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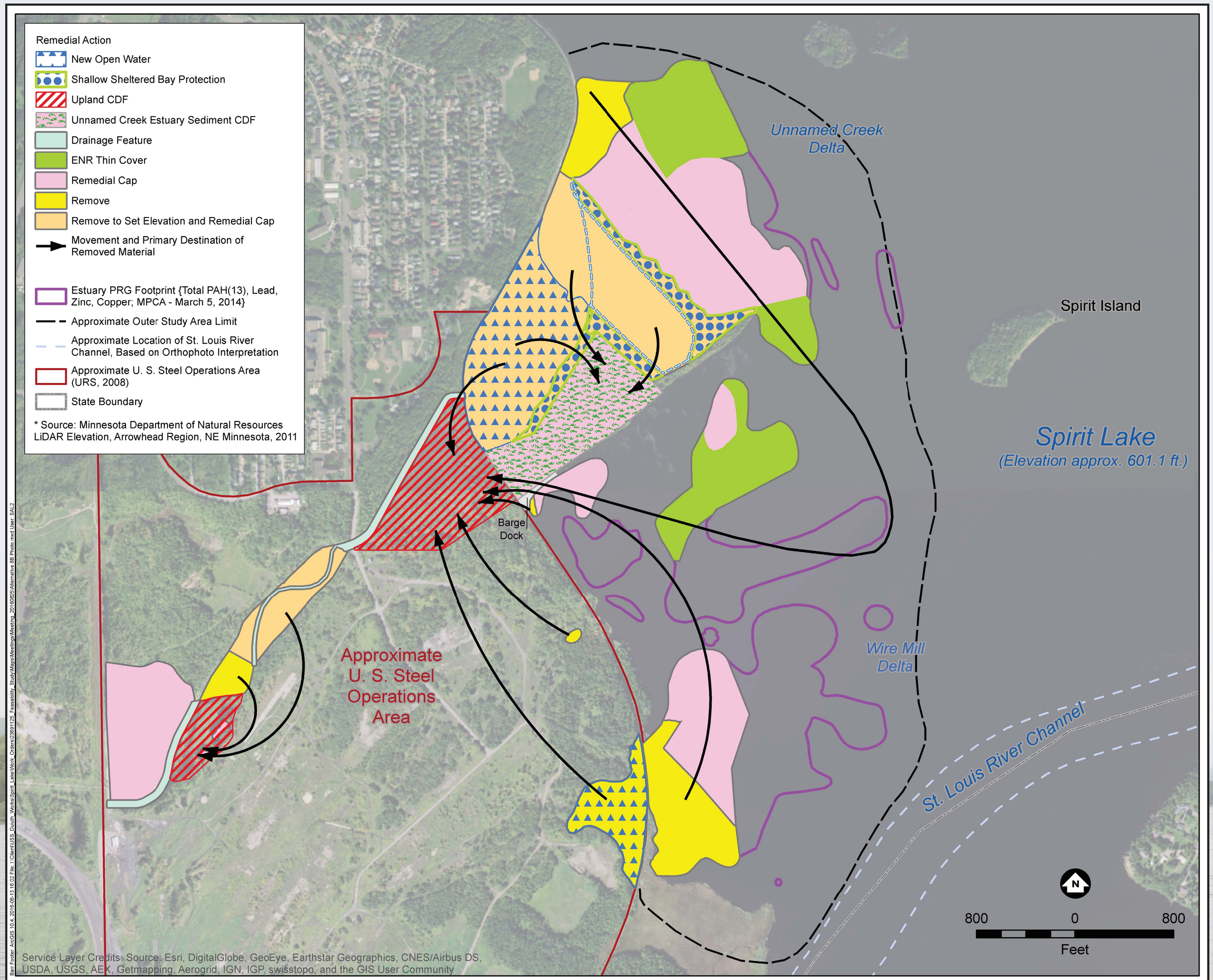
Alternative 8B Visualization



- 30 acres new shallow sheltered bays
- Environmental dredging—removal of 697,000 cubic yards
- Underwater environmental capping—109 acres (estuary)
- Natural recovery areas—89 acres
- Confined disposal facilities—3 CDFs, all above high-water line
- Improved unnamed creek stormwater drainage
- Two years to construct

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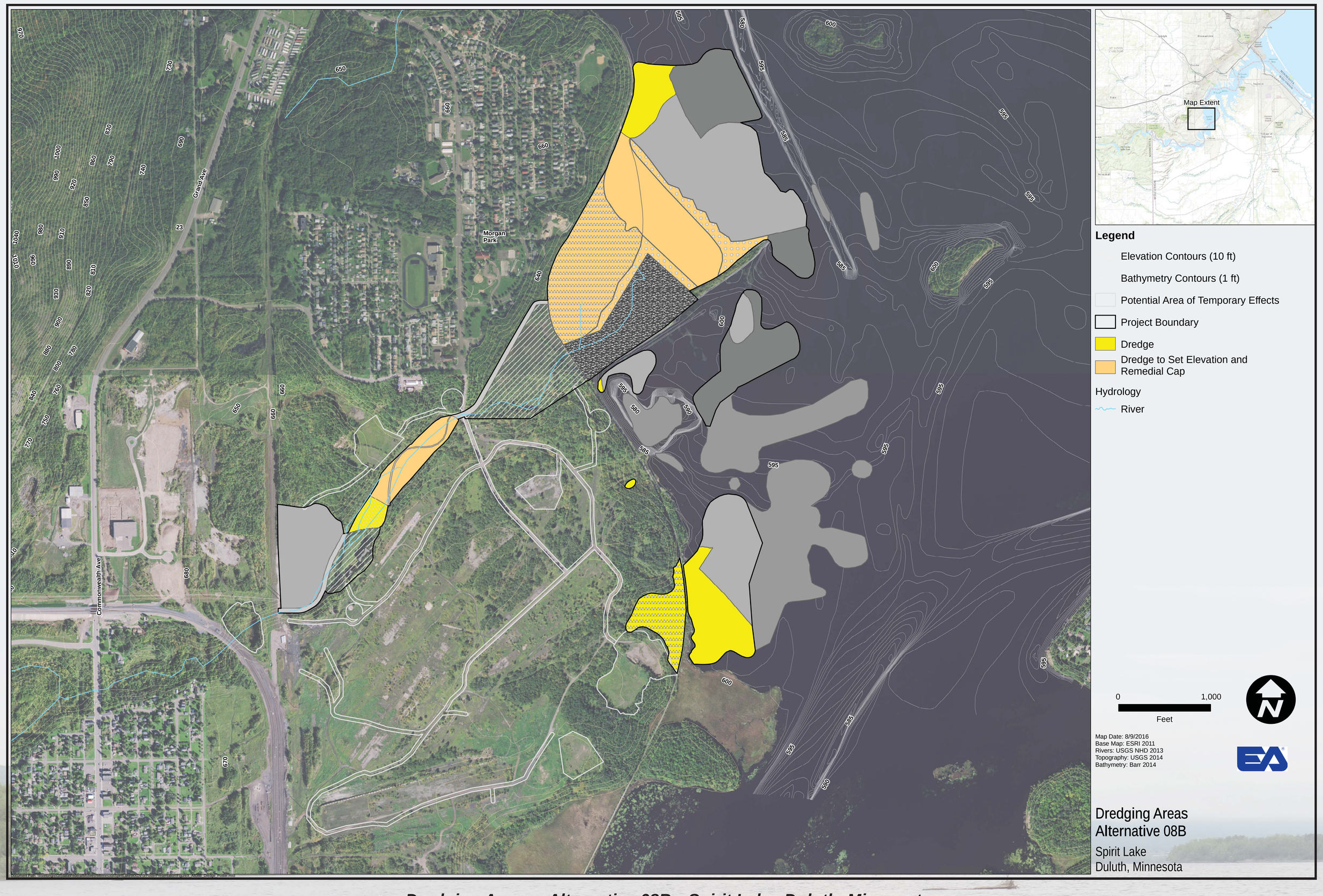
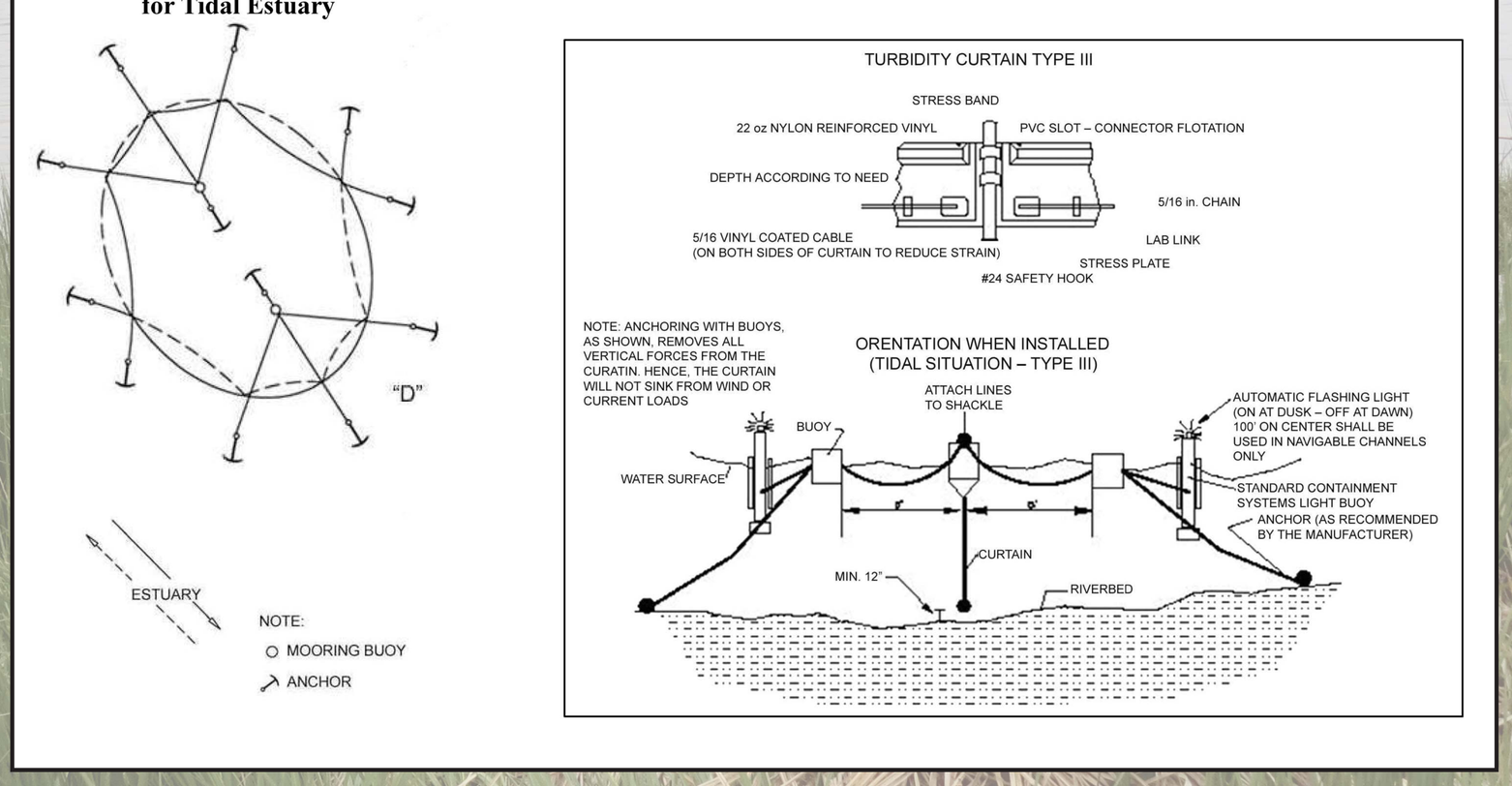
Environmental Dredging



Dredging Areas—Alternative 08B—Spirit Lake, Duluth, Minnesota

Installation of silt curtain

Water quality monitoring



Example Silt Curtain Configuration – Plan View and Cross Section Alignment

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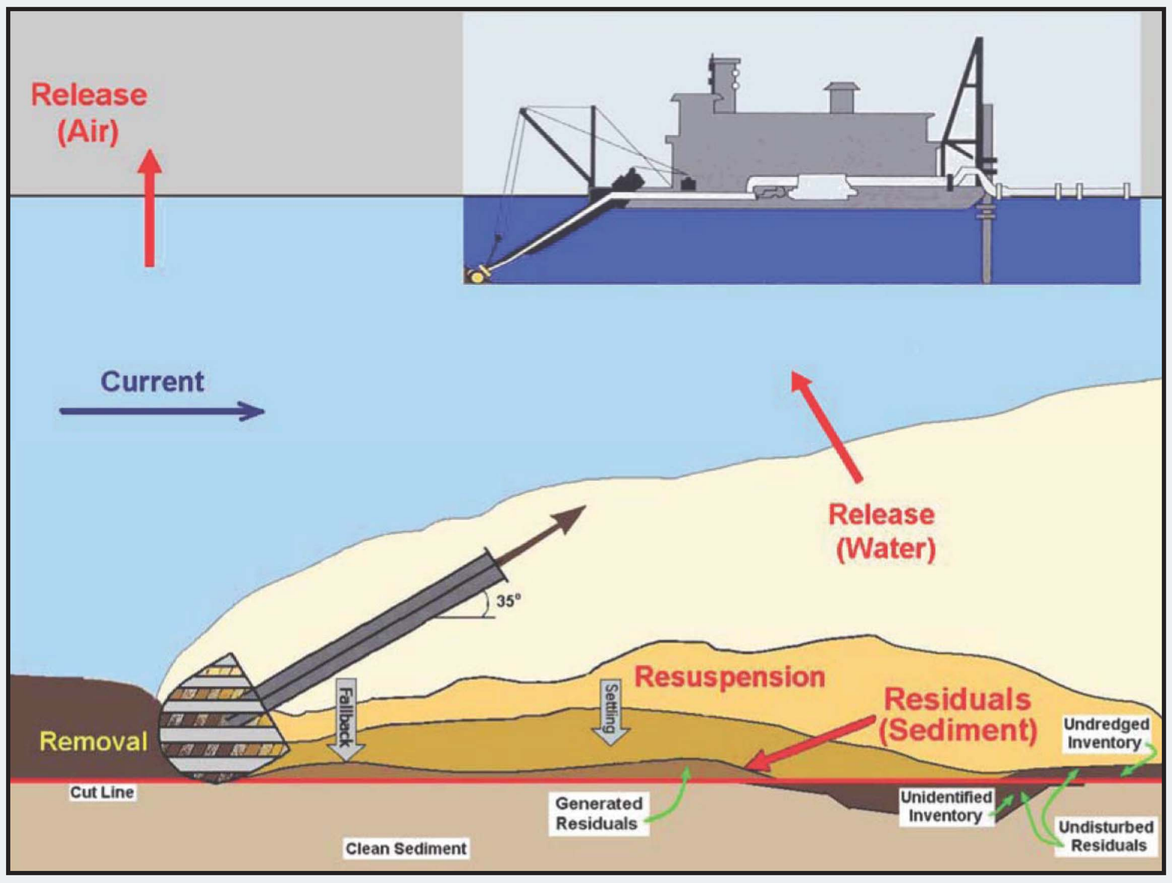
Environmental Dredging

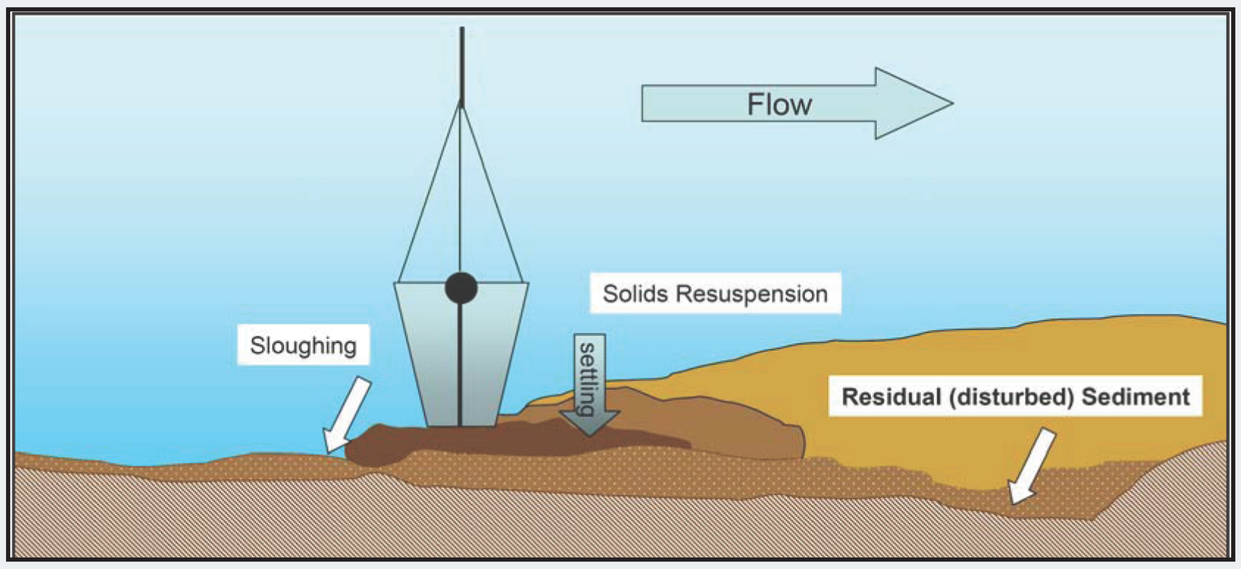
Dredging Methods



Environmental dredging process and considerations—hydraulic

Design must consider the "4 Rs"

- **Resuspension of impacted sediment**
- **Release of contaminants to environment**
- **Residual impacted sediment**
- **Risks (e.g., environmental risks), objective of remediation**



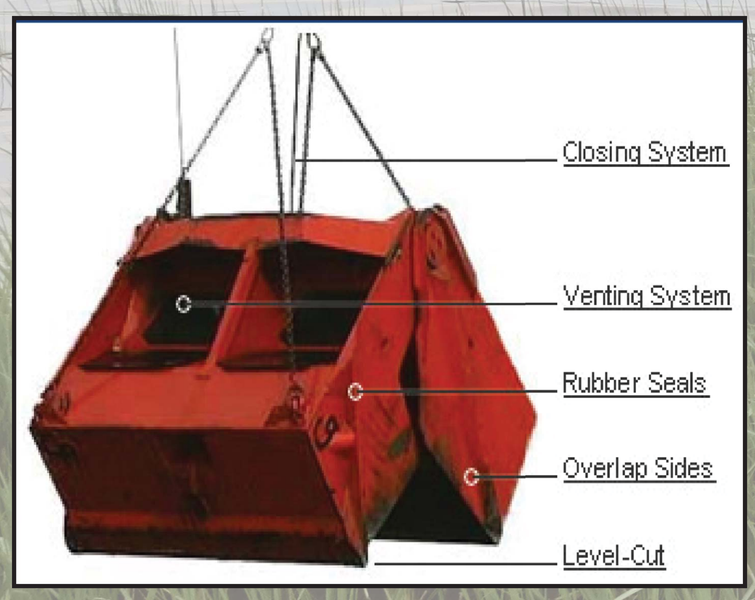
Environmental dredging process and considerations—mechanical

Dredging Considerations

- **Removes contaminated sediment from the environment**
- **Can be done using mechanical or hydraulic dredging; may be done in a structure (e.g., cofferdam) to isolate the area from open water**
- **Removed material has to be processed, including dewatering and water treatment, transportation, and placement in disposal facility**

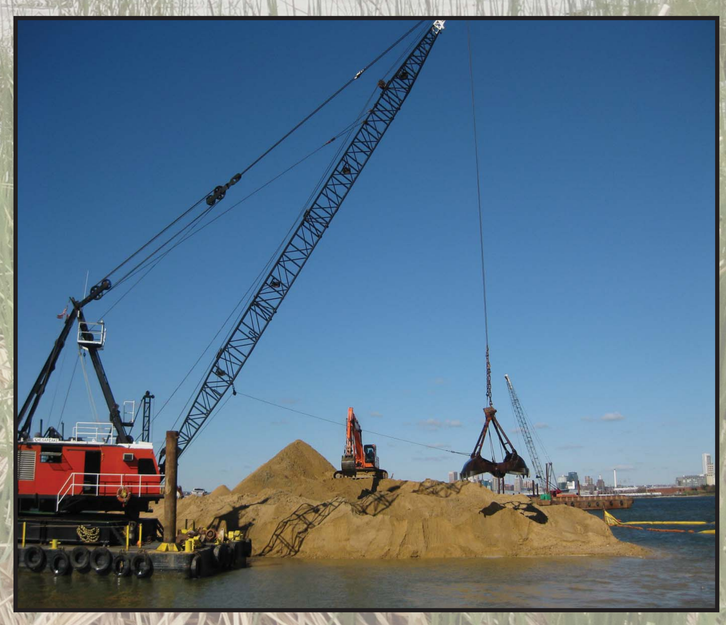
Hydraulic dredge with cutter above water

Material Removal



Common features for environmental buckets for minimizing short-term water quality impacts *(Source: CableArm)*

Excavator with environmental bucket



Crane with conventional bucket

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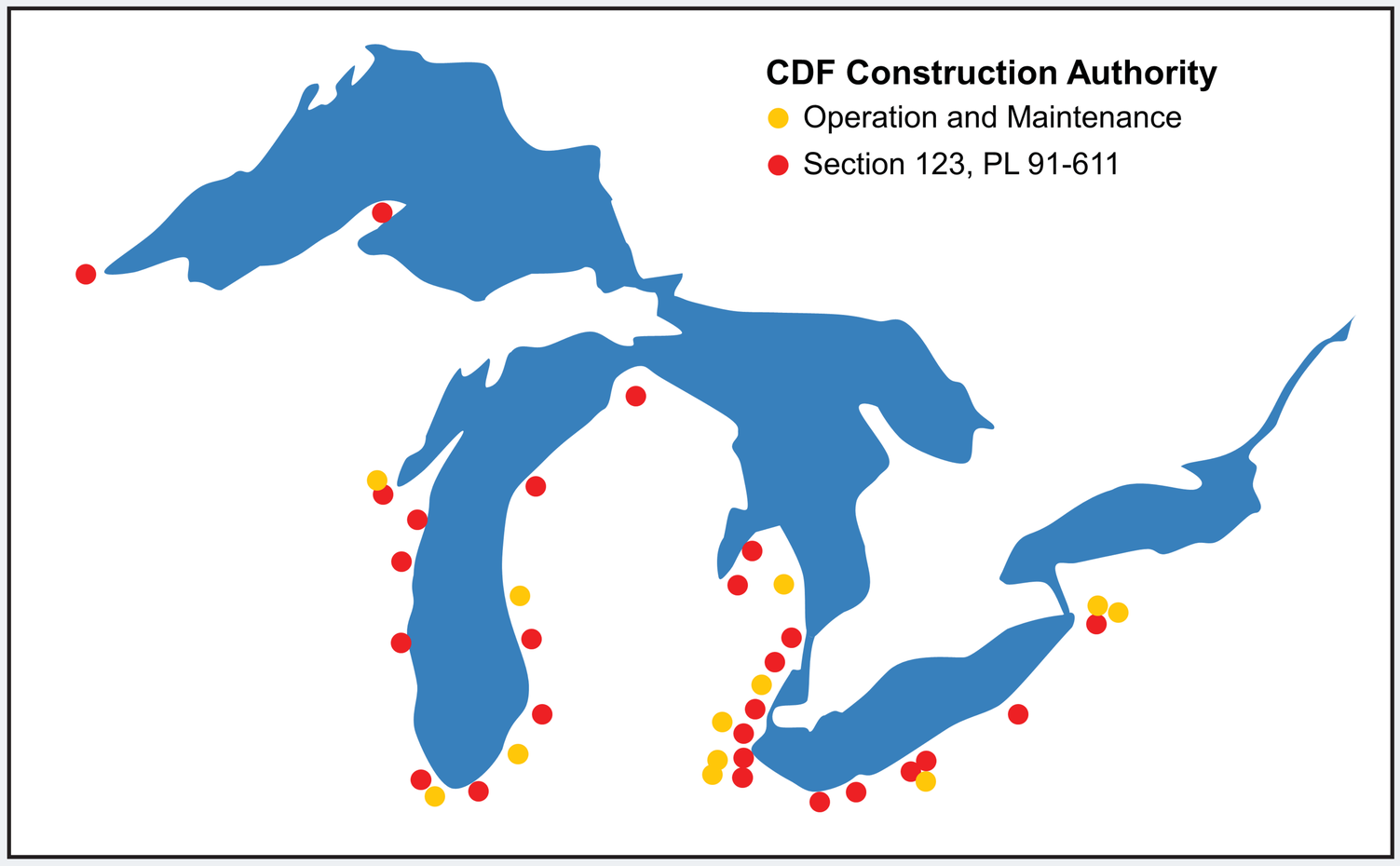
Confined Disposal Facilities

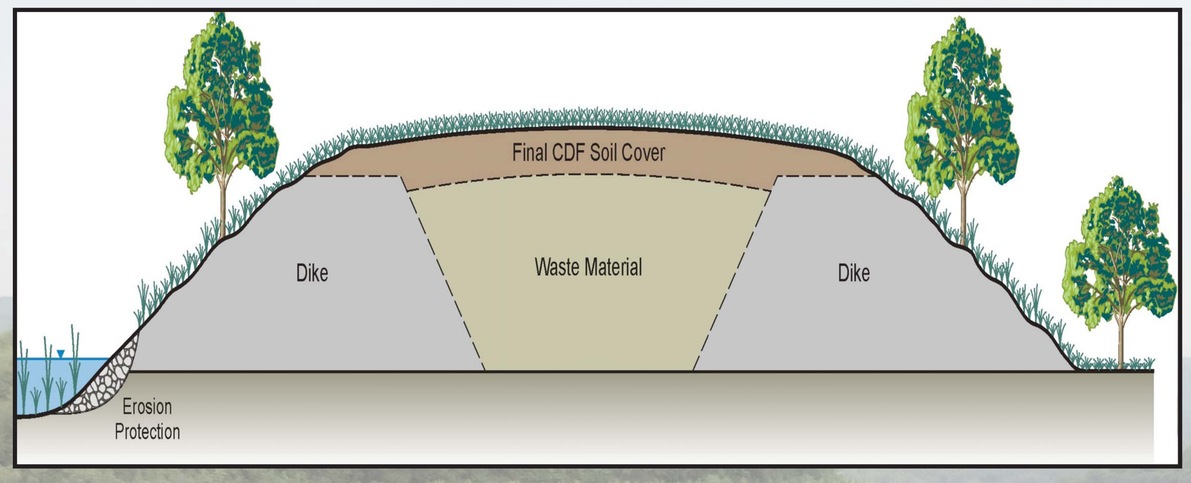


Great Lakes CDF locations

What is a Confined Disposal Facility?

A CDF is a containment structure designed specifically for the storage and containment of contaminated sediments. CDFs can be constructed upland or adjacent to the water. The proposed plan includes three CDFs, two adjacent to Unnamed Creek and one in the Unnamed Creek delta.

Design Perspective

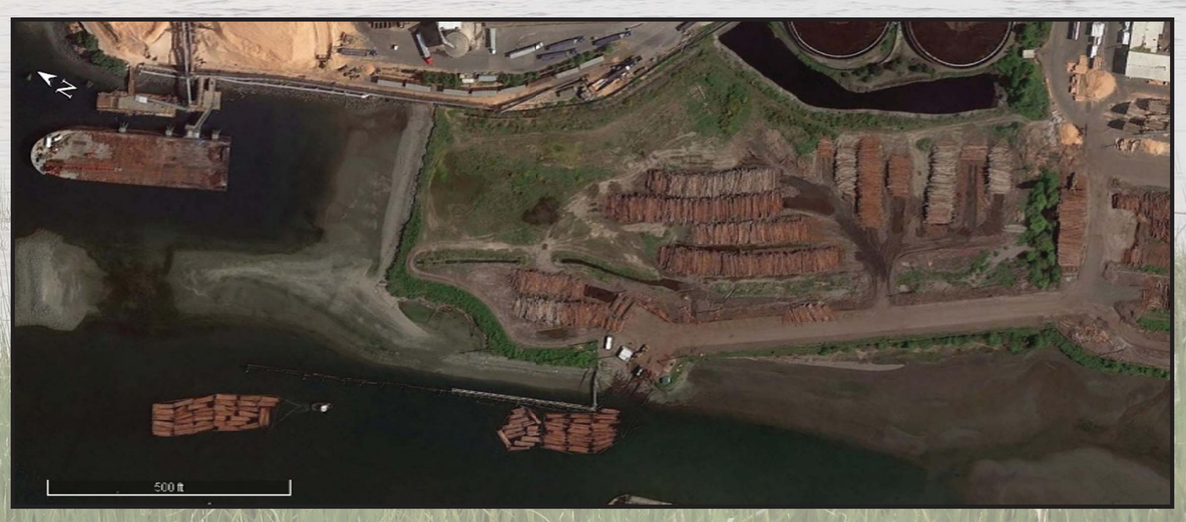


CDF integrating shoreline habitat features

Plantings to promote habitat restoration

Are CDFs Safe? Yes, CDFs are safe.

CDFs have been used extensively throughout the Great Lakes region for over 50 years to manage and dispose of contaminated sediments from Great Lakes harbors. 45 CDFs have been constructed and safely operated in the Great Lakes Region since 1970. Monitoring studies conducted at operating CDFs have shown that CDFs are extremely effective at containing contaminated sediments with minimal risks of contaminant releases.



CDF with softened shoreline for habitat development

Berm construction

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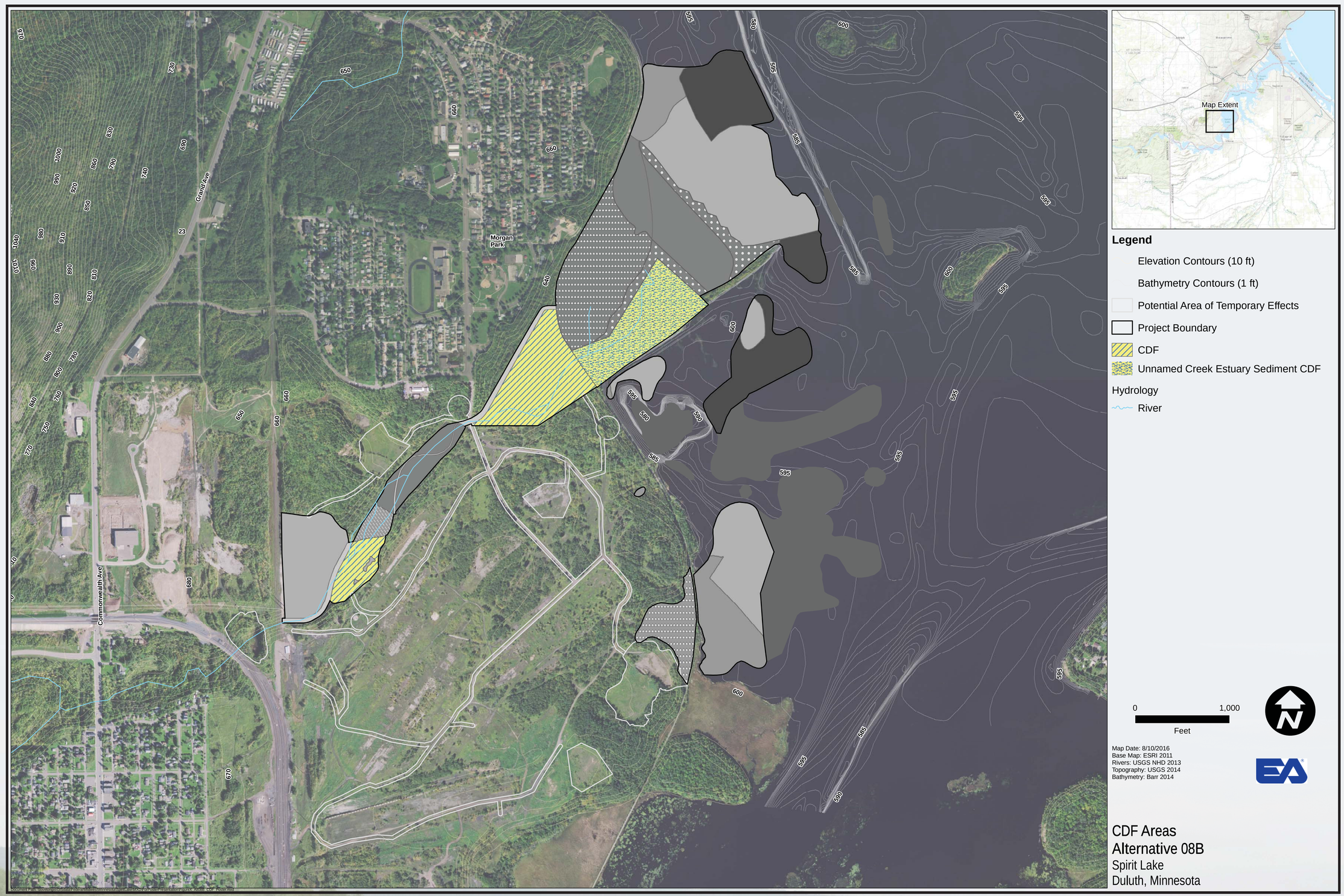
Confined Disposal Facilities



Examples of CDFs

Cox Creek Dredged Material Containment Facility (CDF)

Port of Cleveland CDF (Cleveland Lakefront Nature Preserve)

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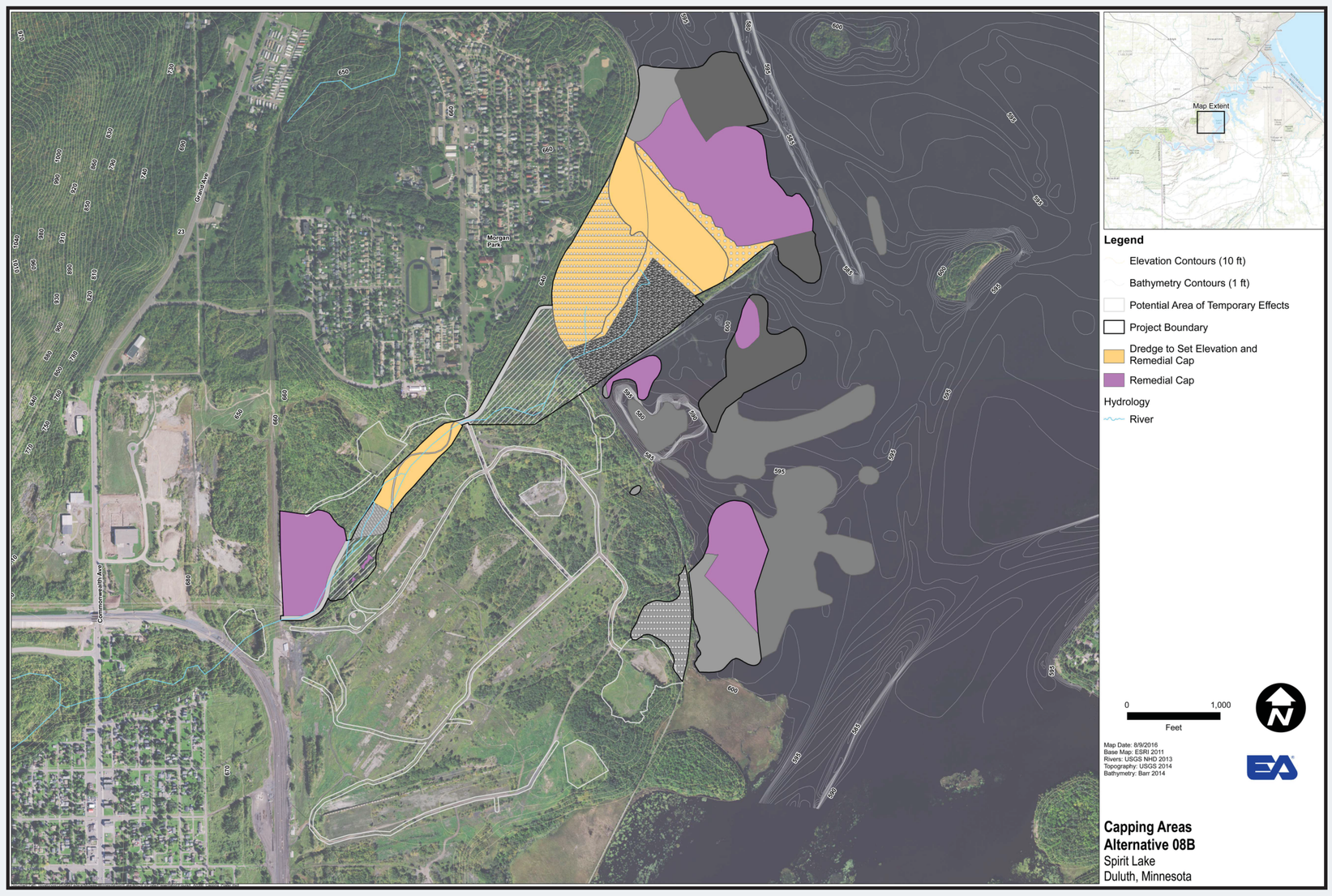
Environmental Capping



How do Caps Work?

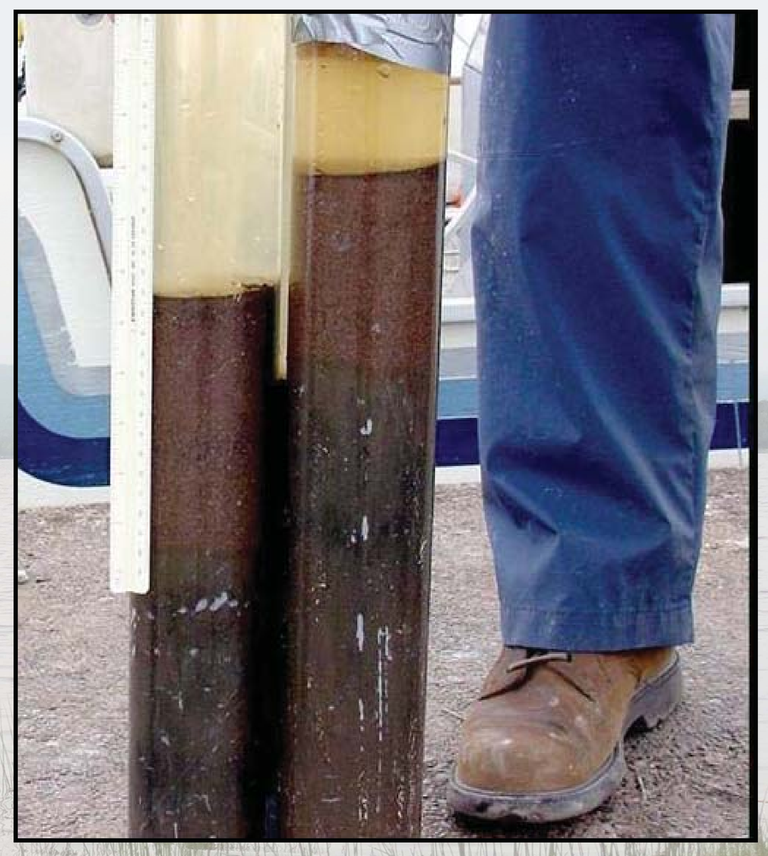
Underwater caps provide both a physical and a chemical barrier to prevent exposure of humans and wildlife to harmful contaminants in the sediments. Caps prevent direct contact with the sediments and also substantially reduced movement of impacts through surface water and groundwater.

Have Caps Been Used at Other Sites?

Caps have been used throughout the Great Lakes and the U.S. to successfully remediate contaminated sediments. They can be one of the most effective ways to immediately reduce contaminant exposures and risks associated with impacted sediment. The Interlake/Duluth Tar site and the recently completed Slip 2 project are local examples of successful sediment capping remedies.

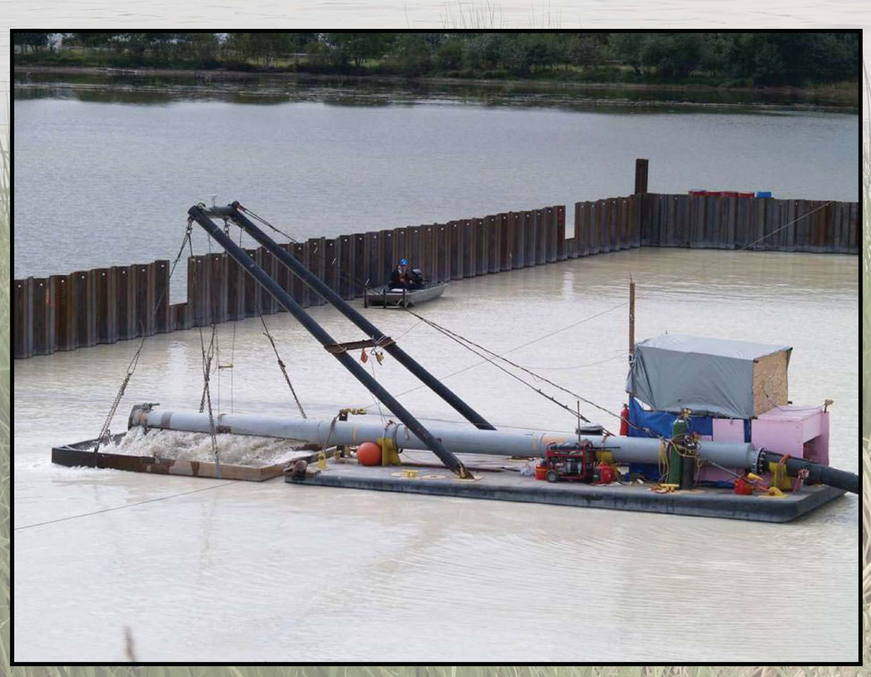
Installation Methods

Cap armor along shoreline

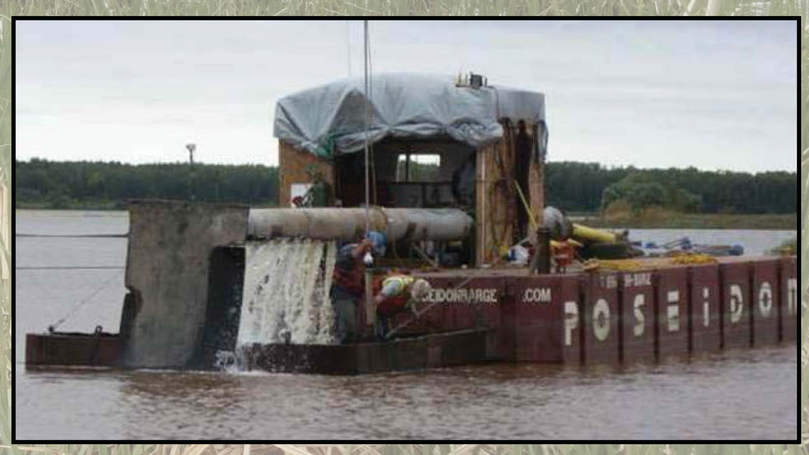


Cap thickness verification sampling by coring

Installing root barrier in cap



Cap spreader barge



Cap spreader barge

How Long Do Caps Last?

Caps are usually designed to last at least 100-200 years, but modeling indicates that they can be effective for even longer than that. MPCA and EPA will require long-term monitoring of the site to verify that the capping component of the remedy remains effective.

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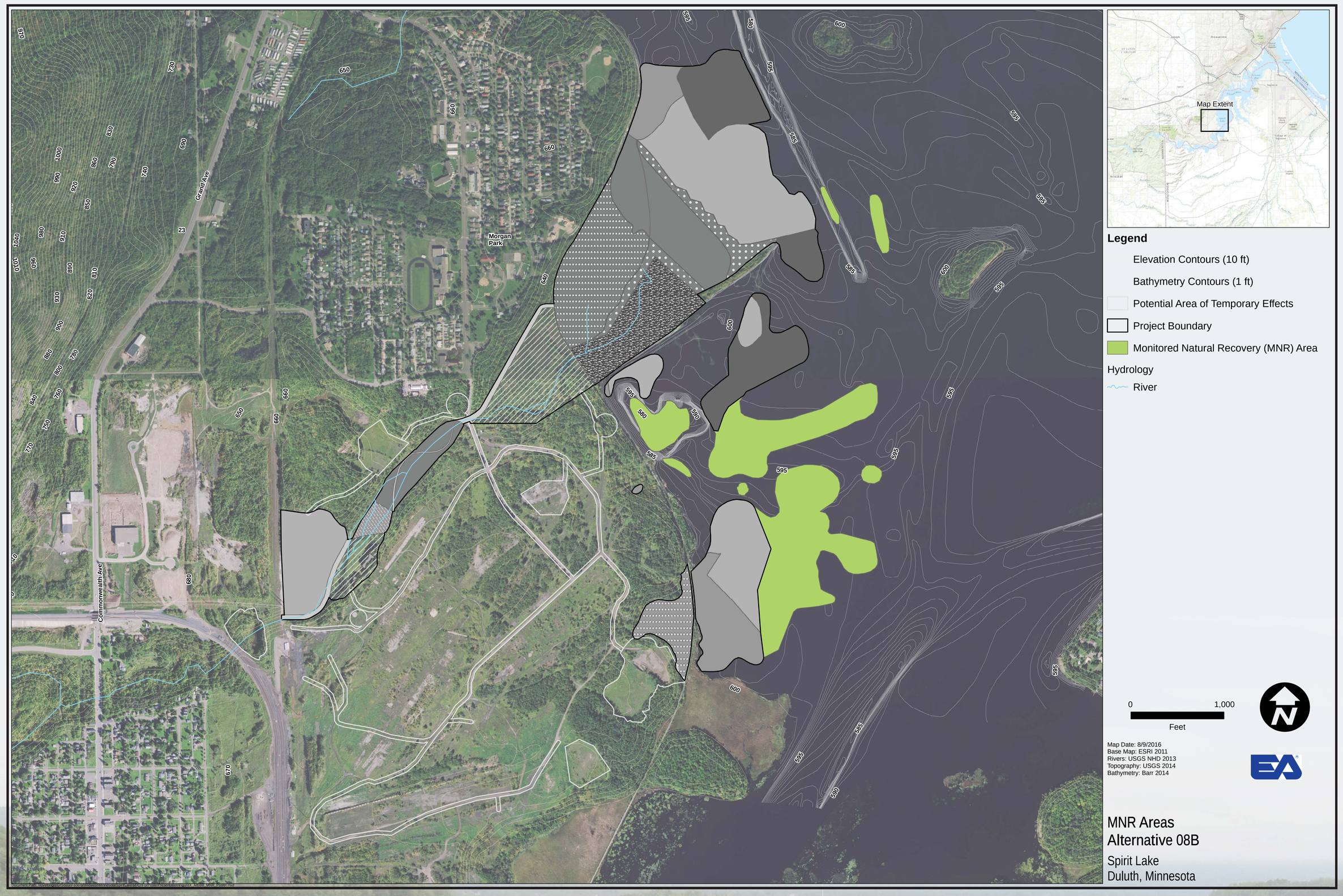
Monitored Natural Recovery

MNR Remedy Area Locations

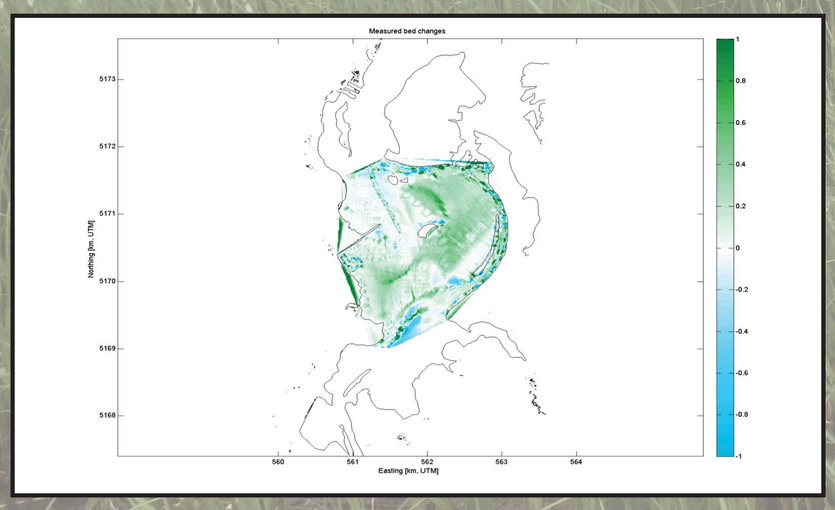


What is Monitored Natural Recovery?

MNR is an approach that allows natural processes to break down and/or bury sediment contamination to significantly reduce risks associated with the contamination.

Where will MNR be used at the Spirit Lake site?

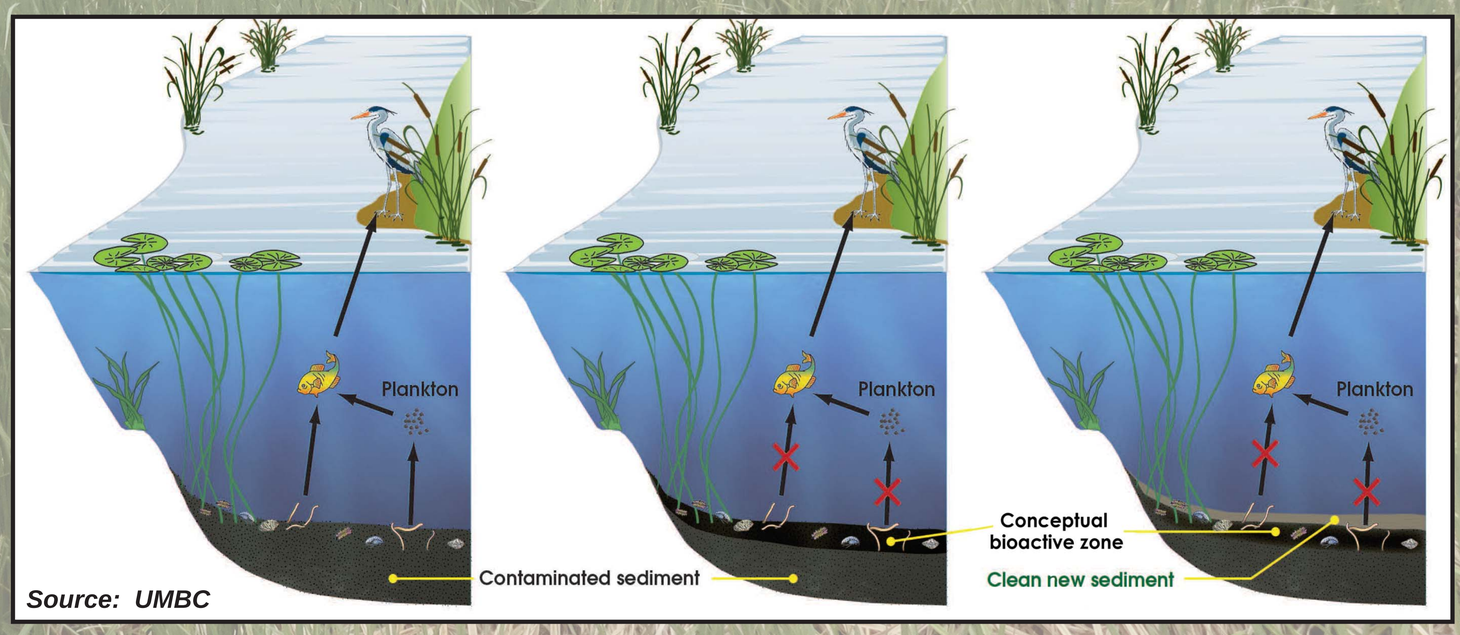
MNR is most appropriate for locations with low to moderate levels of contamination and areas that have seen significant amount of sedimentation over the last 25-30 years. This sedimentation is expected to continue.



Comparison of pre- vs. post-flood event bathymetry: green shading represents deposition, blue shading represents erosion

What type of monitoring will take place and for how long?

During design, MPCA, EPA, and U. S. Steel will develop a comprehensive monitoring plan to look at sedimentation and erosion rates, the levels of contaminants in surface sediments and surface water, and the uptake of contaminants to biological organisms. These measurements will be evaluated to determine the rate of on-going natural recovery. Monitoring to evaluate MNR is expected to continue for decades, and will continue until the agencies are comfortable that the contaminants no longer present a risk to human health or the environment.



Natural recovery process illustrated left to right: arrows denote exposure pathways, which become mitigated by burial, degradation, or related processes.

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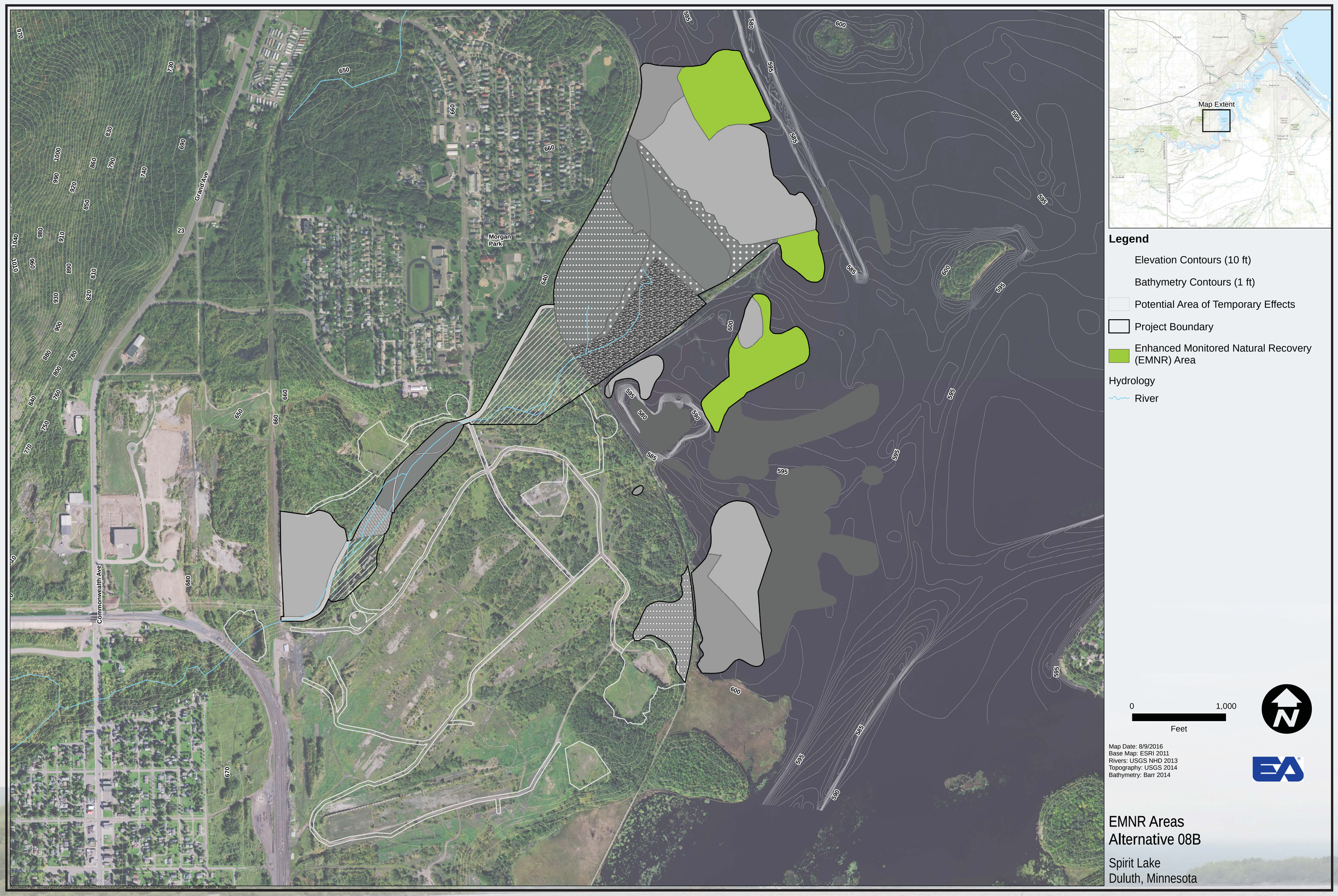
Enhanced Monitored Natural Recovery



Enhanced Monitored Natural Recovery

EMNR seeks to increase the rate of recovery by providing a cover of un-impacted material and/or by adding amendments that bind or sequester chemicals of concern. Cover material may include sand, silt or organic matter, and/or amendments (activated carbon particles). A thin cover provides a "jump start" for burial by natural processes, and a clean substrate surface. Amendments may enhance recovery by altering contaminants and/or reducing their mobility and toxicity.

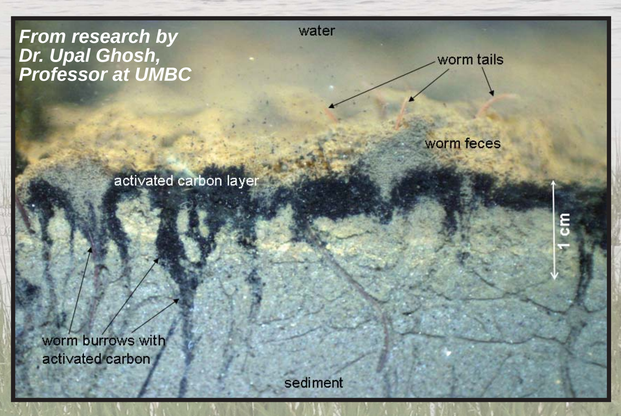
Amendments are granular or pelletized products that can be mixed with sand, applied directly to the sediment as a thin layer, or placed in a manufactured geotextile mat onto the sediment.

- Activated carbon or naturally occurring carbon sources adsorb PAHs.
- Other reactive media such as apatite, zeolites, and similar manufactured products bind with metals.

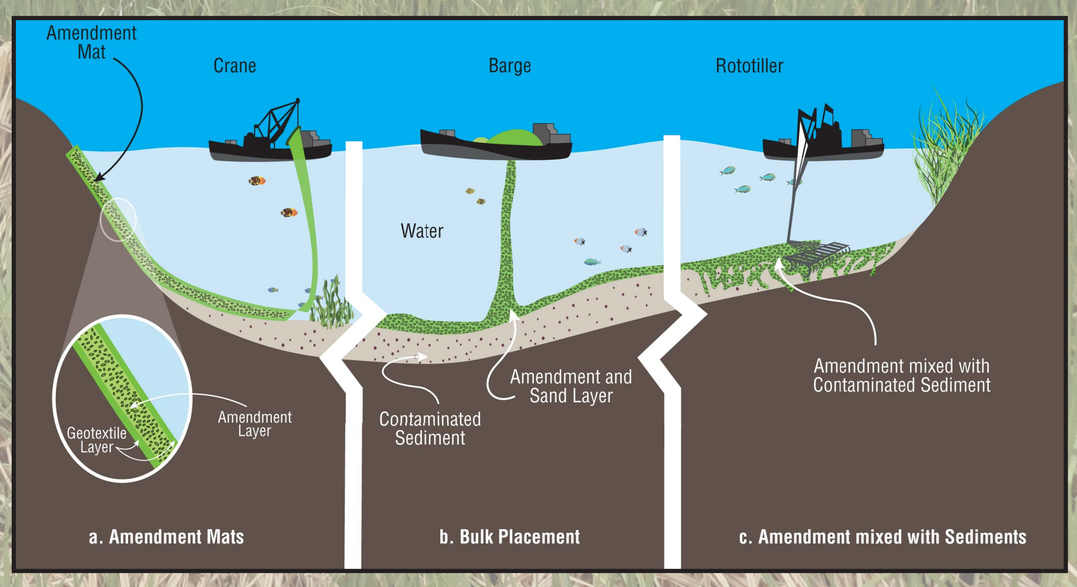
Are these amendments safe for human health and the environment?

Yes, amendments have been used on other contaminated sediment remediation projects in aquatic environments and have successfully contributed to risk reduction.

Enhanced Approaches



EMNR Cover Construction



Use of amendments is most common with capping, but may be used for enhancing natural recovery or providing in-situ treatment

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Potential Habitat Enhancements

Habitat enhancements include potential elements in open-water areas, such as deep-to-shallow-water transitions, shoreline restoration through vegetation establishment, and shallow, sheltered bays. Some habitat enhancement may be part of the remedy construction, other elements may be implemented later. Conceptual examples are illustrated below.

Creating a shallow, sheltered bay allows for emergent vegetation and protected areas where such habitat is currently absent

Restoration of shoreline habitat

An example of a shallow, sheltered water area with emergent vegetation transitioning to a shoreline

Shallow, sheltered water helps re-establish emergent vegetation types

An example of a restored shoreline with established vegetation

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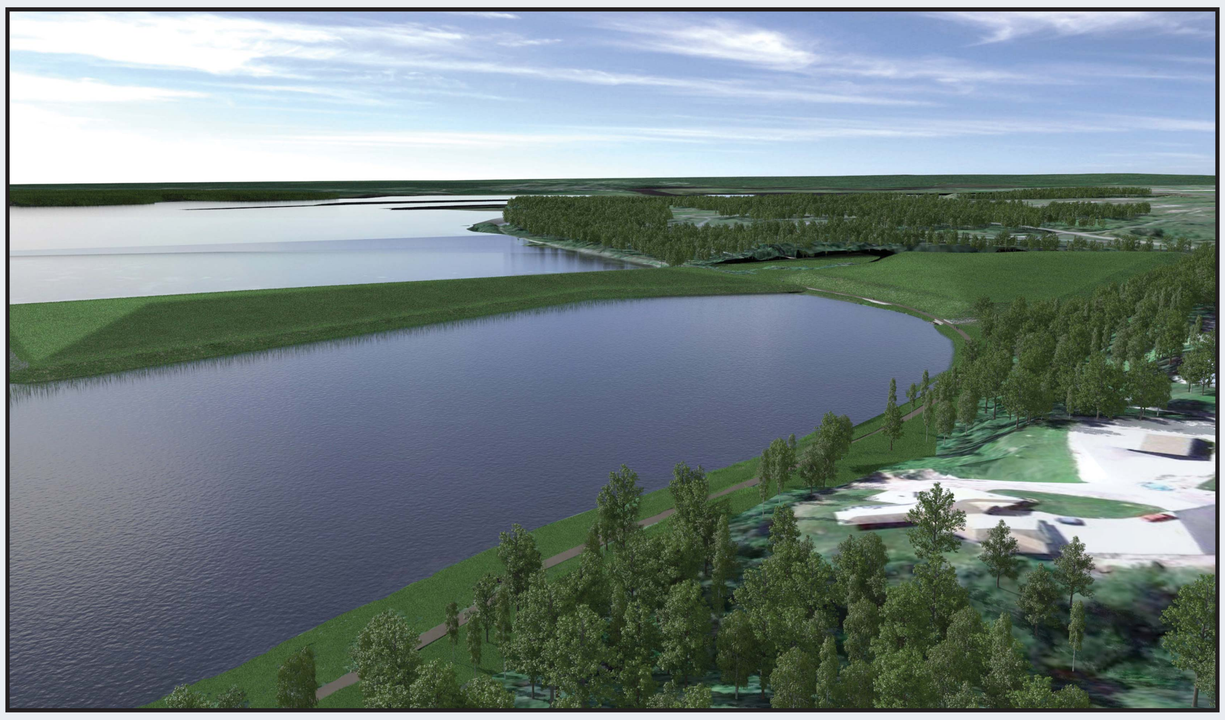
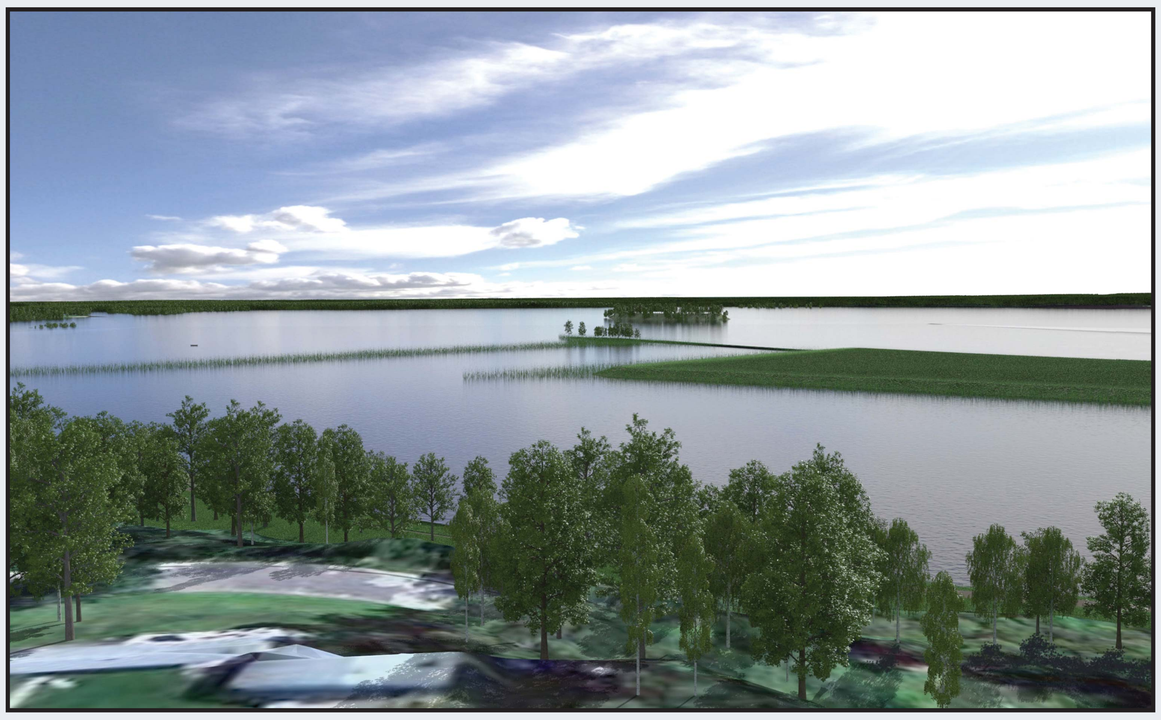
Alternative 8B Visualization

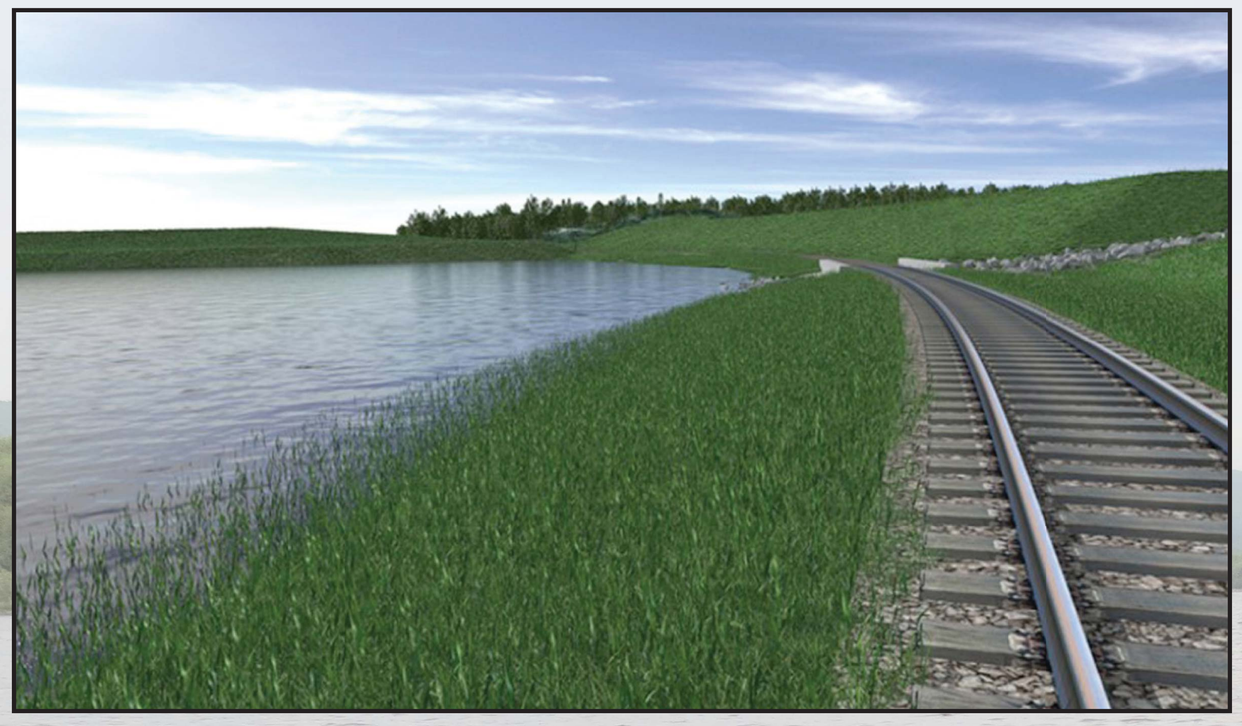
The following visualizations show what different areas will look like from several vantage points once the sediment remediation project is complete.



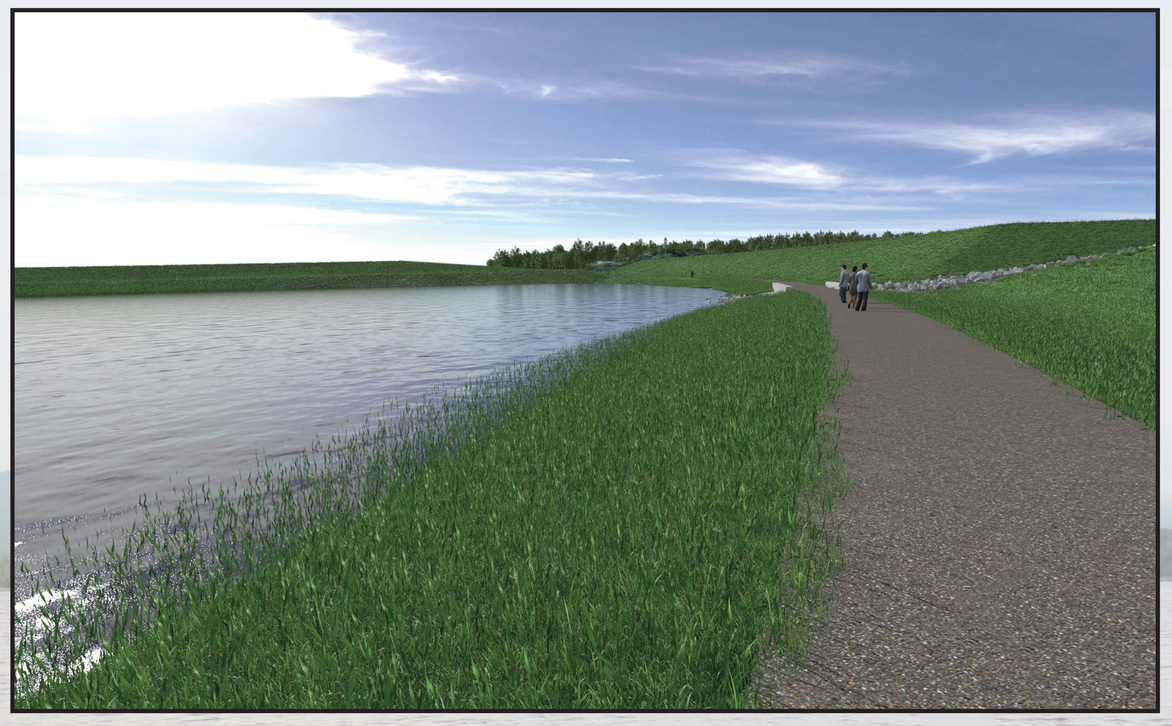
Unnamed Creek Bay and CDFs



Unnamed Creek Bay from neighborhood



Unnamed Creek Bay—railroad view



Unnamed Creek Bay—trail view

Wire Mill Bay—railroad view

Wire Mill Bay without causeway

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Alternative 8B Visualization

The following visualizations show what the western shore of Spirit Lake will look like when viewed from Spirit Island once the sediment remediation project is complete.

View from Spirit Island west to the Unnamed Creek delta area

View from Spirit Island west to the Wire Mill delta area

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Potential Shoreline Access and Trails

Features that may be created either as part of the remediation project or afterward by others could include trails and access to greenspaces along the river, possibly including water access or viewing locations. Conceptual examples are shown below.

Trails with interpretive signs

Shoreline access and canoe landing

Formal trails

Water viewing/fishing access

Informal trails