: ALOG

QA/QC By: JA

Remarks:



DRAFT
Somat Engineering Inc.

**Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwood CSO Facility
Detroit, Michigan**

PROJECT NO. 2022136A DATE STARTED: 12/2/2022 DATE COMPLETED: 12/2/2022 LOG OF TEST BORING OAK-05

ELEVATION ft	LOG OF SOIL PROFILE		DEPTH (ft)	FIELD DATA			LABORATORY DATA						▼ SPT N VALUE ▼					
				SAMPLE NO.	NO. OF BLOWS FOR 6-inch DRIVE	N VALUE	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200	10 20 30 40				
														● MOISTURE CONTENT (%) ●				
														10 20 30 40				
													■ UCC STRENGTH (psf) ■					
													2000 4000 6000 8000					
		Ground Surface Elevation ft	0															
		6 inches of clayey TOPSOIL, dark brown	0.5															
		FILL - Silty sand, few gravel, brown, moist (SM)	2.0	HA1			1.5						43					
		SANDY LEAN CLAY, few gravel, trace roots, dark brown (CL) (Possible fill)	4.0	HA2			2.7	3000*	14.8									
		End of Boring at 4 ft. In-Situ falling head permeability test performed at a depth of 4 ft. had mean hydraulic conductivity of 0.025 inch/hour	5															
			10															

GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company: NA

Drill Rig: NA

Engineer on Rig: A. Patil

Drilling Method: Hand Auger

Method Notes: ---

Hammer Type:

Backfilled With: Cuttings

Checked By: ALOG

QA/QC By: JA

Remarks:



DRAFT
Somat Engineering Inc.

**Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwood CSO Facility
Detroit, Michigan**

PROJECT NO. 2022136A DATE STARTED: 12/2/2022 DATE COMPLETED: 12/2/2022 LOG OF TEST BORING OAK-06

ELEVATION ft	LOG OF SOIL PROFILE		DEPTH (ft)	FIELD DATA			LABORATORY DATA							▼ SPT N VALUE ▼																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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GROUNDWATER READINGS

First Encountered: none
Upon Completion: none

BORING LOCATION INFORMATION

Coordinates/GSE determined by:
Project Surveyor

KEY

Torvane
* Penetrometer
<> Disturbed Sample

Drilling Company: NA
Drill Rig: NA
Engineer on Rig: A. Patil
Drilling Method: Hand Auger
Method Notes: ---
Hammer Type:
Backfilled With: Cuttings
Checked By: ALOG
QA/QC By: JA
Remarks:



DRAFT
Somat Engineering Inc.

**Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwood CSO Facility
Detroit, Michigan**



GENERAL NOTES

Unified Soil Classification System (USCS) ASTM D2488 (Modified)

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon – 1 3/8" I.D., 2" O.D. (standard)	BS:	Bulk Sample	RC:	Rock Core with diamond bit, NX size, (unless otherwise noted)
S:	Split Spoon – non-standard size, as noted	HSA:	Hollow Stem Auger	RB:	Rock Bit/Roller Bit
ST:	Thin-Walled Tube – 3" O.D., (unless otherwise noted)	DP:	Direct Push	WR:	Wash Rotary
LS:	Liner Sample	PS:	Piston Sample	NR:	No Recovery
PA:	Power Auger	PT:	Pitcher Sample	VS:	Vane Shear Test
HA:	Hand Auger	WS:	Wash Sample	ER:	Hammer Energy Ratio
AU:	Auger Sample				

Standard Penetration Test Resistance, N-Value: Sum of 2nd and 3rd 6-inch increments, in blows per foot of a 140-pound hammer falling 30 inches and driving an 18-inch to 30-inch long, 2-inch OD split spoon.

WATER LEVEL MEASUREMENT:

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. In pervious soils, the indicated levels may reflect the location of a groundwater table. In low permeability soils (clays and silts), the accurate determination of groundwater levels may not be possible with only short-term observations. Groundwater levels at times and locations other than when and where individual borings were performed could vary.

DESCRIPTIVE SOIL CLASSIFICATION:

Soil classification is based on the Unified Soil Classification (USC) System and ASTM Standards D-2487 and D-2488. Coarse-grained soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are generally described as: clays, if they are plastic, and silts, if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their apparent in-place density and fine-grained soils on the basis of their apparent in-place density (silty soils) or consistency (clayey soils).

CONSISTENCIES OF COHESIVE SOILS:

The pocket penetrometer, pocket torvane, and in-situ vane shear tests are converted into an estimated unconfined compressive strength, in pounds per square feet (psf), for presentation on the logs. The unconfined compressive strength is estimated to be about two time the shear strength.

DESCRIPTORS OF MINOR CONSTITUENTS

Primary Constituent	Fine-Grained (Silt & Clay)	Coarse-Grained (Sand & Gravel)	
Descriptor of Other Constituents	Relative Portion of Coarse Grained Soils as a % of Dry Weight	Relative Portion of Fine Grained Soils as a % of Dry Weight	Relative Portion of Coarse Grained Soils as a % of Dry Weight
Trace	<5%	<5%	<5%
Few	≥5% - <15%	N/A	≥5% - <15%
With	≥15% - <30%	≥5% - 12%	≥15%
Modifier	≥30%	>12%	N/A

FINE-GRAINED SOILS

Unconfined Compressive Strength Q_u , psf	Consistency	N-Value	Apparent Density
< 500	Very Soft	0 – 4	Very Loose
500 - <1,000	Soft	5 – 9	Loose
1,000 - <2,000	Medium	10 – 29	Medium Dense
2,000 - <4,000	Stiff	30 – 49	Dense
4,000 - <8,000	Very Stiff	50 – 80	Very Dense
≥ 8,000	Hard	>80	Extremely Dense

COARSE-GRAINED SOILS

DEFINITIONS OF PAVEMENT CONDITION

Condition	Description
Good	ACC Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks and transverse cracks (open ¼ inch). No patching or very few patches in excellent condition.
	PCC Moderate scaling in several locations. A few isolated surface spalls. Shallow reinforcement causing cracks. Several corner cracks, tight or well sealed. Open (¼ inch wide) longitudinal or transverse joints.
Fair	ACC Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (½ inch deep or less).
	PCC Severe polishing, scaling, map cracking, or spalling over 50% of the area. Joints and cracks show moderate to severe spalling. Pumping and faulting of joints (½ inch with fair ride). Several slabs have multiple transverse or meander cracks with moderate spalling.
Poor	ACC Alligator cracking (over 25% of surface). Severe distortions (over 2 inches deep) Extensive patching in poor condition. Potholes.
	PCC Extensive slab cracking, severely spalled and patched. Joints failed. Patching in very poor condition. Severe and extensive settlement or frost heaves.

DEFINITIONS OF STRUCTURAL AND DEPOSITIONAL FEATURES

Term	Definition
Parting	≤ 1/16 inch (1.6 mm) thick
Seam	> 1/16 inch (1.6 mm) → ½ inch (12.7 mm) thick
Layer	> ½ inch (12.7 mm) to ≤ 12 inches (305 mm) thick
Pocket	Small, erratic deposits of limited lateral extent
Lens	Lenticular deposit
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Varved	Alternating partings or seams (1 mm – 12 mm) of silt and/or clay and sometimes fine sand
Stratified	Alternating layers of varying material or color with layers ≥ 6 mm thick
Laminated	Alternating layers of varying material or color with layers < 6 mm thick
Fissured	Contains shears or separations along planes of weakness
Slickensided	Shear planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Homogeneous	Same color and appearance throughout
Occasional	One or less per foot (305 mm) of thickness
Frequent	More than one per foot (305 mm) of thickness
Interbedded	Applied to strata of soil lying between or alternating with other strata of a different nature

GRAIN SIZE TERMINOLOGY

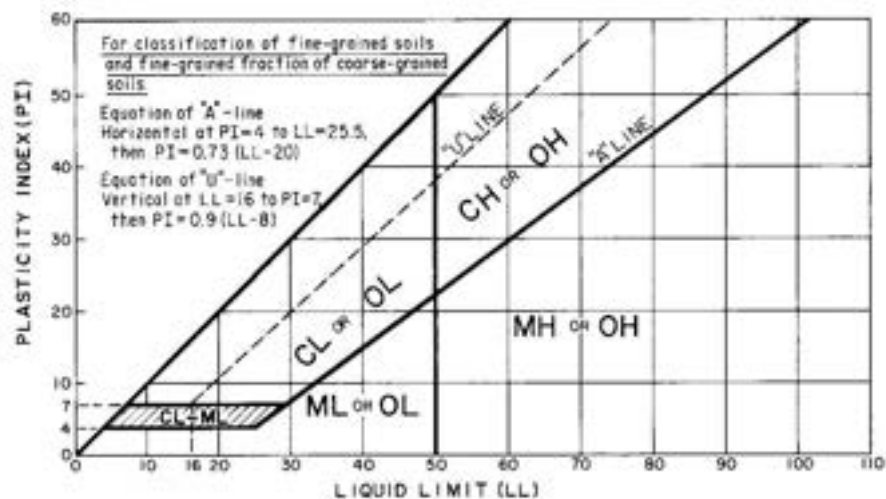
Major Component of Sample	Size Range
Boulders	≥ 12" (300 mm)
Cobbles	< 12" - 3" (300 mm – 75 mm)
Gravel - Coarse	< 3" - ¾" (75 mm – 19 mm)
Gravel - Fine	< ¾" - #4 (19 mm – 4.75 mm)
Sand - Coarse	< #4 - #10 (4.75 mm – 2 mm)
Sand - Medium	< #10 - #40 (2 mm - 0.425 mm)
Sand - Fine	< #40 - #200 (0.425 mm - 0.074 mm)
Silt	< 0.074 mm - 0.005 mm
Clay	< 0.005 mm



GENERAL NOTES

Unified Soil Classification System (USCS) ASTM D2487

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	Group Name <i>B</i>
COARSE-GRAINED More than 50 % retained on No. 200 sieve	Gravels (More than 50 % of coarse fraction retained on No. 4 sieve)	Clean Gravels	$Cu \geq 4$ and $1 \leq Cc \leq 3^D$	GW	Well-graded gravel ^E
		(Less than 5% fines ^C)	$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3]^D$	GP	Poorly graded gravel ^E
		Gravels with Fines	Fines classify as ML or MH	GM	Silty gravel ^{E,F,G}
		(More than 12 % fines ^C)	Fines classify as CL or CH	GC	Clayey gravel ^{E,F,G}
	Sands (50 % or more of coarse fraction passes No. 4 sieve)	Clean Sands	$Cu \geq 6$ and $1 \leq Cc \leq 3^D$	SW	Well-graded sand ^I
		(Less than 5 % fines ^H)	$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3]^D$	SP	Poorly graded sand ^I
		Sands with Fines	Fines classify as ML or MH	SM	Silty sand ^{F,G,I}
		(More than 12 % fines ^H)	Fines classify as CL or CH	SC	Clayey sand ^{F,G,I}
FINE-GRAINED SOILS 50 % or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line ^J	CL	Lean clay ^{K,L,M}
			PI < 4 or plots below "A" line ^J	ML	Silt ^{K,L,M}
		organic	(Liquid Limit - oven dried) / (Liquid Limit - not dried) < 0.75	OL	Organic clay ^{K,L,M,N}
					Organic silt ^{K,L,M,O}
	Silts and Clays Liquid limit more than 50	inorganic	PI plots on or above "A" line	CH	Fat clay ^{K,L,M}
			PI plots below "A" line	MH	Elastic silt ^{K,L,M}
		organic	(Liquid Limit - oven dried) / (Liquid Limit - not dried) < 0.75	OH	Organic clay ^{K,L,M,P}
					Organic silt ^{K,L,M,Q}
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			Pt	Peat
^A Based on the material passing the 3-in. (75-mm) sieve. ^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name. ^C Gravels with 5 to 12 % fines require dual symbols: GW-GM well-graded gravel with silt GW-GC well-graded gravel with clay GP-GM poorly graded gravel with silt GP-GC poorly graded gravel with clay ^D $Cu = D_{60}/D_{10}$ $Cc = (D_{30})^2 / (D_{10} \times D_{60})$ ^E If soil contains ≥ 15 % sand, add "with sand" to group name. ^F If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM. ^G If fines are organic, add "with organic fines" to group name. ^H Sands with 5 to 12 % fines require dual symbols: SW-SM well-graded sand with silt SW-SC well-graded sand with clay SP-SM poorly graded sand with silt SP-SC poorly graded sand with clay ^I If soil contains ≥ 15 % gravel, add "with gravel" to group name. ^J If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay. ^K If soil contains 15 to <30 % plus No. 200, add "with sand" or "with gravel," whichever is predominant. ^L If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name. ^M If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name. ^N $PI \geq 4$ and plots on or above "A" line. ^O $PI < 4$ or plots below "A" line. ^P PI plots on or above "A" line. ^Q PI plots below "A" line.					



Order of Classification: 1) Consistency or Apparent Density, 2) Type of Soil, 3) Minor Soil Type(s), 4) Inclusions, 5) Layered Soils, 6) Color, 7) Water Content, 8) USCS Symbol, 9) Geological Name

APPENDIX C

DYNAMIC CONE PENETROMETER (DCP) TEST RESULTS



SOMAT ENGINEERING, INC.
GEOTECHNICAL - GEORENVIROMENTAL - MATERIALS TESTING

RESULTS OF DCP TESTING

OAK-01

Page 1 of 1

Project: Great Lakes Water Authority (GLWA)
GLWA Oakwood CSO Facility

Hand Aguer
Probe ID:

OAK-01

Location: Roadway Gravel

Project No.: Detroit, Michigan
2022136A

Date: 12/1/2022

Weather: 34°

Personnel: A. Patil

GS Elevation: #REF!

Start Depth: 6.0 in.

Water Depth: none ft.

Latitude:

Longitude:

Type of Material	Classification	# of Blows per Set (1)	Cumulative Penetration (in) (2)	Cumulative Penetration (mm) (3)	Incremental Penetration per Blow Set (mm) (4)	Cumulative Blows (5)	Penetration per Blow for Set (mm/blow) (6)	Hammer (7)	DCP Index (mm/blow) (8)	Estimated CBR (%) (9)
FILL-Mixture of crushed aggregate and sand		5	6.0	153	0	0				
FILL-Mixture of crushed aggregate and sand		5	6.6	168	15	5	3.0	1	3	85
FILL-Mixture of crushed aggregate and sand		5	6.9	174	6	10	1.2	1	1	100
FILL-Mixture of crushed aggregate and sand		5	7.2	183	9	15	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	7.6	194	11	20	2.2	1	2	100
FILL-Mixture of crushed aggregate and sand		5	8.1	205	11	25	2.2	1	2	100
FILL-Mixture of crushed aggregate and sand		5	8.5	215	10	30	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	8.8	224	9	35	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	9.2	233	9	40	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	9.5	242	9	45	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	10.2	258	16	50	3.2	1	3	79
FILL-Mixture of crushed aggregate and sand		5	10.7	273	15	55	3.0	1	3	85
FILL-Mixture of crushed aggregate and sand		5	11.2	285	12	60	2.4	1	2	100
FILL-Mixture of crushed aggregate and sand		5	11.8	299	14	65	2.8	1	3	92
FILL-Mixture of crushed aggregate and sand		5	12.3	312	13	70	2.6	1	3	100
FILL-Mixture of crushed aggregate and sand		5	12.7	323	11	75	2.2	1	2	100
FILL-Mixture of crushed aggregate and sand		5	13.2	335	12	80	2.4	1	2	100
FILL-Mixture of crushed aggregate and sand		5	13.7	348	13	85	2.6	1	3	100
FILL-Mixture of crushed aggregate and sand		5	14.1	357	9	90	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	14.4	365	8	95	1.6	1	2	100
FILL-Mixture of crushed aggregate and sand		5	14.9	378	13	100	2.6	1	3	100
FILL-Mixture of crushed aggregate and sand		5	15.3	388	10	105	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	15.7	398	10	110	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	16.0	407	9	115	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	16.7	425	18	120	3.6	1	4	70
FILL-Mixture of crushed aggregate and sand		5	17.0	433	8	125	1.6	1	2	100
FILL-Mixture of crushed aggregate and sand		5	17.4	443	10	130	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	18.0	458	15	135	3.0	1	3	85
FILL-Mixture of crushed aggregate and sand		5	18.6	473	15	140	3.0	1	3	85
FILL-Mixture of crushed aggregate and sand		5	19.1	485	12	145	2.4	1	2	100
FILL-Mixture of crushed aggregate and sand		5	19.5	495	10	150	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	19.9	505	10	155	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	20.3	516	11	160	2.2	1	2	100
FILL-Mixture of crushed aggregate and sand		5	20.3	516	0	165	0.0	1	0	
FILL-Mixture of crushed aggregate and sand		5	20.6	523	7	170	1.4	1	1	100
FILL-Mixture of crushed aggregate and sand		5	21.0	533	10	175	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	21.4	543	10	180	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	21.6	549	6	185	1.2	1	1	100
FILL-Mixture of crushed aggregate and sand		5	22.0	559	10	190	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	22.4	569	10	195	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	22.8	578	9	200	1.8	1	2	100
FILL-Mixture of crushed aggregate and sand		5	23.0	585	7	205	1.4	1	1	100
FILL-Mixture of crushed aggregate and sand		5	23.4	595	10	210	2.0	1	2	100
FILL-Mixture of crushed aggregate and sand		5	23.8	605	10	215	2.0	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	24.2	615	10	220	2.0	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	24.7	627	12	225	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	25.2	639	12	230	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	25.7	653	14	235	2.8	1	3	92
FILL - Sand, trace silt, trace gravel	SP	5	26.2	665	12	240	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	26.7	677	12	245	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	27.1	689	12	250	2.4	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	27.8	705	16	255	3.2	1	3	79
FILL - Sand, trace silt, trace gravel	SP	5	28.1	715	10	260	2.0	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	28.5	723	8	265	1.6	1	2	100
FILL - Sand, trace silt, trace gravel	SP	5	29.1	740	17	270	3.4	1	3	74

(1) Number of hammer blows between test readings

(2) Cumulative cone penetration after each set of hammer blows.

(3) Incremental penetration between blow sets

(4) Cumulative total of blows

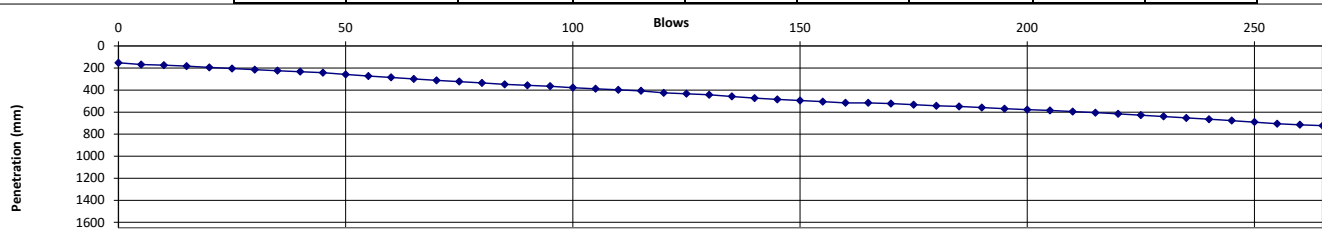
(5) (3) divided by (1)

(6) Enter 1 for 17.6 lb. hammer, 2 for 10.1 lb. hammer.

(7) (5) x (6)

(8) From CBR versus DCP Correlation.

X (# of Blows)		Y (Penetration)		Blow Count	Total Penetration (mm)	Hammer Factor	Log Report	
Begin	End	Begin (mm)	End (mm)				(mm/Blow)	depth (ft)
0	50	153	258	50	105	1	2.1	0.5
50	100	258	378	50	120	1	2.4	0.8
100	150	378	495	50	117	1	2.3	1.2
150	200	495	578	50	83	1	1.7	1.6
200	270	578	740	70	162	1	2.3	1.9





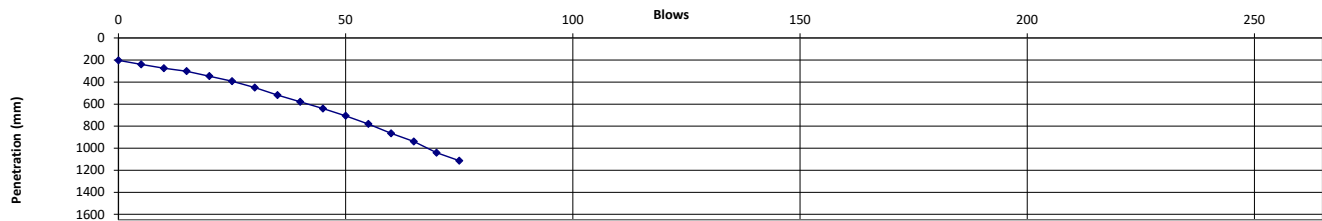
OAK-02

Page 1 of 1

[illegible]

(5) (3) divided by (1)
(6) Enter 1 for 17.6 lb. hammer, 2 for 10.1 lb. hammer.
(7) (5) x (6)
(8) From CBR versus DCP Correlation.

X (# of Blows)		Y (Penetration)		Blow Count	Total Penetration (mm)	Hammer Factor	Log Report	
Begin	End	Begin (mm)	End (mm)				(mm/Blow)	depth (ft)
0	20	204	346	20	142	1	7.1	0.7
20	30	346	450	10	104	1	10.4	1.1
30	60	450	865	30	415	1	13.8	1.5
60	70	865	1041	10	176	1	17.6	2.8
70	75	1041	1114	5	73	1	14.6	3.4





OAK-03

Page 1 of 1

(1) Number of hammer blows between test readings	(5) (3) divided by (1)
(2) Cumulative cone penetration after each set of hammer blows.	(6) Enter 1 for 17.6 lb. hammer, 2 for 10.1 lb. hammer.
(3) Incremental penetration between blow sets	(7) (5) x (6)
(4) Cumulative total of blows	(8) From CBR versus DCP Correlation.

The graph plots Penetration (mm) on the y-axis against Blows on the x-axis. The y-axis scale is inverted, with 0 at the top and 1600 at the bottom. The x-axis scale ranges from 0 to 250 blows. The data points are connected by a smooth curve, showing that penetration increases as the number of blows increases.

Blows	Penetration (mm)
0	0
10	10
20	20
30	30
40	40
50	50
60	60
70	70
80	80
90	90
100	100
110	110
120	120
130	130
140	140
150	150
160	160
170	170
180	180
190	190
200	200
210	210
220	220
230	230
240	240
250	250

Infrastructure Engineering Solutions

APPENDIX D

IN-SITU FALLING HEAD PERMEABILITY TEST RESULTS



PROJECT: Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO)
Improvements Projects GWLA Oakwood CSO Facility
Detroit, Michigan

PROJECT NO: 2022136A

PRESOAK START DATE/TIME/DURATION: 12/1/2022 11:33

TEST START DATE/TIME 12/1/2022 12:03

TEST END DATE/TIME 12/1/2022 13:02

FIELD ENGINEER/ANALYST: A. Patil

BOREHOLE DRILL DATE: 12/1/2022

BOREHOLE LOCATION: Grass

TOP OF BOREHOLE/GROUND ELEV.: _____

LATITUDE: _____

LONGITUDE: _____

COORDINATES/ELEVATION NOTES: Project Surveyor

In-situ falling head permeability test and calculations performed per guidelines adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015) and ASTM D-6391 Method A

EQUIPMENT

PRESSURE TRANSDUCER In-Situ Level TROLL 700

DATA LOGGER SOFTWARE Win-Situ 5

DATA INPUT

CASING DIAMETER, D1 6.0 in.

CASING DIAMETER (inside casing), d 6.0 in.

DISTANCE BOTTOM OF CASING TO BOTTOM OF STRATUM, b1 10.0 ft.

TEST DEPTH (below existing grade) 6.0 ft.

APPROX. TEST ELEVATION -6.0 ft.

EQUATIONS

Mean hydraulic conductivity (K1):
(Equations obtained from D6391-11)

$$K1 = Rt \cdot G1 \cdot \ln(H1/H2) / (t_2 - t_1) \quad (\text{cm/sec}) \quad \text{eq. 1}$$

$$G1 = (\pi d^2 / 11 D1) [1 + a(D1/4b1)] \quad (\text{cm}) \quad \text{eq. 2}$$

Rt = temperature coefficient (varies)

a = material at the test depth = 1

G1 = test setup parameter 4.407 (calculated based on data input)

- 1.) Use inner diameter of casing for "D1" and "d" because no standpipe was used
- 2.) Rt calculated as $2.2902(0.9842^T)^{0.1702}$ and T is temperature in °C
- 3.) "a" in eq. 2 is "-1" for permeable base; or "1" for impermeable base below test stratum
- 4.) b1 is distance from bottom of casing to bottom of stratum
- 5.) H1 and H2 are the the level surface elevations at times t1 and t2

MEAN HYDRAULIC CONDUCTIVITY (K1)

K1 7.062E-06 cm/sec (0.010 inch/hour)

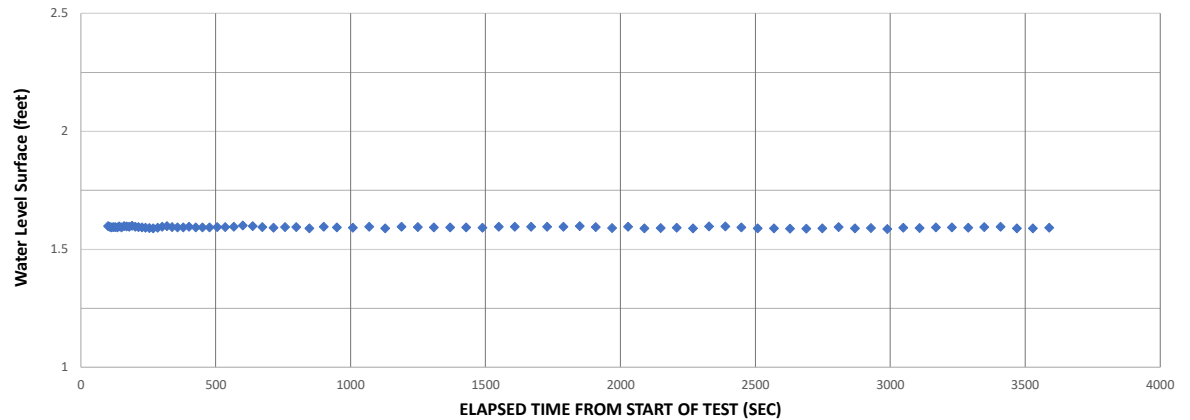
SOIL TYPE AT TEST DEPTH

DESCRIPTION DEPTH (ft.)

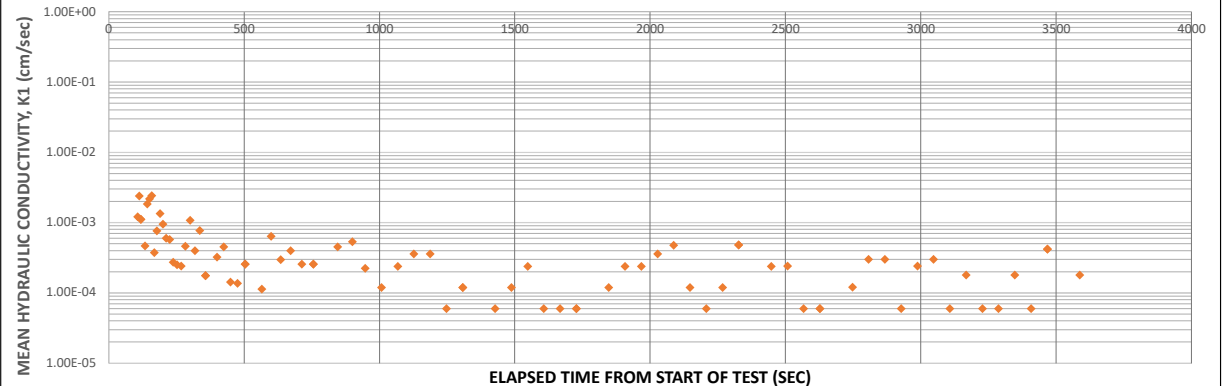
LEAN CLAY, few sand, trace gravel 6.0

NOTES: Groundwater encountered during drilling: none
Groundwater reported upon completion of drilling: none

WATER LEVEL SURFACE vs. TIME ELAPSED



MEAN HYDRAULIC CONDUCTIVITY vs. TIME ELAPSED





PROJECT: Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO)
Improvements Projects GWLA Oakwood CSO Facility
Detroit, Michigan

PROJECT NO: 2022136A

PRESOAK START DATE/TIME/DURATION: 12/2/2022 13:31

TEST START DATE/TIME 12/2/2022 14:01

TEST END DATE/TIME 12/2/2022 15:02

FIELD ENGINEER/ANALYST: A. Patil

BOREHOLE DRILL DATE: 12/2/2022

BOREHOLE LOCATION: Grass

TOP OF BOREHOLE/GROUND ELEV.: _____

LATITUDE: _____

LONGITUDE: _____

COORDINATES/ELEVATION NOTES: Project Surveyor

In-situ falling head permeability test and calculations performed per guidelines adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015) and ASTM D-6391 Method A

EQUIPMENT

PRESSURE TRANSDUCER In-Situ Level TROLL 700

DATA LOGGER SOFTWARE Win-Situ 5

DATA INPUT

CASING DIAMETER, D1 6.0 in.

CASING DIAMETER (inside casing), d 6.0 in.

DISTANCE BOTTOM OF CASING TO BOTTOM OF STRATUM, b1 10.0 ft.

TEST DEPTH (below existing grade) 4.0 ft.

APPROX. TEST ELEVATION -4.0 ft.

EQUATIONS

Mean hydraulic conductivity (K1):

(Equations obtained from D6391-11)

$$K1 = Rt \cdot G1 \cdot \ln(H1/H2) / (t_2 - t_1) \quad (\text{cm/sec}) \quad \text{eq. 1}$$

$$G1 = (\pi d^2 / 11 D1) [1 + a(D1/4b1)] \quad (\text{cm}) \quad \text{eq. 2}$$

Rt = temperature coefficient (varies)

a = material at the test depth = 1

G1 = test setup parameter 4.407 (calculated based on data input)

- 1.) Use inner diameter of casing for "D1" and "d" because no standpipe was used
- 2.) Rt calculated as $2.2902(0.9842^T)T^{-0.1702}$ and T is temperature in °C
- 3.) "a" in eq. 2 is "-1" for permeable base; or "1" for impermeable base below test stratum
- 4.) b1 is distance from bottom of casing to bottom of stratum
- 5.) H1 and H2 are the the level surface elevations at times t1 and t2

MEAN HYDRAULIC CONDUCTIVITY (K1)

K1 1.736E-05 cm/sec (0.025 inch/hour)

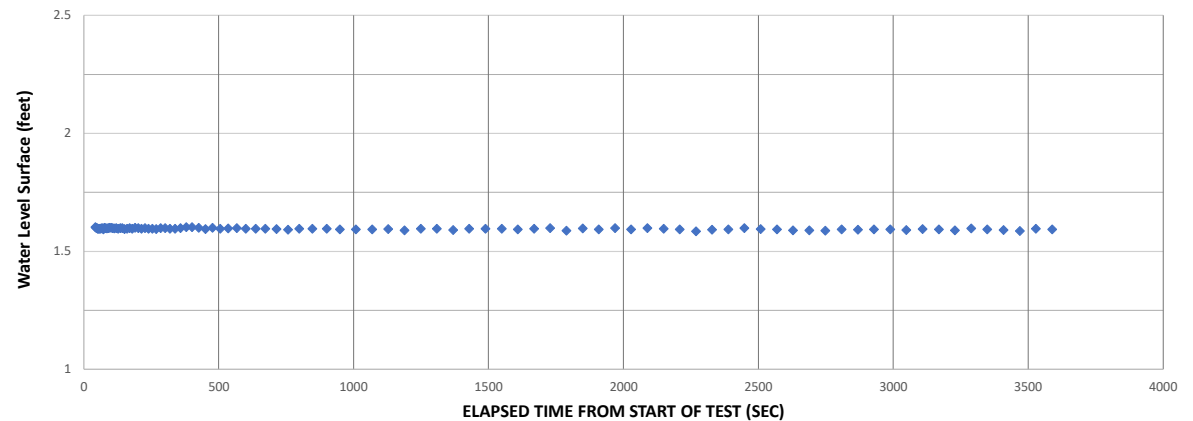
SOIL TYPE AT TEST DEPTH

DESCRIPTION SANDY LEAN CLAY, few gravel, trace roots DEPTH (ft.) 4.0

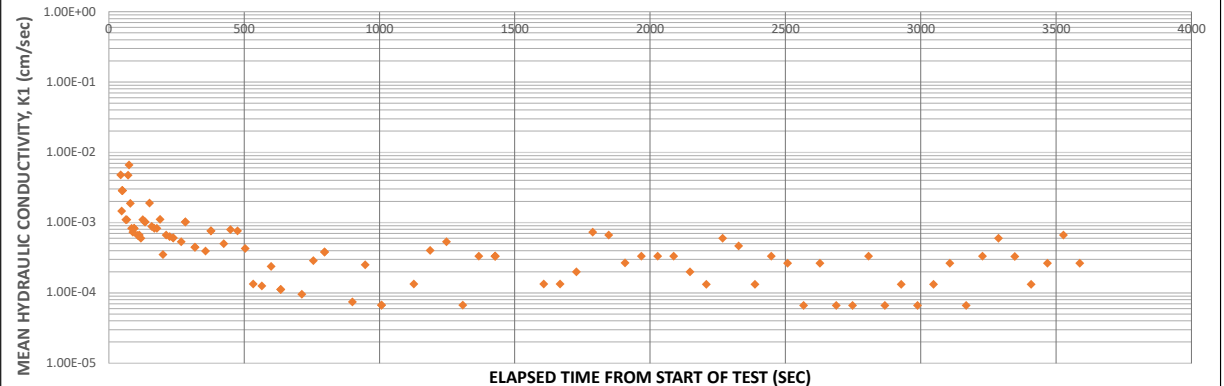
NOTES: Groundwater encountered during drilling: none

Groundwater reported upon completion of drilling: none

WATER LEVEL SURFACE vs. TIME ELAPSED



MEAN HYDRAULIC CONDUCTIVITY vs. TIME ELAPSED





PROJECT: Great Lakes Water Authority (GLWA)
Design Services for Combined Sewer Outfall (CSO)
Improvements Projects GWLA Oakwood CSO Facility
Detroit, Michigan

PROJECT NO: 2022136A

PRESOAK START DATE/TIME/DURATION: 12/2/2022 10:29

TEST START DATE/TIME 12/2/2022 10:59

TEST END DATE/TIME 12/2/2022 12:00

FIELD ENGINEER/ANALYST: A. Patil

BOREHOLE DRILL DATE: 12/1/2022

BOREHOLE LOCATION: Grass

TOP OF BOREHOLE/GROUND ELEV.: _____

LATITUDE: _____

LONGITUDE: _____

COORDINATES/ELEVATION NOTES: Project Surveyor

In-situ falling head permeability test and calculations performed per guidelines adapted from the Philadelphia Water Stormwater Management Guidance Manual (Philadelphia Water, 2015) and ASTM D-6391 Method A

EQUIPMENT

PRESSURE TRANSDUCER In-Situ Level TROLL 700

DATA LOGGER SOFTWARE Win-Situ 5

DATA INPUT

CASING DIAMETER, D1 6.0 in.

CASING DIAMETER (inside casing), d 6.0 in.

DISTANCE BOTTOM OF CASING TO BOTTOM OF STRATUM, b1 10.0 ft.

TEST DEPTH (below existing grade) 5.0 ft.

APPROX. TEST ELEVATION -5.0 ft.

EQUATIONS

Mean hydraulic conductivity (K1):

(Equations obtained from D6391-11)

$$K1 = Rt \cdot G1 \cdot \ln(H1/H2) / (t_2 - t_1) \quad (\text{cm/sec}) \quad \text{eq. 1}$$

$$G1 = (\pi d^2 / 11 D_1) [1 + a(D_1 / 4b_1)] \quad (\text{cm}) \quad \text{eq. 2}$$

Rt = temperature coefficient (varies)

a = material at the test depth = 1

G1 = test setup parameter 4.407 (calculated based on data input)

- 1.) Use inner diameter of casing for "D₁" and "d" because no standpipe was used
- 2.) Rt calculated as $2.2902(0.9842^T)^{0.1702}$ and T is temperature in °C
- 3.) "a" in eq. 2 is "-1" for permeable base; or "1" for impermeable base below test stratum
- 4.) b₁ is distance from bottom of casing to bottom of stratum
- 5.) H₁ and H₂ are the the level surface elevations at times t₁ and t₂

MEAN HYDRAULIC CONDUCTIVITY (K1)

K₁ 5.181E-06 cm/sec (0.007 inch/hour)

SOIL TYPE AT TEST DEPTH

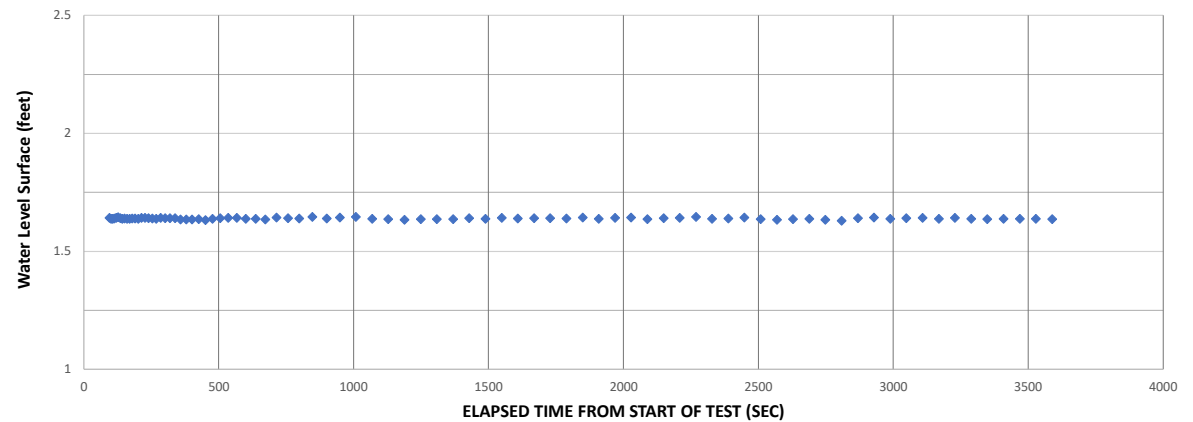
DESCRIPTION DEPTH (ft.)

SANDY LEAN CLAY, trace roots, trace gravel 5.0

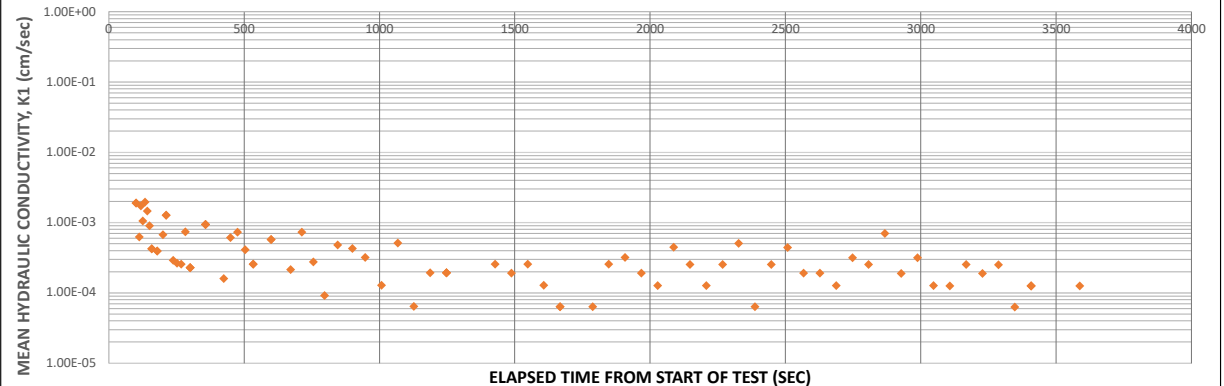
NOTES: Groundwater encountered during drilling: none

Groundwater reported upon completion of drilling: none

WATER LEVEL SURFACE vs. TIME ELAPSED



MEAN HYDRAULIC CONDUCTIVITY vs. TIME ELAPSED



APPENDIX E

LABORATORY TEST RESULTS & LABORATORY TEST DESCRIPTIONS

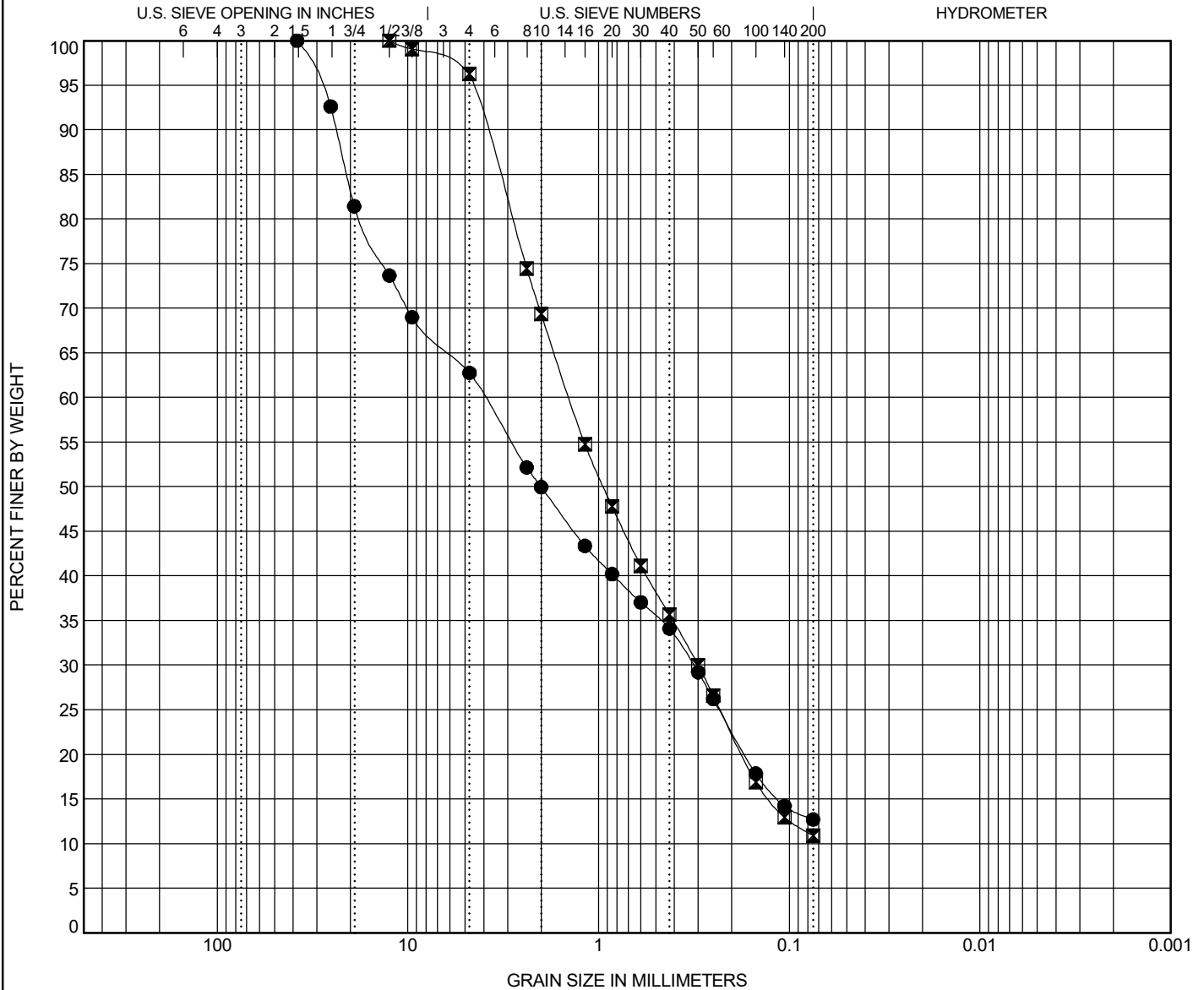


Somat

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A



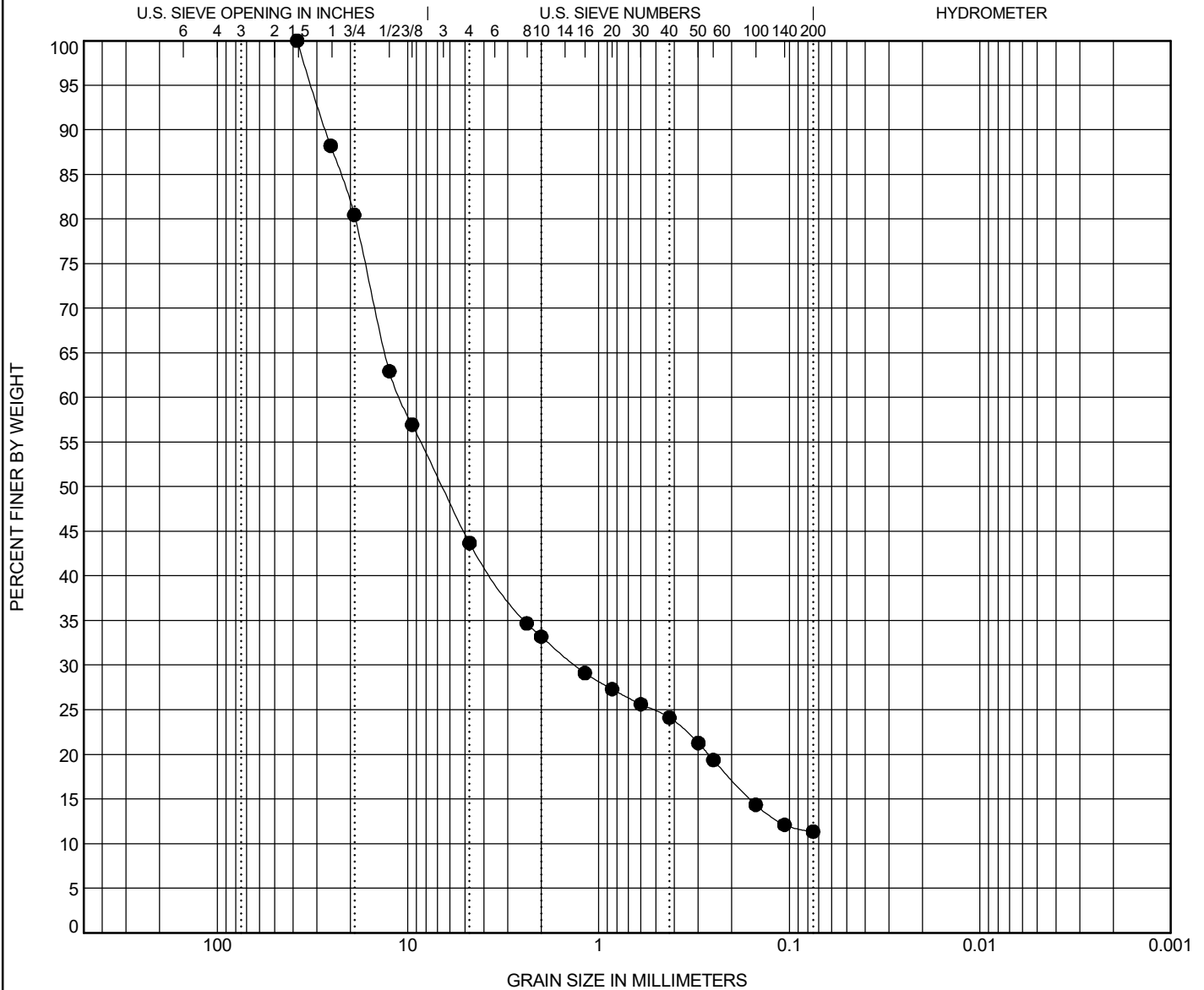


Somat

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A



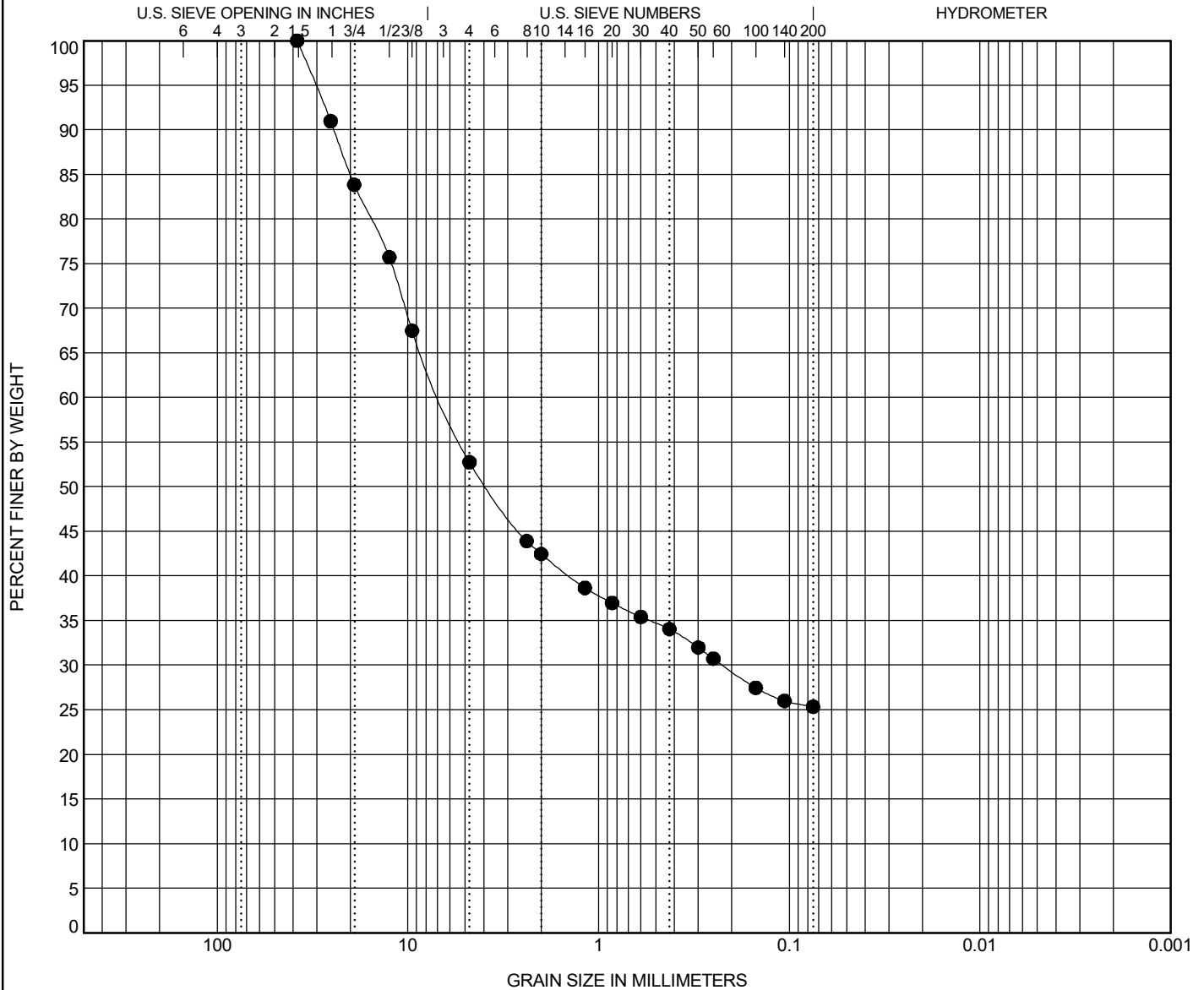


Somat

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Depth ft.	Remarks					LL	PL	PI	Cc	Cu
● OAK-03	0.0										
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● OAK-03	0.0	38.1	6.682	0.223		47.3	27.4	25.3			

GRAIN SIZE GLWA OAKWOOD AND LEIB CSO FACILITIES.GPJ SOMAT.GDT 12/18/22

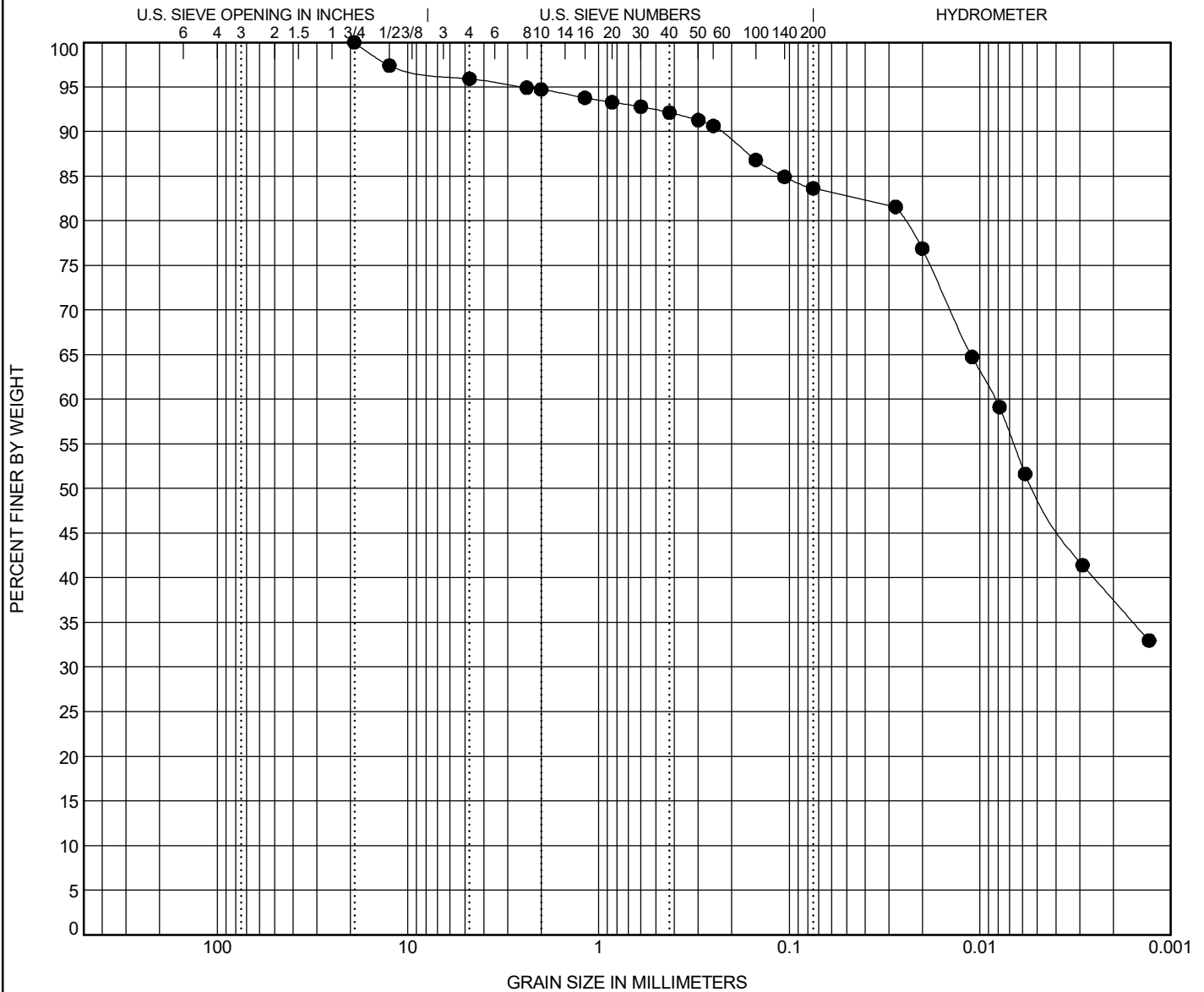


Somat

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Depth ft.	Remarks					LL	PL	PI	Cc	Cu
● OAK-04	3.5										
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● OAK-04	3.5	19.1	0.008			4.1	12.3	34.2	49.4		

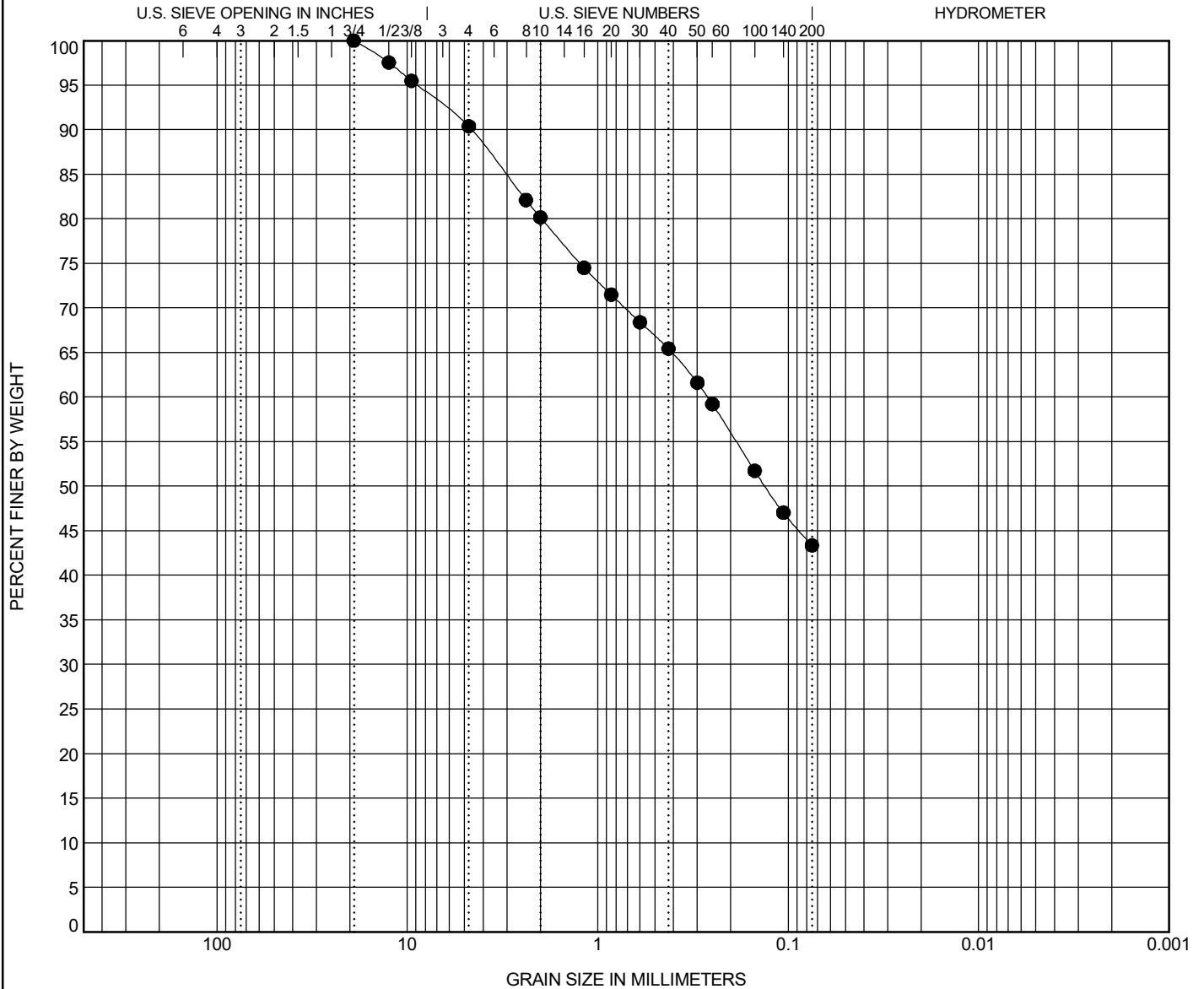


Somat

Great Lakes Water Authority (GLWA) Contract #2101475
Combined Sewer Outfall (CSO) Improvements Project
Oakwook CSO Facility

GRAIN SIZE DISTRIBUTION

PROJECT NO. 2022136A



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Depth ft.	Remarks					LL	PL	PI	Cc	Cu
● OAK-05	1.0										
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● OAK-05	1.0	19.1	0.265			9.6	47.0	43.4			

GRAIN SIZE GLWA OAKWOOD AND LEIB CSO FACILITIES.GPJ SOMAT.GDT 12/18/22

Description of Frequently Used Laboratory Testing Procedures

Visual Engineering Classification

Visual classification was performed on all samples (though other means of refining the classification may also be used). The General Notes provided immediately following the Logs of Test Borings include a brief discussion of the general method used to visually classify the soil, which is based on the visual-manual procedure (ASTM D2488). The visual classification is used to assign an appropriate Unified Soil Classification System (USCS) group symbol. The USCS symbol is shown in parentheses following the textural description of the various strata on the boring logs.

Where more laboratory testing is performed (requiring both grain size and Atterberg limit tests), the classification may also be refined further based on USCS ASTM D2487.

Moisture Content (ASTM D2216)

Moisture content determination tests were performed in accordance with ASTM D2216. Samples were sealed in the field to retain the natural moisture content of the soil specimen. Samples were then dried at a constant temperature (approximately 110° C) overnight in an oven. After drying, the samples were weighed to determine the dry weight of the sample (and the loss in weight representing the water contained in the original sample). The moisture content of the specimen is expressed as a percent and is the weight of the water compared to the dry weight of the specimen.

Hand Penetrometer

A hand/pocket penetrometer was used to estimate the unconfined compressive strength of cohesive (clay) samples. In the hand penetrometer test, the shear strength of a cohesive soil sample is estimated by measuring the resistance of the sample to the penetration of a small, calibrated spring-loaded cylinder. The maximum capacity of the penetrometer is 4.5 tons per square foot. The shear strength is doubled and reported on the soil boring logs as an estimate of the unconfined compressive strength.

Grain Size Analyses (ASTM D6913, D7928, and/or D422-2017)

Grain size analyses were performed in accordance with ASTM D6913, D7928, and/or D422-2017 on selected soil samples to evaluate the gradation of the soil represented by the sample. The distribution of particle sizes larger than 75 micrometers (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 micrometers is determined by a sedimentation process using a hydrometer.

Atterberg Limits Tests (ASTM D4318)

Determination of the Liquid Limit, Plastic Limit, and Plasticity Index of cohesive soils (known as Atterberg Limits) were performed in accordance with ASTM D4318. Fine-grained soils are tested to determine the Liquid Limit (LL) and Plastic Limits (PL), which are moisture contents that define boundaries between material consistency states. The LL and PL values define the transitional boundaries between non-plastic, plastic, and viscous fluid states. The plasticity index (PI) defines the complete range in water content for the plastic state.

Description of Frequently Used Laboratory Testing Procedures (continued)

Organic Content (Loss-On-Ignition) Tests (ASTM D7348)

The organic content of a soil is determined through a Loss-On-Ignition test performed in accordance with ASTM D2974 on soil samples suspected to contain significant organics. After the sample has been oven-dried, the soil sample is super-heated in a 440°C muffle furnace as a means to burn off all present organic matter. The weight of the remaining ash is used to calculate the percentage of organic matter as compared to the dry weight of the sample.



APPENDIX F

GEO-PROFESSIONAL BUSINESS ASSOCIATION (GBA) MESSAGE

Important Information about This Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual site-wide subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists.*



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