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WEDA 34/TAMU 45
"*Expanding the Dredging World*"

Randle Reef Sediment Remediation Project - Overview

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Environment Canada

June 16, 2014
Fairmont Royal York,
Toronto, Ontario
Canada

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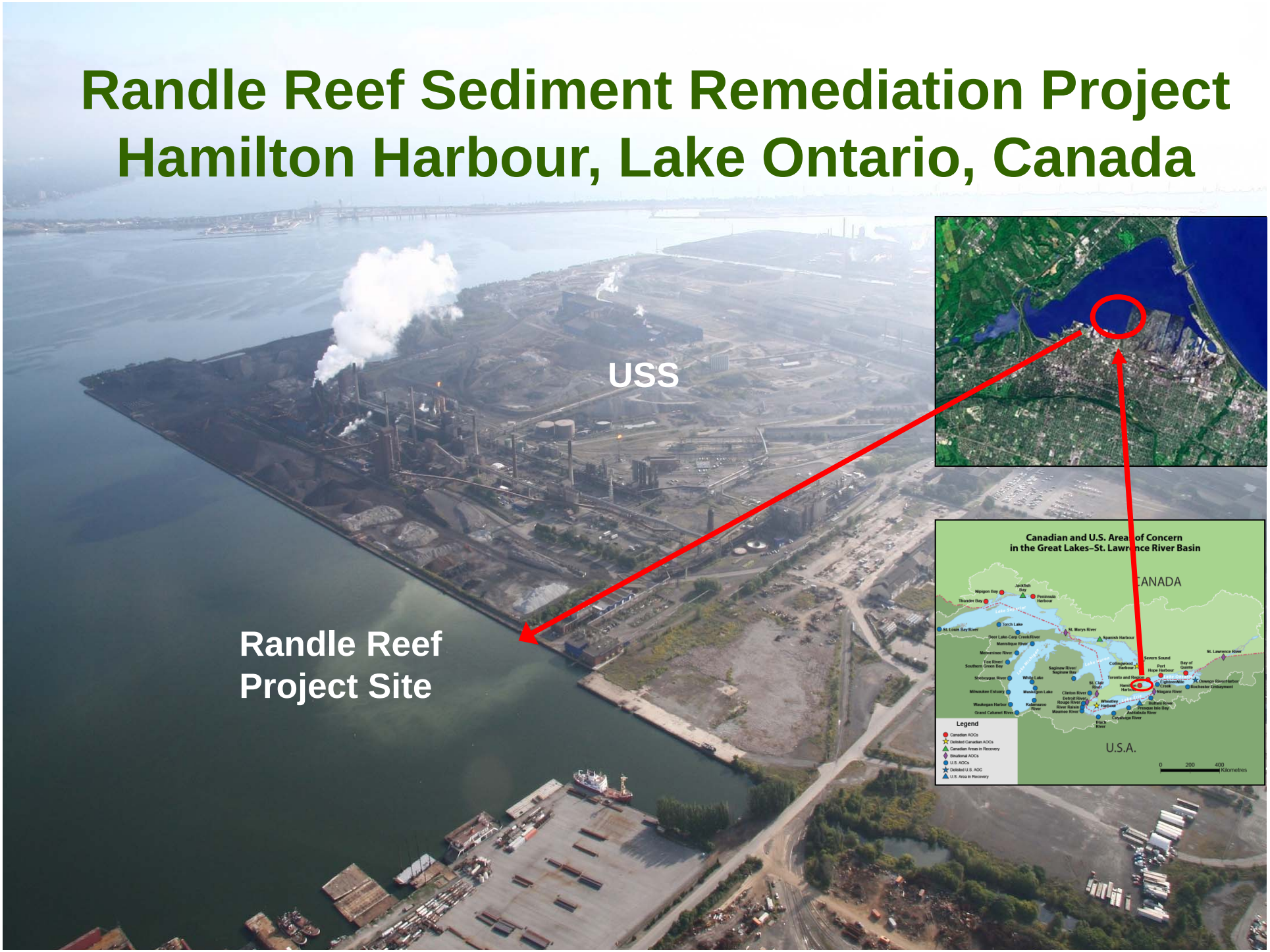
Hamilton Harbour

Randle Reef Sediment Remediation Project
Hamilton Harbour, Lake Ontario, Canada

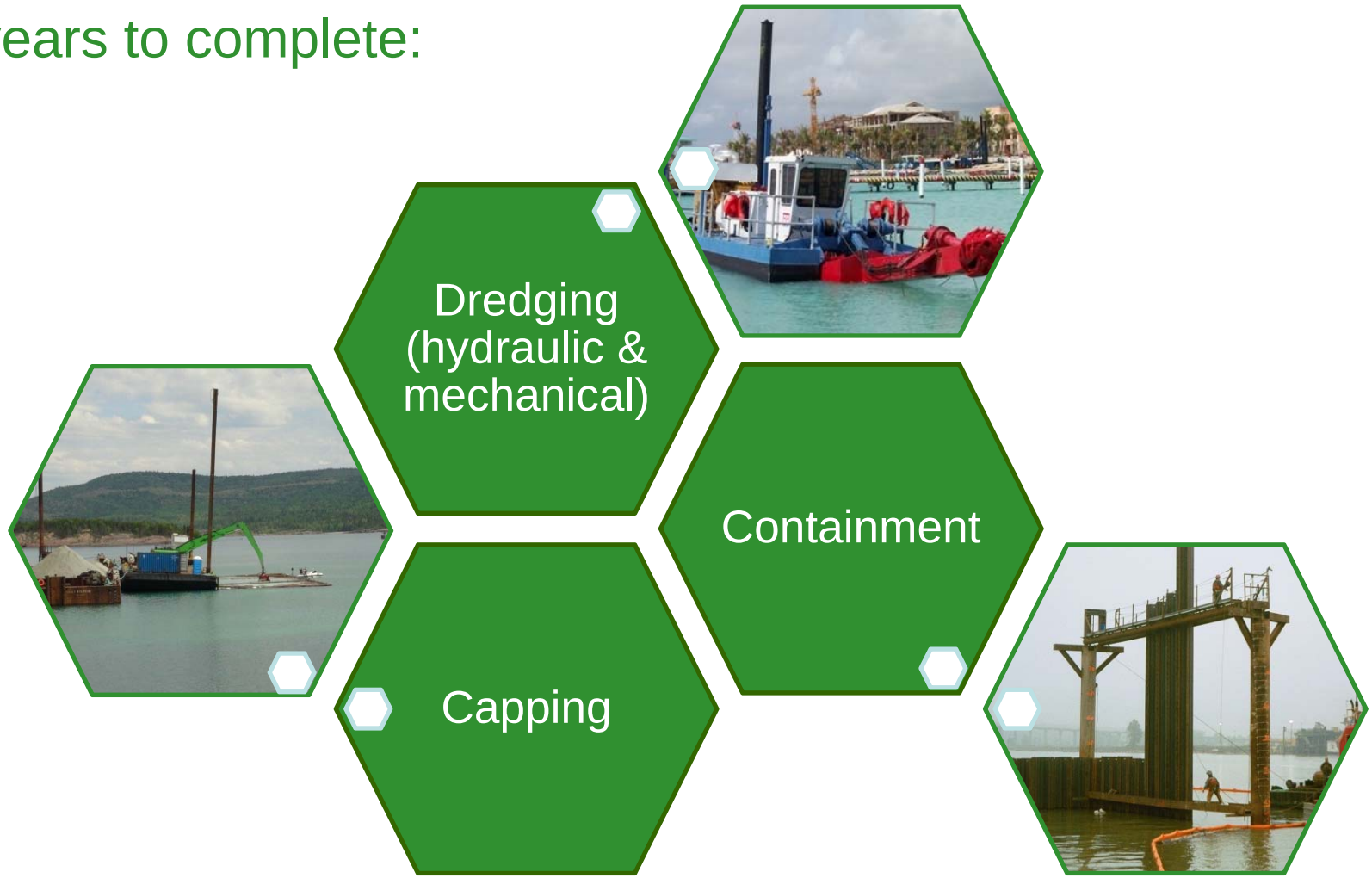


Randle Reef Site Specifics

- Impacted by historic operation of coal gasification plant and steel operations;
- Approximately 675,000 m^3 of contaminated sediment (PAHs & metals); and
- Average total PAH concentration near 5,000 ppm with peaks over 73,000 ppm.
- **Site Area:** ~60 ha (148 acres)
- **Depth of Water:** Ranges from ~4 m to 12 m
- **Sediment Depth:** Ranges from ~0.1 m to >3 m

Remedial Approach

8 years to complete:



Sediment Project Components

- In total 675,000 m^3 of contaminated sediment will be safely managed
- Construct a 7.5 hectare (18.5 acres) Engineered Containment Facility (ECF) over the most highly contaminated sediment (130,000 m^3 *in-situ*);
- Using a combination of hydraulic and mechanical dredging, remove 500,000 m^3 and place within ECF;
- Thin Layer Capping of 40,000 m^3 of marginally contaminated sediment
- Cap U.S. Steel Intake/Outfall Channel sediments 5,000 m^3
- Cap ECF and construct a port facility and open green space.

Dredging Design

➢ Dredging Challenges:

- Dredging of firm clay and volatile management;
- Finite capacity of the ECF;
- Dredging offsets from existing dock walls;
- Residuals management;
- Dredging is not possible in one section due to existing structure stability.

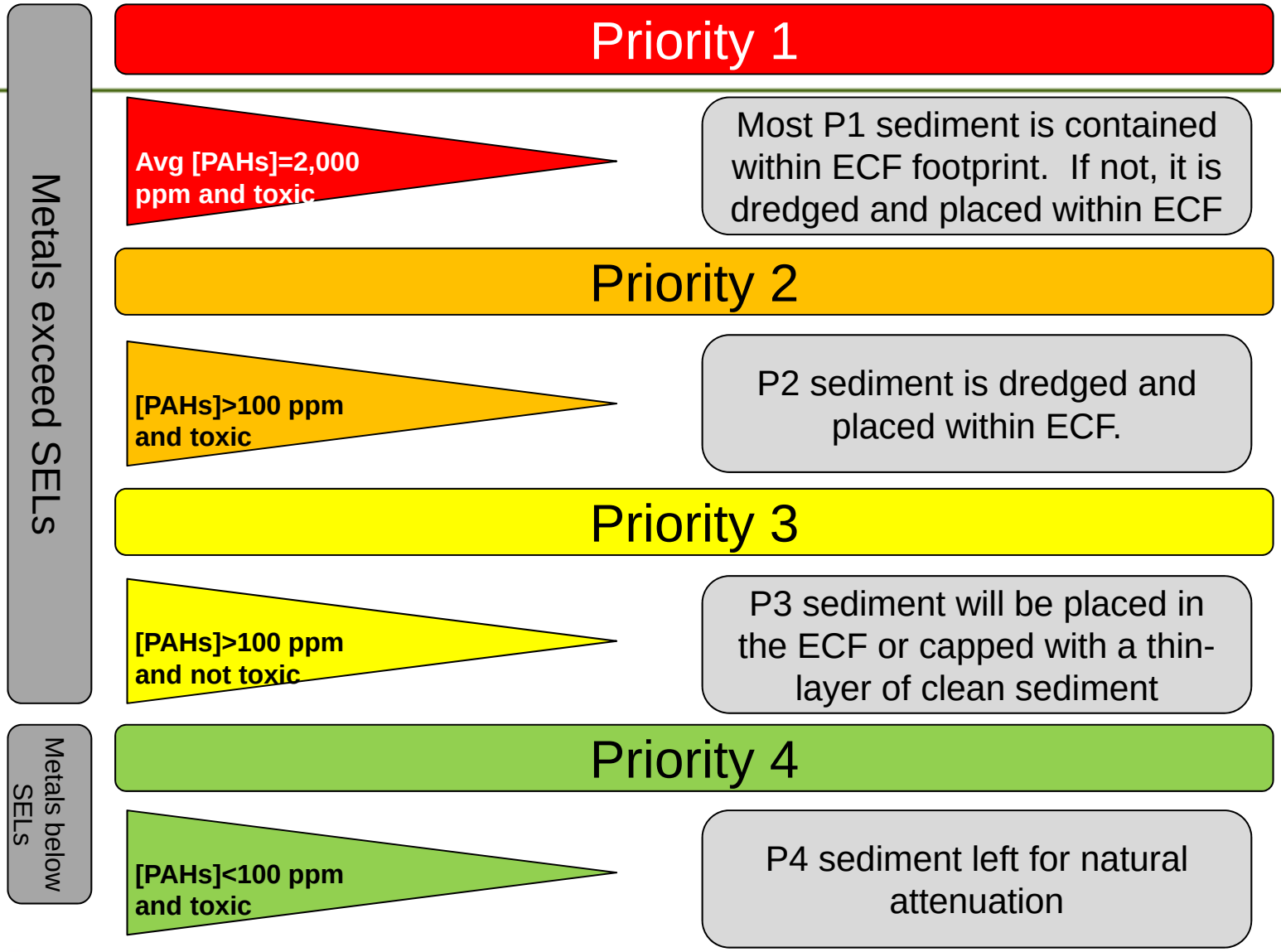
U.S. Steel Channel

Site Specific Clean-Up Criteria

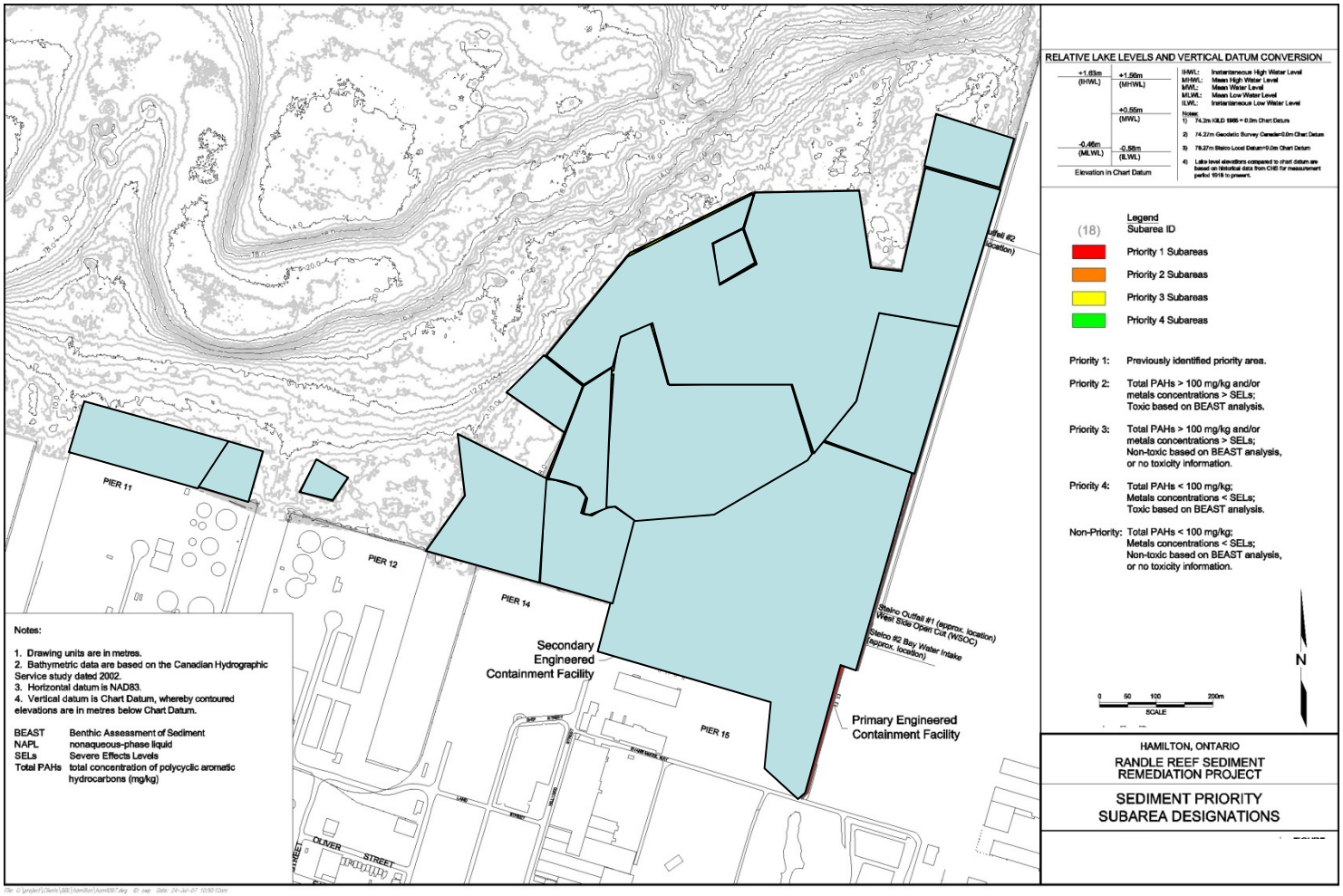
100 mg/kg (ppm) Total PAHs based on the consideration of:

- Background levels of PAHs in the Harbour (30 - 45 mg/kg);
- Average concentrations of PAHs in the Harbour (~68 mg/kg);
- Uncontrollable indirect inputs of PAHs to the Harbour (i.e. vehicular emissions);
- Toxicity data from another similar contaminated sediment site located in Hamilton Harbour as well as Randle Reef itself;

Approach to Remediate Sediment



Dredging Sequence

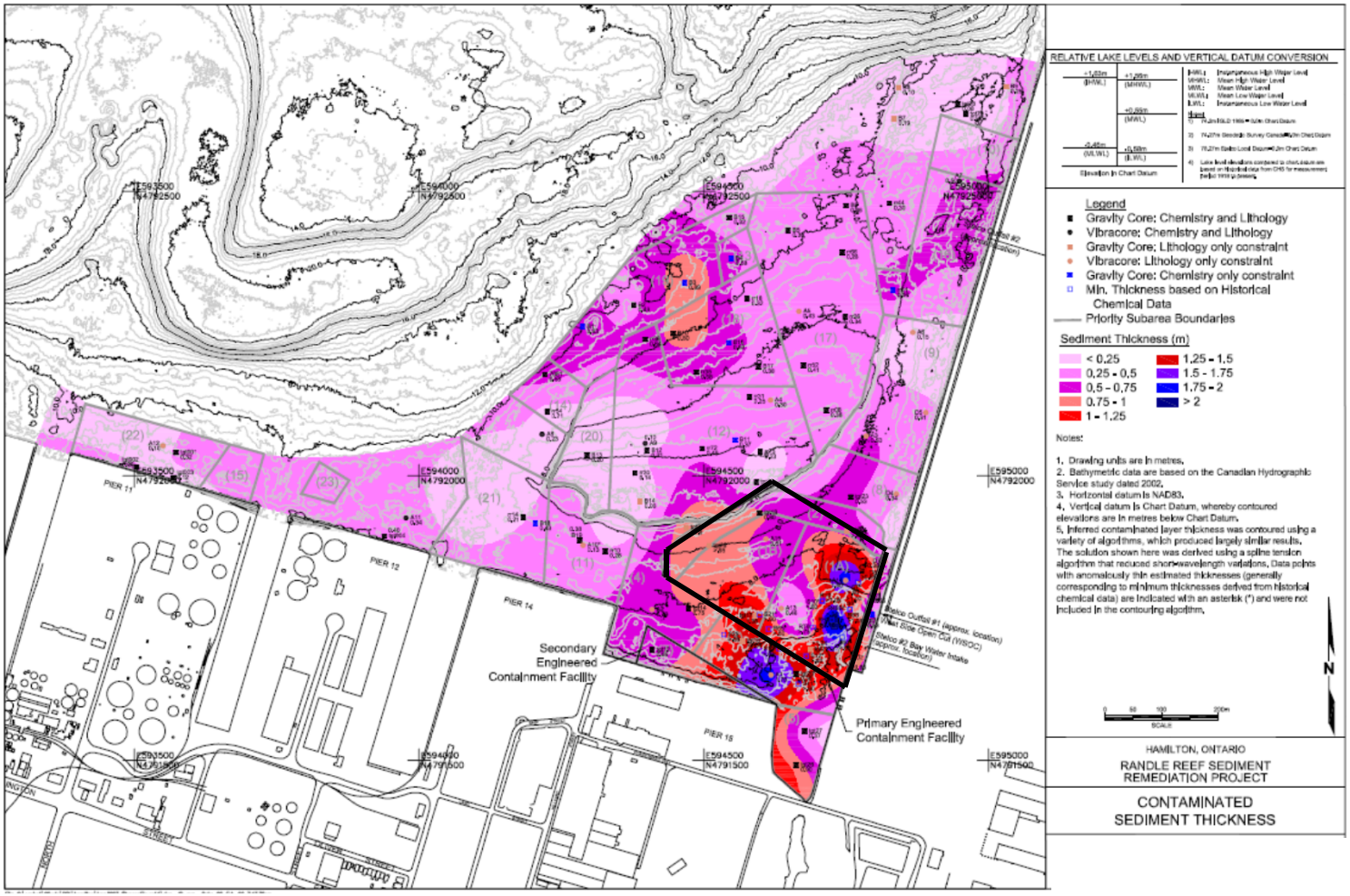


PAH Mass Distribution

Subarea	Priority Designation	Volume (m^3)	Average [Total PAHs] (ug/g)	Mass of PAHs for a Subarea (kg)	Percentage of PAHs in a Subarea Compared to the Site (%)	Cumulative Percentage of PAH (%)
1	1	130,000	6,340	1,318,720	72.3	72.3
2a (soft sediments)	1	23,412	367	13,744	0.8	73.1
2b (clay)	1	42,099	0	0	0.0	73.1
3	1	39,802	3,975	253,122	13.9	87.0
4	1	33,144	325	17,256	0.9	87.9
5	1	8,040	139	1,784	0.1	88.0
6	1	5,655	4,021	36,380	2.0	90.0
7	1	15,449	204	5,038	0.3	90.3
8	1	24,924	283	11,278	0.6	90.9
9	2	31,966	1,747	89,330	4.9	95.8
10	2	9,351	107	1,593	0.1	95.9
11	2	26,850	69	2,969	0.2	96.1
12	2	74,713	62	7,447	0.4	96.5
13	2	5,124	145	1,187	0.1	96.5
14	2	10,299	28	458	0.0	96.6
15	2	6,722	49	526	0.0	96.6
16	3	28,321	283	12,810	0.7	97.3
17	3	74,296	315	37,398	2.1	99.3
18	3	34,704	71	3,920	0.2	99.6
19	3	42,461	80	5,415	0.3	99.9
20	3	20,484	50	1,629	0.1	99.9
21	4	26,770	18	775	0.0	100.0
22	4	13,983	8	181	0.0	100.0
23	4	2,331	5	19	0.0	100.0
Total		730,899		1,822,978	100.0	

ECF Full

Sediment Thickness Layer



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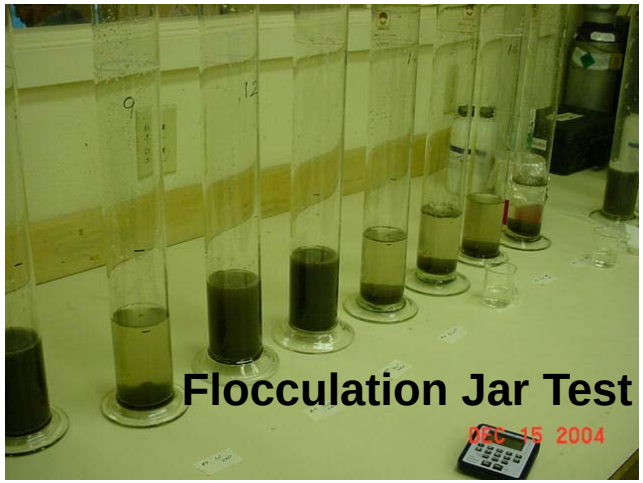
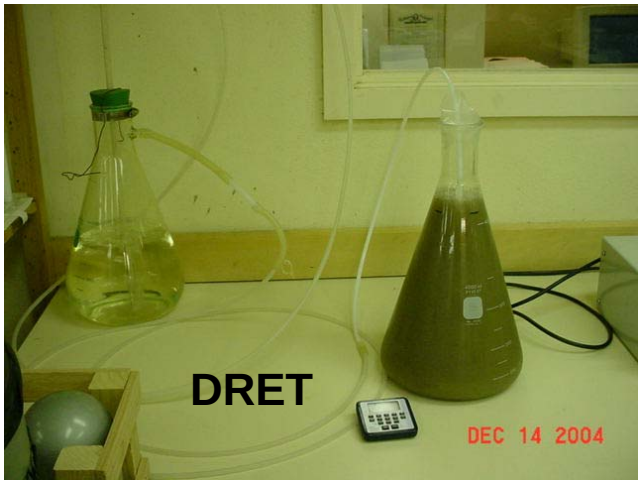
Treatability Studies

- **Flocculation Jar Test** – Determine the most effective coagulant/flocculant
- **Column Settling Test (CST)** – Simulate settling using preferred polymer
- **Column Media Filtration Test** – Determine the most effective filtration media
- **Batch Media Adsorption Test** - Determine adsorption capacity (Kd) of filtration media
- **Thin Column Leach Test (TCLT)** - Models sediment leaching in a ECF by groundwater and rain water
- **Dredge Elutriate Test (DRET)** - Simulates chemical release at the point of dredging
- **Pore Water Extraction** - Measure pore water chemical conc. in equilibrium with sediment

Treatability Studies

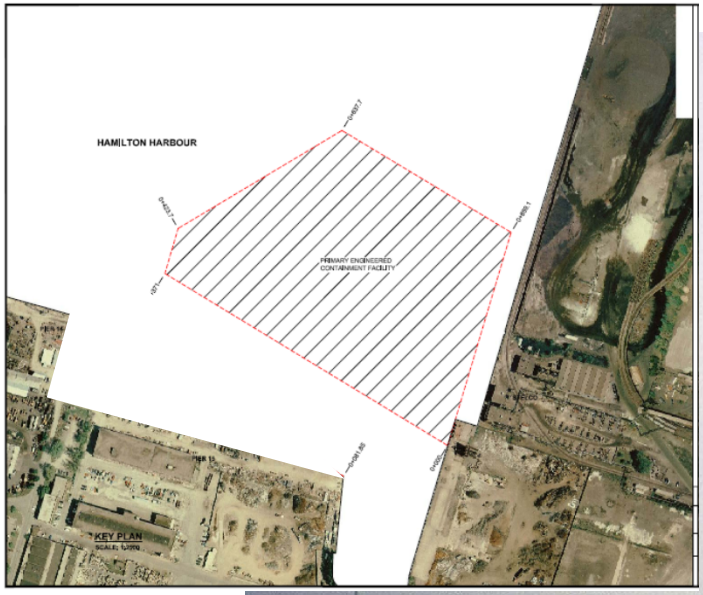




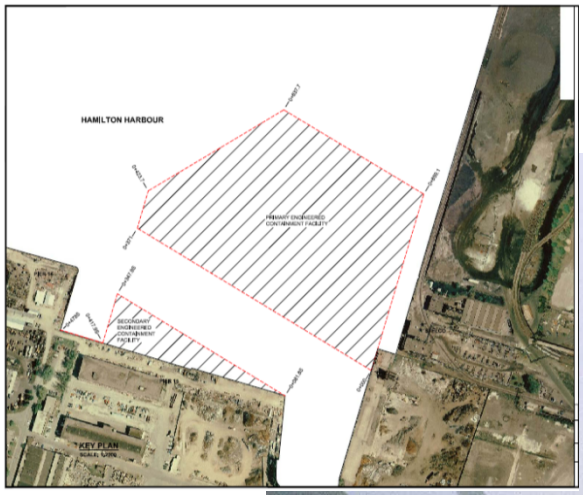
Construction Components

1. Installation of double steel sheetpile walls (ECF structure);
2. Mechanical dredging between ECF walls;
3. Production dredging and thin layer backfill;
4. Capping in U.S. Steel Channel; and
5. Installation of ECF cap.

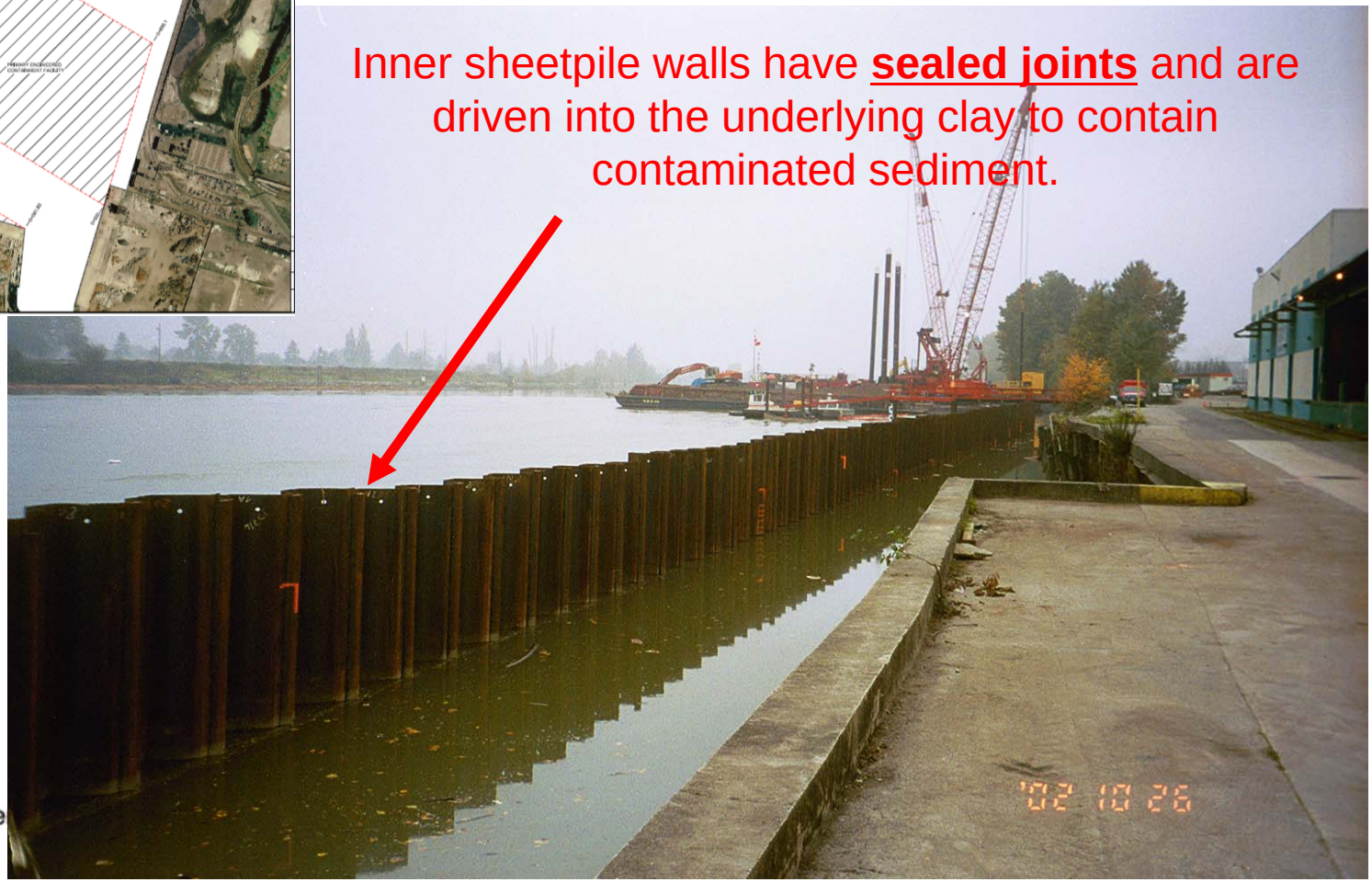
Installation of Double Steel Sheetpile Walls



Installation of Double Steel Sheetpile Walls (cont'd)



Inner sheetpile walls have **sealed joints** and are driven into the underlying clay to contain contaminated sediment.



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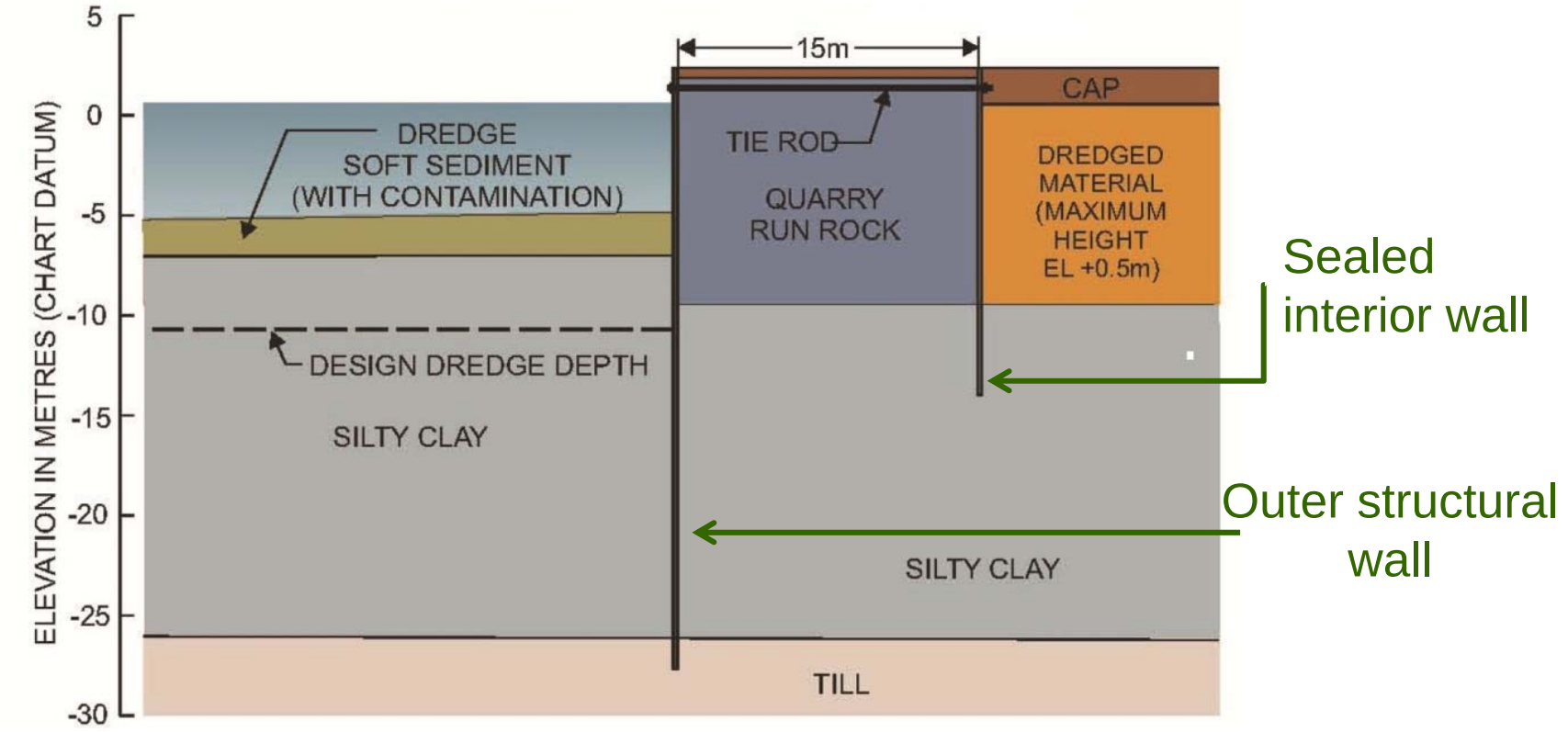
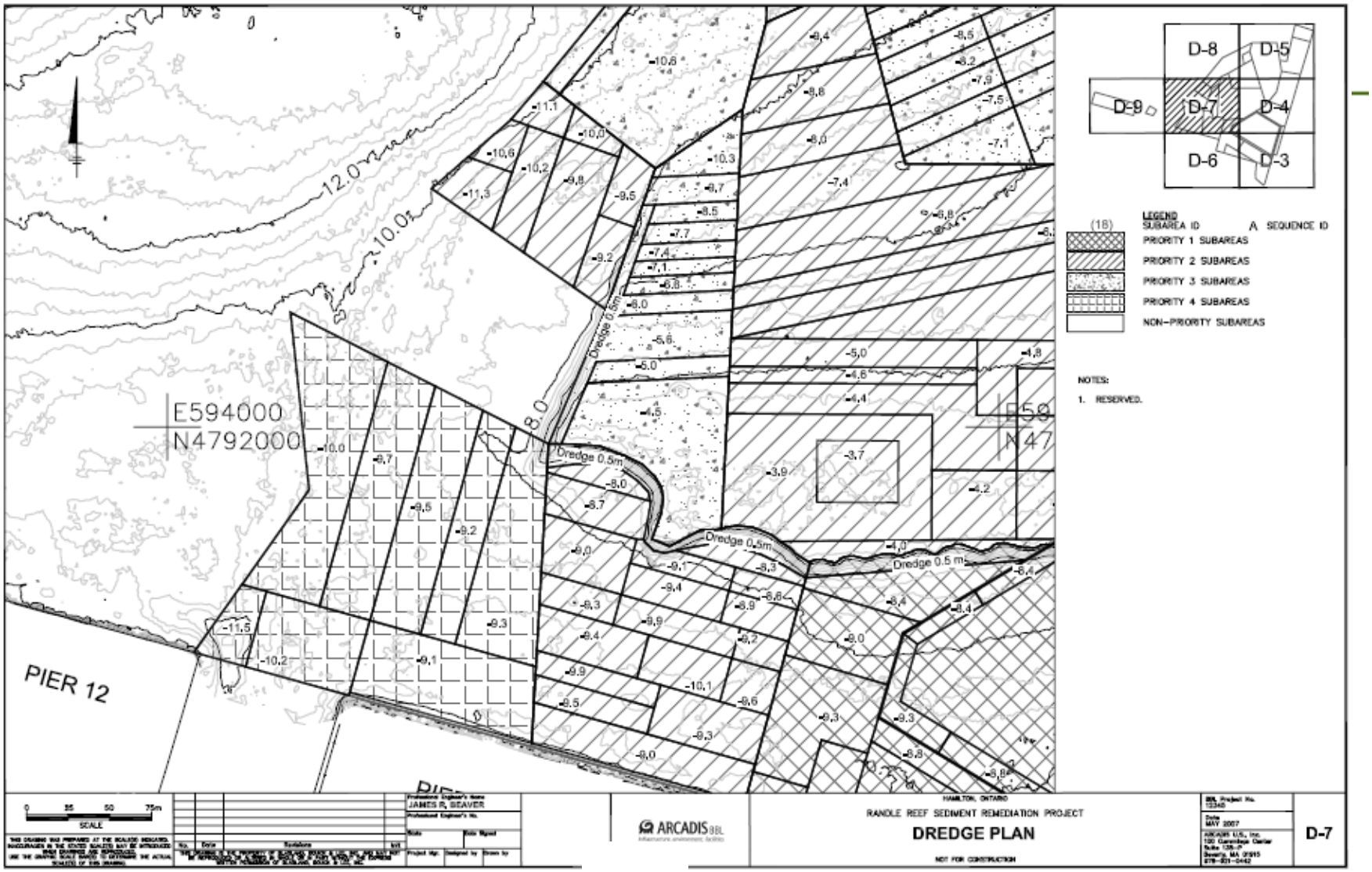
Isolation Structure

- A double steel sheetpile wall with sealed interlocks



Production Dredging – Draft Dredge Plan Section D7



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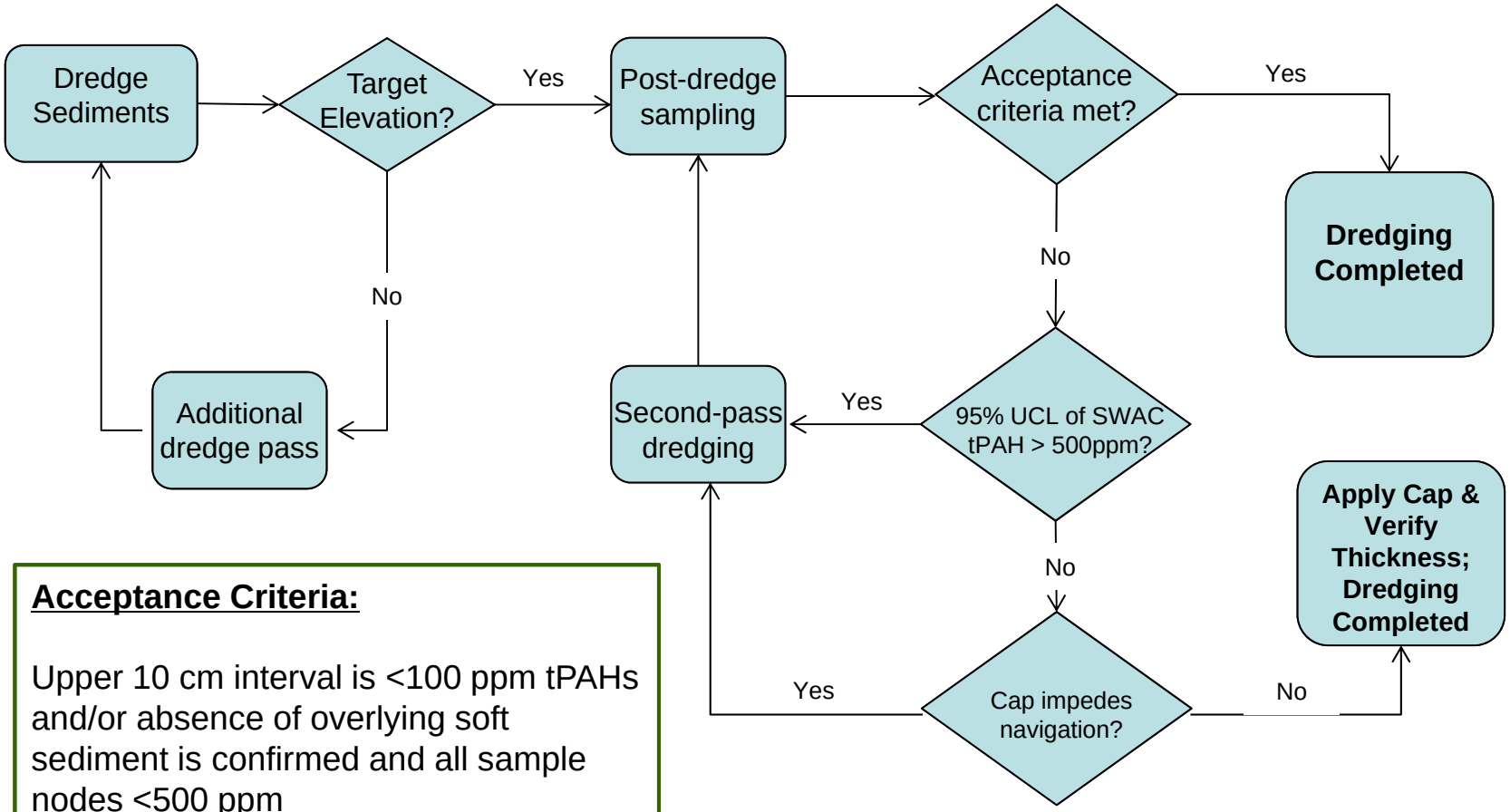
5 Phases of Dredging:

1. **Mechanical dredging** between the double sheet pile walls to remove contaminated sediments.
2. **Mechanical dredging** of clay from between the double sheet pile walls to accommodate the structural design.
3. **Hydraulic dredging** of contaminated sediments down to the underlying clay in Priority 1 and 2 areas.
4. **Hydraulic dredging** of contaminated sediments down to an established clean line in Priority 3 areas.
5. **Second pass dredging** in all dredged areas to address any remaining residual contamination.

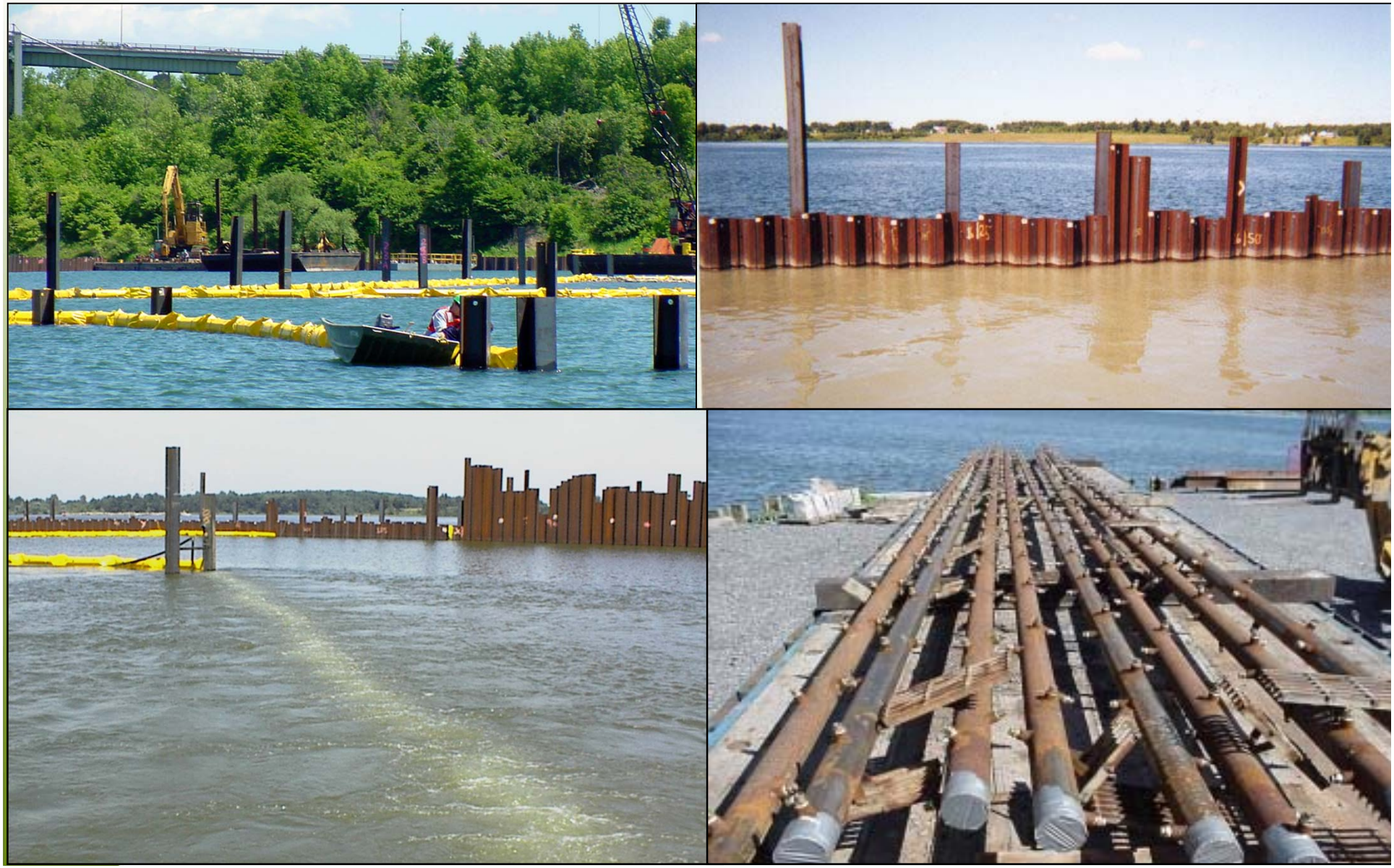
Dredging Decision Process - Overview



Acceptance Criteria:

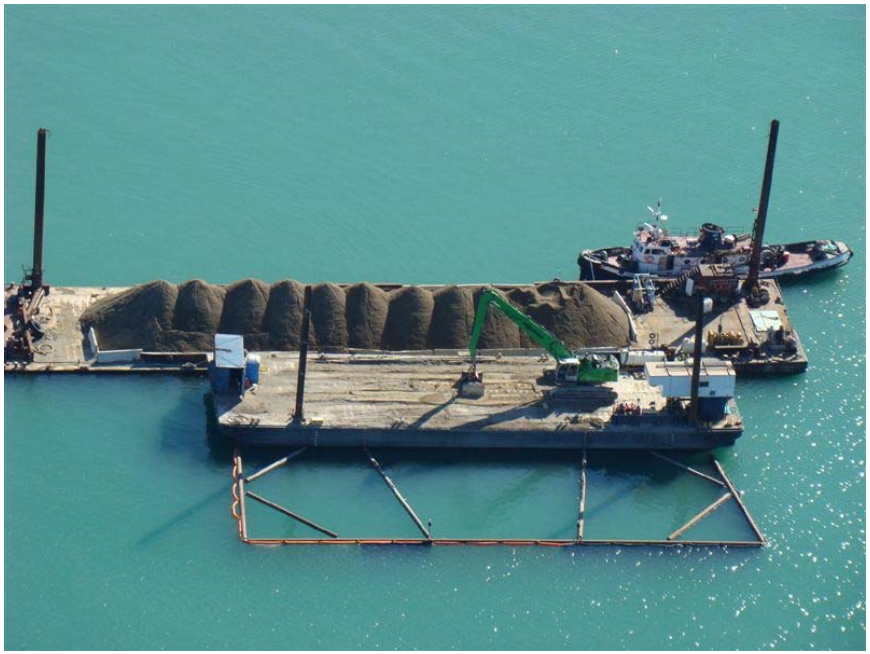
Upper 10 cm interval is <100 ppm tPAHs and/or absence of overlying soft sediment is confirmed and all sample nodes <500 ppm

Resuspension Control

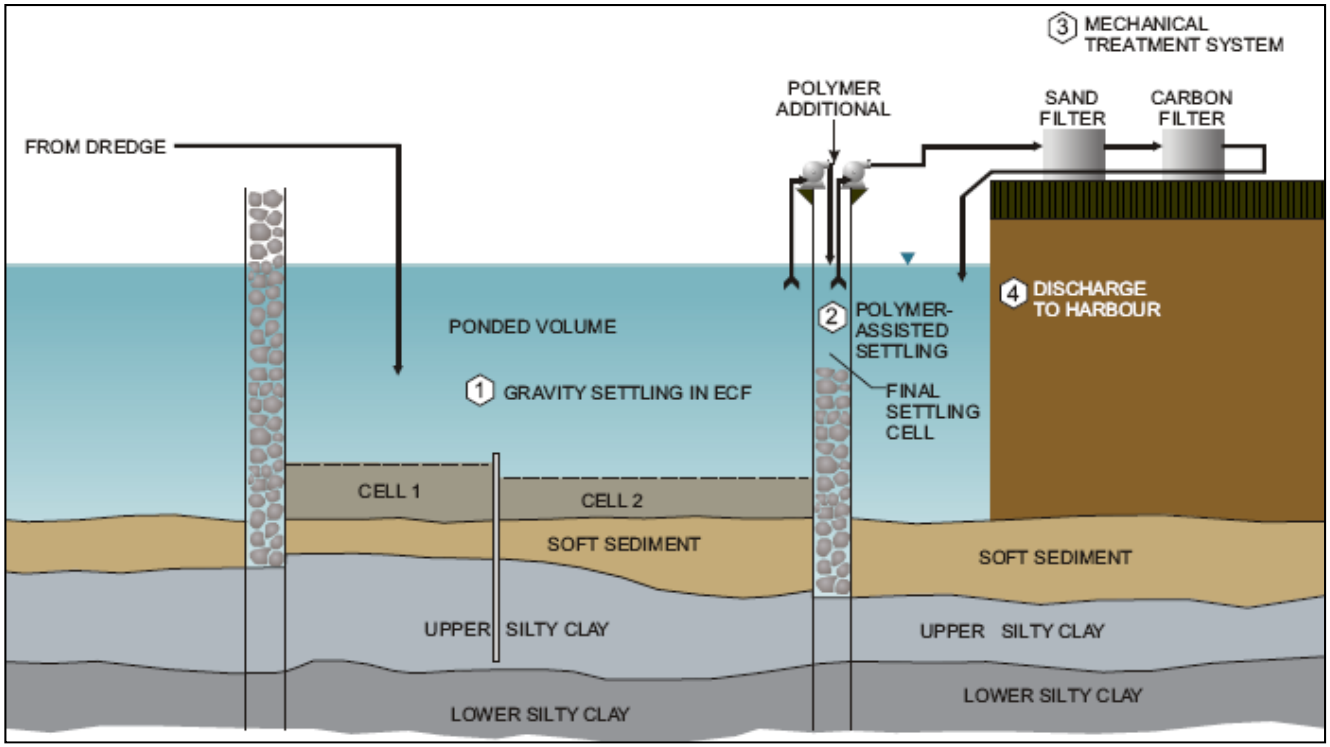


Thin Layer Backfill

- Place a thin-layer cover of sand to backfill areas with PAH concentrations at or above 100 ppm
  a) Thin-layer cap will be approximately 16 cm in thickness; and
  b) Capping is proposed to occur in two separate lifts of approximately 8 cm.

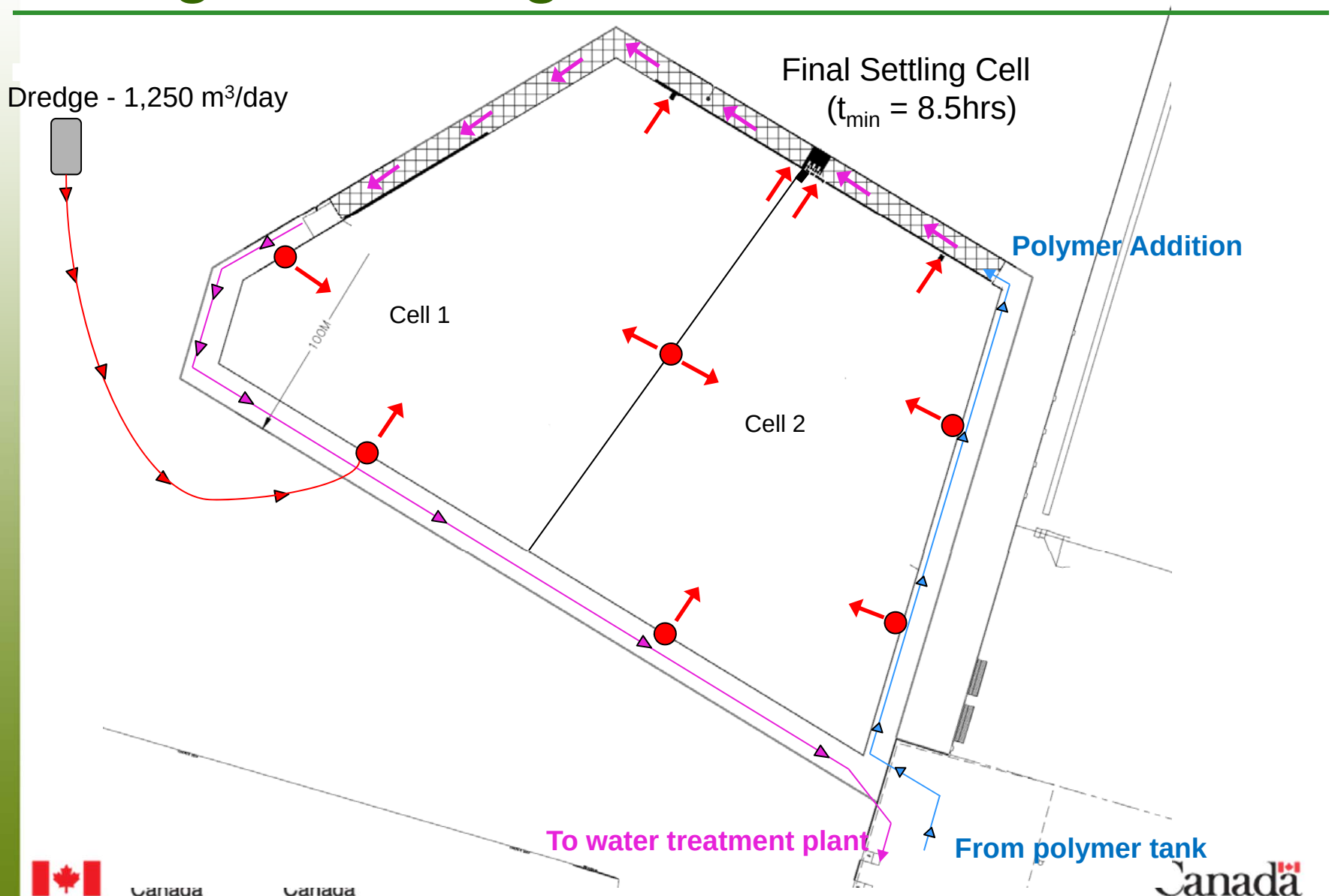


Production Dredging – Dredgeate Management



1. Gravity settling of decant water within the ECF
2. Polymer-assisted settling in a final settling cell (area between the walls)
3. Additional treatment using sand filtration and (GAC) adsorption
4. Discharge to Hamilton Harbour

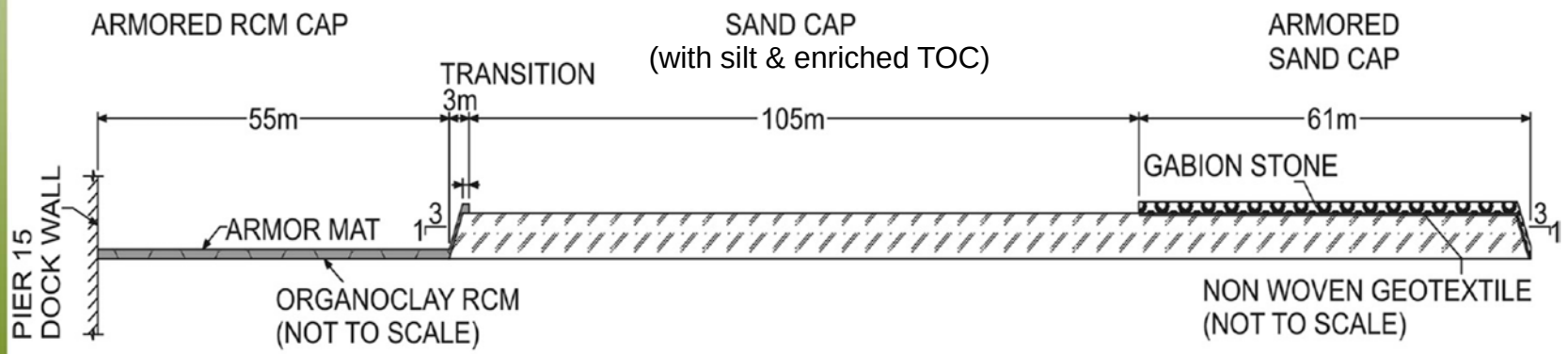
Dredgeate Management



Isolation Cap Design

US Steel Channel

Accommodates intakes and dock wall stability concerns.



SEDIMENT CAP CROSS SECTION

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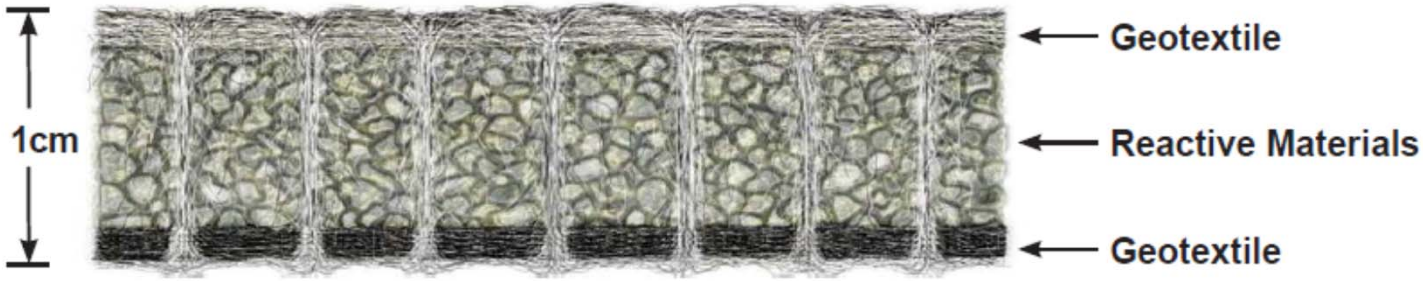
U.S. Steel Channel Capping

- Reactive Core Mats in inflow/outfall areas
- Significantly thinner than traditional cap

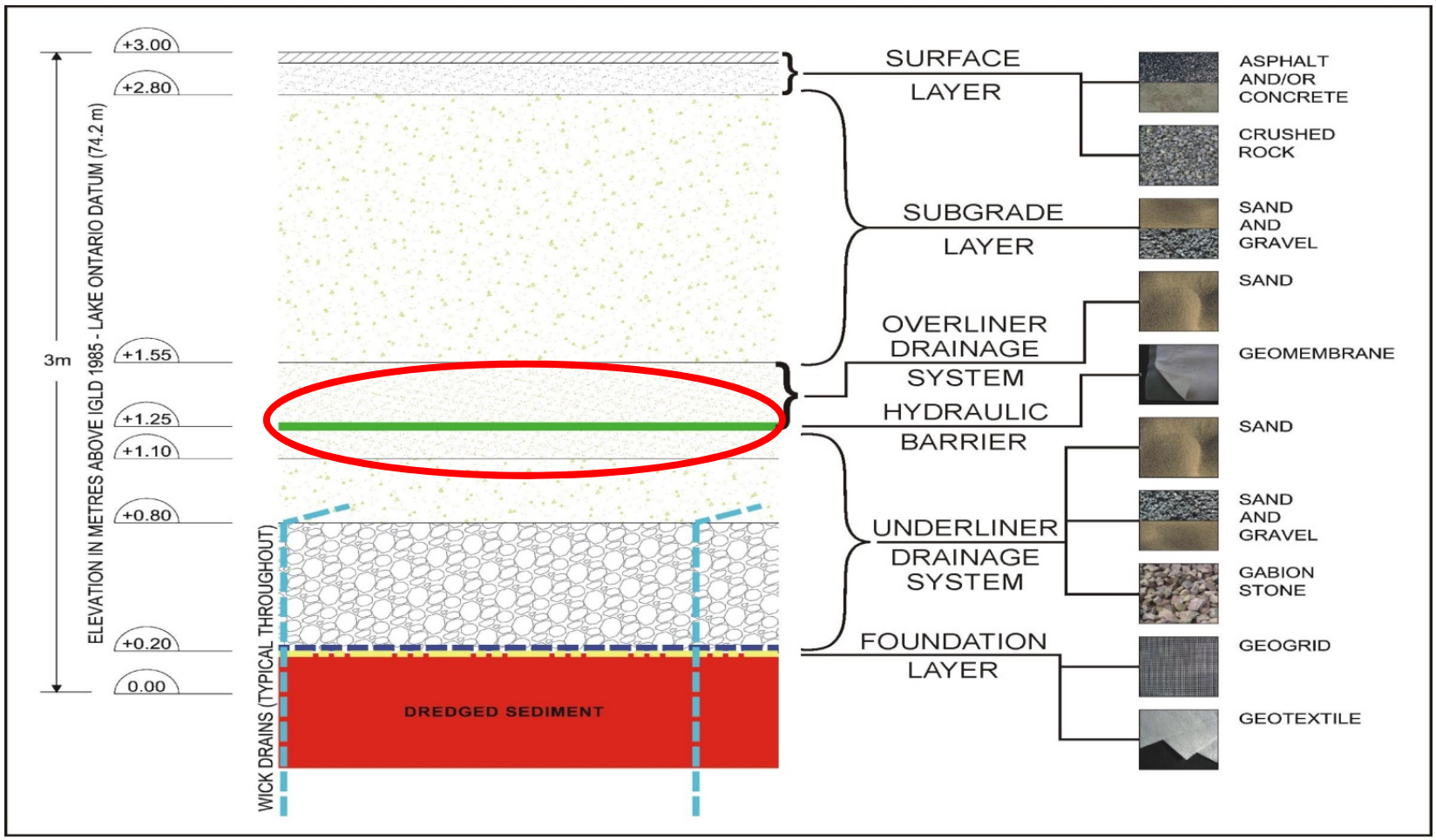


Installation of ECF cap

- The ECF capping system will consist of several layers:
  1. Foundation layer;
  2. Underliner drainage system;
  3. Hydraulic barrier layer;
  4. Overliner drainage system;
  5. Paved surface (in the port facility area);
  6. Vegetative cover (in the greenway area); and
  7. Stormwater management systems.

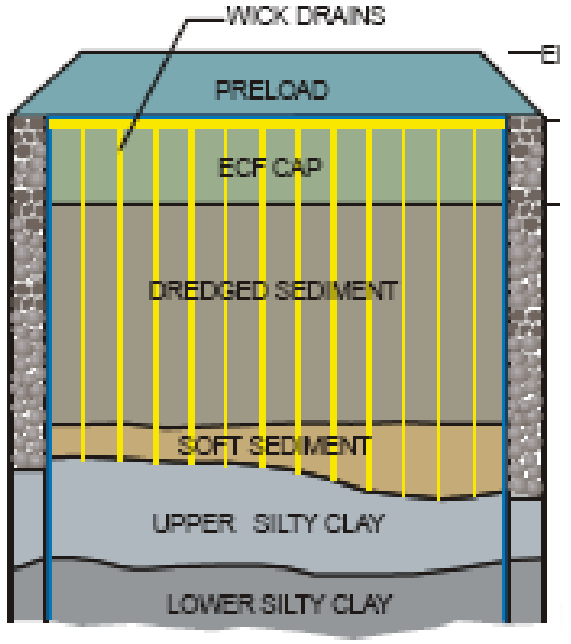
- Cap thickness 3 m

Randle Reef ECF Cap – Multiple Layers



Installation of ECF Cap cont'd

- A 'preload' of 500,000 tonnes will be placed on the cap;
- Wick drains will be used to increase the rate of consolidation and shorten the necessary 'preload' duration;
- Approximately 15,000 wick drains will be installed (4''x 1.5''x 33');
- It is anticipated that the "preload" will be in place for approx. 1 year and then removed.

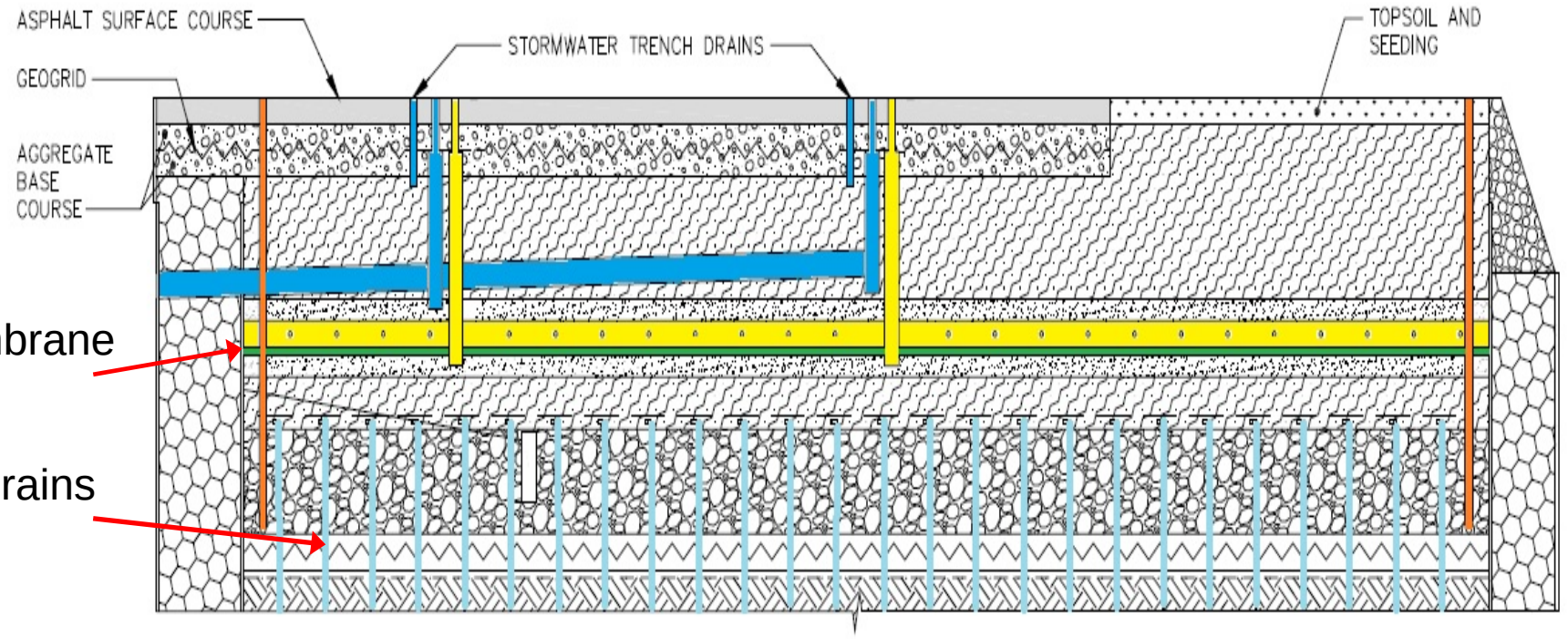


ECF Multi-layer Cap: Drainage Systems

Underliner Drainage

Overliner Drainage

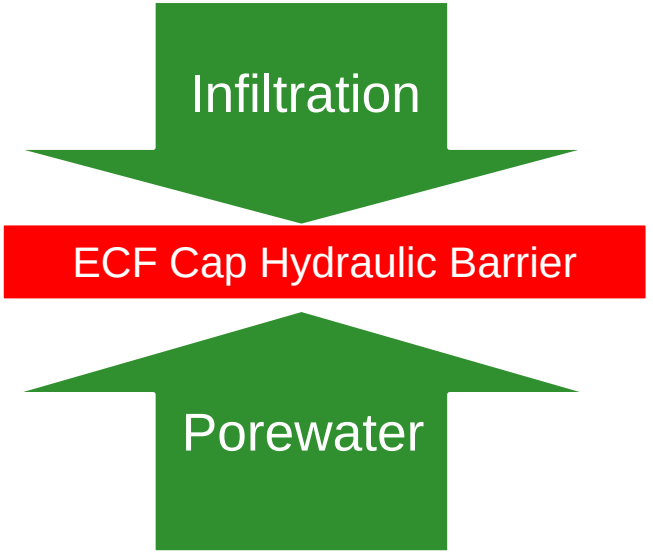
Stormwater Drainage



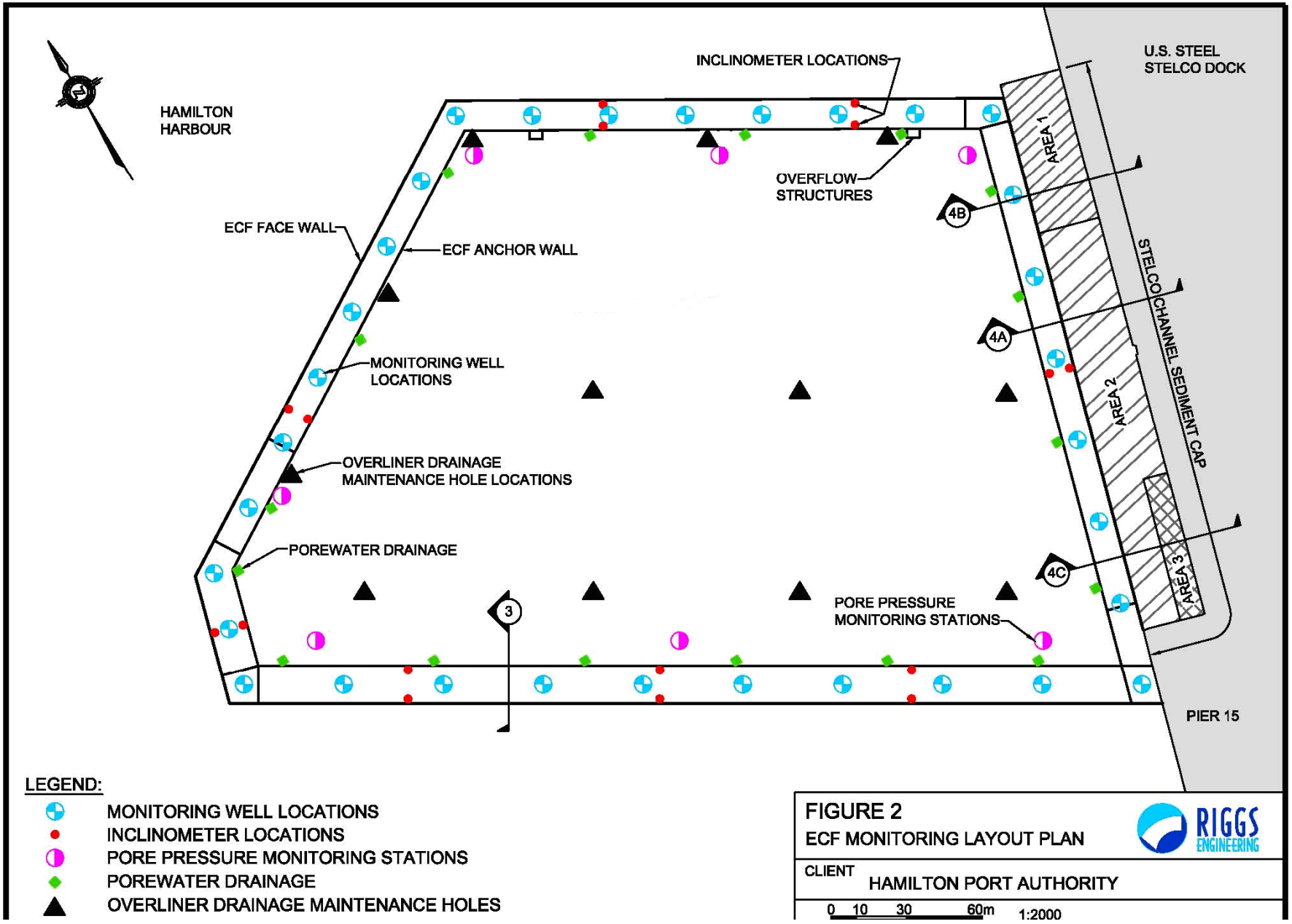
Post-Remediation Monitoring Program

- Isolation cap
- Thin layer backfill
- Perimeter monitoring wells

- Overliner drainage
- Underliner drainage



ECF Long Term Monitoring



Assessing the Effectiveness of the Randle Reef Clean-up

- PAH concentrations & profiles in suspended sediments.
- Sediment toxicity & benthic invertebrate community structure.
- Haemocytic leukemia in caged bivalves.
- Larval & embryo deformities in fish exposed to PAHs.
- Genetic & reproductive endpoints for caged fish and second generation inherited effects.
- Wild fish health endpoints.
- Tumours & external abnormalities in wild fish.

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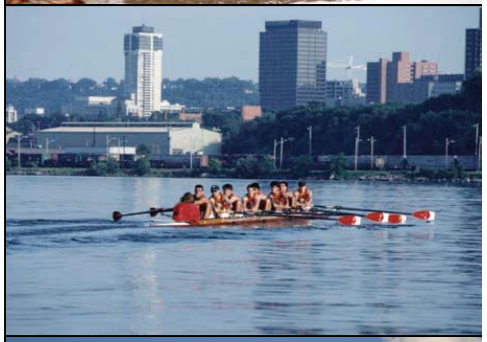
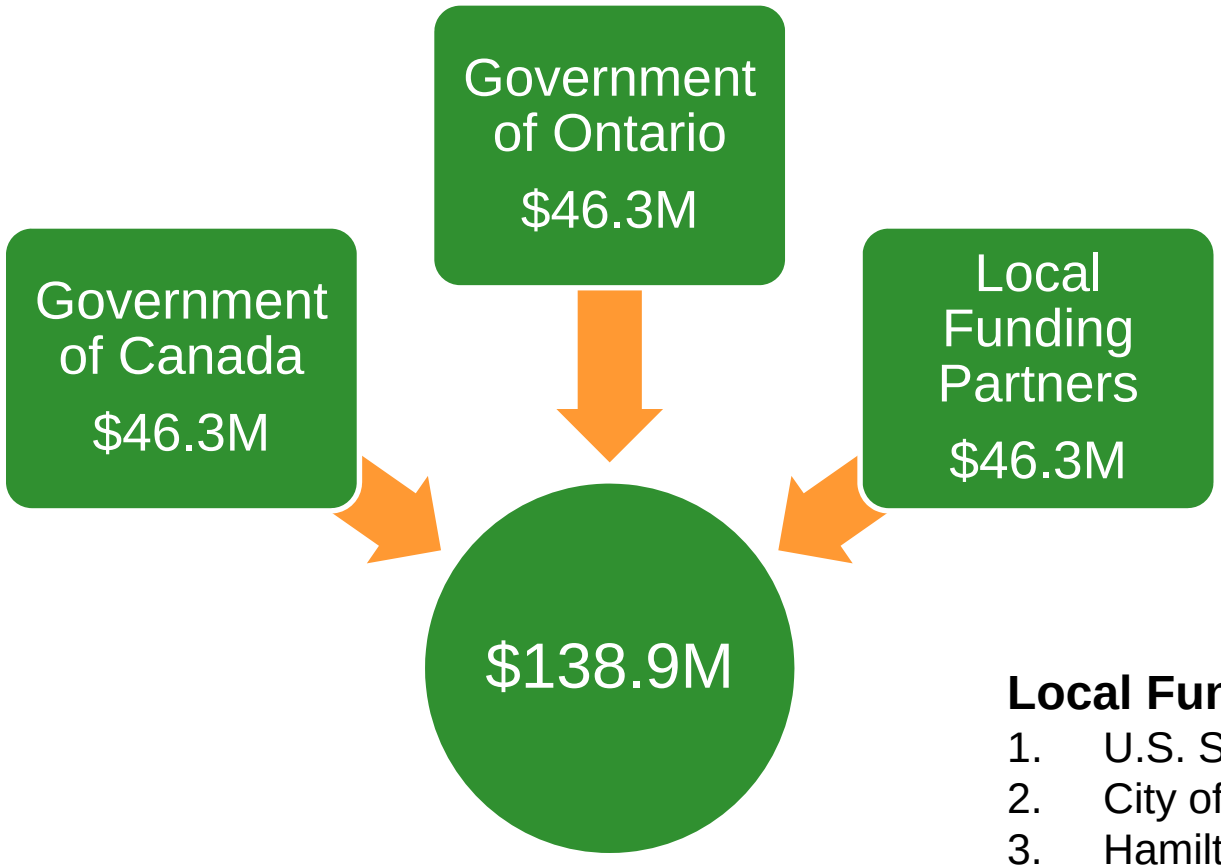
Why Clean Up Randle Reef?

- **Environmental Benefits**
  - restore environmental quality of the harbour
  - improve fish and wildlife habitat
  - reduce spread of contaminants through the harbour
  - essential to delisting Hamilton Harbour as an Area of Concern

- **Economical & Social Benefits**
  - **estimate of $126M (2006$) in economic impact to the community (job creation, business development, tourism)**
  - enhances recreational opportunities (beaches, boating, fishing
  - enhances shipping and port facilities
  - promotes a positive image of the harbour and community as a place to live and work



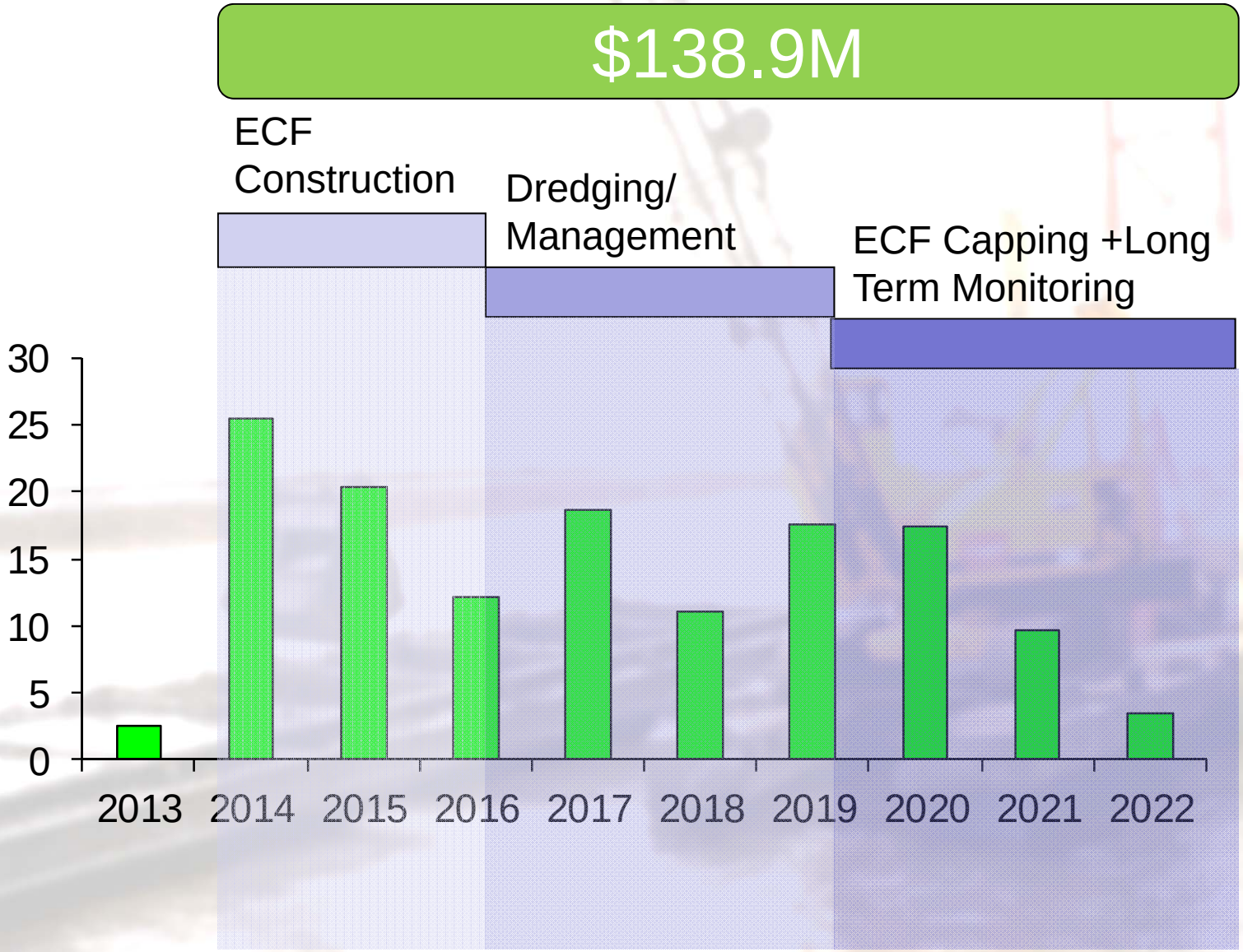
Project Funding



Local Funding Partners:

1. U.S. Steel
2. City of Hamilton
3. Hamilton Port Authority
4. City of Burlington
5. Region of Halton

Draft Construction and Cost Schedule



The End

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