FOCUSED FEASIBILITY STUDY
Ponds behind Erie Pier

SR#1358
Duluth, Minnesota
MPCA Work Order #3000020033

Prepared for:

Minnesota Pollution Control Agency
525 South Lake Avenue Suite 400
Duluth, Minnesota 55802

Prepared by:

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5 Empire Drive
St. Paul, Minnesota 55103

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Executive Summary

This Focused Feasibility Study (FFS) for the Ponds behind Erie Pier (the Site) presents: a summary of current site conditions; a discussion of remedial action objectives (RAOs); and the identification, screening, evaluation, and comparison of potential alternatives. This report was prepared by Bay West LLC (Bay West) in accordance with the Minnesota Pollution Control Agency (MPCA) Contract Work Order No. 3000020033.

The Site has been studied as a part of the St. Louis River (SLR) Area of Concern (AOC). Funding to complete an FFS was obtained through the United States Environmental Protection Agency (USEPA), Great Lakes Legacy Act (GLLA) and state funding through the Minnesota Legacy Fund and the Wisconsin Knowles-Nelson Stewardship Fund. Detailed investigations previously completed for the Site have identified sediments contaminated with cadmium, chromium, copper, lead, mercury, nickel, zinc, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and dioxins/furans. Remedial Investigation (RI; Sediment RI Report; Bay West, 2016) in 2015 evaluated these chemical compounds and their concentrations in sediment identifying contaminants of concern (COCs). The Sediment RI Report identified cadmium, chromium, copper, dioxins/furans, lead, mercury, nickel, zinc, PAHs, and PCBs as the primary COCs for the Site. Contaminated sediment was generally identified throughout the Site and into Shoppers Creek and considered to present a high likelihood of significant effects to benthic invertebrates and/or human health from exposure to surficial sediments throughout the Site.

As identified in the SLR Remedial Action Plans (RAPs): RAP Stage I, MPCA and Wisconsin Department of Natural Resources [WDNR], 1992; and RAP Stage II, MPCA and WDNR, 1995; and later proven with testing, Ponds behind Erie Pier, SR#1358, Duluth Harbor, Duluth, Minnesota (**Figure 1**), is potentially contributing to three impairments in the SLR (AOC):

- Fish consumption advisory;
- Loss of fish and wildlife habitats; and
- Degradation of the benthos environment.

Areas that are contributing to river sediment impairments should be addressed through remedial activities, as recommended by the RAP. In addition, addressing the contaminated sediments from the Site would also help in the reduction of the impaired water resulting from bioaccumulative toxins in the SLR.

Remedial Action Objectives developed by the MPCA for Ponds behind Erie Pier are as follows:

RAOs for the Site were developed based on the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] §300.430[e][2][i]), which defines remedial action objectives as a listing of the COCs and media of concern, potential exposure pathways, and remediation goals. Specific RAOs were developed from a review of the results of site characterization activities, site-specific risk and fate and transport evaluations, and an initial review of Applicable or Relevant and Appropriate Requirements (ARARs). The following RAOs for the Site include goals for the protection of human health and the environment:

1. Minimize or remove human exposure to contaminated sediments with COCs above sediment cleanup goals.;
2. Minimize or remove exposure to sediment contaminants that bioaccumulate in the food chain and contribute to fish consumption advisories;

3. Minimize or remove exposure of the benthic organisms to contaminated sediments above sediment cleanup goals;
4. Preserve or enhance aquatic habitat, if conditions allow, in a manner that contributes to the removal of beneficial use impairments (BUIs).

The following subsection present preliminary sediment cleanup levels (CULs) developed to achieve these RAOs. Alternatives were identified and screened to determine if they could meet these RAOs. The following alternatives were evaluated in this FFS:

Alternative 1: No Action – The NCP at Title 40 CFR provides that a no action alternative should be considered at every site. The no action alternative should reflect the site conditions described in the baseline risk assessment and RI. The No Action Alternative included within this FFS does not include any treatment or engineering controls, institutional controls (ICs), or monitoring. There are no costs associated with the No Action Alternative. A no action alternative applied to the Site would not meet criteria for protection of human health and the environment, but is included as an alternative for comparison purposes.

Alternative 2: Monitored Natural Recovery and Institutional Controls – This alternative would maintain the current site conditions, where the ponds function as stormwater wetland basins, coupled with MNR monitoring to demonstrate that ongoing natural processes are capable of containing, destroying, or reducing the bioavailability of sediment COCs within an acceptable time frame (i.e., < 30 years). ICs would be implemented to educate the public via warning signs and restrict human exposure to contaminated site media. Baseline characterization and annual monitoring at 20 sediment locations would be conducted over a 5-year period to determine whether the ongoing processes were sufficient by themselves or whether enhancements, such as installing flow control structures, are necessary to meet Site recovery goals. During this five-year period, natural recovery processes and their trends would be monitored to quantify the following: changes in Site sediment concentrations, extent of sediment deposition (i.e., isolation of contaminated sediments with clean deposits), observed toxicity to benthos, and/or observed bioaccumulative effects in benthos and fish. If MNR processes are deemed sufficient to achieve the RAOs within an acceptable time, the monitoring would continue annually until results justified program adjustments or until all the RAOs have been met. ICs would also be required until RAOs have been met. The estimated total present value cost for Alternative 2 is $2,170,000.

Alternative 3: Enhanced Monitored Natural Recovery with Flow Control – Alternative 3 would combine Alternative 2 (MNR), with the distribution of COC solidification/stabilization/ treatment broadcast amendment covers across approximately 14.4 acres to destroy, immobilize, and/or reduce the bioavailability of the sediment COCs. Reagents such as Sedimite™, organoclay, or activated charcoal would be distributed in a thin cover across the sediment surface to treat, immobilize and/or reduce the bioavailability of metals, PCB, and dioxins/furans. Alternative 3 would also include the installation of flow control structures on Shoppers Creek, one of the two storm sewer inputs, and the unnamed tributary to minimize pond sediment erosion events and protect the thin sediment amendment cover. Hard bottom flow control sediment basins will be installed on Shoppers Creek, the eastern storm sewer input, and the unnamed tributary prior to their entry into the existing wetlands. These flow control basins would be installed along the existing roadways (e.g., Recycle Way/Ramsey, and Oneonta Street and South 40th Avenue West) to allow for future land-based sediment removal if necessary. Sediments removed from the site during the flow control structure installation along with Shoppers Creek sediments above the flow control structure will be treated prior to off-site disposal. Post sediment treatment and long-term sediment, surface water, and biota monitoring across the 14.4 acres would be conducted at up to 13 locations to demonstrate the effectiveness of the remedy and monitoring. The monitoring would continue annually until results justified program adjustments or until all the RAOs have been met. ICs would also be required following remedy implementation until RAOs have been met. The estimated total present value cost for Alternative 3 is $4,850,000.

Alternative 4: Excavation, and Sediment Consolidation, in Upland Caps – This alternative would consist of implementing elements in Alternative 3, excavation of COCs exceeding CULs across approximately 14.4 acres, and creation of upland caps with the treated sediment to reshape and improve wetland functions of the ponds. Temporary isolation of the ponds and rerouting of surface water flow would be required to allow for dry sediment excavation. Once the ponds were isolated, the water would be pumped, treated with granular activated carbon (GAC), and discharged to Shoppers Creek or the sanitary sewer that runs adjacent to the ponds. Surface water, groundwater, and rainwater collected during the excavation activities will also be treated and released. Approximately 64,000 cubic yards of sediment that exceeds COC CULs would be mechanically excavated and staged within the footprint of the Site, stabilized with amendment materials as needed, and finally consolidated into upland cap features that will reshape and improve the existing wetland functions of the ponds. Once the upland caps are created and the wetland has been restored, Shoppers Creek and the unnamed tributary would be reconnected to the ponds. Long-term sediment, surface water, and biota monitoring across the 14.4 acres would be collected at 6 locations to demonstrate the effectiveness of the remedy. The monitoring would continue every five years at 6 locations until components of the program can be discontinued or until the RAOs have been met. ICs would also be required following remedy implementation until RAOs have been met. The estimated total present value cost for Alternative 4 is $13,614,000.

Alternative 5: Excavation and Off-Site Disposal and Wetland Restoration – This alternative would consist of implementing elements in Alternative 3 and temporarily isolating the ponds from surface water flow to allow for dry sediment excavation across approximately 14.4 acres. Once the ponds were isolated, the water would be pumped, treated with GAC, and discharged to Shoppers Creek or the sanitary sewer that runs adjacent to the ponds. Surface water, groundwater, and rainwater collected during the excavation activities will also be treated and released. Approximately 64,000 cubic yards of sediment that exceeds COC CULs would be mechanically excavated and staged within the footprint of the Site, stabilized with amendment materials as needed, transported by roadway, and disposed of at an off-site landfill. Following sediment removal, upland features will be constructed to reshape and improve the existing wetland functions of the ponds and the ponds would be restored to a Class 4 wetland. ICs and a long-term monitoring (LTM) program would not be implemented following completion of remedy construction if complete removal of contaminated sediments is achieved. The estimated total present value cost for Alternative 5 is $16,716,000.

Alternative 6: Excavation and Off-Site Disposal – This alternative would consist of implementing elements in Alternative 3 and temporarily isolating the ponds from surface water flow to allow for dry sediment excavation across approximately 14.4 acres. Similar to Alternative 5, once the ponds were isolated, the water would be pumped, treated with GAC, and discharged to Shoppers Creek or the sanitary sewer that runs adjacent to the ponds. Surface water, groundwater, and rainwater collected during the excavation activities will also be treated and released. Approximately 64,000 cubic yards of sediment that exceeds COC CULs would be mechanically excavated and staged within the footprint of the Site, stabilized with amendment materials as needed, transported by roadway, and disposed of at an off-site landfill. Following sediment removal, the ponds would be restored to a Class 4 wetland with no construction of upland features in order to maximize the amount of open water and overall pond depth for wildlife habitat. Once the wetlands are restored, the original surface water flow through the ponds would be restored. ICs and a long-term monitoring (LTM) program would not be implemented following completion of remedy construction if complete removal of contaminated sediments is achieved. The estimated total present value cost for Alternative 6 is $15,276,000.

Comparative Analysis Summary

The comparative analysis of alternatives narrative discussion and quantitation table scored Alternative 6 as the highest to achieve RAOs at the Site. The modifying criteria, State/support agency acceptance, and community acceptance are assessed formally after the public comment period. Stakeholder and community input will provide valuable insight as the MPCA considers information for the selection of a preferred alternative. The MPCA will conduct outreach activities to resource managers, the public and local units of government prior to the public comment period.

Further studies are recommended during the design phase of the selected alternative. These recommended studies, depending on the alternative selected, may include:

- Potential ongoing contamination evaluation and source control from Shoppers creek and stormwater inputs;
- Hydrodynamic study of the four surface water inputs to the ponds to understand the depositional and peak flow forces to inform design and placement of sediment basins and creekside armoring, if needed;
- Pore-water transport and COC treatment modeling for reactive cover design pond;
- Cap/sediment consolidation calculations and modeling for engineered cap design; and
- Updated bathymetric survey and mapping of substrate types;
- Future wetland restoration and required water depths evaluations.

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Acronyms and Abbreviations

%	percent
AC	activated carbon
amsl	above mean sea level
AOC	area of concern
ARAR	Applicable or Relevant and Appropriate Requirement
Bay West	Bay West LLC
bss	below sediment surface
BUI	beneficial use impairment
CAD	confined aquatic disposal
CDF	confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
ch. or chs.	chapter or chapters
COC	contaminant of concern
CSM	conceptual site model
CUL	cleanup level
EA	EA Engineering, Science, and Technology, Inc., PBC
EMNR	Enhanced Monitored Natural Recovery
FFS	Focused Feasibility Study
GAC	granular activated carbon
GHG	Greenhouse Gas
GLI	Great Lakes Initiative
GLLA	Great Lakes Legacy Act
GSR	Green Sustainable Remediation
IC	institutional control
ITRC	Interstate Technology and Regulatory Council
IZ	isolation zone
LTM	long-term monitoring
MDH	Minnesota Department of Health
MDNR	Minnesota Department of Natural Resources
MERLA	Minnesota Environmental Response and Liability Act
mg/kg	milligrams per kilogram
MNR	Monitored Natural Recovery
MPCA	Minnesota Pollution Control Agency
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ng TEQ/kg	nanograms toxic equivalence per kilogram
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OIRW	Outstanding International Resource Water
OSWER	Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbon
PBAZ	potentially bioactive zone
PCB	polychlorinated biphenyl
PHC	Public Health Consultation
PPE	personal protective equipment
RAO	Remedial Action Objective
RAP	Remedial Action Plan
RBSE	Risk-Based Site Evaluation
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RME	reasonable maximal exposure
ROD	Record of Decision
ROM	rough order of magnitude
SDS	State Disposal System
SLR	St. Louis River
SLRIDT	St. Louis River/Interlake/Duluth Tar
SQT	sediment quality target
SS	solidification/stabilization
SSM	Sediment Screening Model
SSV	Sediment Screening Value
TBC	to be considered
TOC	total organic carbon
UECA	Uniform Environmental Covenants Act
USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
WCA	Wetlands Conservation Act
WDNR	Wisconsin Department of Natural Resources
WLSSD	Western Lake Superior Sanitary District

1.0 INTRODUCTION AND BACKGROUND

The St. Louis River (SLR), located on the border between Minnesota and Wisconsin, is the second largest United States (U.S.) tributary to Lake Superior and has a special significance in the region. The lower estuary empties into the Duluth-Superior Harbor, the largest freshwater seaport in North America. It serves as a geographic boundary for Wisconsin and Minnesota and provides regional shipping access to Lake Superior.

Development along the SLR over the past 130 years has contributed to contaminated sediments. In 1987, concerns over environmental quality conditions prompted the designation of 73 miles of the lower SLR, which includes the segment from Cloquet, Minnesota, to the Duluth/Superior Harbor, as 1 of 43 Great Lakes Areas of Concern (AOCs). The Minnesota Pollution Control Agency (MPCA) and Wisconsin Department of Natural Resources (WDNR) worked together to divide the SLR AOC into Sediment Assessment Areas for the purposes of evaluation and prioritization of remediation and restoration activities. Contaminated sediments have been identified and characterized through several studies that included the collection and analysis of sediments and biota samples throughout the AOC.

Historical sediment contamination in the SLR AOC has resulted in impaired uses, including degradation of bottom-feeding invertebrate communities, increased incidence of fish tumors and other abnormalities, fish consumption advisories, and restrictions on dredging, resulting in nine beneficial use impairments (BUIs; MPCA, 2008). BUIs are a change in the chemical, physical or biological integrity of the Great Lakes system sufficient to cause any 1 of the 14 established use impairments, or other related uses, such as the microbial objective for waters used for body contact recreational activities (joint commission). The MPCA and WDNR are currently working together to implement a comprehensive long-term plan to restore beneficial use and delist BUIs in the SLR AOC. Many of the BUIs in the AOC are linked to the presence of sediment contaminants. Some sediment-derived contaminants also appear suspended in the water column and carried by the SLR to Lake Superior.

As identified in the SLR Remedial Action Plans (RAPs): RAP Stage I, MPCA and WDNR, 1992; and RAP Stage II, MPCA and WDNR, 1995; and later proven with testing, Ponds behind Erie Pier, SR#1358, Duluth Harbor, Duluth, Minnesota (**Figure 1**), is potentially contributing to three impairments in the SLR (AOC):

- Fish consumption advisory;
- Loss of fish and wildlife habitats; and
- Degradation of the benthos environment.

Areas that are contributing to river and harbor sediment impairments should be addressed through remedial activities, as recommended by the RAPs. According to the MPCA, it is recommended by many programs that biotoxins be reduced within the SLR estuary and harbor. Removing or isolating the contaminated sediments from the surface water/sediment interface will help in the reduction of the impaired water resulting from bioaccumulative toxins in the SLR AOC.

This Focused Feasibility Study (FFS) was prepared to evaluate remedial alternatives for contaminated sediment at the Site. The scope of this FFS does not consider alternatives for any other matrix such as soil, surface water, or groundwater that may be impacted at the Site.

This report was developed pursuant to the Bay West LLC (Bay West) Master Contract No. 63186 and MPCA Contract Work Order No. 3000020033, dated October 16, 2017, and accompanying the Scope of Work/Cost Estimate for the Site. Funding to complete the FFS for the Site comes from the United States Environmental Protection Agency (USEPA), Great Lakes Legacy Act (GLLA) and state funding through the Minnesota Legacy Fund and the Wisconsin Knowles-Nelson Stewardship Fund.

This FFS was written in general accordance with the MPCA Site Response Section Guidance Document Draft Guidelines on Remedy Selection (MPCA, 1998), the Minnesota Environmental Response and Liability Act (MERLA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300, along with other Minnesota and Federal rules, statutes, and guidance.

1.1 Report Organization

Section 1.0 presents general background information including the Site history and a summary of current Site conditions. **Section 2.0** discusses Applicable or Relevant and Appropriate Requirements (ARARs) and summarizes Remedial Action Objectives (RAOs) to provide the framework for alternative evaluations for the Site. **Section 3.0** and **Section 4.0** present alternatives descriptions and the NCP remedy selection criteria used in this FFS. **Section 5.0** presents an evaluation of alternatives against standards and criteria. References are presented in **Section 6.0**.

1.2 Site Location and Current Use

The Site is located at the upstream end of the inner harbor, on the Minnesota side of the SLR and at the approximate intersection of Interstate 35 and Highway 2 (**Figure 1**). The Site is adjacent to, and located behind, Erie Pier as viewed from the river. Erie Pier is an active 89-acre placement and reuse facility owned by the Duluth Seaway Port Authority and is used as a confined disposal facility (CDF) for dredged sediments. Land-side access to the Site is controlled by a locked gate off of South 40th Avenue West. The lands surrounding the ponds are confined by railroad tracks to the southeast, Interstate 35 to the northwest, and private land to the northeast and southwest. The City of Duluth is in the planning stages for installing a bike path along the northern edge of the ponds, which will provide the public increased access to the Site. It is anticipated that the bike path will likely be installed prior to the Site's sediment remedy implementation.

The Site consists of wetlands with two open water ponds, a northeast pond and a southwest pond (**Figure 2**). The two wetland ponds are separated by a narrow piece of land approximately 30 feet in width; a small channel at the southern end links the ponds hydraulically. The wetland ponds are bordered by a small riparian area to the north consisting of mostly small trees and brush; beyond the riparian area is a dirt road followed by a relatively steep slope eventually leading up to Interstate 35. The northeastern and southwestern Site boundaries are characterized by marshland areas followed by forested land along Recycle Way and South 40th Avenue West, respectively. The Site is bordered to the southeast by an active railroad causeway (Wisconsin Central RY Co./Canadian Pacific Railway Co.). It is suspected that the ponds were at one time a small inlet off the harbor but were cut off from the harbor and created when the railroad line was constructed. A short railroad trestle located at the western end of the Site links the wetlands to the harbor. The major landholders for the parcels within the Site include the City of Duluth, the State of Minnesota, Wisconsin Central RY Co., and Canadian Pacific Railway Co.

The southwest pond is located directly beneath the Highway 2 Bridge. The open water portion of the southwest pond is considerably larger than the northeast pond and has a small tributary stream that flows into its western end, referred to as Shoppers Creek and a storm sewer outfall (outfall #1) located behind the building at 4730 Oneota Street. Shoppers Creek forms a shallow delta at the mouth. Marshland areas are present at the northern and western portions of the wetland and contain primarily cattails. The northeast pond is characterized by a small marshland area at its eastern edge, which also contains a small creek referred to as an "unnamed tributary" for the purposes of this report and a second storm sewer outfall (outfall #2) located adjacent to the east bound I-35 ramp to Oneota Street. Water drains from the northeast pond to the southwest pond through a small channel at the end of the narrow strip of land that separates the two ponds; however, the flow direction through the channel may reverse during high seiche periods.

The furthest identified upstream end of Shoppers Creek is located immediately south of the Menards parking lot near the main parking lot entrance off Mike Colalillo Drive (**Figure 2**). Water depth in the creek is approximately 6 inches and the creek bottom generally consists of course sand, large rocks, and small boulders. The Shoppers Creek watershed is approximately 1.1 square miles according to the USGS Streamstate 4.0 calculations; however, the stormwater drainage network discharging to Shoppers Creek has not been defined.

The source of the stormwater sewer outfall #1 entering the southwestern pond is likely limited to the land adjacent to the pond and the neighboring portion of the I-35 corridor. The watershed of the stormwater sewer outfall #2 entering the northeast pond is approximately 0.6 square parallel to the Shoppers Creek watershed according to the USGS Streamstate 4.0 calculations.

The unnamed tributary water shed that contributes to the northeast pond appears to be the surrounding wetland and the eastern portion of the I-35 corridor adjacent to the pond. Little to no sediment transport and deposition from the unnamed tributary is expected, even during peak flow events.

The open water wetlands at the site consist of shallow waters that freeze to the river bottom over much of the winter months. The total wetland area of the Site is approximately 14.4 acres. From the edge of South 40th Avenue West to Recycle Way, the Site is approximately 2,800 feet in length and from the edge of the railway to the northern dirt road boundary the site is approximately 410 feet wide. Average water depth in the Site was 1.8 feet and the water surface elevation ranged from 602.2 feet to 602.9 feet above mean sea level (amsl) during the March and June 2015 sampling events. Sediment elevation ranged from 598.1 feet to 602.5 feet amsl. **Figure 3** shows available 2015 bathymetry (Bay West, 2015).

1.3 Site History

Historically, the area where Ponds behind Erie Pier wetlands are located has undergone several physical modifications since European settlement of the area. The area encompassing the Site was initially residential or commercial land. During the late 19th and early 20th centuries, the Duluth/Superior region experienced a dramatic rise in population as the region began to take advantage of local resources, including vast forests, iron ore, and the natural harbor (the Duluth-Superior Harbor) located on Lake Superior. Construction of the Soo Locks on the eastern outlet of Lake Superior at Sault Ste. Marie, Michigan in 1855 and dredging of the Duluth-Superior Harbor, beginning as early as the mid-1800s, contributed significantly to the port's growth and establishment as a primary shipping harbor. Thriving industries within the region included forest products, smelting, grain milling and transport, and the transport of iron ore, coal, and limestone. Many of these industries were concentrated in the Duluth/Superior Harbor at Rice's Point in Minnesota and Connor's Point and Howard's Bay in Wisconsin. Many of these industries are still present and operating within the harbor today.

Historical maps, aerial photographs, and drawings were reviewed for the Site as part of the 2015 Remedial Investigation (RI; Bay West, 2016). The 2015 RI presents the following description of the historical documentation review.

The 1889 Merritt's sectional survey map depicts the Site as part of the main channel. A peninsula (Grassy Point) is present southwest of the Site, and the Duluth Harbor is present east/northeast of the Site. The Northern Pacific Railway is depicted south of the Site crossing the SLR from West Duluth to West Superior. The area northwest of the Site appears to be residentially developed as West Duluth. The 1902 Frank's Atlas map depicts similar land use features with the addition of two slips, and the Northern Pacific Railway along the southeast of the Site.

The 1909 Duluth Street Railway Co. transit map is similar to previous maps. The 1912 Welbanks Map depicts two slips (corresponding to existing slips) located southeast of the railroad, and the buildings northwest of the railroad and slips have been removed. The 1915 and 1917 United States Geological Survey (USGS) Topographic Map depicts the two ponds, separated by a berm, bounded by the railroad to the southeast and West Duluth to the northwest, which is apparent on subsequent maps. The previously noted ponds are not depicted at the Site in the 1927 McGill Warner Map, the surrounding area remains unchanged.

The 1952 USGS aerial photograph is similar to the 1917 USGS Topographic Map, significant land use changes are not apparent in the surrounding area; however, an industrial plant is present southeast of the Site. In the 1954 topographic map, depicted bathymetry depth within the ponds is approximately 2 feet deep; depths of the SLR range from 6 to 21 feet deep in the middle of the channel, to less than 5 feet along the western shore. In the 1966 aerial photograph, similar features depicted in the 1952 aerial photograph are visible; land use north of the Site appears to be developed as industrial.

Similar features are visible on the 1975 and 1983 topographic maps; significant land use changes are not depicted. The 1991 USGS Aerial Photograph depicts U.S. Highway Route 2 crossing over the Site and the SLR into West Superior; other significant land use changes are not depicted.

Topographic maps for 1993 and 1997 appear similar to existing conditions. Aerial photographs for the period 1992 to 2011 appear similar to existing conditions. The Sediment RI Report details additional site-specific historic use and property ownership.

1.4 Site Characterization

1.4.1 Site Geology

Regional geology in the Duluth area consists primarily of materials deposited during the last glaciation, and more recently as river sediment, overlying Precambrian igneous and sedimentary bedrock. These materials consist of silts, sands, and gravels that were deposited as the glaciers retreated northward. Fine grained sediment, primarily red silt and clay, was deposited in the ancestral glacial Lake Duluth. This red silt and clay occurs over much of the lower elevations in the Duluth area.

Bedrock units underlying the area consist of olivine gabbro and anorthositic gabbro members of the Duluth Complex, and the sedimentary units of the Fond du Lac Formation. The Duluth Complex is lower Precambrian, and the Fond du Lac Formation is upper Precambrian in age. The gabbroic members of the Duluth Complex form the hills to the west of the SLR and Lake Superior shore (MPCA, 1995).

Sediment cores collected during the 2015 RI generally consisted of soft, loosely consolidated dark brown to black silt loam with varying amounts of rootlets, and other organic plant or woody peat debris was observed up to 0.83 meter in length within the cores. This layer typically overlaid brown silt loam much lighter in color and more consolidated in nature. The actual thickness of the peat layer could be substantially greater than observed within the cores due to the extent of sediment bypass observed during sampling.

1.4.2 Site Hydrology

The regional groundwater flow system in the area generally flows from the Minnesota and Wisconsin uplands and discharges to Lake Superior and the St. Louis River estuary. Although a site-specific groundwater study has not been performed, groundwater is anticipated to flow radially out from the piers adjacent to the Site into the Duluth Harbor.

While not measured during the 2015 RI, water drains from the northeast pond to the southwest pond through a small channel at the end of the narrow strip of land that separates the two ponds; however, the flow direction through the channel may reverse during high seiche periods. The source of the unnamed tributary that contributes to the northeast pond appears to be the surrounding wetland and was formed due to drainage of the wetland. Little to no sediment transport and deposition from the unnamed tributary is expected.

According to the National Oceanic and Atmospheric Administration (NOAA) and the Great Lakes Dashboard Project, Lake Superior water level elevations have ranged from 599.5 feet to 603.4 feet amsl since measurements began in 1918 (NOAA, 2016). Seasonal water level fluctuations of Lake Superior affect water level elevations at the Site and may affect Site remedies; however, these effects have not been studied.

1.4.3 Nature and Extent of Contamination

The nature and extent of contamination at the Site was investigated during several studies since 1993. These investigations have resulted in the identification of multiple contaminants of interest (COIs) at the Sites including metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and dioxins/furans.

The most recent investigation was an RI conducted specifically for the Site during March and June of 2015. A summary of previous Site investigations, as presented within the 2015 RI Report, is provided in **Section 1.4.3.1,** and 2017/2018 sampling activities are described in **Section 1.4.3.2**. Screening criteria for application to sediment contaminants identified at the Site are discussed in **Section 1.4.3.3**. **Section 1.4.3.4** presents a discussion of the contaminants of concern (COCs) as identified in the 2016 RI Report and **Section 1.4.3.5** presents the known depth, thickness, and volume of contaminated sediments at the Site.

1.4.3.1 Previous Site Studies

Section 1.5 in the Sediment RI Report identifies and summarizes historic sediment investigations completed at the Site. Section 5.5 in the Sediment RI Report summarizes sediment investigation completed by Bay West in 2014. Overall the following chemicals were identified at the Site in Sediment RI Report: cadmium, chromium, copper, dioxins/furans, lead, mercury, nickel, zinc, PAHs, and PCBs. The RI identified PAHs as a potential COC for risk to human health. Copper, mercury, and dioxins/furans were also identified as a potential COC for risk to sediment dwelling organisms. Cadmium, chromium, lead, PCBs were identified as COCs for risk to human health and to sediment dwelling organisms.

1.4.3.2 2017/2018 Sampling Activities

In October/November 2017 and April/May 2018, a bed load source investigation was conducted to collect information regarding mobilized sediment consisting of suspended sediment and bed load (herein referred to as bed load) entering the Site from upstream sources to determine if the bed load is a source of ongoing contamination at the Site. Data collected will ultimately be used to develop a course for remedial action and aid remedial design to restore and delist the Site BUIs. Specific objectives for the October/November 2017 and April/May 2018 Bed Load Sampling were to:

- Provide site specific information regarding bed load contributions from Shoppers Creek and storm water inputs.
- Collect and analyze bed load samples for Site COCs to determine potential contribution to sediment contamination at the Site.
- Refine the 2016 RI conceptual site model (CSM) that evaluates contaminant fate and transport and provide a comparison between SLR AOC specific risk-based screening values and existing conditions to identify unacceptable risks to human health and/or the environment.

As part of this investigation, Bay West collected two sediment cores from directly outside the Erie Pier Pond discharge location to the SLR to fill in sample location data gaps. Two sediment samples were collected from each core from the 0.0-0.15-meter interval and 0.15-0.5-meter interval. Sediment samples were analyzed for site COCs. Results of the bed load source investigation and sediment core sampling will be presented in a Technical Memorandum; however, sediment core sample locations and results will be displayed on figures throughout this FFS.

1.4.3.3 Screening Criteria

Numerical sediment quality targets (SQTs), adopted for use in the SLR AOC to protect benthic invertebrates, can be used throughout Minnesota as benchmark values for making comparisons to surficial sediment chemistry measurements. Level I and Level II SQTs for the protection of sediment-dwelling organisms are available for 8 trace metals, 13 individual PAHs, total PAHs (all 13 priority PAHs), total PCBs, and 10 organochlorine pesticides. In addition, Level I and Level II SQTs for dioxins/furans were adopted for the protection of fish, as insufficient information is available for sediment-dwelling organisms. SQTs are highly useful when evaluating risk for a specific compound or a group of compounds (i.e., total PCBs and total PAHs).

Contaminant concentrations below the Level I SQTs are unlikely to have harmful effects on sediment-dwelling organisms (i.e., benthic invertebrates). Contaminant concentrations above the Level II SQTS are more likely to result in harmful effects to benthic invertebrates (MPCA, 2007). Based on conversations with the MPCA, a qualitative comparison value midway between the Level I SQTs and Level II SQTs (i.e., Midpoint SQT) were used as criteria to identify, rank, and prioritize sediment-associated COCs within the Site.

Sediment Screening Values (SSVs) were developed to provide a human health-based toxicity value specifically related to sediment for the U.S. Steel Superfund Site in the SLR (Minnesota Department of Health [MDH], 2013). The SSVs were developed using reasonable maximal exposures (RMEs) specific to the U.S. Steel site and the Lower SLR. The Updated Human Health Screening Values for St. Louis River Sediments: U.S. Steel Site, dated April 2013, describes the updated SSVs utilized in this report. SSVs were compared to select PAHs, eight trace metals, and total dioxins/furans (as toxicity equivalents for human health). Chemical concentrations in water-covered sediments at or below the SSVs are considered safe for the general public; however, chemical concentrations in sediments exceeding the SSVs should not be considered unsafe because the SSVs were developed using conservative measures of exposure, bioavailability, and toxicity. Based on ongoing ambient concentration studies, some SSVs likely approach, or are less than, ambient concentrations in sediment, including SSVs for mercury, benzo(a)pyrene equivalents, PCBs, and dioxins/furans. Further, the SSVs do not include RMEs specific to the Site and are not intended to be used as sediment cleanup values.

The most conservative criteria will be used to identify, rank, and prioritize sediment-associated COCs within the Site, which the MPCA has decided will be the Midpoint SQT. The SSVs for mercury, benzo(a)pyrene equivalents, PCBs, and dioxins/furans are more conservative than the respective Midpoint SQTs; however, the MPCA has decided that the Midpoint SQT is a more appropriate screening criterion for these contaminants because the respective SSVs are expected to be below ambient concentrations.

1.4.3.4 Contaminants of Concern

Sediment contaminants and primary Site COCs are identified in **Section 1.4.3.1** and discussed in depth in the Sediment RI Report. Through discussions with the MPCA and review of available sediment analytical data, it was determined that for the purposes of this FFS, any contaminate exceeding Midpoint SQT will be considered a COC. Based on this rationale and on the Sediment RI findings, the following contaminants are identified as COCs at the Site: cadmium, chromium, copper, lead, mercury, nickel, zinc, PAHs, PCBs, and dioxins/furans. The Sediment RI presents an in-depth discussion of risks associated with the COCs at the Site.

1.4.3.5 Depth, Thickness, and Volume of Contaminated Sediment

The depth and volume calculations and assumptions discussed below are based on a bathymetric survey of the Site completed in 2015 by Bay West and analytical data collected in the Sediment RI Report.

A bathymetric survey was not formally completed for the Site; however, bathymetry was interpolated from water depths measured at sample locations, as shown on **Figure 3**. Additional zero depth shoreline points were added to create a more realistic contour map. Bay West has assumed the results of bathymetric contouring are accurate for the purposes of this report but recommends that, should an alternative be implemented, a bathymetric survey be completed and assumptions be updated.

The 2015 RI Report was used to define the COCs, remedial areas, and remedial volumes used to compile this FFS. Distribution of cadmium, chromium, copper, lead, mercury, nickel, zinc, PAHs, and PCBs at the Site are presented in **Figure 4** through **Figure 13**. Areas to be considered for remedial action are those where the COCs listed above exceeded their respective Midpoint SQT and are presented in **Figure 14**.

The sediment portion of the Site totals approximately 14.4 acres as presented in **Figure 15**. COC contamination extends down to 1.0 meter below sediment surface (bss) primarily in the southwestern pond within the Shoppers Creek delta and to 0.5 meters or less in the remaining areas as shown in **Figure 4** through **Figure 13**. The northern legs of the vegetated wetlands have not been sampled and may not be considered open waters of the state, therefore, the extent of COC impact in these areas is uncertain and the remedial footprint does not extend to these areas. A conservative estimate of the total volume of contaminated sediments, assuming the entire 14.4-acre area contains COCs is approximately 64,000 cubic yards based on average depths of contamination and varying bathymetry.

<u>1.4.4 Exposure Pathways</u>

Exposure pathways represent the linkages among contaminant sources, release mechanisms, exposure pathways and routes, and receptors to summarize the current understanding of the risks to human health and the environment due to contamination. The exposure pathway for sediments at the Site is shown in **Diagram 1**. A "complete" exposure pathway means that evidence exists that a COC (cadmium, chromium, copper, lead, mercury, nickel, zinc, PCBs, PAHs, and/or dioxins/furans) may be released from a source and may be transported into and through the environment to an exposure point where a receptor is assumed to be present.

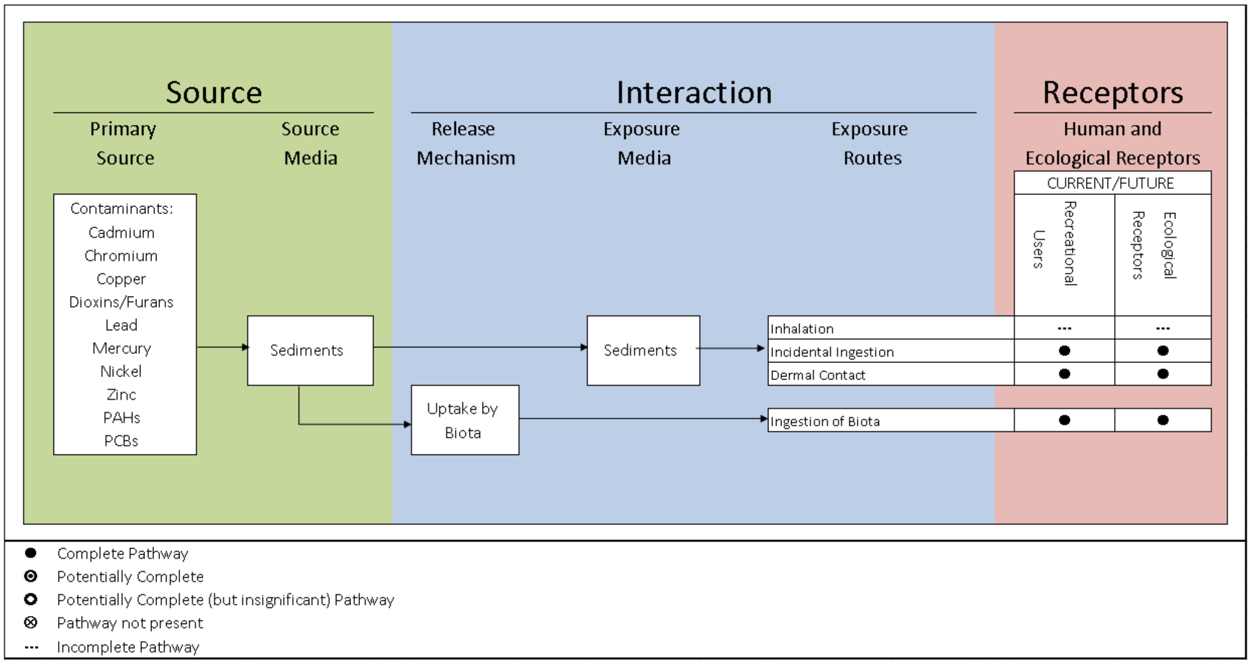

Diagram 1 Exposure Pathway and Receptors

The following sections provide greater detail on the human health and ecological exposure pathways.

1.4.4.1 Risk to Human Health

Significant exposure pathways are complete for human receptors based on the Sediment RI Report. The Site is currently gated and closed to the public; however, trespassers visit the site frequently and have been observed fishing in the ponds. Fish consumption advisories are in effect for selected fish species in the SLR AOC due to elevated concentrations of PCBs and mercury found in fish tissue (MDH, 2014). No fish consumption advisory is currently in place for any of the other Site COCs, and the MDH does not currently provide meal advice based on COCs, except for mercury and PCBs, in fish (MDH, 2014). The City of Duluth is in the planning stages for installing a bike path along the northern edge of the ponds, which will provide the public increased access to the Site. Therefore, ingestion of biota via fish consumption, incidental ingestion of contaminated sediment, and dermal contact with contaminated sediment exposure pathways are complete for recreational users. The COCs are generally non-volatile and not emitted from the waters of the Site; therefore, the inhalation of contaminated sediments is considered incomplete for human receptors.

1.4.4.2 Ecological Risks

Significant exposure pathways are complete for ecological receptors based on the Sediment RI Report. The Sediment RI Report concluded that exposure routes through contact and ingestion of sediment were complete for ecological receptors. In addition, contaminants could be released from sediments and bioaccumulate through the food chain as another exposure pathway to those ecological receptors in higher trophic levels. The COCs also tend to be non-volatile from the water so the contribution to air is not of great concern; therefore, the inhalation of contaminated sediments is considered incomplete for

ecological receptors.

1.4.5 Conceptual Site Model

The development of a conceptual site model (CSM) allows data obtained during ongoing investigations to be integrated in an iterative approach that increases the understanding of the physical and environmental setting of the Site and the fate and transport of COCs. The CSM provides a baseline for consideration of how remedy alternatives could be implemented to protect human and environmental health at the Site. The CSM is provided within the Sediment RI Report and is illustrated in **Figure 16**.

Hydrodynamic observations were not recorded during this RI, with exception to ice observations; however, fluvial geomorphology principles provide a framework for characterizing the hydrodynamics of the Site.

A bathymetric survey has not been conducted at the Site; however, water depths were recorded at each sample location during the June 2015 sampling event following the procedure outlined above in **Section 1.4.3.1**. A bathymetric map interpolated from water depth at sample locations is presented as **Figure 3**.

The Site consists of two ponds, a northeast pond and a southwest pond. The two ponds are separated by a narrow piece of land approximately 30 feet in width; a small channel at the southern end links the ponds hydraulically. The ponds are bordered by a small riparian area to the north consisting of mostly small trees and brush. The northeastern and southwestern Site boundaries are characterized by marshland areas followed by forested land. It is suspected that the ponds were at one time a small inlet off the harbor but were cut off from the harbor and created when the railroad causeway was constructed. A short railroad trestle located at the western end of the southwest pond links the ponds to the harbor.

The 8.5-acre southwest pond has a small tributary stream that flows into its western end, referred to as Shoppers Creek. Marshland areas are present at the northern and western portions of the pond and contain primarily cattails. While not measured during this RI, flow velocities are likely low at the Site. USGS StreamStat software estimates that the peak flow of a 10-year rain event in Shoppers Creek is approximately 180 cubic feet per second (https://water.usgs.gov/osw/streamstats//). As Shoppers Creek enters the southwest pond, the flow velocity quickly reduces, and sediments drop out of suspension forming a small delta within the pond. The only other known input into this pond is a stormwater outfall located on the western side of the pond, noted as Storm Sewer Outfall 1 on **Figure 2**. Water exits the southwest pond through the railroad trestle located on the eastern side of the pond. Flow velocity through the railroad trestle is also relatively low and resuspension of sediments in this area is unlikely; however, resuspension of sediments is more likely during periods of high input from Shoppers Creek and during low seiche periods. During high seiche periods (storm surges), flow may reverse, transporting sediments into the pond. The effects of flow in and out of the southwest pond through the railroad trestle are assumed to be minimal.

The 5.2-acre northeast pond is characterized by a small marshland area at its eastern edge, which also contains a small creek referred to as an "unnamed tributary" for the purposes of this report. A stormwater outfall is located directly north of this pond (Storm Sewer Outfall 2 on **Figure 2**) and discharge from this outfall is expected to flow into the pond. The MPCA indicates that a best management practice sediment control structure is incorporated into this outfall.

Both ponds are characterized by shallow waters that freeze to the river bottom over much of the Site during the winter months. The source of the unnamed tributary that contributes to the northeast pond appears to be the surrounding wetland and was formed due to drainage of the wetland. Flow of the unnamed tributary is extremely low to stagnant; however, flood flow would be expected during rain events. Little to no sediment transport and deposition from the unnamed tributary is expected.

Water drains from the northeast pond to the southwest pond through a small channel at the end of the narrow strip of land that separates the two ponds; however, the flow direction through the channel may reverse during high seiche periods.

Ice observation results indicate that ice likely becomes anchored to sediments throughout most of the pond areas; however, this is unlikely to result in sediment transport during ice shifting and/or breakup due to the low energy dynamics of the ponds.

2.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND REMEDIAL ACTION OBJECTIVES

Remedial actions for releases and threatened releases of hazardous substances, pollutants, or contaminants must be selected and carried out in accordance with State and Federal requirements. These requirements are referred to as ARARs. RAOs specify COCs, media of concern, potential exposure pathways, and remediation goals. Initially, Site remediation goals for the COCs are developed based on readily available information such as chemical-specific ARARs or other reliable information. The Site RAOs are modified, as necessary, as more information becomes available during the FFS process.

This section presents the preliminary ARARs, RAOs, and COCs to be used in the development of this FFS. The final ARARs, RAOs, and COCs will be developed in the ROD for the Site.

2.1 Applicable or Relevant and Appropriate Requirements

This preliminary ARAR section summarizes the MPCA, Minnesota Department of Natural Resources (MDNR), and MDH ARARs, and to be considered (TBC) criteria for aquatic sediment associated with the Site. Local and Federal ARARs have also been included; however, the list may not include all applicable local and Federal ARARs.

The NCP (40 CFR 300.5) defines "applicable" requirements as: "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility citing laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] site." Only those promulgated state standards identified by a state in a timely manner that are substantive and equally or more stringent than federal requirements may be applicable.

The NCP (40 CFR 300.5) further defines "relevant and appropriate" requirements as: "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility citing laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site." Like "applicable" requirements, the NCP also provides that only those promulgated state requirements that are identified in a timely manner and are more stringent than corresponding federal requirements may be relevant and appropriate.

ARARs generally fall into one of the following three classifications:

- **Chemical-specific:** These ARARs are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in numerical values. These values establish an acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. These requirements provide the basis for protective Site remediation levels for the COCs in the designated media.
- **Location-specific:** These ARARs generally restrict certain activities or limit concentrations of hazardous substances solely because of geographical or land use concerns. Requirements addressing wetlands, historic places, floodplains, or sensitive ecosystems and habitats are potential location-specific ARARs.
- **Action-specific:** These ARARs are restrictions on the conduct of certain activities or the operation of certain technologies at a particular site. Examples of action-specific ARARs

would be regulations dictating the design, construction, and/or operating procedures for dredging, on-site landfilling, or capping. Action-specific requirements do not themselves determine the cleanup alternative but define how the chosen cleanup alternative should be achieved.

In addition, criteria, advisories, guidance, and proposed standards developed by Federal and State environmental and public health agencies that are not legally enforceable, but contain helpful information, are collectively referred to as TBCs. TBCs can be helpful in carrying out selected remedies or in determining the level of protectiveness of selected remedies. TBCs are meant to complement the use of ARARs, not compete with or replace them. TBCs are included, where appropriate, in the chemical-, location-, and action-specific discussions.

Several Federal and State laws govern or provide the framework for remedial actions. Remedial actions must comply with substantive portions of these laws or acts, which were also reviewed during the ARAR development process. The following provides a summary of laws and acts that do not readily fall into one of the chemical-, location-, or action-specific classifications, but are applicable to the Site:

ARAR/TBC	Citation	Description/Potential Application
CERCLA	42 United States Code (USC) §§9601 et seq.	Federal Superfund Law.
NCP	40 CFR part 300	Provides organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants.
MERLA	Minn. Stat. §§115B.01 to 115B.20	State Superfund Law.
Water Pollution Control Act	Minn. Stat. chapter (ch.) 115	Administration and enforcement of all laws relating to the pollution of any waters of the state.
Duty to Notify and Avoid Water Pollution	Minn. Stat. §115.061	Requires notification and recovery of discharge pollutants to minimize or abate pollution of the waters of the state.
Pollution Control Agency	Minn. Stat. ch. 116	Provides organizational structure and procedures for responding to problems relating to water, air, and land pollution.
Water Law	Minn. Stat. chs. 103A, 103B, 103C, 103D, 103E; 103F, and 103G	Provides regulations pertaining to any waters of the state, including surface water, wetlands and groundwater.
Safe Drinking Water Act	42 USC §§300f et seq.	Established to protect the quality of drinking water (above or underground).
Clean Water Act	33 USC §§1251 et seq.	Establishes structure for regulating discharges of pollutants and regulating quality standards for surface waters.
Resource Conservation and Recovery Act (RCRA)	42 USC §§6901 et seq.	Establishes RCRA Program and Regulations.
Clean Air Act	42 USC §§7401 et seq.	Regulates air remissions from stationary and mobile sources.

2.1.1 Chemical-Specific ARARs and TBCs

The COCs associated with the sediments include cadmium, chromium, copper, lead, mercury, nickel, zinc, PAHs, PCBs and dioxins/furans. The following are the chemical-specific ARARs and TBCs associated with the sediments and shall be used to develop site-specific cleanup levels (CULs):

ARAR/TBC	Citation/Source	Description/Application
Sediment		
SSVs	MDH, 2013. Public Health Consultation, Updated Human Health Screening Values for SLR Sediments: U.S. Steel Site, April.	To be used as benchmark values for making comparisons to surficial sediment chemistry measurements.
SQTs	Guidance for the Use and Application of SQTs for the Protection of Sediment-dwelling Organisms in Minnesota.	To be used as benchmark values for making comparisons to surficial sediment chemistry measurements.
All Media		
Contaminated Sediments Remediation	Contaminated Sediments Remediation. http://www.itrcweb.org/contseds_remedy-selection/.	Guidance to assist in selecting remedial technology most appropriate for a specific site.
Contaminated Sediment Remediation	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites, USEPA, December 2005.	Guidance to assist in selecting remedial technology most appropriate for a specific site.
Contaminated Sediment Remediation	Use of Amendments for In Situ Remediation at Superfund Sediment Sites, USEPA, April 2013.	Guidance to assist in situ remediation.
Site screening guidelines	Working Draft Site Screening Evaluation Guidelines. MPCA Risk-Based Site Evaluation (RBSE) Manual (09/98).	Guidelines and criteria for screening human health and ecological risks.

Sediment

Human Health Risk

This Screening Level Human Health Evaluation used the SSV values and comparison methods presented in the 2013 MDH Public Health Consultation (PHC) document titled Updated Human Health Screening Values for St. Louis River Sediment: U.S. Steel Site (MDH, 2013). The PHC quantitatively evaluated six different exposure routes using a Sediment Screening Model (SSM): surface water ingestion, sediment ingestion, dermal surface water exposure, dermal sediment exposure, inhalation, and fish consumption. Contributions of different routes to a total exposure were compared. The SSM evaluated chronic and lifetime exposure durations. Due to the general lack of toxicity criteria for short exposures to chemicals, acute exposures are not addressed in the PHC.

As discussed in **Section 1.4.4**, exposure pathways are complete or potentially complete for recreational users at the Site for cadmium, chromium, copper, lead, mercury, nickel, zinc, PAHs, PCBs and dioxins/furans.

SSVs are tools for screening contaminated sediments for potential impacts to human health; however, the potentially complete human health exposure pathway will be mitigated by addressing ecological exposure pathways.

Ecological Risk

Preliminary Sediment Remediation Goals were developed for use in this FFS to achieve protection and restoration of habitat, and to minimize exposure of the benthic organisms to contaminated sediments and movement of contaminants up the food chain. The MPCA does not have sediment quality standards. SQTs adopted for use in the SLR AOC can be used throughout the state as benchmark values for making comparisons to surficial sediment chemistry measurements as described in **Section 1.4.3.3**. The Midpoint SQT will be used to identify, evaluate, and prioritize sediment-associated risk to ecological health.

All Media

This guidance document assists in selecting remedial technology most appropriate for a specific site based on contaminated sediment and site-specific characteristics (http://www.itrcweb.org/contseds_remedy-selection).

The USEPA document *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* presents remedial options available for contaminated sediments discussing advantages and limitations associated with the options.

The USEPA document *Use of Amendments for In Situ Remediation at Superfund Sediment Sites* presents remedial options using amendments available for contaminated sediments discussing advantages and limitations associated with the options.

The MPCA *Site Screening and Evaluation Document* presents an overall process for conducting a Tier 1 evaluation of the various exposure pathways at a site. The screening criteria worksheet can be found at the MPCA website (https://www.pca.state.mn.us/waste/risk-based-site-evaluation-guidance).

2.1.2 Location-Specific ARARs and TBCs

The location-specific ARARs and TBCs for the Site are as follows:

ARAR/TBC	Citation/Source	Description/Application
Waters of the State and Groundwater Protection	Minn. Stat. 103G and 103H	Groundwater protection, nondegredation, and best management practices.
Floodplain Management and Wetlands Protection	40 CFR Part 6, Appendix A, Section 6.a.(1)	Requires agencies to evaluate potential effects of actions in a floodplain to avoid adverse impacts.
Shoreland and Floodplain Management	Minn. Rules ch. 6120	Conserves economic and natural environmental values (MDNR).
St. Louis County Land Use Ordinances	St. Louis County Zoning Ordinances, ch. 1003	Floodplain management, Manages on-site waste disposal and other site activities.
Shoreland Management	Duluth City Code §51-26 et seq.	The City of Duluth requires a permit for any excavation or grading above the Ordinary High Water Mark within 300 feet of a river.
Endangered Species Act	16 USC §1531 et seq. 50 CFR §17.11-12	Conservation of threatened and endangered plants and animals and their habitats.
Endangered, Threatened, Special Concern Species	Minn. Rules ch. 6134 Minn. Statute, Section 84.0895	Protection of endangered, threatened, special concern species (MDNR).
Migratory Bird Treaty Act	16 USC Chapter 7, Subchapter II §§703 and 712.2	Protects migratory birds and their ecosystems.
MDH Advisory for St. Louis River	MDH	Provides fish consumption advisories.

The Site is located within the Lake Superior Drainage Basin. Surface water quality standards and provisions for Class 2B and 3B waters apply. In addition, USEPA and the Great Lakes states agreed in 1995 to a comprehensive plan to restore the health of the Great Lakes. The Final Water Quality Guidance for the Great Lakes System, also known as the Great Lakes Initiative (GLI), includes criteria for states to use when setting water quality standards for 29 pollutants, including bioaccumulative chemicals of concern, and prohibits the use of mixing zones for these toxic chemicals. Because the surface water at the Site is within the drainage basin of Lake Superior, the ARARs specified in the GLI Minn. Rules ch. 7052 are applicable to the Site. Requirements of the Great Lakes Water Quality Agreement of 2012 apply to the Site. In addition, the surface waters adjacent to the Site are identified as an Outstanding International Resource Water (OIRW). The objective for OIRW is to maintain water quality at existing conditions when the quality is better than the water quality standards. Generally, OIRWs are considered surface water quality standards applicable to the SLR for Class 2B and OIRWs, as set forth in Minn. Rules chs. 7050 and 7052 and to the additional surface water quality standards for the SLR, as set forth in Minn. Rules ch. 7065. The OIRW was established after the ROD was issued.

As stated in Minn. Rules ch. 7050.0210 Subp. 2:

> *Nuisance conditions prohibited. No sewage, industrial waste, or other wastes shall be discharged from either point or nonpoint sources into any waters of the state so as to cause any nuisance conditions, such as the presence of significant amounts of floating solids, scum, visible oil film, excessive suspended solids, material discoloration, obnoxious odors, gas ebullition, deleterious sludge deposits, undesirable slimes or fungus growths, aquatic habitat degradation, excessive growths of aquatic plants, or other offensive or harmful effects.*

Title 40 CFR Part 6, Appendix A, Section 6 Requirements: Requires Federal agencies to evaluate the potential effects of actions taken within a floodplain to avoid adversely impacting floodplains wherever possible.

Title 40 CFR Part 6, Appendix A, Section 6.a.(1) Floodplain/Wetlands Determination: Before undertaking an Agency action, each program office must determine whether or not the action will be located in or affect a floodplain or wetlands. The Agency shall utilize maps prepared by the Federal Insurance Administration of the Federal Emergency Management Agency (Flood Insurance Rate Maps or Flood Hazard Boundary Maps), Fish and Wildlife Service (National Wetlands Inventory Maps), and other appropriate agencies to determine whether a proposed action is located in or will likely affect a floodplain or wetlands. If there is no floodplain/wetlands impact identified, the action may proceed without further consideration of the remaining procedures set in this section. If floodplain/wetlands impact is identified, this section presents procedures that must be taken.

Shoreland and Floodplain Management (Minn. Rules Ch. 6120): Provides standards and criteria intended to preserve and enhance the quality of surface waters, conserve the economic and natural environmental values of shorelands, and provide for the wise use of water and related land resources of the state. St. Louis County Zoning Ordinances, ch. 1003, establish additional floodplain management and manage site activities such as on-site waste disposal.

Shoreland Management Permit (Duluth City Code §51-26 et seq.), as defined by the City of Duluth: Requires a permit for any excavation or grading above the Ordinary High Water Mark within 300 feet of a river. Each alternative will involve some of these activities. The substantive requirements of this permit are found in the ordinance and may govern removal of natural vegetation, grading and filling, placement of roads, sewage and waste disposal, and setbacks.

The Endangered Species Act (16 United States Code [USC] §1531 et seq.) and the Minnesota Endangered, Threatened, Special Concern Species Act (Minn. Rules ch. 6134): Protect threatened and endangered plants and animals and their habitats.

Title 16 USC Chapter 7, Subchapter II §§703 and 712.2. (The Migratory Bird Treaty Act): Protects migratory birds and their ecosystems by specifying the taking, killing, or possessing migratory birds unlawful. Public Law 95-616, an amendment to this act, provides measures to protect identified ecosystems of special importance to migratory birds such as bald eagles against pollution, detrimental alterations, and other environmental degradations.

The MDH has established various fish consumption advisories for the SLR due to the presence of PAHs, PCBs, and Resource Conservation and Recovery Act (RCRA) metals in water and sediments.

2.1.3 Action-Specific ARARs and TBCs

The following summarizes the action-specific ARARs for the Site. In addition, Occupational Safety and Health Standards (Minn. Rules ch. 5205) for worker health, safety, and training are applicable to remedial actions performed at the Site.

ARAR/TBC	Citation/Source	Description/Application
Waters of the State (both surface and underground)	Minn. Rules ch. 7050 and 7052	Surface water quality during remedy construction.
Wetlands Conservation Act (WCA)	Minn. Stat. §§103G.221-.2373	Protection of wetlands.
Wetlands Conservation	Minn. Rules 8420	Protection of wetlands, wetland functions for determining public values.
Floodplain Management Order	Executive Order 11988 and 40 CFR Part 6, Appendix A,	Regulates remedial action implementation in floodplains.
Section 404 Permit and Section 401 Certification (Clean Water Act)	33 CFR pts 320 and 323; 33 USC §1341	Applies to discharge of dredged or fill material into waters of the U.S.
National Pollutant Discharge Elimination System (NPDES)/ State Disposal System (SDS) permits	Clean Water Act 33 USC §1342	Surface water quality requirements for discharges of pollutants to waters of the state.
Section 10 (Rivers and Harbors Act of 1899)	33 USC 403	Applies to activities that will obstruct or alter any navigable water of the U.S.
Work in Public Waters	Minn. Stat. §103G.245	Permit requirements applicable to work in public waters that will change or diminish its course, current, or cross-section.
Public Water Resources	Minn. Rules ch. 6115	Water appropriation permitting, standards and criteria for alterations to structure of public water (MDNR).
Minnesota Sediment Quality Targets	Guidance for the Use and Application of Sediment Quality Targets for the Protection of Sediment-dwelling Organisms in Minnesota, MPCA Document Number: tdr-gl-04	Establishes procedures for potentially bioactive zone (PBAZ) caps and covers.

ARAR/TBC	Citation/Source	Description/Application
Western Lake Superior Sanitary District (WLSSD)	WLSSD Industrial Pre-Treatment Ordinance	Requirements for any dredge water discharged into public sanitary sewers.
Construction and Use of Public Sewers	Minn. Rules ch. 4715	Governs the use of sewers and public water systems if any dredge water is disposed in public sewers.
MDNR Invasive Species Management	Minn. Statutes 84D.02	Requirements for sediment transportation if invasive species are present.
Solid Waste	Minn. Rules ch. 7035	Requirements and standards for solid waste facilities.
Hazardous Waste	Minn. Rules ch. 7045	Hazardous waste listing, and generator, transport, and facility standards.
Air Pollution Emissions and Abatement	Minn. Stat. §116.061	Duty to notify and abate excessive or abnormal unpermitted air emissions.
Ambient Air Quality Standards	Minn. Rules ch. 7009	Provides air quality standards.
Preventing Particulate Matter From Becoming Airborne and Emission Standards	Minn. Rule pts. 7011.0150 and 7011.8010	Provides measures to control dust and emission standards for hazardous air pollutants.
Noise Pollution Control	Minn. Rules ch. 7030	Noise standards applicable to remedy construction.

Water Quality

If any activity associated with the remedial actions results in an unregulated release, in accordance with the Water Pollution Control Act and Minn. Stat. 115.061, Duty to Notify, a notification and recovery of any pollutants discharged to minimize or abate pollution of the waters of the state is required.

In accordance with Minn. Rules ch. 7050, surface water quality standards for the maintenance and preservation of surface water quality during remedy construction, including discharges from treatment/work and storm water runoff zones, shall be based on surface water quality standards that currently apply to Class 2B and OIRWs, as set forth in Minn. Rules, chs. 7050 and 7052, and to the additional surface water quality standards for the SLR set forth in Minn. Rules ch. 7065. Therefore, if water is discharged directly to the waters on or adjacent to the Site, it shall be treated to a level that meets applicable surface water discharge standards. Groundwater non-degradation and standards for the protection of groundwater during remedy construction are presented in Minn. Rules 7060.

During remediation, the MPCA would consider the areas in which work is performed as “treatment/work zones,” to which the surface water quality standards normally applicable to the SLR would temporarily not apply. These treatment/work zones would be physically separated from adjacent waters through the use of engineering controls such as single or multiple silt curtains, inflatable dams, sheet piling, or other measures. During construction of the remedy, any discharges occurring within those controlled treatment/work zones, such as the discharge of capping material during capping operations, the release of contaminants during dredging operations, or runoff from activities on shore, would not be subject to water quality standards. Rather, water quality standards would apply outside of the treatment/work zone, beyond the outermost engineering control structure where the water from the treatment/work zone is discharged. Other discharges occurring during remedy construction that are not included in a treatment/work zone, including discharges of treated dredge water, and discharges of stormwater runoff from shoreland modifications outside of the treatment/work zones, would also be subject to regulation.

If water is discharged, it would be treated to a level that meets applicable surface water discharge standards. The MPCA water quality standards may apply to these discharges. Final standards would be determined by the MPCA prior to implementation of the remedial actions. In the event that a standard is exceeded, further management practices would likely be required during remedy construction to reduce the amount of suspended contaminants escaping the treatment/work zone.

Wetlands, Shoreland and Floodplain Management

In accordance with Minn. Rules ch. 7050, wetlands at the Site are classified as unlisted wetlands, Class 2B and 3B waters. In accordance with Minn. Rules ch. 8420, compliance with wetland ARARs will involve consultation with the MDNR to determine the category of wetlands present at the Site and any avoidance, mitigation, and replacement that may be necessary. The National Wetland Inventory Classification of the Site's wetlands is presented along with the site's bathymetry in **Figure 3**. The Corps of Engineers, St. Paul District, conducted a wetland delineation for the 40th Avenue area which confirmed wetlands were present at the Site. The December 2015 memorandum detailing the 40th Avenue wetland delineation is presented in **Appendix A**.

Water quality standards for the maintenance and preservation of surface water quality during remedy construction including discharges from treatment/work and storm water runoff zones shall be based on surface water quality standards that currently apply to Class 2B and 3B waters and shall comply with Minn. Stat. §§103G.221-.2373. Standards and specifications applicable to shoreland and floodplain management can be found in Executive Order 11988 and 40 CFR Part 6, Appendix A, Minn. Rules ch. 6120.

Minn. Stat. §103G.222 provides that a wetland replacement plan must be approved by the Local Governmental Unit before any Wetlands Conservation Act (WCA) wetlands may be drained or filled, unless draining or filling falls within the "De Minimis" exemption or another exemption of Minn. Stat. §103G.2241. WCA wetlands are those wetlands that are not public water wetlands regulated by the MDNR and United States Army Corps of Engineers (USACE). WCA wetlands would be located above the Ordinary High Water Mark. The South St. Louis Soil and Water Conservation District provides additional guidance regarding WCA requirements for the Site at the following website: http:// www.southstlouisswcd.org/wcact.html.

Permits and Certifications

Possible permits for cleanup activities include the following:

Section 404 Permit (Clean Water Act): Required for discharge of dredged or fill material into waters of the United States. The substantive requirements of this permit shall be met for alternatives that dredge or fill waters of the state. USACE evaluates applications for Section 404 permits. Substantive requirements that may be incorporated within a Section 404 permit for off-site activities can be found in 33 CFR Parts 320 and 323.

Section 401 Certification: The Clean Water Act, 33 USC §1341, requires that any application for a Federal permit that may result in a discharge to a navigable water must be accompanied by a certification from the affected state indicating that the discharge will comply with all applicable water quality standards and effluent limitations of the Act. Thus, a Section 401 certification or a

401 certification waiver for remedial action at the Site would be necessary before the USACE may issue a Section 404 permit, and a certification may be necessary before the USACE may issue a Section 10 permit if that permit authorizes a "discharge."

National Pollutant Discharge Elimination System (Clean Water Act 33 USC §1342): Discharges of pollutants to waters of the state associated with construction of the selected remedy would be subject to the requirements applicable to a NPDES permit. Discharges could include the discharge of capping material, the discharge of contaminants released and suspended by dredging operations, the discharge of treated dredge water during dredging operations, and the discharge of storm water runoff from shoreland modifications. These types of discharges would be subject to the same regulatory standards and controls that would apply under an MPCA permit. In addition, NPDES General Permit number MNG990000 has been required for managing dredged materials; however, this permit has expired and has not been renewed. According to Managing Dredged Materials in the State of Minnesota (MPCA, 2009), an individual National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Dredge Materials Management permit may be required. A NPDES Construction Permit and a Stormwater Pollution Prevention Plan are required by the MPCA if more than one acre of land is disturbed by excavation activities.

Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403): A Section 10 permit is required from the USACE for any construction in or over any navigable water, or the excavation or discharge of material into such water, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters. The substantive requirements that may be incorporated within a Section 10 permit can be found in 33 CFR Parts 320 and 322.

Work in Public Waters (Minn. Stat. §103G.245): A permit from the MDNR is necessary for any work in public waters that will change or diminish its course, current, or cross-section. If an alternative under consideration involves dredging or capping, a public waters permit from the MDNR may be required. The substantive requirements that the MDNR may incorporate within its public waters permit are codified in statute and at Minn. Rules, ch. 6115. These requirements include compensation or mitigation for the detrimental aspects of any major change in the resource. The MDNR permits may require restoration of bathymetry (water depth) and habitat substrate (bottom) as part of the public waters permit. The MDNR would set the specific cap depth and composition requirements.

Additionally, if capping of contaminated sediments is conducted, requirements would include specifications for cap construction. In situ caps constructed for the containment of contaminated sediment must contain an isolation zone (IZ) and a potentially bioactive zone (PBAZ). The IZ is the portion of the cap that is applied directly over the contaminated sediments and is designed to isolate and attenuate the Site contaminants that could potentially be transported upward into the PBAZ at concentrations above the CULs by diffusion or advection transport mechanisms. The PBAZ is the area within the cap above the IZ where significant biological activity may potentially be present. The thickness and material specifications for the IZ and PBAZ should be determined based on pore water transport and attenuation modeling.

Air Emissions and Waste Management Permits: In accordance with Minn. Stat. §116.081, a permit is required for the construction, installation or operation of an emission facility, air contaminant treatment facility, treatment facility, potential air contaminant storage facility, storage facility, or system or facility related to the collection, transportation, storage, processing, or disposal of waste, or any part thereof, unless otherwise exempted by any agency rule now in force or hereinafter adopted, until plans have been submitted to the agency, and a written permit granted by the agency.

On-Site Disposal: The placement of dredged sediment into an on-site confined aquatic disposal (CAD) area and any subsequent seepage from the CAD, if implemented, would be regulated by the MPCA under the requirements applicable to an SDS permit. The legal requirements for an SDS are found in Minn. Stat. §115.07, Minn. Rules, Parts 7065.0100 to 7065.0160 and in other MPCA water quality rules including Minn. Rules chs. 7050 and 7052.

Discharge into Sewers: A permit from the Western Lake Superior Sanitary District (WLSSD) will be necessary if any dredge water is discharged into the public sewers. Pretreatment standards that would likely apply can be found at:

http://www.wlssd.duluth.mn.us/pdf/WLSSDPretreatmentOrdinance.pdf.

The permit will also include requirements to ensure that there will be no detrimental effects to their bio-solids program. A WLSSD permit would also represent compliance with Minn. Rule, Part 4715.1600 and the MPCA water rules governing indirect discharges.

Invasive Species: A prohibited/regulated invasive species permit will be required to transport sediment to a landfill, if invasive species are present near the proposed work area.

CERCLA provides for waiving of necessary permits for on-site work, provided the work is conducted in compliance with the substantial conditions of such permits. Although the permits themselves may not be required on CERLCA Sites, compliance with the substantial conditions of these identified permits shall be met.

Construction and Use of Public Sewers

Minn. Rules ch. 4715 governing the use of sewers and public water systems would apply if any water associated with remedial activities is disposed of in public sewers.

Waste Management

Solid and hazardous waste management requirements and standards can be found in Minn. Rules chs. 7035 and 7045, respectively. USEPA guidance has consistently stated that Superfund remedies involving movement of contaminated material within the area of a Site where such material is already located (sometimes referred to as an AOC) do not create a “waste” that is subject to RCRA (42 USC §§6901 et seq.) or other waste management requirements. Remedy alternatives that require contaminated materials to be moved to an off-site land disposal site are considered to generate waste that must be managed under applicable waste management requirements.

St. Louis County Zoning Ordinances, ch. 1003, establish additional floodplain management and manage site activities such as on-site waste disposal.

Ambient Air Quality Standards

Air quality standards applicable to releases into the air from cleanup activities include Min. Stat. 116.061, Air Pollution Emissions and Abatement. During remedy construction, activities such as transportation, storage and placement of capping material may result in particulate matter becoming airborne. Minn. Rules ch. 7009 establishes ambient air quality standards for criteria pollutants regulated under the Clean Air Act. Compliance points shall be selected in accordance with Minn. Rules ch. 7009. The ambient air quality standards for particulate matter that apply to remedial actions are found at: https://www.revisor.mn.gov/rules/?id=7009.0080.

Control of the generation of airborne particulate matter during remedy construction is regulated in Minn. Rule pt. 7011.0150, *Preventing Particulate Matter from Becoming Airborne*, which includes measures to control dust that may be generated during remedy construction activities such as transportation, storage, and placement of capping material, which shall be addressed in the remedial design plan. Minn. Rules pt. 7011.8010, Site Remediation, incorporates the National Emission Standards for Hazardous Air Pollutants applicable during Site remediation activities.

Noise Pollution Control

Minn. Rules ch. 7030 establishes noise standards for various land uses. Compliance points will be selected in accordance with Minn. Rules ch. 7030. The noise standards that will apply to the selected remedial action can be found at:

https://www.revisor.leg.state.mn.us/rules/?id=7030.0040.

2.1.4 Other Considerations

Other considerations under MERLA set forth the regulatory requirements, RAOs and CULs that must be met by a remedy to meet the legal standard for a remedy under MERLA and the threshold criterion for protection of public health and welfare and the environment. A remedy, as defined under MERLA, must also include any monitoring, maintenance and institutional controls (ICs) and other measures that MPCA determines are reasonably necessary to assure the protectiveness of the selected remedy over the long term.

It is particularly important to consider the requirements for long-term assurance of protectiveness where the remedy alternatives involve the use of capping or containment to manage contaminated media within the Site. Some requirements may also be necessary to assure long-term protectiveness of alternatives that involve excavation or dredging and off-site disposal of contaminated soil or sediment.

In addition, MERLA requires the MPCA to consider the planned use of the property where the release of contaminants is located when determining the appropriate standards to be achieved by a remedy.

Other potential ARAR and permit issues may be associated with adjacent active railroad grade and bridge and working under and adjacent to the US Hwy 2 bridge.

Long-Term Assurance of Protectiveness

MERLA requires that a remedy include measures that are reasonably required to assure the ongoing protectiveness of a remedy once the components of the remedy have been constructed and entered their operational phase. Such measures may include, but are not limited to, ICs and monitoring and maintenance requirements. This section discusses the measures that MPCA determines are reasonably necessary to assure long-term protectiveness.

Institutional Controls

Institutional controls are legally enforceable restrictions, conditions or controls on the use of property, groundwater or surface water at a property that are reasonably required to assure the protectiveness of a remedy or other response actions taken at the Site. Areas of the Site where contaminated media remains in place after remedial construction will be subject to ICs (such as easements and restrictive covenants) that are legally binding on current and future owners of the property to assure ongoing protection from disturbance of or exposure to the contamination. Restrictions on use may also be required for areas of the Site where contaminated media are treated and/or removed and where some residual contamination may remain.

Minn. Stat. §115B.16, subd. 2, requires an Affidavit Concerning Real Property Contaminated with Hazardous Substances to be recorded with the St. Louis County recorder by the owner of the property. The Uniform Environmental Covenants Act (UECA) and the authority for requiring environmental covenants can be found in Minn. Stat. ch. 114E. This statute requires MPCA approval of environmental covenants (which include restrictive covenants and access) when there is an environmental response project (which includes superfund cleanups) is overseen by the MPCA. Because the Site is not platted, the UECA may not apply and other ICs such as a City Ordinance may be required to prevent anchoring, fishing, dredging, and other activities that may disturb a cap or contaminated sediments left in place.

Long-Term Operation and Maintenance, Monitoring, and Contingency Action

On-site containment facilities and capping of impacted media (sediment) or any other alternative that may leave impacted media on-site will require post-construction monitoring, operation and maintenance (O&M), and contingency action plan to assure that ARARs, RAOs and CULs that apply to the alternative are fully achieved and maintained over time.

General details of the post-construction monitoring, O&M, and contingency action plan requirements would be set forth in the FFS, along with an estimate of the cost to carry out each activity.

Sediment traps or other means of limiting incoming sediment to maintain appropriate water depth may be required; this need will be further evaluated in the design phase of this project. If sediment traps are implemented, long-term maintenance of these traps such as sediment removal will be required.

Planned Use of Property

In a provision entitled “Cleanup Standards” (Minn. Stat. §115B.17, subd. 2a), MERLA provides that when MPCA determines the standards to be achieved by response actions to protect public health and welfare and the environment from a release of hazardous substances, the agency must consider the planned use of the property where the release is located. The purpose of this provision of MERLA is to allow the MPCA to select cleanup standards that provide a level of protection that is compatible with the uses of the Site property that can be reasonably foreseen.

The specific properties directly affected by the remedies are currently idle land but under near future consideration for development. The cleanup standards must provide protection of public health and welfare and the environment that is consistent with any planned or potential future uses of the Site, including natural resource and habitat restoration, navigation and recreational uses. These cleanup standards are also compatible with the use of the adjacent land for residential, recreational, habitat restoration, or commercial and industrial use.

The site’s average water depths of 1.8 feet and maximum depth of approximately 5 feet limit site use to shallow draft recreational vessels. Site water depths would need to be maintained to continue current use of the Site in the future. The required water depths will be confirmed in the future with the Site stakeholders prior to the implementation of any dredging and capping remedy. As previously discussed, sediment traps or other means of limiting incoming sediment to maintain appropriate water depth may also be required.

2.2 Remedial Action Objectives

The RAOs developed by the MPCA for the Site are:

1. Minimize or remove human exposure to contaminated sediments with COCs above sediment cleanup goals..
2. Minimize or remove exposure to sediment contaminants that bioaccumulate in the food chain and contribute to fish consumption advisories.
3. Minimize or remove exposure of the benthic organisms to contaminated sediments above sediment cleanup goals.

4. Preserve or enhance aquatic habitat, if conditions allow, in a manner that contributes to the removal of BUIs.

The following subsection present preliminary sediment CULs developed to achieve these RAOs.

2.2.1 Preliminary Sediment CULs

To achieve protection to human health, restoration of habitat, to minimize exposure of the benthic organisms to contaminated sediments and to stop movement of contaminants up the food chain, the remedy should meet the Preliminary Sediment CULs. **Table 1** presents the CUL for the COCs established in **Section 1.4.3.3**. The selected remedy should meet the Preliminary CULs and provide protection of ecological and human health. The CULs should also provide cleanup standards consistent with any planned or potential future uses of the Site. The Midpoint SQT for the COCs will serve as the CULs for the Site.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 Remedial Technology Identification and Screening Process

Potential technologies for addressing conditions at the Site were identified based upon professional experience of Bay West staff, discussions between Bay West and MPCA staff, and guidance developed for the remediation of contaminated sediment sites (USEPA, 2005; Interstate Technology and Regulatory Council [ITRC], 2014). Information collected during the 2012 Sediment Assessment Report (Weston, 2012) and the Site Characterization Report (EA Engineering, Science, and Technology, Inc., PBC [EA], 2015) was used to compile the CSM and identify feasible technologies for the Site.

A qualitative approach was used to screen technologies using a three-part ranking system where each technology was evaluated on effectiveness, implementability, and relative cost:

- Effectiveness was evaluated by the predicted ability of the technology under consideration to assure long-term protection of human health and the environment while minimizing short-term impacts during implementation, as well as the technology's ability to meet RAOs.
- Implementability was evaluated by considering the technical and administrative feasibility of the technology. Technical feasibility includes the ability to achieve RAOs and the avoidance of creating additional risk during implementation, including the degree of disruption in the project area. Administrative feasibility includes the consideration of permits required for technology implementation, availability of disposal facilities and equipment necessary for the technology, and coordination with applicable agencies and stakeholders.
- Relative costs used for technology screening were based on engineering judgment, rather than detailed estimates. Detailed cost estimates were compiled for each individual alternative, which incorporate technologies meeting screening criteria, and are presented in **Section 3.3**.

Table 2 presents a summary of the technology screening results. The following sections describe the technologies that were screened using the three-part ranking system.

3.1.1 Institutional Controls

Signs warning the public of the human health site restrictions may be placed as necessary between the Site ponds and the proposed bike path. Institutional controls (ICs) are legally enforceable restrictions, conditions, or controls on the use of property, ground water, or surface water at a contaminated site that are reasonably required to assure the protectiveness of a remedy or other response actions taken at the Site. If contaminated sediments remain in place after remedial actions are taken, the Site would be subject to ICs (such as easements and restrictive covenants) that are legally binding on current and future owners of the property to assure ongoing protection from disturbance of or exposure to the contamination. Most remedial alternatives include ICs until long-term monitoring (LTM) indicates that risk reduction has been achieved and the RAOs have been met (ITRC, 2014). The following information obtained from USEPA sediment remediation guidance (USEPA, 2005) details ICs likely appropriate for use at the Site.

Fish consumption advisories are informational devices that are frequently already in place and incorporated into sediment site remedies. Commercial fishing bans are government controls that ban commercial fishing for specific species or sizes of fish or shellfish. Usually, state departments of health are the governmental entities that establish these advisories and bans. An advisory usually consists of informing the public that they should not consume fish from an area or consume no more than a specified number of fish meals over a specific period of time from a particular area. Sensitive sub-populations or subsistence fishers may be subject to more stringent advisories. Advisories can be publicized through signs at popular fishing locations, pamphlets, or other educational outreach materials and programs. Consumption advisories are not enforceable controls and their effectiveness can be extremely variable (USEPA, 2005).

For any alternative where subsurface contamination remains in place (e.g., capping, MNR, or an in-water confined disposal site), waterway use restrictions may be necessary to ensure the integrity of the alternative. Examples include restricting boat traffic in an area to establish a no-wake zone or prohibiting anchoring of vessels. In considering boating restrictions, it is important to determine who can enforce the restrictions, and under what authority and how effective such enforcement has been in the past. In addition, a restriction on easements for installing utilities, such as fiber optic cables, can be an important mechanism to help assure the overall protectiveness of a remedy (USEPA, 2005).

Where contamination remains in place, it may be necessary to work with private parties, state land management agencies, or local governments to implement use restrictions on nearshore areas and adjacent upland properties. For example, construction of boat ramps, retaining walls, or marina development can expose subsurface contamination and compromise the long-term effectiveness of a remedy. Where contaminated sediment exceeding CULs is identified in proximity to utility crossings or other infrastructure and temporary or permanent relocation of utilities in support of a dredging remedy may not be feasible or practical, capping may be desirable even though temporary cap disruption may be necessary periodically (USEPA, 2005).

ICs are incorporated into each of the remedial alternatives developed for this FFS.

3.1.2 Monitoring

Monitoring is the collection and analysis of data (chemical, physical, and/or biological) over a sufficient period of time and frequency to determine the status and/or trend in one or more environmental parameters or characteristics. Monitoring should not produce a "snapshot in time" measurement, but rather should involve repeated sampling over time in order to define the trends in the parameters of interest relative to clearly defined management objectives. Monitoring of sediment is necessary for remedies both during and after remedial action and can be classified as construction monitoring and performance monitoring (also referred to as LTM), respectively. Monitoring should be conducted for a variety of reasons, including: 1) to assess compliance with design and performance standards; 2) to assess short-term remedy performance and effectiveness in meeting sediment CULs; and/or 3) to evaluate long-term remedy effectiveness in achieving RAOs and in reducing human health and/or environmental risk. In addition, monitoring data are usually needed to complete the five-year review process where a review is conducted.

Monitoring activities applicable to the Site could include one or more of the following based on the selected remedy:

- Collection of sediment chemical data to ensure that CULs have been achieved (due to dredging, in situ treatments, or degradation);
- Measurements of cap thicknesses or other engineered controls to ensure continued isolation or treatment of contaminants and physical cap integrity;
- Measurement of COC concentrations in cap material to ensure that contaminants are not migrating into or through the cap; and
- Measurement of toxicity to and bioaccumulation of COCs within aquatic organisms such as benthics and fish in order to evaluate reduction trends.

Construction monitoring may also be performed to ensure that contamination or nuisance materials are not released during construction activities. Construction monitoring activities applicable to the Site include one or more of the following:

- Turbidity monitoring to ensure that the off-site release of suspended sediments containing COCs is mitigated during dredging and/or cap placement;
- Air monitoring to ensure that the off-site release of nuisance and/or contaminated dusts is mitigated during construction activities such as the mixing of sediments and amendment materials, hauling over dirt or gravel roadways, and excavation or other intrusive Site work;
- Periodic sampling of treated dredge contact water to mitigate contaminant inputs to water bodies or local sewage systems and to ensure that treated water meets permit or municipality requirements;
- Periodic sampling of dredged materials to ensure that landfill requirements for acceptance are achieved;
- Periodic sampling of imported materials (e.g., cap materials, shoreline restoration materials, etc.) to mitigate impacts to water bodies or upland areas as a result of placement; and
- Pre- and post-construction soil sampling to access impacts of construction activities on lands used during the construction phase.

Both construction and performance monitoring (referred to as LTM) are incorporated into each of the remedial alternatives developed for this FFS.

3.1.3 Monitored Natural Recovery

MNR is defined by the National Research Council as a remediation practice that relies on natural processes to protect the environment and receptors from unacceptable exposures to contaminants. This remedial approach depends on natural processes to decrease chemical contaminants in sediment to acceptable levels within a reasonable time frame. With MNR, contaminated sediments are left in place and monitored for ongoing physical, chemical, and biological processes that transform, immobilize, isolate, or remove contaminants until they no longer pose a risk to receptors. Natural processes that contribute to MNR may include sediment burial, sediment erosion or dispersion, and contaminant sequestration or degradation (for example, precipitation, adsorption, or transformation). These natural processes, discussed in detail below, can reduce exposure to receptors (and thus reduce risk) and contribute to the recovery of the aquatic habitat and the ecological resources that it supports. MNR can be used alone or in combination with active remediation technologies to meet RAOs (ITRC, 2014).

3.1.4 Enhanced Monitored Natural Recovery

Enhanced Monitored Natural Recovery (EMNR) relies on the same natural processes as MNR to decrease chemical contaminants in sediment but includes the application of material or amendments to enhance these natural recovery processes. EMNR can use several technologies including, but not limited to, thin-layer capping and introduction of reactive amendments such as activated carbon (AC). Thin-layer caps (typically up to 1 foot) are often applied as part of an EMNR approach. These caps enhance ongoing natural recovery processes, while minimizing effects on the aquatic environment. Thin-layer caps are not intended to completely isolate the affected sediment, as in a conventional isolation capping remedy. This layer also accelerates the process of physical isolation, which continues over time by natural sediment deposition (ITRC, 2014).

3.1.5 In Situ Treatment

In situ sediment treatment involves applying or mixing of an amendment into sediments. Mixing may be achieved either passively, through natural biological processes such as bioturbation, or actively through mechanical means such as augers. In situ treatment technologies can achieve risk reduction in environmentally sensitive environments such as wetlands and submerged aquatic vegetation habitats, where sediment removal or containment by capping might be harmful. Treatment amendments typically reduce concentrations of freely dissolved chemicals that are available for exposure to organisms or that may be mobilized and transferred from sediment to the overlying water column (ITRC, 2014). The following in situ treatment technologies were screened in this evaluation:

- Immobilization – Immobilization treatments add chemicals or cements to reduce the leachability of contaminants. Mechanisms include solidification (encapsulation) or stabilization (chemical or absorptive reactions that convert contaminants to less toxic or mobile forms);
- Enhanced bioremediation – Microbial degradation by bacteria or fungi is enhanced by adding materials such as oxygen, nitrate, sulfate, hydrogen, nutrients, or microorganisms to the sediment;
- Oxidation/reduction – Chemicals are injected into sediment to act as an oxidant/electron acceptor to facilitate aerobic decomposition of organic matter;
- Chemical oxidation – The addition of chemical oxidizers to sediment can cause the rapid and complete chemical destruction of many toxic organic chemicals;
- Phytoremediation – Phytoremediation uses plant species to remove, transfer, stabilize, and destroy contaminants in sediment. Generally limited to sediments in shallow water zones and low concentrations; and
- Adsorption – Adsorbents can be used as sediment amendments for in situ treatment of contaminants. Sorption of metals and organics can take place simultaneously with a suitable combination of sorbents.

3.1.6 Capping

Capping is the process of placing a clean layer of sand, sediments, or other material over contaminated sediments in order to mitigate risk posed by those sediments by creating a physical barrier between the sediment and PBAZ. The cap may also include geotextiles to aid in layer separation or geotechnical stability, amendments to enhance protectiveness, or additional layers to armor and maintain its integrity or enhance its habitat characteristics.

Thin-layer caps (typically up to 1 foot) are often applied as part of an EMNR approach. These caps enhance ongoing natural recovery processes, while minimizing effects on the aquatic environment. Thin-layer caps are not intended to completely isolate the affected sediment, as in a conventional isolation capping remedy. The objective of a thin-layer cap is to “assist” the process of physical isolation and accelerate naturally occurring processes within the Site, such as contaminant isolation through sedimentation, and thus reduce risks to aquatic life (ITRC, 2014).

When amendments are mixed directly into sediments, the resulting remedy is termed “in situ treatment.” When these amendments are added to cap material, the remedy is called an “amended cap,” and the amendments enhance the performance of the cap material. The same amendment used in the same proportions is generally more effective at isolating contaminants when used in a cap than when placed directly into sediments. The amended cap provides the benefits of capping in addition to the benefits of the treatment amendment (ITRC, 2014).

Cap design considerations for the Site include the following, as also noted for the SLR Interlake/Duluth Tar Site (Service Engineering Group, 2002; 2003; 2004):

- Control of contaminant transport through the cap via cap amendments or IZs;
- Use of materials suitable for benthic habitat such as fine to medium-grained sand;
- Use of erosion controls where appropriate such as armoring to prevent scour from prop wash and other sources; and
- Maintenance or creation of water depths suitable for current and/or planned Site use.

Additional concerns regarding cap design, construction, and long-term effectiveness include ebullition of gases originating from below the cap, mixing of cap materials with contaminated sediments during cap construction, and strength of in situ sediments and their ability to support the cap during placement.

3.1.7 Dredging and Excavation

Dredging consists of the removal of contaminated sediment from water bodies in order to reduce risks to human health and the environment. Removal is particularly effective for source control (mass removal of hot spots) but potentially less effective for overall risk reduction because of resuspension and residual contamination. The three methods of contaminated sediment removal are mechanical dredging, hydraulic dredging, and excavation. As with any type of removal operation, additional technologies are required to appropriately handle the removed sediment. Dredged material handling technologies may involve transport, dewatering, treatment, and or disposal of sediment (ITRC, 2014). Mechanical dredging, hydraulic dredging, and excavation were screened independently in this evaluation.

After removal, the contaminated sediment can be treated or disposed of in a controlled setting, such as an off-site landfill or other treatment, storage, and disposal facility, an on-site aquatic or terrestrial CDF, or a facility that converts the sediment to a reusable product. Disposal methods were evaluated independently from dredging and excavation and are described further in **Section 3.1.9**.

3.1.8 Dewatering

Dewatering may be necessary to prepare dredged materials for disposal. Dewatering reduces the water content and hence the volume and weight of the disposed sediment. If the material is to be reused or further treated, dewatering also leads to reduced transportation cost and improves handling properties. The nature and extent of dewatering needed depends on the sediment characteristics and the type of dredging, transport, and disposal methods planned for the removed material (ITRC, 2014). Dewatering technologies may rely upon gravity draining and evaporation processes (e.g., spreading and geotextile bags), mechanical processes (e.g., filter presses), and chemical conditioning (e.g., polymer additions and stabilization additives). The type of dewatering technology selected for use may depend upon the amount of space available for dewatering, the distance of the dewatering space from dredging operations, discharge options for treated dredge contact water, project scope, and cost of implementing the technology.

3.1.9 Disposal

Disposal of dredged or excavated sediment is the placement of materials into a controlled site or facility to permanently contain contaminants within the sediment. Management is achieved through the placement of materials into facilities such as sanitary landfills, hazardous material landfills, CDFs, or CAD facilities. Off-site landfills are generally used for dredged material disposal when on-site disposal is not feasible or when off-site disposal is more cost effective.

Landfills have been used for sediment volumes of over 1 million cubic yards. Typically, some type of on-site or near-site disposal facility is used at sites where dredged material volumes greater than 200,000 cubic yards are generated. Landfilling is also favored at smaller or moderately sized sites, where transportation is feasible. The associated hazards and cost of transporting and landfilling large volumes of sediment make this disposal method somewhat less desirable than other solutions. Other considerations, such as public and stakeholder acceptance, lack of access to suitable on-site land- or water-based disposal facilities, and proximity to an existing off-site landfill may support the landfilling option.

CDFs are constructed to isolate dredged sediment from the surrounding environment. CDFs can be located upland, near shore, or in the water (as an island). Material staging or a temporary CDF may be necessary for dewatering dredged sediment. CDFs represent a common disposal method and typically are built for larger volume sites (200,000 cubic yards or more of sediment).

The CAD method deposits dredged material within a nearby body of water. A pre-existing depression within the sediment surface is preferred, though one can be created if necessary. Dredged sediment is deposited in the depression and capped with clean material. This process carries with it the same risks associated with using capping as a remedy. The goal of moving the contaminated sediment to the aquatic disposal site is to reduce the risk of exposure to contaminated materials (ITRC, 2014).

Disposal at landfills, CDFs, and CADs were screened independently in this evaluation.

3.1.10 Remedial Technology Screening Results

Table 2 documents the technology screening process and results. The following remedial technologies were determined to be the most effective, implementable, and cost-effective and were retained for assembling the alternatives:

- ICs;
- Monitored Natural Recovery (MNR);
- Enhanced Monitored Natural Recovery;
- Mechanical Excavation;
- Gravity and Chemical Conditioning Dewatering;
- On-Site Sediment Consolidation and Disposal
- Landfill Disposal.

3.2 Implementation Assumptions

This section describes important factors and assumptions for implementing one or more of the alternatives presented in **Section 3.3**.

3.2.1 Staging Area Identification

Implementation of alternatives would require identification and construction of a staging area in which to stage and conduct all construction support activities. These activities can include importing and stockpiling materials, loading and offloading dump trucks, dewatering and stabilizing dredged sediments to meet RCRA paint filter testing as a condition for either on-site or off-site disposal. Based on conversations between Bay West, the City of Duluth, and the MPCA, the most likely staging area location would be in the corner of site adjacent to South 40th Avenue West (**Figure 17**). Other staging areas such as Erie Pier, and the adjacent MNDOT right of way, are also being evaluated by the MPCA and stakeholders; however, implementation strategy and cost evaluations in this FFS assume staging in the corner of site adjacent to South 40th Avenue West.

Based on satellite imagery, the assumed upland staging area is approximately 5 acres, which is sufficient for handling the anticipated 55,000 cubic yards sediments that may need to be addressed over the course of the Site's remedial activities. The staging area is approximately 2,800 feet from the furthest point on the Shoppers Creek portion of the site. In addition, the City of Duluth is planning to install a bike path along the narrow strip of land between the wetland ponds and the I-35 corridor and placing the staging area on South 40th Avenue West will provide a separation between heavy equipment used during remedial activities and the public using the proposed bike path adjacent to the Site.

Staging area construction for alternatives involving sediment excavation would include initial removal of site vegetation and the installation of fencing to protect construction equipment and prevent unauthorized personnel from entering the staging area while the remedy is being implemented. A water treatment system may be installed within the staging area in secondary containment to treat both the drained pond water and water collected from the sediment Slack drying cells. Depending on contaminant levels, drained pond water and water collected from the sediment slack drying cells may also be discharged to the sanitary sewer system for treatment at WLSSD. Treated site water will be returned to the temporary pond diversion via a culvert under the assumed bike path location. Two Slack drying cells will be created with sumps to allow for the collection and treatment of sediment drainage and rain water. Sediment will be placed into the cells and mixed with amendments to both desiccate the sediments as well as meet the conditions for the RCRA paint filter testing prior to either on-site or off-site disposal transportation. The Slack drying cells will consist of multiple cells each with one working days capacity such that trucks bringing sediment into the staging area for treatment could also leave the staging area with treated sediment to be returned to the site under the on-site disposal alternative.

3.2.2 Construction Equipment and Production Rates

Pond Isolation, water drainage, and dry excavation was assumed to be most cost-effective approach for handling the sediment material for either on-site or off-site disposal. The ponds would be drained in phases to allow the excavation of sediments using traditional bulldozers, excavators, and low ground pressure dump trucks. Excavation of sediment in dry conditions will allow remediation personnel a better view of the sediment to be removed and ease in removal of debris such as trees from the excavation area, and improve the effectiveness of the sediment removal (i.e., less residual contaminated sediments left behind).

3.2.3 Environmental Controls and Construction Monitoring

Environmental controls and construction monitoring are important elements in mitigating environmental impacts occurring as a direct result from construction activities and also in ensuring that remedial/construction goals are achieved. Environmental controls can include surface water control structures (e.g., silt curtains, sheet piling, and absorbent boom), lined sediment dewatering pads, tire washes, stormwater controls, and site fencing (for protection of human health). Construction monitoring can include turbidity monitoring during dredging activities, air monitoring during intrusive site activities, treated dredge contact water sampling, post-dredge verification sampling, cap thickness verification coring, bathymetric surveys, imported materials sampling, dewatered sediment sampling, and collection of pre- and post-construction upland soil samples within the staging area footprint. Alternatives involving capping as a remedy would likely require less controls and monitoring than alternatives incorporating dredging.

For the purposes of this FFS, it was assumed that alternatives consisting of excavating sediments would require controls and monitoring as listed below:

- Staging area fencing, stormwater controls, lined and bermed dewatering pad, and tire wash at the staging area for trucks leaving the site;
- Surface water controls and water treatment;
- Sediment conditioning;
- Post-dredge verification sampling;
- Dewatered sediment sampling;
- Treated sediment contact water sampling;
- Chemical and physical sampling of imported post-excavation sediment replacement materials to ensure that they are suitable for use; and
- Sediment replacement cover thickness verification to ensure that specifications are achieved.

Surface water controls will be particularly important for preventing off-site migration of suspended and potentially contaminated sediments during the dry excavation activities.

3.3 Development of Alternatives

This section describes the alternatives developed for the Site. The alternatives were developed using the selected remedial technologies discussed in **Section 3.1**, historical Site data, and the CSM. Historical sample data was used to estimate the depth and spatial extent of the remedial areas for COCs as presented in **Figure 14**. A summary of the proposed alternatives is presented in **Table 3**. **Table 4** through **Table 8** present a detailed cost breakdown of each Alternative. Calculations used to determine volumes, rates, and time frames related to remedy construction are presented in Table 1 in **Appendix B**. Assumptions made to compile cost estimates were incorporated into a Technical Analysis and are included in **Appendix B**.

The total present value costs for alternatives presented within this FFS should be considered to be rough order of magnitude (ROM) costs. Based on the Association for the Advancement of Cost Engineering ROM classification chart, estimates presented in this FFS are considered Class 4. Class 4 estimates are considered Schematic Designs; 15 to 20 percent (%) of the level of effort required to have a complete estimate has been done. Actual cost of the project could be 50% greater or 30% less (+50/-30) than the estimates developed thus far. ROM cost estimates for the FSS were compiled using a variety of sources. These sources include construction cost data from RSMeans estimating software for open shop pricing in Duluth, Minnesota; current Bay West and state contract rates for labor, equipment, and sample analysis; personal communication with vendors (Appendix C); historic cost data from projects similar in size and scope; other FFS documents, presentations, or technical papers that provided estimated or real construction cost data; and available online vendor pricing of materials. Present value calculations are included in **Table 12**.

3.3.1 Alternative 1: No Action

The NCP at 40 CFR provides that a no action alternative should be considered at every site. The no action alternative should reflect the site conditions described in the baseline risk assessment and RI. The no action alternative does not typically include any treatment, engineering controls, or ICs but may include monitoring (USEPA, 2005). A no action alternative applied to the Site would not meet criteria for protection of human health and the environment, but is included as an alternative for comparison purposes. The No Action Alternative included within this FFS does not include any treatment or engineering controls, ICs, or monitoring. There are no costs associated with the No Action Alternative.

3.3.2 Alternative 2: Monitored Natural Recovery and Institutional Controls

An MNR and ICs alternative would consist of monitoring Site conditions over an extended period of time to evaluate restoration trends in sediment chemical concentrations, sediment toxicity, and COC bioaccumulation within aquatic organisms (i.e., benthics and fish). ICs appropriate for maintaining protectiveness of human and environmental health would continue to be implemented for an indefinite period of time and until sufficient contaminant degradation, transformation, isolation, or other natural recovery processes reduce Site-related risks.

The objective of this alternative is to provide data to determine the potential for natural recovery processes to reduce availability and concentrations of COCs in sediment and/or reducing toxic/bioaccumulative effects in marine organisms (i.e., benthics and fish) at the Site. The major components of the MNR and IC Alternative are described in the following sections.

3.3.2.1 Monitored Natural Recovery Long-Term Monitoring

The MNR LTM program would include collection of Site data to determine trends in sediment chemical concentrations, sediment toxicity, fish tissue, and bioaccumulation of Site COCs in benthic organisms. Monitoring activities would be conducted to track or estimate the time frame to when remedial goals would be met and to ensure that contamination is not increasing or migrating to an extent to increase risks to human health or the environment.

Data collection would be conducted periodically for an indefinite period of time or until RAOs are achieved. For the purposes of this FFS, it was assumed that during a successful implementation, MNR data collection would occur annually for 10 years, biennially for 10 years, and every 5 years for 10 years, for a total of 17 monitoring events over a period of 30 years. The monitoring and evaluation period includes the following elements:

- MNR Remedy Implementation Work Plan;
- Collection of bulk sediment for analysis of physical characteristics including grain size and total organic carbon (TOC);
- Collection of sediment chemical data for COCs;
- Installation and monitoring of erosion pins and sediment traps;
- Collection of sediment samples for benthic toxicity and bioaccumulation analysis;
- Collection of fish tissue samples for bioaccumulation analysis;
- Bathymetric survey;
- MNR Remedy Implementation Completion Report to include monitoring results and recommendations; and
- A review of IC enforcement status.

Potential monitoring locations are presented in **Figure 18**.

3.3.2.2 Institutional Controls

Under the MNR and IC alternative, contaminated sediments would remain in place; therefore, ICs would be necessary to restrict fish consumption and contact with sediment. The MDH currently communicates fish consumption guidelines for the lakes and rivers of Minnesota. Advisories for consumption of fish within the SLR and below the Fond du Lac Dam are in place for 11 species of fish due to the presence of mercury and PCBs within fish tissue. No specific advisories are in place related to other COC tissue concentrations. It is currently unknown whether the meal advice provided within the fish consumption guidelines is protective for all COCs; therefore, the applicability of meal guidelines to the remaining COCs would require investigation. Additional signage would be placed along the site boundaries, especially between the proposed bike path and the ponds, warning the public about the Site's human health concerns.

3.3.2.3 Cost

The costs associated with each alternative are presented as Class 4 (+50/-30) estimates and are appropriate for remedial design alternative evaluations only. The estimated total present value cost for Alternative 2 is $2,170,000. **Table 4** presents a detailed breakdown of the estimated costs associated with Alternative 2. Calculations used to determine unit rate costs for each of the alternatives are presented in **Appendix B**, including costs determined on a lump sum basis, and the monitoring and evaluation program and associated costs.

3.3.3 Alternative 3: Enhanced Monitored Natural Recovery with Broadcasted Amendment

Alternative 3 would combine Alternative 2 (MNR and IC) as detailed within **Section 3.3.2** with the distribution of a solidification/stabilization/treatment amendment thin-layer cover across the wetland and creek beds to destroy, immobilize, and/or reduce the bioavailability of the COCs. Alternative 3 would also include the installation of flow control structures on Shoppers Creek, on storm sewer outfall #1 and the unnamed tributary to minimize pond sediment erosion events and protect the long-term integrity of the thin-layer cover. The objective of this alternative is to provide an immediate, cost-conscious improvement to the PBAZ through construction of a 0.010-meter amended thin-layer cover over sediments with COCs over the CUL as listed in **Table 1**. The cover thickness was determined by applying the manufacture-recommended product dosage rate of 31 tons per acre. It is anticipated that the amendment material would be mixed into the underlying sediments over time through natural bioturbation processes caused by burrowing organisms, larger animal life, and rooting plants; therefore, this alternative is intended to reduce contaminant availability rather than provide isolation from contaminants as in a traditional capping scenario.

Hard bottom flow control sediment basins will be installed on Shoppers Creek, the eastern storm sewer input and the unnamed tributary prior to their entry into the existing wetlands. Sediments removed from the site during the flow control structure installation along with Shoppers Creek sediments above the flow control structure will be treated to meet RCRA paint filter testing prior to off-site disposal. These flow control basins would be installed along the existing roadways (i.e., Recycle Way/Ramsey, and Oneonta Street and South 40th Avenue West) to allow for future land-based sediment removal if necessary.

3.3.3.1 Institutional Controls

Contaminated sediments would remain in place beneath the EMNR thin-layer cap; therefore, ICs applicable to Alternative 3 include those that would protect cap integrity as well as ICs as detailed in **Section 3.3.2.2**. The cap-specific ICs include prevention of anchoring within the footprint of capped areas, prevention of future construction of docks or piers or other invasive improvements to the ponds, and prevention of future dredging activities within the Site. Review of IC enforcement status will be conducted annually in concert with the annual monitoring report.

3.3.3.2 0.010-Meter Thin-Layer Sediment Cover

A combination of amendments such as Sedimite™, organoclay, or activated charcoal would be distributed in a thin-layer cap across the sediment surface (**Figure 19**) to treat, immobilize, and/or reduce the bioavailability of COCs.

SediMite™ was selected for the Alternative 3 EMNR thin-layer cap approach. SediMite™ is an agglomerate that comprises a treatment agent (typically AC), a weighting agent (to enable it to sink and resist resuspension), and an inert binder. AC applied as an active cover through SediMite™ will be used to bind up COCs and reduce COC uptake in the aquatic food chain. ACs have been demonstrated to have strong affinities for the known bioaccumulative COCs present at the Sites such as PCBs, mercury, methylmercury, dioxins/furans, and PAHs. SediMite and will provide clean substrate for wetland vegetation and habitat for macroinvertebrate organisms. Bench scale testing and the final selection of broadcast amendments and cover construction details would be determined during the design phase. The cover thickness of 0.010-meters was determined by applying the manufacture-recommended product dosage rate of 31 tons per acre.

Implementation of the Alternative 3 EMNR would require construction of an upland support area in which to stage and conduct all construction activities. The upland support area would be along South 40th Avenue West. Features of the upland support area would consist of a site entrance, office trailer and parking area, cover material stockpile area, various equipment storage areas, and a hopper area.

3.3.3.3 Broadcast Amendment Implementation

Sand and/or amendment placement for construction of caps has been conducted via numerous methods, including dumping from barges, washing materials overboard from barge decks, spraying of sand/water slurry, mechanical placement with buckets, and hydraulic pumping with controlled discharge (e.g., diffuser box or plate). This FFS assumes that the cover materials will be broadcasted via stone slingers throughout the COC-impacted footprint to minimize disruption to the ecosystem present at the Site.

3.3.3.4 Enhanced Monitored Natural Recovery Monitoring and Evaluation

Contaminated sediments would remain in place as part of Alternative 3 and, therefore, a monitoring and evaluation period would be necessary. Post-sediment treatment monitoring would be conducted to demonstrate the effectiveness of the remedy and monitoring. Annual monitoring and evaluation would be conducted as detailed within **Section 3.3.2** The EMNR monitoring would continue until components of the program can be discontinued or until the RAOs have been met. For the purposes of this FFS, it was assumed that data collection would occur at 17 locations annually for 5 years, biennially for 10 years, and every 5 years for 15 years, for a total of 13 monitoring events over a period of 30 years.

Data collection will consist of the following:

- Bulk sediment physical for grain size and TOC;
- Collection of sediment chemical data for COCs;
- Collection of sediment samples for benthic toxicity and bioaccumulation analysis;
- Collection of fish tissue samples for bioaccumulation analysis;
- Sediment coring to determine cap thicknesses and ensure that the integrity of the thin-layer cap is maintained;

- Periodic observation of the vegetated wetlands to ensure that the thin-layer cap has not negatively impacted these areas.
- Bathymetric surveys; and
- A review of IC enforcement status.

Potential monitoring locations are presented in **Figure 19**.

3.3.3.5 Cost

The costs associated with each alternative are presented as Class 4 (+50/-30) estimates and are appropriate for remedial design alternative evaluations only. The estimated total present value cost for Alternative 3 is $4,850,000. **Table 5** presents a detailed breakdown of the estimated costs associated with Alternative 3. Calculations used to determine unit rate costs for each of the alternatives are presented in **Appendix B**, including costs determined on a lump sum basis, and the monitoring and evaluation program and associated costs.

3.3.4 Alternative 4: Sediment Excavation and Consolidation in Upland Caps and Wetland Restoration

This alternative would consist of temporarily isolating the ponds from surface water flow to allow for dry excavation and treatment of sediments exceeding CULs, construction of upland caps for treated sediments, and restoration of wetlands. The ponds would be isolated from surface water flow by placing sheet pile across the wetland bridging the elevated active railway to the south of the Site and the unpaved roadway to the north of the ponds (**Figure 20**). Once the ponds were isolated, the wetland water would be pumped, treated with granular activated carbon (GAC), and discharged to Shoppers Creek and/or the St. Louis Bay. During wetland dewatering, fish and wetland land inhabitants would be collected as necessary and either euthanized to eliminate contaminated organisms from the food chain or if bioaccumulation and/or tissue toxicity is not a concern, the organisms would be released to the adjacent St. Louis Bay. The pond sediment that exceeds COC CULs would be mechanically excavated and transported via low ground pressure dump trucks to a staging area constructed adjacent to South 40th Avenue West shown on **Figure 17**. Dredging of sediments would target several dredge elevations based on the remedial footprint and bathymetry, as shown on **Figure 21** and further described in the following sections. In the staging area the sediment will be dewatered and the COCs stabilized with the addition of 15%, by weight, Portland cement.

Once treated, the sediment will be returned to the wetland and used to create upland CDF features within the ponds, reshaping and improving the overall quality and function of the wetland (**Figure 22**). The upland CDF caps will be planted with shrubbery and trees typical of shrub (type 6) wetlands to stabilize the caps against future erosion and isolate the sediments from human and wetland inhabitant exposure. Once the upland CDF caps are created and the wetland has been reshaped and revegetated, natural flow into the wetland from Shoppers Creek, the storm sewer outlets, and the unnamed tributary will be restored. Long-term sediment, surface water, and biota monitoring would be conducted to demonstrate the effectiveness of the remedy. The monitoring would continue until components of the program can be discontinued or until the RAOs have been met.

3.3.4.1 Institutional Controls

Contaminated sediments would remain in place beneath the upland caps; therefore, ICs applicable to Alternative 4 include those that would protect cap integrity as well as ICs as detailed in **Section 3.3.2.2**. The cap-specific ICs include prevention of intrusive activities within the footprint of capped areas, prevention of future construction of docks or piers, or other invasive improvements to the upland areas. Review of IC enforcement status will be conducted annually in concert with the annual monitoring report.

3.3.4.2 Wetland Pond Isolation and Dewatering

The wetland ponds would be isolated from surface water inputs by creating a new culvert linking the eastern storm sewer drainage ditch adjacent to the northeastern pond to Shoppers Creek and diverting Shopper Creek directly to St. Louis Bay via the existing train trestle current linking the ponds to the Bay (**Figure 20**). Initially, flow control structures would be installed on Shoppers Creek, storm sewer outfall #2, and the unnamed tributary to minimize pond sediment erosion events and protect the upland CDF caps as detailed in Alternative 3. Approximately 1,300 feet of sheet pile would be driven along the western edge of the southwest pond (parallel to the 604 and 602 amsl contours) cutting off the ponds from Shoppers Creek and the wester storm sewer inlet. A 1,900-foot culvert will be installed connecting the eastern storm sewer drainage ditch to the flow control structure on Shoppers Creek to create a flow path around the ponds. The new surface culvert would pass underneath the proposed bike path near the existing western storm sewer input. Next, the culvert connecting the eastern storm sewer inlet and the ponds would be blocked, and the flow control structure placed on the unnamed tributary would be sealed to allow for the collected surface water to be pumped to the eastern storm sewer drainage ditches. Based on satellite imagery, it appears that the eastern storm sewer drainage ditch has an additional holding capacity of at least 1.3 acre-feet, which should provide holding capacity during a high water runoff event. Tree and stump debris collected after the ponds have been drained will be stockpiled on-site for use during wetland restoration activities. Large trash items such as tires will be transported to the staging area for proper disposal.

3.3.4.3 Sediment and Water Treatment Staging Area.

The most likely staging area location for sediment and water treatment is located on the corner of the site adjacent to South 40th Avenue West (**Figure 17**). Based on satellite imagery, the assumed upland staging area is approximately 5 acres, which is sufficient for phased handling of approximately 64,000 cubic yards of sediment that may need to be addressed over the course of the Site's remedial activities. The staging area is approximately 2,800 feet from the furthest point on the Shoppers Creek portion of the site. In addition, the City of Duluth is planning to install a bike path along the narrow strip of land between the wetland ponds and the I-35 corridor, and placing the staging area on South 40th Avenue West will provide a separation between heavy equipment used during remedial activities and the public using the adjacent bike path.

Pond and post-drainage surface water; groundwater infiltration collected by sumps; and the stormwater collected from the staging area, the Slack drying bins, and wheel wash area will be treated by a water treatment system installed in the staging area. The water treatment system will consist of a series of settling frac tanks, coagulant mix tanks, clarifier tanks, and a series of sand, organoclay, and GAC filter tanks to treat the water prior to being released to the surface water diversion culvert and ultimately St. Louis Bay via a NPDES permit. Backwash from the filters will be directed back to the initial settling tanks for reprocessing while sludge collected in the settling tanks and clarifiers will be collected and added to the Slack drying cells for treatment with the sediment.

3.3.4.4 Sediment Excavation

Excavation in dry conditions will allow for greater precision in removing the minimal required sediment to achieve RAOs. An excavation sediment approach would include removal of all sediments with COC concentrations exceeding the CULs. The proposed area for sediment removal is presented in **Figure 21** and equals approximately 14.4 acres. For the purposes of this FFS, three dredge elevations have been established within areas of the Site identified as exceeding the COCs CULs as defined in **Section 2.2.1**. Each dredge elevation was selected based on the elevation of the sediment surface and the average depth of contamination in that area. Additionally, some portions of the excavation footprint will receive a 1-foot sediment surface scrape. During implementation, post-excavation verification sampling would be completed to verify dredging of contaminated sediments exceeding the CUL had been achieved. Dredge elevations and contaminated material thicknesses are presented on **Figure 21**. Abutments from the Bong Memorial Bridge, which crosses over the southern pond, may impact excavation strategy and should be taken into account during the design phase of the project. The total volume of in situ sediments requiring removal across the 14.4-acre site is estimated to be 64,000 cubic yards; however, the horizontal and vertical extent of CUL exceedance has not been fully delineated. Additional sampling will be required prior to the design phase to refine the total volume of sediment requiring removal. It is assumed that sediments dredged from the Site will be classified as non-hazardous based on historic sample concentrations. The final volume of sediments requiring disposal will be a result of in situ volume, dewatering and treatment of sediments as they handled, and the addition of stabilizing agents during the dewatering process. For the purposes of this FFS, sediment bulking by the addition of 15% by weight Portland cement was assumed to counter balance sediment dewatering resulting in a total disposal volume of approximately 64,000 cubic yards.

3.3.4.5 Sediment Stabilization

Excavated sediments are expected to have interstitial water making them unsuitable for direct consolidation within the wetlands and use as a base for the upland areas proposed for wetland restoration. Therefore, excavated sediments would require conditioning to make the sediment structurally suitable for use as a base for the proposed upland areas. The dewatering/ stabilization process would rely upon the addition of amendments to the excavated sediments to dewater the sediments as defined during final remedy design, along with gravity draining of entrained and interstitial water within the Slack drying cells.

The Slack drying cells would be constructed within the staging area located adjacent to South 40th Avenue West prior to commencement of excavation activities. The drying cells, along with the water treatment system, would be a primary feature of the sediment staging area and must be large enough so that three operations could be conducted on the pad at once. These operations include:

- Offloading excavated sediments into the Slack drying cells;
- Mixing of sediments with an amendment such as Portland cement or Calciment and allowing to cure for several days to attain adequate cohesiveness; and
- Loadout of Slack drying cells into off-road dump trucks for return delivery to the excavation site.

The staging area and Slack drying cells will each be lined, paved, bermed, and be equipped with gravity drainage to a sump to contain contaminated sediments and to facilitate handling of water, both sediment water and precipitation falling onto the area. Slack drying cells will be 140 feet by 45 feet in 450 cubic yard Slack drying cells (i.e., one production day) and treated with amendments for free-water desiccation and sediment/COC solidification/stabilization (SS). Tarps will be placed over the piles when the Slack drying piles are not being used to minimize exposure to rain and possible volatilization and/or odor control. Dredge contact water collected in the sump would be pumped into frac tanks (i.e., equalization tanks) and would be treated as described in **Section 3.3.4.3**.

The dewatering/stabilization process would incorporate the use of SS binders that generate a cementitious reaction with the available water and solid matrix of the dredged sediments. SS alters the physical and/or chemical characteristics of the sediment through the addition of binders, including cements and pozzolans (USEPA, 1994) so contaminants are less prone to leaching. Alteration of the physical character of the sediment to form a solid material, such as a cement matrix, reduces the accessibility of the contaminants to water and entraps the contaminated solids in a stable matrix (Myers, T.E. and M.E. Zappi, 1989). Common amendments for sediment dewatering/stabilization include Portland cement, fly ash, lime cement, and lime kiln dusts. These amendments are powdered materials that require enclosed transport and storage systems to reduce dust migration and premature hydration. Some materials, such as fly ash, may be available locally at a substantially reduced cost relative to Portland cement. For the purposes of this FFS, it was assumed that solidification with 15% Portland cement by volume would be conducted. Pilot scale or treatability studies should be conducted during the design phase to identify desirable amendment materials and amendment rates.

3.3.4.6 On-Site Sediment disposal, Upland Cap, and Wetland Restoration

Once the sediment is stabilized, the sediment will be returned to the wetland and staged for use in the creation of upland wetland cap areas during wetland restoration. The objective of upland sediment capping sediments at the Site is to limit exposure of human receptors to contaminated sediments; limit exposure of aquatic organisms to contaminated sediments; and thereby limit transfer of COC contamination to higher trophic organisms. The benefits of consolidating sediments under upland wetland caps include the following:

- Elimination of off-site disposal transportation and tipping fees;
- Minimizing the area susceptible to future disturbance from intrusive Site activities such as anchoring, ice scour, prop wash, etc.; and
- Enhance the aquatic habitat in a manner that accelerates to the extent possible the removal of BUIs.

Consolidation of sediments in upland caps would minimize the area required for capping but could potentially increase accessibility to contaminated sediments by humans and burrowing upland species.

Clean sediment excavated from the wetland will be stockpiled along the active the railway footing to protect the railway footing from heavy equipment traffic and general erosion that may occur during sediment excavation and for later use as cover material. Upland caps will be built up for eventual creation of clean emergent marshlands. The original open water area will be reshaped to increase surface water residency time within the wetland. Approximately 8.5 acres of uplands will be made to bisect the wetland creating an elongated flow path through the wetland as shown in **Figure 22**. After sediment upland cap consolidation, a 0.22-meter (9-inch) clean cover would be placed in water-covered areas across the Site to restore the PBAZ. Abutments from the Bong Memorial Bridge, which crosses over the southern pond, may impact upland cap construction strategy and should be taken into account during the design phase of the project. The final depth and clean cover composition requirements will be defined by the MDNR as part of the public waters permit. The use of geotextiles to protect the capped sediment and erosion controls (i.e., armoring) along the upland shore line will be evaluated during the design phase when the exact wetland restoration requirements have been defined. The upland portions of the wetland will be restored with the goal of an eventual type 6 wetland. Plants that would be used in the type 6 wetland restoration include alder, willow, dogwood, and buttonbush. The open water portion of the wetland will be restored with the goal of an eventual type 4 shallow marsh wetland. Plants that would be used in the type 4 wetland restoration include grasses; bulrush; spikerush; and various other marsh plants, such as cattail, arrowhead, pickerelweed, and smartweed. The volume sediment consolidation and clean cover required would be determined during the design phase and would ultimately determine the water depth, shape, area, and elevation of the upland caps within the area of consolidation following construction activities.

Following the wetland recreation and revegetation, the flow into the wetland from Shoppers Creek will be restored along with the other surface water inputs. The temporary storm sewer and unnamed tributary diversion will be filled in and the culvert under the bike path will be abandoned in place.

3.3.4.7 Long-Term Monitoring

LTM would commence after remedy implementation and would include collection of Site data to ensure that the upland sediment cap integrity is maintained as long as COCs remain in sediments above the CUL; ensure that ICs continue to be enforced as long as COCs remain in sediments above the CUL; and ensure that sediment contaminants are not migrating into or through the cap.

LTM data collection would be conducted periodically for an indefinite period of time or until concentrations of COCs in sediments beneath the cap attenuate to levels below the CUL and are deemed protective of human health and the environment. For the purposes of this FFS, it was assumed that data collection would occur at 10 locations once every 5 years, for a total of 6 monitoring events over a period of 30 years.

Data collection will consist of the following:

- Bulk sediment physical for grain size and TOC;
- Collection of sediment chemical data for COCs;
- Collection of sediment samples for benthic toxicity and bioaccumulation analysis;
- Collection of fish tissue samples for bioaccumulation analysis;
- Bathymetric surveys and coring to determine cap thicknesses;
- Bathymetric surveys; and
- A review of IC enforcement status.

Potential monitoring locations are presented in **Figure 22**.

3.3.4.8 Cost

The costs associated with each alternative are presented as Class 4 (+50/-30) estimates and are appropriate for remedial design alternative evaluations only. The estimated total present value cost for Alternative 4 is $13,614,000. **Table 6** presents a detailed breakdown of the estimated costs associated with Alternative 4. Calculations used to determine unit rate costs for each of the alternatives are presented in **Appendix B**, including costs determined on a lump sum basis, and the monitoring and evaluation program and associated costs. In the development of Alternative 4, several capping modifications were contemplated to evaluate reduced cost capping approaches. One such modification was to place treated sediment on a portion of untreated and undisturbed land areas. This modified capping approach reduced the volume of excavated and treated sediment by approximately 25%; however the overall costs were only reduced by approximately 10% to $12,252,600. Since the modified capping approaches were less protective of the Site and less likely to be accepted by the MDNR to complete, the excavation approach was presented as the capping option.

3.3.5 Alternative 5: Sediment Excavation, Off-Site Disposal and Wetland Restoration.

Alternative 5 would consist of the complete removal of all sediments with COC concentrations exceeding CULs. The wetland ponds would be isolated from surface water flow to allow for dry excavation as detailed in **Section 3.3.4.2**. Removal of contaminated sediments would mitigate exposure of aquatic and human receptors to sediment contaminants thus allowing for achievement of RAOs.

Sheet pile would be placed across the wetland bridging the elevated active railway to the south of the site and the unpaved roadway to the north of the ponds. A new trenched drainage ditch would divert surface water from the unnamed tributary and storm sewer outfalls #1 and #2 along the northern edge of the ponds west to Shoppers Creek. The ponds would be pumped dry so that the excavation operations can be conducted using conventional moving equipment in dry conditions.

The excavated sediments would be transported by low ground pressure dump truck to staging area located adjacent to South 40th Avenue West, dewatered and the COCs stabilized with the addition of 15%, by weight, Portland cement as needed, and transported by roadway for disposal at an off-site landfill. Following sediment removal, the ponds would be restored using either clean sediment displaced during the excavation and/or stockpiled sediment from the Erie Pier CDF facility located adjacent to the Site. The clean sediment will be used to create a longer surface water residence time within the ponds but not to the extent as in Alternative 4. The open water portion of the wetland will be restored with the goal of an eventual type 4 shallow marsh wetland (**Figure 23**).

Once the wetlands were reshaped and revegetated, the original surface water flow through the ponds would be restored with the three new surface flow control structures remaining in place. ICs and an LTM program would not be implemented following completion of remedy construction if complete removal of contaminated sediments is achieved.

The major components of this alternative are described in the following sections.

3.3.5.1 Institutional Controls

Since contaminated sediments above CULs would be removed, ICs would not be included in this alternative.

3.3.5.2 Wetland Pond Isolation and Dewatering

The wetland ponds would be isolated from surface water inputs as detailed in **Section 3.3.4.2**.

3.3.5.3 Sediment and Water Treatment Staging Area.

A staging area will be developed as detailed in **Section 3.3.4.3**.

3.3.5.4 Sediment Excavation

Sediment excavation will be executed as detailed in **Section 3.3.4.4**.

3.3.5.5 Sediment Stabilization

Sediment stabilization will be executed as detailed previously in **Section 3.3.4.5** with the exception of shipping the sediments off-site for disposal rather than returned to the excavation site. Prior to off-site departure, all vehicles will be deconned in a wash-down area with the rinsate water collected for processing through the water treatment system.

3.3.5.6 Off-Site Sediment Disposal and Wetland Restoration

The disposal option evaluated for this FFS is off-site landfill disposal. Stabilized sediments would be periodically sampled to ensure that landfill requirements for disposal are continuously met. In addition, the dewatered sediments would be required to pass the paint filter test prior to site exit and upon arrival at the landfill to confirm that they are suitable for transportation and will be workable at the landfill.

It is assumed that sediments excavated from the Site will be classified as non-hazardous based on historic sample concentrations. The final volume of sediments requiring disposal will be a result of in situ volume, bulking of sediments as they are excavated and handled, and the addition of stabilizing agents during the dewatering process, as discussed in **Section 3.3.4.5**, resulting in an estimated total disposal volume of 64,000 cubic yards.

The wetland will be restored in a similar fashion as detailed in **Section 3.3.4.6**, however, since the stabilized sediment will not be available for use in the construction of upland caps, a much smaller upland area will be created during the wetland restoration. Abutments from the Bong Memorial Bridge, which crosses over the southern pond, may impact excavation and upland cap construction strategy and should be taken into account during the design phase of the project.

3.3.5.7 Long-Term Monitoring

Since Alternative 5 removes all of the impacted sediment with COC concentrations above the CULs and disposes of them off-site, complete a post-treatment LTM program would not be warranted. However, baseline predesign sediment sampling and post-treatment QA/QC sediment monitoring is required.

Data collection will consist of the following:

- Collection of sediment chemical data for COCs to refine area and depth of sediment requiring off-site disposal;
- Collection of fish for bioaccumulation (i.e., tissue) to determine the fate of wetland inhabitants collected during the draining of the ponds; and
- Bathymetric surveys to confirm existing conditions.

3.3.5.8 Cost

The costs associated with each alternative are presented as Class 4 (+50/-30) estimates and are appropriate for remedial design alternative evaluations only. The estimated total present value cost for Alternative 5 is $16,716,000. **Table 7** presents a detailed breakdown of the estimated costs associated with Alternative 5. Calculations used to determine unit rate costs for each of the alternatives are presented in **Appendix B**, including costs determined on a lump sum basis, and the monitoring and evaluation program and associated costs.

3.3.6 Alternative 6: Sediment Excavation and Off-Site Disposal

Alternative 6 would consist of the complete removal of all sediments with COC concentrations exceeding CULs. The wetland ponds would be isolated from surface water flow to allow for dry excavation as detailed in **Section 3.2.7**. Removal of contaminated sediments would mitigate exposure of aquatic and human receptors to sediment contaminants thus allowing for achievement of RAOs.

Sheet pile placement, outfall diversion, and dewatering would be implemented similar to Alternative 5 as described in **Section 3.3.4.2**.

The excavated sediments would be transported by low ground pressure dump truck to staging area located adjacent to South 40th Avenue West, dewatered and the COCs stabilized with the addition of 15%, by weight, Portland cement as needed, and transported by roadway for disposal at an off-site landfill. Following sediment removal, a dredge residual layer of 9-inches of sand would be placed throughout the pond footprint using either clean sediment displaced during the excavation and/or stockpiled sediment from the Erie Pier CDF facility located adjacent to the Site. The open water portion of the wetland will be restored with the goal of an eventual type 4 shallow marsh wetland (**Figure 24**).

Once the wetlands were revegetated, the original surface water flow through the ponds would be restored with the three new surface flow control structures remaining in place. No upland features, such as those detailed in Alternative 4 and 5, would be constructed, maximizing the amount of open water and overall pond depth for wildlife habitat. ICs and an LTM program would not be implemented following completion of remedy construction if complete removal of contaminated sediments is achieved.

The major components of this alternative are described in the following sections.

3.3.6.1 Institutional Controls

Since contaminated sediments above CULs would be removed, ICs would not be included in this alternative.

3.3.6.2 Wetland Pond Isolation and Dewatering

The wetland ponds would be isolated from surface water inputs as detailed in **Section 3.3.4.2**.

3.3.6.3 Sediment and Water Treatment Staging Area.

A staging area will be developed as detailed in **Section 3.3.4.3**.

3.3.6.4 Sediment Excavation

Sediment excavation will be executed as detailed in **Section 3.3.4.4**.

3.3.6.5 Sediment Stabilization

Sediment stabilization will be executed as detailed previously in **Section 3.3.4.5** with the exception of shipping the sediments off-site for disposal rather than returned to the excavation site. Prior to off-site departure, all vehicles will be deconned in a wash-down area with the rinsate water collected for processing through the water treatment system.

3.3.6.6 Off-Site Sediment Disposal and Wetland Restoration

The disposal option evaluated for this FFS is off-site landfill disposal. Stabilized sediments would be periodically sampled to ensure that landfill requirements for disposal are continuously met. In addition, the dewatered sediments would be required to pass the paint filter test prior to site exit and upon arrival at the landfill to confirm that they are suitable for transportation and will be workable at the landfill.

It is assumed that sediments excavated from the Site will be classified as non-hazardous based on historic sample concentrations. The final volume of sediments requiring disposal will be a result of in situ volume, bulking of sediments as they are excavated and handled, and the addition of stabilizing agents during the dewatering process, as discussed in **Section 3.3.4.5**, resulting in an estimated total disposal volume of 64,000 cubic yards.

The wetland will be restored in a similar fashion as detailed in **Section 3.3.4.6**, however, no upland flow path features will be constructed, resulting in a maximum area of open water. Abutments from the Bong Memorial Bridge, which crosses over the southern pond, may impact excavation strategy and should be taken into account during the design phase of the project.

3.3.6.7 Long-Term Monitoring

Since Alternative 6 removes all of the impacted sediment with COC concentrations above the CULs and disposes of them off-site, complete a post-treatment LTM program would not be warranted. However, baseline predesign sediment sampling and post-treatment QA/QC sediment monitoring is required.

Data collection will consist of the following:

- Collection of sediment chemical data for COCs to refine area and depth of sediment requiring off-site disposal;
- Collection of fish for bioaccumulation (i.e., tissue) to determine the fate of wetland inhabitants collected during the draining of the ponds; and
- Bathymetric surveys to confirm existing conditions.

3.3.6.8 Cost

The costs associated with each alternative are presented as Class 4 (+50/-30) estimates and are appropriate for remedial design alternative evaluations only. The estimated total present value cost for Alternative 6 is $15,726,000. **Table 8** presents a detailed breakdown of the estimated costs associated with Alternative 5. Calculations used to determine unit rate costs for each of the alternatives are presented in **Appendix B**, including costs determined on a lump sum basis, and the monitoring and evaluation program and associated costs.

4.0 REMEDY SELECTION CRITERIA

The alternatives were evaluated and compared using the NCP remedy selection criteria outlined below and in general accordance with USEPA guidelines for feasibility studies (USEPA, 1990). The NCP remedy selection criteria are divided into three groups based on the function of the criteria in remedy selection. The NCP definitions of each criterion are included below. Green Sustainable Remediation (GSR) criteria were also evaluated during this FFS and are included as a fourth group of criteria. Additional detail may be added from MPCA and/or USEPA guidance where appropriate.

4.1 Threshold Criteria

The Threshold Criteria relate to statutory requirements that each alternative must satisfy in order to be eligible for selection and include:

4.1.1 Overall Protection of Human Health and the Environment

Alternatives shall be assessed to determine whether they can adequately protect human health and the environment, in both the short term and long term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site by eliminating, reducing, or controlling exposures to levels established during development of remediation goals. Overall protection of human health and the environment draws on the assessment of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.1.2 Compliance with ARARs

The alternatives shall be assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility citing laws or provide grounds for invoking a waiver.

4.2 Primary Balancing Criteria

The Primary Balancing Criteria are the technical criteria upon which the detailed analysis is primarily based and include the following.

4.2.1 Long-Term Effectiveness and Permanence

Alternatives shall be assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. Factors that shall be considered, as appropriate, include the following:

1. Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residual should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

2. Adequacy and reliability of controls, such as containment systems and ICs, necessary to manage treatment residuals and untreated waste. This factor addresses, in particular, the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cap, a slurry wall, or a treatment system; and the potential exposure pathways and risks posted should the remedial action need replacement.

4.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the Site. Factors that shall be considered, as appropriate, include the following:

1. The treatment or recycling processes the alternatives employ and materials they will treat;
2. The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated or recycled;
3. The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reductions(s) are occurring;
4. The degree to which the treatment is irreversible;
5. The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents; and
6. The degree to which treatment reduces the inherent hazards posed by principal threats at the Site.

4.2.3 Short-Term Effectiveness

The short-term impacts of alternatives shall be assessed considering the following:

1. Short-term risks that might be posed to the community during implementation of an alternative;
2. Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;
3. Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigating measures during implementation; and
4. Time until protection is achieved.

4.2.4 Implementability

The ease or difficulty of implementing the alternatives shall be assessed by considering the following types of factors, as appropriate:

1. Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy;
2. Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions); and
3. Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and the availability of prospective technologies.

4.2.5 Costs

The types of costs that shall be assessed include the following:

1. Capital costs, including both direct and indirect costs;
2. Annual O&M costs; and
3. Net present value of capital and O&M costs.

The USEPA guidance document *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA, 2000) was used to develop cost estimates presented in this FFS. The cost estimates developed for this Revised FFS are primarily for the purpose of comparing remedial alternatives during the remedy selection process, not for establishing project budgets.

4.3 Modifying Criteria

The third group is made up of the Modifying Criteria specified below. These last two criteria are assessed formally after the public comment period, although to the extent that they are known will be factored into the identification of the preferred alternative.

4.3.1 State/Support Agency Acceptance

Assessment of state/agency concerns may not be completed until comments on this Revised FFS are received, but may be discussed, to the extent possible, in the proposed plan issued for public comment. The state/agency concerns that shall be assessed include the following:

1. The state's/agency's position and key concerns related to the preferred alternative and other alternatives; and
2. State/agency comments on ARARs or the proposed use of waivers.

4.3.2 Community Acceptance

This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment may not be completed until comments on the proposed plan are received.

4.4 Green Sustainable Remediation

The last group is made up of the GSR criteria specified below. There are six criteria included with this analysis, which are then summarized to provide each alternative with an overall GSR rating. The six GSR criteria evaluated with this Revised FFS include the following:

- Greenhouse Gas (GHG) Emissions;
- Toxic Chemical Usage and Disposal;
- Energy Consumption;
- Use of Alternative Fuels;
- Water Consumption; and
- Waste Generation.

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The purpose of the comparative analysis is to identify and compare advantages and disadvantages of each evaluated alternative relative to one another with respect to remedy selection criteria presented in **Section 4.0** in order to determine which of the alternatives best meets those criteria. The comparative analysis is documented in this section and summarized in **Tables 9 and 10**. **Table 11** presents a numerical comparison of the evaluated alternatives.

5.1 Threshold Criteria

Only those alternatives that would meet the threshold criteria of providing overall protection of human health and the environment and whether they would attain compliance with ARARs were carried forward with the comparative analysis. Alternative 1 No Action does not meet the threshold criteria but was carried forward as it is required for analysis under the NCP. Alternative 2 MNR does not meet the threshold criteria given that the Site's COCs are likely to have been present for decades with little evidence that natural processes can progress towards achieving RAOs within an acceptable time frame. Alternative 3 EMNR does not meet the threshold criteria since a combination of reagents, or other EMNR enhancements, capable of addressing the complex suite of COCs present that protect the benthic community within an acceptable time frame has not been validated. Alternatives 4, 5, and 6 will achieve protection of human health and the environment and comply with the identified ARARs. Contaminated sediment would remain in place under Alternative 4, requiring monitoring every 5 years to ensure long-term effectiveness. Alternative 5 and 6 would provide the highest level of protection since contaminated sediments would be removed from the aquatic environment. Additionally, based on stakeholder and MPCA input, Alternative 6 would result in the best habitat for fish and wildlife.

5.2 Balancing Criteria

5.2.1 Long-Term Effectiveness and Permanence

Alternatives 1 and 2 are not effective in the long-term or permanent. Alternative 3 may provide increased effectiveness; however, it is uncertain whether a combination of MNR enhancements can achieve the RAOs for the complex suite of COCs present over the long term. Alternatives 4 and 5 are effective in the long term, however, contaminated sediment, although stabilized with Portland cement, would remain in place under Alternative 4, requiring long-term O&M and ICs to ensure long-term effectiveness; therefore, Alternative 4 is not as permanent. Alternative 5 and 6's disposal of sediment at an off-site landfill would be equally effective in the long term. Since all contaminated sediments would be removed, Alternative 5 and 6 would provide the most permanence, even though contaminants would not be permanently destroyed in the landfill.

Table 3 presents the estimated construction completion time for each alternative at the Site. The estimated construction completion time required for alternative implementation ranges from 0 weeks for Alternative 1 to 45 weeks over two construction seasons for Alternative 5. Alternatives 1 through 3 can be completed in one construction period. While Alternatives 4, 5, and 6 are anticipated to require two construction seasons, the first to drain the pond and excavate and treat/dispose of the sediments, and a second season to restore the wetland.

In summary, Alternative 3 may provide low to moderate achievement of these criteria since the COCs will stay in the aquatic environment and only be treated once they come in contact with the reagents of the EMNR cover. Alternative 4 will provide a moderate to high achievement of this criterion by isolating all of the contaminated sediment in the aquatic environment above the CULs. Alternative 5 and 6 will provide a high achievement of this criterion by removing all of the contaminated sediment in the aquatic environment above the CULs.

5.2.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 2 provides no achievement of these criteria because no treatment is involved in the remedy. Alternatives 3, 4, 5, and 6 attempt to treat the contaminated sediments to reduce toxicity, mobility, or volume. Alternative 3 would enhance the natural processes through the addition of reagents to immobilize or sequester the COC while also adding a cover that accelerates the burial of the COC beyond bioactive zone. Alternatives 4, 5, and 6 include the ex situ addition of sediment stabilization reagents to excavated sediment as a means to bind excess free water and immobilize the COCs. Addition of the sediment stabilization reagents would indirectly reduce the toxicity and mobility of sediment disposed of either on-site beneath an upland cap or at an off-site landfill. Therefore, removal of contaminants from the aquatic environment and treatment of the sediments would provide a reduction in toxicity and mobility of contaminants. Removal and treatment of the contaminants followed by disposal at a landfill would be considered permanent.

In summary, Alternatives 4, 5, and 6 will provide the highest achievement of this criterion by removing all of the contaminated sediment in the aquatic environment above CULs and the addition of a solidification agent to sediment will reduce mobility of contaminated sediments. Alternative 3 would provide moderate achievement of this criterion since the sediments would be covered with a reactive cap although the contaminated sediment would remain in the aquatic environment underneath the cover. Alternatives 1 and 2 will provide no achievement of this criterion, as all the contaminated sediment would remain in place undergoing only natural degradation.

5.2.3 Short-Term Effectiveness

There are no short-term risks associated with Alternatives 1 and 2 as no actions would be implemented at the Site; however, the pending installation of a bike path adjacent to the Site would increase the potential for exposure to the contaminated sediments. The rest of the alternatives would have some short-term risks during implementation of the remedy through the activities of implementation. Alternatives 3, 4, 5, and 6 require varying amounts of excavation and/or capping that may impact short-term effectiveness. The potential short-term risks increase as the volume of contaminated sediment to be excavated or consolidated increases due to additional coordination and the uncertainty of resuspension and migration potential. The potential short-term risks to the community and workers with Alternatives 3, 4, 5, and 6 are associated with safety, noise, and related impacts due to working in the ponds and adjacent to the proposed bike path lane or other publicly accessible locations. There are also potential short-term risks to workers from dust created from stabilization agents that are stockpiled and mixed for Alternatives 3, 4, 5, and 6. Truck transportation of sediments to an off-site landfill for Alternative 5 would also have an increase in the short-term risks to the community and workers.

Alternatives 1 and 2 would provide the least short-term adverse effects to aquatic habitat and biota because the sediment would not be disturbed during implementation. Short-term adverse effects to aquatic habitat and biota for Alternatives 3 would include displacement of fish and possibly smothering of benthic organisms. Alternatives 4, 5, and 6 would provide the most adverse effect since both harvest the wetland inhabitants with the pond drainage and removal of the sediments that would destroy the current benthic community. The effects from Alternatives 3, 4, 5, and 6 would occur during remedy construction and during the recovery period after the wetlands had been reshaped and revegetated and surface water flow had been restored. Benthic organisms and wetland inhabitants would be expected to be re-established for all alternatives within several growing seasons. Following the wetland restoration in Alternatives 4, 5 and 6, the overall quality of the wetland will be improved with the removal of invasive species, if any are present, and surface flow optimization during the reconstruction phase.

Overall, Alternatives 1 and 2 will have a high achievement of the short-term effectiveness criterion. Alternative 3 will have a moderate achievement of the short-term effectiveness criterion due to an increase in short-term risks from the reactive cover implementation. Alternatives 4, 5, and 6 will have a low achievement of the short-term effectiveness criterion as it presents the greatest short-term adverse effects to the wetland ecology the total excavation of contaminated sediments. Alternatives 5 and 6 also presents short-term risks to the community from construction truck traffic to an off-site landfill.

5.2.4 Implementability

There are no implementability concerns associated with Alternatives 1 and 2.

Reactive cover, excavation, capping, restoration, surface water control structures, as well as monitoring and/or O&M that would be required under Alternatives 3, 4, 5, and 6 are all technically feasible and implementable from an engineering perspective. These technologies have been implemented successfully at other sediment sites and could be readily implemented at the Site. Services and materials are available for implementing each component of the remedy.

Weather could significantly impact productivity, particularly if done in the early spring or late fall. High winds in the late fall produce large waves that could impact productivity. Water craft-based activities would be postponed in the spring until ice breaking in the ponds is completed. Winter or freezing conditions in the fall could also impact productivity. Alternative 5 has the longest estimated time to complete and, therefore, would stand to be the most impacted by weather.

Monitoring can be completed to evaluate the effectiveness of the remedy.

Implementability also includes administrative feasibility of the remedy. As with most sediment remediation activities, multiple State and Federal agencies and other stakeholders input is required, providing a lower achievement of administrative feasibility of implementing a remedy. Additional time will be required to obtain any necessary approvals and permits from other agencies. Alternatives 5 and 6 will require more coordination with other regulatory agencies due to off-site disposal than Alternatives 1, 2, 3, and 4. Permits for the reactive cover and capping, however, would be required for Alternatives 3 and 4.

In summary, Alternatives 1 and 2 have no actions to be implemented and will provide the highest achievement of the implementability criterion. Alternative 3 provides a moderate achievement of the implementability criterion since it only requires the reactive cover and does not require contaminated sediment staging and disposal. Alternative 3 also requires less overall coordination than Alternatives 4 and 5. Alternatives 4, 5, and 6 will provide the lowest achievement of the implementability criterion as both require more coordination with other regulatory agencies; however, Alternative 6 is more implementable than Alternatives 4 and 5 because reconstruction of upland features are not required, making Alternative 6 more simple.

5.2.5 Cost

Cost estimates developed for each alternative are included in **Section 3.0** and summarized in **Table 3**. **Table 4** through **Table 8** present the Class 4 (+50/-30) estimates for each alternative. The present value calculations are presented in **Table 12**. The cost estimates include the following: capital costs, including both direct and indirect costs; annual O&M costs; and net present value of capital and O&M costs.

In summary, Alternative 1 provides the most cost-effective option, followed by Alternative 2 because it requires MNR monitoring. Alternative 3 is the next most cost effective as no sediment excavation is required. Alternatives 4, 5, and 6 are the least cost effective, with Alternative 5 being the highest cost, as they require total removal of contaminated sediments and the two trade off the cost for on-site cap construction (Alternative 4) for transport costs and disposal costs (Alternatives 5 and 6).

5.3 Modifying Criteria

The modifying criteria, State/support agency and community acceptance, are typically assessed formally after a public comment period; however, this FFS will not go to public comment. This FFS was developed in coordination with the MPCA and the final document will have MPCA acceptance.

5.4 Green Sustainable Remediation Criteria

5.4.1 Greenhouse Gas Emissions

Alternatives 1 would have no GHG emissions. Alternative 2 would only produce GHG emissions associated with mobilization/demobilization and boat operation associated with sampling efforts. Alternatives 3, 4, 5, and 6 would result in GHG emissions from the mobilization, operation, and demobilization of all fuel-powered construction equipment required to construct the cap and/or excavation. Alternatives 5 and 6 would also produce emissions during transport by truck to the disposal facility. Reduction of emissions can be accomplished by using equipment that is compliant with the latest USEPA non-road engine standards and retrofitting older equipment with appropriate filters.

5.4.2 Toxic Chemical Usage and Disposal

There are no known toxic chemicals associated with these alternatives with the exception of Portland cement used as the stabilization agent for Alternatives 4, 5, and 6.

5.4.3 Energy Consumption

Alternatives 1 would consume no additional energy. Alternative 2 would consume minimal amounts of fossil fuels compared to the other alternatives. Alternatives 3, 4, 5, and 6 would result in the consumption of fossil fuels for the mobilization, operation, and demobilization of all diesel-powered construction equipment associated with the dredging, hauling, and disposal of the contaminated sediment and the installation of the cover/cap material. Only placement of cap material is required for Alternatives 3 whereas Alternative 4 requires consolidation and cap material placement, resulting in more fossil fuel consumption. Alternatives 5 and 6 would require the greatest amount of energy to implement as dredging and transportation of dredged materials to an off-site landfill is required.

5.4.4 Use of Alternative Fuels

Alternatives 1 and 2 would not require the use of alternative fuels. Biodiesel blended fuels (B10 or B20) could be used as a supplemental fuel source for all diesel-powered construction equipment associated with Alternatives 3, 4, 5, and 6.

5.4.5 Water Consumption

Alternatives 1 and 2 would not require the consumption of water. There are few water consumption considerations associated with Alternatives 3. A minimal quantity of water would be required to decontaminate personnel and equipment during sediment dredging/consolidation activities with Alternatives 4, 5, and 6.

5.4.6 Waste Generation

Alternatives 1, 2, 3, and 4 would not generate waste beyond personal protective equipment (PPE) and other on-site consumables. Alternatives 5 and 6 would generate waste that includes the dredged contaminated sediments that would be removed from the Site and disposed of at an off-site landfill.

5.5 Comparative Analysis Summary

The comparative analysis of the alternatives narrative discussion and quantitation table identified Alternatives 6 as the highest scoring alternative to address contamination at the Site with a score of 17. The next highest scoring alternatives were Alternatives 4 and 5, scoring 16.5 and 15.5, respectively. Alternatives 1 and 2, which scored 11 and 12, respectively, do not achieve overall protection of human health and the environment; do not achieve ARARs; are not effective in the long term; do not reduce toxicity, mobility, or volume of contamination; and are not effective in the short term; however, these two alternatives are implementable and cost effective. Alternative 3 scored a numerical value of 13. Alternative 3's duration to implement is the shortest and is the least complex of the active remediation alternatives.

The modifying criteria, State/support agency acceptance, and community acceptance are assessed formally after the public comment period. Stakeholder and community input will provide valuable insight as the MPCA considers information for the selection of a preferred alternative. The MPCA will conduct outreach activities to resource managers, the public and local units of government prior to the public comment period.

Further studies are recommended during the design phase of the selected alternative. These recommended studies, depending on the alternative selected, may include:

- Potential ongoing contamination evaluation and source control from Shoppers creek and stormwater inputs;
- Hydrodynamic study of the four surface water inputs to the ponds to understand the depositional and peak flow forces to inform design and placement of sediment basins and creekside armoring, if needed;
- Pore-water transport and COC treatment modeling for reactive cover design pond;
- Cap/sediment consolidation calculations and modeling for engineered cap design; and
- Future wetland restoration and required water depths evaluations.

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Figures

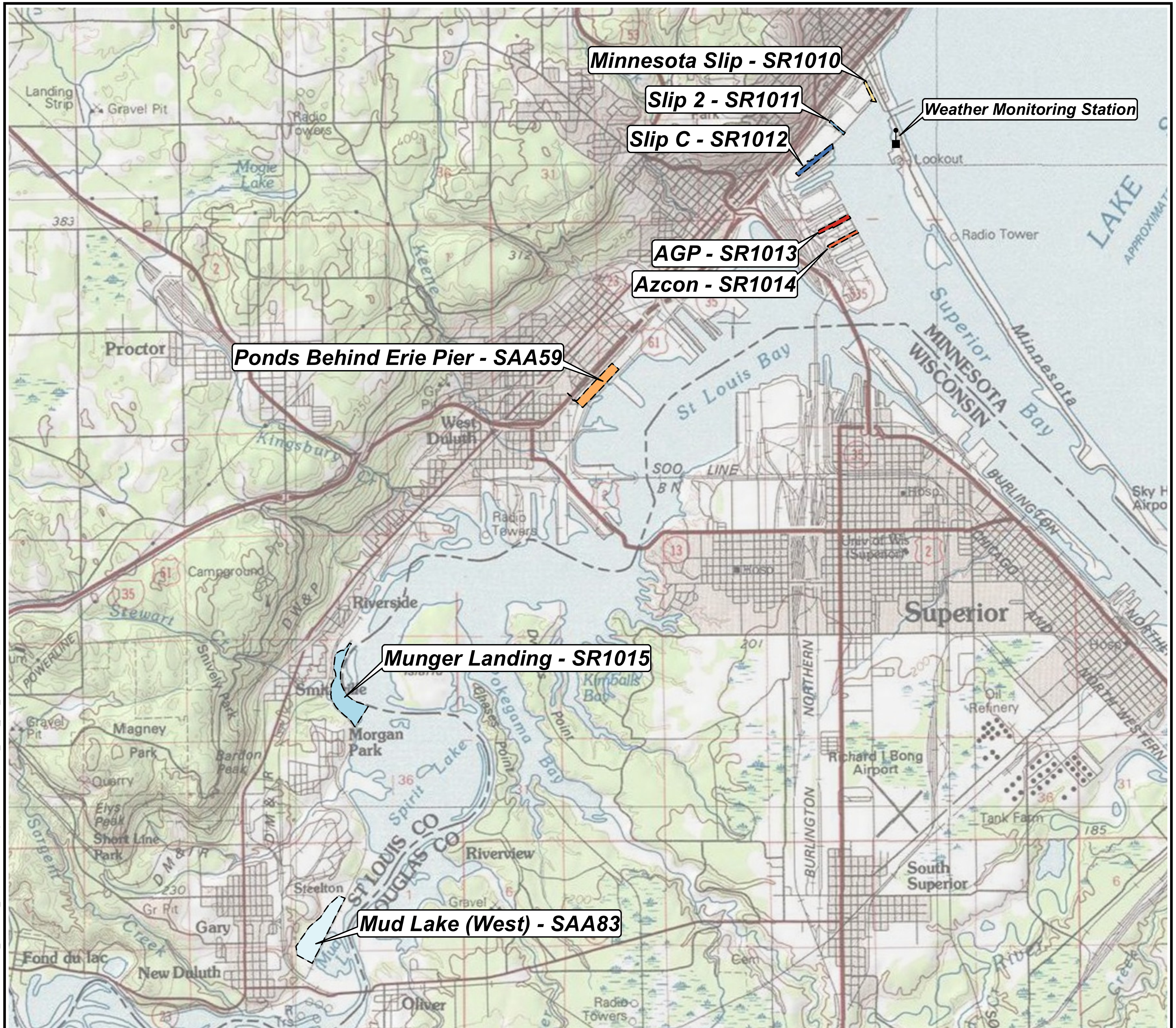

Figure 1

Site Location Map

SLR Sediment AOCs

Duluth, MN

Duluth
MINNESOTA

N S E W

Map Projection: NAD 1983 UTM Zone 15 N
Basemap: National Geographic Society, i-cubed

0 1 2 Miles
0 1.5 3 Kilometers

1 inch = 5,000 feet

Weather Monitoring Station

Slip Identification

- AGP (SR1013)
- Azcon (SR1014)
- Ponds Behind Erie Pier (SAA59)
- Minnesota Slip (SR1010)
- Mud Lake - West (SAA83)
- Munger Landing (SR1015)
- Slip 2 (SR1011)
- Slip C (SR1012)

CLEAN WATER LAND & LEGACY AMENDMENT

Bay West
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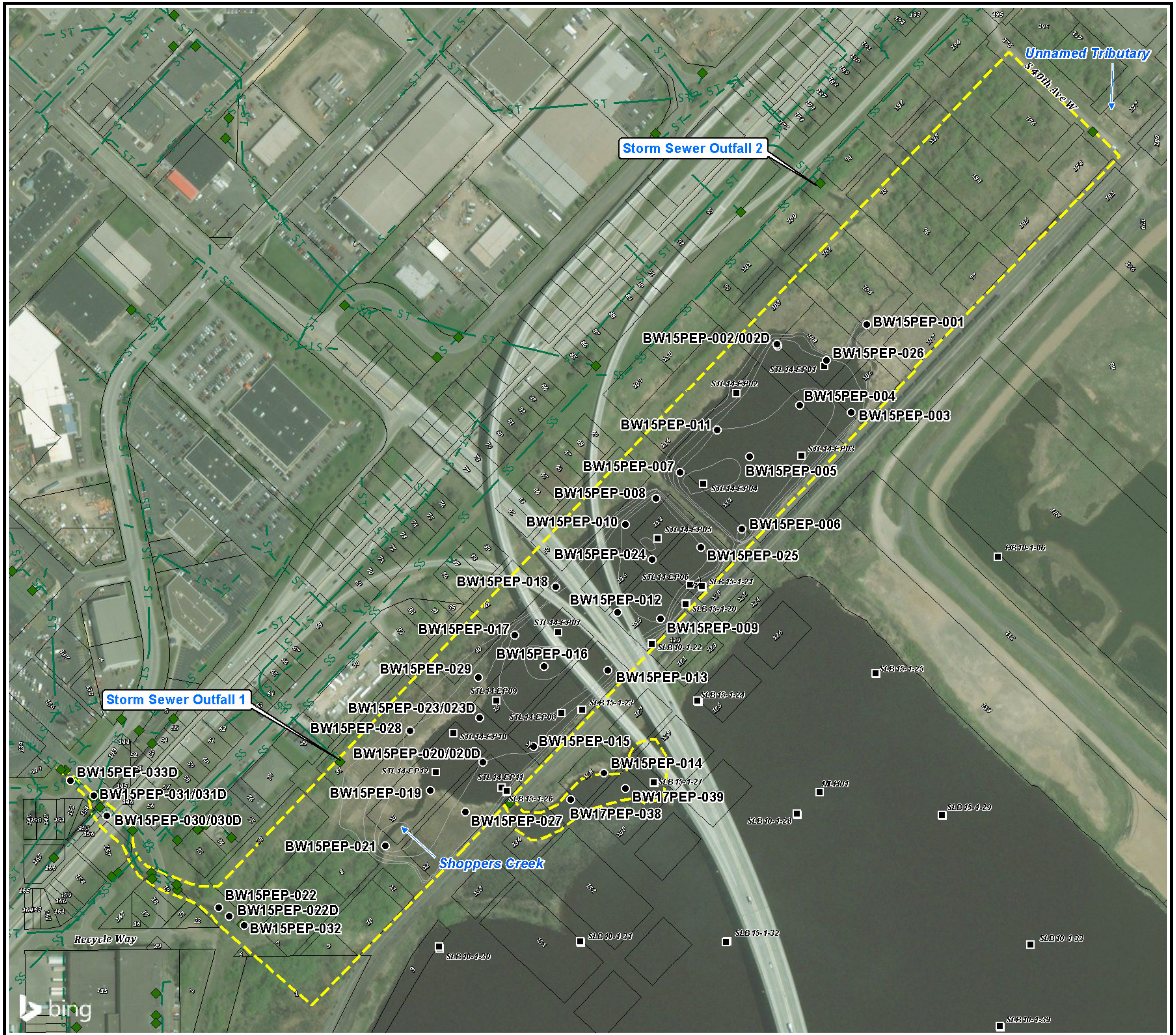
Date Drawn/Revised:6/12/2018 Project No.J170539



Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 02 Erie Pier Site Map.mxd

Figure 2

Site Map

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN

Duluth
MINNESOTA

N W E S

Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Bing Aerial Imagery WMS

0 300 600 Feet
0 100 200 Meters

1 inch = 300 feet

- ● Sediment Sample (Bay West 2015)
- ■ Historical Sediment Sample (2010/2014)
- ◆ Sewer Outfall
- Bathymetry Elevation Contour Line
- SS Sanitary Sewer
- ST Storm Sewer
- Erie Pier Site Boundary
- Parcel Boundary

Note: Bathymetric data derived from water depth/sediment elevation measurements collect during the Bay West 2015 investigation.

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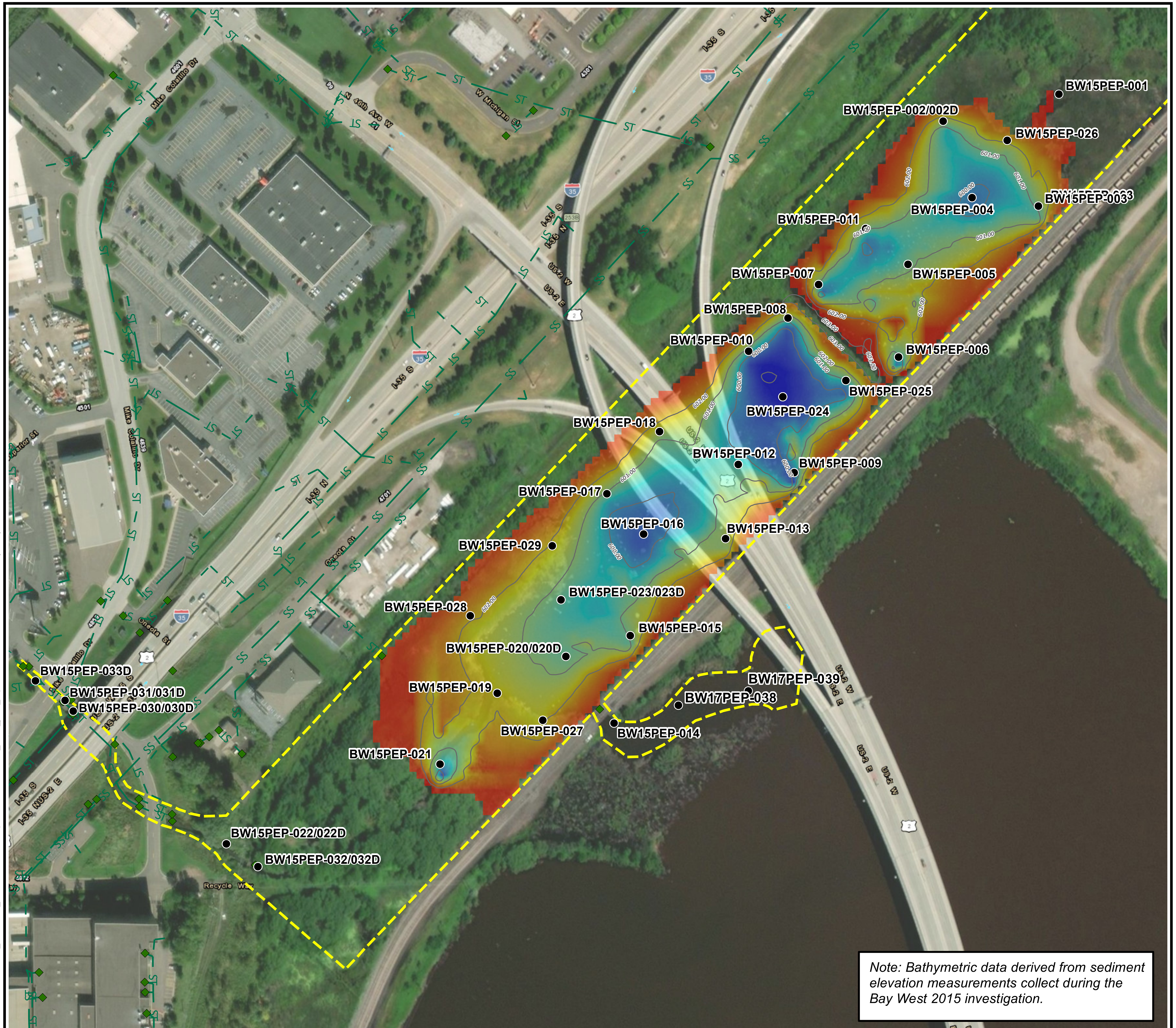
Figure 3

Ponds Behind Erie Pier (SAA59)
Bathymetry and 2015 Core Locations

SLR Sediment AOCs

Duluth, MN



Note: Bathymetric data derived from sediment elevation measurements collect during the Bay West 2015 investigation.

N E S W

Map Projection: NAD 1983 UTM Zone 15 N
Basemap: ESRI World Imagery WMS, 9/14/2015

0 250 500 Feet
0 80 160 Meters

- Sewer Outfall
- Sediment Sample (Bay West 2015)
- SS Sanitary Sewer
- ST Storm Sewer
- Bathymetric Contour Line
- Erie Pier Site Boundary

Sediment Elevation

603.5 ft
600.5 ft
599.0 ft
ELEVATION ABOVE MSL

(Based on March/June 2015 Sample Data)

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Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 03 Erie Pier Bathymetry and 2015 Core Locations.mxd

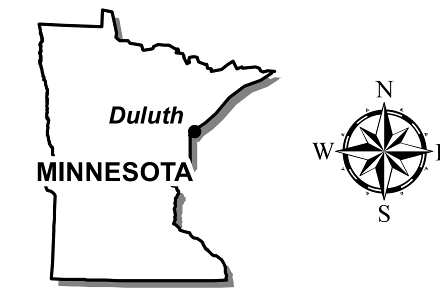
Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 04 Erie Pier Cadmium SQT Results.mxd

Figure 4

Cadmium SQT Results

Ponds Behind Erie Pier
SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

Sewer Outfall
Sanitary Sewer
Storm Sewer
Erie Pier Site Boundary

Sample Type

Sediment Sample (Bay West 2015)
Sediment Sample (Historical)

Sample Interval

0-0.15 m
0.15-0.50 m
0.50-1.0 m
>1.0 m

Cadmium SQT Comparison

Does not exceed Level 1 SQT (0.99 mg/kg)
Exceeds Level 1 SQT (0.99 mg/kg)
Exceeds Midpoint SQT (3 mg/kg)
Exceeds Level 2 SQT (33 mg/kg)

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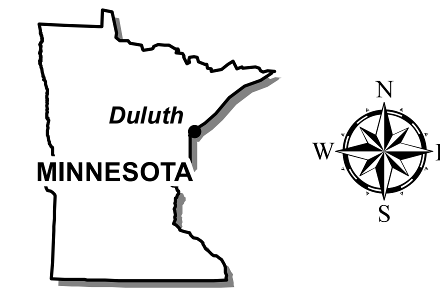
Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 05 Erie Pier Chromium SQT Results.mxd

Figure 5

Chromium SQT Results

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

Sewer Outfall
Sanitary Sewer
Storm Sewer
Erie Pier Site Boundary

Sample Type

Sediment Sample (Bay West 2015)
Sediment Sample (Historical)

Sample Interval

0-0.15 m
0.15-0.50 m
0.50-1.0 m
>1.0 m

Chromium SQT Comparison

Does not exceed Level 1 SQT (43 mg/kg)
Exceeds Level 1 SQT (43 mg/kg)
Exceeds Midpoint SQT (76 mg/kg)
Exceeds Level 2 SQT (110 mg/kg)

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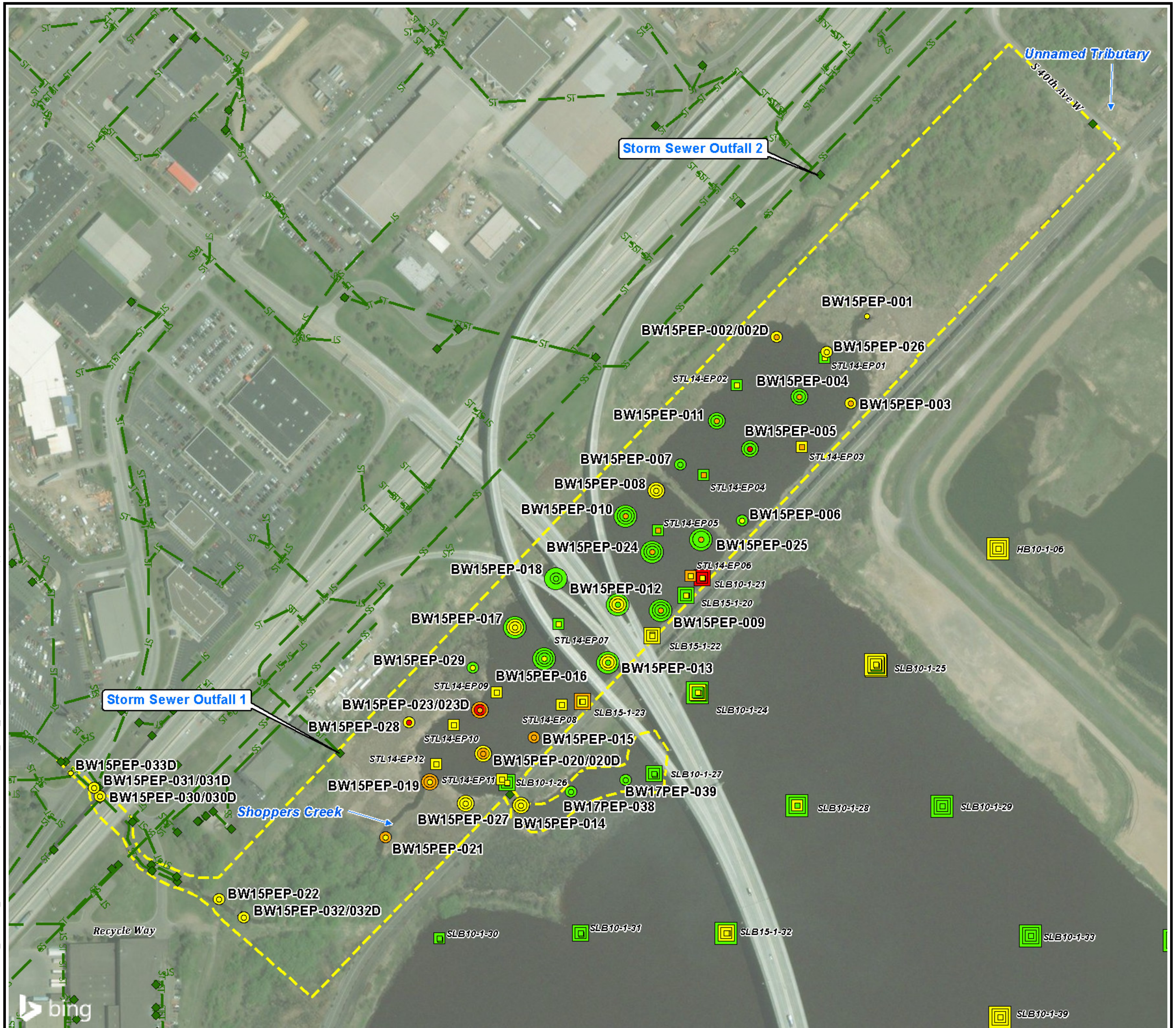


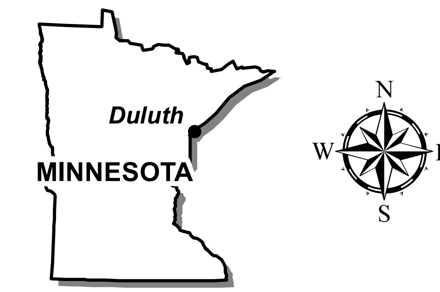
Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 06 Erie Pier Copper SQT Results.mxd

Figure 6

Copper SQT Results

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

Sewer Outfall
SS Sanitary Sewer
ST Storm Sewer
Erie Pier Site Boundary

Sample Type

○ Sediment Sample (Bay West 2015)
□ Sediment Sample (Historical)

Sample Interval

0-0.15 m
0.15-0.50 m
0.50-1.0 m
>1.0 m

Copper SQT Comparison

Does not exceed Level 1 SQT (32 mg/kg)
Exceeds Level 1 SQT (32 mg/kg)
Exceeds Midpoint SQT (91 mg/kg)
Exceeds Level 2 SQT (150 mg/kg)

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Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 07 Erie Pier Lead SQT Results.mxd

Figure 7

Lead SQT Results

Ponds Behind Erie Pier
SLR Sediment AOCs

Duluth, MN

Duluth
MINNESOTA

N
W E
S

Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet
0 100 200 Meters

1 inch = 300 feet

Sewer Outfall
Sanitary Sewer
Storm Sewer
Erie Pier Site Boundary

Sample Type
- Sediment Sample (Bay West 2015)
- Sediment Sample (Historical)

Sample Interval
- 0-0.15 m
- 0.15-0.50 m
- 0.50-1.0 m
- >1.0 m

Lead SQT Comparison
- Does not exceed Level 1 SQT (36 mg/kg)
- Exceeds Level 1 SQT (36 mg/kg)
- Exceeds Midpoint SQT (83 mg/kg)
- Exceeds Level 2 SQT (130 mg/kg)

Bay West
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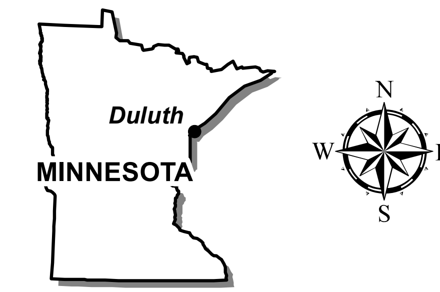
Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 08 Erie Pier Mercury SQT Results.mxd

Figure 8

Mercury SQT Results

Ponds Behind Erie Pier
SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

Sewer Outfall

Sanitary Sewer

Storm Sewer

Erie Pier Site Boundary

Sample Type

Sediment Sample (Bay West 2015)

Sediment Sample (Historical)

Sample Interval

0-0.15 m

0.15-0.50 m

0.50-1.0 m

>1.0 m

Mercury SQT Comparison

Does not exceed Level 1 SQT (0.18 mg/kg)

Exceeds Level 1 SQT (0.18 mg/kg)

Exceeds Midpoint SQT (0.64 mg/kg)

Exceeds Level 2 SQT (1.1 mg/kg)

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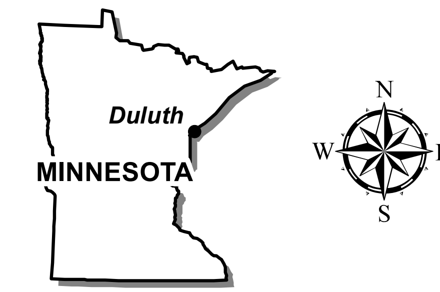
Figure 9

Nickel SQT Results

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

- Sewer Outfall
- SS Sanitary Sewer
- ST Storm Sewer
- Erie Pier Site Boundary

Sample Type

- Sediment Sample (Bay West 2015)
- Sediment Sample (Historical)

Sample Interval

- 0-0.15 m
- 0.15-0.50 m
- 0.50-1.0 m
- >1.0 m

Nickel SQT Comparison

- Does not exceed Level 1 SQT (23 mg/kg)
- Exceeds Level 1 SQT (23 mg/kg)
- Exceeds Midpoint SQT (36 mg/kg)
- Exceeds Level 2 SQT (49 mg/kg)

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Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 09 Erie Pier Nickel SQT Results.mxd

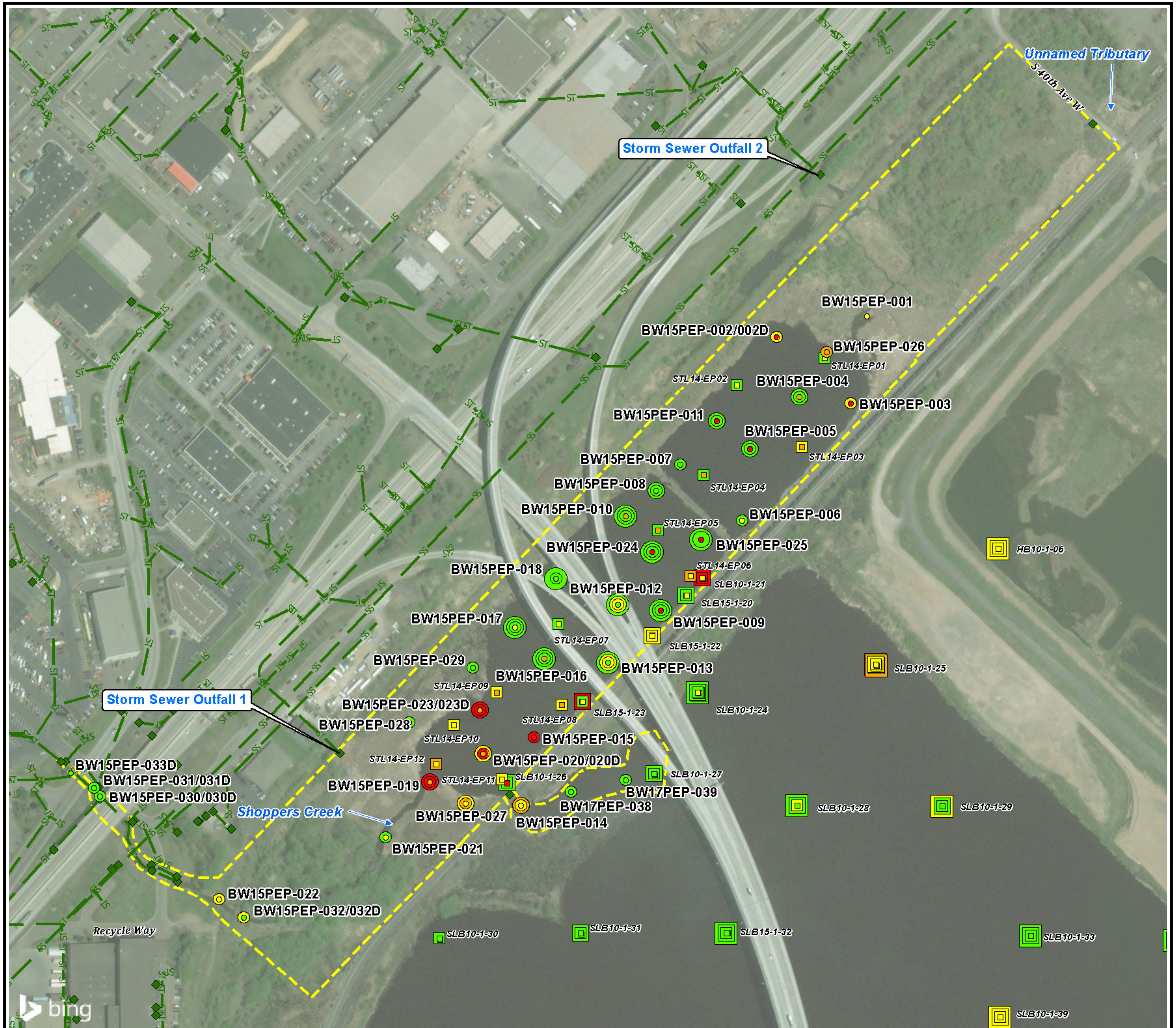
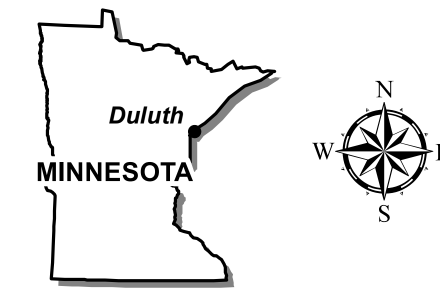


Figure 10

Zinc SQT Results

Ponds Behind Erie Pier
SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

- Sewer Outfall
- Sanitary Sewer
- Storm Sewer
- Erie Pier Site Boundary

Sample Type

- Sediment Sample (Bay West 2015)
- Sediment Sample (Historical)

Sample Interval

- 0-0.15 m
- 0.15-0.50 m
- 0.50-1.0 m
- >1.0 m

Zinc SQT Comparison

- Does not exceed Level 1 SQT (120 mg/kg)
- Exceeds Level 1 SQT (120 mg/kg)
- Exceeds Midpoint SQT (290 mg/kg)
- Exceeds Level 2 SQT (460 mg/kg)

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Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 10 Erie Pier Zinc SQT Results.mxd

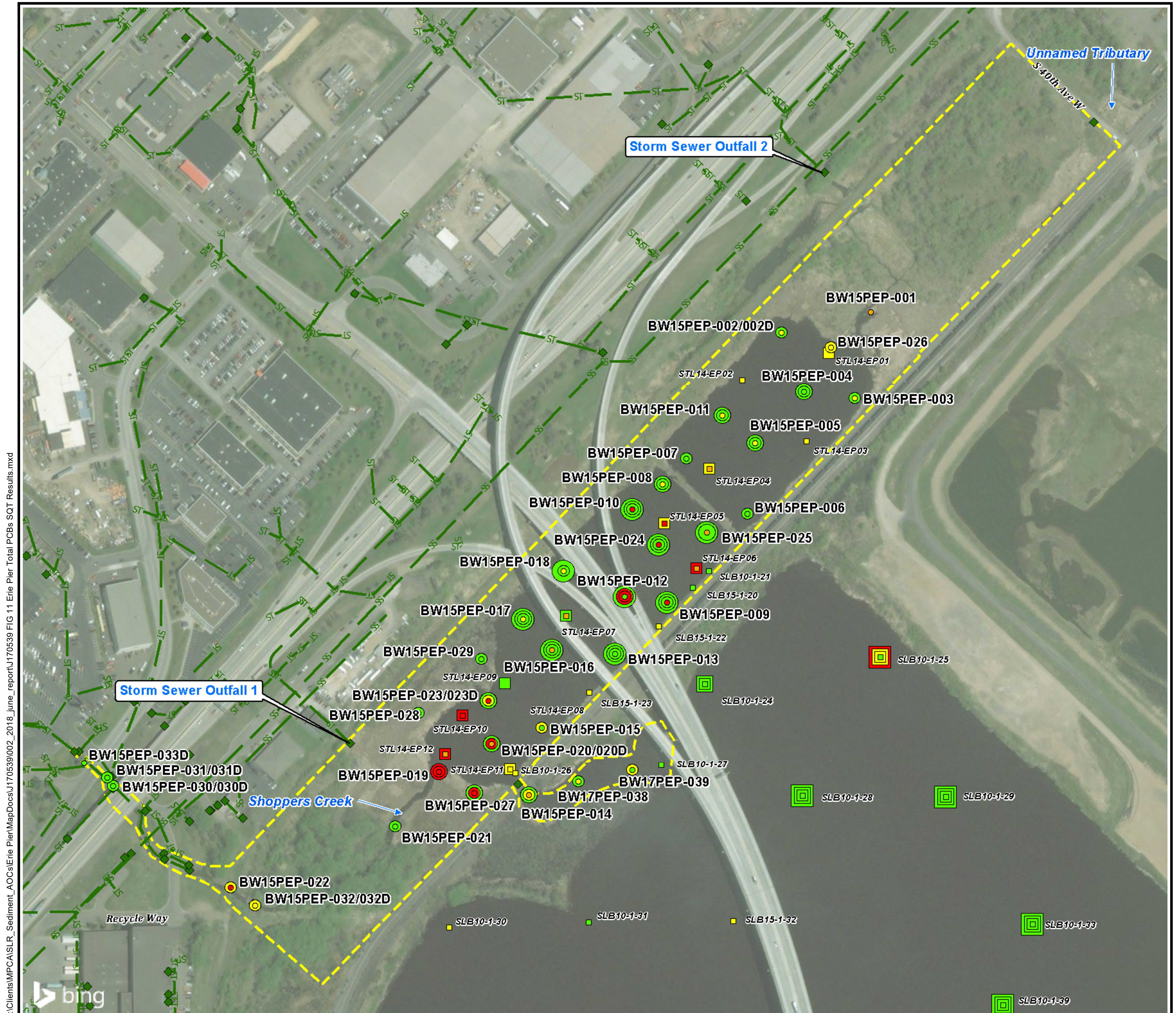
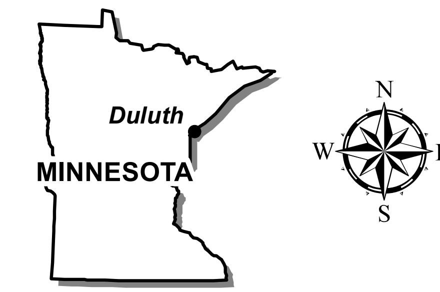


Figure 11

Total PCBs SQT Results

Ponds Behind Erie Pier
SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet
0 100 200 Meters

1 inch = 300 feet

Sewer Outfall
Sanitary Sewer
Storm Sewer
Erie Pier Site Boundary

Sample Type

Sediment Sample (Bay West 2015)
Sediment Sample (Historical)

Sample Interval

0-0.15 m
0.15-0.50 m
0.50-1.0 m
>1.0 m

Total PCBs SQT Comparison

Does not exceed Level 1 SQT (60 µg/kg)
Exceeds Level 1 SQT (60 µg/kg)
Exceeds Midpoint SQT (370 µg/kg)
Exceeds Level 2 SQT (680 µg/kg)

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Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 12 Erie Pier Total PAH13 SQT Results.mxd

Figure 12

Total PAH13 SQT Results

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN

Duluth

MINNESOTA

N W E S

Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

Sewer Outfall

Sanitary Sewer

Storm Sewer

Erie Pier Site Boundary

Sample Type

Sediment Sample (Bay West 2015)

Historical Sediment Sample (2010/2014)

Sample Interval

0-0.15 m

0.15-0.50 m

0.50-1.0 m

>1.0 m

Total PAH13 SQT Comparison

Does not exceed Level 1 SQT (1600 µg/kg)

Exceeds Level 1 SQT (1600 µg/kg)

Exceeds Midpoint SQT (12300 µg/kg)

Exceeds Level 2 SQT (23000 µg/kg)

Bay West

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Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 13 Erie Pier Dioxins SQT Results.mxd

Figure 13

Dioxins SQT Results

Ponds Behind Erie Pier
SLR Sediment AOCs

Duluth, MN

Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet
0 100 200 Meters

1 inch = 300 feet

- Sewer Outfall
- Sanitary Sewer
- Storm Sewer
- Erie Pier Site Boundary

Sample Type

- Sediment Sample (Bay West 2015)
- Sediment Sample (Historical)

Sample Interval

- 0-0.15 m
- 0.15-0.50 m
- 0.50-1.0 m
- >1.0 m

TEQ KM Fish SQT Comparison

- Does not exceed Level 1 SQT (0.85 ng TEQ/kg)
- Exceeds Level 1 SQT (0.85 ng TEQ/kg)
- Exceeds Midpoint SQT (11.2 ng TEQ/kg)
- Exceeds Level 2 SQT (21.5 ng TEQ/kg)

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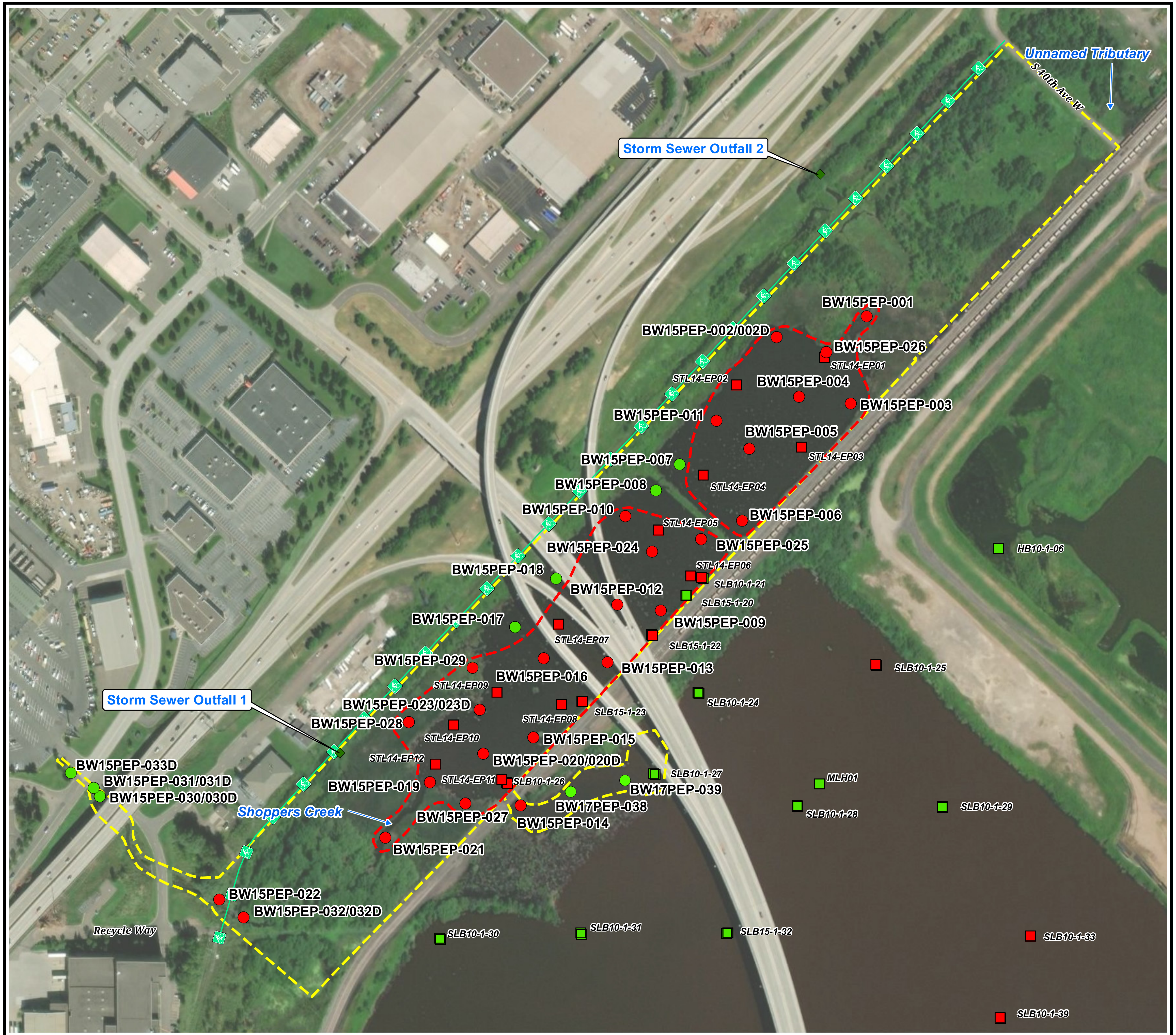
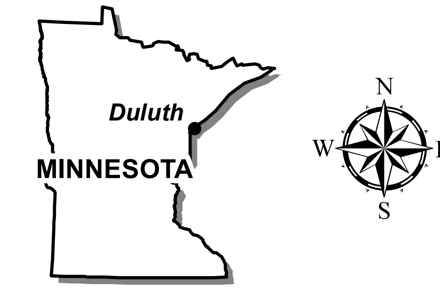


Figure 14

COC Midpoint SQT Exceedances in the Upper 0.5 Meter

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: ESRI World Imagery WMS

0 300 600 Feet
0 100 200 Meters

1 inch = 300 feet

- Assumed Bike Path Corridor
- Estimated Area of Contamination (14.39 Acres)
- Erie Pier Site Boundary

Upper 0.5 m SQT Comparison

- ○ Sediment Sample (Bay West 2015)
- □ Historical Sediment Sample (2010/2014)
- Does not exceed Midpoint SQT for cadmium, chromium, copper, lead, mercury, nickel, zinc, PCBs, and/or dioxins/furans
- Meets or exceeds Midpoint SQT for cadmium, chromium, copper, lead, mercury, nickel, zinc, PCBs, and/or dioxins/furans

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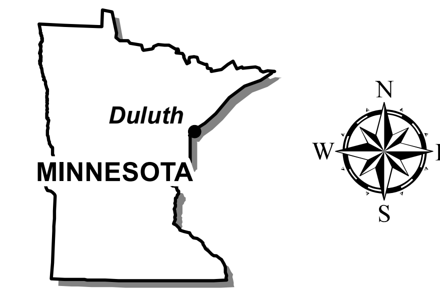
Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 14 Erie Pier COC Midpoint SQT Exceedances in the Upper 0.5 Meter.mxd

Figure 15

Estimated Area of Contamination

Ponds Behind Erie Pier
SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Bing Aerial Imagery WMS

0 300 600 Feet
0 100 200 Meters

1 inch = 300 feet

- Sewer Outfall
- Sanitary Sewer
- Storm Sewer
- Assumed Bike Path Corridor
- Erie Pier Site Boundary
- Estimated Area of Contamination (14.39 Acres)

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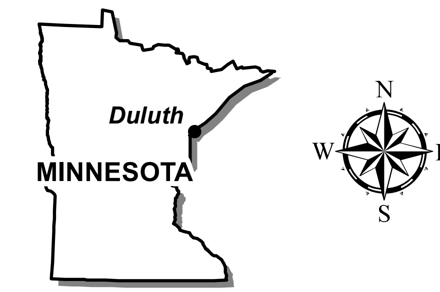
Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 15 Erie Pier Total Sediment Area.mxd

Figure 16

Conceptual Site Model

Ponds Behind Erie Pier
SLR Sediment AOCs
Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Bing Aerial Imagery WMS

NOTES:

1) Water/sediment profile is vertically and horizontally exaggerated
2) Not the exact location of storm water outfalls

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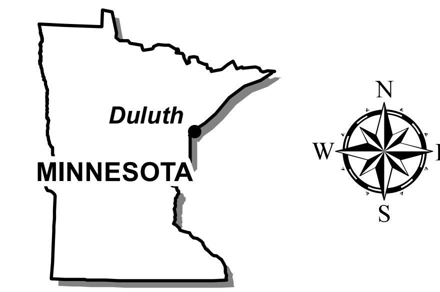
Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 16 Erie Pier Conceptual Site Model.mxd

Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 17 Erie Pier Site Staging Area.mxd

Figure 17

Site Staging Area

Ponds Behind Erie Pier
SLR Sediment AOCs
Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Bing Aerial Imagery WMS

0 300 600 Feet
0 100 200 Meters

1 inch = 300 feet

- Sewer Outfall
- Assumed Bike Path Corridor
- Sanitary Sewer
- Storm Sewer
- Erie Pier Site Boundary
- Staging Area (5.0 Acres)

Bay West
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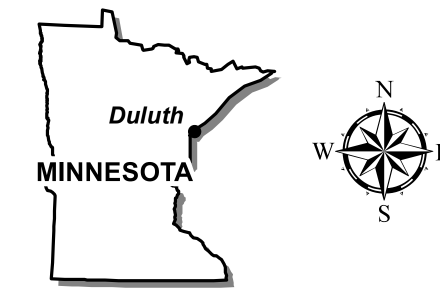
Figure 18

Alternative 2 - Monitored Natural Recovery and Institutional Controls

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

- Proposed Monitoring Locations
- Assumed Bike Path Corridor
- Erie Pier Site Boundary
- Estimated Area of Contamination (14.39 Acres)

Bay West
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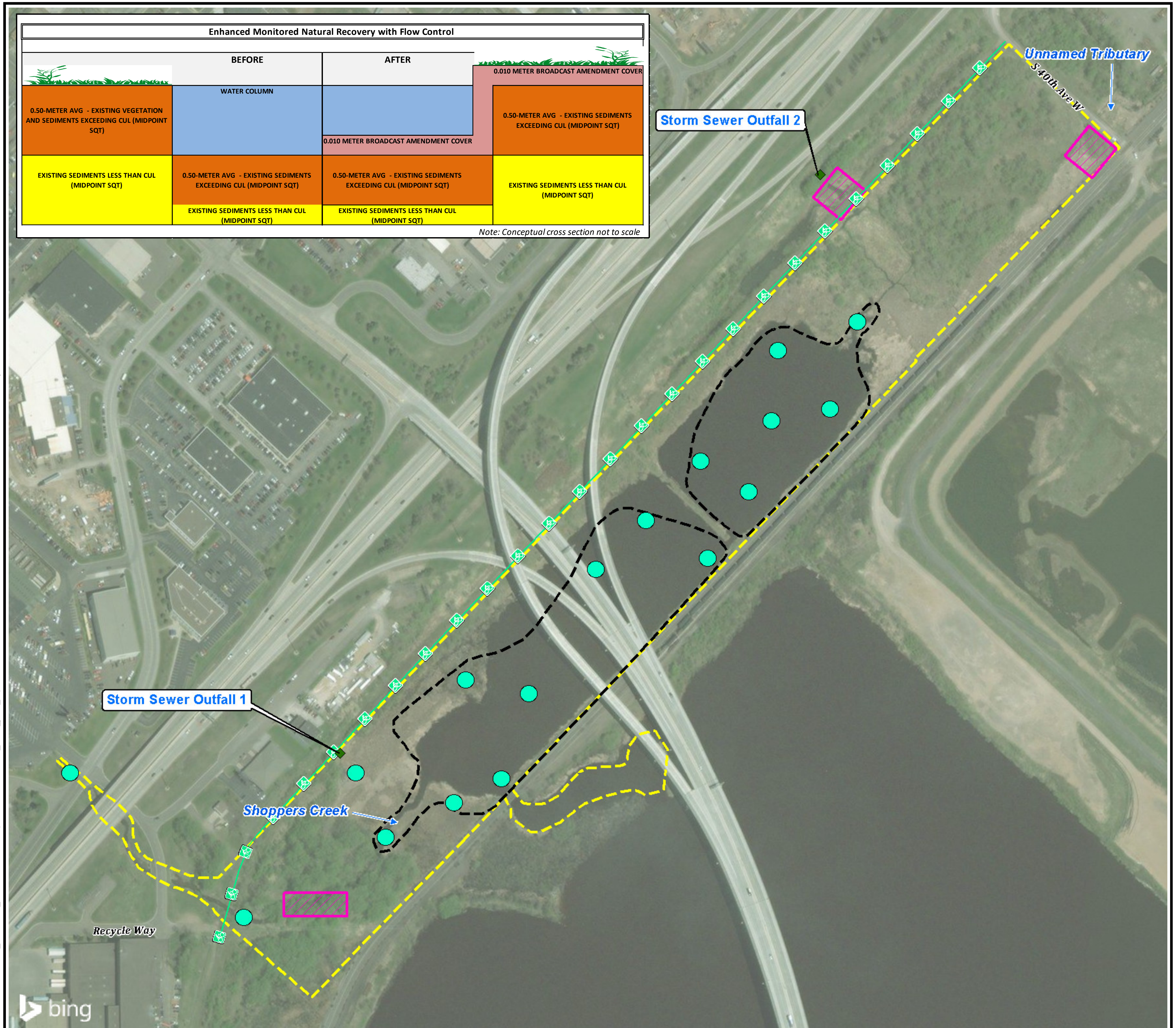
Drawn By: S.G. Date Drawn/Revised:6/12/2018 Project No.J150329

Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 18 Erie Pier Alternative 2 Monitored Natural Recovery and Institutional Controls.mxd



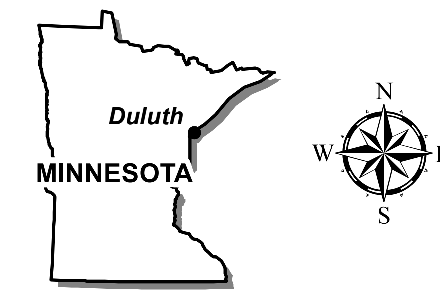
Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 19 Erie Pier Alternative 3 Enhanced Monitored Natural Recovery With Broadcasted Amendment.mxd

Figure 19

Alternative 3 - Enhanced Monitored Natural Recovery With Broadcasted Amendment

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet
0 100 200 Meters
1 inch = 300 feet

- Proposed Monitoring Locations
- Assumed Bike Path Corridor
- Targeted Thin-Layer Cover Areas
- Erie Pier Site Boundary
- Flow Control Sediment Basin

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: S.G. Date Drawn/Revised:6/13/2018 Project No.J150329

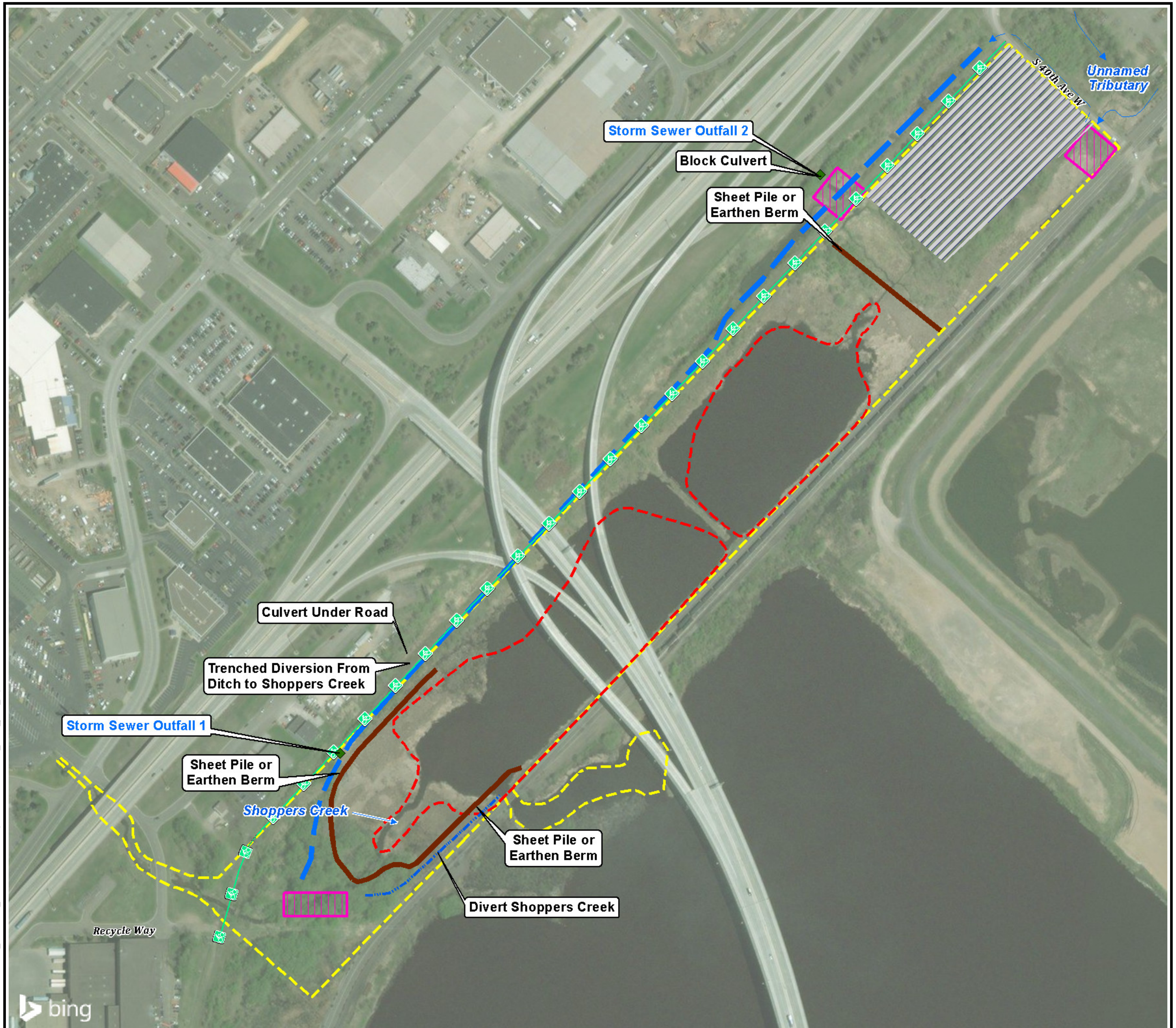
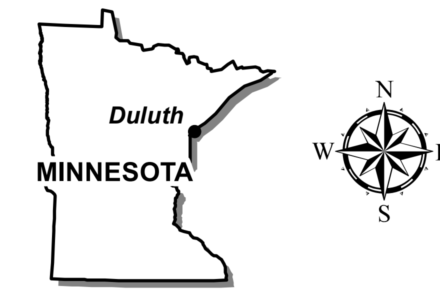


Figure 20

Surface Water Diversion Features

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

- Assumed Bike Path Corridor
- Trench New Creek (Connect to Shoppers)
- Temporarily Divert Shoppers Creek
- Sheet Pile or Earthen Berm
- Erie Pier Site Boundary
- Flow Control Sediment Basin
- Estimated Area of Contamination (14.39 Acres)
- Staging Area (5.0 Acres)

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: S.G. Date Drawn/Revised:6/12/2018 Project No.J150329

Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 20 Erie Pier Surface Water Diversion Features.mxd

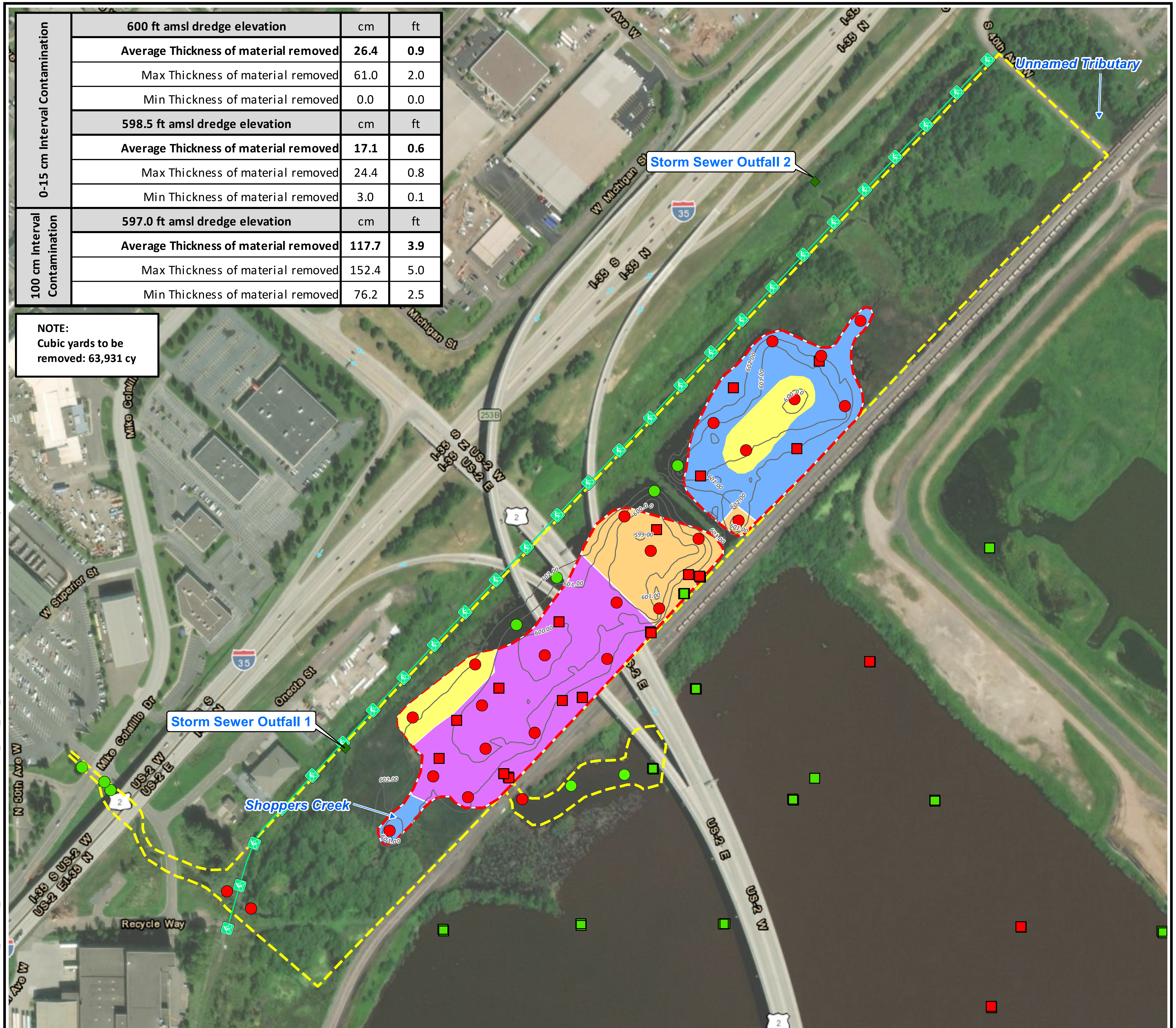
Figure 21

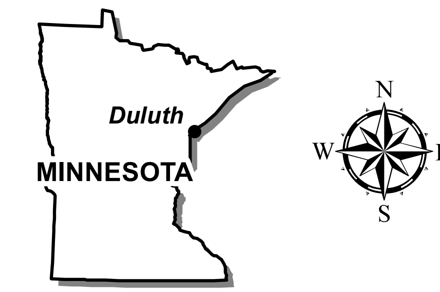
Proposed Dredge Elevations

Ponds Behind Erie Pier
SLR Sediment AOCs
Duluth, MN

		cm	ft
0-15 cm Interval Contamination	**600 ft amsl dredge elevation**	cm	ft
	Average Thickness of material removed	**26.4**	**0.9**
	Max Thickness of material removed	61.0	2.0
	Min Thickness of material removed	0.0	0.0
	598.5 ft amsl dredge elevation	cm	ft
	Average Thickness of material removed	**17.1**	**0.6**
	Max Thickness of material removed	24.4	0.8
	Min Thickness of material removed	3.0	0.1
100 cm Interval Contamination	**597.0 ft amsl dredge elevation**	cm	ft
	Average Thickness of material removed	**117.7**	**3.9**
	Max Thickness of material removed	152.4	5.0
	Min Thickness of material removed	76.2	2.5

NOTE:
Cubic yards to be removed: 63,931 cy





Map Projection: NAD 1983 UTM Zone 15 N
Basemap: ESRI World Imagery WMS

0 300 600 Feet
0 100 200 Meters

Assumed Bike Path Corridor

Revised Area of Contamination

Estimated Area of Contamination (14.39 Acres)

Erie Pier Site Boundary

600.00 ft amsl Dredge Depth

598.50 ft amsl Dredge Depth

597.00 ft amsl Dredge Depth

1-foot Sediment Surface Scrape

Upper 0.5 m SQT Comparison

Sediment Sample (Bay West 2015)

Historical Sediment Sample (2010/2014)

Does not exceed Midpoint SQT for cadmium, chromium, copper, lead, mercury, nickel, zinc, PCBs, and/or dioxins/furans

Meets or exceeds Midpoint SQT for cadmium, chromium, copper, lead, mercury, nickel, zinc, PCBs, and/or dioxins/furans

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: S.G. Date Drawn/Revised:6/13/2018 Project No.J170539

Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 21 Erie Pier Proposed Dredge Elevations.mxd

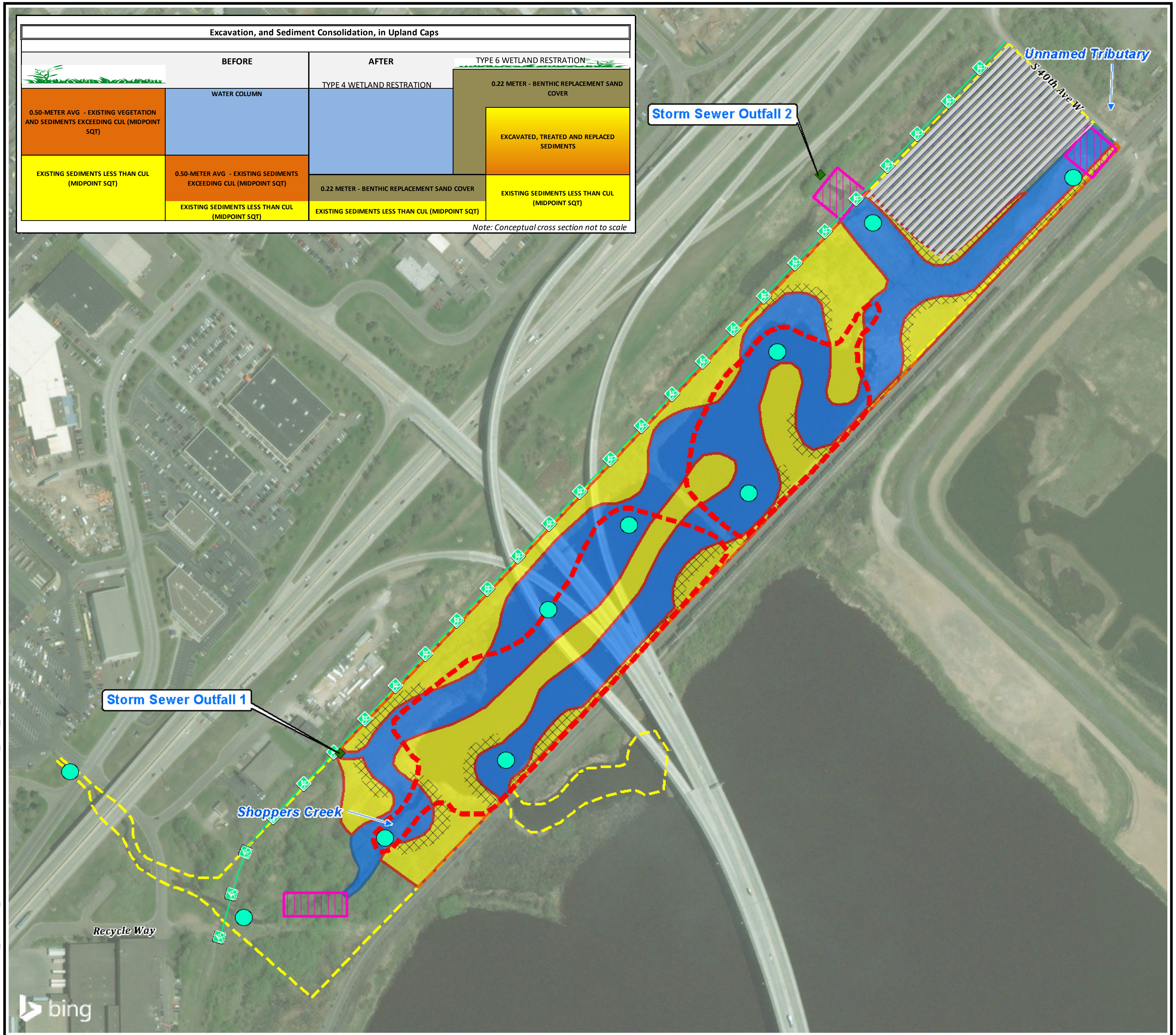
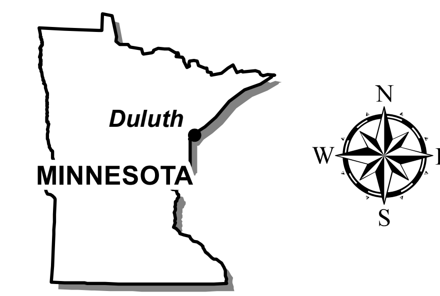


Figure 22

Alternatives 4 - Sediment Excavation and Consolidation in Upland Caps and Wetland Restoration

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet
0 100 200 Meters

1 inch = 300 feet

- Proposed Monitoring Locations
- Assumed Bike Path Corridor
- Erie Pier Site Boundary
- Upland Type 6 Wetland With Consolidated Sediment
- Armored Area
- Open Water; Type 4 Wetland
- Flow Control Sediment Basin
- Staging Area (5.0 Acres)
- Estimated Area of Contamination (20.79 Acres)

Bay West
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Drawn By: S.G. Date Drawn/Revised:6/13/2018 Project No.J150329

Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 22 Erie Pier Alternatives 4 Sediment Excavation and Consolidation in Upland Caps and Wetland Restoration.mxd

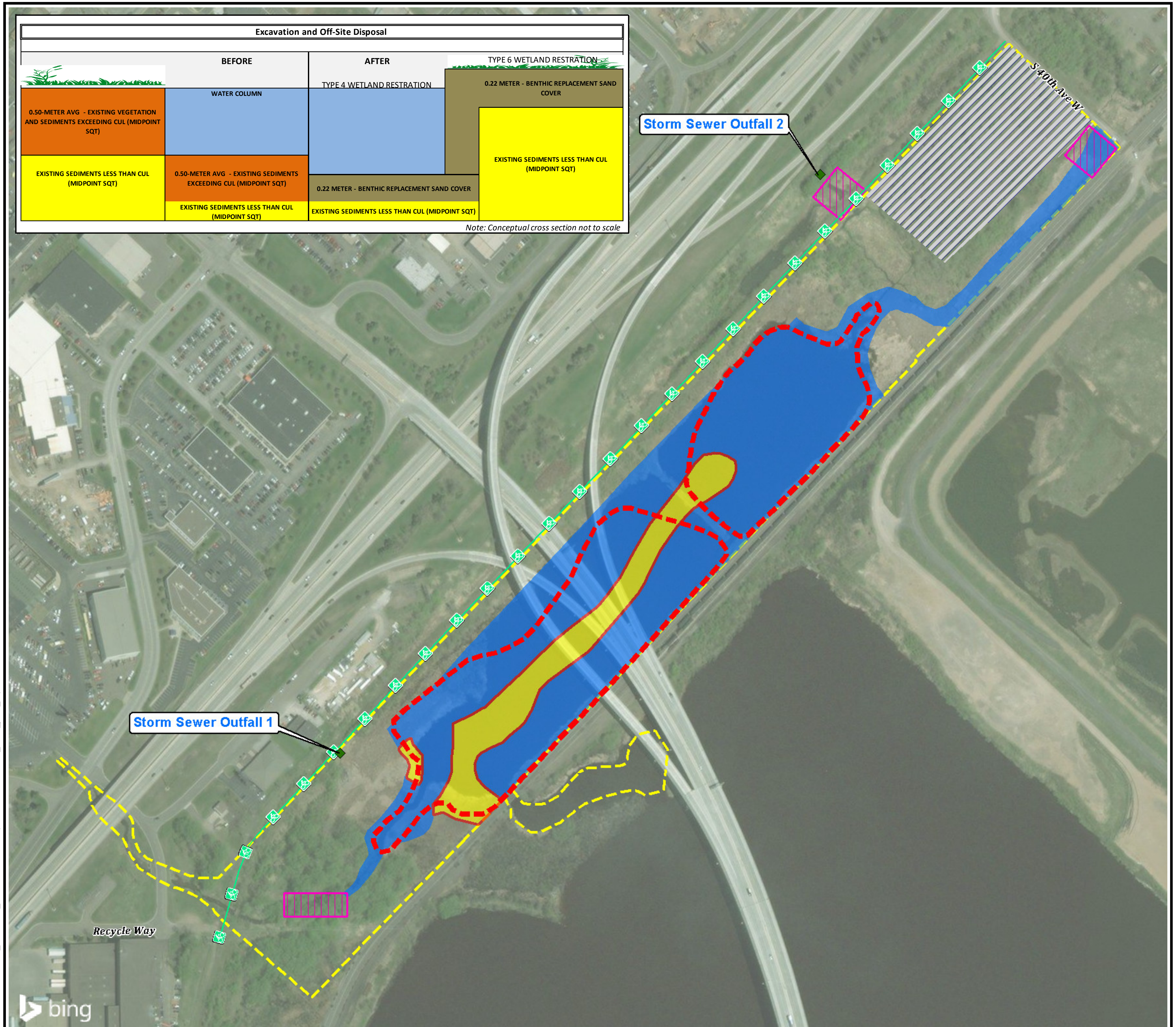

Figure 23

Alternatives 5 - Sediment Excavation, Offsite Disposal, and Wetland Restoration

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN

Duluth
MINNESOTA

N S E W

Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet

0 100 200 Meters

1 inch = 300 feet

- Assumed Bike Path Corridor
- Erie Pier Site Boundary
- Flow Control Sediment Basin
- Upland Type 6 Wetland With Consolidated Sediment
- Armored Area
- Open Water; Type 4 Wetland
- Staging Area (5.0 Acres)
- Estimated Area of Contamination (14.39 Acres)

Bay West
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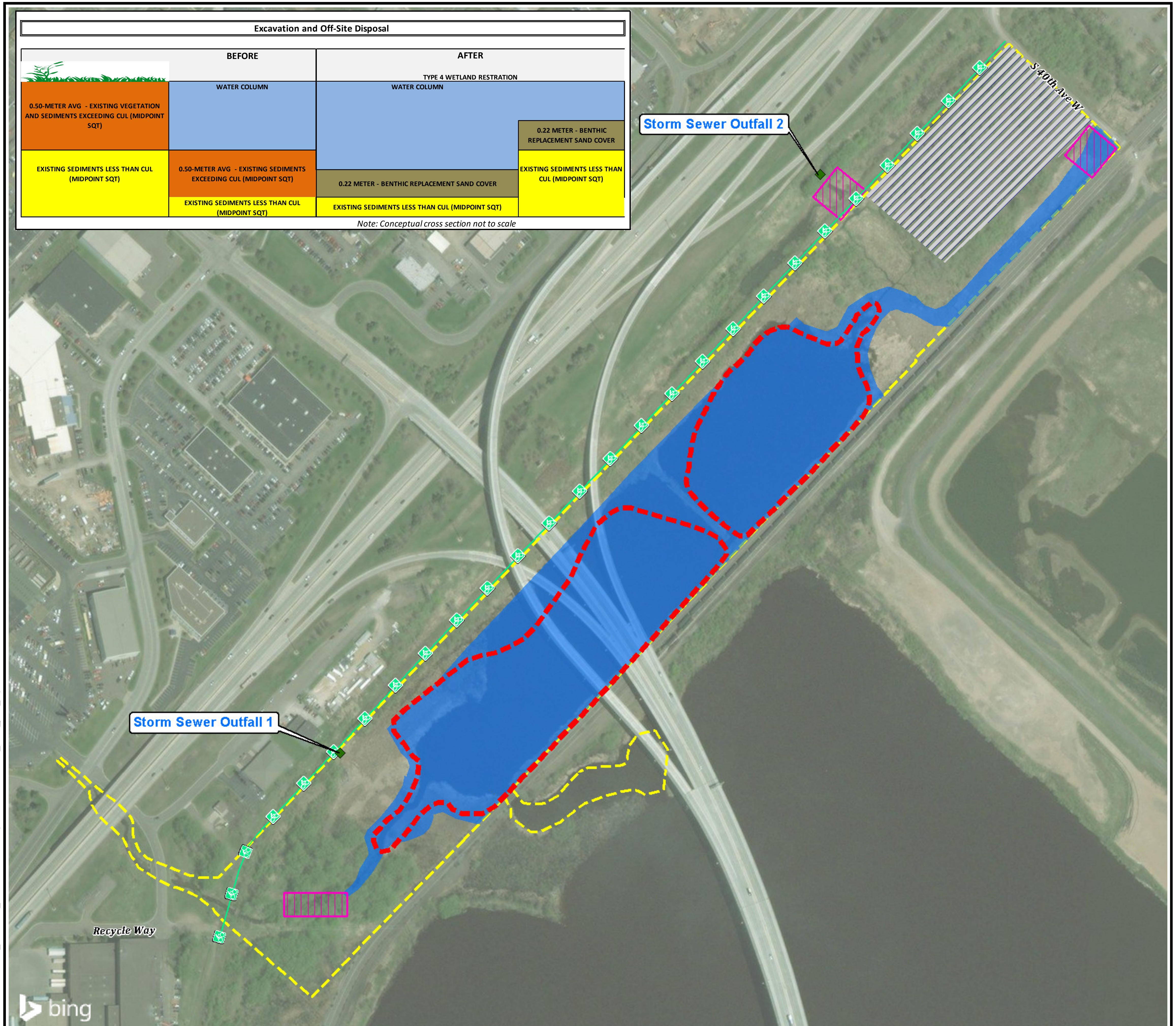
Drawn By: S.G. Date Drawn/Revised:6/13/2018 Project No.J150329

Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 23 Erie Pier Alternatives 5 Sediment Excavation, Offsite Disposal, and Wetland Restoration.mxd



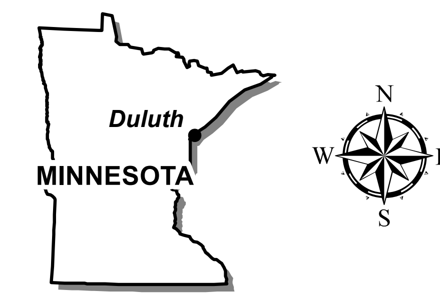
Y:\Clients\MPCA\SLR_Sediment_AOCs\Erie Pier\MapDocs\J170539\002_2018_june_report\J170539 FIG 24 Erie Pier Alternatives 6 Sediment Excavation, Offsite Disposal, and Wetland Restoration.mxd

Figure 24

Alternative 6: Sediment Excavation, Offsite Disposal

Ponds Behind Erie Pier SLR Sediment AOCs

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Microsoft Bing WMS

0 300 600 Feet
0 100 200 Meters
1 inch = 300 feet

- Assumed Bike Path Corridor
- Erie Pier Site Boundary
- Flow Control Sediment Basin
- Open Water; Type 4 Wetland
- Staging Area (5.0 Acres)
- Estimated Area of Contamination (14.39 Acres)

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: S.G. Date Drawn/Revised:6/13/2018 Project No.J150329

Tables

Table 1
Ponds behind Erie Pier Cleanup Levels
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Contaminant	Units	Cleanup Level	Maximum Concentration Detected
Cadmium	mg/kg	3	60.8
Chromium	mg/kg	76	859
Copper	mg/kg	91	193
Lead	mg/kg	83	380
Mercury	mg/kg	0.64	15.8
Nickel	mg/kg	36	320
Zinc	mg/kg	290	656
PCBs	mg/kg	0.37	23.6
PAHs	mg/kg	12.3	28.041
Dioxins/Furans	ng TEQ/kg	11.2	49.92

mg/kg = milligrams per kilogram

ng TEQ/kg = nanograms toxic equivalence per kilogram

Table 2
Technologies Screening Summary
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Category	Technology	Description	Applicability	Ranking						Retained for Consideration	Rationale
				Effectiveness		Implementablility		Relative Cost			
Institutional Controls	Institutional Controls	Institutional controls in the form of an environmental restrictive covenant or conditions of future permits may be used to prevent exposure and contact with impacted soil or sediment by restricting land uses or disturbances to the material.	May consist of fish consumption advisories, commercial fishing bans, waterway use restricitons, or deed restrictions	○	Effective in meeting RAOs when combined with other remedies.	●	Easily implemented with little distruption to the Site.	$	Minimal but there are long term costs associated with initiating and maintaining institutional controls.	Yes.	Some institutional controls already in place; however, additional controls are expected to be a required component of any remedy.
Monitoring and Evaluation	Monitoring	The collection and analysis chemical, physical, and/or biological data over a sufficient period of time and frequency to determine the status and/or trend in one or more environmental parameters or characteristics.	Monitoring should be conducted to asses compliance with design and performance standards; to assess short-term remedy performance and effectiveness in meeting sediment cleanup levels; and/or to evaluate long-term remedy effectiveness in achieving RAOs and in reducing human health and/or environmental risk.	○	Effective in meeting RAOs when combined with other remedies.	●	Highly implementable with no disturbance to the Site.	$	The main cost is associated with laboratory analysis.	Yes.	Monitoring is expected to be a required component of any remedy.
Natural Recovery	Monitored Natural Recovery	MNR leaves impacted sediment in place and relies on ongoing, naturally occurring processes to isolate, destroy, or reduce exposure or toxicity of impacted sediment.	Burial of contaminated sediments does not appear to be occuring at the Site and depsotion rates are not likely sufficient to isolate COCs in reasonable timeframe and concentrations do not appear to be reducing.	⊗	Burial does not appear to be occuring and current data does not indicated the extent of MNR effectiveness in COC reduction.	●	Highly implementable with no disturbance to the Site.	$	The main cost of NR is associated with monitoring.	No.	Effectiveness at the Site has not been demonstrated and does not appear to be effective under current conditions.
	Enhanced Monitored Natural Recovery	EMNR adds amendments to the sediment to accelerate physical isolation process and facilitates re-establishment of benthic or plant habitat. May include a granular or carbon sorbent cover (over sediments) or biological stimulants (to soil).	EMNR is not effective because burial is not likely occuring at suffficient rates at the Site.	⊗	Burial does not appear to be occuring and current data does not indicated the extent of EMNR effectiveness in COC reduction.	◉	Implementable; however, requires site access, staging area, and placement equipment. Impact to Site operation can be minimal with advanced planning.	$$	Greater initial cost than NR due to thin cover or amendment placement however remedy will not achieveve RAOs.	No.	Effectiveness at the Site has not been demonstrated and does not appear to be effective under current conditions.
Capping	Capping	Capping provides a physical barrier and chemical isolation from COCs. Caps may be constructed from clean sediment, sand, gravel, geotextiles, liners, reactive or absorptive material and may consist of multiple layers. Granular sediment caps can provide erosion protection and limit bioturbation.	Cap thickness depends on bioactive zone (BAZ) thickness requirements, which vary by habitat, substrate and water depth. A cap may alter hydrologic conditions and Site use.	◉	Highly effective and prevent technology. COCs have low solubility and mobility. Short term movement of COCs in porewater is possible during consolidation. Armoring required to prevent scour due to propeller wash.	◉	Implementable. Consolidation of sediments may be required to minimize spatial placement of cap, maintenance may be required depending on hydrologic conditions.	$$$	Capping costs are generally less than sediment removal, and depend on cap thickness, material, lateral extent and surface water engineering factors. Material costs for a synthetic cap are generally higher than a granular cap.	Yes.	Proven effective method to control exposure and erosion.

Table 2
Technologies Screening Summary
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Category	Technology	Description	Applicability	Ranking						Retained for Consideration	Rationale
				Effectiveness		Implementablility		Relative Cost			
Excavation and Removal	Mechanical Dredging	Sediment is lifted to the surface using a mechanical excavator or crane and placed on a barge for transport. Removed sediment has a similar moisture content as the in situ material, requiring dewatering prior to disposal. Residual cover is typically needed to manage remaining impacts.	Mechanical dredging is implementable within the Site and areas for staging equipment and dewatering are available. Sediment resuspension controls expected to be needed.	◉	Highly effective and preventative technology; however, resuspension may limit effectiveness.	◉	Requires dredging equipment and up land staging infrastructure for sediment treatment and transportation. Less staging space required than hydraulic dredging.	$$$	Main capital costs include equipment mobilization, staging area devlopment, equipment operation, residual cover materials, and construction and operation of a containment area for dredged material.	Yes.	Suitible for dredging within slips.
	Hydraulic Dredging	Hydraulic dredging captures water with the sediment and removes it by pumping the sediment slurry typically through a pipeline to the dewatering location or final disposal site. High water content of slurry requires significant dewatering. Residual cover is typically needed to manage remaining impacts.	Hydraulic dredging unfavorable due to small scale of Site and distance from dewatering and disposal area.	●	Highly effective and preventative technology with less resuspension than mechanical dredging.	○	Implementable; however, requires large staging area for dewatering equipment, requires more water treatment than mechanical dredging.	$$$$	Additional treatment and disposal costs due to greater water content of the slurried sediment.	No	Not suitable for small volume removal areas and staging area for dewating prohibitively far from Site .
	Mechanical Removal in Dry Conditions	Water is diverted or drained from the excavation area using a containment barrier such as a cofferdam to allow for excavation of dry sediment with conventional equipment (e.g. backhoe). Typically limited to shallow areas.	Well suited for shallow areas and geometry that allows for construction of containment barrier and water diversion.	●	Effective and proven technology. Allows for visual inspection during removal. Minimal resuspension/redeposition. High degree of accuracy.	○	Feasible in small-volume removal areas. Site preparation difficult due to water management.	$$$	Costs are similar to mechanical dredging, with the added cost to construct diversion or containment structures.	No	Not suitable when compared to mechanical dredging.
Disposal	Off-Site	Removed sediment is transported to an offsite disposal location that will accept the waste. Dewatering of sediments is generally required before transport.	Transportation of large volumes of sediment would create significant truck traffic through the surrounding community for a long duration.	●	Effective at meeting RAOs, low risk of spills during transportation.	◉	Disruption to neighbors during trucking, may result in limited work hours. Seasonal restrictions may also apply.	$$$$	Costs for offsite disposal include dewatering, water treatment, loading and transportation costs and landfill disposal fees. Transportation costs depend on distance to the landfill.	Yes.	Suitable. Industrial area results in minimal disruption to community. Onsite storage facilities are not available.
	Confined Disposal Facility (CDF)	CDFs are engineered structures enclosed by dikes and specifically designed to contain sediment. CDFs may be located either upland (above the water table), near-shore (partially in the water), or completely in the water (island CDFs).	Land in the vicinity of the Site is not available for a CDF.	●	Most widely used method for disposal and has been demonstrated effective.	○	Requires high level of design, detailed knowledge of dredge plans, requires large permanent area for construction, and treatment of discharge.	$$$	Costs for a CDF include engineering and design costs, materials for dikes and suspended solids control, and construction equipment and labor.	No	Based on the surrounding land use and lack of input from Minnesota Power, consolidation areas are not developed or feasible.
	On-site Contained Aquatic Disposal (CAD)	Dredged or excavated sediment is disposed within a natural or excavated depression elsewhere in the water body.	A suitable location to accommodate entire sediment volume is not available. Areas of sufficient depth to hold some volume are currently used for ship docking.	○	May be effective at containing COCs due to low mobility/solubility.	⊗	A suitable location to accommodate entire sediment volume is not available.	$$$	Specialized equipment for a CAD may be required, especially if the disposal site is in deep water. Dredging to create a CAD would add cost.	No	Based on the Site charateristics as wells as its use for ship docking, a suitable location is not available at the Site to accommodate the required disposal volume.

Table 2
Technologies Screening Summary
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Category	Technology	Description	Applicability	Ranking						Retained for Consideration	Rationale
				Effectiveness		Implementablity		Relative Cost			
In Situ Treatment	Immobilization	Immobilization treatments add chemicals or cements to reduce the leachability of COCs. Mechanisms include solidification (encapsulation) or stabilization (chemical or absorptive reactions that convert COCs to less toxic or mobile forms).	Implementation at a sediment site is difficult due to submerged work requirement and restricting future Site use.	○	Is effective for COCs. Stabilization of sediments reduces erosion potential. May result in poor environment for benthic community.	⊗	Sediment mixing can be difficult. May require dewatering. Requires equipment for mixing. Solidified sediment would restrict future Site use.	$$$	Costs for solidification or stabilization affected by the quantity and type of reagents added to the waste and the need for specialized equipment for mixing reagents with sediment.	No	Not proven to be effective for sediments. Costly and more difficult to implement than other technologies.
	Enhanced Bioremediation	Microbial degradation by bacteria or fungi is enhanced by adding materials such as oxygen, nitrate, sulfate, hydrogen, nutrients, or microorganisms to the sediment.	Can be effective for COCs.	○	Requires specific geochemical parameters to be successful (temperature, Ph, nutrient availability)	○	Easily implemented with little disruption to the Site.	$$$	Costs of enhanced bioremediation are relatively low, but several treatments and monitoring similar to MNR may be required.	No	Difficult to implement sub aqueously.
	Oxidation/Reduction	Chemicals are injected into sediment to act as an oxidant/electron acceptor to facilitate aerobic decomposition of organic matter.	chemical addition may create toxic conditions.	○	Chemical addition may create toxic conditions.	○	Bench-scale testing and pilot-scale testing required to determine the type, concentration, and quantity of oxidant and amendments required.	$$$	Costs include bench- or pilot-scale tests. Monitoring may be required.	No	Not proven safe for subaqueous conditions.
	Chemical Oxidation	The addition of chemical oxidizers to sediment can cause the rapid and complete chemical destruction of many toxic organic chemicals.	Limited effectiveness for Site COCs.	⊗	Addition of chemicals may form temporarily toxic conditions for benthic or aquatic organisms	◉	Pilot studies would be required to determine the effectiveness of specific oxidants for COCs.	$$$	Costs include bench- or pilot-scale tests to determine effectiveness, oxidants for injection, and a delivery system. Monitoring may also be required.	No	Limited effectiveness. Chemical addition may create toxic conditions.
	Phytoremediation	Phytoremediation uses plant species to remove, transfer, stabilize, and destroy COCs in soil and sediment. Generally limited to sediments in shallow water zones and low concentrations.	Habitat restoration not likely necessary, technology not effective in deep areas of reservoir.	○	Effective only in shallow contaminated areas, which are sparse at the Site.	●	Implementation involves planting and in some cases harvesting with little disruption to the Site.	$$	Primary costs are purchasing and planting applicable species. Monitoring may also be required.	No	May be implemented for habitat restoration, but not effective alone.
	Adsorption	Adsorbents can be used as sediment amendments for in situ treatment of COCs. Sorption organics can take place simultaneously with a suitable combination of sorbents.	May be useful as EMNR amendment.	◉	Sorption organics can take place simultaneously with a suitable combination of sorbents.	◉	Sorbent amendments can be delivered to the sediment in the form of pellets that are dense enough to sink through the water column and are resistant to re-suspension while being worked into the sediments	$$	The main costs include the adsorbent material, and a method for depositing it on the surface sediment. Monitoring may also be required.	No	Not retained as sole remedy, but may be useful as capping or ENR amendment.

Table 2
Technologies Screening Summary
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Category	Technology	Description	Applicability	Ranking						Retained for Consideration	Rationale
				Effectiveness		Implementablility		Relative Cost			
Dewatering	Passive Dewatering	Passive dewatering relies on natural evaporation and drainage to remove moisture from the sediment. Drainage may be driven by gravity or assisted with a vacuum pump. Passive dewatering may occur in CDFs, lagoons, tanks, or temporary holding/rehandling facilities.	Dewatering will occur during barge transport and Hallet dock 7 could be used to serve as a staging area for further passive dewatering.	○	Passively dewatered sediments may not have low enough water content for landfill disposal, so supplemental technologies may be required.	◉	Implementable with small volume of removed sediments at Site. Time frames for passive dewatering likely longer than for mechanical dewatering.	$$	Costs to consider include construction of a dewatering facility or adequately sized CDF.	Yes.	Appropriate for off-site disposal when used with hydruospoic amendment addition.
	Sediment Reworking	Reworking sediments to promote drainage, and mixing sediments with excavation equipment can enhance passive dewatering.	If a CDF is constructed, sediment reworking could be performed within the CDF.	◉	Sediment mixing and reworking would facilitate a timelier and more complete dewatering.	◉	Mixing and reworking sediments would decrease time needed to dewater with passive methods. Reworking and mixing could be done with standard excavation equipment already required for the project.	$$	Cost savings are expected over passive dewatering alone due to time saved.	No	Not appropriate for offsite disposal.
	Hydrospoic Amendment Addition	Dredged sediments are mixed with amendments such as slags or cementitious materials to remove moisture and improve strength and stability.	Could be used to enhance dewatering in conjunction with passive dewatering	◉	Effectiveness of amendments depend on the moisture content of removed sediment. Pre-treatment dewatering likely required due to hydraulic dredging for maximum effectiveness and to achieve desired geotechnical properties.	◉	Would require staging, mixing, and curing areas. However, the process can be completed in a relatively short time frame. Amendment addition creates a greater volume and mass, which needs to be considered in disposal options. Likely requires pre-treatment dewatering.	$$	Costs include amendment materials and mixing equipment. Costs increase with increased moisture content. Both the addition rate and the bulking factor of treated material should be considered when evaluating costs of amendment material.	Yes.	Appropriate for off-site disposal when used with passive dewatering.
	Geotextile Tube Dewatering	Sediment slurry from hydraulic dredging is pumped into the geotextile tube and filtered by the geotextile fabric. Sediment is retained within the geotextile tube, while free liquids pass through the exterior of the tube.	Not applicable to mechanical dredging, which is retained for alternatives for the Site.	⊗	Not applicable to mechanical dredging, which is retained for alternatives for the Site.	⊗	Not applicable to mechanical dredging, which is retained for alternatives for the Site.	$$$	Costs include flocculent and coagulant materials, cost of geotextile tubes and construction of staging area.	No	Not appropriate for use with mechanical dredging.
	Mechanical Dewatering	Mechanical dewatering technologies include use of plate filters, presses, centrifuges or other equipment to squeeze, press, or draw water from dredged sediment.	Requires homogeneous waste stream provided by hydraulic dredging methods and site sediments.	◉	Generally works best with a homogeneous waste stream produced via hydraulic dredging. Selection of specific mechanical dewatering equipment depends on treatment or disposal methods that follow.	◉	Faster than passive dewatering and requires less space. Production rates depend on size and quality of the dewatering device and on the solids content of the input stream.	$$$$	Costs of mechanical dewatering are generally higher than passive dewatering due to the energy and equipment requirement.	No	Not cost effective.
	Rapid Dewatering Systems	A system that continuously processes the slurry from a hydraulic dredge and separates solids into piles of debris; shells; and gravel, sand, and fines. Includes polymer addition and flocculation, which may remove some COCs.	Not applicable to mechanical dredging, which is retained for alternatives for the Site.	⊗	Not applicable to mechanical dredging, which is retained for alternatives for the Site.	⊗	Not applicable to mechanical dredging, which is retained for alternatives for the Site.	$$$	Not applicable to mechanical dredging, which is retained for alternatives for the Site.	No	Not applicable to mechanical dredging, which is retained for alternatives for the Site.

Table 2
Technologies Screening Summary
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Category	Technology	Description	Applicability	Ranking						Retained for Consideration	Rationale
				Effectiveness		Implementablility		Relative Cost			
Water Treatment	Filtration	Filters remove solids and sediments from wastewater, also removing absorbed COCs from the waste stream. Flocculants may be added to the waste stream to facilitate solids removal.	Filtration is a standard method for water treatment and would be effective at removing site COCs sorbed to suspended sediments in the waste stream.		Filters can be selected based on the required particulate size. Treatability study to determine if filtration is effective at reducing the COC concentration.		Filtration is a widely used method for water treatment. Selection of the filtration methods and type requires engineering design and site specific knowledge of the waste stream.	$$$	Costs depend on change out frequency of filtration material.	Yes.	Effective for COC removal when used in combination with liquid adsorption.
	Liquid Adsorption	Involves pumping water through a vessel containing granular activated carbon (GAC), organoclay, or another adsorbent material; dissolved compounds to adsorb to its surface.	Conventional absorptive materials would remove dioxins.		Activated carbon vessels are appropriate for treating dioxins. The presence of multiple constituents can impact the performance of activated carbon systems.		Liquid adsorption systems are widely available, have a relatively small footprint, and require a relatively short timeframe for treatment.	$$$	Costs include activated carbon, or other adsorbent vessels. The adsorbent must be recharged or replaced periodically. Power is required for pumping.	Yes.	Effective for COC removal.
	Advanced Oxidation	Advanced oxidation uses UV light and the addition of strong oxidizers to destroy organic constituents in water.	Advanced oxidation is applicable for treating most organics, including PAHs; however, it is not applicable to lead.		Advanced oxidation is applicable for treating most organics, including dionxins.		Advanced oxidation systems are widely available, have a relatively small footprint, and require a relatively short timeframe for treatment. Handling and storage of oxidizers would require special safety precautions.	$$$$	Costs may be higher because of energy requirements to power UV lights.	No	Effective for PAH removal but not applicable for lead removal and cost too high.

	Effectiveness	Implementability	Relative Cost
	Not effective at reaching RAOs	Not implementable at the Site	$$$$ - High
	Partially effective for some COCs or Site areas	Difficult to implement	$$$ - Medium-high
	Effective under certain conditions	Implementable, requires technical knowledge	$$ - Moderate
	Demonstrated effective technology	Readily implemented	$ - Low

Table 3
Alternatives Summary
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Alternative	Alternative 1: No Action	Alternative 2: MNR and Institutional Controls	Alternative 3: Enhanced MNR with Broadcasted Amendment	Alternative 4: Excavate, Consolidate, Upland Cap & Wetland Restoration	Alternative 5: Excavate, Offsite Disposal & Wetland Restoration	Alternative 6: Excavate, Offsite Disposal
Total Present Worth Cost	$0	$2,170,000	$4,850,000	$13,614,000	$16,716,000	$15,726,000
Cover/Cap Area	0 acres	0 acres	14.39 acres (a 0.010-meter [0.38 inch] Sedimite reactive cover)	14.39 acres (includes treated sediment under a (0.23-meter [9-inch] clean cover)	14.39 acres (0.23-meter [9-inch] clean cover)	14.39 acres (0.23-meter [9-inch] clean cover)
Cover Volume - Sand/Amendment	0 CY/ 0 CY	0 CY/ 0 CY	0 CY/ 734 CY	17400 CY/ 0 CY	17400 CY/ 0 CY	17400 CY/ 0 CY
Excavation Area	0 acres	0 acres	0 acres	14.39 acres to three elevation surfaces	14.39 acres to three elevation surfaces	14.39 acres to three elevation surfaces
Excavation Volume	0 CY	0 CY	0 CY	64000 CY	64000 CY	64000 CY
Disposal Volume	0 CY	0 CY	0 CY	64000 CY/ 90000 tons (on site CDF)	64000 CY/ 90000 tons (off-site landfill)	64000 CY/ 90000 tons (off-site landfill)
Construction Timeframe	0 weeks	1 weeks	15 weeks	28 weeks 1st season (mob, excavation and consolidate sediments); 16 weeks 2nd season (place cover, restore wetland, demob)	29 weeks 1st season (mob, excavation and dispose sediments); 16 weeks 2nd season (place cover, restore wetland, demob)	29 weeks 1st season (mob, excavation and dispose sediments); 4 weeks 2nd season (demob)
Monitoring Program	None	Chemical and physical sediment; benthic toxicity and bioaccumulation; bathymetric survey; institutional control review	Chemical and physical sediment; benthic toxicity and bioaccumulation; bathymetric survey; institutional control review	Chemical and physical sediment; benthic toxicity and bioaccumulation; bathymetric survey; institutional control review	None	None

Table 4
Cost Estimate - Alternative 2: MNR and Institutional Controls
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Description	Unit	Estimated Unit Cost	Estimated Quantity	Extended Value	Present Value	Comments
Long-Term Monitoring						
Monitoring and Evaluation Report	Each	$ 4,000	17	$ 68,000	$ 36,256	Every year for 10 years, biennial for 10 years, every five for 10 years
Field Sampling	Event	$ 34,000	17	$ 578,000	$ 308,178	Every year for 10 years, biennial for 10 years, every five for 10 years
Sample Analysis	Event	$ 48,235	17	$ 819,995	$ 437,204	Every year for 10 years, biennial for 10 years, every five for 10 years
			SUBTOTAL	$ 1,465,995	$ 781,638	
			25% Contingency	$ 366,499	$ 195,409	
			MONITORING GRAND TOTAL	$ 1,832,494	$ 977,047	
Professional and Technical Services						
MNR Design (6%)	Lump Sum	$ 110,000	1	$ 110,000	$ 110,000	Year 0
Project Management and Permitting (5%)	Lump Sum	$ 92,000	1	$ 92,000	$ 85,981	Year 1
Monitoring Management (6%)	Lump Sum	$ 110,000	17	$ 1,870,000	$ 997,045	Every year for 10 years, biennial for 10 years, every five for 10 years
			SUBTOTAL	$ 2,072,000	$ 1,193,026	
			TOTAL	**$ 3,904,000**	**$ 2,170,000**	

Notes:

All values are based on 2016 dollars with an assumed discount rate of 7 percent per year. See Table 3-6 for present value calculations.

Assumptions are based on professional judgment and experience of specialists at Bay West. Actual project costs will be highly dependent upon final design.

Table 5
Cost Estimate - Alternative 3: Enhanced MNR with Broadcasted Amendment
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Description	Unit	Estimated Unit Cost	Estimated Quantity	Extended Value	Present Value	Comments
Construction Costs						
Mobilization/Demobilization	Lump Sum	$ 92,000	1	$ 92,000	$ 85,981	All construction occurs on Year 1
Staging Area Construction	Lump Sum	$ 574,000	1	$ 574,000	$ 376,636	
Purchase Amendment Materials and Stockpile at Staging Area	Lump Sum	$ 1,784,000	1	$ 1,784,000	$ 1,667,290	
Broadcast Amendment in Wetland Areas - SediMite™	CY	$ 54.99	734	$ 40,379	$ 37,737	5% ammendment (SediMite™) by sediment dry weight in the upper 6 inches of sediment
Construction Monitoring/CQA and Oversight	Week	$ 12,802	15	$ 192,030	$ 179,467	
Monthly Operating Expenses and Site Security	Month	$ 34,000	4	$ 127,500	$ 222,430	
Implement Institutional Controls	Lump Sum	$ 5,000.00	1	$ 5,000	$ 4,673	Site postings
			SUBTOTAL	$ 2,814,909	$ 2,574,214	
Long-Term Monitoring						
Monitoring and Evaluation Report	Each	$ 4,000	13	$ 52,000	$ 28,374	Every year for 5 years, biennial for 10 years, every five for 15 years
Field Sampling	Event	$ 34,000	13	$ 442,000	$ 241,176	Every year for 5 years, biennial for 10 years, every five for 15 years
Sample Analysis	Event	$ 53,995	13	$ 701,935	$ 383,009	Every year for 5 years, biennial for 10 years, every five for 15 years
			SUBTOTAL	$ 1,195,935	$ 652,559	
			TOTAL	$ 4,010,844	$ 3,226,773	
			25% Contingency	$ 1,002,711	$ 806,693	
			CONSTRUCTION GRAND TOTAL	$ 5,013,555	$ 4,033,467	
Professional and Technical Services						
Remedial Design (6%)	Lump Sum	$ 301,000	1	$ 301,000	$ 301,000	Year 0
Project Management and Permitting (5%)	Lump Sum	$ 251,000	1	$ 251,000	$ 234,579	Year 1
Construction Management (6%)	Lump Sum	$ 301,000	1	$ 301,000	$ 281,308	Year 1
			SUBTOTAL	$ 853,000	$ 816,888	
			TOTAL	**$ 5,867,000**	**$ 4,850,000**	

Notes:

All values are based on 2016 dollars with an assumed discount rate of 7 percent per year. See Table 3-6 for present value calculations.

Assumptions are based on professional judgment and experience of specialists at Bay West. Actual project costs will be highly dependent upon final design.

Table 6
Cost Estimate - Alternative 4: Excavate, Consolidate, Upland Cap Wetland Restortation
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Description	Unit	Estimated Unit Cost	Estimated Quantity	Extended Value	Present Value	Comments
Construction Costs						
Mobilization/Demobilization	Lump Sum	$ 146,000	1	$ 146,000	$ 136,449	
Staging Area Construction	Lump Sum	$ 574,000	1	$ 574,000	$ 536,449	
Site Work	Lump Sum	$ 1,721,000	1	$ 1,721,000	$ 1,608,411	
Excavate Sediment and Rough grading	Lump Sum	$ 3,544,000	1	$ 3,544,000	$ 3,279,756	
Sediment Treatment, Excavation & Site Return for Capping	Lump Sum	$ 1,927,000	1	$ 1,927,000	$ 1,800,935	
Sediment Consolidation in Upland Caps	Lump Sum	$ 49,000	1	$ 49,000	$ 45,794	
Wetland Restoration	Lump Sum	$ 640,000	1	$ 640,000	$ 598,131	
Implement Institutional Controls	Lump Sum	$ 5,000.00	1	$ 5,000	$ 4,673	
Construction Monitoring/CQA and Oversight (Labor/Equipment)	Week	$ 12,802	44	$ 563,288	$ 526,437	
Construction Monitoring and Sample Analysis	Lump Sum	$ 133,000	1	$ 133,000	$ 124,299	
Monthly Operating Expenses and Site Security	Month	$ 34,000	11	$ 374,000	$ 349,533	
			SUBTOTAL	$ 9,676,288	$ 9,010,867	
Long-Term Monitoring						
Monitoring and Evaluation Report	Each	$ 4,000	6	$ 24,000	$ 12,631	Predesign and Every 5 years for 30 years
Field Sampling	Event	$ 34,000	6	$ 204,000	$ 107,366	Predesign and Every 5 years for 30 years
Sample Analysis	Event	$ 35,732	6	$ 214,392	$ 112,835	Predesign and Every 5 years for 30 years
			SUBTOTAL	$ 442,392	$ 232,832	
			TOTAL	$ 10,118,680	$ 9,243,699	
			25% Contingency	$ 2,529,670	$ 2,310,925	
			CONSTRUCTION GRAND TOTAL	$ 12,648,350	$ 11,554,624	
Professional and Technical Services						
Remedial Design (6%)	Lump Sum	$ 760,000	1	$ 760,000	$ 760,000	Year 0
Project Management and Permitting (5%)	Lump Sum	$ 630,000	1	$ 630,000	$ 588,785	Year 1
Construction Management (6%)	Lump Sum	$ 760,000	1	$ 760,000	$ 710,280	Year 1
			SUBTOTAL	$ 2,150,000	$ 2,059,065	
			TOTAL	**$ 14,798,000**	**$ 13,614,000**	

Notes:

All values are based on 2016 dollars with an assumed discount rate of 7 percent per year. See Table 3-6 for present value calculations.

Assumptions are based on professional judgment and experience of specialists at Bay West. Actual project costs will be highly dependent upon final design.

Table 7
Cost Estimate - Alternative 5: Excavate, Offsite Disposal Wetland Restoration
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Description	Unit	Estimated Unit Cost	Estimated Quantity	Extended Value	Present Value	Comments
Construction Costs						
Mobilization/Demobilization	Lump Sum	$ 169,000	1	$ 169,000	$ 157,944	
Staging Area Construction	Lump Sum	$ 574,000	1	$ 574,000	$ 536,449	
Site Work	Lump Sum	$ 1,513,000	1	$ 1,513,000	$ 1,414,019	
Excavate Sediment and Rough grading	Lump Sum	$ 3,544,000	1	$ 3,544,000	$ 3,312,150	
Sediment treatment, Excavation & Load on Dumps	Lump Sum	$ 1,867,000	1	$ 1,867,000	$ 1,744,860	
Sediment Landfill Disposal	Lump Sum	$ 2,071,000	1	$ 2,071,000	$ 1,935,514	
Wetland Restoration	Lump Sum	$ 1,305,000	1	$ 1,305,000	$ 1,219,626	
Implement Institutional Controls	Lump Sum	$ 5,000.00	1	$ 5,000	$ 4,673	
Construction Monitoring/CQA and Oversight (Labor/Equipment)	Week	$ 12,802	45	$ 576,090	$ 538,402	
Construction Monitoring and Sample Analysis	Lump Sum	$ 133,000	1	$ 133,000	$ 124,299	
Monthly Operating Expenses and Site Security	Month	$ 34,000	11	$ 374,000	$ 349,533	
			SUBTOTAL	$ 12,131,090	$ 11,337,467	
Long-Term Monitoring						
Monitoring and Evaluation Report	Each	$ 4,000	1	$ 4,000	$ 4,000	One predesign investigation
Field Sampling	Event	$ 34,000	1	$ 34,000	$ 34,000	One predesign investigation
Sample Analysis	Event	$ 20,994	1	$ 20,994	$ 20,994	One predesign investigation
			SUBTOTAL	$ 58,994	$ 58,994	
			TOTAL	$ 12,190,084	$ 11,396,461	
			25% Contingency	$ 3,047,521	$ 2,849,115	
			CONSTRUCTION GRAND TOTAL	$ 15,237,605	$ 14,245,577	
Professional and Technical Services						
Remedial Design (6%)	Lump Sum	$ 910,000	1	$ 910,000	$ 910,000	Year 0
Project Management and Permitting (5%)	Lump Sum	$ 760,000	1	$ 760,000	$ 710,280	Year 1
Construction Management (6%)	Lump Sum	$ 910,000	1	$ 910,000	$ 850,467	Year 1
			SUBTOTAL	$ 2,580,000	$ 2,470,748	
			TOTAL	**$ 17,818,000**	**$ 16,716,000**	

Notes:

All values are based on 2016 dollars with an assumed discount rate of 7 percent per year. See Table 3-6 for present value calculations.

Assumptions are based on professional judgment and experience of specialists at Bay West. Actual project costs will be highly dependent upon final design.

Table 8
Cost Estimate - Alternative 6: Excavate, Offsite Disposal
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Description	Unit	Estimated Unit Cost	Estimated Quantity	Extended Value	Present Value	Comments
Construction Costs						
Mobilization/Demobilization	Lump Sum	$ 146,000	1	$ 146,000	$ 136,449	
Staging Area Construction	Lump Sum	$ 574,000	1	$ 574,000	$ 536,449	
Site Work	Lump Sum	$ 1,478,000	1	$ 1,478,000	$ 1,381,308	
Excavate Sediment and Rough grading	Lump Sum	$ 3,544,000	1	$ 3,544,000	$ 3,312,150	
Sediment treatment, Excavation & Load on Dumps	Lump Sum	$ 1,867,000	1	$ 1,867,000	$ 1,744,860	
Sediment Landfill Disposal	Lump Sum	$ 2,071,000	1	$ 2,071,000	$ 1,935,514	
Construction Monitoring/CQA and Oversight (Labor/Equipment)	Week	$ 12,802	33	$ 422,466	$ 394,828	
Construction Monitoring and Sample Analysis	Lump Sum	$ 133,000	1	$ 133,000	$ 124,299	
Monthly Operating Expenses and Site Security	Month	$ 34,000	8	$ 272,000	$ 254,206	
			SUBTOTAL	$ 10,507,466	$ 10,806,043	
Long-Term Monitoring						
Monitoring and Evaluation Report	Each	$ 4,000	1	$ 4,000	$ 4,000	One predesign investigation
Field Sampling	Event	$ 34,000	1	$ 34,000	$ 34,000	One predesign investigation
Sample Analysis	Event	$ 20,994	1	$ 20,994	$ 20,994	One predesign investigation
			SUBTOTAL	$ 58,994	$ 58,994	
			TOTAL	$ 10,566,460	$ 10,865,037	
			25% Contingency	$ 2,641,615	$ 2,716,259	
			CONSTRUCTION GRAND TOTAL	$ 13,208,075	$ 13,581,296	
Professional and Technical Services						
Remedial Design (6%)	Lump Sum	$ 790,000	1	$ 790,000	$ 790,000	Year 0
Project Management and Permitting (5%)	Lump Sum	$ 660,000	1	$ 660,000	$ 616,822	Year 1
Construction Management (6%)	Lump Sum	$ 790,000	1	$ 790,000	$ 738,318	Year 1
			SUBTOTAL	$ 2,240,000	$ 2,145,140	
			TOTAL	**$ 15,448,000**	**$ 15,726,000**	

Notes:

All values are based on 2016 dollars with an assumed discount rate of 7 percent per year. See Table 3-6 for present value calculations.

Assumptions are based on professional judgment and experience of specialists at Bay West. Actual project costs will be highly dependent upon final design.

Table 9
Comparative Analysis Summary - Threshold, Balancing, and Modifying Criteria
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Evaluation Criteria	Alternative 1: No Action	Alternative 2: MNR and Institutional Controls	Alternative 3: Enhanced MNR with Broadcasted Amendment	Alternative 4: Excavate, Consolidate, Upland Cap & Wetland Restoration	Alternative 5: Excavate, Offsite Disposal & Wetland Restoration	Alternative 6: Excavate, Offsite Disposal
Threshold Criteria						
Overall Protection of Human Health & Environment	Provides a **low achievement** of protection of Human Health and the Environment as contaminant concentrations remain with minimal controls to prevent exposure.	Provides a **low achievement** of protection of Human Health and the Environment as contaminant concentrations remain with minimal controls to prevent exposure.	Provides a **low to moderate achievement** of protection of Human Health and the Environment. Contaminated sediment would remain in place but contaminants would be beneath a reactive cover.	Provides a **high achievement** of protection of Human Health and the Environment. Contaminated sediment would remain in place but contaminants would be stabilized and completely isolated .	Provides a **high achievement** of protection of Human Health and the Environment. Only residual contaminated sediment would remain in place; however, it is anticipated that the residual contamination will not exceed the RAOs.	Provides a **high achievement** of protection of Human Health and the Environment. Only residual contaminated sediment would remain in place; however, it is anticipated that the residual contamination will not exceed the RAOs.
ARARs	Provides a **low achievemen**t of ARARs since chemical-specific TBCs are not met for sediment. Location and action-specific ARARs do not apply to this alternative.	Provides a **low achievement** of ARARs since chemical-specific TBCs are not met for sediment. Location and action-specific ARAR s do not apply to this alternative.	Provides a **moderate achievement** of ARARs if implemented properly and reactive cover amendments are able to address the entire suite of COCs; however, COCs may not be reduced to concentrations less than RAOs in a reasonable time frame.	Provides a **moderate achievement** of ARARs if implemented properly.	Provides a **high achievement** of ARARs if implemented properly. Contaminants above the RAOs would be removed.	Provides a **high achievement** of ARARs if implemented properly. Contaminants above the RAOs would be removed.
Primary Balancing Criteria						
Long-term Effectiveness and Permanence	Provides a **low achievement** of long-term effectiveness and remedy is not long-term effective or permanent.	Provides a **low achievement** of long-term effectiveness and remedy is not likely long-term effective or permanent.	Provides a **low to moderate achievement** of long-term effectiveness and permanence. Contaminated sediments would remain in place and be further but not completely removed from receptors. Monitoring will indicate the remedy effectiveness and whether additional cover material may be necessary to reach ROAs.	Provides a **moderate to high achievement** of long-term effectiveness and permanence because it stabilizes and isolates consolidated sediments from receptors	Provides a **high achievement** of long-term effectiveness. Contaminated sediments would be permanently removed from the Site.	Provides a **high achievement** of long-term effectiveness. Contaminated sediments would be permanently removed from the Site.
Reduction of Toxicity, Mobility or Volume through Treatment	Provides a **low achievement** of this criterion as no reduction in toxicity, mobility, or volume is provided.	Provides a **low achievement** of this criterion as current MNR information provided no evidence for a ongoing reduction in toxicity, mobility, or volume.	Provides a **moderate achievement** of this criterion as all contaminated sediment that exceed the RAOs would be left in pace; however, mobility would be reduced with the reactive cover placement.	Provides a **high achievement** of this criterion as all contaminated sediment that exceed the RAOs would be stabilized, consolidated and isolated under caps reducing mobility at the time of cap placement.	Provides a **high achievement** of this criterion by removing all contaminated sediments that exceed the RAOs. The removed sediments would be treated through stabilization and disposed of at a permitted landfill.	Provides a **high achievement** of this criterion by removing all contaminated sediments that exceed the RAOs. The removed sediments would be treated through stabilization and disposed of at a permitted landfill.
Short-term effectiveness	Provides a **low achievement** of this criterion as no actions are implemented, exposure risks to the community will therefore increase with the future bike path installation and receptors would continue to be exposed to contaminated sediment.	Provides a **moderate achievement** of this criterion as no actions are implemented, exposure risks to the community will likely increase with the future bike path installation, and receptors would continue to be exposed to contaminated sediment.	Provides a **moderate achievement** of this criterion since installation of the reactive cover which would displace the benthic community. Risks to workers is moderate.	Provides a **high achievement** of this criterion as all contaminated sediment that exceed the RAOs would be stabilized, consolidated and isolated under caps. During the construction period the benthic and wetland community would be completely destroyed; however, the overall wetland environment would be improved within a few years after wetland restoration.	Provides a **moderate achievement** of this criterion as all contaminated sediment that exceed the RAOs would be removed from the site. During the construction period the benthic and wetland community would be completely destroyed; however, the overall wetland environment would be improved within a few years after wetland restoration. Off-site disposal lowers the effectiveness due to a slight increase in short-term risks from truck traffic to an off-site landfill.	Provides a **moderate achievement** of this criterion as all contaminated sediment that exceed the RAOs would be removed from the site. During the construction period the benthic and wetland community would be completely destroyed; however, the overall wetland environment would be improved within a few years after wetland restoration. Off-site disposal lowers the effectiveness due to a slight increase in short-term risks from truck traffic to an off-site landfill.
Implementability	Provides a **high achievement** of this criterion as no actions would be implemented.	Provides a **high achievement** of this criterion as monitoring has been conducted in the past and there are know barriers to the implementation of MNR.	Provides a **moderate achievement** of implementability since the effectiveness of reagents to address the complex suite of COCs is unknown and potential difficulties with implementing the cover in densely vegetated and/or low water coverage areas.	Provides a **low to moderate achievement** of implementability. The approach has been implemented at other sites; however, the greatest challenge may be managing the coordination and required permitting between all the stakeholders and regulatory agencies.	Provides a **low to moderate achievement** of implementability. The approach has been implemented at other sites; however, the greatest challenge may be managing the coordination and required permitting between all the stakeholders and regulatory agencies.	Provides a **moderate achievement** of implementability. The approach has been implemented at other sites; however, the greatest challenge may be managing the coordination and required permitting between all the stakeholders and regulatory agencies.
Cost (1)	No Cost	$2,170,000	$4,850,000	$13,614,000	$16,716,000	$15,726,000
Modifying Criteria						
State Support / Agency Acceptance	TBD	TBD	TBD	TBD	TBD	TBD
Community Acceptance	TBD	TBD	TBD	TBD	TBD	TBD
Green Sustainable Remediation (GSR) Criteria*						

Notes
(1) Cost are presented as Present Value.
M = Million
** Not included in numerical comparison on (Table 5-2).*
TBD = To Be Determined

Table 10
Comparative Analysis Summary - Green Sustainable Remediation Criteria
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Evaluation Criteria	Alternative 1: No Action	Alternative 2: MNR and Institutional Controls	Alternative 3: Enhanced MNR with Broadcasted Amendment	Alternative 4: Excavate, Consolidate, Upland Cap & Wetland Restoration	Alternative 5: Excavate, Offsite Disposal & Wetland Restoration	Alternative 6: Excavate, Offsite Disposal & Wetland Restoration
Green Sustainable Remediation (GSR) Criteria*						
Green House Gas (GHG) Emissions	No GHG emissions would occur as no equipment would be mobilization/demobilization to the site under the No Action Alternative.	Total GHG emissions are limited to equipment mobilization related to sampling activities.	Total GHG emissions produced during cover material delivery and placement and equipment mobilization related to sampling activities.	Total GHG emissions produced during consolidation activities, cap material delivery, and placement and equipment mobilization related to sampling activities.	Total GHG emissions are limited to excavation activities and hauling wastes by land to landfill. More dredging and hauling generates more GHG emissions.	Total GHG emissions are limited to excavation activities and hauling wastes by land to landfill. More dredging and hauling generates more GHG emissions.
Toxic Chemical Usage and Disposal	No toxic chemicals would be used or disposed under the No Action Alternative.	No toxic chemicals would be used or require disposal during MNR implementation.	No toxic chemicals would be used or require disposal during EMNR implementation.	No toxic chemicals are used or disposed.	Portland cement used to stabilize dredged material.	Portland cement used to stabilize dredged material.
Energy Consumption	Fossil fuels will not be consumed under the No Action Alternative.	Fossil fuels are limited to equipment mobilization for MNR sampling activities.	Fossil fuels consumption are limited to the equipment mobilization for sampling activities and thin cover placement operations.	Fossil fuels are limited to the equipment mobilization for sampling activities, excavation, contaminated sediment consolidation activities, and cap material delivery and placement operations.	Fossil fuels are required for equipment mobilization for sampling activities, dredging activities, and hauling wastes by land to landfill. More dredging and hauling requires more fossil fuels.	Fossil fuels are required for equipment mobilization for sampling activities, dredging activities, and hauling wastes by land to landfill. More dredging and hauling requires more fossil fuels.
Use of Alternative Fuels	Alternative fuels will not be consumed under the No Action Alternative.	Implementation of MNR does not warrant a significant use of alternative fuels.	Alternative fuels could be used to run heavy construction equipment during reactive cover placement .	Alternative fuels could be used to run heavy construction equipment.	Alternative fuels could be used to run heavy construction equipment.	Alternative fuels could be used to run heavy construction equipment.
Water Consumption	Water will not be consumed under the No Action Alternative.	An insignificant amount of water will be consumed under the MNR Alternative.	An insignificant amount of water will be consumed under the EMNR Alternative.	Little water consumption is necessary.	Little water consumption is necessary.	Little water consumption is necessary.
Waste Generation	No waste will be generation under the No Action Alternative.	An insignificant amount of PPE and sampling associated waste will be generation under the MNR Alternative.	An insignificant amount of reactive cover construction, PPE and sampling associated waste will be generation under the EMNR Alternative.	An insignificant amount of reactive cover construction, PPE and sampling associated waste will be generation under the EMNR Alternative.	64000 CY of sediment for disposal will be generated.	64000 CY of sediment for disposal will be generated.
GSR Criteria Summary	Since no actions occur GSR criterion can not be evaluated under the No Action Alternative.	Provides a **high achievement** of the GSR criterion.	Provides a **moderate to high achievement** of the GSR criterion.	Provides a **moderate achievement** of the GSR criterion.	Provides a **low achievement** of the GSR criterion.	Provides a **low achievement** of the GSR criterion.

Notes
(1) Cost are presented as Present Value.
M = Million
** Not included in numerical comparison on (Table 5-2).*
TBD = To Be Determined

Table 11
Numerical Comparative Analysis Summary
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Evaluation Criteria	Alternative 1: No Action	Alternative 2: MNR and Institutional Controls	Alternative 3: Enhanced MNR with Broadcasted Amendment	Alternative 4: Excavate, Consolidate, Upland Cap & Wetland Restoration	Alternative 5: Excavate, Offsite Disposal & Wetland Restoration	Alternative 6: Excavate, Offsite Disposal
Overall Protection of Human Health & Environment	1	1	1.5	3	3	3
ARARs	1	1	2	2	2	3
Long-term Effectiveness and Permanence	1	1	1.5	2.5	3	3
Reduction of Toxicity, Mobility or Volume through Treatment	1	1	2	3	3	3
Short-term effectiveness	1	2	2	3	2	2
Implementability	3	3	2	1.5	1.5	2
Cost (1)	3	3	2	1.5	1	1
State Support / Agency Acceptance	TBD	TBD	TBD	TBD	TBD	TBD
Community Acceptance	TBD	TBD	TBD	TBD	TBD	TBD
Total Numerical Value	**11**	**12**	**13**	**16.5**	**15.5**	**17**

Notes

(1) Cost are presented as Present Value.

Ratings are based on achievement of criterion: low achievement; moderate achievement; and high achievement.

Scores are based on 1 = low achievement; 2 = moderate achievement; and 3 = high achievement.

Scoring for cost are based on the following cost breakpoints: > $ 10 million = low achievement; $3-10 Million = moderate achievement; and < $3 million = high achievement.

GSR criteria not included in this numerical comparison.

See Table 6 for a discussion of each criterion.

Table 12
Present Value Calculations
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Discount rate used for present worth calculations: 7.00%

Present worth calculation is: [(2016 Cost)/(1.07^Event Year 1)]+[(2016 Cost)/(1.07^Event Year 2)]+…
Year 0 is 2016.

Alternative 1: No Action	**2016 Costs**	**Years**	**Total Present Worth**	**Note**
No Costs Associated with this Alternative				

Alternative 2: MNR and Institutional Controls	**2016 Costs**	**Years**																	**Total Present Worth**	**Note**
Long-Term Monitoring																				
Monitoring and Evaluation Report	$4,000	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	25	30	$36,256	
Field Sampling	$34,000	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	25	30	$308,178	
Sample Analysis	$48,235	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	25	30	$437,204	
Professional and Technical Services																				
Remedial Design (6%)	$110,000	0																	$110,000	
Project Management and Permitting (5%)	$92,000	1																	$85,981	
Monitoring Management (6%)	$110,000	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	25	30	$997,045	

Alternative 3: Enhanced MNR with Broadcasted Amendment	**2016 Costs**	**Years**																	**Total Present Worth**	**Note**
Construction Costs																				
Mobilization/Demobilization	$92,000	1																	$85,981	
Staging Area Construction	$403,000	1																	$376,636	
Purchase sand benthic cover and Stockpile at Staging Area	$1,784,000	1																	$1,667,290	
Broadcast combined Amendment	$40,379	1																	$37,737	
Construction Monitoring/CQA and Oversight	$192,030	1																	$179,467	
Monthly Operating Expenses and Site Security	$238,000	1																	$222,430	
Implement Institutional Controls	$5,000	1																	$4,673	
Long-Term Monitoring																				
Monitoring and Evaluation Report	$4,000	1	2	3	4	5	7	9	11	13	15	20	25	30					$28,374	
Field Sampling	$34,000	1	2	3	4	5	7	9	11	13	15	20	25	30					$241,176	
Sample Analysis	$53,995	1	2	3	4	5	7	9	11	13	15	20	25	30					$383,009	
Professional and Technical Services																				
Remedial Design (6%)	$301,000	0																	$301,000	
Project Management and Permitting (5%)	$251,000	1																	$234,579	
Construction Management (6%)	$301,000	1																	$281,308	

Table 12
Present Value Calculations
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Alternative 4: Excavate, Consolidate, Upland Cap & Wetland Restoration	**2016 Costs**	**Years**																	**Total Present Worth**	**Note**
Construction Costs																				
Mobilization/Demobilization	$146,000	1																	$136,449	
Staging Area Construction	$574,000	1																	$536,449	
Site Work	$1,721,000	1																	$1,608,411	
Excavate Sediment and Rough Grading	$3,509,339	1																	$3,279,756	
Sediment Treatment, Excavation & Site Return for Capping	$1,927,000	1																	$1,800,935	
Sediment Consolidation in Upland Caps	$49,000	1																	$45,794	
Wetland Restoration	$640,000	1																	$598,131	
Implement Institutional Controls	$5,000	1																	$4,673	
Construction Monitoring/CQA and Oversight (Labor/Equipment)	$563,288	1																	$526,437	
Construction Monitoring and Sample Analysis	$133,000	1																	$124,299	
Monthly Operating Expenses and Site Security	$374,000	1																	$349,533	
Long-Term Monitoring																				
Monitoring and Evaluation Report	$4,000	0	5	10	15	20	25	30											$12,631	year zero would be predesign and baseline for following 5 year reviews monitoring events
Field Sampling	$34,000	0	5	10	15	20	25	30											$107,366	
Sample Analysis	$35,732	0	5	10	15	20	25	30											$112,835	
Professional and Technical Services																				
Remedial Design (6%)	$760,000	0																	$760,000	
Project Management and Permitting (5%)	$630,000	1																	$588,785	
Construction Management (6%)	$760,000	1																	$710,280	

Table 12
Present Value Calculations
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Alternative 5: Excavate, Offsite Disposal & Wetland Restoration	2016 Costs	Years	Total Present Worth	Note
Construction Costs				
Mobilization/Demobilization	$169,000	1	$157,944	
Staging Area Construction	$574,000	1	$536,449	
Site Work	$1,513,000	1	$1,414,019	
Excavate Sediment and Rough Grading	$3,544,000	1	$3,312,150	
Sediment Treatment, Excavation & load for Disposal	$1,867,000	1	$1,744,860	
Sediment Offsite Disposal	$2,071,000	1	$1,935,514	
Wetland Restoration	$1,305,000	1	$1,219,626	
Implement Institutional Controls	$5,000	1	$4,673	
Construction Monitoring/CQA and Oversight (Labor/Equipment)	$576,090	1	$538,402	
Construction Monitoring and Sample Analysis	$133,000	1	$124,299	
Monthly Operating Expenses and Site Security	$374,000	1	$349,533	
Long-Term Monitoring				
Monitoring and Evaluation Report	$4,000	0	$4,000	Predesign only
Field Sampling	$34,000	0	$34,000	
Sample Analysis	$20,994	0	$20,994	
Professional and Technical Services				
Remedial Design (6%)	$910,000	0	$910,000	
Project Management and Permitting (5%)	$760,000	1	$710,280	
Construction Management (6%)	$910,000	1	$850,467	

Alternative 6: Excavate, Offsite Disposal & Wetland Restoration	2016 Costs	Years	Total Present Worth	Note
Construction Costs				
Mobilization/Demobilization	$146,000	1	$136,449	
Staging Area Construction	$574,000	1	$536,449	
Site Work	$1,478,000	1	$1,381,308	
Excavate Sediment and Rough Grading	$3,544,000	1	$3,312,150	
Sediment Treatment, Excavation & load for Disposal	$1,867,000	1	$1,744,860	
Sediment Offsite Disposal	$2,071,000	1	$1,935,514	
Wetland Restoration	$1,050,000	1	$981,308	
Implement Institutional Controls	$5,000	1	$4,673	
Construction Monitoring/CQA and Oversight (Labor/Equipment)	$422,466	1	$394,828	
Construction Monitoring and Sample Analysis	$133,000	1	$124,299	
Monthly Operating Expenses and Site Security	$272,000	1	$254,206	
Long-Term Monitoring				
Monitoring and Evaluation Report	$4,000	0	$4,000	Predesign only
Field Sampling	$34,000	0	$34,000	
Sample Analysis	$20,994	0	$20,994	
Professional and Technical Services				
Remedial Design (6%)	$790,000	0	$790,000	
Project Management and Permitting (5%)	$660,000	1	$616,822	
Construction Management (6%)	$790,000	1	$738,318	

Appendix A

Memorandum

40th Avenue Wetland Delineation for St. Louis River RAP Projects, St. Louis County, Minnesota, on behalf of the Detroit District USACE

St. Paul District
Regulatory Branch

31 December 2015

MEMORANDUM

SUBJECT: *40th Avenue Wetland Delineation for St. Louis River RAP Projects, St. Louis County, Minnesota, on behalf of the Detroit District USACE*

1. Introduction.

The U.S. Army Corps of Engineers, St. Paul District Regulatory Branch conducted a wetland delineation on behalf of the Detroit District Planning Branch for four project areas proposed within and adjacent to the St. Louis River in St. Louis County, Minnesota at the following sites: 21st Avenue, 40th Avenue, Kingsbury Bay, and Perch Lake. The purpose of this memorandum is to document the methods used and conclusions made regarding the extent of wetlands present at the 40th Avenue site.

The area of investigation (AOI) for the 40th Avenue site encompasses approximately 119 acres as shown on Figure 1 (Appendix A), and is located in parts of Sections 7, 8, 17, and 18, T.49N., R. 1W., St. Louis County, Minnesota.

2. Methods and Materials.

The wetland delineation was conducted using a combination of on-site and off-site methods detailed below.

On-site procedures were conducted in accordance with the 1987 *Corps of Engineers Wetlands Delineation Manual* (*Corps Manual*) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: North Central and Northeast Region (Version 2.0)* (U.S. Army Corps of Engineers 2010). The Corps staff team conducted the on-site data collection on Wednesday, October 14, 2015. Off-site wetland determination methods using aerial photography and elevation data, coupled with field verification, were employed to determine the extent of wetlands in areas where access was not permitted.

The following resources were utilized for the wetland delineation:

- ArcMap 10.2.2 FSA 1991, 2002, 2006, 2008, 2009, 2010, 2013, 2015 aerial photographs
- Google Earth (version 7.1.5.1557) 1991, 2003, 2004, 2006, 2008, 2009, 2011, 2012, 2015 true color aerial photographs;
- DNR Landview Aerial Photography 1948, 1972, 1981, 1989
- Minnesota Climatology Working Group Website (http://climate.umn.edu/gridded_data/precip/wetland/wetland.asp) "Wetland Delineation Precipitation Data Retrieval";
- National Wetlands Inventory (NWI) mapping;
- MN Department of Natural Resources (DNR) Public Waters Inventory;
- USDA Web Soil Survey digital soil mapping;
- St. Louis County LiDAR data
- Trimble Geoexplorer XT GPS unit to record the locations of data points and wetland/upland boundaries during field investigation
- ArcMap 10.2.2 GIS program to digitize and display the results of the investigation.

In addition, the following methods were used:

a. Placing Observations of Hydrology in the Context of Antecedent Precipitation. *Hydrology Tools for Wetland Determination* (Woodward *et al*. 1997) and *Assessing and Using Meteorological Data to Evaluate Wetland Hydrology* (Sprecher and Warne 2000) recommend evaluation of precipitation for the 3 months prior to the date of the aerial imagery to assist in making determinations regarding signatures noted on aerial photography. The Minnesota Climatology Working Group website was used to determine antecedent precipitation for the site visit as well as any aerial photography reviewed. Direct observations of hydrology indicators made during the site visit were then placed in the context of antecedent precipitation.

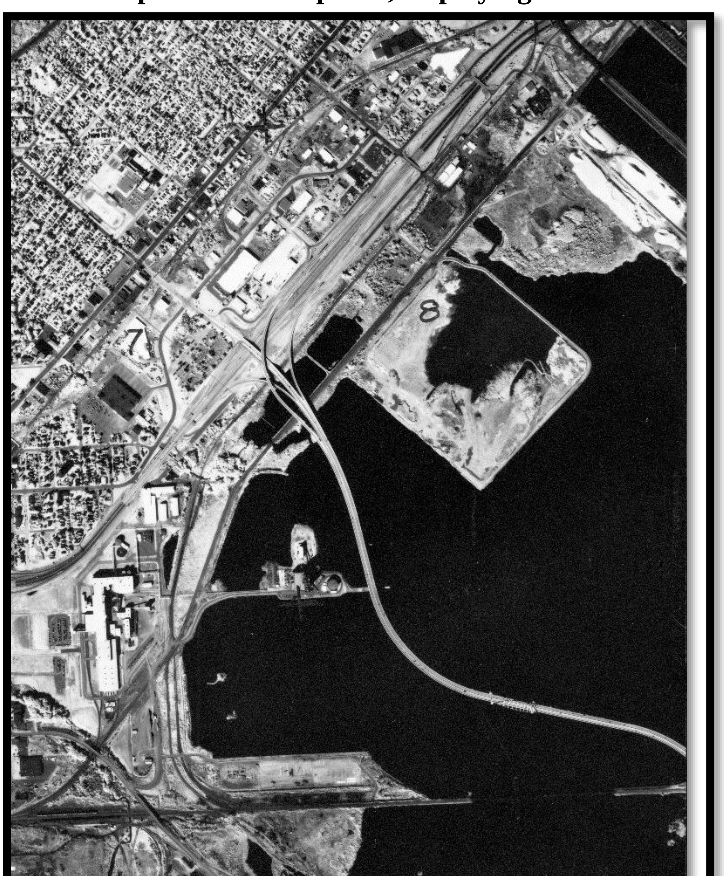
3. Landscape and Soils.

The 40th Avenue site is industrialized and lies along the Minnesota side of the St. Louis River Bay. While the site is located at the eastern edge of the North Shore Highlands Subsection of the Laurentian Mixed Forest Province, as described in accordance with the Minnesota Department of Natural Resources (DNR) Ecological Classification System, the immediate location of the 40th Avenue site has been impacted by a progression of human-induced changes through excavation and fill since prior to 1939, as evidenced in the following series of historic aerial photographs.

Photo 1: August, 1939 Aerial, showing the human influence underway at 40th Avenue

Photo 2: September 1972 Aerial

Photo 3: September 1989 photo, displaying much of the most recent configurations.



Native soils are developed from rocky, red tills of the Superior Lobe, however, due to the human-induced changes at the 40th Avenue site, a high percentage of the existing soils are mapped mainly as non-native Urban Land. Soils mapped within the project area are listed in the table below and are shown on Figure 2 in Appendix A.

Map Unit Symbol	**Map Unit Name (40th Ave)**	**Hydric Percent of Map Unit**
1020A	Bowstring and Fluvaquents, loamy, 0 to 2 percent slopes, frequently flooded	100%, flats on flood plains
1028A	Urban land-Udorthents-Aqents complex, 0 to 8 percent slopes	55%, Depressions on spits, depressions on shores, flats on spits, flats on shores
E8D	Amnicon-Fluvaquents, frequently flooded, complex, 0 to 18 percent slopes	50%, flats on flood plains
E18B	Urban Land-Cuttre-Rock outcrop complex, 0 to 8 percent slopes	15%, Flats on till plains, depressions on till plains

4. NWI and DNR Mapping.

The NWI mapped approximately 11.0 acres of wetlands within the project area, as shown on Figure 3. Field review determined that the north and southwest portions of the project area contain wetlands. , all identified on Figure 1.

5. Site Visit 14 October 2015.

Access was not granted for all locations within the AOI, as shown on Exhibit "A" in Appendix B, and even where permission was provided, physical access was not possible due to fencing and other access issues. Inaccessible areas were observed from as close as possible through fences, and decisions regarding the presence of wetlands within the 40th Avenue site were informed by the on-site data collection at the 21st Avenue and Kingsbury Bay sites. Precipitation during the three months antecedent to the site visit on 14 October 2015 was wetter than normal (see Appendix B).

6. Results and Discussion.

Wetland resources were identified and delineated within the project area as shown on Figure 1 – 40th Avenue Project Area, Figure 1a – 40th Avenue, North Part and Figure 1b – 40th Avenue, South Part. The resources were identified primarily using off-site review of all available aerial photography and LiDAR elevation data, and correlated using on-site data collection methods at similar nearby locations. The wetland resources are briefly described below:

Within the AOI of the 40th Avenue site, thirteen wetlands (Table 1) were identified between the ordinary high water of the St. Louis River and the areas of fill, consisting in type of shallow marsh and hardwood swamp.

The delineation was based on evidence of the changes in vegetation and topography between the wetland and upland areas. In much of the area, the filled land has steep slopes from upland fill (usually rock riprap along the edge) down to the St. Louis River with no wetlands along the landward edge. Dominant vegetation observed includes black willow (*Salix nigra*, OBL) and other willow species (*Salix spp.*), balsam poplar (*Populus balsamifera*, FACW), cattail species (*Typha spp*, OBL), Canada blue-joint (*Calamagrostis canadensis*, OBL), reedcanary grass (*Phalaris arundinacea*, FACW) with smooth brome (*Bromus inermus*, UPL) and bird's-foot trefoil (*Lotus corniculatus*, UPL) dominating the upland areas.

TABLE 1 40th Avenue Wetland Resources		
Wetland Name	**Type**	**Approximate Size in AOI (ac)**
Wetland 1	Shallow marsh and hardwood swamp	8.97
Wetland 2	Shallow marsh	2.79
Wetland 3	Shallow marsh	3.74
Wetland 4	Hardwood swamp	.98
Wetland 5	Shallow marsh	.02
Wetland 6	Shallow marsh	.26
Wetland 7	Shallow marsh	3.93
Wetland 8	Hardwood swamp	3.44
Wetland 9	Shallow marsh	1.87
Wetland 10	Shallow marsh	.14
Wetland 11	Hardwood swamp	2.91
Wetland 12	Hardwood swamp and shallow marsh	.50
Wetland 13	Hardwood swamp	1.82

Shallow marsh and hardwood swamp wetlands cited herein are based on the descriptions and key in Eggers and Reed (1997, 2011). Table 1 compares these plant communities with the classification systems Cowardin *et al*. (1979) and Circular 39, used for Wetland Conservation Act purposes.

TABLE 2 Comparison of Wetland Classification Systems		
Eggers and Reed (1997, 2011)	**Cowardin et al. (1979)**	**Circular 39**
Shallow Marsh	Palustrine; emergent; persistent and nonpersistent	Type 3: Inland shallow fresh marsh
Hardwood Swamp	Palustrine; forested; broad-leaved deciduous	Type 7: Wooded swamp

7. Conclusion.

Based on the procedures described above, a preponderance of evidence demonstrates the extent of wetland areas within the 40th Avenue St. Louis River RAP project area, as shown on Figures 1, 1a and 1b in Appendix A.

Corps of Engineers, St. Paul District Regulatory Branch Team for 40th Avenue delineation:

Barbara Walther, Senior Ecologist (PWS #1750, WDC #1052), Project Lead
Greg Larson, Senior Ecologist (PSS MN #30037; WI #82-112, and WDC #1140)
Leslie Day, Senior Ecologist/District Bank Coordinator
Paul Hauser, Project Manager

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Appendix A

Figures

- **Figure 1 – 40th Avenue Area of Investigation**
- **Figure 1a – 40th Avenue Wetlands, North Part**
- **Figure 1b – 40th Avenue Wetlands, South Part**
- **Figure 2 – 40th Avenue Soils**
- **Figure 3 – 40th Avenue NWI**

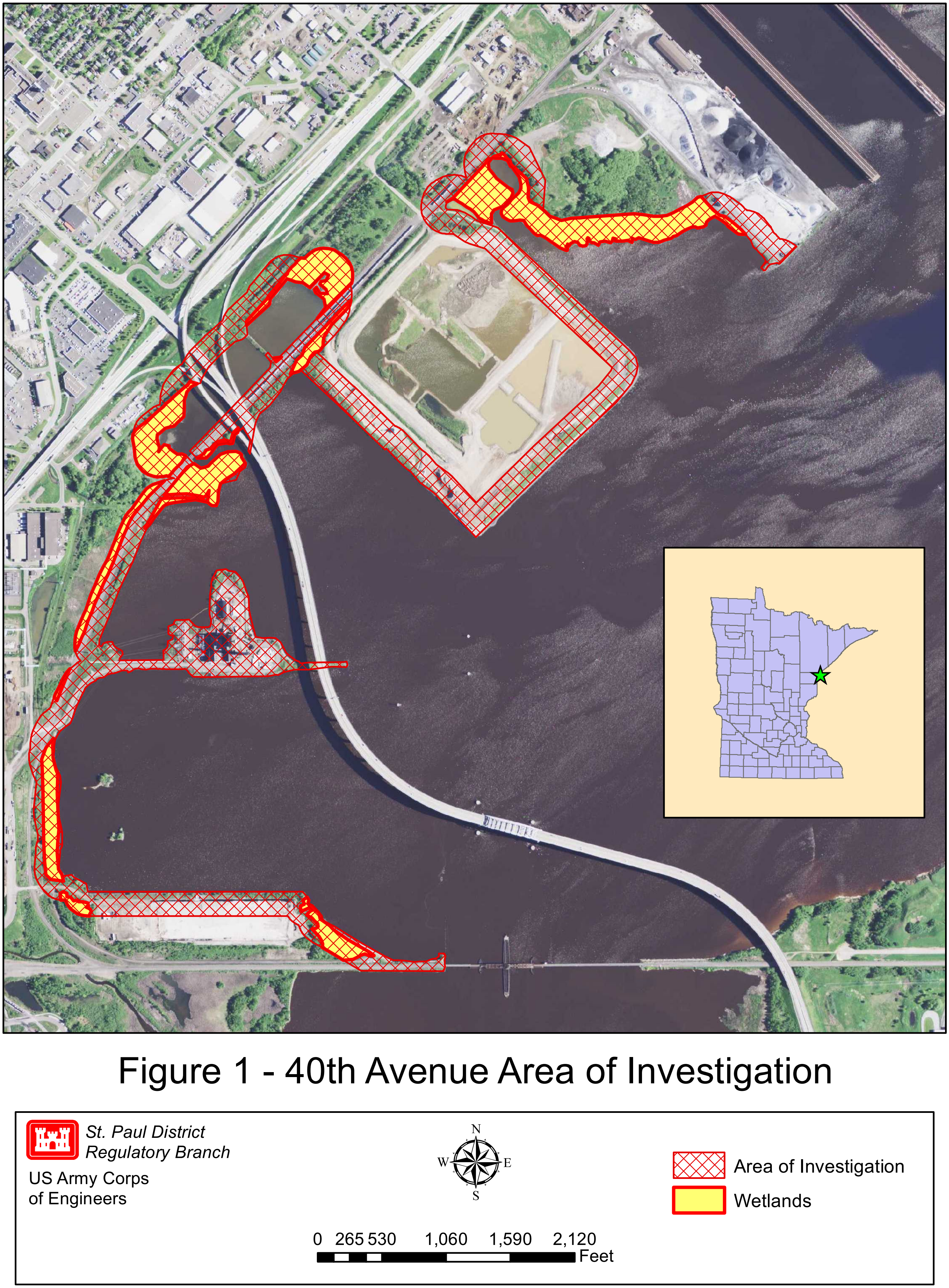


Figure 1 - 40th Avenue Area of Investigation

Figure 1a - 40th Avenue, North Part

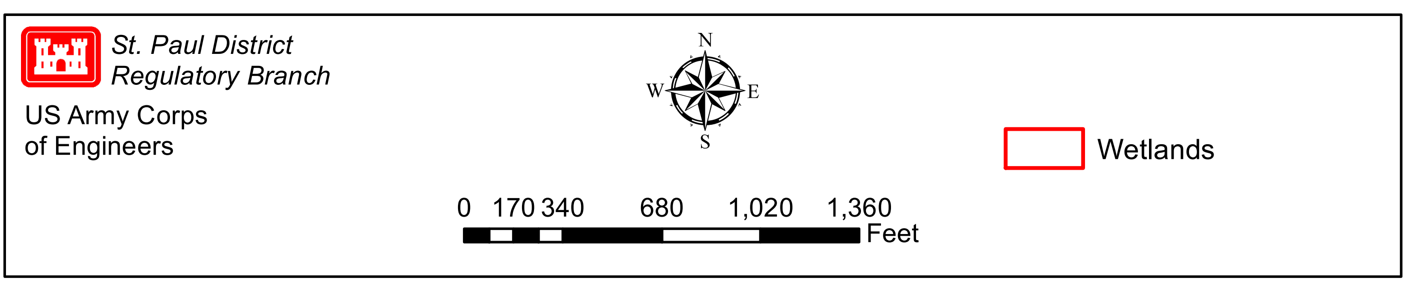
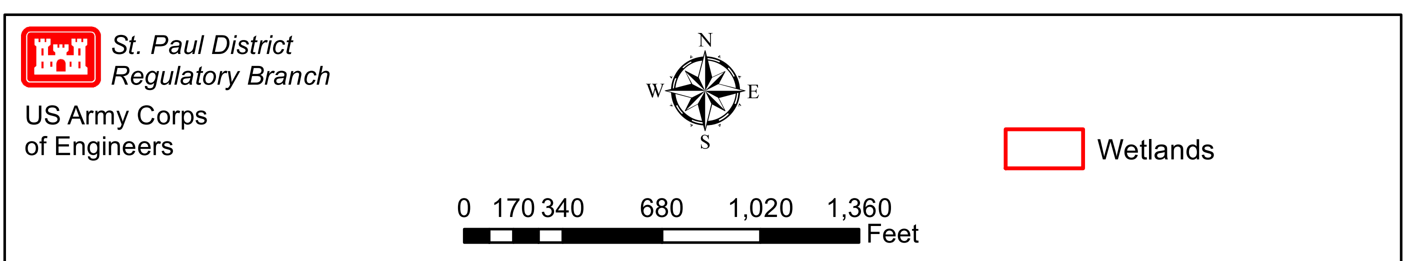


Figure 1b - 40th Avenue, South Part



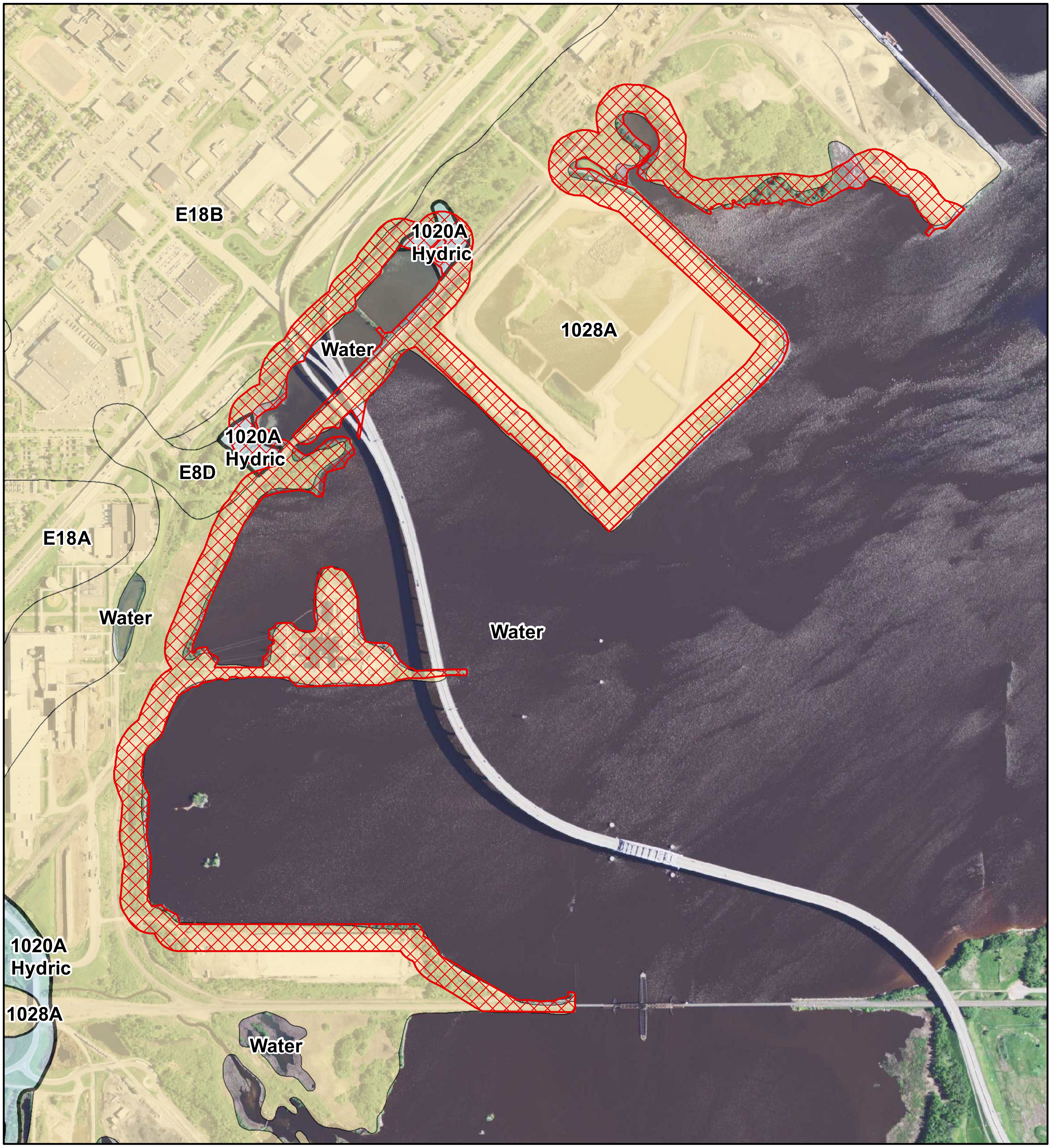


Figure 2 - 40th Avenue Soils

St. Paul District
Regulatory Branch
US Army Corps
of Engineers

N W E S

0 265 530 1,060 1,590 2,120 Feet

Area of Investigation

St Louis County Soils

Partially Hydric

Not Hydric

All Hydric

Figure 3 - 40th Avenue NWI

St. Paul District
Regulatory Branch

US Army Corps
of Engineers

N
W E
S

Area of Investigation

0 265 530 1,060 1,590 2,120
Feet

Appendix B

October 14, 2015 Site Visit Documentation

- **Exhibit "A" – Rights of Entry accessible areas**
- **Antecedent precipitation**

RAP St Louis River Parcels

U.S. Army Corps
of Engineers
Detroit District

Legend

Site_ID

- Signed ROE
- No Access

Location Map

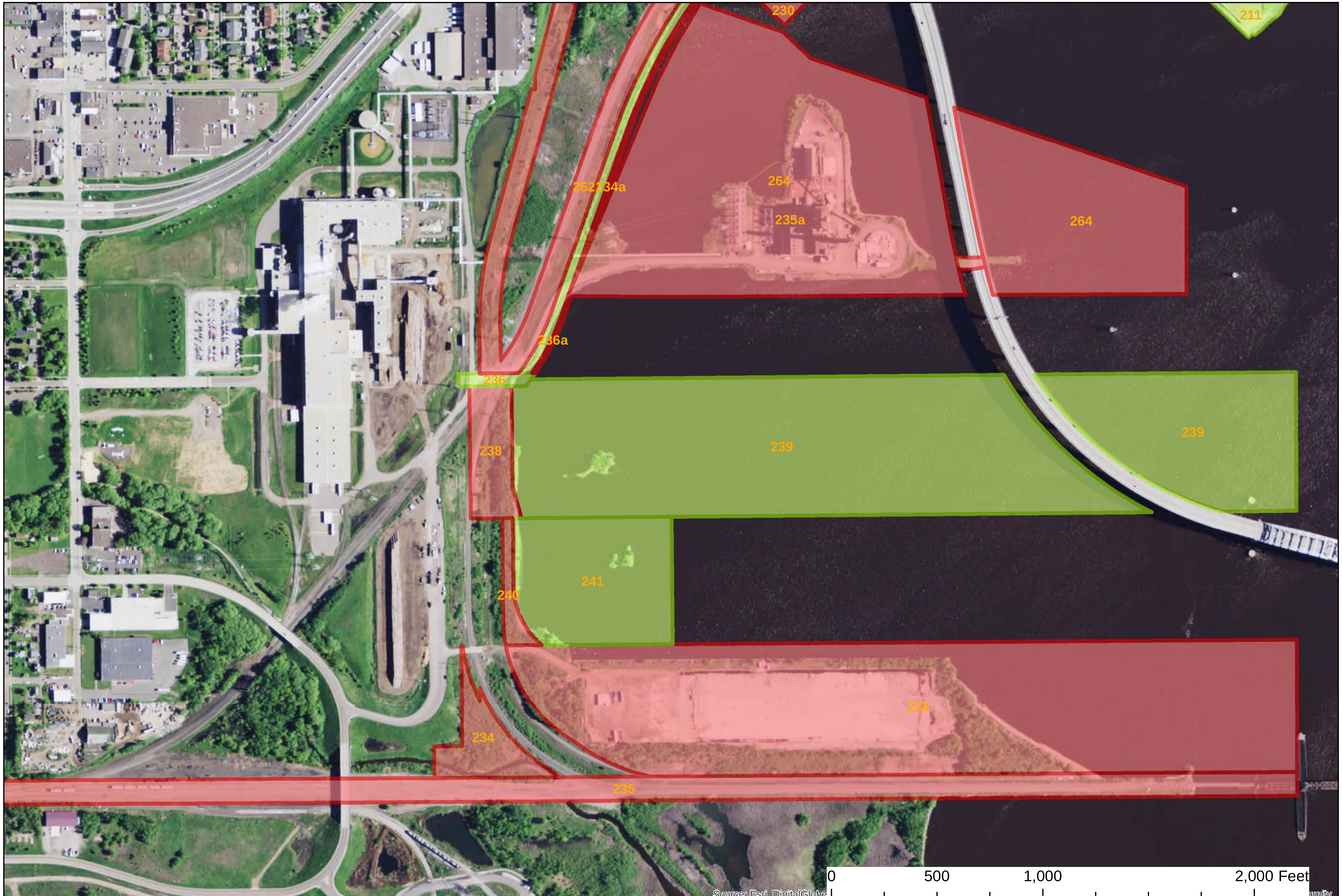
N
W E
S

DISCLAIMER - While the United States Army Corps of Engineers, (hereinafter referred to USACE) has made a reasonable effort to insure the accuracy of the maps and associated data, its should be explicitly noted that USACE makes no warranty, representation or guaranty, either express or implied, as to the content, sequence, accuracy, timeliness or completeness of any of the data provided herein. The USACE, its officers, agents, employees, or servants shall assume no liability of any nature for any errors, omissions, or inaccuracies in the information provided regardless of how caused. The USACE, its officers, agents, employees or servants shall assume no liability for any decisions made or actions taken or not taken by the user of the maps and associated data in reliance upon any information or data furnished here. By using these maps and associated data the user does so entirely at their own risk and explicitly acknowledges that he/she is aware of and agrees to be bound by this disclaimer and agrees not to present any claim or demand of any nature against the USACE, its officers, agents, employees or servants in any forum whatsoever for any damages of any nature whatsoever that may result from or may be caused in any way by the use of the maps and associated data.

Site - 2
Exhibit "A"
DACW35-9-15-______

RAP St Louis River Parcels

U.S. Army Corps
of Engineers
Detroit District



Legend

Site_ID

- Signed ROE
- No Access

Location Map

N
W E
S

Site - 2
Exhibit "A"
DACW35-9-15-______

Minnesota Climatology Working Group

State Climatology Office - DNR Division of Ecological and Water Resources University of Minnesota

home | current conditions | journal | past data | summaries | agriculture | other sites | contact us | search |

Precipitation Worksheet Using Gridded Database

Precipitation data for target wetland location:

county: **Saint Louis**
township name: **unnamed**
nearest community: **Missabe Junction**
township number: **50N**
range number: **14W**
section number: **31**

Aerial photograph or site visit date:
Wednesday, October 14, 2015

Score using 1971-2000 normal period

(values are in inches)	first prior month: **September 2015**	second prior month: **August 2015**	third prior month: **July 2015**
estimated precipitation total for this location:	**missing**	**4.69**	**3.27**
there is a 30% chance this location will have less than: *	2.75	2.92	2.62
there is a 30% chance this location will have more than: *	4.95	4.90	4.67
type of month: dry normal wet	[illegible]	**normal**	**normal**
monthly score	**missing**	**2 * 2 = 4**	**1 * 2 = 2**
multi-month score: 6 to 9 (dry) 10 to 14 (normal) 15 to 18 (wet)	**missing**		

Score using 1981-2010 normal period

(values are in inches)	first prior month: **September 2015**	second prior month: **August 2015**	third prior month: **July 2015**
estimated precipitation total for this location:	6.13	**4.69**	**3.27**
there is a 30% chance this location will have less than: *	2.95	2.60	2.52
there is a 30% chance this location will have more than: *	4.97	4.34	4.45
type of month: dry normal wet	WET	**wet**	**normal**
monthly score	3*3=9	**2 * 3 = 6**	**1 * 2 = 2**
multi-month score: 6 to 9 (dry) 10 to 14 (normal) 15 to 18 (wet)	17 (WET)		

(Using "Retrieve Daily Precipitation Data" to determine most recent data)

Appendix B

Technical Analysis

Five remedial alternatives involving monitoring and/or construction activities for the Ponds behind Erie Pier (the Site) were developed and evaluated as part of the Focused Feasibility Study (FFS) and include the following:

Alternative 2 – Monitored Natural Recovery and Institutional Controls;
Alternative 3 – Enhanced Monitored Natural Recovery;
Alternative 4 – Sediment Excavation, Consolidation in Upland Caps and Wetland Restoration;
Alternative 5 – Sediment Excavation, Offsite Disposal and Wetland Restoration; and,
Alternative 6 – Sediment Excavation, Offsite Disposal.

Class 4 rough order of magnitude (ROM) cost analyses (+50/-30) were developed for each of these alternatives and are summarized within **Section 3** of the FFS document. This Technical Analysis serves to provide the calculations and outline the assumptions used to compile each of the alternative cost analyses.

Cost estimates were compiled using a variety of sources. These sources include construction cost data from RS Means estimating software for open shop pricing in Duluth, Minnesota; current Bay West LLC (Bay West) and state contract rates for labor, equipment, and sample analysis; personal communication with vendors; historic cost data from projects similar in size and scope; other FFS documents, presentations, or technical papers that provided estimated or real construction cost data; and available online vendor pricing of materials.

The selection of construction equipment, production rates, remedial volumes, remedial action areas, and other “design-type” elements used as a starting point to develop alternative costs are based on a current understanding of Site conditions at this early feasibility study-level stage.

This document is divided into the following sections:

Section 1: Remedial Areas and Volumes
Section 2: Construction Equipment and Production Rates
Section 3: Staging Area
Section 4: Construction Implementation Assumptions
Section 5: Environmental Controls and Construction Monitoring
Section 6: Sediment Stabilization
Section 7: Transportation and Disposal
Section 8: Cover/Cap Materials
Section 9: References

The following tables were used to calculate values incorporated into each alternative cost analysis and are included within this Technical Analysis:

Appendix A Table 1: Volume, Rate, and Time Frame Calculations
Appendix A Table 2: Unit Rate Calculations
Appendix A Table 3: Lump Sum Costs
Appendix A Table 4: Monitoring and Evaluation Costs

Many of the assumptions used to compile the cost analyses for the alternatives are included within the tables. Those aspects of alternative development not readily apparent within the tables and the Site FFS text are described in the following sections.

Section 1: Remedial Areas and Volumes

Areas targeted for remedial action (remedial areas) include those with one or more contaminants of concern (COCs; cadmium, chromium, copper, dioxins/furans, lead, mercury, nickel, zinc, polynuclear aromatic hydrocarbons [PAHs], and polychlorinated biphenyls [PCBs]) exceeding their respective Midpoint Sediment Quality Target (SQT), also referred to as the preliminary cleanup levels (CULs). A conservative remedial area, as shown in the FFS **Figure 14**, was developed based on historical and the most recent 2015 sample results, bathymetric data, and professional judgement. Remedial areas total 14.4 acres in size.

The total volume of contaminated sediment at the Site was calculated by dividing the remedial area up into several dredge elevations based on bathymetry and COC depths, resulting in 64,000 cubic yards of in situ sediment contaminated with COCs (**Appendix B**, Table 1). Two important factors should be noted regarding the total volume of contaminated sediment calculation:

1. Overburden sediments (i.e., sediments with total COC concentrations less than the preliminary CUL but located above [vertically] sediments exceeding the preliminary CUL) were included within the calculation. Overburden sediments were included because overburden sediments would require consolidation/removal in order to reach contaminated sediments below. Additionally some clean sediment areas may likely be moved as part of the wetland restoration activities in Alternatives 4, 5, and 6.

2. The Shoppers Creek delta area has COC detections that extend to or exceed a depth of 1 meter; however, an average contaminated depth of 0.5 meter was used to balance the more expansive areas where contaminants have not been detected below 0.5 meter (FFS **Figure 4** through **Figure 13**) and/or have not been delineated such as the far northern reaches of the unnamed tributary or area adjacent to storm sewer outfall #2.

One reactive cover reagents, SediMite™, was selected for the Alternative 3 enhanced MNR approach. SediMite is an agglomerate comprises a treatment agent (typically activated carbon), a weighting agent (to enable it to sink and resist resuspension), and an inert binder. Activated carbon applied as a reactive cover through SediMite will be used to bind up pollutants and reduce uptake by aquatic plants and animals, thus mitigating the transfer of sediment contaminants through the food web. Activated carbons have been demonstrated to have strong affinities for bioaccumulative pollutants present at the Site such as PCBs, mercury, methylmercury (the most toxic form of mercury commonly found in fish tissue), dioxins/furans, and PAHs.

It was assumed that an 0.010 meter broadcast thin-layer cover of SediMite would be sufficient to achieve RAO s over the 14.4-acre Site, resulting in a requirement of approximately 743 cubic yards of amendments (**Appendix B**, Table 1). It is unknown how effective this reactive cover can be in addressing the complex suite of metals, PAH, PCBs, and dioxins/furans present in Site sediment or whether it would complement each other in achieving the removal action objectives (RAOs). Bench scale testing must be completed to establish whether this specific treatments or a combination of similar sediment cap amendments can effectively achieve the Site's RAOs.

It was assumed for Alternatives 4, 5, and 6 that following excavation, a 9-inch (0.22-meter) layer of clean cover would be placed over the 14.4-acre site to reconstruct the potential bioactive zone (PBAZ), resulting in a requirement of approximately 17,400 cubic yards of clean cover (**Appendix B**, Table 1). It is unknown whether the material currently underlying the contaminated sediment would provide a sufficient matrix for restoring the PBAZ and thereby reduce the amount of imported material required to restore the PBAZ.

Section 2: Construction Equipment and Production Rates

Unit rate calculations are presented in **Appendix B**, Table 2 and assumed lump sum costs are presented in **Appendix B**, Table 3. Excavation "in the dry" and the use of traditional mechanical equipment was assumed to be a more cost-effective approach for sediment excavation and cover/cap construction than using barge-mounted equipment "in the wet". Additionally, it was assumed that the upland area within the Site boundary adjacent to South 40th Avenue West was available for use as a staging area as discussed in **Section 3**.

Amended thin-layer cover and PBAZ replacement cover placement rates (432 yd^3/day) were based on production rates of a low ground pressure amphibious dump truck delivery, assuming the reagents or clean cover could be distributed across the frozen ponds and marshland during winter leaving the material to drop into place with the spring thaw (Alternative 3) or under dry conditions following the dewatering of the ponds (Alternatives 4, 5, and 6). The daily production rate for excavation activities (436 yd^3/day, Alternatives 4, 5, and 6) was based on the average Site travel distance from the staging area as well as the production rate achieved (450 yd^3/day) during a similar sediment excavation at the Universal Oil Product superfund site in East Rutherford, New Jersey (corresponded with Richard P. Traver, P.E., May 2, 2016).

Section 3: Staging Area

Satellite imagery and topography maps indicate that the northeast corner of the site contains uplands that could be used for the development of a staging area for remedial activities. The proposed staging area location would allow for direct access between the Site and South 40th Avenue West and avoid the proposed bike path corridor. The staging area that sits above an elevation of 606 feet above mean sea level (amsl) is approximately 5 acres. For the purposes of the cost analyses clearing and grubbing would be followed by Site leveling and the construction of the laydown areas. Construction of the staging area includes lined, bermed, and gravel-based water treatment, sediment dewatering/curing and truck wash-down areas, an amendment staging area, staging area water capture and management systems, high truck traffic lanes, fencing and site access gates. Power requirements and power availability were not fully established during the FFS development; however, it was assumed that a generator could provide the necessary electrical power for Alternative 3 (office trailer, lights) and that power would be brought to the Site for Alternatives 4, 5, and 6 (office trailer, lights, pond water pumping and water treatment systems). The final water treatment, sediment drying/treatment, truck wash-down, amendment storage and/or trailer layout and design of the staging area would be determined during the future remedial design work plan.

Section 4: Construction Implementation Assumptions

Alternatives with Thin-Layer Cover/Replacement of PBAZ Cover Elements

A general order of operations was assumed in order to facilitate costing of alternatives involving cap or PBAZ replacement cover elements. This order of operations was used to assist in selecting construction equipment, labor, production rates, timeframes, etc. The general order of operations for cap/cover placement is described below.

- Cap amendments (e.g. SediMite) or clean washed sand from a local upland borrow source meeting project specifications would be purchased and imported to the staging area via on-road dump trucks. The final selection of thin-layer cover amendments would likely be selected following bench scale testing. At a minimum, cover amendments, cover amendment feed stock, or clean cover sand would be dumped at the sand stockpile area at a volume equaling or exceeding the volume required for daily operations.
- Off road dump trucks would be loaded in the staging area for transport of the cover amendments or sand to its placement location within the remedial area. For the thin layer cover it is assumed that the cover will be broadcast throughout the site using stone slingers. The delivery of the PBAZ sand cover to the remedial area will take place under dry conditions during the normal construction season.

Alternatives with Excavation Elements

A sequence of events and methods for sediment excavation activities was assumed in order to facilitate costing of alternatives involving sediment excavation. The assumed method was used to assist in selecting construction equipment and labor required for implementation. The assumed sequence of events and method of excavation are described below.

Surface water diversion:

Initially the two ponds will be isolated from the five existing surface water inputs (FFS **Figure 3**) so that the ponds can be drained, and the proceeding sediment excavation activities can be conducted under dry conditions using traditional earth moving equipment.

- Sheet pile or earthen berms will be placed across the southwestern (1,300 ft) edge of the ponds to divert water from Shoppers Creek, Storm Sewer Outfall #1, and the outlet to the SLR (FFS **Figure 20**).
- Sheet pile or earthen berms will be placed across the northeastern (400 ft) edges of the ponds to divert water from the unnamed tributary and wetland area (FFS **Figure 20**).
- Flow control structures will be installed on the three major inputs (Shoppers Creek, sewer outfall #2, and the unnamed tributary) to capture any ongoing sediment deposits during the remedial construction activities (FFS **Figure 20**).
- A 1,900 feet long surface water diversion lined with rip-rap will be installed linking the western reach of the storm sewer outfall #2 drainage ditch to storm sewer outfall #1 and ultimately to Shoppers Creek. For the FFS it was assumed that a 6 feet deep by 24 feet wide open water culvert (**Appendix B**, Table 1) would be sufficient to handle the peak flow of the non-Shoppers Creek surface water. Based on the USGS StreamStats it is anticipated that the three non-Shoppers Creek inputs provides approximately 30% of the total surface water flow to the ponds.

Shoppers Creek will be routed directly to the SLR and will bypass the ponds.

Pond water removal and treatment:

Prior to excavation activities the pond water at the site will be drained and the last 30% of the pond water is assumed to require treatment to address potential suspended sediments/COCs. Following the pond water evacuation, infiltrating groundwater, precipitation accumulated within the excavation, and truck wash-down water will also be collected in sumps to be pumped to and processed by the water treatment system in the staging area. The following describes assumptions regarding dewatering activities:

- Assuming an open water pond area of 13.7 acres and an average depth of 1.8 feet, just over 8 million gallons of pond water would need to be drained. It was assumed that the first 70% (5.6 million gallons) of the pond water could be pumped out at a rate of 1,000 gpm and delivered directly to the SLR without treatment. The first 70% of the pond water could be drained over a 4 day, 24-hours per day pumping effort. It should be noted that seasonal water level fluctuations could make a significant difference in water depth and therefore the volume of pond water that would require pumping.
- The final 5% (400,000 gallons) of the pond water may contain varying levels of suspended sediment and therefore water treatment would be required prior to release to the SLR via a National Pollutant Discharge Elimination System (NPDES) permit or discharged to the local publicly owned treatment works (POTW), Western Lake Superior Sanitary District (WLSSD) system. Treating pond water at a rate of 300 gpm over 10-hour work days, the last 5% of the pond water could be drained over a 3-day pumping effort.
- The water treatment system will consist of a series of settling frac tanks, coagulant mix tanks, clarifier tanks, and a series of sand, organoclay, and GAC filter tanks constructed in the staging area. This system of water treatment was used at the Universal Oil Products superfund site sediment excavation project in east Rutherford New Jersey (http://www.sevenson.com/index.php/project-summaries/universal-oil-products-superfund-site-streamlands-remediation/). Final design of the water treatment system and water disposal requirements and procedures will be determined during the future remedial design work plan.
- Once the pond water was drained, sumps will be installed to collect precipitation and groundwater intrusion as needed to maintain safe optimal working conditions for the sediment excavation and following wetland restoration activities. Monthly operating expenses were assumed following the pond water treatment for the duration of the anticipated remedial activities. The final number, size and water treatment system connections of the sumps will be determined during the future remedial design work plan.
- Treatment of staging and excavation area water during excavation activities would occur on a batch basis over a 10-hour work day.
- The cost analysis for treatment of pond and process water includes rental rates for equipment, costs for procuring media and filters, disposal costs of media and filters, and labor. Costs were obtained from a contractor quote provided for a different project but relevant to the scale of dredging activities evaluated for the Site.

Sediment Excavation

A general order of operations was assumed in order to facilitate the sediment excavation for Alternatives 4, 5, and 6. This order of operations was used to assist in selecting construction equipment, labor, production rates, time frames, etc. The general order of operations for the excavation activities alternative is described below.

- Bull dozers and excavators would be used to collect and consolidate the COC-impacted sediment for loading in off road low ground pressure dump trucks.

- A gravel-based truck lane and or swamp mats will be used to provide efficient truck traffic the length of the ponds into and out of the sediment excavation area. The FFS assumed that it was approximately 2,800 feet from the staging area to the furthest point within the sediment excavation area.
- The off-road dump truck will deliver the sediment to the slack drying cells in the staging area where the sediment will be treatment with Portland cement (15% by weight) and allowed to dewater and cure.
- Cured sediment will be either delivered back to the excavation area upon the dump trucks return trip or loaded into on road dump trucks for transport to a permitted off-site land fill facility (Vonco V Waste Management Campus located at 1100 West Gary Street in Duluth, Minnesota).
- Tree trunks, boulders and other natural debris will be collected and staged within the excavation areas to be used during the wetland restoration efforts. Non-native debris (e.g. tires, plastic bottles, cans) will be removed from the site along with the contaminated sediment and stored in the staging for off-site disposal along with other consumables (i.e. water treatment bag filters).

The methods outlined above were incorporated into the cost analysis and are assumed appropriate for the volume of material to be handled. Other methods or requirements for the surface water diversion, pond and sump water treatment and discharge, and sediments handling, treatment, and disposal would be further evaluated and specified during the project design or project bidding phase.

Section 5: Environmental Controls and Construction Monitoring

Environmental controls and construction monitoring are important elements in mitigating environmental impacts occurring as a direct result from construction activities and also in ensuring remedial/construction goals are achieved. The monitoring and evaluation costs are detailed in **Appendix B**, Table 4. Environmental controls can include surface water control structures (e.g., silt curtains, sheet piling, and absorbent boom), lined sediment dewatering pads, tire washes, stormwater controls, and site fencing (for protection of human health). Construction monitoring can include turbidity monitoring during thin-layer capping activities, air monitoring during intrusive site activities, treated pond water sampling, post-excavation verification sampling, cap thickness verification coring, bathymetric surveys, imported materials sampling, dewatered sediment sampling, and collection of pre- and post-construction upland soil samples within the staging area footprint.

For the purposes of this FFS, it was assumed that consisting of a thin-layer cover (Alternative 3) or post excavation PBAZ replacement cover placement (Alternatives 4, 5, and 6) would incorporate the following control and monitoring elements:

- Fencing at the staging area;
- Chemical and physical sampling of imported cap/cover materials to ensure that they are suitable for use; and
- Cap/cover thickness verification coring and bathymetric surveys to ensure that cap specifications are achieved.

Excavation of sediments for Alternatives 4, 5, and 6 would require controls and monitoring as listed above for PBAZ cover replacement and in addition:

- Staging area stormwater and process water controls;
- Lined and bermed sediment drying cell, truck wash, and water treatment areas;
- Excavation site surface/ground water sumps and controls;
- Post-excavation verification sampling;
- Dewatered and treated sediment sampling; and
- Treated water sampling.

<u>Section 6: Sediment Stabilization</u>

Sediments excavated from the Site are expected to contain interstitial water making them unsuitable for direct transportation to an off-site landfill and/or use as the base of the proposed upland caps. Therefore, excavated sediments would require dewatering/stabilization in order for them to pass the paint filter test (i.e., essentially no free water) and make them suitable for off-site transportation/disposal and on-site wetland restoration. The dewatering/stabilization process would rely upon the addition of amendments to the sediments, along with gravity draining of interstitial water within bermed and lined slack drying and curing cells located within the staging area.

The staging area sediment drying/treatment cells would be constructed prior to commencement of dredging activities. The drying/treatment cells would be a primary feature of the sediment staging area and must be large enough so that four operations could be conducted on the pad at once. These operations include:

- Offloading untreated sediments from the dump trucks and placing them into the drying cells with end loader or dozer;
- Mixing the sediments with dewatering/stabilization amendments such as Portland Cement within the drying cells;
- Curing of the amended sediments for several days within the drying cells as necessary to attain adequate cohesiveness; and
- loadout of dewatered sediments into on-road dump trucks for off-site disposal or off-road dump trucks for their return to the excavation area for on-site disposal.

The constructed pad would be lined, bermed and covered with gravel to contain contaminated sediments and to facilitate gravity draining of interstitial water and precipitation falling onto the pad into a drying cell sumps. Sediment water collected in the sump would be pumped to the water treatment system frac tanks (i.e., equalization tanks) and treated. Construction of twelve 145 feet by 45 feet drying cells for a total area of approximately 2 acres was incorporated into the cost analysis of the dredging alternative. Each drying cells would be sized to contain one day's worth of excavated sediment (~432 yd^3) and enough working room to conduct the amendment mixing. Multiple cells are required to allow for the sediment to cure within the cell for up to 10 days and be tested for transport qualifications prior to be up load onto dump trucks for disposal.

The dewatering/stabilization process would incorporate the use of binders (i.e., amendments) that generate a cementitious reaction with the available water and solid matrix of the excavated sediments. Common amendments for sediment dewatering/stabilization include Portland cement, fly ash, lime cement, and lime kiln dusts. These amendments are powdered materials that require enclosed transport and storage systems to reduce dust migration and premature hydration. Some materials, such as fly ash, may be available locally at a substantially reduced cost relative to Portland cement. For the purposes of this FFS it was assumed that solidification with 15% Portland cement by volume would be conducted. Pilot scale or treatability studies should be conducted during the design phase to identify desirable amendment materials and amendment rates.

Section 7: Transportation and Disposal

Transportation costs for sediment disposal were estimated on a per ton basis using truck rental and operator rate data obtained from RS Means cost estimating software. It was assumed that each truck would carry 12 tons or 16 cubic yards (1.4 tons per cubic yard) and would complete one round trip per hour and seven round trips per day. Correspondence with local landfill and sand and gravel companies indicate that transportation costs could be less than the $13.90 per cubic yard or $9.93 per ton estimated rate, but the estimated rate was retained within the cost estimates to provide a conservative scenario.

Disposal costs were obtained for the Vonco V Waste Management Campus (obtained during compilation of the Minnesota Slip Feasibility Study) located at 1100 West Gary Street in Duluth, Minnesota (approximately 12 miles west of the Site) and Shamrock Environmental Landfill located at 761 Highway 45 in Cloquet, Minnesota (approximately 20 miles west of the Site). Costs for these two disposal facilities were comparable for the purposes of this FFS, at $12 per ton and $16 per ton (not including environmental fees and taxes) respectively. The Vonco V landfill was used for the cost analysis due to its closer proximity to the Site.

The final volume of sediments requiring disposal will be a result of in situ volume, bulking of sediments as they are excavated and handled, and the addition of stabilizing agents during the dewatering process minus water volume lost during the treatment process. For the purposes of this FFS, sediment bulking and amendment addition was assumed to result in a 1.25 final sediment expansion This equates to a total dewatered sediment volume of approximately 80,000 cubic yards. An average density of 1.4 tons per cubic yard was assumed for dredged and stabilized sediment, resulting in a total disposal quantity of 112,000 tons.

Section 8: Cover/Cap Materials

Potential sources of cover/cap materials include materials from an upland borrow location (e.g., sand and gravel pit), sediments previously dredged for navigational purposes, and common earth upland soil. Natural materials such as dredged sediments and common earth upland soils often contain fine-grained components which make placement more difficult (ITRC, 2014). It was assumed for the purposes of the cost analyses that upland borrow materials would be used; however, the use of previously dredged materials from the Erie Pier CDF facility should be evaluated during the project design or project bidding phase.

Upland borrow material consisting of clean, washed sand was assumed for alternatives incorporating sand cover or cap elements. The exact grain size specifications would be developed during the design phase but would likely consist of medium to coarse grain sands that would withstand mild erosive forces in the slip. Cobble obtained from an upland borrow location was also assumed for alternatives requiring cap armor.

For the Alternatives 4, 5, and 6 PBAZ sand cover replacement, it was assumed that sand will be purchased from an upland borrow location and loaded into trucks at a rate of $6.90 per CY based on pricing procured from a local supplier. Rip rap or cobbles used as armor over cap materials was estimated at $30.38 per cubic yard based on available online pricing.

Assumptions used for importing materials to the site were the same as those for transportation and disposal of dewatered sediments, as described in **Section 7**.

Section 9: References

USEPA, 2005. "Contaminated Sediment Remediation Guidance for Hazardous Waste Sites."

Interstate Technology and Regulatory Council (ITRC) Contaminated Sediments Team, 2014. "Contaminated Sediments Remediation – Remedy Selection for Contaminated Sediments," August.

Dirk Pohlmann with Bay West corresponded with Richard P. Traver, P.E. formerly with CH2M-Hill. Mr. Traver was the Non-time Critical Removal Action Project Engineer of Record, for the Universal Oil Products (UOP) Superfund site at the time of the UOP project design and execution. The May 2, 2016 and follow up conversations covered the sediment handling and treatment processes used during the UOP sediment excavation project as well as the lessons learned.

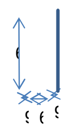
Appendix B: Table 1
Volume, Rate, and Timeframe Calculations
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Remedial Areas			
Total Remedial Area			
Total vegetated wetland areas for remediation (acres)	0.75	901,600	
Total open water wetland areas for remediation (acres)	13.64	594,000	
Total wetland remedial area (acres)	14.39		
Contaminated Sediment Excavation Volumes			
Volume of contaminated sediment removed to 539 amsl (cubic yards)	63,931		
Excavation Volume - Alternative 4: Excavate, Consolidate, Upland Cap & Wetland Restoration			
Excavation volume (cubic yards)	63,931		
Over-Excavate depth (feet)	0	0.00	(meter)
Over-Excavate volume (cubic yards)	0		
Total Excavation volume (cubic yards)	63,931		
Total Excavation volume (tons)	89,504	1.4	ton per CY
Excavation Volume - Alternative 5 and 6: Excavate, Offsite Disposal &/or Wetland Restoration			
Total wetland area (acres)	14.4		
Over-Excavate depth (feet)	0		
Excavation volume (cubic yards)	63,931		
Total Excavation volume (tons)	89,504	1.4	ton per CY
Amendment/Cover Volumes			
Alternative 3: Enhanced MNR with Broadcasted Amendment			
Amendment in cubic yards			
Application areas (acres)	14.39		
Amendment thickness required per acre (inches)	0.38	0.010	(meter)
Amendment required (cubic yards)	743		
Amendment in tons			
Contaminated areas (acres)	14.39		
Amendment tons per acre	31		metric tons
Amendment required (tons)	446		
Sedimite dry bulk density (pounds per cubic foot)	45		
Sedimite required based on dry bulk density (cubic yards)	734		

Alternative 4: Excavate, Consolidate, Upland Cap & Wetland Restoration			
Vegetated Wetland areas (acres)	0.8		
Dredge residual thickness (feet)	0.75		
Sand required (cubic yards)	908		
Open water wetland areas (acres)	13.64		
Dredge residual thickness (feet)	0.75		
Sand required (cubic yards)	16,504		
Total amount of clean cover sand required for Alternative 4 (cubic yards)	17,412		
Alternative 5 and 6: Excavate, Offsite Disposal &/or Wetland Restoration			
Vegetated Wetland areas (acres)	0.8	From Alternative #4	
Cover thickness (feet)	0.75	From Alternative #4	
Sand required (cubic yards)	908	From Alternative #4	
Total materials required (cubic yards)	908		
Open water areas (acres)	13.64	From Alternative #4	
Sand layer thickness (feet)	0.75	From Alternative #4	
Sand required (cubic yards)	16,504	From Alternative #4	
Total amount of sand required for Alternative 5 and 6 (cubic yards)	17,412		

Surface Water Diversion Volumes and Area

Surface Water Diversion			
Cross sectional area	90	sq. ft.	
surface area	28	ft.	
length	1,900	ft.	
Ditch excavation	6,967	yd^3	
Rip-Rap surficial area	5,834	yd^2	



Slack Drying cells (12 planned)

Surface Water Diversion			
Width	45	ft.	
Length	140	ft.	
Surficial area	6,300	ft2	
area for 12 drying cells	75,600	ft2	
	2	Acre	

Production Rates

Amphibious Dump Truck Production Rate (Amendment Placement in Wetland Areas - Alternatives #4, #5, and #6)			
Cycle Time			
Average round trip travel distance (miles)	0.27		
Average speed (miles per hour)	4		
Travel time (hours)	0.0675		
Truck capacity (cubic yards)	6		
Application time per cubic yard placed (minutes)	2	0.03	hours
Application time per load (minutes)	24	0.40	hours
Load time (minutes)	5	0.08	hours
Total cycle time (hours)	0.55		
Production Rate			
Active placement time per day (hours)	10		
Number of cycles per day per truck	18		
Number of trucks	4		
Total production per day (cubic yards)	432		

Stone Slinger Barge Production Rate (Broadcasted Amendment in Open Water Areas) - Alternative #3		
Cycle Time		
Hopper capacity (cubic yards)	12	
Application time per cubic yard placed (minutes)	6	
Application time per load (minutes)	72	1.2 hours
Load time (minutes)	5	0.083 hours
Add in time for travel (minutes)	5	0.08 hours
Total cycle time (hours)	1.37	
Production Rate		
Active placement time per day (hours)	11	
Number of cycles per day per barge	8	
Number of barges	2	
Total volume of amendment applied per day (cubic yards)	192	
Excavation Production Rate		
Bucket size (cubic yards)	3.0	
Percent fill	80	
Sediment per bucket (cubic yards)	2.4	
Minutes per cycle	3.3	
Active excavation duration per day (hours)	10.0	
Daily production (cubic yards)	436	

Construction Timeframe		
Alternative 3: Enhanced MNR with Broadcasted Amendment		
Construct staging area and mobilize/setup equipment (days)	21	assume a 2 acre site
Place amendment in all areas (days)	45	
Breakdown equipment/demobilize and site restoration (days)	7	
Total time on-site (days)	73	15 weeks
Alternative 4: Excavate, Consolidate, Upland Cap & Wetland Restoration		
Construction Season #1		
Construct staging area and mobilize/setup equipment (days)	42	
Construct pond cutoff/dig surface water diversion (days)	28	concurrent with staging are construction
Install surface water control structures	28	concurrent with staging are construction
Dewater ponds (days)	22	14.4 acres, 2.34 ft. average depth (updated on 12/6/17), assume no treat 1k gpm for 1st 70%, last 30% pumped at 500 gpm 10 hours a day
Excavation sediments (days)	73.5	Assumes 5 days per week
	138	28 weeks
Construction Season #2		
Construct up land caps and place clean sand cover (days)	40	Sand cover and sediment excavation conducted concurrently
Plant wetlands, restore surface water flow (days)	21	
Breakdown equipment/demob and site restoration (days)	21	
	82.3	16 weeks
Alternative 5 and 6: Excavate, Offsite Disposal &/or Wetland Restoration		
Construction Season #1		
Construct staging area and mobilize/setup equipment (days)	42	
Construct pond cutoff/dig surface water diversion (days)	28	concurrent with staging are construction
Install surface water control structures	28	concurrent with staging are construction
Dewater ponds (days)	22	14.4 acres, 1.8 ft. average depth, assume no treat 1k gpm for 1st 70%, last 30% pumped at 500 gpm 10 hours a day
Excavation sediments in open water areas (days)	74	Assumes 24 hours per day, 5 days per week; Conducted concurrently with wetland work
Place Erie pier cover in wetland areas (days)	3	Conducted concurrently with excavation
Place sand cover in open water areas (days)	38	
Breakdown equipment/demob and site restoration (days)	10	
	145	29 weeks
Construction Season #2		29 weeks
essentialy same as Alt 4		16 weeks
		4 weeks
		45 weeks
		33 weeks

Appendix B: Table 2
Unit Rate Calculations
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Surface Broadcast Amendment Material across site (Alt. 3 Only)					
Description	ıdment Materia	Unit Cost	Quantity	Extended	Comments
Equipment					
Generator	Day	5.00	1	$5.00	
Skid steer	Day	366.00	1	$366.00	Consolidate materials in material staging area
Excavator/frontend loader	Day	580.00	1	$580.00	Loads dump mounted hopper
Stone slinger and hopper	Day	508.00	1	$508.00	12 cubic yard capacity hopper
Dump truck	Day	883.00	2	$1,766.00	2 Carries hopper and stone slinger, two for amendment from staging a
Pickup trucks	Day	97.00	2	$194.00	Site supervisor, foreman, mechanic
			SUBTOTAL	$3,414.00	
Labor					
On-site project management	Day	1200.00	1	$1,200.00	
Foreman	Day	854.00	1	$854.00	
Excavator/frontend loader	Day	1106.00	1	$1,106.00	
Stone slinger operators	Day	1036.00	1	$1,036.00	
dump truck operator	Day	1036.00	2	$2,072.00	
Lodging and Per-Diem	Day	146.00	6	$876.00	
			SUBTOTAL	$7,144.00	
			TOTAL	$10,558.00	
			DAILY PRODUCTION (CY)	192.00	
			UNIT RATE (CY)	$54.99	

Description	Unit	Unit Cost	Quantity	Extended	Comments
Excavate Sediments (Alt 4, Alt 5, and Alt 6)					
Equipment					
Excavator (2)	Day	$1,265.00	2	$2,530.00	2 on both ends of the work
Dozer	Day	$1,265.00	2	$2,530.00	to feed sediment excavators
Amphibious dump trucks (2)	Day	$1,445.00	2	$2,890.00	to move sediments to staging areas
Pickup Trucks	Day	$97.00	3	$291	Site supervisor, foreman, mechanic
			SUBTOTAL	$8,241	
Labor					Assumes 12 hour day with overtime
On-site project management	Day	$1,200.00	1	$1,200	
Foreman	Day	$854.00	1	$854	
Mechanic	Day	$980.00	1	$980	
Excavator operator	Day	$1,106.00	2	$2,212.00	
Dump truck	Day	$1,036.00	2	$2,072.00	for work in staging area
Dozer operator	Day	$1,036.00	2	$2,072	
Amphibious dump truck operators	Day	$1,106.00	4	$4,424.00	
Lodging and Per-Diem	Day	$146.00	13	$1,898	
			SUBTOTAL	$15,712	
			TOTAL	$23,953	
			DAILY PRODUCTION (CY)	436.36	
			UNIT RATE (CY)	$54.89	
Dewatered/Cure Sediment w/ Portland cement (Alt 4, Alt 5, and Alt 6)					
Excavate drying cell (12-hour day)					
2 CY Excavator (x2)	Day	$1,265.00	1	$1,265.00	
Water Truck	Day	$861.00	1	$861.00	
Telehandler	Day	$305.85	1	$305.85	
Operator (x2)	Day	$1,036.00	3	$3,108.00	
Add in lodging and per-diem for 4 man crew	Day	$146.00	4	$584.00	
			TOTAL	$6,123.85	
			DAILY PRODUCTION (CY)	1500	Limited by load time
			UNIT RATE (CY)	$4.08	
Sediment Hauling and Landfill Disposal (Alt 5, and Alt 6)					
Transport sediments to landfill	Ton	$4.93	1	$4.93	
Dispose of sediments at landfill					Vonco V Landfill in Duluth
Disposal	Ton	$12.00	1	$12.00	
Environmental Fee	Ton	$0.27	1	$0.27	
Industrial Solid Waste Tax	Ton	$0.46	1	$0.46	
			UNIT RATE (TON)	$17.66	
Purchase and Import Sand					
Purchase sand from upland borrow source	CY	$6.90	1	$6.90	
Import sand to staging area	CY	$13.90	1	$13.90	40 mile cycle; 15 minute wait
			UNIT RATE (CY)	$20.80	

Appendix B: Table 2
Unit Rate Calculations
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Construction Quality Assurance and Oversight (Alt 3, Alt 4, Alt 5, and Alt 6)					
Description	Unit	Unit Cost	Quantity	Extended	Comments
QA/QC and federal oversight personnel	Week	$10,200.00	1	$10,200	Two staff
Lodging and per-diem	Week	$1,460.00	1	$1,460	Two staff
Truck and mileage	Week	$1,142.00	1	$1,142	Includes mileage
			UNIT RATE (WEEK)	$12,802	

Monthly Operating Expenses and Site Security (Alt 3, Alt 4, Alt 5, and Alt 6)					
Description	Unit	Unit Cost	Quantity	Extended	Comments
Field Offices					
Office trailers and storage boxes (3)	Month	$942.00	1	$942	Includes utilities, equipment, and supplies for three units
Utilities	Month	$400.00	7	$2,800	Guessimate, used longest first year construction season
Water treatment plant supplies	Month	$12,860.00	1	$12,860	Incudes O&M, bag filters & drums for filter disposal
Security Guard	Month	$17,280.00	1	$17,280.00	$40 per hour; 108 hours per week
			UNIT RATE (MONTH)	$34,000	Rounded

Appendix B: Table 3
Lump Sum Costs
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Lump Sum Costs - Alternative 1: No Action

No lump sum costs associated with Alternative 1.

Lump Sum Costs - Alternative 2: MNR

Description	Unit	Unit Cost	Quantity	Extended	Comments
Mobilization/Demobilization					
Pickup trucks (1)	Mile	$0.56	620	$347	To staging area; 250 miles each way
Push boats (2)	Each	$1,914.00	1	$1,914	To staging area; 1 load
			TOTAL	$2,000	Rounded

Lump Sum Costs - Alternative 3: Enhanced MNR with Broadcasted Amendment

Description	Unit	Unit Cost	Quantity	Extended	Comments
Mobilization/Demobilization					
Office trailers (3) and connex boxes to staging area	Mile	$12.26	240	$2,942	To staging area; within 20 miles of site
Telehandler	Each	$1,914.00	1	$1,914	To staging area; within 20 miles of site
Hopper/conveyor	Each	$1,914.00	2	$3,828	To staging area; within 20 miles of site
Excavator	Each	$1,914.00	4	$7,656	To staging area; within 20 miles of site
Dump truck	Each	$1,914.00	2	$3,828	To staging area; within 20 miles of site
Stone slinger and hoppers	Each	$1,914.00	1	$1,914	To staging area; 1 load
Additional mileage for non-local equipment	Mile	$2.52	1250	$3,150.00	Assume 5 loads non-local; 250 miles away
Diesel Generator, 250 kW	Day	82.84	73	$6,047	Provides site trailer power as needed
Equipment setup and breakdown	Day	$10,000.00	6	$60,000	Setup/breakdown equipment; 3 days each
			TOTAL	$92,000	Rounded
Purchase amendment material					
Sedimite activated carbon	Ton	$4,000.00	446	$1,784,360.00	Cost is material delivered
				$1,784,000	Rounded
Staging Area Construction					
Site supervision during site work	Day	$135.00	42	$5,670	Assume 10 days during haul road and pad construction
Clear and grub staging area	Acre	$10,489	4	$41,956	
Construct laydown areas	SY	$11.20	19,360	$216,832	4-inch crushed concrete; assume 5 acres
Install 40-mil VLDPE Liner	SF	$0.60	90,720	$54,432	2007 ASTM presentation on landfill construction costs
Install haul roads within ponds, 2800' by 20'	SY	$13.10	6,222	$81,508.20	
Install staging area fencing	LF	$5.39	1500	$8,085.00	Install fencing around staging area perimeter
			TOTAL	$403,000	Rounded

Appendix B: Table 3
Lump Sum Costs
Focused Feasibility Study
Ponds behind Erie Pier
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Lump Sum Costs - Alternative 4: Excavate, Consolidate, Upland Cap & Wetland Restoration					
Description	Unit	Unit Cost	Quantity	Extended	Comments
Mobilization/Demobilization					
Office trailers (3) and connex boxes to staging area	Mile	$12.26	240	$2,942	To staging area; within 20 miles of site
Telehandler	Each	$1,914.00	1	$1,914	To staging area; within 20 miles of site
Hopper/conveyor	Each	$3,828.00	2	$7,656	To staging area; within 20 miles of site
Excavator	Each	$7,656.00	4	$30,624	To staging area; within 20 miles of site
Dump truck	Each	$3,828.00	2	$7,656	To staging area; within 20 miles of site
Amphibious dump trucks	Each	$11,184.00	2	$22,368	To staging area; assumed double cost for wide load and chase vehicles
Water treatment system mobe	Each	$71,375.00	1	$71,375	To staging area
HDPE pipe	Each	$1,914.00	1	$1,914	To staging area
			TOTAL	$146,000	Rounded
Staging Area Construction					
Site supervision during site work	Day	$2,540.00	42	$106,680	Assume 10 days during haul road and pad construction
Clear and grub staging area	Acre	$10,489	5	$52,445	
Construct laydown areas	SY	$11.20	24,200	$271,040	4-inch crushed concrete; assume 5 acres
Install 40-mil VLDPE Liner	SF	$0.60	87120	$52,272	2007 ASTM presentation on landfill construction costs
Construct haul roads	SY	$13.10	6,222	$81,508	8-inch crushed concrete; assume 2800 feet of road at 20 feet wide
Construct site fencing	LF	$5.39	1,855	$9,998	Surrounding 5 acre area
			TOTAL	$574,000	Rounded
Site Work Year 1					
Excavate Surface water diversion	SY	$17.20	6,967	$119,827	1,900 ft. by 90 sq. feet x-section
Place Rip-Rap for surface water diversion	SY	$5.17	5,834	$30,160	
Install surface water culverts and Sediment basins	Lump sum	$20,000	3.5	$70,000	Assume $20k for each sediment basin, $10k for culvert & their placements
Install water treatment plant	Lump sum	$10,000	1	$10,000	
Install sheet pile shore driven	LF	$437.83	1,700	$744,311	
Water treatment plant	month	$50,270	8	$402,160	
Reshape wetland post sediment removal	Acre	$16,880	14.39	$242,903	includes placement of treated sediment in caps/import of Erie pier sediment
Site supervision during site work	Day	$2,540.00	40	$101,600	Assume 10 days during haul road and pad construction
			TOTAL	$1,721,000	Rounded
Excavate Sediment and Rough Grading					
Sediment excavation	CY	$54.89	63,931	$3,509,339	
Rough grading post sediment removal	Acre	$2,426	14.39	$34,910	rough grading at price /45- 50k SqFT plus finish grading
			TOTAL	$3,544,000	Rounded
Alt 4 - Sediment treatment, Excavation & Return to Site for Capping					
Sediment mixing	CY	$2.20	63,931	$140,649	assume similar effort as loading trucks
Dewatering Amendments (Portland cement)	ton	$120	13,426	$1,611,071	assume 15% addition by weight
Sediment excavation	CY	$2.20	63,931	$140,649	load truck and dump them in pond area
Rough grading sediment into caps	Acre	$2,426	14.39	$34,910	rough grading at price /45- 50k SqFT plus finish grading
			TOTAL	$1,927,000	Rounded
Alt 4 - Sediment Consolidation in Upland Caps					
Cover & Grade over consolidated Sediment	Acre	$2,426	14.39	$34,910	rough grading at price /45- 50k SqFT plus finish grading
Finish grading for wetland prep	SY	$0.20	69648	$14,000	
			TOTAL	$49,000	Rounded
Wetland Restoration					
Purchase sand & import to staging	CY	$21	17412	$362,159	
Place sand benthic replacement cover	Acre	$2,426	14.4	$34,910	Washed Sand & Spread sand in 6" lifts
Wetland replanting (seeding, trees and shrubs)	Acre	$16,880.00	14.4	$243,000	
			TOTAL	$640,000	Rounded
Construction Monitoring and Sample Analysis					
Air Monitoring	Week	$600.00	6	$3,600.00	Three monitors and software; Dewatered sediment excavation
Pre- and Post-Construction Soil Sampling					
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	48	$28,560.00	One composite sample per 1/4 acre, 4 grabs/composite
PCBs (EPA 8290A)	Per Sample	$60.00	48	$2,880.00	One composite sample per 1/4 acre, 4 grabs/composite
Select Metals* (EPA 6020A/7471B)	Per Sample	$140.00	48	$6,720.00	One composite sample per 1/4 acre, 4 grabs/composite
Treated Discharge Water Sampling					
TSS (SM 2540 D)	Per Sample	$14.00	15	$210.00	1 sample per week
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	15	$8,925.00	1 sample per week
PCBs (EPA 8020A)	Per Sample	$60.00	15	$900.00	1 sample per week
Select Metals* (EPA 6020A/7471B)	Per Sample	$140.00	15	$2,100.00	1 sample per week
Low-level Mercury	Per Sample	$85.00	15	$1,275.00	1 sample per week
Surface Water Sampling					
TSS (SM 2540 D)	Per Sample	$14.00	15	$210.00	One sample per week
Turbidity (EPA 180.1)	Per Sample	$10.00	15	$150.00	One sample per week
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	15	$8,925.00	One sample per week
PCBs (EPA 8020A)	Per Sample	$60.00	15	$900.00	One sample per week
Select Metals* (EPA 6020A/7471B)	Per Sample	$140.00	15	$2,100.00	One sample per week
Post-Excavation Verification Sampling					
Select Metals* (EPA 6020A/7471B)	Per Sample	$32.00	58	$1,856.00	One sample per 1/4 acre
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	83	$49,385.00	One sample per 1/4 acre
Dewatered Sediment Sampling					
TCLP Metals* (EPA 6020A/7471B)	Per Sample	$110.00	13	$1,430.00	One sample per 5,000 CY
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	11	$6,545.00	One sample per 5,000 CY
PCBs (EPA 8020A)	Per Sample	$60.00	11	$660.00	One sample per 5,000 CY
Flash Point	Per Sample	$10.00	13	$130.00	One sample per 5,000 CY
pH (EPA 9045)	Per Sample	$10.00	13	$130.00	One sample per 5,000 CY
Paint Filter	Per Sample	$0.00	13	$0.00	One sample per 5,000 CY
			TOTAL	$133,000.00	Rounded

Appendix B: Table 3
Lump Sum Costs
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Lump Sum Costs - Alternative 5: Excavate, Offsite Disposal & Wetland Restoration					
Description	Unit	Unit Cost	Quantity	Extended	Comments
Mobilization/Demobilization					
Office trailers (3) and connex boxes to staging area	Mile	$12.26	240	$2,942	To staging area; within 20 miles of site
Telehandler	Each	$1,914.00	1	$1,914	To staging area; within 20 miles of site
Hopper/conveyor	Each	$3,828.00	2	$7,656	To staging area; within 20 miles of site
Excavator	Each	$7,656.00	4	$30,624	To staging area; within 20 miles of site
Dump truck	Each	$3,828.00	2	$7,656	To staging area; within 20 miles of site
Amphibious dump trucks	Each	$22,368.00	2	$44,736	To staging area; assumed double cost for wide load and chase vehicles
Water treatment system mobe	Each	$71,375.00	1	$71,375	To staging area
HDPE pipe	Each	$1,914.00	1	$1,914	To staging area
			TOTAL	$169,000	Rounded
Staging Area Construction					
Site supervision during site work	Day	$2,540.00	42	$106,680	Assume 10 days during haul road and pad construction
Clear and grub staging area	Acre	$10,489	5	$52,445	
Construct laydown areas	SY	$11.20	24,200	$271,040	4-inch crushed concrete; assume 5 acres
Install 40-mil VLDPE Liner	SF	$0.60	87120	$52,272	2007 ASTM presentation on landfill construction costs
Construct haul roads	SY	$13.10	6,222	$81,508	8-inch crushed concrete; assume 2800 feet of road at 20 feet wide
Construct site fencing	LF	$5.39	1,855	$9,998	Surrounding 5 acre area
			TOTAL	$574,000	Rounded
Site Work Year 1					
Excavate Surface water diversion	SY	$17.20	6,967	$119,827	1,900 ft. by 90 sq. feet x-section
Place Rip-Rap for surface water diversion	SY	$5.17	5,834	$30,160	
Install surface water culverts and Sediment basins	Lump sum	$20,000	3.5	$70,000	Assume $20k for each sediment basin, $10k for culvert & their placements
Install water treatment plant	Lump sum	$10,000	1	$10,000	
Install sheet pile shore driven	LF	$437.83	1,700	$744,311	
Water treatment plant	month	$50,270	8	$402,160	
Reshape wetland post sediment removal	Acre	$2,426	14.39	$34,910	includes placement of treated sediment in caps/import of Erie pier sediment
Site supervision during site work	Day	$2,540.00	40	$101,600	Assume 10 days during haul road and pad construction
			TOTAL	$1,513,000	Rounded

Appendix B: Table 3
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Excavate Sediment and Rough Grading					
Sediment excavation	CY	$54.89	63,931	$3,509,339	
Rough grading post sediment removal	Acre	$2,426	14.39	$34,910	rough grading at price /45- 50k SqFT plus finish grading
			TOTAL	$3,544,000	Rounded
Alt 5 - Sediment treatment, Excavation & Load on Dumps					
Sediment mixing	CY	$2	63,931	$127,863	assume similar effort as loading trucks
Dewatering Amendments (Portland cement)	ton	$120	13,426	$1,611,071	assume 15% addition by weight
Sediment excavation	CY	$2	63,931	$127,863	load on to trucks for offsite disposal
			TOTAL	$1,867,000	Rounded
Alt 5 - Sediment Landfill Disposal					
Sediment landfill transport	CY	$18	5,328	$95,897	30 miles round trip at 5 mpg, $3/gal
Dispose of sediments at Shamrock/SKB in Cloquet	ton	$17.66	111,880	$1,975,266	Quote
			TOTAL	$2,071,000	Rounded
Wetland Restoration					
Purchase sand & import to staging	CY	$21	49,377	$1,027,045	Includes material for 9 inch sand cover and for upland water diversions features (wetland features assumed to use approximately half the volume of sediment removed from excavation)
Place sand benthic replacement cover	Acre	$2,426	14.4	$34,910	Washed Sand & Spread sand in 6" lifts
Wetland replanting (seeding, trees and shrubs)	Acre	$16,880.00	14.4	$243,000	
			TOTAL	$1,305,000	Rounded
Construction Monitoring and Sample Analysis					
Air Monitoring	Week	$600.00	6	$3,600.00	Three monitors and software; Dewatered sediment excavation
Pre- and Post-Construction Soil Sampling					
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	48	$28,560.00	One composite sample per 1/4 acre, 4 grabs/composite
PCBs (EPA 8290A)	Per Sample	$60.00	48	$2,880.00	One composite sample per 1/4 acre, 4 grabs/composite
Select Metals* (EPA 6020A/7471B)	Per Sample	$140.00	48	$6,720.00	One composite sample per 1/4 acre, 4 grabs/composite
Treated Discharge Water Sampling					
TSS (SM 2540 D)	Per Sample	$14.00	15	$210.00	1 sample per week
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	15	$8,925.00	1 sample per week
PCBs (EPA 8020A)	Per Sample	$60.00	15	$900.00	1 sample per week
Select Metals* (EPA 6020A/7471B)	Per Sample	$140.00	15	$2,100.00	1 sample per week
Low-level Mercury	Per Sample	$85.00	15	$1,275.00	1 sample per week
Surface Water Sampling					
TSS (SM 2540 D)	Per Sample	$14.00	15	$210.00	One sample per week
Turbidity (EPA 180.1)	Per Sample	$10.00	15	$150.00	One sample per week
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	15	$8,925.00	One sample per week
PCBs (EPA 8020A)	Per Sample	$60.00	15	$900.00	One sample per week
Select Metals* (EPA 6020A/7471B)	Per Sample	$140.00	15	$2,100.00	One sample per week
Post-Excavfation Verification Sampling					
Select Metals* (EPA 6020A/7471B)	Per Sample	$32.00	58	$1,856.00	One sample per 1/4 acre
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	83	$49,385.00	One sample per 1/4 acre
Dewatered Sediment Sampling					
TCLP Metals* (EPA 6020A/7471B)	Per Sample	$110.00	13	$1,430.00	One sample per 5,000 CY
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	11	$6,545.00	One sample per 5,000 CY
PCBs (EPA 8020A)	Per Sample	$60.00	11	$660.00	One sample per 5,000 CY
Flash Point	Per Sample	$10.00	13	$130.00	One sample per 5,000 CY
pH (EPA 9045)	Per Sample	$10.00	13	$130.00	One sample per 5,000 CY
Paint Filter	Per Sample	$0.00	13	$0.00	One sample per 5,000 CY
			TOTAL	$133,000.00	Rounded

Lump Sum Costs - Alternative 6: Excavate, Offsite Disposal

Description	Unit	Unit Cost	Quantity	Extended	Comments
Mobilization/Demobilization					
Office trailers (3) and connex boxes to staging area	Mile	$12.26	240	$2,942	To staging area; within 20 miles of site
Telehandler	Each	$1,914.00	1	$1,914	To staging area; within 20 miles of site
Hopper/conveyor	Each	$3,828.00	2	$7,656	To staging area; within 20 miles of site
Excavator	Each	$7,656.00	4	$30,624	To staging area; within 20 miles of site
Dump truck	Each	$3,828.00	2	$7,656	To staging area; within 20 miles of site
Amphibious dump trucks	Each	$11,184.00	2	$22,368	To staging area; assumed double cost for wide load and chase vehicles
Water treatment system mobe	Each	$71,375.00	1	$71,375	To staging area
HDPE pipe	Each	$1,914.00	1	$1,914.00	To staging area
			TOTAL	$146,000	Rounded
Staging Area Construction					
Site supervision during site work	Day	$2,540.00	42	$106,680	Assume 10 days during haul road and pad construction
Clear and grub staging area	Acre	$10,489	5	$52,445	
Construct laydown areas	SY	$11.20	24,200	$271,040	4-inch crushed concrete; assume 5 acres
Install 40-mil VLDPE Liner	SF	$0.60	87120	$52,272	2007 ASTM presentation on landfill construction costs
Construct haul roads	SY	$13.10	6,222	$81,508	8-inch crushed concrete; assume 2800 feet of road at 20 feet wide
Construct site fencing	LF	$5.39	1,855	$9,998.45	Surrounding 5 acre area
			TOTAL	$574,000	Rounded
Site Work Year 1					
Excavate Surface water diversion	SY	$17.20	6,967	$119,827	1,900 ft. by 90 sq. feet x-section
Place Rip-Rap for surface water diversion	SY	$5.17	5,834	$30,160	
Install surface water culverts and Sediment basins	Lump sum	$20,000	3.5	$70,000	Assume $20k for each sediment basin, $10k for culvert & their placements
Install water treatment plant	Lump sum	$10,000	1	$10,000	
Install sheet pile shore driven	LF	$437.83	1,700	$744,311	
Water treatment plant	month	$50,270	8	$402,160	
Reshape wetland post sediment removal	Acre	$0	0.00	$0	
Site supervision during site work	Day	$2,540.00	40	$101,600.00	Assume 10 days during haul road and pad construction
			TOTAL	$1,478,000	Rounded

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Excavate Sediment and Rough Grading					
Sediment excavation	CY	$54.89	63,931	$3,509,339	
Rough grading post sediment removal	Acre	$2,426	14.39	$34,910	rough grading at price /45- 50k SqFT plus finish grading
			TOTAL	$3,544,000	Rounded
Alt 6 - Sediment treatment, Excavation & Load on Dumps					
Sediment mixing	CY	$2	63,931	$127,863	assume similar effort as loading trucks
Dewatering Amendments (Portland cement)	ton	$120	13,426	$1,611,071	assume 15% addition by weight
Sediment excavation	CY	$2	63,931	$127,863	load on to trucks for offsite disposal
			TOTAL	$1,867,000	Rounded
Alt 6 - Sediment Landfill Disposal					
Sediment landfill transport	CY	$18	5,328	$95,897	30 miles round trip at 5 mpg, $3/gal
Dispose of sediments at Shamrock/SKB in Cloquet	ton	$17.66	111,880	$1,975,266.23	Quote
			TOTAL	$2,071,000	Rounded
Wetland Restoration					
Purchase sand & import to staging	CY	$21	37145.38667	$772,624	
Place sand benthic replacement cover	Acre	$2,426	14.4	$34,910	Washed Sand & Spread sand in 6" lifts
Wetland replanting (seeding, trees and shrubs)	Acre	$16,880.00	14.4	$242,903.00	
			TOTAL	$1,050,000	Rounded
Construction Monitoring and Sample Analysis					
Air Monitoring	Week	$600.00	6	$3,600.00	Three monitors and software; Dewatered sediment excavation
Pre- and Post-Construction Soil Sampling					
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	48	$28,560.00	One composite sample per 1/4 acre, 4 grabs/composite
PCBs (EPA 8290A)	Per Sample	$60.00	48	$2,880.00	One composite sample per 1/4 acre, 4 grabs/composite
Select Metals* (EPA 6020A/7471B)	Per Sample	$140.00	48	$6,720.00	One composite sample per 1/4 acre, 4 grabs/composite
Treated Discharge Water Sampling					
TSS (SM 2540 D)	Per Sample	$14.00	15	$210.00	1 sample per week
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	15	$8,925.00	1 sample per week
PCBs (EPA 8020A)	Per Sample	$60.00	15	$900.00	1 sample per week
Select Metals* (EPA 6020A/7471B)	Per Sample	$140.00	15	$2,100.00	1 sample per week
Low-level Mercury	Per Sample	$85.00	15	$1,275.00	1 sample per week
Surface Water Sampling					
TSS (SM 2540 D)	Per Sample	$14.00	15	$210.00	One sample per week
Turbidity (EPA 180.1)	Per Sample	$10.00	15	$150.00	One sample per week
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	15	$8,925.00	One sample per week
PCBs (EPA 8020A)	Per Sample	$60.00	15	$900.00	One sample per week
Select Metals* (EPA 6020A/7471B)	Per Sample	$140.00	15	$2,100.00	One sample per week
Post-Excavfation Verification Sampling					
Select Metals* (EPA 6020A/7471B)	Per Sample	$32.00	58	$1,856.00	One sample per 1/4 acre
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	83	$49,385.00	One sample per 1/4 acre
Dewatered Sediment Sampling					
TCLP Metals* (EPA 6020A/7471B)	Per Sample	$110.00	13	$1,430.00	One sample per 5,000 CY
Dioxins/Furans (EPA 8290A)	Per Sample	$595.00	11	$6,545.00	One sample per 5,000 CY
PCBs (EPA 8020A)	Per Sample	$60.00	11	$660.00	One sample per 5,000 CY
Flash Point	Per Sample	$10.00	13	$130.00	One sample per 5,000 CY
pH (EPA 9045)	Per Sample	$10.00	13	$130.00	One sample per 5,000 CY
Paint Filter	Per Sample	$0.00	13	$0.00	One sample per 5,000 CY
			TOTAL	$133,000.00	Rounded

Appendix B: Table 4
Monitoring Elements
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Monitoring and Evaluation Costs - Alternative 1: No Action

No monitoring and evaluation costs associated with Alternative 1.

Monitoring and Evaluation Costs - Alternative 2: MNR with Institutional Controls

Monitoring Elements	Unit	Cost	Extended	Total	Comment
Monitoring and Evaluation Report	Each	$4,000.00	17	$68,000	Every year for 10 years, biennial for 10 years, every five for 10 years
Field Sampling	Event	$34,000.00	17	$578,000	Every year for 10 years, biennial for 10 years, every five for 10 years
Sample Analysis	Event	$48,235.00	17	$819,995	Every year for 10 years, biennial for 10 years, every five for 10 years
Select Metals (EPA 6020A/7471B)*	*Sample*	*$140.00*	*17*	*$2,380.00*	*20 locations*
PCBs (EPA 8020A)	*Sample*	*$60.00*	*17*	*$1,020.00*	*20 locations*
Dioxins/Furans (EPA 8290A)	*Sample*	*$595.00*	*17*	*$10,115.00*	*20 locations*
Grain Size (ASTM D422 w/ Hydrometer)	*Sample*	*$375.00*	*5*	*$1,875.00*	*Needed for tox/bio; 5 locations*
TOC Quad Burn (EPA 9060A)	*Sample*	*$105.00*	*5*	*$525.00*	*Needed for tox/bio; 5 locations*
10-d toxicity C. tentans	*Sample*	*$1,638.00*	*5*	*$8,190.00*	*5 locations*
28-d toxicity H. azteca	*Sample*	*$2,013.00*	*5*	*$10,065.00*	*5 locations*
28-d bioaccumulation	*Sample*	*$2,013.00*	*5*	*$10,065.00*	*5 locations*
Nickel and Zinc (Benthic Tissue)	*Sample*	*$100.00*	*25*	*$2,500.00*	*Individual replicate analysis*
Lipids content (Pace SOP)	*Sample*	*$100.00*	*10*	*$1,000.00*	*One composite per sample; benthics and fish*
Nickel and Zinc (Fish Tissue)	*Sample*	*$100.00*	*5*	*$500.00*	*Five composite samples from five species*
				$48,235.00	*Rounded*
				$1,466,000	Rounded

Monitoring and Evaluation Costs - Alternative 3: Enhanced MNR with Thin-Layer Amended Cover

Monitoring Elements	Unit	Cost	Extended	Total	Comment
Monitoring and Evaluation Report	Each	$4,000.00	13	$52,000	Every year for 5 years, biennial for 10 years, every five for 15 years
Field Sampling	Event	$34,000.00	13	$442,000	Every year for 5 years, biennial for 10 years, every five for 15 years
Sample Analysis	Event	$53,995.00	13	$701,935	Every year for 5 years, biennial for 10 years, every five for 15 years
Select Metals (EPA 6020A/7471B)*	*Sample*	*$140.00*	*17*	*$2,380.00*	*20 locations*
PCBs (EPA 8020A)	*Sample*	*$60.00*	*17*	*$1,020.00*	*20 locations*
Dioxins/Furans (EPA 8290A)	*Sample*	*$595.00*	*17*	*$10,115.00*	*20 locations*
Grain Size (ASTM D422 w/ Hydrometer)	*Sample*	*$375.00*	*17*	*$6,375.00*	*20 locations*
TOC Quad Burn (EPA 9060A)	*Sample*	*$105.00*	*17*	*$1,785.00*	*20 locations*
10-d toxicity C. tentans	*Sample*	*$1,638.00*	*5*	*$8,190.00*	*5 locations*
28-d toxicity H. azteca	*Sample*	*$2,013.00*	*5*	*$10,065.00*	*5 locations*
28-d bioaccumulation	*Sample*	*$2,013.00*	*5*	*$10,065.00*	*5 locations*
Nickel and Zinc (Benthic Tissue)	*Sample*	*$100.00*	*25*	*$2,500.00*	*Individual replicate analysis*
Lipids content (Pace SOP)	*Sample*	*$100.00*	*10*	*$1,000.00*	*One composite per sample; benthics and fish*
Nickel and Zinc (Fish Tissue)	*Sample*	*$100.00*	*5*	*$500.00*	*Five composite samples from five species*
				$53,995.00	
				$1,196,000	Rounded

Monitoring and Evaluation Costs - Alternative 4: Excavation, Sediment Consolidation in Upland Caps & Wetland Restoration.					
Monitoring Elements	Unit	Cost	Extended	Total	Comment
Monitoring and Evaluation Report	Each	$4,000.00	6	$24,000	Predesign and Every 5 years for 30 years
Field Sampling	Event	$34,000.00	6	$204,000	Predesign and Every 5 years for 30 years
Sample Analysis	Event	$35,732.00	6	$214,392	Predesign and Every 5 years for 30 years
Nickel and Zinc (EPA 6020A)	*Sample*	*$140.00*	*10*	*$1,400.00*	*5 cover samples; 5 from below cover; wetland areas only*
PCBs (EPA 8020A)	*Sample*	*$60.00*	*20*	*$1,200.00*	*20 locations*
Dioxins/Furans (EPA 8290A)	*Sample*	*$595.00*	*20*	*$11,900.00*	*20 locations*
Grain Size (ASTM D422 w/ Hydrometer)	*Sample*	*$375.00*	*3*	*$1,125.00*	*Needed for tox/bio; 3 locations in wetland areas*
TOC Quad Burn (EPA 9060A)	*Sample*	*$105.00*	*3*	*$315.00*	*Needed for tox/bio; 3 locations in wetland areas*
10-d toxicity C. tentans	*Sample*	*$1,638.00*	*3*	*$4,914.00*	*3 locations in wetland areas*
28-d toxicity H. azteca	*Sample*	*$2,013.00*	*3*	*$6,039.00*	*3 locations in wetland areas*
28-d bioaccumulation	*Sample*	*$2,013.00*	*3*	*$6,039.00*	*3 locations in wetland areas*
Nickel and Zinc (Benthic Tissue)	*Sample*	*$100.00*	*15*	*$1,500.00*	*Individual replicate analysis*
Lipids content (Pace SOP)	*Sample*	*$100.00*	*8*	*$800.00*	*One composite per sample; benthics and fish*
Nickel and Zinc (Fish Tissue)	*Sample*	*$100.00*	*5*	*$500.00*	*Five composite samples from five species; select metals and dioxins/furans*
				$35,732.00	
				$442,392	Rounded

Monitoring and Evaluation Costs - Alternative 5: Excavation, off site Sediment Disposal & Wetland Restoration.					
Monitoring Elements	Unit	Cost	Extended	Total	Comment
Predesign and Evaluation Report	Each	$4,000.00	1	$4,000	One Predesign event
Field Sampling	Event	$34,000.00	1	$34,000	One Predesign event
Sample Analysis	Event	$20,994.00	1	$20,994	One Predesign event
Nickel and Zinc (EPA 6020A)	*Sample*	*$140.00*	*17*	*$2,380.00*	*20 locations*
PCBs (EPA 8020A)	*Sample*	*$60.00*	*17*	*$1,020.00*	*20 locations*
Dioxins/Furans (EPA 8290A)	*Sample*	*$595.00*	*17*	*$10,115.00*	*20 locations*
Grain Size (ASTM D422 w/ Hydrometer)	*Sample*	*$375.00*	*3*	*$1,125.00*	*Needed for tox/bio; 3 locations in wetland areas*
TOC Quad Burn (EPA 9060A)	*Sample*	*$105.00*	*3*	*$315.00*	*Needed for tox/bio; 3 locations in wetland areas*
10-d toxicity C. tentans	*Sample*	*$1,638.00*	*0*	*$0.00*	*3 locations in wetland areas*
28-d toxicity H. azteca	*Sample*	*$2,013.00*	*0*	*$0.00*	*3 locations in wetland areas*
28-d bioaccumulation	*Sample*	*$2,013.00*	*3*	*$6,039.00*	*3 locations in wetland areas*
Nickel and Zinc (Benthic Tissue)	*Sample*	*$100.00*	*0*	*$0.00*	*Individual replicate analysis*
Lipids content (Pace SOP)	*Sample*	*$100.00*	*0*	*$0.00*	*One composite per sample; benthics and fish*
Nickel and Zinc (Fish Tissue)	*Sample*	*$100.00*	*0*	*$0.00*	*Five composite samples from five species; select metals and dioxins/furans*
				$20,994.00	
				$58,994	Rounded

Monitoring and Evaluation Costs - Alternative 6: Excavation, off site Sediment Disposal & Wetland Restoration.					
Monitoring Elements	Unit	Cost	Extended	Total	Comment
Predesign and Evaluation Report	Each	$4,000.00	1	$4,000	One Predesign event
Field Sampling	Event	$34,000.00	1	$34,000	One Predesign event
Sample Analysis	Event	$20,994.00	1	$20,994	One Predesign event
Nickel and Zinc (EPA 6020A)	*Sample*	*$140.00*	*17*	*$2,380.00*	*5 cover samples; 5 from below cover; wetland areas only*
PCBs (EPA 8020A)	*Sample*	*$60.00*	*17*	*$1,020.00*	*20 locations*
Dioxins/Furans (EPA 8290A)	*Sample*	*$595.00*	*17*	*$10,115.00*	*20 locations*
Grain Size (ASTM D422 w/ Hydrometer)	*Sample*	*$375.00*	*3*	*$1,125.00*	*Needed for tox/bio; 3 locations in wetland areas*
TOC Quad Burn (EPA 9060A)	*Sample*	*$105.00*	*3*	*$315.00*	*Needed for tox/bio; 3 locations in wetland areas*
10-d toxicity C. tentans	*Sample*	*$1,638.00*	*0*	*$0.00*	*3 locations in wetland areas*
28-d toxicity H. azteca	*Sample*	*$2,013.00*	*0*	*$0.00*	*3 locations in wetland areas*
28-d bioaccumulation	*Sample*	*$2,013.00*	*3*	*$6,039.00*	*3 locations in wetland areas*
Nickel and Zinc (Benthic Tissue)	*Sample*	*$100.00*	*0*	*$0.00*	*Individual replicate analysis*
Lipids content (Pace SOP)	*Sample*	*$100.00*	*0*	*$0.00*	*One composite per sample; benthics and fish*
Nickel and Zinc (Fish Tissue)	*Sample*	*$100.00*	*0*	*$0.00*	*Five composite samples from five species; select metals and dioxins/furans*
				$20,994.00	
				$58,994	Rounded

Appendix B: Table 4
Monitoring Elements
Focused Feasibility Study
Ponds behind Erie Pier
Minnesota Pollution Control Agency

Field Sampling Event					
Description	Unit	Cost	Extended	Total	Comment
Project Management	Hour	$115.00	30	$3,450.00	Project coordination
Scientist II	Hour	$84.00	10	$840.00	Field event planning and coordination
QA/QC	Hour	$94.00	20	$1,880.00	Chemical, tox/bio, tissue results
Field Sampling					
Field Labor	Person	$4,452.00	4	$17,808.00	5 hours meetings; 40 sampling; 8 mob/demob
Truck	Day	$75.00	10	$750.00	2 trucks; boat and office trailer
Mileage	Mile	$0.57	750	$423.75	
Pontoon	Day	$200.00	5	$1,000.00	
Vibracore rental	Lump Sum	$2,500.00	1	$2,500.00	Includes freight
Disposables	Lump Sum	$1,500.00	1	$1,500.00	Vibracore tubing
Office trailer	Day	$75.00	5	$375.00	
GPS	Day	$75.00	5	$375.00	
Generator	Day	$45.00	5	$225.00	
Drum	Each	$105.00	2	$210.00	
Sediment bundle	Day	$65.00	5	$325.00	
Fuel	Lump Sum	$50.00	1	$50.00	
IDW Disposal	Lump Sum	$250.00	1	$250.00	
Lodging	Night	$100.00	16	$1,600.00	
Per-Diem	Day	$35.00	20	$700.00	
			TOTAL	$34,000.00	Rounded

Bathymetric Survey Break-Down					
Parameter	Unit	Cost	Extended	Total Cost	
Daily labor cost					
Scientist III	Hour	$109	16	$1,744	Prep equipment; mob/demob; perform survey
Field Tech II	Hour	$64	16	$1,024	Prep equipment; mob/demob; perform survey
Lodging	Night	$100	2	$200	1 night each
Per-diem	Day	$36	4	$144	2 days each
Daily equipment cost					
Boat	Day	$200	2	$400	
Fuel	Day	$25	1	$25	
Multi-beam survey equipment	Day	$1,500	2	$3,000	
GPS	Day	$75	2	$150	
Truck	Day	$75	2	$150	
Mileage	Mile	$0.56	350	$196	
Data reduction/mapping	Hour	$109	20	$2,180	
GIS	Hour	$64	10	$640	
			TOTAL	$10,000	Rounded

Appendix C

Record of Communication

Appendix C – Record of Communications
Feasibility Study
Ponds Behind Erie Pier
Minnesota Pollution Control Agency

- Dirk Pohlmann with Bay West LLC corresponded with John Hull and John Collins of AquaBlok, in October 2015, April 2016, and May 2016 via email. Mr. Hull and Mr. Collins provided Bay West with information regarding AquaBlok products and applications.
- Dirk Pohlmann with Bay West corresponded with Matthew Lambert, Environmental Protection Agency, November 2015 via email. Mr. Lambert provided Bay West with clarification regarding Tier 1 and 2 sediment site lists, site action levels, site cleanup levels, objectives and goals.
- Chris Musson of Bay West corresponded with Omar's Sand and Gravel, Inc. (Omar's) of Carlton, Minnesota via email and phone between February 10 and 18, 2016. The Thomson Reservoir alternative scopes were discussed with John, a long-term employee at Omar's, and it was stated that projects on the scale of Thomson Reservoir are conducted regularly by Omar's. Supply, loading, and transportation services are offered by Omar's, and large quantities of washed sand are always kept in stock (i.e., stockpiled and ready for load-out). Quotes for supply and delivery of crushed concrete and washed sand were supplied to Bay West, but it was requested that pricing information be kept confidential (this pricing was incorporated into cost estimates). Gradation reports for two types of washed sand were also supplied to Bay West.
- Chris Musson of Bay West corresponded with Kyle Backstrom of SKB Environmental Services/Shamrock Trucking (Shamrock Landfill) located in Cloquet, Minnesota via phone and email on February 10, 2016. The Thomson Reservoir Dredging Alternative scope was discussed and Mr. Backstrom stated that Shamrock Landfill would have capacity to accept the dredge material and could also supply trucking services. No discount for use of sediment as daily cover would likely be given as large quantities of daily cover are already available. A rough estimate cost of $16 per ton for disposal and approximately $100 per hour per 23.5-ton end dump truck was supplied.
- Dirk Pohlmann with Bay West corresponded with Chuck Hornaday of Vadose Remediation Technologies, the Minnesota representative of CETCO, on April 21, 2016, via email. Mr. Hornaday provided Bay West with information regarding CETCO reactive core mats and associated remedial products and applications.
- On April 27, 2016, Matt Schemmel (Bay West) and Paul Raymaker (Bay West) met with MPCA and City of Duluth officials to discuss the status and plan for proposed remedies for various SLR sites, including the Ponds behind Erie Pier. The City of Duluth indicated that the route for the Cross City Bike Trail was planned to run directly adjacent to the west side of the Ponds Behind Erie Pier. The planned Cross City Bike Trail is depicted on figures and incorporated into remedy alternatives for the Ponds behind Erie Pier Focused Feasibility Study.
- Dirk Pohlmann with Bay West corresponded with Richard P. Traver, P.E. formerly with CH2M-Hill. Mr. Traver was the Non-time Critical Removal Action Project Engineer of Record, for the Universal Oil Products (UOP) Superfund site at the time of the UOP project design and execution. The May 2, 2016, and follow up conversations covered the sediment handling and treatment processes used during the UOP sediment excavation project as well as the lessons learned.