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Via Electronic Transmittal

December 23, 2015

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**Subject: Addendum to Revised Feasibility Study
Former Duluth Works and Spirit Lake Sediment Site
St. Louis River, Duluth, Minnesota**

Dear Ms. Endsley and Mr. Bryant:

Enclosed please find an Addendum to our revised Feasibility Study (FS) report for the Former Duluth Works – Spirit Lake Sediment Site (Site). This addendum is the result of our collaboration with the US Environmental Protection Agency – Great Lakes National Program Office (GLNPO), to plan for a sediment remediation and restoration project at the Site.

We look forward to continuing to work with you in moving this important remediation/restoration project forward into design, permitting and implementation. If you have any questions or comments regarding this document, please contact me at (219) 888-4400.

Sincerely,



John J. Prusiecki, Jr.

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Addendum to Feasibility Study

Former Duluth Works and Spirit Lake Sediment Site

Prepared for

Great Lakes Legacy Act Partnership between
United States Steel Corporation,
United States, Environmental Protection Agency, Great Lakes
National Program Office, and
Minnesota Pollution Control Agency

In consultation with

EA Engineering, Science, and Technology, Inc.

Prepared by

Barr Engineering Company
AECOM (formerly URS Corporation)

December 2015

Addendum to Feasibility Study
Former Duluth Works and Spirit Lake Sediment Site

December 2015

Contents

1.0	Introduction	1
1.1	Background	1
1.2	Purpose.....	1
1.2.1	Remedial Elements Discussed by Feedback Group	1
2.0	Updated Alternatives Evaluation	3
2.1	Description of Hybrid Alternative 8B	3
2.2	Detailed Evaluation of Updated Alternatives.....	4
2.3	Recommended Alternative	4
3.0	Recommendations and Path Forward	6
3.1	Recommended Project Alternative.....	6
3.2	Path Forward.....	8
3.2.1	Pre-Implementation Activities.....	8
3.2.2	Project Implementation	9
4.0	References	10

List of Tables

Table 2-1	Quantities Summary
Table 2-2	Screening Level Evaluation of Alternatives
Table 2-3	Evaluation Criteria
Table 2-4	Principles for Managing Contaminated Sediment Risks
Table 2-5	Detailed Analysis of Alternatives Summary - Alternative 4 - CDF on OU-M Delta (within Shoreline)
Table 2-6	Detailed Analysis of Alternatives Summary - Alternative 6 - Shallow Sheltered Bay with CDF
Table 2-7	Detailed Analysis of Alternatives Summary - Alternative 7 - Shallow Sheltered Bay and Delta Cap Area with Upland CDFs
Table 2-8	Detailed Analysis of Alternatives Summary - Alternative 8 - Shallow Sheltered Bay with Delta Sediment CDF and Upland CDFs
Table 2-9	Detailed Analysis of Alternatives Summary - Alternative 8B - Shallow Sheltered Bay with Delta Sediment CDF above OHWL and Upland CDFs
Table 2-10	Detailed Analysis of Alternatives Summary - Alternative 12 - Open Water Bay with Upland CDFs
Table 2-11	Alternatives Comparison
Table 2-12	Cost Estimate Summary

List of Figures

Figure 2-1	Alternative 8b - Shallow Sheltered Bay with Delta Sediment CDF above OHWL and Upland CDFs
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1.0 Introduction

1.1 Background

This addendum is prepared to update the *Revised Feasibility Study: Former Duluth Works and Spirit Lake Sediment Site* (Barr, AECOM, 2015), which was completed in July 2015 (hereafter referred to as the FS). The FS was conducted to develop and then evaluate alternatives to address potential risks to human health and the environment posed by impacts present at both the Duluth Works Site and the Estuary Site as described in Section 1.0 of the FS.

Upon completion of the FS, multiple meetings with stakeholders and resource managers occurred to review and discuss the FS report information. The Minnesota Pollution Control Agency (MPCA) and Great Lakes National Program Office (GLNPO) of Region V, United States Environmental Protection Agency (USEPA) sought feedback and input regarding the alternatives presented in Sections 5.5 through 5.6 of the FS. These discussions, occurring during the period August through October 2015; resulted in identifying further refinements to aspects shared by the detailed alternatives presented in the FS.

1.2 Purpose

The purpose of this Addendum is to present the results of additional discussions amongst the project partners, stakeholder and resource manager groups to modify the presented FS alternatives, and to communicate that alternative 8b is recommended by U. S. Steel and USEPA. These discussions identified a “hybrid” alternative that would achieve greater consensus from the stakeholders, and will be evaluated in this document.

1.2.1 Remedial Elements Discussed by Feedback Group

Stakeholders and resource managers provided feedback on the detailed alternatives presented in the FS. Suggested modifications were developed to address the concerns that were highlighted; following which, the stakeholders and resource managers provided further feedback and input that was taken into account to develop a hybrid alternative. The evolution of a hybrid alternative from the alternatives developed in Section 5.6 of the FS, required addressing and balancing competing stakeholder interests. The stakeholders and resource managers provided input and feedback throughout the multiple meetings that were facilitated by the USEPA. This Addendum describes the resulting hybrid alternative that evolved from this process and provides an updated detailed evaluation of alternatives. Below is a bulleted summary of the primary elements discussed and evaluated to develop the hybrid alternative evaluated in this FS addendum.

- Confined disposal facility (CDF) location and size
 - Upland development area concerns
 - Ordinary high water level (OHWL)/permitting concerns
 - Cultural concerns

-
- Visual impacts
 - Stormwater flow concerns
 - The amount of impacted (non-native) material removed from the estuary
 - Geotechnical challenges
 - Water front access
 - Desire for waterfront views and access
 - Recreational opportunities
 - The amount of impacted (non-native) material contained in the estuary
 - Sheltered Bay Configuration
 - Size and configuration
 - Water depths of shallow sheltered bay
 - Sheltering feature (shoal)
 - Future potential wild rice restoration opportunities in Spirit Lake
 - Future potential fisheries restoration opportunities in Spirit Lake

Discussions led to further development of modified or hybrid alternatives – the primary alternatives that were modified were – alternatives 8 and 12. A hybrid alternative called 8B was developed, and this new hybrid alternative has been evaluated against the prior 12 alternatives in Section 2.0 of this Addendum.

The format of the following Addendum sections generally follows the FS report organization of Sections 5.6 through 5.7.

2.0 Updated Alternatives Evaluation

2.1 Description of Hybrid Alternative 8B

Alternative 8B – Shallow Sheltered Bay with Delta Sediment CDF above OHWL and Upland CDFs

Alternative 8B includes elements of Alternative 8 and Alternative 12 that are combined into this hybrid alternative (Figure 2-1). Labels for the operable units (OU) and other areas shown on Figure 2.1 are defined in the FS. Alternative 8B includes excavation of impacted soils and sediment and placement of a 2-foot thick soil cap over OU-I and the CDA. Additionally, a restored estuary will be created where impacted material will be excavated from the OU-M Delta, creating a shallow sheltered bay (average water depth of 3 to 5 feet) and a shallow open water bay that maintains the existing water depth between the shoal feature and OU-M Delta CDF (average water depth of 1 to 2 feet). The shoal feature is intended to reduce wave energy and protect constructed remedy elements, as well as focusing and increasing seiche induced water flow into and out of the sheltered bay.

Alternative 8B also includes removal of sediments that exceed PRGs from near the shoreline in the southern portion of the Wire Mill Delta and the northern portion of the Unnamed Creek Delta (identified as "Remove" in Figure 2-1). Sediment will be removed from the designated areas in the northern portion of the Unnamed Creek estuary Delta to a target elevation and a cap will be placed (identified as "Remove to Set Elevation and Cap" in Figure 2-1) to create a shallow sheltered bay (average water depth of 3 to 5 feet), which is an element included in Alternative 8. In addition, sediments will also be removed from between the shoal feature and OU-M Delta CDF to a target elevation and a cap will be placed (identified as "Remove to Set Elevation and Cap" in Figure 2-1) to create an open water bay feature that maintains existing water depth (approximate water depth of 1 to 2 feet), which is an element included in Alternative 12. The OU-M Delta CDF will be confined to an elevation greater than the ordinary high water level (OHWL). The alternative also includes placement of a cap or an enhanced natural recovery (ENR) thin cover over portions of the estuary area (same areas shown for Alternatives 8 and 12).

Storm water flow upstream of the Unnamed Creek water level control weir that is located at the entrance road to the site, would be similar to current conditions and would include similar ponding capacity of peak flows. Downstream of the weir, storm water flow would be directed to the shallow sheltered bay created in the OU-M Delta.

Removed/Excavated Material Management – The majority of the materials will be consolidated in the CDF located in the OU-L/OU-M Upland area and the CDF located in the portion of the OU-M Delta that is above the OHWL and along the spit of land. A smaller amount of excavated soil/sediment will be consolidated in the OU-J area in a manner previously described in this report section. Only estuary sediments will be placed in the OU-M Delta CDF. The CDF berm heights will range from 10 feet to 25 feet. A shoal would be constructed at the mouth of the bay to serve as an energy dissipation barrier between the bay and the greater estuary and as a remedial cap. The final configuration of the shoal will be determined during detailed design with input from resource managers.

Change in Open Water – By constructing the OU-M Delta CDF above the OHWL and creating the open water bay between the shoal and CDF, the overall net gain of open water for Alternative 8B is more than in Alternative 8, which results in a net gain in open water for the estuary (Table 2-1) of 30 acres.

2.2 Detailed Evaluation of Updated Alternatives

The FS performed a screening evaluation of Alternatives 1 through 12 that concluded by identifying five Alternatives for detailed evaluation (Barr, AECOM, 2015). This Addendum adds a sixth (hybrid) Alternative and performs a new detailed evaluation of the following Alternatives:

- Alternative 4 – CDF on OU-M Delta (within Shoreline)
- Alternative 6 – Shallow Sheltered Bay with Low CDF
- Alternative 7 – Shallow Sheltered Bay and Delta Cap Area with Upland CDFs
- Alternative 8 – Shallow Sheltered Bay with Delta Sediment CDF and Upland CDFs
- Alternative 8B - Shallow Sheltered Bay with Delta Sediment CDF above OHWL and Upland CDFs (new hybrid of 8 and 12)
- Alternative 12 – Open Water Bay with Upland CDFs

The alternatives screened in the FS addendum are presented in Table 2-2 with the addition of Alternative 8B. The information summarized about the previously screened alternatives remains the same as presented in the FS. Alternative 8B includes elements of Alternatives 8 and 12 and reflects inputs from the resource managers and stakeholders. The hybrid alternative provides more open water creation and more sheltered bay conditions through positioning of a shallow shoal at the eastern side of the Unnamed Delta shallow sheltered bay. Alternative 8B addresses permitting concerns by keeping the foot print of the estuary CDF west of the OHWL.

Tables 2-3 and 2-4 summarize the FS evaluation criteria and principles for managing contaminated sediment risks.

Tables 2-5 through 2-10 present detailed evaluations of each of the six detailed alternatives. Table 2-11 presents the detailed alternatives comparison with scoring. Table 2-12 presents cost estimate information for each of the six detailed alternatives along with estimated cost ranges for associated post-implementation operation and monitoring costs.

2.3 Recommended Alternative

Based on the discussions and evaluations which led to development of a hybrid alternative and the detailed analysis presented above, **Alternative 8B-Shallow Sheltered Bay with Delta Sediment CDF above OHWL and Upland CDFs** compares favorably to and is fully consistent with the remedy evaluation criteria of the governing Federal statute, rules and guidance [the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), CERCLA's National Contingency Plan (NCP), USEPA's

Contaminated Sediment Guidance (2004)] and the Minnesota Environmental Response and Liability Act (MERLA). In addition, Alternative 8B favorably incorporates additional habitat enhancements. Alternative 8B is a hybrid developed from Alternatives 8 and 12 and is ranked amongst the upper echelon of alternatives in the FS screening evaluation (Table 2-2) (revision of Table 5-2 from the FS) and is ranked second in the detailed evaluation (Table 2-11), with Alternatives 4 and 8 scoring the same and ranking better than Alternative 8B.

Although Alternative 8B does not have the lowest (most favorable) score, it incorporates the additional factors articulated by resource managers and stakeholders after publication of the FS. These additional factors include: keeping the estuary CDF footprint above the OHWL and providing a greater amount of open water with varied water depths and protected conditions. Based on the input received after publication of the FS and evaluations made in this FS addendum, the project partners are recommending the higher cost alternative (Alternative 8B), rather than the alternative (Alternative 8) proposed in the FS as a compromise to move the project forward.

3.0 Recommendations and Path Forward

The FS evaluated Site conditions and developed a series of Conceptual Site Models (CSMs) to provide a detailed understanding of the nature, extent, and magnitude of the constituents of interest (COIs) across the Former Operations and Estuary portions of the Site. Using the process outlined in the FS, potential Project alternatives were identified, screened, and evaluated in detail to identify a preferred alternative. Input was received at multiple stages as outlined in the preceding sections of the FS. The U.S. EPA also entered into formal tribal consultations under Section 106 of the National Historic Preservation Act (NHPA). As noted in Sections 1.0 and 5.0 of the FS, an additional alternative was identified as a result of those consultations and Alternative 12 was evaluated with four other alternatives, the results of that evaluation are set forth in Section 5.0 of the FS.

Further stakeholder discussions have occurred since July 2015, using the FS as a tool to focus on project elements of importance to the stakeholders. A hybrid alternative was developed and this FS Addendum evaluated that hybrid alternative against the five detailed alternatives presented in the FS.

This section of the FS Addendum includes a discussion of the recommended Project alternative and outlines the path forward for implementation of a Project in the Former Operations and the Estuary areas of the Site.

3.1 Recommended Project Alternative

Using the FS process, this FS Addendum compared the six alternatives retained for detailed evaluation in Section 2.0. This Section summarizes the elements of the recommended project alternative (Alternative 8B) as it compares to the criteria set forth in the FS and the input received throughout the FS process.

Alternative 8B-Shallow Sheltered Bay with Delta Sediment CDF above OHWL and Upland CDFs was identified in Section 2.3 as the acceptable overall Project alternative because it compares favorably with CERCLA and MERLA's remedy evaluation threshold criteria while incorporating stakeholder input that meet the balancing criteria. **Alternative 8B** embodies numerous key elements of the remediation and habitat goals for the Former Operations and Estuary Areas of the site. It is reflective of important priorities identified by stakeholder input such as the creation of two shallow sheltered bay habitat areas; features which are currently absent in Spirit Lake. This alternative provides more acres of sheltered bay open water than Alternative 8. The need for shallow sheltered bay habitat is discussed in the Lower St. Louis River Habitat Plan (SLR-CAC, 2002) and Lower St. Louis River Habitat Plan Strategies Implementation Planning Worksheet: Project 2.7: Sheltered Bays/Shallow Wetlands- Spirit Lake (LimnoTech, 2012). This Alternative provides betterment of the St. Louis River AOC through habitat benefits such as the creation of two shallow sheltered bay areas, creation of more locations with water depth transitions from shallow to deeper water and shoal areas that can provide future sites for floating leaf emergent vegetation establishment. This alternative focuses the footprint of the OU-M Delta CDF to the area of OU-M above the OHWL. Alternative 8B provides these features in accordance with the conceptual goals of the AOC habitat objectives set forth in the Lower St. Louis River Habitat Plan (SLR-CAC, 2002) and the Lower St. Louis River Habitat Plan Strategies Implementation Planning Worksheet: Project 2.7: Sheltered

Bays/Shallow Wetlands- Spirit Lake (LimnoTech, 2012). In addition, the recommended alternative includes important stormwater retention elements in the Unnamed Creek drainage way. This Alternative incorporates a combination of remedial technologies and was developed out of an iterative, risk-based decision-making process that sought, and included input from various groups throughout the FS development as well as recent further stakeholder and resource manager input.

Alternative 8B reflects a balance of factors with respect to how it manages sediment in separate areas- Former Operations area sediments and some estuary sediments are consolidated in upland CDFs within the Unnamed Creek ravine where the CDF facilities have lower visual impact and can take some advantage of the valley side to help contain the material. A trade-off is required, however, due to space limitations and stormwater flow needs within the upper Unnamed Creek; which means that some estuary sediments, removed to create a shallow sheltered bay in the OU-M Delta area, are consolidated along with the remainder of the in-place OU-M Delta material in a low CDF constructed against the northern side of the Spit of Land. This will result in a broad peninsula beside what will be a longer and deeper embayment on the north. In consideration of potential permitting and cultural concerns, the peninsula will not extend east past the OHWL, meaning the Alternative 8B estuary CDF has a smaller footprint than the Alternative 8 estuary CDF and does not contain impacted materials in existing open water. The full thickness of sediments exceeding the PRGs will be removed from the WM Delta shore area and OU-P and -Q. This results in partially recreating the topography of the embayment that existed in this location prior to the Duluth Works site development. This results in an increase in open water and creation of a second shallow sheltered bay habitat area. Alternative 8B increases open water area by 30 acres, which is another important goal of the AOC delisting effort for the lower St. Louis River (SLR-CAC, 2002 and LimnoTech, 2012).

Comparison of the LimnoTech (2012) Spirit Lake Conceptual (Habitat) Restoration Plan with the preferred alternative, identified that although the spit of land will remain with a broad low CDF on its northern side, the majority of the project area will be available for implementing the conceptual plan for habitat improvements in Spirit Lake. Overall the preferred remedy is consistent with the conservation goals set forth in the Restoration Concept Plan. All four of the general habitat types identified in the plan would not be precluded by Alternative 8B. Open water – shallow, mid- and deep-water areas either already exist or would not be precluded over most areas of Spirit Lake. Shallow and deep marsh area could be expanded and would not be precluded by Alternative 8B. Saturated islands could be developed as broadly outlined in the Restoration Concept Plan.

The sustainability of Alternative 8B is also consistent with the overall Vision for this Project (Section 3). This alternative is consistent with CERCLA and USEPA's National Contingency Plan (NCP) remedy evaluation criteria (40 CFR §300.430), the Minnesota Environmental Response and Liability Act (MERLA, Minn. Stat. § 115B), the USEPA Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (EPA, 2002), and the USEPA Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA, 2005).

The 11 risk management principles outlined in the EPA guidance (EPA, 2002) are summarized in Section 6.0 of the FS with a brief discussion of how each principle has been applied throughout the RI/FS

process. The application of these remedy evaluation principles discussed in the FS, are equally applicable to Alternative 8B. In fact following principles 2 - *Involve the Community Early and Often* and 3 - *Coordinate with States, Local Governments, Tribes and Natural Resource Trustees*, has been part of the process that led to the development of this hybrid alternative, which is also fully consistent with the contaminated sediment risk management principles.

Added benefits to the recommended alternative are the improvements that could occur to the shoreline and shallow water areas of the Site once the remedial work is completed. Opportunities will exist for incorporating further habitat enhancements along the reconstructed shoreline. Previously prohibited shoreline and shallow water uses such as recreational access could be improved. The post-remedy configuration of shore features will be planned in consultation with the current land owners and neighboring stakeholders during Project design.

In addition, upland areas (Former Operations area) of the site are maintained for future redevelopment opportunities.

3.2 Path Forward

U. S. Steel, GLNPO and MPCA are following an aggressive project implementation path forward for the remaining pre-implementation activities described in Section 6.2.1 of the FS (Barr, AECOM, 2015) in order to meet the goal of beginning construction of the preferred alternative during 2016.

3.2.1 Pre-Implementation Activities

To meet this desired Project implementation schedule, several tasks will need to occur in parallel. Below is a summary of the primary pre-implementation tasks that need to occur prior to Project implementation.

- FS review and approval – completed
- Stakeholder discussions and tribal consultations regarding the proposed remedy
- FS Addendum review and finalization
- Finalization of the proposed remedy
- Secure Legacy Act funding for the Project implementation phase
- EAW preparation, public comment, and expeditious EIS decision
- Design development
 - Habitat elements included in design
 - Coordination with resource managers
- Collect supplemental sediment data to refine PRG extent and determine remedy element boundaries to support design, including areas with adjacent remedy elements – in progress

-
- Conduct supplemental geotechnical sampling and testing to support design for Alternative 8B – in progress
 - Negotiate and implement property access agreements and agreements regarding reconstruction of areas disturbed by the remedy construction, including replacement or new infrastructure
 - Permitting coordination, application preparation, and agency review (Appendix G, of the FS report)
 - Preparation of contractor bid documents, review contractor bids and select contractor

The MPCA will assist with the EAW and the permit review process to help meet the Project schedule.

3.2.2 Project Implementation

The recommended alternative is anticipated to require two full construction seasons to complete. Specific Project implementation schedules will be included as part of the design and will be determined based on input from the selected response action contractor.

Implementation of the recommended alternative, or any of the other alternatives retained for detailed analysis, may require full-time (24 hours per day/7 days per week) project operations at some areas of the Site. The design and associated documents, including the construction quality assurance plan, response action contractor implementation plan, Site-specific health and safety plan, and applicable permits or other regulatory requirements will determine the methods and frequency of monitoring to ensure compliance with applicable standards and guidelines, including noise, air emission quality, surface water quality and turbidity.

4.0 References

- Barr, AECOM, 2015. *Revised Feasibility Study: Former Duluth Works and Spirit Lake Sediment Site*. Prepared by Barr Engineering Company and AECOM (formerly URS) for Great Lakes Legacy Act Partnership between- United States Steel Corporation, United States, Environmental Protection Agency, Great Lakes National Program Office, and Minnesota Pollution Control Agency, in consultation with EA Engineering, Science, and Technology, Inc. July 2015.
- EPA, 2002. *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites*. U.S. EPA, Office of Emergency and Remedial Response, Washington D.C., OSWER Directive 928 5.6-08, February 12, 2002.
- EPA, 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*. U.S. EPA, Office of Emergency and Remedial Response, Washington D.C., OSWER Directive 9355.0-85, December 2005.
- LimnoTech, 2012. *Lower St. Louis River Habitat Plan Strategies Implementation Planning Worksheet, Project 2.7: Sheltered Bays/Shallow Wetlands – Spirit Lake, Conceptual Restoration Plan*, prepared for the Minnesota Pollution Control Agency with funding from GLRI, October 19, 2012.
- SLR-CAC, 2002. *Lower St. Louis River Habitat Plan*. Prepared by St. Louis River Citizens Action Committee (SLR CAC) with funding from U.S. EPA Grant X995385010, May, 2002.

Tables

Table 2-1
(FS Addendum - Revision of Table 5-1 to Include Alternative 8B)
Quantities Summary
U. S. Steel Former Duluth Works

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 8B	Alternative 9	Alternative 10	Alternative 11	Alternative 12
Removal Total Volume (cubic yards)	0	0	287,000	354,000	454,000	648,000	616,000	648,000	697,000	327,000	1,139,000	3,008,000	716,000

Capping Area (acres)	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 8B	Alternative 9	Alternative 10	Alternative 11	Alternative 12
Estuary Remedial Cap	--	172	57	77	78	91	91	91	102	121	121	--	114
Estuary ENR Thin Cover	--	--	30	30	30	30	30	30	30	30	30	--	30
Upland Remedial Cap	--	47	37	37	37	28	14	22	22	22	22	--	22
CDF Cap	--	--	57	36	42	46	31	23	23	23	34	76	40
Unnamed Creek Estuary Sediment CDF Cap	--	--	--	--	--	--	--	29	16	--	--	--	--
Delta Cap (Alternative 7 and 7B)	--	--	--	--	--	--	29	--	--	--	--	--	--
Total Area (acres)	0	219	181	181	187	196	196	196	194	196	207	76	207

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 8B	Alternative 9	Alternative 10	Alternative 11	Alternative 12
Net Change in Open Water (acres, relative to 601.1 FT LWD)	0	-48	-11	9	10	20	20	20	30	7	56	56	44

CDF Berm Height (feet)	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 8B	Alternative 9	Alternative 10	Alternative 11	Alternative 12
OU-M Delta/ Estuary Sediment CDF	--	--	4	8	9	19	--	6	10	--	--	--	--
OU-M Upland CDF	--	--	--	--	--	6	20	9	20	14	--	--	20
OU-I CDF	--	--	--	--	--	--	13	--	--	--	--	--	--
Behind OU-J CDF	--	--	--	--	25	25	25	25	25	25	--	--	25
Borrow Site CDF (Side Slope Height)	--	--	--	--	--	--	--	--	--	--	--	--	20
Upland Coke Plant Area CDF (Side Slope Height)	--	--	--	--	--	--	--	--	--	--	26	26	--

Table 2-2
 (FS Addendum - Revision of Table 5-2 to include Alternative 8B)
 SCREENING LEVEL EVALUATION OF ALTERNATIVES
 Former U. S. Steel Duluth Works - Spirit Lake Sediment Site
 Saint Louis River
 Duluth, Minnesota

Alternative	Description	Effectiveness of Achieving RAOs and Considerations		Implementability	Relative Cost Relative Rankings: #1 = lowest cost; #12 = highest cost	Screening Level Score (sum of Effectiveness, Implementability, and Cost scores)	Additional Factors for Consideration	Retained for Detailed Evaluation?
		Upland RAOs and Considerations • Protect human health and the environment • Provide a stable water course for stormwater conveyance and discharge • Preserve areas for economic development	Estuary RAOs and Considerations • Protect human health and the environment • Reduce beneficial use impairments for St. Louis River Area of Concern • Improve habitat (betterment)					
Alternative 1 No Action	No Action.	NA - current conditions		NA	NA	NA	NA	
Alternative 2 Remedial Capping	Alternative 2 is the "cap-only" option and involves placement of a remedial cap over portions of the Upland Site and the Estuary Site. Unnamed Creek would be re-routed to discharge into the former water intake area in the northern portion of Wire Mill Delta.	Low-Medium - 4 - Would be effective at protection of human health and environment as a result of physical barrier, but would not remove any impacted material. - Would be effective at achieving RAOs and Considerations, with the exception that it would result in the loss of open water habitat.	Medium - 3 - Large volume of capping material is necessary; however, traditional earthwork and subaqueous capping equipment could be used. - Construction of the Wire Mill discharge structure would be possible, but challenging.	Low-Medium - 2 Relative Cost Ranking: #2	9	As a result of cap placement, approximately 48 acres of open water would be lost.	No, because results in a net loss of aquatic habitat.	
Alternative 3 Delta/Estuary CDF	Alternative 3 involves removal of impacted sediments from the Upland Site and Estuary Site with placement in a CDF that extends from the OU-M Delta into the estuary. The alternative also involves placing a remedial cap over three areas on the Upland Site and placement of a remedial cap or ENR thin cover over a portion of the Estuary Site. Unnamed Creek would be allowed to pond in OU-I and would be re-routed to discharge into the former water intake area in the northern portion of Wire Mill Delta. Stormwater management in Alternative 3 would include construction of a small base-flow channel through OU-I (allowing OU-I to flood during high flow conditions).	Low-Medium - 4 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving RAOs and Considerations, with the exception that it would result in the loss of open water habitat.	Medium - 3 - Dredging, subaqueous capping and traditional earthwork equipment would be necessary. - Construction of the Wire Mill discharge structure would be possible, but challenging.	Low-Medium - 2 Relative Cost Ranking: #3	9	CDF located in OU-M Delta and estuary. CDF is placed on top of existing OU. Net loss of approximately 11 acres of open water.	No, because results in a net loss of aquatic habitat and both upland and estuary sediments are consolidated in a Delta/Estuary CDF.	
Alternative 4 CDF on OU-M Delta	Alternative 4 involves the same actions as Alternative 3 except that the extent of the CDF is entirely within OU-M Delta. Additional material would be removed from the estuary in the area that was covered by CDF in Alternative 3. Capping would involve three areas on the Upland Site and placement of a remedial cap or ENR thin cover over a portion of the Estuary Site. Stormwater management in Alternative 4 would include construction of a small base-flow channel through OU-I (allowing OU-I to flood during high flow conditions).	Medium-High - 2 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving all RAOs and Considerations. - Results in a net gain of open water as a result of removal from the Wire Mill pond; however, significant habitat improvement is not a major component.	Medium - 3 - Dredging, subaqueous capping and traditional earthwork equipment would be necessary. - Construction of the Wire Mill discharge structure would be possible, but challenging.	Low-Medium - 2 Relative Cost Ranking: #4	7	CDF is placed on top of existing OU.	Yes	
Alternative 5 CDF with Open Water Bay	Alternative 5 involves removal of impacted sediments from the Upland Site and Estuary Site with placement in a CDF that extends throughout a portion of OU-M Delta into the Estuary Site. The shape of the OU-M Delta/Estuary CDF creates an open water bay. A small CDF would also be constructed at OU-J. Capping would involve three areas on the Upland Site and placement of a remedial cap or ENR thin cover over a portion of the Estuary Site. Stormwater management in Alternative 5 would include construction of a small base-flow channel through OU-I (allowing OU-I to flood during high flow conditions) and discharge of Unnamed Creek into the open water bay.	High - 1 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving all RAOs and Considerations. - Significant habitat betterment would be achieved through creation of the open water bay.	Medium - 3 - Dredging, subaqueous capping and traditional earthwork equipment would be necessary.	Medium - 3 Relative Cost Ranking: #6	7	Placement of excavated and dredged sediments in a CDF that extends into the estuary. CDFs are placed on top of existing OUs. Open water bay (1 ft avg. depth) has less water depth than shallow sheltered bay (3 to 5 ft avg. depth). Less open water and shallower average water depth than Alternative 6.	No, because although similar to Alternative 6, this alternative does not provide a Shallow Sheltered Bay habitat improvement element.	
Alternative 6 Shallow Sheltered Bay with CDF	Alternative 6 involves removal of impacted sediments from the Upland Site and Estuary Site with placement in a CDF that extends throughout a portion of OU-M Upland and OU-M Delta and into the Estuary Site. Material removed from the Estuary Site would be placed in the Estuary portion of the CDF and material from the Upland Site would be placed in the Upland portion of the CDF. The shape of the CDF creates a shallow sheltered bay in OU-M and the estuary. Because the footprint is larger, the CDF height is lower than in Alternative 5. Capping and stormwater management are generally the same as in Alternative 5.	High - 1 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving all RAOs and Considerations. - Significant habitat betterment would be achieved through creation of a shallow sheltered bay.	Medium - 3 - Dredging, subaqueous capping and traditional earthwork equipment would be necessary.	Medium - 3 Relative Cost Ranking: #9	7	Creation of shallow sheltered bay. Placement of dredged sediments in a CDF constructed within the OU-M Delta and estuary. CDFs are placed on top of existing OUs.	Yes, because this alternative follows the AOC habitat plan more closely than Alternative 5.	
Alternative 7 Shallow Sheltered Bay and Delta Cap Area with Upland CDFs	Alternative 7 involves removal of impacted sediments from the Upland Site and Estuary Site with placement in several CDFs that are located entirely within the Upland site. A remedial cap would be placed over impacted materials on the spit-side of the OU-M Delta. Removal of impacted material from the landward side of the OU-M Delta would create a shallow sheltered bay. Construction of a CDF in OU-I would present stormwater challenges that would require additional permitting effort, and construction will require extensive soil stabilization, riprap channel, root barrier, and erosion protection against a large flood event that will impact the OU-I CDF and OU-J CDFs. Capping of the CDA in the Upland Site and capping of impacted sediments in portions of the Estuary Site would also be completed.	High - 1 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving all RAOs and Considerations. - Significant habitat betterment would be achieved through creation of a shallow sheltered bay.	Low-Medium - 4 - Dredging and traditional earthwork equipment would be necessary. - Construction of CDF in OU-I creates added stormwater management and engineering challenges - tall, steep berms and does not allow for stormwater ponding. - High flow stormwater discharge events would be difficult to accommodate in this alternative.	Medium-High - 4 Relative Cost Ranking: #11	9	Creation of shallow sheltered bay, with no placement of dredged sediments in OU-M Delta or the estuary. CDFs are placed on top of existing OUs. Does not allow for stormwater detention in OU-I area, creating challenges for erosion-control and bank stability on a short-term and long-term basis.	Yes, retained for comparison with Alternative 8 which differs mainly in location of one CDF and stormwater management capabilities.	

Table 2-2
 (FS Addendum - Revision of Table 5-2 to include Alternative 8B)
 SCREENING LEVEL EVALUATION OF ALTERNATIVES
 Former U. S. Steel Duluth Works - Spirit Lake Sediment Site
 Saint Louis River
 Duluth, Minnesota

Alternative	Description	Effectiveness of Achieving RAOs and Considerations		Implementability	Relative Cost Relative Rankings: #1 = lowest cost; #12 = highest cost	Screening Level Score (sum of Effectiveness, Implementability, and Cost scores)	Additional Factors for Consideration	Retained for Detailed Evaluation?
		Upland RAOs and Considerations • Protect human health and the environment • Provide a stable water course for stormwater conveyance and discharge • Preserve areas for economic development	Estuary RAOs and Considerations • Protect human health and the environment • Reduce beneficial use impairments for St. Louis River Area of Concern • Improve habitat (betterment)					
Alternative 8 Shallow Sheltered Bay with Delta Sediment CDF and Upland CDFs	Alternative 8 is similar to Alternative 7 except that material that is removed from OU-M Delta and the Estuary Site to create the shallow sheltered bay would be consolidated on the spit-side of OU-M Delta in a delta sediment CDF. All other material would be placed in CDFs located within OU-M Upland and at OU-J. Additional stormwater management actions would be required; however, they would likely be more readily constructed and permitted than those in Alternative 7. Stormwater management along Unnamed Creek, from OU-J to OU-M Upland would be similar to the described for Alternative 5. Capping of two areas in the Upland Site and capping of impacted sediments in portions of the Estuary Site would also be completed.	High - 1 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving all RAOs and Considerations. - Significant habitat betterment would be achieved through creation of a shallow sheltered bay.		Medium - 3 - Dredging, subaqueous capping and traditional earthwork equipment would be necessary.	Medium - 3 Relative Cost Ranking: #7	7	Only material that is removed to create the shallow sheltered bay is consolidated within the OU-M Delta and estuary (same material is consolidated together). CDFs are placed on top of existing OUs.	Yes
Alternative 8B Shallow Sheltered Bay with Delta Sediment CDF Above OHWL and Upland CDFs	Alternative 8B includes elements of Alternatives 8 and 12. The OU-M Delta CDF does not extend beyond the OHWL into the estuary. Only estuary sediments will be placed in the OU-M Delta CDF. All other material would be placed in CDFs located within OU-M Upland and at OU-J. The berm height for the OU-M Upland would be taller than Alternative 8. Both a Shallow Sheltered Bay and Open Water Bay will be created for this alternative. Stormwater management along Unnamed Creek, from OU-J to OU-M Upland would be similar to the described for Alternative 8. Capping of two areas in the Upland Site and capping of impacted sediments in portions of the Estuary Site would also be completed.	High - 1 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving all RAOs and Considerations. - Significant habitat betterment would be achieved through creation of a shallow sheltered bay and open water bay.		Low-Medium - 4 - Dredging, subaqueous capping and traditional earthwork equipment would be necessary. - Consolidation of large volume of sediment in OU-M Upland results in tall berms.	Medium - 3 Relative Cost Ranking: #8	8	Only material that is removed to create the shallow sheltered bay is consolidated within the OU-M Delta CDF (same material is consolidated together). CDFs are placed on top of existing OUs.	Yes
Alternative 9 Upland CDF and Delta Cover	Alternative 9 is similar to Alternative 7 in that all material is consolidated in an upland CDF. However, in Alternative 9, there is not a CDF in OU-I, since less total sediment is being removed. Another difference is that a remedial cap is placed throughout the OU-M Delta, eliminating the creation of a shallow sheltered bay. Capping of two areas in the Upland Site and capping of impacted sediments in portions of the Estuary Site would also be completed.	Medium-High - 2 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving all RAOs and Considerations. - Results in a net gain of open water as a result of Upland sediment removal from the Wire Mill Delta; however, significant habitat improvement is not a major component.		Low-Medium - 4 - Dredging, subaqueous capping and traditional earthwork equipment would be necessary.	Medium - 3 Relative Cost Ranking: #5	9	Placement of impacted sediments in upland CDFs. CDFs are placed on top of existing OUs. Significant habitat improvement is not a major component. Capping OU-M Delta may require wetland mitigation. Stormwater conveyance a challenge at outer OU-M Delta.	No, lacks significant habitat betterment at Unnamed Creek Delta.
Alternative 10 Targeted Removal with Coke Plant Area CDF	Alternative 10 involves removal of impacted sediments from the Upland Site and Estuary Site and placement in an approximately 35 acre CDF located in the potentially developable area of the Upland Site. Capping of the two areas in the Upland site and capping of impacted sediments in portions of the Estuary Site would also be completed.	Medium - 3 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving all RAOs and Considerations except for preserving areas for economic benefit (construction of large CDF in Upland Site would eliminate possibility for development). - Results in a net gain of open water as a result of Upland Site removal; however, significant habitat improvement is not a major component.		Low-Medium - 4 - Dredging, subaqueous capping and traditional earthwork equipment would be necessary. - Large volume of sediment to remove and transport to Upland CDF. - Would cause a high degree of disruption to the Site. - Large volume of water to be treated.	High - 5 Relative Cost Ranking: #12	12	Significant habitat improvement is not a major component. Developable upland area lost due to the construction of an upland consolidation area.	No
Alternative 11 Removal with Large Coke Plant Area CDF	Alternative 11 is the "remove all" option and involves removal of all sediments that exceed criteria in the Estuary Site and Upland Site. Removed materials would be deposited in a nearly 80 acre CDF located in the potentially developable area of the Upland Site. Capping is not included in this Alternative, though the CDF will include a final cover.	Medium - 3 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Would be effective at achieving all RAOs and Considerations except for preserving areas for economic benefit (construction of large CDF in Upland Site would eliminate possibility for development).		Low - 5 - Dredging and traditional earthwork equipment would be necessary. - Very large volume of sediment to remove and transport. - Would cause a high degree of disruption to the Site. - Very large volume of water to be treated.	High - 5 Relative Cost Ranking: #13	13	Developable upland area lost due to the construction of an upland consolidation area.	No
Alternative 12 Open Water Bay with Upland CDFs	Alternative 12 involves removal of impacted sediments from the Upland Site and the Estuary Site and placement in several Upland CDFs. Alternative 12 is unique from other alternatives for several reasons: (1) no material is placed in the OU-M Delta. (2) Some removed material will be placed in a CDF that will be constructed in an area referred to as the "Borrow Site." (3) Removal of material from the OU-M Delta will create an open water bay that is larger than other alternatives with a similar feature. Capping of two areas in the Upland Site and capping of impacted sediments in portions of the Estuary Site would also be completed.	Medium-High - 2 - Would be effective at protection of human health and environment as a result of cap placement and impacted material removal. - Significant habitat betterment would be achieved through creation of the shallow sheltered bay. - Would be effective at achieving all RAOs and Considerations except for preserving areas for economic benefit (construction of large CDF in Upland Site would eliminate possibility for development).		Low-Medium - 4 - Dredging, subaqueous capping and traditional earthwork equipment would be necessary. - Sediment would be transported greater distances than in all alternatives except for Alternatives 10 and 11. - Consolidation of large volume of sediment in OU-M Upland CDF results in high berms.	Medium-High - 4 Relative Cost Ranking: #10	10	More area of open water generated but shallower average water depth than shallow sheltered bays in other alternatives. No placement of removed material in OU-M Delta. CDF constructed in non-impacted portion of site.	Yes, retained for comparison based on feedback from project partners.

Screening Key:	Effectiveness	Implementability	Cost	Overall Score
	Highest Effectiveness - 1 point	Highest Implementability - 1 point	Lowest Cost - 1 point	<4
	Medium-High Effectiveness - 2 points	Medium-High Implementability - 2 points	Low-Medium Cost - 2 points	5-7 points
	Medium Effectiveness - 3 points	Medium Implementability - 3 points	Medium Cost - 3 points	8-10 points
	Low-Medium Effectiveness - 4 points	Low-Medium Implementability - 4 points	Medium-High Cost - 4 points	11-13 points
	Lowest Effectiveness - 5 points	Lowest Implementability - 5 points	Highest Cost - 5 points	>13 points

Lowest score is the most desirable

Table 2-3
 (FS Addendum - Formerly Table 5-3)
 EVALUATION CRITERIA
 Former U. S. Steel Duluth Works - Spirit Lake Sediment Site
 Saint Louis River
 Duluth, Minnesota

Category	Criteria	Description	Factors Considered
Threshold Criteria	Overall Protection of Human Health and the Environment	How does the alternative achieve and maintain protection of human health and the environment?	Elimination, reduction, or control of current and potential/future risks from direct or indirect exposure to COIs by representative individuals and targeted environmental species based on site specific exposure scenarios and site specific understanding of COI fate and transport.
	Compliance with Regulatory Requirements (ARARs)	How does the alternative comply with applicable regulatory requirements and ARARs?	<ul style="list-style-type: none"> - Review and understanding of the requirements for compliance with action-specific, location-specific and chemical specific ARARs. - Compliance with other criteria, advisories and guidance.
Balancing Criteria	Long Term Effectiveness and Permanence	The functional ability of the completed activities to maintain protection of human health and the environment after response actions have been implemented by removal or destruction of materials containing COIs or engineered barriers to prohibit contact with materials containing COIs.	<ul style="list-style-type: none"> - Magnitude of residual risk. - Adequacy and reliability of containment or control systems including: safety factors for engineered barriers; operation, maintenance, and monitoring of programs for containment systems; and institutional measures to maintain and report on long-term activities, as necessary.
	Reduction of Toxicity and Mobility (Overall Risk)	Quantitative assessment of the mass and/or volume of material that is transformed, removed from the site, or contained in a manner that prohibits future migration of COIs or direct or indirect exposures.	<ul style="list-style-type: none"> - Process used and materials mitigated. - Expected reductions in toxicity, mobility and volume. - Degree to which the remedy reduces principal threats.
	Short-Term Effectiveness	Consideration of the effect of secondary impacts associated with the implementation of an alternative and their related impacts on human health and the environment near the site during construction and implementation of a remedy and continuing until the response objectives have been achieved.	<ul style="list-style-type: none"> - Protection of the local community during remedial actions from potential environmental impacts including dust, noise, erosion, increased traffic, or other factors. - Environmental impacts of remedial actions. - Duration of remedial actions.
	Implementability	Evaluation of the technical and administrative feasibility of completing an alternative including the availability of services, materials, equipment and skilled manpower and other resources needed to successfully complete the Project.	<ul style="list-style-type: none"> - Ability to construct and operate the technology. - Reliability of the technology. - Coordination with other stakeholders and agencies. - Capacity and availability of necessary equipment and specialists.
	Cost	An engineering estimate of the likely capital and O&M cost of each alternative, with appropriate contingencies to match the preliminary nature of the design work completed and the design work that will remain prior to implementing the Project.	<ul style="list-style-type: none"> - Capital costs. - Operating and maintenance costs. - Performance period/duration of construction. - Proportionality between the risk reduction and cost of the remedy.

Table 2-4
 (FS Addendum - Formerly Table 5-4)
 PRINCIPLES FOR MANAGING CONTAMINATED SEDIMENT RISKS
 Former U. S. Steel Duluth Works - Spirit Lake Sediment Site
 Saint Louis River

Risk Management Principle ¹	Summary
1. Control Sources Early.	<ul style="list-style-type: none"> -Identify direct and indirect sources of significant contamination to the sediments under investigation. -Assess which continuing sources can be controlled and by what mechanisms. -Evaluate the potential for future recontamination of sediments when selecting a response action.
2. Involve the Community Early and Often.	<ul style="list-style-type: none"> -Ensure early and meaningful community involvement by providing community members with necessary technical information for their informed participation. -Provide affected parties with the same information used by the decision makers. -Include all affected parties in the entire decision-making process to the extent possible. -Allow adequate time for evaluation and comment on the information by all parties.
3. Coordinate with States, Local Governments, Tribes, and Natural Resource Trustees.	<ul style="list-style-type: none"> -Communicate and coordinate early to ensure the most relevant information is considered and that these viewpoints are considered in the remedy selection process.
4. Develop and Refine a Conceptual Site Model that Considers Sediment Stability.	<ul style="list-style-type: none"> -A conceptual site model should identify all known and suspected sources of contamination. The types of contaminants and affected media, existing and potential pathways, and the known or potential human and ecological receptors that may be threatened. -Prepare the conceptual site model early and use it to guide site investigations and decision making. -Update conceptual site model when new information becomes available and understanding of the site increases. -Conceptual site model is especially important at sediment sites for understanding the complex interrelationships and potential for changing conditions.
5. Use an Iterative Approach in a Risk-Based Framework.	<ul style="list-style-type: none"> -Use a risk-based framework or strategy for remedy evaluation and selecting response actions appropriate for the site. -Use an iterative approach that incorporates testing of hypotheses/conclusions and fosters re-evaluation of site assumptions as new information is gathered. -Consider the benefits of phasing remediation especially when early action is needed to quickly reduce risks or control the spread of contamination. -This framework should not be used to delay a decision at a site if sufficient information is available to make an informed decision.
6. Carefully Evaluate the Assumptions and Uncertainties Associated with Site Characterization Data and Site Models.	<ul style="list-style-type: none"> -The amount of site specific data required and complexity of models used to support site decisions should depend on the complexity of the site and significance of the decision. -Clearly describe the basis for all models used and their uncertainties when using the predicted results to make a site decision.
7. Select Site-Specific, Project-Specific, and Sediment-Specific Risk Management Approaches that will Achieve Risk-Based Goals.	<ul style="list-style-type: none"> -There is no presumptive remedy for any contaminated sediment sites, regardless of the contaminant or level of risk. -Evaluate all remedies that may potentially meet the project goals/objectives prior to selecting the site remedy. -Remedies should be evaluated on a comparative basis, considering all components of the remedies, temporal and spatial aspects of the site and the overall risk reduction potentially achieved. -At many sites, a combination of options will be the most effective to manage risk.
8. Ensure that Sediment Cleanup Levels are Clearly Tied to Risk Management Goals.	<ul style="list-style-type: none"> -While it is generally more practical to use measures such as contaminant concentrations in sediment to identify areas to be remediated, other measures can be used to ensure human health and/or ecological risk reduction goals are being met.
9. Maximize the Effectiveness of Institutional Controls and Recognize their Limitations.	<ul style="list-style-type: none"> -Institutional controls are often used as a component of the remedial decisions at sediment sites to limit human exposures and to prevent further contaminant redistribution until remedial action objectives are met. -Institutional controls may not be effective in eliminating or significantly reducing all exposures.
10. Design Remedies to Minimize Short-term Risks while Achieving Long-term Protection.	<ul style="list-style-type: none"> -Consider the advantages and disadvantages of available options and balance the risks, costs and benefits of each option. -Identify and consider short-term and long-term impacts of each alternative on societal and cultural practices, as appropriate.
11. Monitor During and After Sediment Remediation to Assess and Document Remedy Effectiveness.	<ul style="list-style-type: none"> -Establish a physical, chemical and/or biological monitoring program to determine if risks are being mitigated and to evaluate remedy effectiveness. -Collect baseline data for use in comparing and long-term remedy effectiveness. -Identify long term monitoring indicators that are used to determine the success of a remedy in meeting broader remedial objectives.

¹ Based on "Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites." EPA OSWER. 12 February 2002.

Table 2-5
 (FS Addendum - Revision of Table 5-5 to include Alternative 8B)
 DETAILED ANALYSIS OF ALTERNATIVES SUMMARY
 Alternative 4 – CDF on OU-M Delta (within Shoreline)
 Former U. S. Steel Duluth Works - Spirit Lake Sediment Site
 Saint Louis River
 Duluth, Minnesota

<u>Criteria and Applicable Factors</u>	<u>Detailed Analysis Summary</u>
<p>Overall Protection of Human Health and the Environment <u>Human Health Protection</u></p> <ul style="list-style-type: none"> Mitigate the potential for direct contact with and/or incidental ingestion of, impacted soils and sediment. Addresses potential recreational and trespass user risks. <p><u>Environmental Protection</u></p> <ul style="list-style-type: none"> Reduce the potential for unacceptable risk to ecological receptors. 	<p>Implementation of Alternative 4 is anticipated to be protective of human health and the environment. The actions of excavating and dredging impacted soils/sediment and consolidating these materials within an OU-M delta CDF will partially cover the greatest thickness of non-native sediment and reduce the footprint of impacted materials across the Site. The complimentary actions of remedial capping and placement of an ENR thin cover will eliminate direct human health exposure pathways and control the risk to ecological receptors.</p>
<p>Compliance with Regulatory Requirements (ARARs) <u>Compliance with Applicable Regulatory Guidance</u></p> <ul style="list-style-type: none"> Meets the regulatory requirements of governing agencies. <p><u>Compliance with ARARs</u></p> <ul style="list-style-type: none"> Actions are permit-able by stakeholder agencies 	<p>Execution of Alternative 4 will address regulatory requirements by achieving Upland RAOs and Estuary SMGs.</p>
<p>Long-Term Effectiveness and Permanence <u>Magnitude of Residual Risk</u></p> <ul style="list-style-type: none"> Remedy addresses residual risk to human health and the environment. <p><u>Adequacy and Reliability of Containment or Controls</u></p> <ul style="list-style-type: none"> Remedy is permanent and effective in the long-term. 	<p>The combination of removal, consolidation and capping of impacted soil and sediment will effectively mitigate residual risk by eliminating human health and ecological exposure pathways in the FS areas of concern. The remedy is permanent, but will require long-term monitoring and O&M to maintain effectiveness of engineering controls. Institutional controls layered over engineering controls will address the future threat of disturbance to protective measures associated with this remedy. Diversion of storm water to the former plant water intake area will require engineered energy dissipation and armoring structures that will require on-going maintenance.</p>
<p>Reduction of Toxicity and Mobility (Overall Risk) <u>Process Used and Materials Mitigated</u> <u>Expected Reductions in Toxicity, Mobility and Volume</u> <u>Type and Quantity of Materials Remaining After Implementation</u> <u>Degree to which the Remedy Reduces Principal Threats</u></p>	<p>Alternative 4 will be effective in reducing the overall risk posed by COIs present in the Upland and Estuary areas of the Site. This alternative utilizes industry-proven methods for removal, consolidation and capping of impacted soil and sediment. The volume of impacted material will be reduced through off-site disposal of characteristic hazardous lead-impacted soil from OU-Q. However, the future mobility of COI will be eliminated through implementation of proposed engineering controls.</p>
<p>Short-Term Effectiveness <u>Protection of Community during Remedial Actions</u> <u>Environmental Impacts of Remedial Actions</u> <u>Duration of Remedial Actions</u></p>	<p>Implementation of Alternative 4 is not anticipated to have a significant adverse effect on the community or environment while construction is underway. Construction-related traffic will be moderate and proper protective measures will be implemented to eliminate exposure risk to the community. Best management practices will be implemented during construction to minimize environmental impacts. The duration of Alternative 4 is consistent with Alternatives 6, 8 and 8B and is expected to encompass two years.</p>
<p>Implementability <u>Ability to Construct and Operate the Technology</u> <u>Reliability of the Technology</u> <u>Coordination with Other Stakeholders and Agencies</u> <u>Capacity and Availability of Equipment and Specialists</u></p>	<p>Alternative 4 is implementable and will provide a reliable remedy to address risks posed by COCs present in the Upland and Estuary areas of the Site. The technology associated with this alternative is proven and there are no perceived capacity or availability issues with earth moving and dredging contractors who will perform the work. Placement of a CDF within the OU-M delta presents slightly increased logistical challenges associated with longer haul routes from some removal areas.</p>
<p>Cost <u>Capital Costs</u> <u>Long-Term O&M Costs</u> <u>Performance Period</u></p>	<p>Alternative 4 is identified as the lowest cost alternative advancing to detailed analysis. Long-term O&M is projected to be slightly higher than Alternatives 6, 8 and 8B because of maintenance of the concrete stormwater structures. The O&M costs are projected to be similar to Alternative 12, but less than Alternative 7. The estimated two year duration of Alternative 4 construction is also consistent with Alternatives 6, 8 and 8B.</p>

Table 2-6
 (FS Addendum - Revision of Table 5-6 to include Alternative 8B)
 DETAILED ANALYSIS OF ALTERNATIVES SUMMARY
 Alternative 6 – Shallow Sheltered Bay with CDF
 Former U. S. Steel Duluth Works - Spirit Lake Sediment Site
 Saint Louis River
 Duluth, Minnesota

<u>Criteria and Applicable Factors</u>	<u>Detailed Analysis Summary</u>
<p>Overall Protection of Human Health and the Environment <u>Human Health Protection</u></p> <ul style="list-style-type: none"> Mitigate the potential for direct contact with and/or incidental ingestion of impacted soils and sediment. Addresses potential recreational and trespass user risks. <p><u>Environmental Protection</u></p> <ul style="list-style-type: none"> Reduce the potential for unacceptable risk to ecological receptors. 	<p>Implementation of Alternative 6 is anticipated to be protective of human health and the environment. The actions of excavating and dredging impacted soils/sediment and consolidating these materials within OU-M (delta and upland) CDF will partially cover the greatest thickness of non-native sediment and reduce the footprint of impacted materials across the Site. The complimentary actions of remedial capping and placement of an ENR thin cover will eliminate direct human health exposure pathways and control the risk to ecological receptors.</p>
<p>Compliance with Regulatory Requirements (ARARs) <u>Compliance with Applicable Regulatory Guidance</u></p> <ul style="list-style-type: none"> Meets the regulatory requirements of governing agencies. <p><u>Compliance with ARARs</u></p> <ul style="list-style-type: none"> Actions are permit-able by stakeholder agencies 	<p>Execution of Alternative 6 will address regulatory requirements by achieving Upland RAOs and Estuary SMGs. The portion of the CDF residing in the OU-M delta extends along the Spit of Land eastward beyond the OHWL. The open water element north of the CDF creates additional layers of permitting and compliance with ARARs will be more complicated in comparison to Alternatives 4 and 7.</p>
<p>Long-Term Effectiveness and Permanence <u>Magnitude of Residual Risk</u></p> <ul style="list-style-type: none"> Remedy addresses residual risk to human health and the environment. <p><u>Reliability of Controls</u></p> <ul style="list-style-type: none"> Remedy is permanent and effective in the long-term. 	<p>The combination of removal, consolidation and capping of impacted soil and sediment will effectively mitigate residual risk by eliminating human health and ecological exposure pathways in the FS areas of concern. The remedy is permanent, but will require long-term monitoring and O&M to maintain effectiveness of engineering controls. Institutional controls layered over engineering controls will address the future threat of disturbance to protective measures associated with this remedy. Future storm water conveyance will generally follow the current Unnamed Creek alignment and discharge to the shallow sheltered bay created north of the CDF. This alignment, in tandem with storm water retention and ponding components within OU-I, provides the lowest risk option for managing storm water in the future consolidation/capping areas.</p>
<p>Reduction of Toxicity and Mobility (Overall Risk) <u>Process Used and Materials Mitigated</u> <u>Expected Reductions in Toxicity, Mobility and Volume</u> <u>Type and Quantity of Materials Remaining After Implementation</u> <u>Degree to which the Remedy Reduces Principal Threats</u></p>	<p>Alternative 6 will be effective in reducing the overall risk posed by COCs present in the Upland and Estuary areas of the Site. This alternative utilizes industry-proven methods for removal, consolidation and capping of impacted soil and sediment. The volume of impacted material will be reduced through off-site disposal of characteristic hazardous lead-impacted soil from OU-Q. However, the future mobility of COCs will be eliminated through implementation of proposed engineering controls.</p>
<p>Short-Term Effectiveness <u>Protection of Community during Remedial Actions</u> <u>Environmental Impacts of Remedial Actions</u> <u>Duration of Remedial Actions</u></p>	<p>Implementation of Alternative 6 is not anticipated to have a significant adverse effect on the community or environment while construction is underway. Construction-related traffic will be moderate and proper protective measures will be implemented to eliminate exposure risk to the community. Best management practices will be implemented during construction to minimize environmental impacts. The duration of Alternative 6 is consistent with Alternatives 4, 8 and 8B and is expected to encompass a term of two years.</p>
<p>Implementability <u>Ability to Construct and Operate the Alternative</u> <u>Reliability of the Alternative</u> <u>Coordination with Other Stakeholders and Agencies</u> <u>Capacity and Availability of Equipment and Specialists</u></p>	<p>Alternative 6 is implementable and will provide a reliable remedy to address risks posed by COCs present in the Upland and Estuary areas of the Site. The technology associated with this alternative is proven and there are no perceived capacity or availability issues with earth moving and dredging contractors who will perform the work. To reduce haul routes and consolidate finer grained industrial sediment close to the area of original deposition, dredge material from the OU-M delta, the Unnamed Creek delta and the Wire Mill delta will be placed within a comparatively narrow CDF along the Spit of Land. Consolidation of these materials within a restricted foot-print will create potential sight-line impairments with a peak height of 29 feet above the estuary. Loading of soft sediment and long term berm/slope stability are unique design and construction challenges for this structure. Material derived from shallow storm water-related improvements in OU-I will be contained within a small valley-fill CDF south of OU-J.</p>
<p>Cost <u>Capital Costs</u> <u>Long-Term O&M Costs</u> <u>Performance Period</u></p>	<p>Alternative 6 is comparatively higher in cost than Alternatives 4 and 8, because of a larger OU-M delta CDF with more significant berms and material handling requirements, consistent in cost with Alternative 8B, but less than Alternative 7 and Alternative 12. Long-term O&M is projected to be similar to Alternative 8 and less than Alternatives 4 and 7 because of fewer stormwater management requirements. The approximate two year duration of Alternative 6 construction is also consistent with Alternatives 4, 8, and 8B.</p>

Table 2-7

(FS Addendum - Revision of Table 5-7 to include Alternative 8B)

DETAILED ANALYSIS OF ALTERNATIVES SUMMARY

Alternative 7 – Shallow Sheltered Bay and Delta Cap Area with Upland CDFs

Former U. S. Steel Duluth Works - Spirit Lake Sediment Site

Saint Louis River

Duluth, Minnesota

<u>Criteria and Applicable Factors</u>	<u>Detailed Analysis Summary</u>
<p>Overall Protection of Human Health and the Environment</p> <p><u>Human Health Protection</u></p> <ul style="list-style-type: none"> Mitigate the potential for direct contact with and/or incidental ingestion of impacted soils and sediment. Addresses potential recreational and trespass user risks. <p><u>Environmental Protection</u></p> <ul style="list-style-type: none"> Reduce the potential for unacceptable risk to ecological receptors. 	<p>Implementation of Alternative 7 is anticipated to be protective of human health and the environment. The actions of excavating and dredging impacted soils/sediment and consolidating these materials within the Unnamed Creek corridor will reduce the footprint of impacted materials across the Site. The complimentary actions of remedial capping and placement of an ENR thin cover will eliminate direct human health exposure pathways and control the risk to ecological receptors.</p>
<p>Compliance with Regulatory Requirements (ARARs)</p> <p><u>Compliance with Applicable Regulatory Guidance</u></p> <ul style="list-style-type: none"> Meets the regulatory requirements of governing agencies. <p><u>Compliance with ARARs</u></p> <ul style="list-style-type: none"> Actions are permit-able by stakeholder agencies. 	<p>Implementation of Alternative 7 will address regulatory requirements by achieving Upland RAOs and Estuary SMGs. This alternative simplifies permitting and compliance with ARARs by eliminating placement of a CDF east of the railway tracks.</p>
<p>Long-Term Effectiveness and Permanence</p> <p><u>Magnitude of Residual Risk</u></p> <ul style="list-style-type: none"> Remedy addresses residual risk to human health and the environment. <p><u>Reliability of Controls</u></p> <ul style="list-style-type: none"> Remedy is permanent and effective in the long-term. 	<p>The combination of removal, consolidation and capping of impacted soil and sediment will effectively mitigate residual risk by eliminating human health and ecological exposure pathways in the FS areas of concern. The remedy is permanent, but will require long-term monitoring and O&M to maintain effectiveness of engineering controls. The level of effort associated with long-term O&M is anticipated to be higher comparative to other alternatives as this alternative involves construction of three challenging CDFs. Institutional controls layered over engineering controls will address the future threat of disturbance to protective measures associated with this remedy. Future storm water conveyance presents the greatest challenge and risk among the alternatives advancing to detailed analysis. Consolidation of impacted media within the Unnamed Creek corridor will eliminate storm water retention and ponding within OU-I and create a constricted channel for managing peak flows. Enhanced armoring of the creek channel will be necessary to mitigate CDF berm and slope failure risks. Enhanced stabilization of CDF berms along the Unnamed Creek stream channel will be necessary to prevent CDF berm and slope failure issues.</p>
<p>Reduction of Toxicity and Mobility (Overall Risk)</p> <p><u>Process Used and Materials Mitigated</u></p> <p><u>Expected Reductions in Toxicity, Mobility and Volume</u></p> <p><u>Type and Quantity of Materials Remaining After Implementation</u></p> <p><u>Degree to which the Remedy Reduces Principal Threats</u></p>	<p>Alternative 7 will be effective in reducing the overall risk posed by COIs present in the Upland and Estuary areas of the Site. This alternative utilizes industry-proven methods for removal, consolidation and capping of impacted soil and sediment. The volume of impacted material will be reduced through off-site disposal of characteristic hazardous lead-impacted soil from OU-Q. However, the future mobility of COCs will be eliminated through implementation of proposed engineering controls.</p>
<p>Short-Term Effectiveness</p> <p><u>Protection of Community during Remedial Actions</u></p> <p><u>Environmental Impacts of Remedial Actions</u></p> <p><u>Duration of Remedial Actions</u></p>	<p>Implementation of Alternative 7 is not anticipated to have a significant adverse effect on the community or environment while construction is underway. However, this alternative presents the greatest challenge for temporary storm water management during construction due to extensive filling and construction activity within the Unnamed Creek corridor. Construction-related traffic will be moderate and proper protective measures will be implemented to eliminate exposure risk to the community. Best management practices will be implemented during construction to minimize environmental impacts. The duration of Alternative 7 is the longest among the alternatives advancing to detailed analysis and is expected to encompass a term of three years.</p>
<p>Implementability</p> <p><u>Ability to Construct and Operate the Technology</u></p> <p><u>Reliability of the Technology</u></p> <p><u>Coordination with Other Stakeholders and Agencies</u></p> <p><u>Capacity and Availability of Equipment and Specialists</u></p>	<p>Alternative 7, while the most challenging, is implementable and will provide a reliable remedy to address risks posed by COIs present in the Upland and Estuary areas of the Site. The technology associated with this alternative is proven and there are no perceived capacity or availability issues with earth moving and dredging contractors who will perform the work. Alternative 7 will entail consolidation of all removed soil and sediment into a CDF located west of the railway tracks. Consolidation of these materials within the space constraints of Unnamed Creek corridor results in three high CDF structures with peak heights ranging from 25 feet above grade (within the OU-I area to 29 feet above grade (within the OU-M upland area). Loading of soft sediment and long term berm/slope stability are unique design and construction challenges for these structures. The long-term risk of failure is also increased given the concerns cited for storm water conveyance.</p>
<p>Cost</p> <p><u>Capital Costs</u></p> <p><u>Long-Term O&M Costs</u></p> <p><u>Performance Period</u></p>	<p>Alternative 7 is the highest construction cost alternative because of the need to construct 3 CDFs and implement more robust stormwater management features. It will yield the highest annual O&M costs due to the requirement of maintaining three CDF structures and potentially less stable storm water conveyance features. The duration of Alternative 7 construction is expected to encompass a term of three years.</p>

Table 2-8

(FS Addendum - Revision of Table 5-8 to include Alternative 8B)

DETAILED ANALYSIS OF ALTERNATIVES SUMMARY

Alternative 8 – Shallow Sheltered Bay with Delta Sediment CDF and Upland CDFs

Former U. S. Steel Duluth Works - Spirit Lake Sediment Site

Saint Louis River

Duluth, Minnesota

<u>Criteria and Applicable Factors</u>	<u>Detailed Analysis Summary</u>
<p>Overall Protection of Human Health and the Environment</p> <p><u>Human Health Protection</u></p> <ul style="list-style-type: none"> Mitigate the potential for direct contact with and/or incidental ingestion of impacted soils and sediment. Addresses potential recreational and trespass user risks. <p><u>Environmental Protection</u></p> <ul style="list-style-type: none"> Reduce the potential for unacceptable risk to ecological receptors. 	<p>Implementation of Alternative 8 is anticipated to be protective of human health and the environment. Similar to other alternatives, the actions of excavating and dredging impacted soils/sediment and consolidating these materials within CDF structures will partially cover residual non-native sediment and reduce the footprint of impacted materials across the Site. The complimentary actions of remedial capping and placement of an ENR thin cover will eliminate direct human health exposure pathways and control the risk to ecological receptors.</p>
<p>Compliance with Regulatory Requirements (ARARs)</p> <p><u>Compliance with Applicable Regulatory Guidance</u></p> <ul style="list-style-type: none"> Meets the regulatory requirements of governing agencies. <p><u>Compliance with ARARs</u></p> <ul style="list-style-type: none"> Actions are permit-able by stakeholder agencies 	<p>Execution of Alternative 8 will address regulatory requirements by achieving Upland RAOs and Estuary SMGs. To create a shallow sheltered bay habitat betterment in the OU-M delta, non-native sediment excavated during this process will be consolidated within a low profile, single source CDF extending along the Spit of Land eastward beyond the OHWL. This open water element creates additional layers of permitting and compliance with ARARs in comparison to Alternatives 4 and 7.</p>
<p>Long-Term Effectiveness and Permanence</p> <p><u>Magnitude of Residual Risk</u></p> <ul style="list-style-type: none"> Remedy addresses residual risk to human health and the environment. <p><u>Reliability of Controls</u></p> <ul style="list-style-type: none"> Remedy is permanent and effective in the long-term. 	<p>The combination of removal, consolidation and capping of impacted soil and sediment will effectively mitigate residual risk by eliminating human health and ecological exposure pathways in the FS areas of concern. The remedy is permanent, but will require long-term monitoring and O&M to maintain effectiveness of engineering controls. The level of effort associated with long-term O&M for the three CDFs is anticipated to be similar to Alternative 6 and 8B but less than Alternative 7. Institutional controls layered over engineering controls will address the future threat of disturbance to protective measures associated with this remedy. Future storm water conveyance will generally follow the current Unnamed Creek alignment and discharge to the shallow sheltered bay created north of the CDF. This alignment, in tandem with storm water retention and ponding components within OU-I, provides the lowest risk option for managing storm water in the future consolidation/capping areas.</p>
<p>Reduction of Toxicity and Mobility (Overall Risk)</p> <p><u>Process Used and Materials Mitigated</u></p> <p><u>Expected Reductions in Toxicity, Mobility and Volume</u></p> <p><u>Type and Quantity of Materials Remaining After Implementation</u></p> <p><u>Degree to which the Remedy Reduces Principal Threats</u></p>	<p>Alternative 8 will be effective in reducing the overall risk posed by COIs present in the Upland and Estuary areas of the Site. This alternative utilizes industry-proven methods for removal, consolidation and capping of impacted soil and sediment. The volume of impacted material will be reduced through off-site disposal of characteristic hazardous lead-impacted soil from OU-Q. However, the future mobility of COCs will be eliminated through implementation of proposed engineering controls.</p>
<p>Short-Term Effectiveness</p> <p><u>Protection of Community during Remedial Actions</u></p> <p><u>Environmental Impacts of Remedial Actions</u></p> <p><u>Duration of Remedial Actions</u></p>	<p>Implementation of Alternative 8 is not anticipated to have a significant adverse effect on the community or environment while construction is underway. Construction-related traffic will be moderate and proper protective measures will be implemented to eliminate exposure risk to the community. Best management practices will be implemented during construction to minimize environmental impacts. The duration of Alternative 8 is consistent with Alternatives 4 and 6 and 8B and is expected to encompass a term of two years.</p>
<p>Implementability</p> <p><u>Ability to Construct and Operate the Alternative</u></p> <p><u>Reliability of the Alternative</u></p> <p><u>Coordination with Other Stakeholders and Agencies</u></p> <p><u>Capacity and Availability of Equipment and Specialists</u></p>	<p>Alternative 8 is implementable and will provide a reliable remedy to address risks posed by COIs present in the Upland and Estuary areas of the Site. The technology associated with this alternative is proven and there are no perceived capacity or availability issues with earth moving and dredging contractors who will perform the work. Consolidation of non-native sediment will largely be proximal to its source area, improving construction efficiencies and simplifying staging. Material derived from the OU-M delta shallow sheltered bay removal area will be contained in the same area within the delta sediment CDF. Material derived from the estuary dredge areas, as well as OU-P and Q and the Unnamed Pond will be contained within the OU-M upland area CDF. Material derived from shallow storm water-related improvements in OU-I will be contained within a small valley-fill CDF south of OU-J.</p>
<p>Cost</p> <p><u>Capital Costs</u></p> <p><u>Long-Term O&M Costs</u></p> <p><u>Performance Period</u></p>	<p>Alternative 8 is comparatively higher in cost than Alternative 4, but is exceeded by Alternatives 6, 7, 8B and 12 among the options advancing to detailed analysis. Long-term O&M is projected to be in alignment with Alternatives 6, and 8B but less than Alternatives 4 and 7 because of fewer stormwater management requirements. The approximate two year duration of Alternative 8 construction is also consistent with Alternatives 4 and 6 and 8B.</p>

Table 2-9

(FS Addendum - Revision to include Alternative 8B)

DETAILED ANALYSIS OF ALTERNATIVES SUMMARY

Alternative 8B – Shallow Sheltered Bay with Delta Sediment CDF above OHWL and Upland CDFs

Former U. S. Steel Duluth Works - Spirit Lake Sediment Site

Saint Louis River

Duluth, Minnesota

<u>Criteria and Applicable Factors</u>	<u>Detailed Analysis Summary</u>
<p>Overall Protection of Human Health and the Environment</p> <p><u>Human Health Protection</u></p> <ul style="list-style-type: none"> Mitigate the potential for direct contact with and/or incidental ingestion of impacted soils and sediment. Addresses potential recreational and trespass user risks. <p><u>Environmental Protection</u></p> <ul style="list-style-type: none"> Reduce the potential for unacceptable risk to ecological receptors. 	<p>Implementation of Alternative 8B is anticipated to be protective of human health and the environment. Similar to other alternatives, the actions of excavating and dredging impacted soils/sediment and consolidating these materials within CDF structures will partially cover residual non-native sediment and reduce the footprint of impacted materials across the Site. The complimentary actions of remedial capping and placement of an ENR thin cover will eliminate direct human health exposure pathways and control the risk to ecological receptors.</p>
<p>Compliance with Regulatory Requirements (ARARs)</p> <p><u>Compliance with Applicable Regulatory Guidance</u></p> <ul style="list-style-type: none"> Meets the regulatory requirements of governing agencies. <p><u>Compliance with ARARs</u></p> <ul style="list-style-type: none"> Actions are permit-able by stakeholder agencies 	<p>Execution of Alternative 8B will address regulatory requirements by achieving Upland RAOs and Estuary SMGs. To create a shallow sheltered bay and open water bay habitat betterment in the OU-M delta, non-native sediment excavated during this process will be consolidated within a low profile, single source CDF along the Spit of Land. The CDF will not extend eastward beyond the OHWL, resulting in less permitting requirements.</p>
<p>Long-Term Effectiveness and Permanence</p> <p><u>Magnitude of Residual Risk</u></p> <ul style="list-style-type: none"> Remedy addresses residual risk to human health and the environment. <p><u>Reliability of Controls</u></p> <ul style="list-style-type: none"> Remedy is permanent and effective in the long-term. 	<p>The combination of removal, consolidation and capping of impacted soil and sediment will effectively mitigate residual risk by eliminating human health and ecological exposure pathways in the FS areas of concern. The remedy is permanent, but will require long-term monitoring and O&M to maintain effectiveness of engineering controls. The level of effort associated with long-term O&M for the three CDFs is anticipated to be similar to Alternative 6 and 8 but less than Alternative 7. Institutional controls layered over engineering controls will address the future threat of disturbance to protective measures associated with this remedy. Future storm water conveyance will generally follow the current Unnamed Creek alignment and discharge to the shallow sheltered bay created north of the CDF. This alignment, in tandem with storm water retention and ponding components within OU-I, provides the lowest risk option for managing storm water in the future consolidation/capping areas.</p>
<p>Reduction of Toxicity and Mobility (Overall Risk)</p> <p><u>Process Used and Materials Mitigated</u></p> <p><u>Expected Reductions in Toxicity, Mobility and Volume</u></p> <p><u>Type and Quantity of Materials Remaining After Implementation</u></p> <p><u>Degree to which the Remedy Reduces Principal Threats</u></p>	<p>Alternative 8B will be effective in reducing the overall risk posed by COIs present in the Upland and Estuary areas of the Site. This alternative utilizes industry-proven methods for removal, consolidation and capping of impacted soil and sediment. The volume of impacted material will be reduced through off-site disposal of characteristic hazardous lead-impacted soil from OU-Q. However, the future mobility of COCs will be eliminated through implementation of proposed engineering controls.</p>
<p>Short-Term Effectiveness</p> <p><u>Protection of Community during Remedial Actions</u></p> <p><u>Environmental Impacts of Remedial Actions</u></p> <p><u>Duration of Remedial Actions</u></p>	<p>Implementation of Alternative 8B is not anticipated to have a significant adverse effect on the community or environment while construction is underway. Construction-related traffic will be moderate and proper protective measures will be implemented to eliminate exposure risk to the community. Best management practices will be implemented during construction to minimize environmental impacts. The duration of Alternative 8B is consistent with Alternatives 4, 6 and 8 and is expected to encompass a term of two years.</p>
<p>Implementability</p> <p><u>Ability to Construct and Operate the Alternative</u></p> <p><u>Reliability of the Alternative</u></p> <p><u>Coordination with Other Stakeholders and Agencies</u></p> <p><u>Capacity and Availability of Equipment and Specialists</u></p>	<p>Alternative 8B is implementable and will provide a reliable remedy to address risks posed by COIs present in the Upland and Estuary areas of the Site. The technology associated with this alternative is proven and there are no perceived capacity or availability issues with earth moving and dredging contractors who will perform the work. Consolidation of non-native sediment will largely be proximal to its source area, improving construction efficiencies and simplifying staging. Material derived from the OU-M delta shallow sheltered bay removal area will be split between the area within the delta sediment CDF and the OU-M upland area CDF. The berms at the OU-M Upland CDF will be much higher than in Alternatives 6, and 8, and similar to those in Alternative 7 and 12. Material derived from the estuary dredge areas, as well as OU-P and Q and the Unnamed Pond will be contained within the OU-M upland area CDF. Material derived from shallow storm water-related improvements in OU-I will be contained within a small valley-fill CDF south of OU-J.</p>
<p>Cost</p> <p><u>Capital Costs</u></p> <p><u>Long-Term O&M Costs</u></p> <p><u>Performance Period</u></p>	<p>Alternative 8B is similar in cost to Alternatives 6 and 8, comparatively higher in cost than Alternative 4, but is exceeded by Alternatives, 7, and 12 among the options advancing to detailed analysis. Long-term O&M is projected to be in alignment with Alternatives 6 and 8, but less than Alternatives 4 and 7 because of fewer stormwater management requirements. The approximate two year duration of Alternative 8B construction is also consistent with Alternatives 4, 6 and 8.</p>

Table 2-10
 (FS Addendum - Revision of Table 5-9 to include Alternative 8B)
 DETAILED ANALYSIS OF ALTERNATIVES SUMMARY
 Alternative 12 – Open Water Bay with Upland CDFs
 Former U. S. Steel Duluth Works - Spirit Lake Sediment Site
 Saint Louis River
 Duluth, Minnesota

<u>Criteria and Applicable Factors</u>	<u>Detailed Analysis Summary</u>
<p>Overall Protection of Human Health and the Environment <u>Human Health Protection</u></p> <ul style="list-style-type: none"> Mitigate the potential for direct contact with and/or incidental ingestion of impacted soils and sediment. Addresses potential recreational and trespass user risks. <p><u>Environmental Protection</u></p> <ul style="list-style-type: none"> Reduce the potential for unacceptable risk to ecological receptors. 	<p>Implementation of Alternative 12 is anticipated to be protective of human health and the environment. Similar to other alternatives, the actions of excavating and dredging impacted soils/sediment and consolidating these materials within CDF structures will partially cover residual non-native sediment and reduce the footprint of impacted materials across the Site. The complimentary actions of remedial capping and placement of an ENR thin cover will eliminate direct human health exposure pathways and control the risk to ecological receptors.</p>
<p>Compliance with Regulatory Requirements (ARARs) <u>Compliance with Applicable Regulatory Guidance</u></p> <ul style="list-style-type: none"> Meets the regulatory requirements of governing agencies. <p><u>Compliance with ARARs</u></p> <ul style="list-style-type: none"> Actions are permit-able by stakeholder agencies 	<p>Execution of Alternative 12 will address regulatory requirements by achieving Upland RAOs and Estuary SMGs. To create an open water bay habitat betterment in the OU-M delta, non-native sediment excavated during this process will be removed from the delta and placed in several upland CDFs. This alternative simplifies permitting by eliminating placement of a CDF east of the railway tracks but retains a third CDF location that requires other permitting considerations.</p>
<p>Long-Term Effectiveness and Permanence <u>Magnitude of Residual Risk</u></p> <ul style="list-style-type: none"> Remedy addresses residual risk to human health and the environment. <p><u>Reliability of Controls</u></p> <ul style="list-style-type: none"> Remedy is permanent and effective in the long-term. 	<p>The combination of removal, consolidation and capping of impacted soil and sediment will effectively mitigate residual risk by eliminating human health and ecological exposure pathways in the FS areas of concern. The remedy is permanent, but will require long-term monitoring and O&M to maintain effectiveness of engineering controls. The level of effort associated with long-term O&M for the three CDFs is anticipated to be more than Alternatives 6, 8 and 8B because the third CDF is located a significant distance away from the other two CDFs. However, the level of effort is anticipated to be less than Alternative 7. Institutional controls layered over engineering controls will address the future threat of disturbance to protective measures associated with this remedy. Future storm water conveyance will generally follow the current Unnamed Creek alignment and discharge to the open water bay created north of the spit. This alignment, in tandem with storm water retention and ponding components within OU-I, provides the lowest risk option for managing storm water in the future consolidation/capping areas.</p>
<p>Reduction of Toxicity and Mobility (Overall Risk) <u>Process Used and Materials Mitigated</u> <u>Expected Reductions in Toxicity, Mobility and Volume</u> <u>Type and Quantity of Materials Remaining After Implementation</u> <u>Degree to which the Remedy Reduces Principal Threats</u></p>	<p>Alternative 12 will be effective in reducing the overall risk posed by COIs present in the Upland and Estuary areas of the Site. This alternative utilizes industry-proven methods for removal, consolidation and capping of impacted soil and sediment. The volume of impacted material will be reduced through off-site disposal of characteristic hazardous lead-impacted soil from OU-Q. However, the future mobility of COCs will be eliminated through implementation of proposed engineering controls.</p>
<p>Short-Term Effectiveness <u>Protection of Community during Remedial Actions</u> <u>Environmental Impacts of Remedial Actions</u> <u>Duration of Remedial Actions</u></p>	<p>Implementation of Alternative 12 is not anticipated to have a significant adverse effect on the community or environment while construction is underway. Construction-related traffic will be moderate but likely less than the other options advancing to detailed analysis because material generated from excavation of the borrow site CDF will be utilized for earthwork, reducing the volume of imported material required. However, more on-site transportation will be required because of the haul distance to the CDFs. Proper protective measures will be implemented to eliminate exposure risk to the community. Best management practices will be implemented during construction to minimize environmental impacts. Because of the additional volume removed from the OU-M Delta, construction of tall berms at the OU-M Upland CDF, and excavation of the Borrow Site CDF, the construction duration is expected to encompass a term of three years, which is longer than Alternatives 4, 6, 8 and 8B and consistent with Alternative 7.</p>
<p>Implementability <u>Ability to Construct and Operate the Alternative</u> <u>Reliability of the Alternative</u> <u>Coordination with Other Stakeholders and Agencies</u> <u>Capacity and Availability of Equipment and Specialists</u></p>	<p>Alternative 12 is implementable and will provide a reliable remedy to address risks posed by COIs present in the Upland and Estuary areas of the Site. The technology associated with this alternative is proven and there are no perceived capacity or availability issues with earth moving and dredging contractors who will perform the work. Although consolidation of non-native material will be proximal to its source area where feasible, on average it will require greater travel distances than Alternatives 8 and 8B, reducing construction efficiencies and complicating staging. The OU-M Upland CDF will be filled with material generated from the Unnamed Creek dredge area and the open water bay removal area. The berms at the OU-M Upland CDF will be much higher than in Alternatives 4, 6, and 8, and similar to those in Alternative 7 and 8B. Additionally, because of the limited capacity of the OU-M Upland CDF, a significant volume of material from the open water bay removal area will be transported to the borrow site CDF. Material derived from the Wire Mill Delta dredge area, from OU-P and Q, and from the Unnamed Pond will be contained within the Borrow Site CDF. Material derived from shallow storm water-related improvements in OU-I will be contained within a small valley-fill CDF south of OU-J.</p>
<p>Cost <u>Capital Costs</u> <u>Long-Term O&M Costs</u> <u>Performance Period</u></p>	<p>Alternative 12 is comparatively higher in cost, exceeded only by Alternative 7 among the options advancing to detailed analysis. Long-term O&M is projected to be slightly higher than Alternatives 6, 8 and 8B but less than Alternatives 4 and 7. The approximate three year duration of Alternative 12 construction is consistent with Alternative 7 but one year longer than Alternatives 4, 6, 8 and 8B.</p>

Table 2-11
 (FS Addendum - Revision of Table 5-10 to include Alternative 8B)
 ALTERNATIVES COMPARISON
 Former U. S. Steel Duluth Works - Spirit Lake Sediment Site
 Saint Louis River
 Duluth, Minnesota

	Alternative 4 CDF on OU-M Delta (within shoreline)	Alternative 6 Shallow Sheltered Bay with CDF	Alternative 7 Shallow Sheltered Bay and Delta Cap Area with Upland CDFs	Alternative 8 Shallow Sheltered Bay with Delta Sediment CDF and Upland CDFs	Alternative 8B Shallow Sheltered Bay with Delta Sediment CDF above OHWL and Upland CDFs	Alternative 12 Open Water Bay with Upland CDFs
Overall protection of human health and the environment	Score: <u>1</u> Protective	Score: <u>1</u> Protective	Score: <u>1</u> Protective	Score: <u>1</u> Protective	Score: <u>1</u> Protective	Score: <u>1</u> Protective
Compliance with regulatory requirements (ARARs)	Score: <u>1</u> Compliant	Score: <u>2</u> Compliant. Requires additional permit considerations as part of CDF is located within assumed OHWL.	Score: <u>1</u> Compliant	Score: <u>2</u> Compliant. Requires additional permit considerations as part of CDF is located within assumed OHWL.	Score: <u>1</u> Compliant. CDF footprint entirely west of the OHWL results in less permitting requirements.	Score: <u>1</u> Compliant
Long-term effectiveness and permanence	Score: <u>2</u> More stormwater structures to maintain.	Score: <u>1</u> Effective	Score: <u>3</u> Stormwater management and three CDFs would require more O&M than other alternatives and would be more likely to result in greater potential risk of short and long-term failure than the other alternatives.	Score: <u>2</u> Effective. Three CDFs would require more O&M than other alternatives.	Score: <u>2</u> Effective. Three CDFs would require more O&M than other alternatives.	Score: <u>2</u> Effective. Three CDFs would require more O&M than other alternatives.
Reduction of toxicity, mobility (overall risk)	Score: <u>1</u> Effective at reducing overall risk	Score: <u>1</u> Effective at reducing overall risk	Score: <u>1</u> Effective at reducing overall risk	Score: <u>1</u> Effective at reducing overall risk	Score: <u>1</u> Effective at reducing overall risk	Score: <u>1</u> Effective at reducing overall risk
Short-term effectiveness	Score: <u>2</u> Effective. Stormwater diversion south of spit.	Score: <u>1</u> Effective.	Score: <u>3</u> Stormwater management presents risks during construction. Less effective than other alternatives because of longer construction duration.	Score: <u>1</u> Effective	Score: <u>1</u> Effective	Score: <u>2</u> Less effective than other alternatives because of longer construction duration.
Implementability	Score: <u>3</u> Implementable; however, Upland material must be moved longer distance to CDF.	Score: <u>5</u> Implementable; however, height of delta CDF creates potential sight-line impairments and geotechnical loading concerns. In addition, elimination of the LS&M Railroad is required.	Score: <u>5</u> Implementable; however, has the most uncertainty because of the complications of stormwater management in a confined channel, and CDF construction, which includes steeper berms and requires soil stabilization, is more complicated than other alternatives. Height of OU-M Delta CDF has potential to create view-shed impacts. Longer construction schedule than other alternatives.	Score: <u>2</u> Implementable. Consolidation areas are proximal to source removal areas.	Score: <u>4</u> Implementable. Consolidation areas are proximal to source removal areas. Height of OU-M Upland CDF and its berms requires soil stabilization and has the potential to create view-shed impacts.	Score: <u>5</u> Implementable; however, removed material must be moved greater distance than other alternatives retained for detailed analysis. Height of OU-M Upland CDF berms requires soil stabilization and has the potential to create view-shed impacts. Longer construction schedule than other alternatives.
Cost	Score: <u>2</u> Lowest cost of the alternatives retained for detailed analysis	Score: <u>3</u> Moderate cost, more than Alternatives 4 and 8, but less than Alternatives 7 and 12	Score: <u>5</u> Most expensive of the alternatives retained for detailed analysis	Score: <u>3</u> Moderate cost	Score: <u>3</u> Moderate cost	Score: <u>4</u> Second highest among the alternatives retained for detailed analysis
Compliance with 11 Sediment Principles/Sediment Guidance	Score: <u>1</u> Compliant	Score: <u>1</u> Compliant	Score: <u>1</u> Compliant	Score: <u>1</u> Compliant	Score: <u>1</u> Compliant	Score: <u>1</u> Compliant
Total Score	13	15	20	13	14	17

Scoring Key: 1 through 5, lowest score is the most desirable

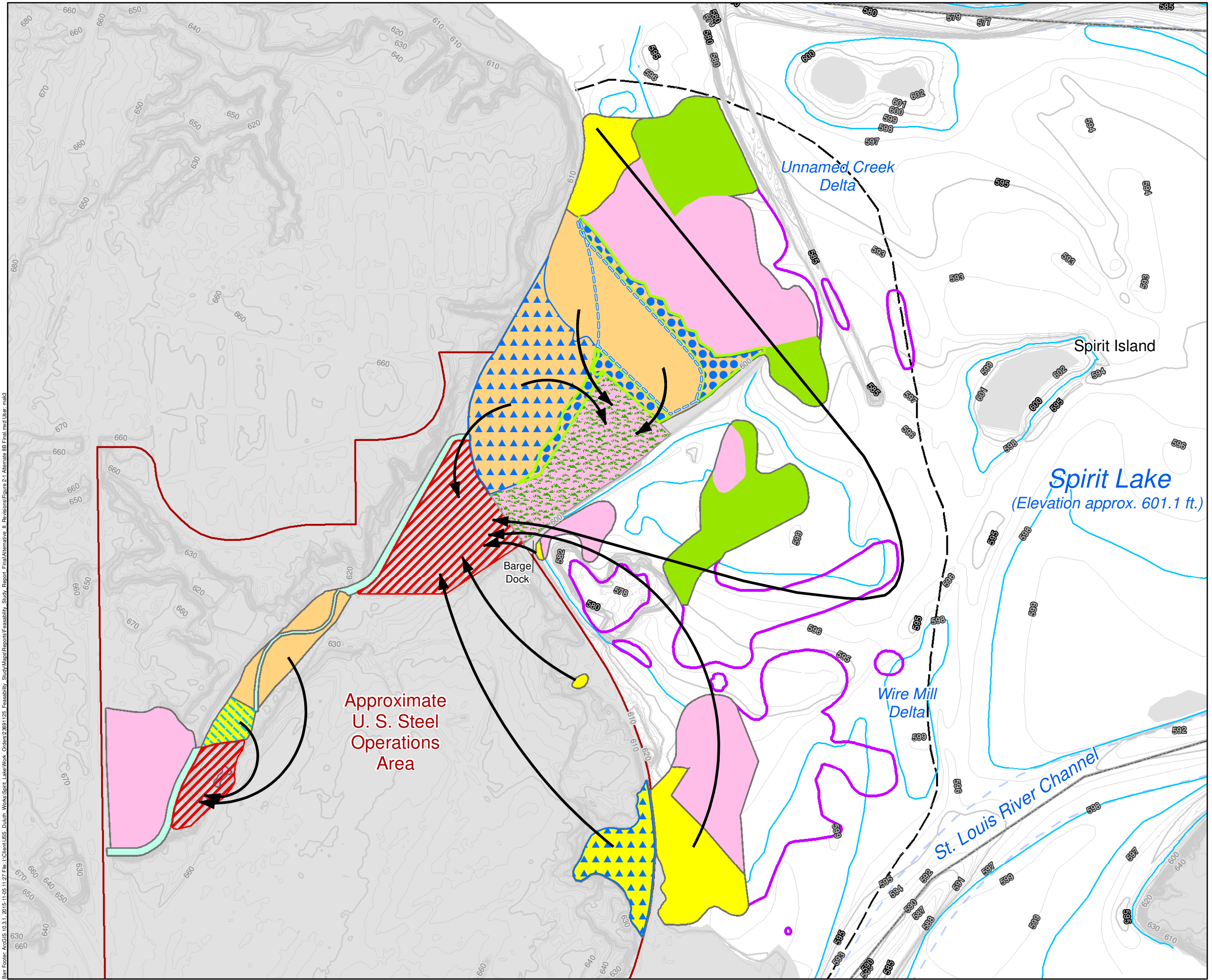
Table 2-12
(FS Addendum - Revision of Table 5-11 to Include Alternative 8B)

Cost Estimate Summary
U. S. Steel Former Duluth Works

Construction Costs	Alternative 4	Alternative 6	Alternative 7	Alternative 8	Alternative 8B	Alternative 12
Estuary/OU-M Delta	\$21,400,000	\$26,000,000	\$29,800,000	\$26,100,000	\$26,300,000	\$31,100,000
Dredge and Transport - Subaqueous	\$4,790,000	\$4,790,000	\$4,790,000	\$4,790,000	\$4,790,000	\$4,790,000
Dredge and Transport - Dry	\$3,080,000	\$5,080,000	\$5,590,000	\$5,080,000	\$5,730,000	\$6,570,000
Capping - Subaqueous	\$11,200,000	\$10,830,000	\$10,830,000	\$10,830,000	\$10,990,000	\$10,830,000
Capping and Shoal Construction - Dry	\$2,310,000	\$5,250,000	\$8,480,000	\$5,300,000	\$4,710,000	\$8,870,000
Shoreline Stabilization	\$70,000	\$70,000	\$70,000	\$70,000	\$70,000	\$70,000
Former Operations Area	\$10,000,000	\$5,500,000	\$10,700,000	\$5,100,000	\$5,100,000	\$5,100,000
Excavation and Transport	\$910,000	\$750,000	\$500,000	\$750,000	\$750,000	\$750,000
Stormwater Features	\$5,850,000	\$2,000,000	\$8,680,000	\$2,000,000	\$2,000,000	\$2,000,000
Capping and Restoration	\$3,270,000	\$2,770,000	\$1,560,000	\$2,380,000	\$2,380,000	\$2,380,000
CDF	\$9,100,000	\$14,300,000	\$16,000,000	\$12,500,000	\$15,200,000	\$16,300,000
Construction, Capping, and Operation	\$9,150,000	\$14,290,000	\$15,980,000	\$12,480,000	\$15,110,000	\$16,270,000
OU-P/OU-Q	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$4,800,000
Dredging, Transport, and Restoration	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$4,830,000
Water Management and Treatment	\$2,600,000	\$3,400,000	\$5,240,000	\$3,650,000	\$3,650,000	\$4,180,000
Mobilization and Demobilization	\$1,110,000	\$1,110,000	\$1,110,000	\$1,110,000	\$1,110,000	\$1,110,000
WTP Operation and Water Management	\$1,490,000	\$2,290,000	\$4,130,000	\$2,540,000	\$2,540,000	\$3,070,000
Engineering and Administration	\$6,200,000	\$6,800,000	\$8,400,000	\$6,600,000	\$6,900,000	\$7,800,000
Design, CQA, and Reporting	\$6,150,000	\$6,840,000	\$8,410,000	\$6,580,000	\$6,910,000	\$7,750,000
Contractor Preparation, Mobilization, and Demobilization	\$6,900,000	\$7,200,000	\$8,500,000	\$6,600,000	\$6,900,000	\$7,500,000
Contractor Preparation, Mobilization, Demobilization	\$6,860,000	\$7,160,000	\$8,500,000	\$6,600,000	\$6,950,000	\$7,550,000
Project Total	\$61,000,000	\$68,000,000	\$84,000,000	\$66,000,000	\$69,000,000	\$77,000,000

Operation and Maintenance - 30 Year Life Cycle Costs Range	Alternative 4		Alternative 6		Alternative 7		Alternative 8		Alternative 8B		Alternative 12	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Estuary Subtotal	\$1,400,000	\$3,300,000	\$1,400,000	\$3,300,000	\$1,600,000	\$3,600,000	\$1,600,000	\$3,600,000	\$1,600,000	\$3,600,000	\$1,800,000	\$4,200,000
Former Operations Area Subtotal	\$6,200,000	\$9,600,000	\$3,400,000	\$7,000,000	\$9,300,000	\$13,400,000	\$4,100,000	\$8,000,000	\$4,100,000	\$8,000,000	\$4,200,000	\$7,900,000
Total	\$7,600,000	\$12,900,000	\$4,800,000	\$10,300,000	\$10,900,000	\$17,000,000	\$5,700,000	\$11,600,000	\$5,700,000	\$11,600,000	\$6,000,000	\$12,100,000

Figures



- Remedial**
- New Open Water
 - Shallow Sheltered Bay Protection
 - Stormwater Ponding
 - Upland CDF
 - Unnamed Creek Estuary Sediment CDF
 - Drainage Feature
 - ENR Thin Cover
 - Remedial Cap
 - Remove
 - Remove to Set Elevation and Remedial Cap
 - Remove to Set Elevation and Remedial Cap (To Maintain Existing Water Depth)
 - Movement and Primary Destination of Removed Material
- Estuary PRG Footprint {Total PAH(13), Lead, Zinc, Copper; MPCA - March 5, 2014}
 - 2011 Upland Elevation Contours (10-Foot) *
 - 2011 Upland Elevation Contours (2-Foot) *
 - 2012 Bathymetry Contours (5-Foot)
 - 2012 Bathymetry Contours (1-Foot)
 - 598 Feet Bathymetry Contour
 - Approximate Outer Study Area
 - Approximate Location of St. Louis River Channel, Based on Orthophoto Interpretation
 - Approximate U. S. Steel Operations Area (URS, 2008)
 - State Boundary
- * Source: Minnesota Department of Natural Resources LIDAR Elevation, Arrowhead Region, NE Minnesota, 2011

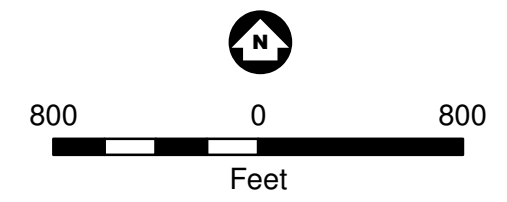


Figure 2-1

**ALTERNATIVE 8B
SHALLOW SHELTERED BAY WITH
DELTA SEDIMENT CDF ABOVE OHWL
AND UPLAND CDFS**
Former U. S. Steel Duluth Works -
Spirit Lake Sediment Site
Saint Louis River
Duluth, Minnesota

Bar Footer: ArcGIS 10.3.1, 2015-11-25 11:27 File: I:\Client\US - Duluth Works\Spirit Lake\Work Orders\23891125 Feasibility Study\Mapa\Reports\Featibility Study Report Final\Alternative 8 - Revisions\Figure 2-1 Alternative 8B Final.mxd User: mack