FOCUSED FEASIBILITY STUDY ADDENDUM
Munger Landing

SR0001015
Duluth, Minnesota
MPCA Work Order #3000024312

Prepared for:

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CLEAN WATER LAND & LEGACY AMENDMENT

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Acronyms and Abbreviations

% .....percent
µg/kg .....micrograms per kilogram
AOC.....area of concern
ARAR .....Applicable or Relevant and Appropriate Requirement
Bay West.....Bay West LLC
BLM……. Bureau of Land Management
BSAF .....biota-sediment accumulation factor
BTV .....background threshold value
BUI……..Beneficial Use Impairment
CFR.....Code of Federal Regulations
CH2M .....CH2M Hill
COC .....contaminant of concern
CSM .....conceptual site model
CUL .....cleanup level
dioxins .....polychlorinated dibenzo-p-dioxins/dibenzofurans
EMNR.....Enhanced Monitored Natural Recovery
FFS.....Focused Feasibility Study
GHG .....greenhouse gas
IC.....institutional control
MNR .....Monitored Natural Recovery
MPCA.....Minnesota Pollution Control Agency
NCP .....National Oil and Hazardous Substances Pollution Contingency Plan
ng/kg .....nanograms per kilogram
O&M.....operation and maintenance
PAH.....polycyclic aromatic hydrocarbon
PCB.....polychlorinated biphenyl
PEP.....Ponds behind Erie Pier
RAO .....Remedial Action Objective
RAP.....Remedial Action Plan
RI.....Remedial Investigation
ROM.....rough order of magnitude
SAA.....Sediment Assessment Area
SDCV .....sediment cleanup value
SLR .....St. Louis River
SQT.....sediment quality target
TEQ.....toxic equivalency
U.S. .....United States
USEPA.....United States Environmental Protection Agency
WDNR.....Wisconsin Department of Natural Resources

1.0 INTRODUCTION AND BACKGROUND

1.1 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) are currently working together, and with other AOC partners, to implement a remedial action plan (RAP) to restore beneficial uses and remove beneficial use impairments (BUIs) in the SLR AOC. Many of the BUIs in the AOC are linked to the presence of contaminated sediment. The MPCA and WDNR divided the SLR AOC into Sediment Assessment Areas (SAAs) for the purposes of evaluation and prioritization of remediation and restoration activities. Contaminated sediments were identified and characterized through several studies that included the collection and analysis of sediments and biota samples throughout the AOC.
Areas that are contributing to river and harbor sediment impairments should be addressed through remedial activities, as recommended by the RAP. Contaminated sediment at this site is considered to present a high likelihood of significant effects to benthic invertebrates, and represent a risk to human health. These contaminated sediments are contributing to at least five BUIs to the SLR AOC:

- Restrictions on dredging,
- Fish consumption advisories,
- Degradation of the sediment surface or environment,
- Beach closings and body contact restrictions, and
- Loss of fish and wildlife habitat.

Munger Landing (the Site), is located approximately 6 to 7 miles upstream of the Blatnick Bridge, which crosses from Rice's Point in Minnesota to Conner's Point in Wisconsin (**Figure 1** and **Figure 2**). The southern portion of the Site is divided by the Minnesota-Wisconsin border. The nature and extent of contamination at the Site was investigated during several studies between 2011 and 2018. Because the contaminated sediment at the Site crosses the state line into Wisconsin, MPCA is coordinating with WDNR to develop a cleanup plan for the site that is protective of human health and the environment and meets management objectives and regulatory requirements for each state.

A Focused Feasibility Study (FFS) was prepared for the Site in June 2018 to evaluate remedial alternatives for contaminated sediment at the Site (Bay West LLC [Bay West], 2018). The FFS presented a summary of the Site, Applicable or Relevant and Appropriate Requirements (ARARs)[1], and remedial action objectives (RAOs). The RAOs for this site include:

[1] The tables summarizing the ARARs in Section 2.0 of the June 2018 FFS do not contain a comprehensive list for Wisconsin specific requirements. Wisconsin ARARs include, but are not limited to Wis. Stats. Chapter 292 and Wis. Adm. Code chs. NR 700 to 754. A future Decision Summary Document will include a complete list of permits, approvals and other authorizations needed for the selected remedy.

1. Minimize or remove exposure to sediment contaminants that bioaccumulate in the food chain and contribute to fish consumption advisories.

2. Minimize or remove exposure of the benthic organisms to contaminated sediments above sediment cleanup goals.

3. Preserve water depth to enable the current and/or planned use of the Site.

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

5. Minimize or remove human exposure to contaminated sediments above sediment cleanup goals.

The FFS also presented the development and screening of the following remedial alternatives:

- Alternative 1: No Action
- Alternative 2: Monitored Natural Recovery
- Alternative 3: Enhanced Monitored Natural Recovery (MNR) with Broadcasted Amendment
- Alternative 4: Enhanced Monitored Natural Recovery (EMNR) with Thin-Layer Amended Cover
- Alternative 5: Excavate with Off-site Disposal
- Alternative 6: Hotspot Dredge Off-site Disposal & Enhanced MNR with Broadcasted Amendment

The remedial alternatives were then scored based on threshold criteria, primary balancing criteria, and modifying criteria. Areas of the remedial footprint exist within Wisconsin and remedial actions would be implemented in cooperation with the WDNR. For the FFS and this FFS addendum, remedies to address contamination at the Site and associated costs have been developed for the entire remedial footprint across both states. The FFS should be reviewed prior to reading this document for an understanding of the Site history, previous work completed at the Site, and the complete FFS evaluation process. WDNR was unable to comment on the June 2018 FFS before it was made final, and since then, has indicated they do not necessarily support all the statements or conclusions of the FFS. However, since the FFS, the MPCA has engaged WDNR regularly, and this FFS addendum includes input from both agencies.

1.2 Purpose

The purpose of this FFS Addendum is to present revised remedial alternatives and incorporate updated information for the Site. Remedial alternatives were revised based on additional data gathering and stakeholder input. Stakeholder input included, but was not limited to, MPCA discussions with WDNR and US EPA about a joint project to address impairments at the Site as part of a Great Lakes Legacy Act (GLLA) project. Accordingly, this FFS addendum was prepared in consideration of the MPCA and WDNR pursuing a cooperative GLLA project for remedial action at the Site. Revisions include the removal of Alternative 3 and modification of Alternatives 4 and 6. Revisions to remedial alternatives primarily involved removal of amendments (SediMite, carbon, etc.) from alternatives. Although amendments address potential impacts to benthic organisms by reducing bioavailability, they do not adequately address human health risks, and thus were eliminated from consideration. Remedial alternatives also include updated remedial footprint areas and associated material volumes based on recently obtained sediment characterization data. For this FFS Addendum, the revised remedial alternatives include the following:

- Alternative 1: No Action
- Alternative 2: Monitored Natural Recovery
- Alternative 3: (formerly Alternative 4): Enhanced Monitored Natural Recovery with Thin-Layer Sand Cover
- Alternative 4: (formerly Alternative 5): Dredge with Off-site Disposal
- Alternative 5: (formerly Alternative 6): Hotspot Dredge Off-site Disposal & Enhanced MNR with Thick-Layer Sand Cover

This document summarizes remedial alternative development and Site updates, describes the revised remedial alternatives in detail, provides an updated comparative analysis of the revised remedial alternatives, and presents a preferred remedial alternative for the Site.

2.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

2.1 Development of Alternatives

This section describes Site updates since the 2018 FFS and the alternatives developed for the Site. The alternatives were developed using the selected remedial technologies discussed in Section 3.1 of the FFS, Site data collected during previous investigations and the 2015 Remedial Investigation (RI), 2017 sampling, and the conceptual site model (CSM).

Contaminants of concern (COCs) identified during the 2015 RI include cadmium, copper, lead, mercury, nickel, zinc, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and polychlorinated dibenzo-p-dioxins/dibenzofurans (dioxins). Of the COCs, dioxins and PCBs present the highest likelihood of significant effects to benthic invertebrates from exposure to surficial sediments and highest risk to human health through direct contact with sediments or ingestion of contaminated biota (i.e., fish consumption); therefore, dioxins and PCBs are considered primary COCs, and were used to define the remedial footprint. All other COCs for the Site are considered secondary COCs. Sample locations where sediment concentrations exceed cleanup levels for the secondary COCs are located within the remedial footprint based on the primary COCs. The St. Louis River has a fish consumption advisory for mercury and the highest mercury concentrations at the Site are collocated with at least one primary COC and are within the remedial footprint.

Primary COCs	*Secondary COCs*
• Dioxins; and • PCBs	• Cadmium; • Copper; • Lead; • Mercury; • Nickel; • Zinc; and • PAHs

In 2017, Bay West conducted sediment sampling at the Site at locations where there were gaps in PCB and dioxin data. The results were used to refine the remedial footprint and are included in the 2018 FFS (Bay West, 2018). In 2018, CH2M Hill (CH2M), contracted by the United States Environmental Protection Agency (USEPA), conducted site characterization to determine if either Snively Creek or Stewart Creek may be ongoing contaminant sources to the Site sediments, and to collect additional data within the Site to fill data gaps (CH2M, 2019). Results of the PCB and dioxin analysis in 2018 were used to refine the remedial footprint used in this FFS Addendum.

As part of this FFS Addendum, sediment chemical data collected since publishing the FFS was combined with previously collected chemical data and used to further refine the depth and spatial extent of the COC contamination. The criteria used to define the remedial footprint was also updated based on stakeholder input, recently developed background threshold values (BTVs), and projects of similar size, environment, and COCs. The following criteria was used to define the remedial footprint and hotspot footprint:

- Remedial footprint
    - BTV of 24.9 nanograms per kilogram (ng/kg) toxic equivalency (TEQ) for dioxins
    - Total PCBs midpoint sediment quality target (SQT) of 370 micrograms per kilogram (µg/kg)

- Hotspot footprint
    - 50 ng/kg TEQ for dioxins
    - 1,000 µg/kg for PCBs

Based on these criteria, the refined remedial footprint for the Site is 35.3 acres in size with 29.5 acres located in Minnesota and 5.8 acres located in Wisconsin. The refined hotspot footprint for the site is 20 acres in size, with 15.3 acres located in Minnesota and 4.7 acres located in Wisconsin. Summarized sediment chemical data and the refined remedial and hotspot footprints are presented in **Figure 3**.

In April 2018, the MPCA developed site-specific human health-based criteria to provide a recommendation regarding the potential risks to people from PCBs in sediments that use the Site for recreational purposes. This analysis of human health risks incorporates dermal contact and incidental ingestion from swimming and wading, but does not include risks from fish consumption. Additional details on the development and applicability of the site-specific sediment cleanup values (SDCVs) are detailed in the Munger Landing PCB Human Health SDCV Technical Memorandum which is included in Appendix B of the FFS. Areas of the Site where water covered sediment and intertidal sediment site-specific SDCVs apply are shown on **Figure 4**. SDCVs were used to create a human health remedial footprint, also shown in **Figure 4**. This human health remedial footprint was considered in the process of defining the remedial footprint and the current remedial footprint includes the human health remedial footprint.

In 2018 and 2019, the USEPA conducted a fish tissue study at the Site. Fish tissue collected from the site was analyzed for PCBs, mercury, and dioxins. The results of the tissue analysis will be used to model biota-sediment accumulation factors (BSAFs) and to inform fish consumption advisories. This fish tissue study is ongoing; however, preliminary results indicate that fish tissue collected from the site contains PCB concentrations that may be hazardous to human health. There are currently fish consumption advisories in place for the SLR for PCBs and mercury. However, based on these preliminary results, the MPCA has requested the Minnesota Department of Health's assistance in evaluating whether the fish consumption advisories need to be updated. This study is expected to be finalized and made available to the public in 2019. This data will be used to further refine the human health remedial footprint; however, this data is not expected to significantly change the remedial approach to the Site.

In July 2019, Bay West conducted additional sediment characterization for PCBs and dioxins to further refine the remedial footprint, specifically in hotspot and shoreline areas. The results of this investigation will be reported in a Data Summary Report and is expected to be finalized in 2019; however, the results of the sediment characterization are not expected to significantly change the remedial approach to the Site.

A summary of the proposed alternatives is presented in **Table 1**. Calculations used to determine volumes, rates, and time frames related to remedy construction are available upon request from the MPCA. Assumptions made to compile cost estimates were incorporated into a Technical Analysis and are also included in Appendix C of the FFS. Areas of the Site exceeding the cleanup levels (CULs) equal approximately 35.3 acres; however, 5.8 acres of the remedial footprint exists within Wisconsin, so all remedial alternatives may be implemented in cooperation with the WDNR.

The total present value costs for alternatives presented within this FFS Addendum 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 Addendum 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 was 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; 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 5 in Appendix C of the FFS.

2.2 Alternatives

2.2.1 Alternative 1: No Action

This alternative remains unchanged from the FFS. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) at Title 40 Code of Federal Regulations (CFR) provides that a No Action Alternative should be considered at every site. A No Action Alternative should reflect the site conditions described in the baseline risk assessment and remedial investigation. 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. The No Action Alternative is not a viable alternative for implementation because it does not meet the threshold criteria for overall protection of human health and the environment or compliance with the ARARs.

2.2.2 Alternative 2: Monitored Natural Recovery

This alternative, which remains unchanged from the FFS, consists of a monitoring and evaluation period of 30 years and implementation of ICs. Potential monitoring locations are presented in **Figure 5**. The objective of this alternative is to provide data to determine the potential for natural recovery processes at the Site. There is some uncertainty whether sedimentation rates at the Site are sufficient to reduce availability and concentrations of COCs in sediment and/or reducing toxic/bioaccumulative effects in marine organisms (i.e., benthics and fish).

The approximate present value cost associated with Alternative 2 is $244,000. **Table 2** presents the breakdown of the estimated costs associated with Alternative 2.

2.2.3 Alternative 3: (Modified Version of Alternative 4 in FFS): Enhanced Monitored Natural Recovery with Thin-Layer Sand Cover

This alternative remains the same as presented in the FFS with the exception of the use of amendment in the thin-layer sand cover. The use of amendment was removed from this alternative because it does not adequately address human health risk.

This alternative would consist of applying a thin layer, 0.15 meters (6 inches), of sand material directly on top of the sediment surface in the remedial footprint (**Figure 6**). Monitoring of sediment chemical concentrations, sediment toxicity, and bioaccumulation of COCs in aquatic life would be conducted until sufficient contaminant sequestration, degradation, transformation, or other natural recovery processes reduce risks to acceptable levels.

Implementation of this alternative assumes that approximately 29,000 cubic yards of sand would be applied over a 35.3-acre area at an average thickness of 0.15 meter.

The approximate present value cost associated with Alternative 3 is $3,570,000. **Table 3** presents the breakdown of the estimated costs associated with Alternative 3.

2.2.4 Alternative 4: (formerly Alternative 5 in the FFS): Dredge with Offsite Disposal

This alternative remains unchanged from the FFS and would consist of the complete removal of COCs within the remedial footprint and subsequent off-site disposal of contaminated sediment.

The estimated dredge area for this alternative is presented in **Figure 7**. Following dredging, a 0.15-meter (0.5-foot) layer of clean sand, similar to Alternative 3 and 5, would be placed throughout the dredged areas to provide benthic habitat. No long-term monitoring of COCs is required under this alternative.

Implementation of this alternative assumes that a total volume of approximately 121,400 cubic yards of contaminated sediments would be removed within the remedial footprint, a 35.3-acre area.

The approximate present value cost associated with Alternative 4 is $19,346,000. **Table 4** presents a breakdown of the estimated costs associated with Alternative 4.

2.2.5 Alternative 5: (Alternative 6 in FFS and modified): Hotspot Dredge Offsite Disposal & Enhanced MNR with Thin-Layer Sand Cover

This alternative remains the same as presented in the FFS with the exception of the use of a thin-layer sand cover rather than a thin-layer amended cover. This alternative would consist of removal of sediments within the hotspot remedial footprint only, combined with a thin-layer sand cover applied to the entire remedial footprint as shown on **Figure 8**.

The depth of contamination was estimated at 0.50 meter (1.6 feet) within the hotspot remedial. These estimates equate to a total volume of approximately 68,800 cubic yards of contaminated sediments requiring removal. Monitoring of sediment chemical concentrations, sediment toxicity, and bioaccumulation of COCs in aquatic life would be conducted until sufficient contaminant sequestration, degradation, transformation, or other natural recovery processes reduce risks to acceptable levels.

The estimated total present value cost for Alternative 5 is $12,918,000. **Table 5** presents a breakdown of the estimated costs associated with Alternative 5.

3.0 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 of the FFS in order to determine which of the alternatives best meets those criteria. The comparative analysis is documented in this section and summarized in **Table 6** and **7**. **Table 8** presents a numerical comparison of the evaluated alternatives.

3.1 Threshold Criteria

Only those alternatives that would meet the threshold criteria of providing overall protection of human health and the environment and would attain compliance with ARARs were carried forward with the comparative analysis, with the exception of Alternative 1. Alternative 1 does not meet the threshold criteria but was carried forward as it is required for analysis under the NCP. Alternative 2 provides a low achievement of threshold criteria because additional study of natural processes at the site to bury and degrade COC-impacted sediment is required.

Alternatives 3, 4, and 5 will achieve protection of human health and the environment and comply with the identified ARARs. Alternatives 3 and 5 would eliminate, reduce, or control exposure to contaminated sediment; however, contaminated sediment would remain in place under both alternatives, requiring monitoring to ensure long-term effectiveness. Alternatives 3 and 5 would provide similar levels of protection, while Alternative 5 removes the most contaminated sediments (hotspot area). Alternative 4 would provide the highest level of protection as all COCs exceeding CULs would be removed from the remedial footprint.

3.2 Balancing Criteria

3.2.1 Long-Term Effectiveness and Permanence

Alternative 1 is not effective in the long term or permanent. Alternative 2 maybe be effective and permanent in the long term; however, RAOs may not be achieved in a reasonable time frame because the natural degradation processes are poorly understood at the Site and a possible contamination source is located directly upstream of the Site. Alternatives 3 and 5 are effective in the long term; however, contaminated sediment would remain in place under each, though the most contaminated sediments would be removed under Alternative 5. Alternatives 3 and 5 require long-term operation and maintenance (O&M) and ICs to ensure long-term effectiveness. Alternative 4 is the most effective in the long term as COC contaminated sediment would be permanently removed from the remedial footprint.

In summary, Alternative 2 will provide a low achievement of this criterion, and Alternative 3 will provide a low to moderate achievement of this criterion by providing immediate isolation of contaminated sediments. Alternative 5 provides a moderate level of achievement because it combines removal of the hotspot area with the addition of the isolation of the contaminated sediments. Alternative 4 provides the highest level of achievement as all COCs exceeding CULs are removed from the remedial footprint.

3.2.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment of contaminated sediments to reduce toxicity, mobility, or volume is not a component of Alternatives 1 and 2; therefore, these alternatives provide no achievement of this criterion. Alternative 3, 4, and 5 provide varying levels of achievement of this criterion through treatment as each of these alternatives use the same application of a thin-layer sand cover at some point in the remedial process, which may reduce contamination in sediment over time; however, the length of time required to reduce sediment contamination from the thin-layer sand cover

application my not be feasible to achieve RAOs. Alternative 5 provides a moderate achievement of this criterion because it reduces the volume of contamination in the hotspot remedial footprint, though this is done by excavation, not treatment. Alternative 4 provides a high achievement of this criterion because reduces the most volume of contaminated sediments through dredging of all contaminated sediment in the remedial footprint though this is done by excavation, not treatment.

In summary, Alternative 3 will provide a low achievement of this criterion, Alternative 4 will provide a high achievement of this criterion, and Alternative 5 will provide a moderate achievement of this criterion. Alternatives 1 and 2 will provide the lowest achievement of this criterion because treatment of COC-impacted sediment is not a component of these remedies.

3.2.3 Short-Term Effectiveness

There are no short-term risks associated with Alternatives 1 and 2 as no actions would be implemented at the Site. The rest of the alternatives would have some short-term risks during implementation of the remedy. Short-term adverse effects to aquatic habitat and biota for Alternative 3 would include displacement of fish and smothering of benthic organisms. The effects from Alternative 3 would occur during remedy construction and during the recovery period thereafter. Alternatives 4 and 5 would result in substantially more short-term adverse effects than Alternatives 3 because entire benthic communities would be removed, with the most adverse effects occurring with Alternative 4. Alternatives 4 and 5 both include some level of habitat restoration, and benthic organisms would be expected to be reestablished for all alternatives within several growing seasons.

In summary, Alternatives 1 and 2 would provide a high achievement of the short-term effectiveness criterion as there would be no impact to surrounding community and aquatic habitat and no risk to Site workers. Alternative 3 would have a moderately high achievement of the short term effectiveness criterion, due to an increase in short-term adverse effects to aquatic biota during cover construction; however, impacts are anticipated to be small. Alternatives 4 and 5 would provide low and moderate achievement of this criterion, respectively resulting in the most adverse effects to benthic communities.

3.2.4 Implementability

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

Application of cover materials utilized in Alternatives 3, 4, and 5 would require barging of materials to and/or from a nearby staging area or a staging area located along the SLR, such as Hallett Dock #7 or Ponds behind Erie Pier (PEP). It is anticipated that Hallett Dock #7 or PEP would be available as a staging area, but these alternatives assume the use of Hallett Dock #7 and successful coordination of future access agreements. Methods for placement of cover materials are technically feasible and implementable from an engineering perspective.

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. Barge traffic and any Site activities would be postponed in the spring until ice melt is completed. Winter or freezing conditions in the fall could shorten the construction season. Alternative 4 has the longest estimated time to complete and, therefore, would stand to be the most impacted by weather.

Implementability also includes administrative feasibility of the remedy. As with most sediment remediation activities, multiple state and federal agencies and other stakeholder input is required, providing a lower achievement of administrative feasibility of implementing a remedy. Additional time would be required to obtain any necessary approvals and permits from other agencies. Alternatives 4 and 5 would require more coordination with regulatory agencies than Alternative 3

because of the additional permitting required for dredging and increased impacts to the ecosystem. For these reasons Alternatives 4 and 5 provide only a low to moderate level of achievement of the implementability criterion, while Alternative 3 provides a moderate achievement.

In summary, Alternatives 1 and 2 have no actions to be implemented and thus provide a high achievement of the implementability criterion. Alternative 3 provides a moderate level of achievement. Alternative 4 provides a low level of achievement of the implementability criterion because it is a more complex alternative to execute due to the coordination of dredging sediments and placement of sand cover. Alternative 5 is slightly less complex than Alternative 4 because it involves the same elements with while dredging a smaller area.

3.2.5 Cost

Cost estimates developed for each alternative are included in Section 3.0 of the FFS and summarized in **Table 1**. 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. While this FFS assumes that Former Hallet Dock #7 will be used as a staging area for Alternatives 3, 4, and 5, costs associated with renting it are not included in this estimate, as the cost would need to be negotiated with the current property owner. The rental costs could significantly impact the final cost. If another facility is idenfitied during design as a feasible staging area, costs for use of that facility could impact total project cost.

In summary, Alternative 1 provides the most cost-effective option with no costs, followed by Alternative 2 ($244,000) because it requires only monitoring. Alternative 3 ($3,570,000) is the next most cost-effective option as less volume of cover materials are required compared to Alternative 4 ($19,346,000), making Alternative 4 the least cost-effective option because it requires the removal and off-site disposal of contaminated sediments within the remedial footprint. Alternative 5 ($12,918,000) is a combination of Alternative 3 and Alternative 4, making it less cost effective than Alternative 3 but more cost effective than Alternative 4. **Table 8** presents a numerical score that compares the cost for all alternatives.

3.3 Modifying Criteria

The modifying criteria, state/support agency acceptance and community acceptance, are assessed formally after the public comment period, and to the extent that they are known will be factored into the identification of the preferred alternative.

3.3.1 State Support/Agency Acceptance

State/agency input will be assessed to assist in determining the appropriate alternative for the Site. Key factors that will influence alternative selection include but are not limited to knowledge of future Site use, Site remediation prioritization, and funding source availability. Alternatives 1 through 5 will be formally assessed after the public comment period.

3.3.2 Community Acceptance

Lands surrounding the Site are owned by the City of Duluth and private owners and access is generally limited to the Munger Landing boat launch and fishing dock. Any remediation work completed at the Site involving dredging or application of a cover would require construction of a mooring area adjacent to the boat launch (i.e., driving of dolphin pilings); therefore, coordination with the City of Duluth would be required for implementation of Alternatives 3, 4, and 5, which incorporate dredging and/or cover material placement. Additional coordination would be required with the current or future owners of Hallett Dock #7, or possibly other locations, for use as a material staging area. The majority of work related to implementation of Alternatives 3, 4, and 5 would take place directly on-site and presumably at a privately owned staging area. It is

anticipated that community acceptance of Alternatives 3, 4, and 5 will be high based on the comparative analysis above.

3.4 Green Sustainable Remediation Criteria

3.4.1 Greenhouse Gas Emissions

Alternative 1 would have no greenhouse gas (GHG) emissions. Alternative 2 would only produce GHG emissions associated with mobilization/demobilization and boat operation associated with sampling efforts. Alternatives 3, 4, and 5 would result in GHG emissions from the mobilization, operation, and demobilization of all fuel-powered construction equipment required to place cover material and dredging. 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.

3.4.2 Toxic Chemical Usage and Disposal

There are no known toxic chemicals associated with any alternatives.

3.4.3 Energy Consumption

Alternative 1 would consume no additional energy. Alternative 2 would consume minimal amounts of fossil fuels compared to the other alternatives. Alternatives 3, 4, and 5 would result in the consumption of fossil fuels for the mobilization, operation, and demobilization of all diesel-powered construction equipment associated with dredging and the placement of the cover material, with Alternative 4 requiring the most energy consumption due to the volume of sediments to be dredged.

3.4.4 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, and 5.

3.4.5 Water Consumption

Alternatives 1 and 2 would not require the consumption of water and there are few water consumption considerations associated with Alternatives 3, 4, and 5.

3.4.6 Waste Generation

Alternatives 1, 2, and 3 would not generate significant amounts of waste. Alternatives 4 and 5 would generate a significant dredge material that will require disposal at a landfill, with Alternative 4 producing the most waste.

3.5 Comparative Analysis Summary and Preferred Alternative

The comparative analysis of alternatives narrative discussion and quantitation table scored Alternative 4 the highest. Alternative 1 scored the lowest overall.

Alternative 1 does not achieve overall protection of human health and the environment, does not achieve ARARs, is not effective in the long term, and does not reduce toxicity, mobility, or volume of contamination through treatment. Natural processes occurring at the Site are currently poorly understood; therefore, Alternative 2 ranks low for overall protection of human health and the environment, achievement ARARs, and effectiveness in the long term and short term. Alternative 2 does not reduce toxicity, mobility, or volume of contamination through treatment. Short-term risks associated with Alternatives 1 and 2 are low, and both are implementable and cost-effective.

Alternative 4 provides the highest achievement of protection of human health and the environment and achievement of ARARs, followed by Alternative 5. Alternative 4 has the highest long-term effectiveness, followed by Alternative 5, because the alternatives remove some or all contaminated sediment at the site permanently. Alternative 3 includes a thicker cover than Alternative 5, which further reduces mobility of COCs. Alternative 4 does not reduce the toxicity, mobility, or volume through treatment; however, it does reduce the volume of contaminated sediment through dredging and disposal. Alternative 4 results in the most short-term impacts to the benthic community and also provide the most risk to site workers. Alternative 5 is a mix between Alternative 3 and 4. Alternative 4 is slightly less implementable than Alternative 3. Alternative 5 is the most complicated and therefore least implementable. Alternative 3 is the most cost effective, followed by Alternative 5 and 4, respectively.

The MPCA and WDNR have selected Alternative 4: Dredging and Off-Site Disposal as the preferred remedial alternative for cleaning up contaminated sediments at the Site. This alternative provides the highest achievement of protection of human health and the environment, as well as long-term effectiveness and permanence, as all contaminated sediments exceeding cleanup levels would be removed. MPCA is currently seeking public comment, and will work with the WDNR to make a final remedy decision after considering public comments, including support from local, state, and federal agencies.

Further studies are recommended during the design phase of the selected alternative. These recommended studies may include, but are not limited to:

- Additional COC characterization and delineation throughout the Site, as well as refinement of the remedial footprint (in progress);
- Hydrodynamic study to understand natural processes such as depositional and scouring forces to inform design and placement of cover materials, and effectiveness of MNR, if needed (in progress);
- Fish tissue assessment and BSAF modeling to inform fish consumption advisories, remedial design, and long-term monitoring (in progress);
- High resolution bathymetric survey to refine volume estimations for dredging and slope stability considerations for placement of sand cover;
- Bench scale testing of sediment and evaluation of methods for dewatering and disposal of sediments; and
- Preparation of a Pre-Design Data Summary Report which will compile all historic and recent site data for the purposes of informing remedial design.

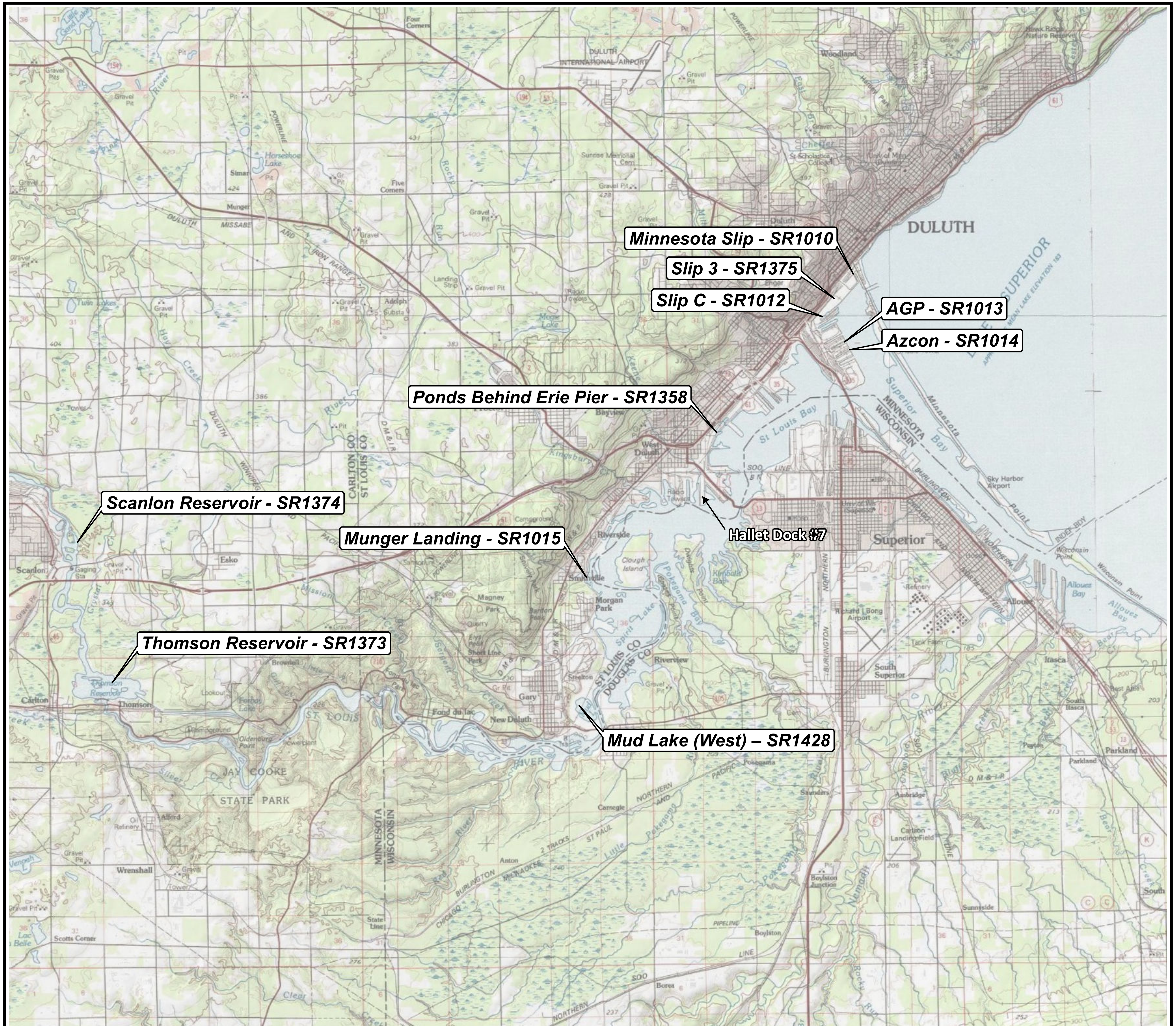
Additional information, including but not limited to the list above, as well as input from stakeholders and an understanding of project funding, may result in modifications to the selected remedial alternative. This FFS Addendum document is intended to provide the final evaluation of alternatives under the current understanding of the Site; however, additional FFS addenda may be required if additional information becomes available that would significantly affect remedial alternatives.

4.0 REFERENCES

Bay West LLC (Bay West), 2018. “Focused Feasibility Study, Revision 01, Munger Landing, Duluth Minnesota.” June.

CH2M Hill (CH2M), 2019. “Draft Site Characterization Report, Munger Landing Sediment Characterization, St. Louis River AOC, Minnesota and Wisconsin.” June.

Figures

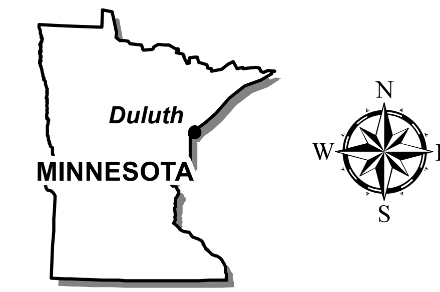


Y:\Clients\MPCA\SLR_Sediment_AOCs\Munger_Landing\MapDocs\J190398\001_FFS_Addendum_Figures\J190398 FIG 01 Munger Landing Site Location Map.mxd

Figure 1

Site Location Map

Munger Landing
SLR Sediment Sites
Duluth, MN



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

0 2 4 Miles
0 3 6 Kilometers

Site Location (Labeled on map)

CLEAN WATER LAND & LEGACY AMENDMENT

Bay West
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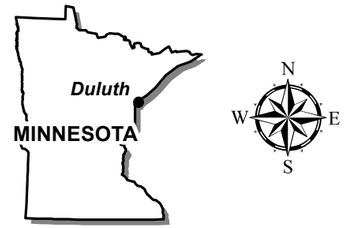
Figure 2

Site Map

Munger Landing
SLR Sediment Sites
Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Google Earth Aerial Imagery, 6/5/2017

0 500 1,000 Feet
0 150 300 Meters

1 inch = 450 feet

- Sediment Sample (Bay West)
- Historical Sediment Sample
- Sewer Outfall
- Sanitary Sewer
- Storm Sewer
- Stream
- Shipping Channel
- State Border
- Bathymetry Elevation Contour

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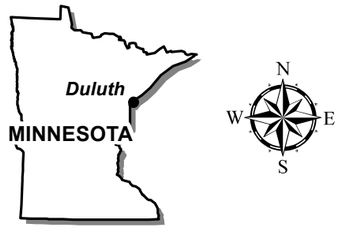
Y:\Clients\MPCA\SLR_Sediment_AOCs\Munger_Landing\MapDocs\J190398\001_FFS_Addendum_Figures\J190398 FIG 02 Munger Landing Site Map.mxd

Figure 3

Remedial Footprint Map

Munger Landing
SLR Sediment Sites
Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Google Earth Aerial Imagery, 6/5/2017

0 500 1,000 Feet
0 150 300 Meters

Sample Results

- PCBs < 370 ug/kg or TEQ Fish < 24.9 ng/kg
- PCBs >370 ug/kg or TEQ Fish > 24.9 ng/kg
- PCBs >1,000 ug/kg or TEQ Fish >50 ng/kg
- Shipping Channel
- State Border
- Stream
- Ordinary High Water (OHW) Level at 602.8 ft (Vertical datum of IGLD85)
- Sewer Outfall
- SS Sanitary Sewer
- ST Storm Sewer

Remedial Footprint
TEQ Fish = 24.9 ng/kg (BTV)
Total PCBs = 370 ug/kg (Midpoint)
MN Acreage = 29.5
WI Acreage = 5.8

Hotspot
TEQ Fish = 50 ng/kg
Total PCBs = 1000 ug/kg
MN Acreage = 15.3
WI Acreage = 4.7

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Date Drawn/Revised:8/6/2019 Project No.J190398

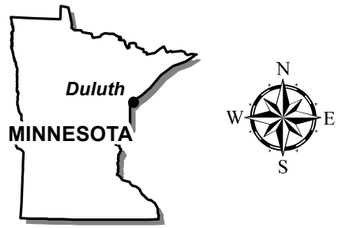
Y:\Clients\MPCA\SLR_Sediment_AOCs\Munger_Landing\MapDocs\J190398\001_FFS_Addendum_Figures\J190398 FIG 03 Remedial Footprint Map.mxd

Figure 4

Munger Landing SR1015 Human Health Remedial Footprint

Munger Landing SLR Sediment Sites

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Google Earth Aerial Imagery, 6/5/2017

0 500 1,000 Feet

0 150 300 Meters

- Human Health Remedial Footprint
- Maximum Wading and Swimming Depth – 5.5 feet
- Intertidal area – 0 feet
- Intertidal Zone

- BW17ML-052 — Water Covered Sediment (7.8 mg/kg)
- BW17ML-052 — Intertidal Sediment (1.6 mg/kg)
- Sewer Outfall
- SS — Sanitary Sewer
- ST — Storm Sewer
- Shipping Channel
- State Border
- Stream

Note:
Human health footprint is based on risk from swimming and wading activities.

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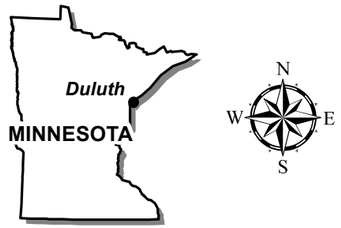
Y:\Clients\MPCA\SLR_Sediment_AOCs\Munger_Landing\MapDocs\J190398\001_FFS_Addendum_Figures\J190398 FIG 04 Human Health Remedial Footprint.mxd

Figure 5

Alternative 2
Monitored Natural Recovery
Munger Landing
SLR Sediment Sites
Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Google Earth Aerial Imagery, 6/5/2017

0 500 1,000 Feet

0 150 300 Meters

- Proposed Sample Locations
- Sewer Outfall
- Sanitary Sewer
- Storm Sewer
- Shipping Channel
- State Border
- Stream
- Ordinary High Water (OHW) Level at 602.8 ft (Vertical datum of IGLD85)

Bay West
Customer-Focused Environmental & Industrial Solutions

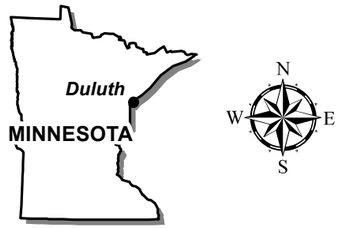
Drawn By: M.L. Date Drawn/Revised:8/6/2019 Project No.J170539

Y:\Clients\MPCA\SLR_Sediment_AOCs\Munger_Landing\MapDocs\J190398\001_FFS_Addendum_Figures\J190398 FIG 05 Munger Landing Alternative 2 Monitored Natural Recovery.mxd

Figure 6

Alternative 3 (formerly Alternative 4): Enhanced Monitored Natural Recovery with Thin-Layer Sand Cover

Munger Landing
SLR Sediment Sites
Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Google Earth Aerial Imagery, 6/5/2017

0 500 1,000 Feet
0 150 300 Meters

- Proposed Sample Locations
- Sewer Outfall
- Sanitary Sewer
- Storm Sewer
- Shipping Channel
- State Border
- Stream
- Ordinary High Water (OHW) Level at 602.8 ft (Vertical datum of IGLD85)
- Remedial Footprint
  - TEQ Fish = 24.9 ng/kg (BTV)
  - Total PCBs = 370 ug/kg (Midpoint)
  - MN Acreage = 29.5
  - WI Acreage = 5.8

Bay West
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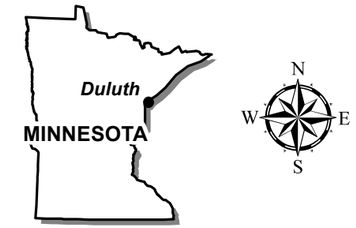
Y:\Clients\MPCA\SLR_Sediment_AOCs\Munger_Landing\MapDocs\J190398\001_FFS_Addendum_Figures\J190398 FIG 06 Munger Landing Alternative 3 Enhanced MNR with Thin Layer Amended Cover.mxd

Figure 7

Alternative 4 (formerly Alternative 5): Dredge Offsite Disposal

Munger Landing
SLR Sediment Sites
Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Google Earth Aerial Imagery, 6/5/2017

0 500 1,000 Feet
0 150 300 Meters

- Sewer Outfall
- Sanitary Sewer
- Storm Sewer
- Shipping Channel
- State Border
- Stream
- Ordinary High Water (OHW) Level at 602.8 ft (Vertical datum of IGLD85)
- Remedial Footprint
  - TEQ Fish = 24.9 ng/kg (BTV)
  - Total PCBs = 370 ug/kg (Midpoint)
  - MN Acreage = 29.5
  - WI Acreage = 5.8

Bay West
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Drawn By: M.L. Date Drawn/Revised:8/6/2019 Project No.J170539

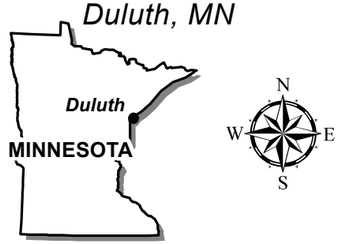
Y:\Clients\MPCA\SLR_Sediment_AOCs\Munger_Landing\MapDocs\J190398\001_FFS_Addendum_Figures\J190398 FIG 07 Munger Landing Alternative 4.mxd

Figure 8

Alternative 5 (formerly Alternative 6): Hotspot Dredge Offsite Disposal and Enhanced MNR with Thin-Layer Sand Cover

Munger Landing
SLR Sediment Sites

Duluth, MN



Map Projection: NAD 1983 UTM Zone 15 N
Basemap: Google Earth Aerial Imagery, 6/5/2017

0 500 1,000 Feet

0 150 300 Meters

- Proposed Sample Locations
- Sewer Outfall
- SS — Sanitary Sewer
- ST — Storm Sewer
- Shipping Channel
- State Border
- Stream
- Ordinary High Water (OHW) Level at 602.8 ft (Vertical datum of IGLD85)
- Remedial Footprint
  - TEQ Fish = 24.9 ng/kg (BTV)
  - Total PCBs = 370 ug/kg (Midpoint)
  - MN Acreage = 29.5
  - WI Acreage = 5.8
- Hotspot
  - TEQ Fish = 50 ng/kg
  - Total PCBs = 1000 ug/kg
  - MN Acreage = 15.3
  - WI Acreage = 4.7

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: M.L. Date Drawn/Revised:8/6/2019 Project No.J170539

Y:\Clients\MPCA\SLR_Sediment_AOCs\Munger_Landing\MapDocs\J190398\001_FFS_Addendum_Figures\J190398 FIG 08 Munger Landing Alternative 5.mxd

Tables

Table 1
Alternatives Summary
Focused Feasibility Study Addendum
Munger Landing
Minnesota Pollution Control Agency

Alternative	Alternative 1: No Action	Alternative 2: Monitored Natural Recovery	Alternative 3 (formerly Alternative 4): Enhanced MNR with Thin-Layer Sand Cover	Alternative 4 (formerly Alternative 5): Dredge, Offsite Disposal	Alternative 5 (formerly Alternative 6): Hotpsot Dredge Offsite Disposal & Enhanced MNR with Thin-Layer Sand Cover
Total Present Worth Cost	**$0**	**$244,000**	**$3,570,000**	**$19,346,000**	**$12,918,000**
Present Worth Cost - MN	$0	$244,000	$2,983,000	$16,167,000	$10,381,000
Present Worth Cost - WI	$0	$0	$587,000	$3,179,000	$2,537,000
Broadcast/Cover Area	0 acres	0 acres	35.3 acres (0.15-meter [6-inch] thin-layer sand cover	35.3 acres (0.15-meter [6-inch] sand dredge cover)	35.3 acres (0.15-meter [6-inch] thin-layer sand cover and dredge cover
Dredge Area	0 acres	0 acres	0 acres	35.3 acres	20 acres
Cover Volume - Sand/Amendment	0 CY Sand / 0 CY Amendment	0 CY Sand / 0 CY Amendment	28500 CY Sand / 0 CY Amendment) Total = 28500 CY	28500 CY Sand / 0 CY Amendment Total = 28500 CY	28500 CY Sand / 0 CY Amendment Total = 28500 CY
Dredge Volume	0 CY	0 CY	0 CY	121400 CY	68800 CY
Construction Timeframe	0 weeks	0 weeks	15 weeks	42 weeks over 2 construction seasons	38 weeks over 2 construction seasons
Monitoring Program	None	Chemical and physical sediment; benthic toxicity and bioaccumulation; fish tissue; bathymetric surveys	Chemical and physical sediment and cover; benthic toxicity and bioaccumulation; fish tissue	None, all contaminated sediment removed	Chemical and physical sediment and cover; benthic toxicity and bioaccumulation; fish tissue

Notes:

Cost are presented as rough order or magnitude Present Value.

Present worth costs for Minnesota and Wisconsin are based on the proportion of each remedial alternative within the respective state boundary.

CY = cubic yard

Table 2
Cost Estimate - Alternative 2: Monitored Natural Recovery
Focused Feasibility Study Addendum
Munger Landing
Minnesota Pollution Control Agency

Description	Unit	Estimated Unit Cost	Estimated Quantity	Extended Value	Present Value	Comments
Construction Costs						
No construction costs associated with this alternative						
Long-Term Monitoring						
Implementation Plan Report	Lump Sum	$ 11,000	1	$ 11,000	$ 11,000	Work Plan, Field Sampling Plan, QAPP
Monitoring and Evaluation Report	Each	$ 4,000	6	$ 24,000	$ 8,631	Every 5 years for 30 years
Field Sampling	Event	$ 34,000	6	$ 204,000	$ 73,366	Every 5 years for 30 years
Sample Analysis	Event	$ 35,920	6	$ 216,000	$ 77,509	Every 5 years for 30 years
Bathymetric Survey	Each	$ 10,000	6	$ 60,000	$ 21,578	Every 5 years for 30 years
Institutional Control Review	Each	$ 1,500	6	$ 9,000	$ 3,237	
			TOTAL	$ 524,000	$ 195,321	
			25% Contingency	$ 131,000	$ 48,830	
		LONG-TERM MONITORING GRAND TOTAL		$ 655,000	$ 244,000	
Professional and Technical Services						
No professional and technical services associated with this alternative						
			TOTAL	**$ 655,000**	**$ 244,000**	

Notes:
All values are based on 2016 dollars with an assumed discount rate of 7 percent per year. See Appendix A 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 3
Cost Estimate - Alternative 3 (formerly Alternative 4): Enhanced MNR with Thin-Layer Sand Cover
Focused Feasibility Study Addendum
Munger Landing
Minnesota Pollution Control Agency

Description	Unit	Estimated Unit Cost	Estimated Quantity	Extended Value	Present Value	Comments
Construction Costs						
Mobilization/Demobilization	Lump Sum	$ 205,000	1	$ 205,000	$ 191,589	All construction occurs on Year 1
Rent Hallett Dock #7 for Staging Area	Month	$ 10,000.00	4	$ 40,000	$ 37,383	
Install and Remove Dolphin Pilings	Lump Sum	$ 95,000.00	1	$ 95,000	$ 88,785	Required for barge tie-up
Purchase Amendment Materials and Stockpile at Staging Area	CY	$ 2,477.00	0	$ -	$ -	Assumed Sedimite for amendment application
Purchase Sand and Stockpile at Staging Area	CY	$ 20.80	28475	$ 592,280	$ 553,533	
Construct Thin-Layer Sand Cover	CY	$ 41.23	28475	$ 1,173,947	$ 1,097,146	462 CY per day production rate
Construction Monitoring/CQA and Oversight	Week	$ 13,000	15	$ 195,000	$ 182,243	15 week construction timeframe
Monthly Operating Expenses and Site Security	Month	$ 20,000	4	$ 80,000	$ 74,766	15 week construction timeframe
Implement Institutional Controls	Lump Sum	$ 10,000	1	$ 10,000	$ 9,346	Site postings; restrictions
			SUBTOTAL	$ 2,391,227	$ 2,234,791	
Long-Term Monitoring						
Monitoring and Evaluation Report	Each	$ 4,000	6	$ 24,000	$ 8,631	Every 5 years for 30 years
Field Sampling	Event	$ 34,000	6	$ 204,000	$ 73,366	Every 5 years for 30 years
Sample Analysis	Event	$ 35,920	6	$ 215,520	$ 77,509	Every 5 years for 30 years
			SUBTOTAL	$ 443,520	$ 159,506	
			TOTAL	$ 2,834,747	$ 2,394,297	
			25% Contingency	$ 708,687	$ 598,574	
			CONSTRUCTION GRAND TOTAL	$ 3,543,433	$ 2,992,871	
Professional and Technical Services						
Remedial Design (6%)	Lump Sum	$ 213,000	1	$ 213,000	$ 213,000	Year 0
Project Management and Permitting (5%)	Lump Sum	$ 177,000	1	$ 177,000	$ 165,421	Year 1
Construction Management (6%)	Lump Sum	$ 213,000	1	$ 213,000	$ 199,065	Year 1
			SUBTOTAL	$ 603,000	$ 577,486	
			TOTAL	**$ 4,146,000**	**$ 3,570,000**	

Notes:
All values are based on 2016 dollars with an assumed discount rate of 7 percent per year. See Appendix A 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 4
Cost Estimate - Alternative 4 (formerly Alternative 5): Dredge Offsite Disposal
Focused Feasibility Study Addendum
Munger Landing
Minnesota Pollution Control Agency

Description	Unit	Estimated Unit Cost	Estimated Quantity	Extended Value	Present Value	Comments
Construction Costs						
Mobilization/Demobilization	Lump Sum	$ 593,560	1	$ 593,560	$ 554,729	All construction occurs on Year 1
Rent Hallett Dock #7 for Staging Area	Month	$ 10,000.00	4	$ 40,000	$ 37,383	
Install and Remove Dolphin Pilings	Lump Sum	$ 95,000.00	1	$ 95,000	$ 88,785	Required for barge tie-up
Turbidity Controls	SF	$ 7.60	10280	$ 78,128	$ 73,017	
Debris Removal	Day	$ 44,302.00	3	$ 132,906	$ 124,211	
Dredge, Barge, and Stabilize Sediments	CY	$ 59.93	121419	$ 7,276,926	$ 6,800,866	740 CY production rate in 24 hr shift
Sediment Hauling and Landfill Disposal	Ton	$ 17.66	169987	$ 3,001,161	$ 2,804,823	Assumes 1.4 tons/CY
Purchase Sand and Stockpile at Staging Area	CY	$ 20.80	28475	$ 592,280	$ 553,533	
Construct Thin-Layer Cover	CY	$ 41.23	28475	$ 1,173,947	$ 1,097,146	462 CY per day production rate
Construction Quality Assurance Monitoring	Week	$ 13,000	42	$ 546,000	$ 510,280	26 weeks for first construction season, 16 weeks for second construction season
Construction Quality Assurance Sample Analysis	Lump Sum	$ 353,000	1	$ 353,000	$ 329,907	Dredge confirmation sampling
Monthly Operating Expenses and Site Security	Month	$ 20,000	10.5	$ 210,000	$ 196,262	26 weeks for first construction season, 16 weeks for second construction season
Implement Institutional Controls	Lump Sum	$ 10,000	1	$ 10,000	$ 9,346	Site postings; restrictions
			SUBTOTAL	$ 14,102,908	$ 13,180,288	
			TOTAL	$ 14,102,908	$ 13,180,288	
			25% Contingency	$ 3,525,727	$ 3,295,072	
			CONSTRUCTION GRAND TOTAL	$ 17,628,635	$ 16,475,360	
Professional and Technical Services						
Remedial Design (6%)	Lump Sum	$ 1,058,000	1	$ 1,058,000	$ 1,058,000	Year 0
Project Management and Permitting (5%)	Lump Sum	$ 881,000	1	$ 881,000	$ 823,364	Year 1
Construction Management (6%)	Lump Sum	$ 1,058,000	1	$ 1,058,000	$ 988,785	Year 1
			SUBTOTAL	$ 2,997,000	$ 2,870,150	
			TOTAL	**$ 20,626,000**	**$ 19,346,000**	

Notes:

All values are based on 2016 dollars with an assumed discount rate of 7 percent per year. See Appendix A 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 5 (formerly Alternative 6):
Hotspot Dredge Offsite Disposal Enhanced MNR with Thin-Layer Sand Cover
Focused Feasibility Study Addendum
Munger Landing
Minnesota Pollution Control Agency

Description	Unit	Estimated Unit Cost	Estimated Quantity	Extended Value	Present Value	Comments
Construction Costs						
Mobilization/Demobilization	Lump Sum	$ 296,780	1	$ 296,780	$ 277,364	All construction occurs on Year 1
Rent Hallett Dock #7 for Staging Area	Month	$ 10,000.00	4	$ 40,000	$ 37,383	
Install and Remove Dolphin Pilings	Lump Sum	$ 95,000.00	1	$ 95,000	$ 88,785	Required for barge tie-up
Turbidity Controls	SF	$ 7.60	10280	$ 78,128	$ 73,017	
Debris Removal	Day	$ 44,302.00	2	$ 88,604	$ 82,807	
Dredge, Barge, and Stabilize Sediments	CY	$ 59.93	68793	$ 4,122,898	$ 3,853,176	740 CY production rate in 24 hrs shift
Sediment Hauling and Landfill Disposal	Ton	$ 17.66	121419	$ 2,143,681	$ 2,003,441	Assumes 1.4 tons/CY
Purchase Sand and Stockpile at Staging Area	CY	$ 20.80	28475	$ 592,280	$ 553,533	
Construct Dredge Cover	CY	$ 41.23	28475	$ 1,173,947	$ 1,097,146	462 CY per day production rate
Purchase Amendment Materials and Stockpile at Staging Area	CY	$ 2,477	0	$ -	$ -	Assumed Sedimite for amendment application
Broadcast Amendment	CY	$ 105.11	0	$ -	$ -	168 CY per day production rate
Construction Quality Assurance Monitoring	Week	$ 13,000	38	$ 494,000	$ 461,682	38 week construction timeframe
Construction Quality Assurance Sample Analysis	Lump Sum	$ 79,000	1	$ 79,000	$ 73,832	Dredge confirmation sampling
Monthly Operating Expenses and Site Security	Month	$ 20,000	9.5	$ 190,000	$ 177,570	38 week construction timeframe
Implement Institutional Controls	Lump Sum	$ 10,000	1	$ 10,000	$ 9,346	Site postings; restrictions
			SUBTOTAL	$ 9,404,318	$ 8,789,083	
			TOTAL	$ 9,404,318	$ 8,789,083	
Long-Term Monitoring						
Monitoring and Evaluation Report	Each	$ 4,000	6	$ 24,000	$ 8,631	Every 5 years for 30 years
Field Sampling	Event	$ 34,000	6	$ 204,000	$ 73,366	Every 5 years for 30 years
Sample Analysis	Event	$ 35,920	6	$ 215,520	$ 77,509	Every 5 years for 30 years
			SUBTOTAL	$ 443,520	$ 159,506	
			TOTAL	$ 9,847,838	$ 8,948,588	
			25% Contingency	$ 2,461,960	$ 2,197,271	
			CONSTRUCTION GRAND TOTAL	$ 11,866,278	$ 10,986,353	
Professional and Technical Services						
Remedial Design (6%)	Lump Sum	$ 712,000	1	$ 712,000	$ 712,000	Year 0
Project Management and Permitting (5%)	Lump Sum	$ 593,000	1	$ 593,000	$ 554,206	Year 1
Construction Management (6%)	Lump Sum	$ 712,000	1	$ 712,000	$ 665,421	Year 1
			SUBTOTAL	$ 2,017,000	$ 1,931,626	
			TOTAL	**$ 13,883,000**	**$ 12,918,000**	

Notes:

All values are based on 2016 dollars with an assumed discount rate of 7 percent per year. See Appendix A 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
Comparative Analysis Summary - Threshold, Balancing, and Modifying Criteria
Focused Feasibility Study Addendum
Munger Landing
Minnesota Pollution Control Agency

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Monitored Natural Recovery	Alternative 3 (formerly Alternative 4): Enhanced MNR with Thin-Layer Sand Cover	Alternative 4 (formerly Alternative 5): Dredge, Offsite Disposal	Alternative 5 (formerly Alternative 6): Hotspot Dredge Offsite Disposal & Enhanced MNR with Thin-Layer Sand Cover
Threshold Criteria					
Overall Protection of Human Health & Environment	Provides **no achievement** of protection of Human Health and the Environment as contaminant concentrations remain with minimal controls to prevent exposure.	Provides **low achievement** of protection of Human Health and the Environment as contaminant concentrations remain with minimal controls to prevent exposure; however RAOs would be achieved over time.	Provides a **moderate achievement** of protection of Human Health and the Environment. Sediment contaminants would be covered through addition of an a thin-layer sand cover. May require monitoring to ensure effectiveness and future additions of amendment material.	Provides a **high achievement** of protection of Human Health and the Environment. Sediment contaminants would be completely removed from the remedial footprint and disposed of off-site.	Provides a **moderate to high achievement** of protection of Human Health and the Environment. The most contaminated sediments would be removed from the remedial footprint and the remaining sediment contaminants would be covered with a thin-layer sand cover. May require monitoring to ensure effectiveness and future additions of sand cover material.
ARARs	Provides **no achievement** 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; 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; however, COCs may not be reduced to concentrations less than RAOs in a reasonable time frame.	Provides a **high achievement** of ARARs if implemented properly.	Provides a **moderate to high achievement** of ARARs if implemented properly; however, COCs outside the hotspot area may not be reduced to concentrations less than RAOs in a reasonable time frame.
Primary Balancing Criteria					
Long-term Effectiveness and Permanence	Provides **no achievement** of long-term effectiveness and remedy is not long-term effective or permanent.	Provides a **low achievement** of long-term effectiveness and permanence because sediment contaminants would eventually be sequestered and degraded by natural processes and rendered unavailable to biota within the most biologically active zone; however, natural processes may not occur at rates to achieve RAOs in a reasonable timeframe.	Provides a **low to moderate achievement** of long-term effectiveness and permanence because sediment contaminants would eventually be sequestered by thin-layer cover materials and rendered unavailable to biota within the most biologically active zone; however, sequestration of contaminants at deeper intervals may not occur and monitoring and possible reapplication of thin-layer cover material may be necessary as contaminants would remain in place.	Provides a **high achievement** of long-term effectiveness and permanence because sediment contaminants would eventually be sequestered by amendment materials and rendered unavailable to biota within the most biologically active zone; however, sequestration of contaminants at deeper intervals may not occur and monitoring and possible reapplication of amendment material may be necessary as contaminants would remain in place.	Provides a **moderate achievement** of long-term effectiveness and permanence because sediment contaminants in the hotspot area would be completely removed and remaining sediment contaminants would eventually be sequestered by amendment materials and rendered unavailable to biota within the most biologically active zone; however, sequestration of contaminants at deeper intervals may not occur and monitoring and possible reapplication of amendment material may be necessary as contaminants would remain in place.
Reduction of Toxicity, Mobility or Volume through Treatment	Provides a **no achievement** of this criterion as no reduction in toxicity, mobility, or volume through treatment is provided.	Provides a **no achievement** of this criterion as no reduction in toxicity, mobility, or volume through treatment is provided.	Provides a **low achievement** of this criterion as the toxicity and mobility of sediment contaminants may be reduced over time through addition of a thin-layer sand cover over the sediment surface; however, it is possible that deeper sediment contamination could remain in place indefinitely and the time required to reduce sediment contamination from the thin-layer sand cover application my not be feasible to achieve RAOs	Provides a **high achievement** of this criterion as while the toxicity and mobility of sediment contaminants would not be reduced through treatment, the volume of contaminated sediment would be reduced through the complete removal of contaminated sediment in the remedial footprint.	Provides a **moderate achievement** of this criterion as the toxicity and mobility of sediment contaminants would be reduced over time through addition of a thin-layer sand cover at the sediment surface; however, it is possible that deeper sediment contamination could remain in place indefinitely. Though not through treatment, the volume of contaminated sediment would also be reduced through the removal of the hotspot remedial footprint
Short-term effectiveness	Provides a **moderate achievement** of this criterion as no actions are implemented, so no risks to the community would result from remedy implementation; however, receptors would continue to be exposed to contaminated sediment.	Provides a **moderate achievement** of this criterion as no remedial actions are implemented, so no risks to the community would result from remedy implementation and risk to workers is low; however, receptors would continue to be exposed to contaminated sediment.	Provides a **moderate to high achievement** of this criterion since thin-layer cover placement would temporarily displace the benthic community. Risks to workers is low.	Provides a **low achievement** of this criterion since excavation of all contaminated sediment within the remedial footprint would also remove the entire plant and benthic community, resulting in the longest recovery time of all the alternatives. The risk to site workers is relatively high due to the removal of sediments and associated transport to a landfill.	Provides a **moderate achievement** of this criterion since excavation of all contaminated sediment within the hotspot would also remove the entire plant and benthic community in that area; however, the rest of the remedial footprint would be minimally impacted with the addition of broadcast amendment. The risk to site workers is relatively high due to the removal of sediments and associated transport to a landfill.
Implementability	Provides a **high achievement** of this criterion as no actions would be implemented.	Provides a **high achievement** of this criterion as only monitoring would be required.	Provides a **moderate achievement** of implementability since it only requires placement of thin-layer cover material using proven methods with a low to moderate level of complexity.	Provides a **low achievement** of implementability since it is a more complex alternative to execute due to the coordination of dredging sediments and placement of sand cover.	Provides a **low to moderate achievement** of implementability since it involves complexities of both dredging and broadcasting amendment.
Cost (1)	$0	$244,000	$3,570,000	$19,346,000	$12,918,000
Modifying Criteria					
State Support / Agency Acceptance	TBD	TBD	TBD	TBD	TBD
Community Acceptance	TBD	TBD	TBD	TBD	TBD

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

Table 7
Comparative Analysis Summary - Green Sustainable Remediation Criteria
Focused Feasibility Study Addendum
Munger Landing
Minnesota Pollution Control Agency

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Monitored Natural Recovery	Alternative 3 (formerly Alternative 4): Enhanced MNR with Thin-Layer Sand Cover	Alternative 4 (formerly Alternative 5): Dredge, Offsite Disposal	Alternative 5 (formerly Alternative 6): Hotpsot Dredge Offsite Disposal & Enhanced MNR with Thin-Layer Sand Cover
Green Sustainable Remediation (GSR) Criteria*					
Green House Gas (GHG) Emissions	None.	None.	Total GHG emissions produced during cover material delivery and placement and equipment mobilization related to sampling activities.	Total GHG emissions produced during dredging, hauling and cover material delivery equipment mobilization related to sampling activities.	Total GHG emissions produced during dredging, hauling and cover material delivery equipment mobilization related to sampling activities.
Toxic Chemical Usage and Disposal	None.	No toxic chemicals are used or disposed.	No toxic chemicals are used or disposed.	No toxic chemicals are used or disposed.	No toxic chemicals are used or disposed.
Energy Consumption	None.	Fossil fuels are limited to the equipment mobilization for sampling activities.	Fossil fuels are limited to the equipment mobilization for sampling activities and cover placement operations.	Fossil fuels are limited to the equipment mobilization for sampling activities, dredging operations, and cover placement operations.	Fossil fuels are limited to the equipment mobilization for sampling activities, dredging operations, and cover placement operations.
Use of Alternative Fuels	None.	None.	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	None.	No water consumption is necessary.	Little water consumption is necessary.	Little water consumption is necessary.	Little water consumption is necessary.
Waste Generation	None.	No waste generation.	No waste generation.	Contaminated sediments from the remedial footprint would be removed and disposed of at a landfill.	Contaminated sediments from the hotspot area would be removed and disposed of at a landfill.
GSR Criteria Summary	Provides a **high achievement** of the GSR criterion.	Provides a **high achievement** of the GSR criterion.	Provides a **moderate to high achievement** of the GSR criterion.	Provides a **low achievement** of the GSR criterion.	Provides a **moderate achievement** of the GSR criterion.

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

Table 8
Numerical Comparative Analysis Summary
Focused Feasibility Study Addendum
Munger Landing
Minnesota Pollution Control Agency

Evaluation Criteria	Alternative 1: No Action	Alternative 2: Monitored Natural Recovery	**Alternative 3 (formerly Alternative 4): Enhanced MNR with Thin-Layer Sand Cover**	**Alternative 4 (formerly Alternative 5): Dredge, Offsite Disposal**	**Alternative 5 (formerly Alternative 6): Hotpsot Dredge Offsite Disposal & Enhanced MNR with Thin-Layer Sand Cover**
Overall Protection of Human Health & Environment	0	1	2	3	2.5
ARARs	0	1	2	3	2.5
Long-term Effectiveness and Permanence	0	1	1.5	3	2
Reduction of Toxicity, Mobility or Volume through Treatment	0	0	1	3	2
Short-term effectiveness	2	2	2.5	1	2
Implementability	3	3	2	1	1.5
Cost (1)	3	3	2	1	1.5
State Support / Agency Acceptance	TBD	TBD	TBD	TBD	TBD
Community Acceptance	TBD	TBD	TBD	TBD	TBD
Total Numerical Value	**8**	**11**	**13**	**15**	**14**

Notes

(1) Cost are presented as Present Value.

Ratings are based on achievement of criterion: no achievement, low achievement; moderate achievement; and high achievement.

Scores are based on 0 = no achievement; 1 = low achievement; 2 = moderate achievement; and 3 = high achievement.

Scoring for cost are based on the following cost breakpoints: > $15 million = low achievement; $5-15 Million = moderate achievement; and < $10 million = high achievement.

GSR criteria not included in this numerical comparison.

See Table 6 for a discussion of each criterion.