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Managing Contaminated Sediment
2012 St. Clair River Symposium

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Overview

- ***Ex-Situ*** **Remedial Options**
- ***In-Situ*** **Remedial Options**
- **Monitored Natural Recovery**
- **St. Clair River Sediment Management Update**

Managing Contaminated Sediment: General Remediation Options

***In-Situ* Options**:

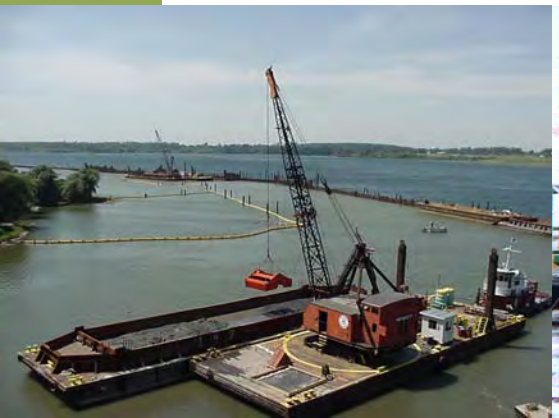
- *In-Situ* Treatment
- Subaqueous Cap
- Dry Cap (Containment)

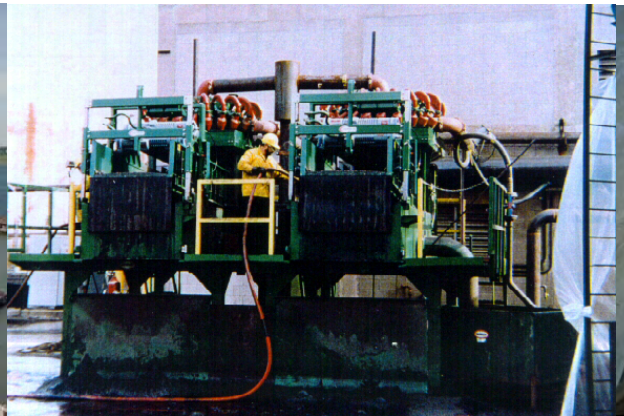
Monitored Natural Recovery:

- Administrative Controls

***Ex-Situ* Options:**

- Removal with direct Disposal
- Removal with pre-treatment and/or treatment followed by Disposal or Re-Use





Contaminated Sediment: *Ex-Situ* Options

- **Removal:** Mechanical, Hydraulic, Pneumatic, Hybrid and Alternative
- **Pretreatment:** Extraction/Soil Washing, Particle Size Separation, Effluent Treatment
- **Treatment:** Bioremediation, Chemical Treatment, Thermal Destruction, Solidification/Stabilization
- **Disposal:** Confined Disposal Facility, Confined Aquatic Sites, Industrial/Hazardous Waste Landfill Site

Contaminated Sediment Removal:

- **Mechanical**

  Cable Arm Env. Clamshell,

- **Hydraulic**

  Eddy Pump

- **Pneumatic**

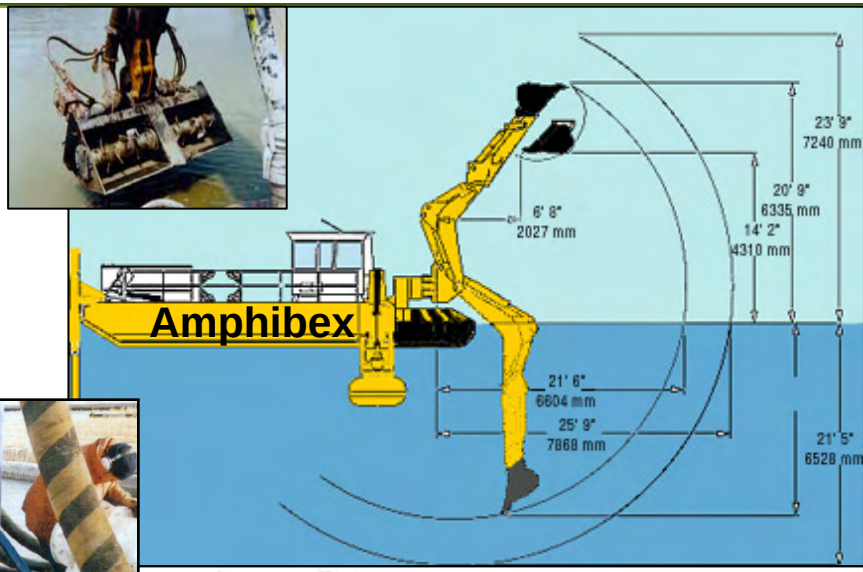
  Pneuma Pump

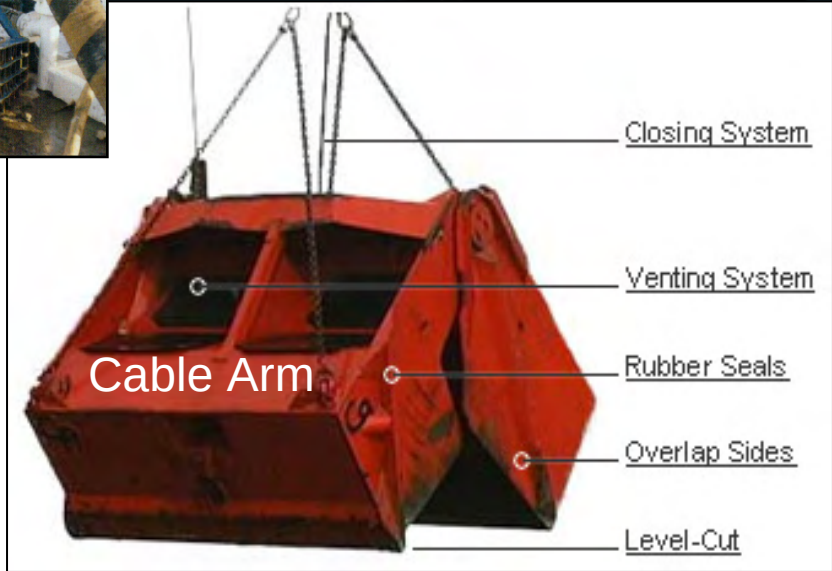
- **Hybrid**

  Amphibex

- **Alternative**

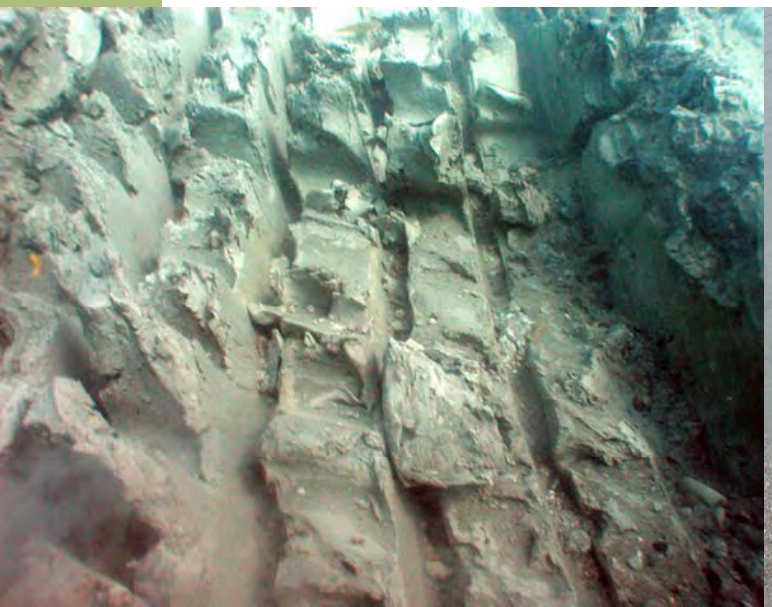
  Caissons





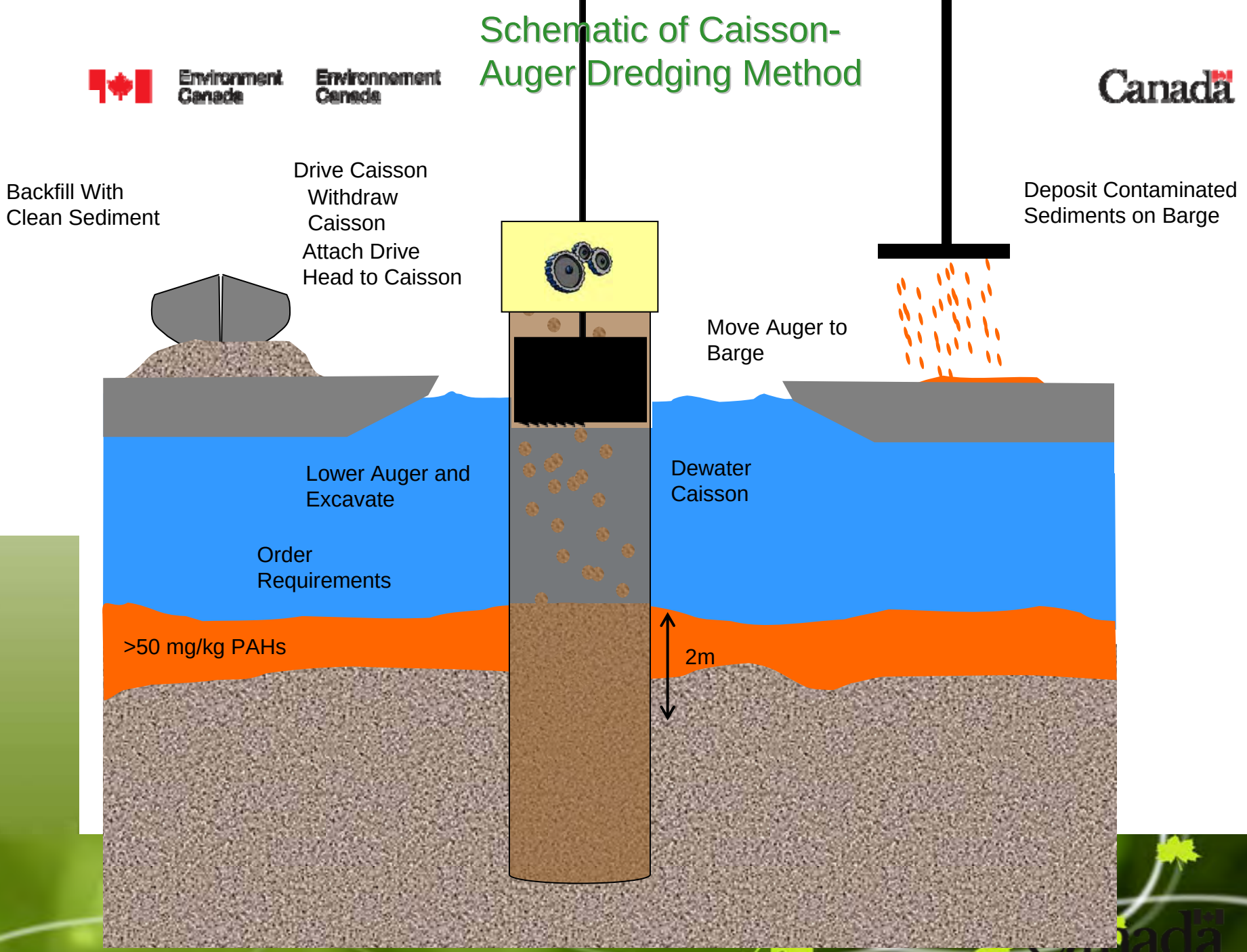
St. Clair River Sediment Remediation Project

- Eddy Pump hydraulic dredge used to remove 13,000 m^3 of contaminated sediment (Hg, and organics) with physical dewatering and anaerobic bioremediation (biopile) and on-site disposal

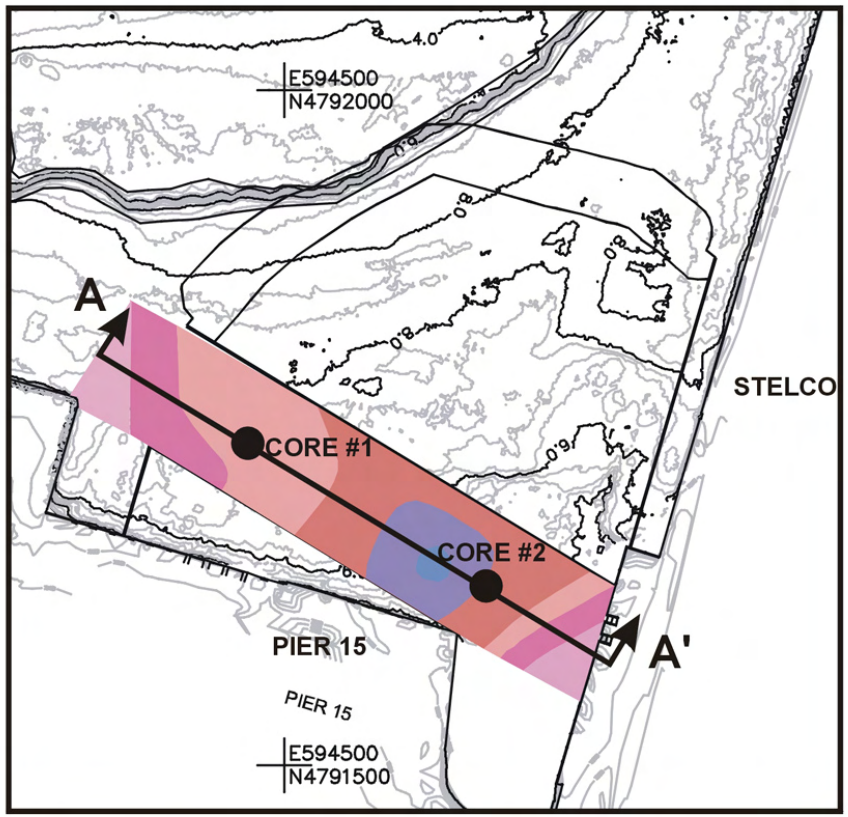


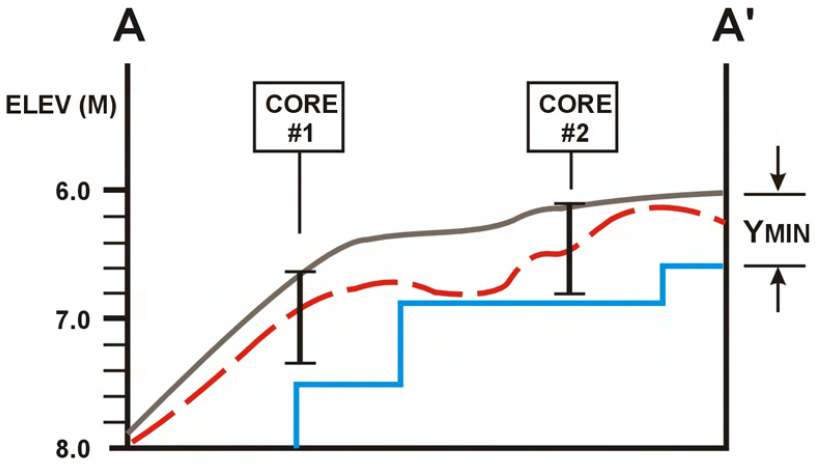
Alternative Sediment Removal

Schematic of Caisson-Auger Dredging Method



Contaminant Sediment Layer Surface vs. Dredge Surface





(1) YMIN = MINIMUM COST-EFFECTIVE DREDGE DEPTH
(2) VERTICAL EXAGGERATION APPROX 100X
(3) DIAGRAM CAPTURES ONLY GENERAL BATHYMETRIC FEATURES

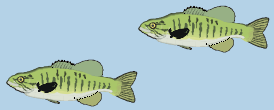
SEDIMENT SURFACE

BOTTOM OF CONTAMINATED SEDIMENT SURFACE

DREDGE SURFACE

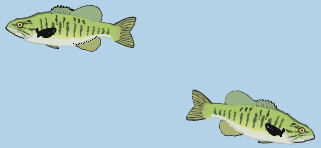
Mass Removal ≠ Risk Reduction

Before Removal
(Mass = 100 lbs)



0 - 3”	Bioavailable	5 ppm
3 - 12”	Stable & Not Bioavailable	50 ppm
12 - 24”		500 ppm
24 - 36”		1000 ppm

After Removal
(Mass = 0.3 lbs)



10 ppm	Bioavailable	0 - 3”
10 ppm		3 - 6”

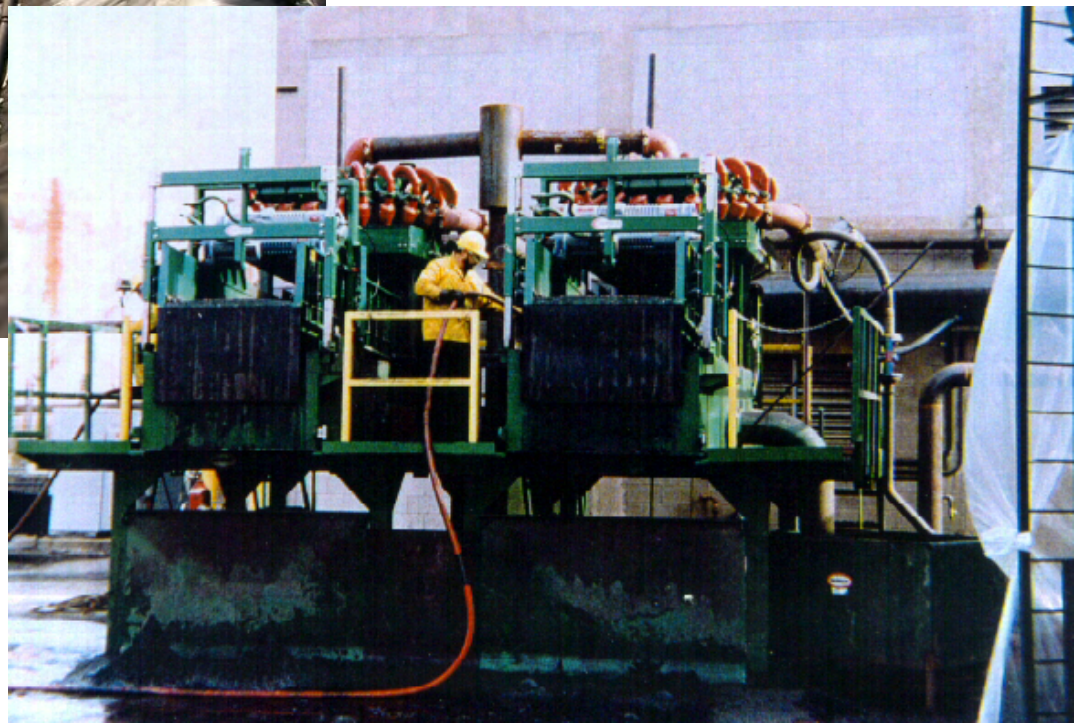
Mass Reduction = 99.7%
Risk = potential 100% increase

Resuspension Control

Pretreatment

Geotubes

Hydrocyclones



Water Treatment

- Water was treated through a series of filters to meet drinking water quality standards

Treatment

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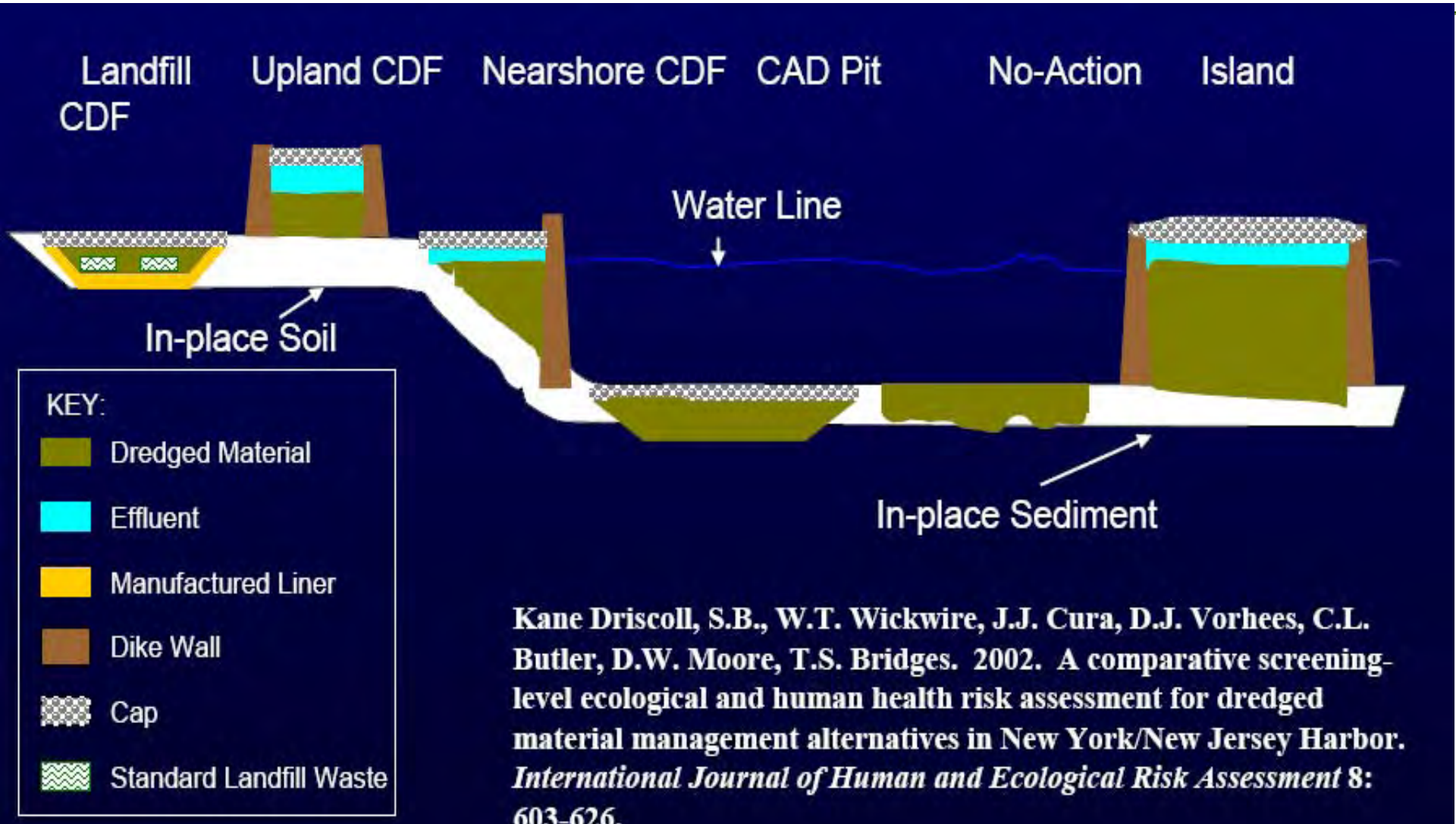
Sediment Disposal Alternatives

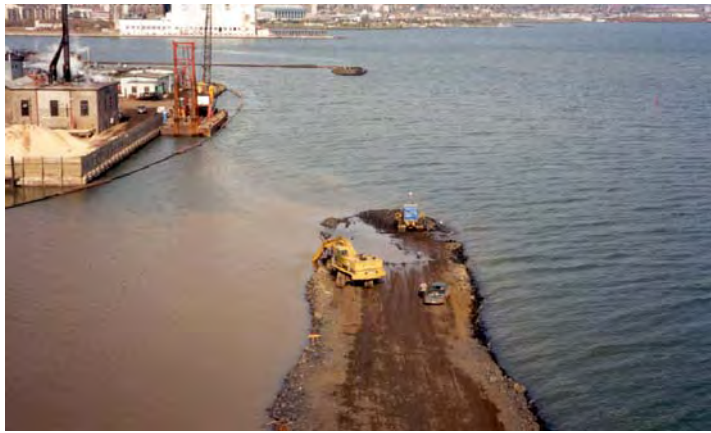


Kane Driscoll, S.B., W.T. Wickwire, J.J. Cura, D.J. Vorhees, C.L. Butler, D.W. Moore, T.S. Bridges. 2002. A comparative screening-level ecological and human health risk assessment for dredged material management alternatives in New York/New Jersey Harbor. *International Journal of Human and Ecological Risk Assessment* 8: 603-626.

Sediment Disposal Alternatives

Contaminated Sediment: *In-Situ* Options

- **Treatment:** Injection of chemicals or micro-organisms to enhance biodegradation or to solidify or stabilize.
- **Capping:** Placement of clean material over in thin layer (subaqueous) or final grade is above water level (dry).
- **Containment:** Isolation of contaminated sediment with sheetpiling, earthen dykes and or rubble mound.



Capping (Materials)

What kind of clean material is typically placed on top of the sediment?

- Sand/topsoil mixture;
- Granulated bentonite (clay);
- AquaBlok (a solid aggregate covered in clay)
- Activated Carbon (absorbent material used to bind organic contaminants, non toxic)
- Reactive Core Mats (RCM)
- Any combination of the above.

Capping (Materials)

Sand/Topsoil Mixing Process

Granular Bentonite (Wyo-Ben #8)

AquaBlok™ Material

Activated Carbon

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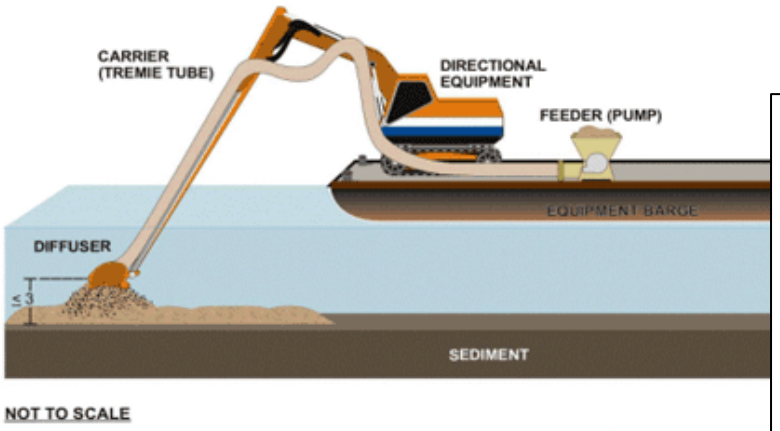
Capping (Mechanical Application)

Surface Clamshell Application

Subsurface Clamshell Application

Capping (Hydraulic Application)

Schematic of Tremie Pumping Application



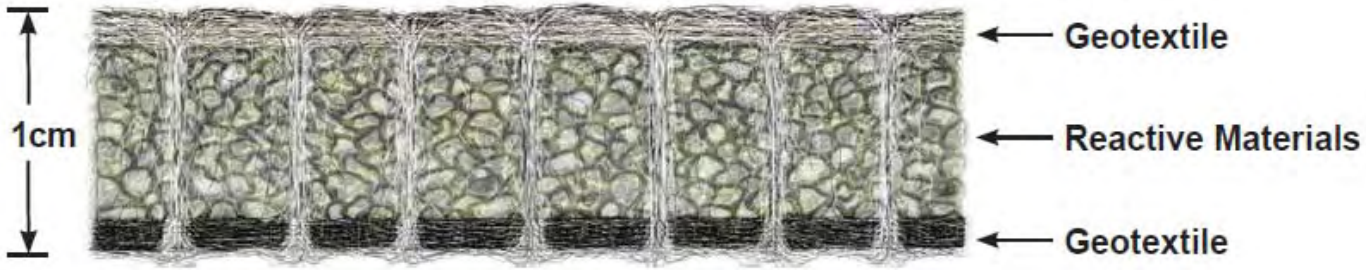
NOT TO SCALE

Land Test of Tremie System

Capping (Reactive Core Mats)

Striker Bay Duluth, MN

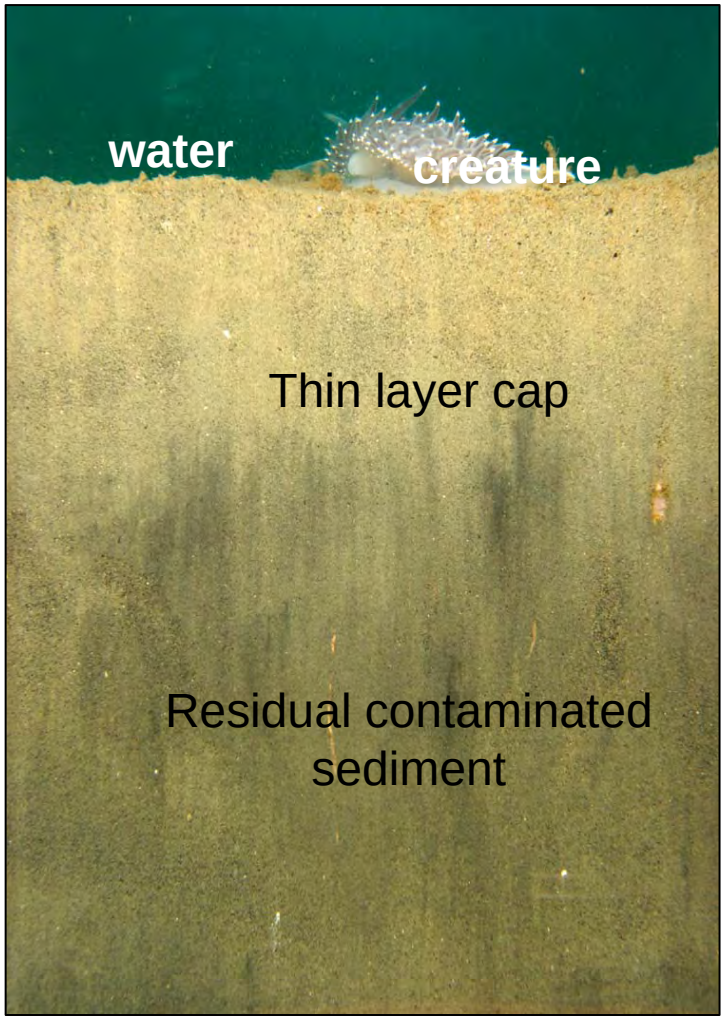
46,500 m^2



Capping (Conveyer)

- Restore the area to a state of granular sediment.
- During the Dow 2004 Sediment Cleanup it was also used to enhance fisheries habitat and promote benthic macroinvertebrate recolonization.

Thin-Layer Capping



- **Following dredging, less contaminated undredged and or residual sediment (which cannot be effectively dredged) will be covered over with a thin layer of clean sand to achieve the site specific clean-up criteria.**

Thin layer cap could vary in thickness from 8 cm up.

Applying Monitored Natural Recovery (MoNR)

- **Assess Lines of Evidence**
  - Site conditions and MoNR Processes
- **Long-Term Monitoring**
  - To ensure continuous reductions in contaminant concentration/toxicity
- **Administrative Controls**
  - To prevent disturbance

MoNR Lines of Evidence

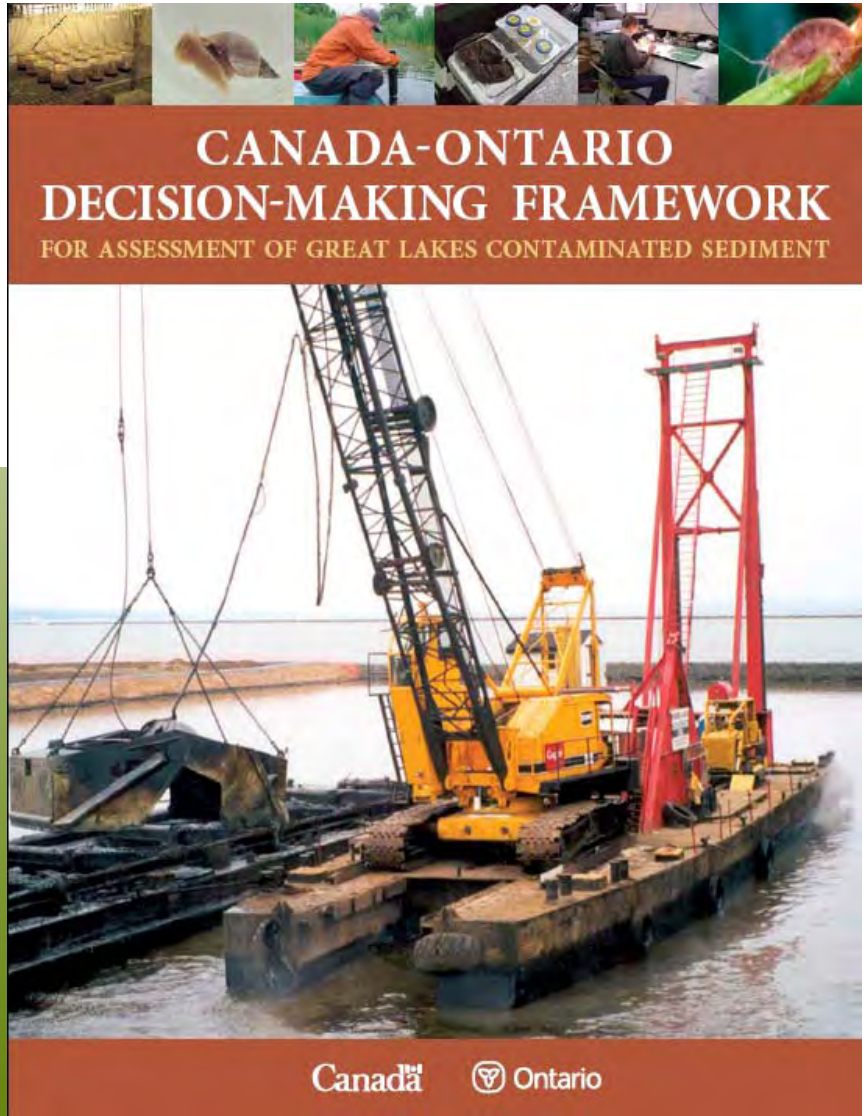
1. Have sources at the site been sufficiently controlled?
2. Do historical data show decreasing exposure?
3. What evidence exists of **chemical transformation** at the site?

   What evidence exists of **reduced bioavailability** and mobility at the site?

   What evidence exists of **physical isolation** of contaminants at the site?

   What evidence exists of natural recovery via chemical or **sediment dispersion** processes?
4. To what extent do process interactions influence natural recovery?
5. How effectively will natural recovery processes reduce risks?

St. Clair River Risk Assessment



1. Sediment Chemistry
   - 61% of sediment samples more than 2 mg/kg Hg (Provincial SEL)
   - Hg in buried sediment up to 5 times higher than surface sediment in some places
2. Sediment Toxicity
   - No strong evidence of toxicity to Hg
3. Changes to Benthic Community
   - No strong evidence of community changes due to Hg compared to reference sites
4. Potential for Biomagnification
   - Negligible risk to wildlife that eat fish
   - **Risks to some fish species**
   - **Priority Areas identified based on risk to fish**

Management Goals

Removal of Hg-contaminated sediment:

1. as a source to downstream sites
2. to promote local risk reduction
3. for contaminant mass removal

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Priority Zones for Sediment Management

Three priority zones for management;

1. Suncor dock site (51,400 m^2, 25,700 m^3)
2. Shell dock site (11,000 m^2, 5,500 m^3)
3. Guthrie Park (7,500 m^2, 3,750 m^3)

These areas represent depositional areas downstream from the original source.

The total estimated area and volume to be managed are ~69,900 m^2, and ~34,900 m^3.

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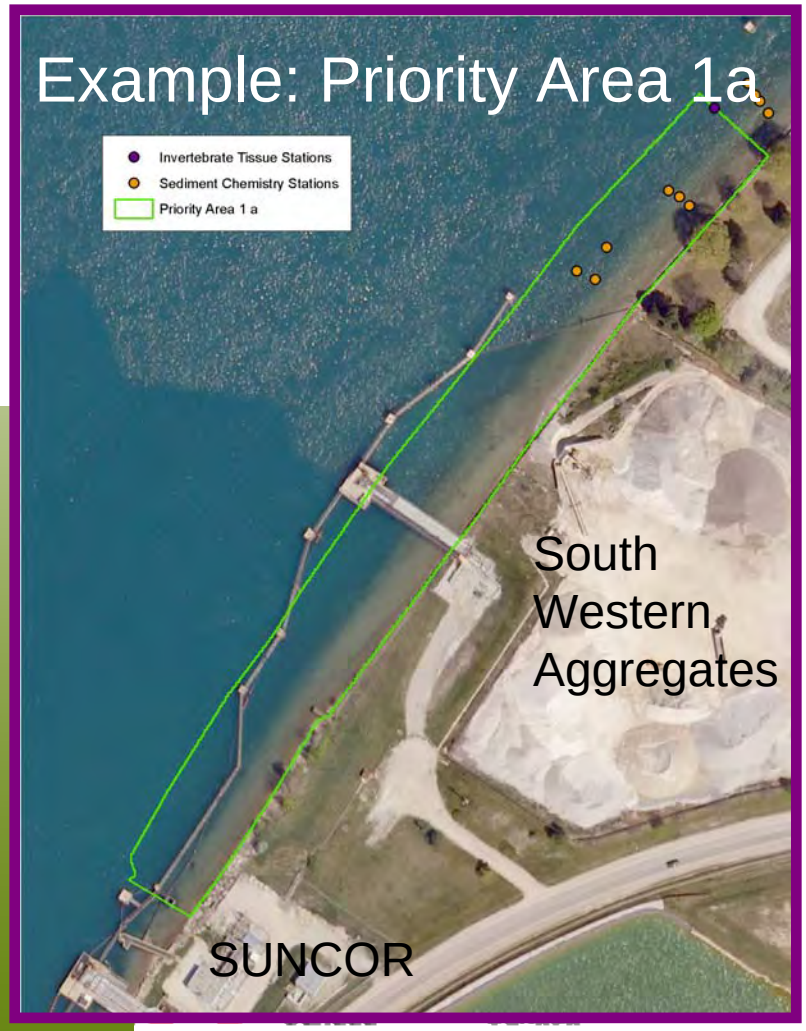
Management Options - Dredging



Considerations for Dredging:

- A 8-16 cm cap may be placed post-dredging for residuals management (thin-layer capping)
- Buried Pipelines
- Site Access/Material Handling Areas
- Debris Management
- Water Handling and Treatment Requirements

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Management Options – Capping

Considerations for Capping:

- The 40-60 cm isolation cap should include an armoring layer (such as gravel) to limit potential for cap erosion
- Cap material should be coarse-grained with low total organic carbon (TOC)
- Administrative controls should be established to limit vessel traffic within cap area footprint
- Need to identify group to undertake long term monitoring, and maintenance of cap
- Habitat Compensation for Infilling

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Management Options - Monitored Natural Recovery

Example: Priority Area 1b

Considerations for Monitored Natural Recovery

- Rate of Natural Deposition vs. Dispersion
- Need for Administrative Controls
- Long term monitoring considerations vs. Adaptive Management

Certainty of Project Cost Estimate

Stages of Sediment Projects

(7) Post Construction

(6) During Construction

(5) Tender Award

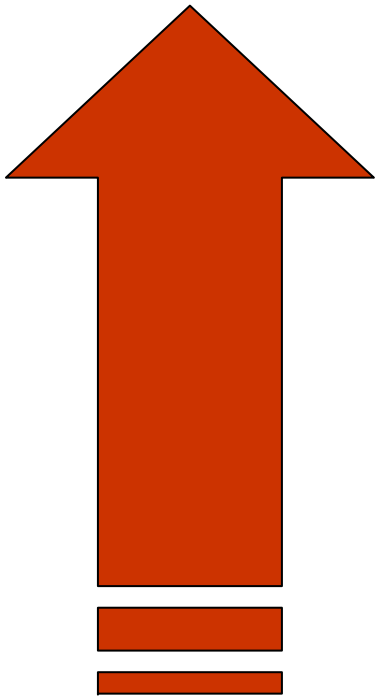
(4) Detailed Engineering Design

(3) (SMO) Preliminary Engineering Design

(2) Conceptual Design

(1) Sediment Assessment

Increasing Certainty in Estimate



St. Clair River Sediment Management Next Steps

1. Completion of Preferred Sediment Management Option(s) Assessment Report (Summer 2012)
2. Consultation of Preferred Option(s) (Fall Winter 2012/13)
3. Selection of Preferred Option(s) (Summer 2013)
4. Initiate Detailed Engineering Design and Environmental Assessment (Fall 2013)
5. Peer Review, Tender, Award and Mobilization (2015/16)
6. Implementation of Preferred Option (2016/17)

Questions?

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