Optimization of Sediment Restoration Through Combined Remedy and Risk Management

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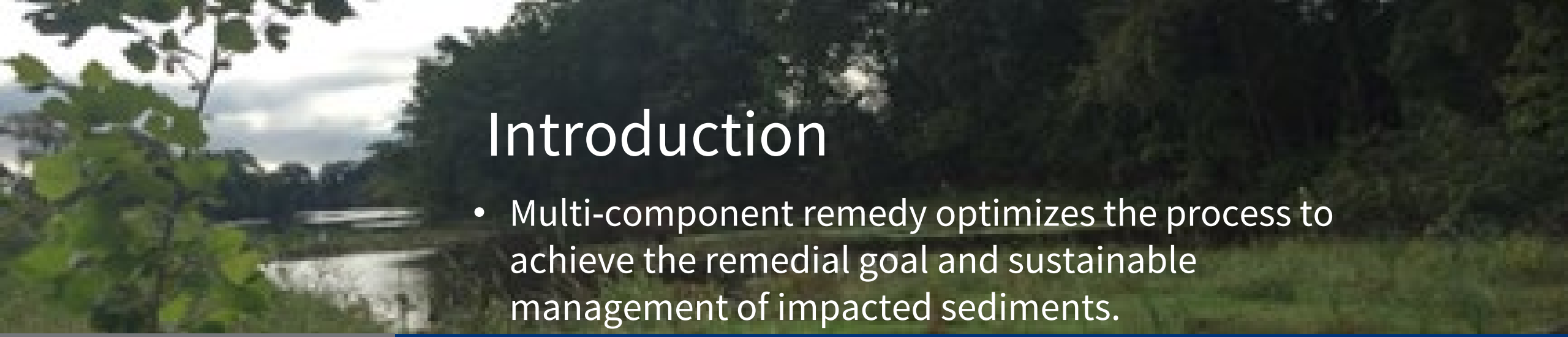

Introduction

- Multi-component remedy optimizes the process to achieve the remedial goal and sustainable management of impacted sediments.

- Success of sediment remediation projects can be maximized by add-on value of habitat restoration, nature–based solution to restore health of sediments.

- A collaborative approach to gain the support of public, environmental agencies and other stakeholders is the key for sustainable sediment management.

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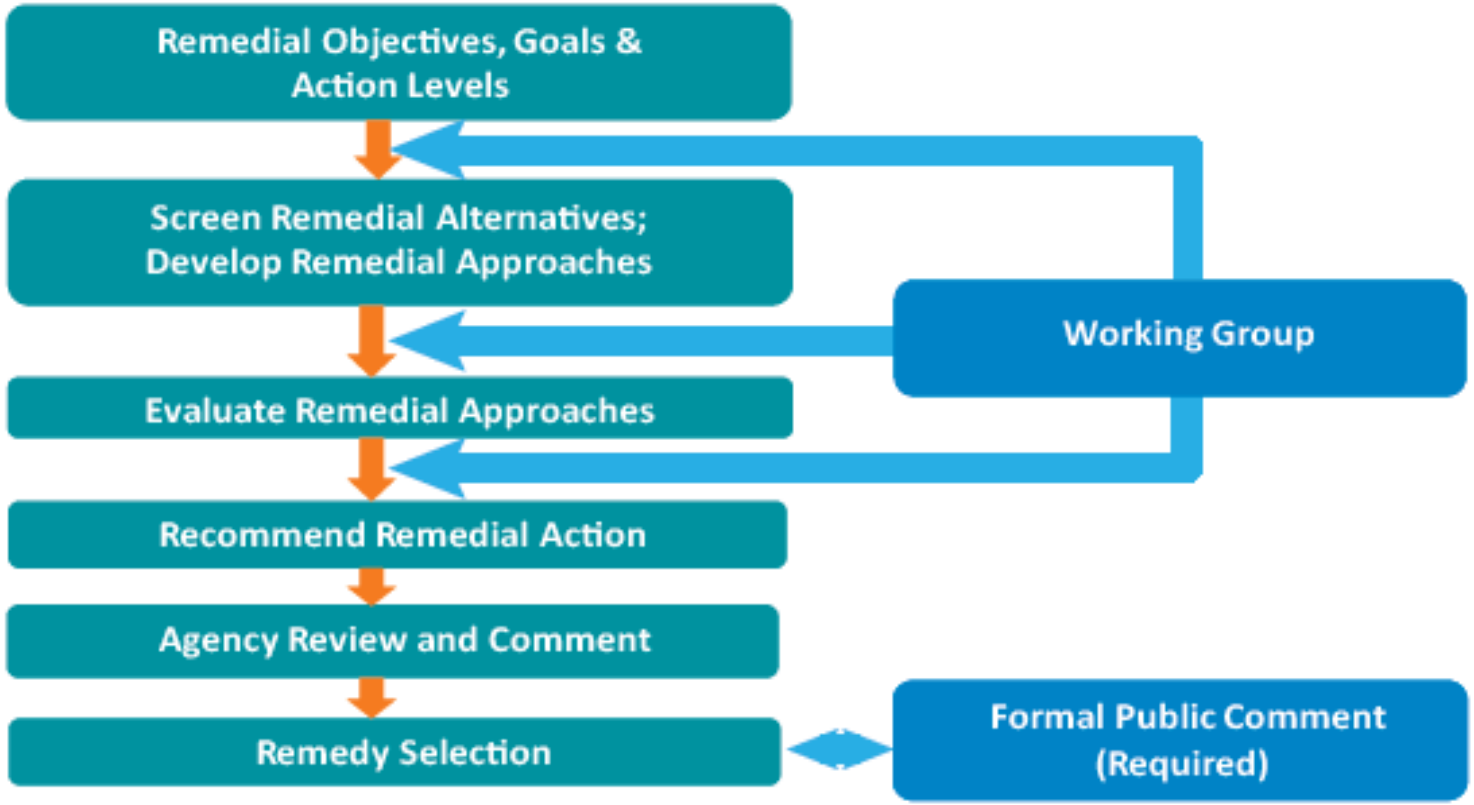
Site characteristics

- Creek and tidally influenced estuary
- Creek discharging into the cove
- Industrial and residential area
- Partial navigation channel
- Recreational use (boating, swimming, fishing)
- 3-meter water depth in the cove
- Silty sand sediment
- Organic carbon ~ 1 – 5.5%
- PCB contamination
  - <1 – 3,600 mg/kg PCBs

Remedy selection

- Community workshops
- Meeting with agencies and stakeholders



Community Working Group Process

Public Information Session – Solicitation of Interested Parties

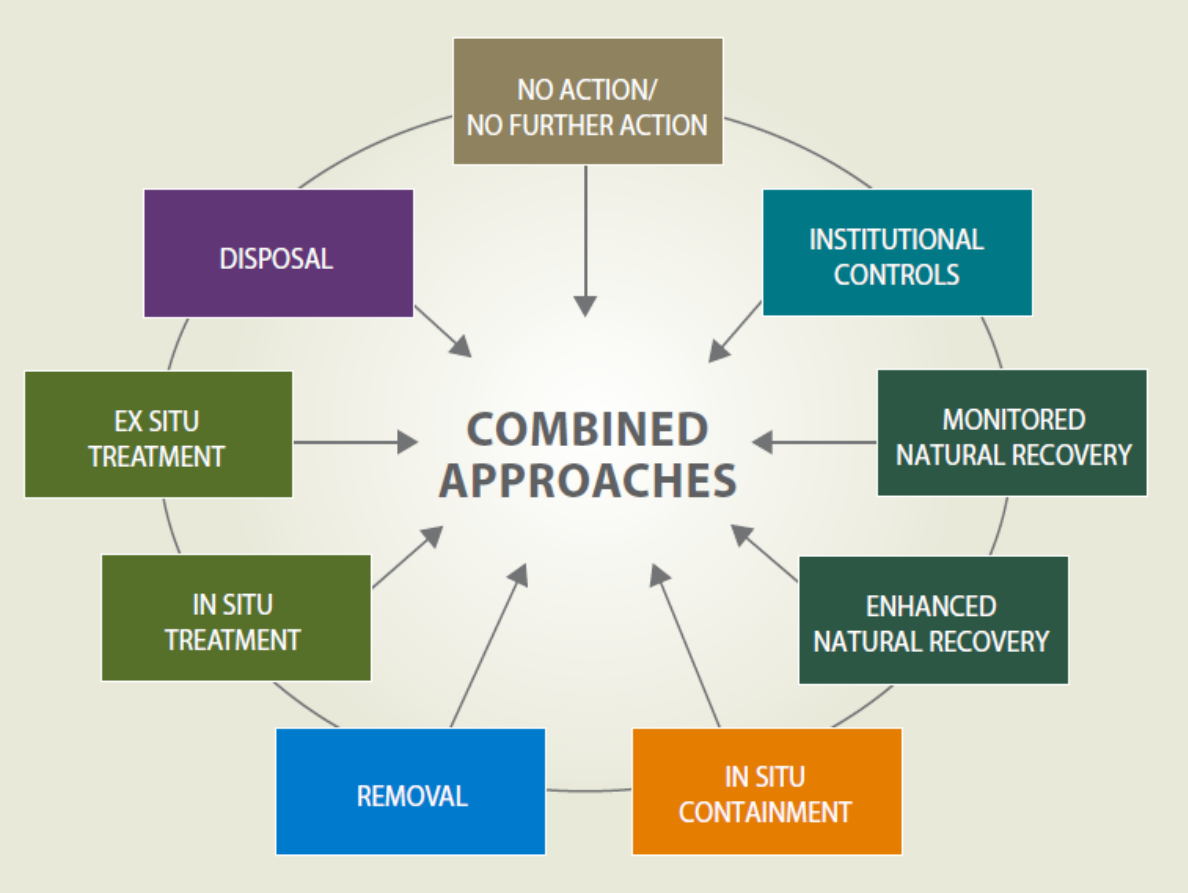
Community Working Group Sessions:

1. Site Characterization and Risk Assessment Results
2. Feasibility Studies, Remedial Alternatives, and Considerations
3. Decision Making, Expressed Preferences, Informed Consent

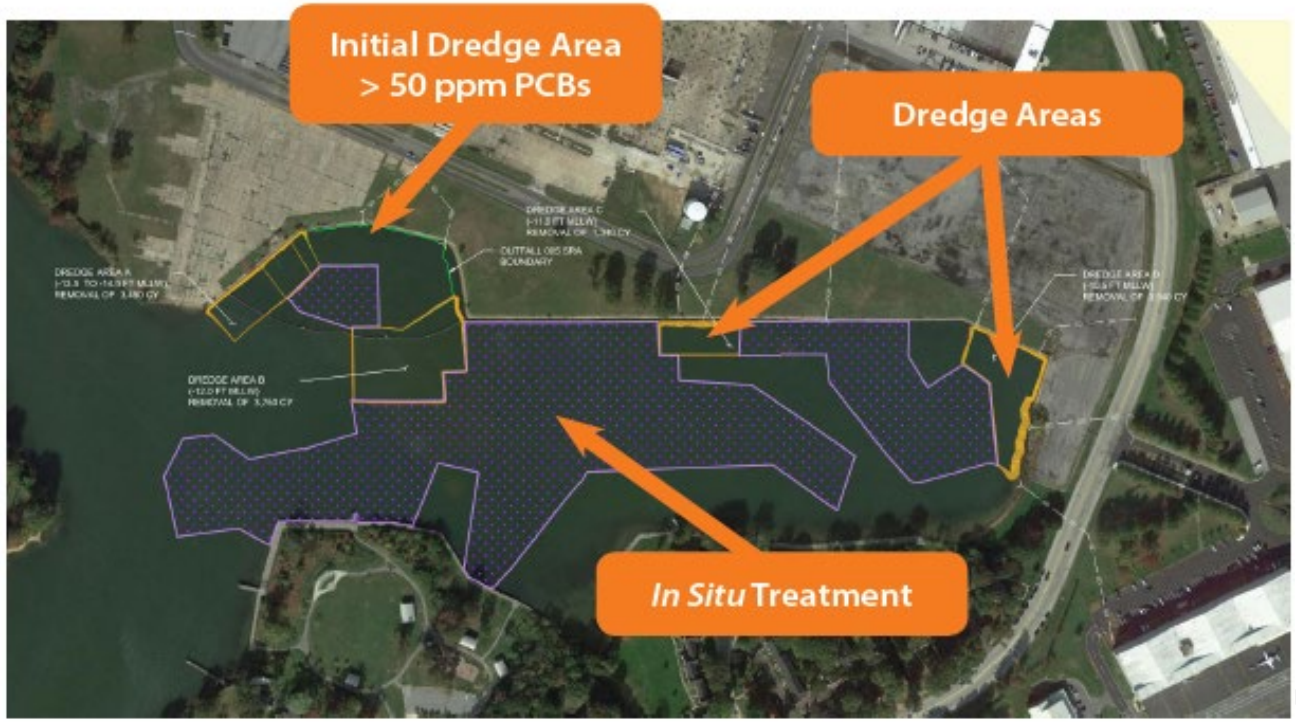
Criterium Decision Plus(R)

- Multi-parameter Decision Analysis tool
- Evaluated the USEPA Feasibility Study Criteria and
  - Sustainability
  - Community Acceptance

Combined remedy

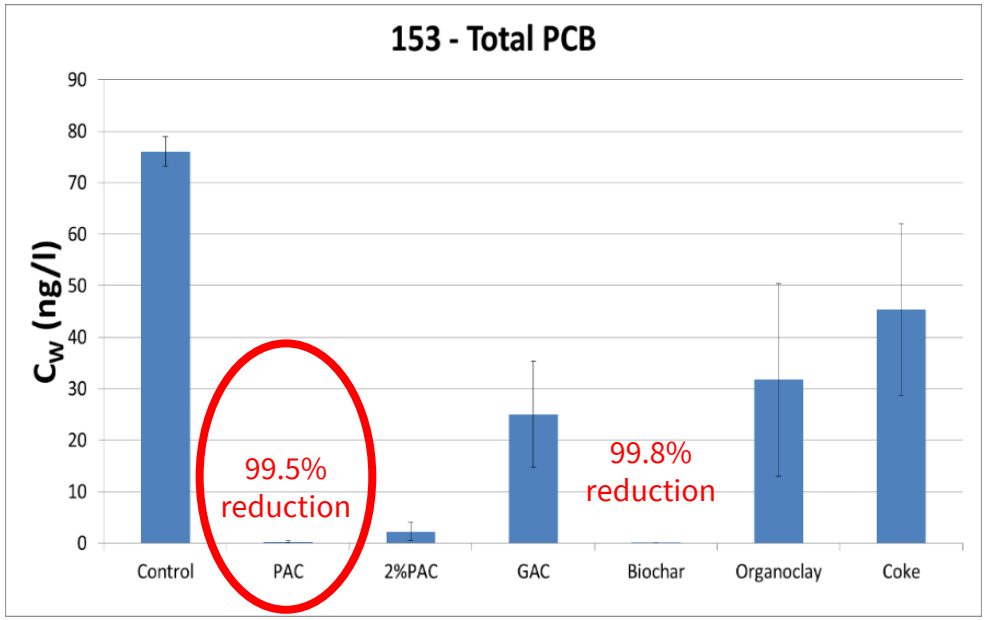


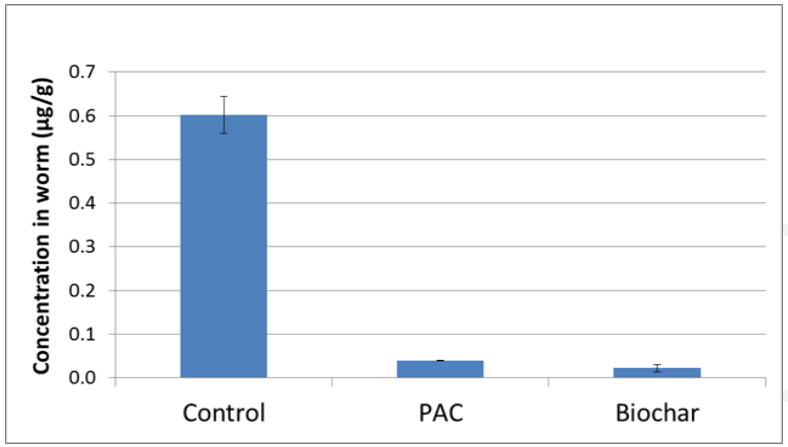
Combined remedy: Removal, residual management, restoration and *in situ* treatment



In-situ treatment *t*reatability study

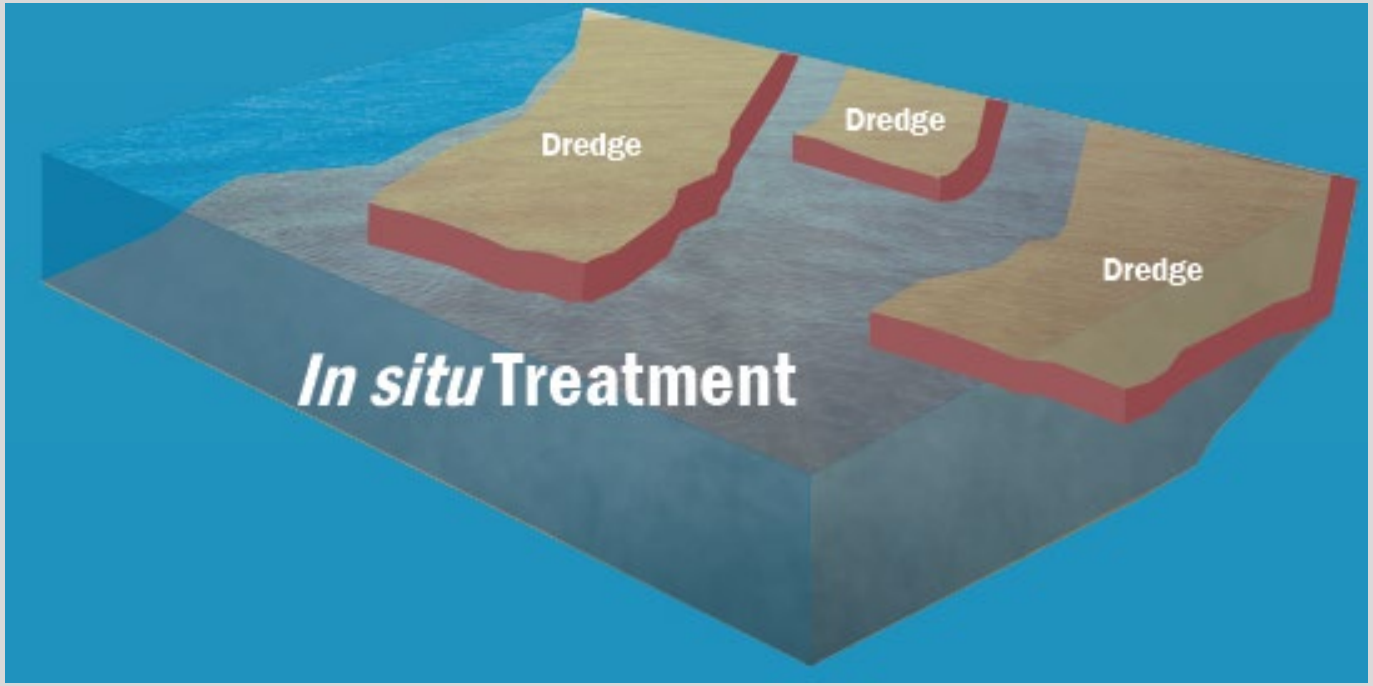
- Evaluation of sediments with approximately 1 – 2.5 mg/kg total PCBs and 5 amendment materials
- Porewater reduction
  - Powder activated carbon (PAC) and biochar reductions 94.9 – 99.8%
  - Granular activated carbon (GAC) reductions 67 – 81.6%
  - Organoclay and coke reductions 36 – 58%
- Bioaccumulation tissue reduction
  - 92 – 96 % reduction in tissue concentrations for PAC
  - 96 % reduction in tissue concentrations for Biochar





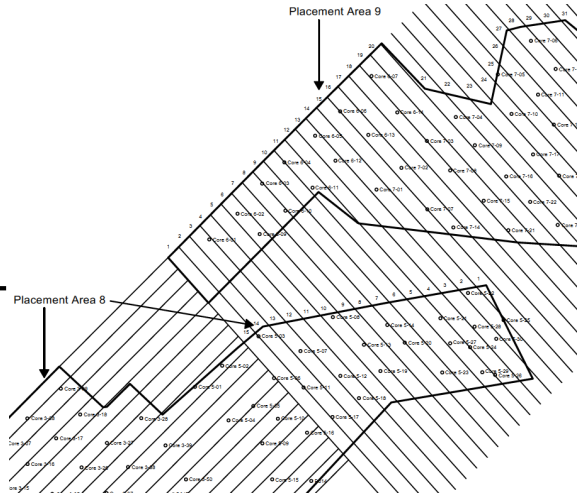
Remedial design

- Combined remedy of dredging and in-situ treatment
- Completion of dredging for areas of higher PCB concentrations followed by application of a residuals management layer
- Application of PAC for the in-situ treatment in areas with PCB contamination in the surface sediment between 0.7 mg/kg and 2.5 mg/kg
- Approximately 1/3 of the area (2.4 ha) of contaminated sediment to be dredged and 2/3 of the area (5.7 acres) with in-situ treatment



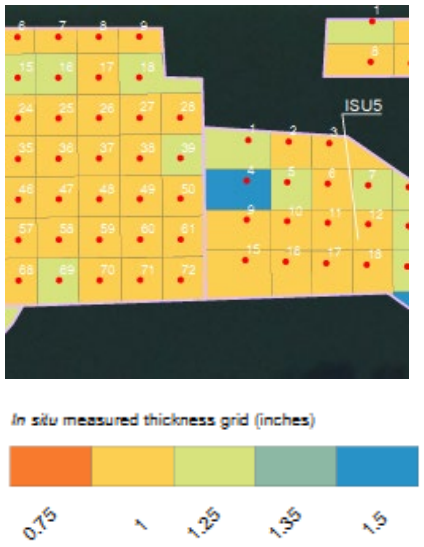
In-situ treatment implementation

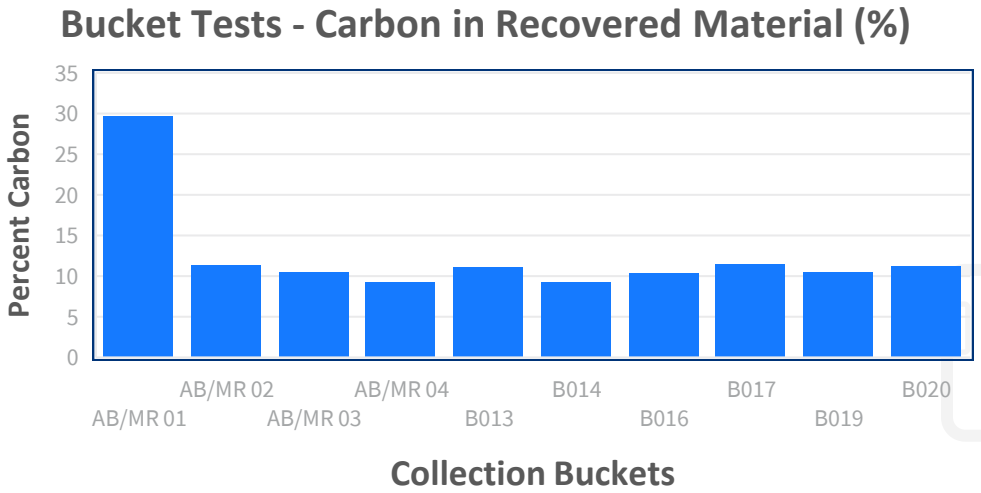
- 2,500 tons of AquaGate + PAC (10%)
- Cable-propelled barge spreader to place material
- Initial test runs to establish barge and spreader operation rates to achieve project goals of ~5% PAC
- Application challenge – consistent placement of an ~ 2.5 cm layer of the AquaGate + PAC



Construction quality control

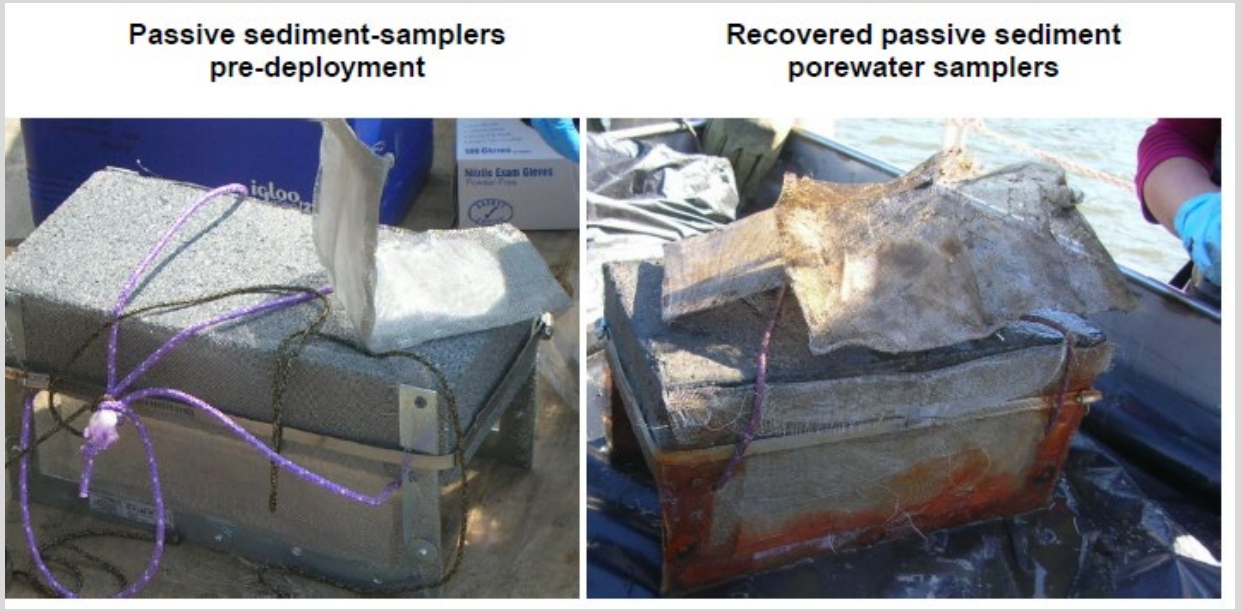
- Manufacturing quality control documentation verified material quality (PAC content)
- Multiple lines of evidence used to verify placement
  - Application rate calculated 445 tons/ha
  - Aggregate thickness measurements
  - Total organic carbon and black carbon analysis
  - Sample buckets collected for verification of quantity of PAC placed
- Bucket Collection Test Sample Results
  - Verification of PAC placement
  - Initial barge/spreader calibration
  - Full scale in-situ placement





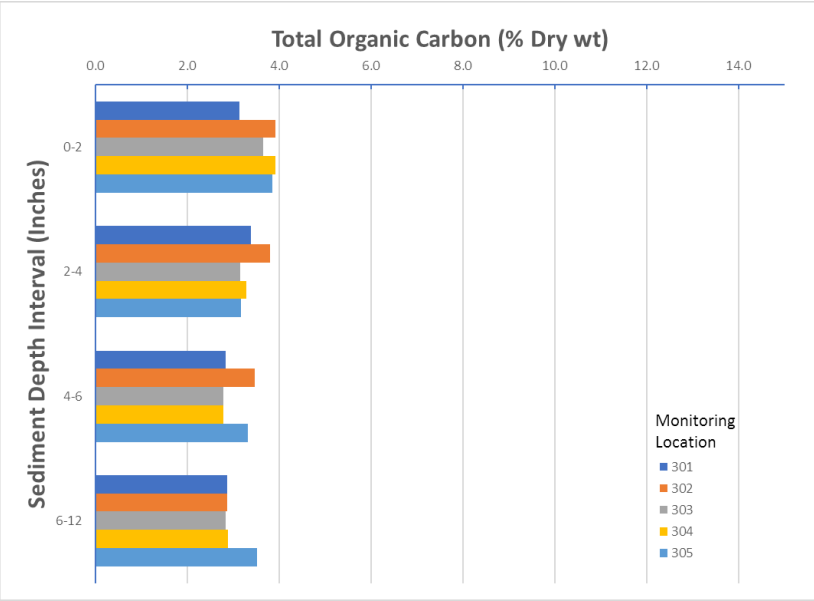
Post-remedy monitoring plan

- Repeat of baseline sampling approach – porewater sampling and bioaccumulation testing at same 5 locations
- Year 1, 3 and 5
- Criteria:
  - 70% reduction in tissue bioaccumulation concentrations
  - 80% reduction in porewater concentrations

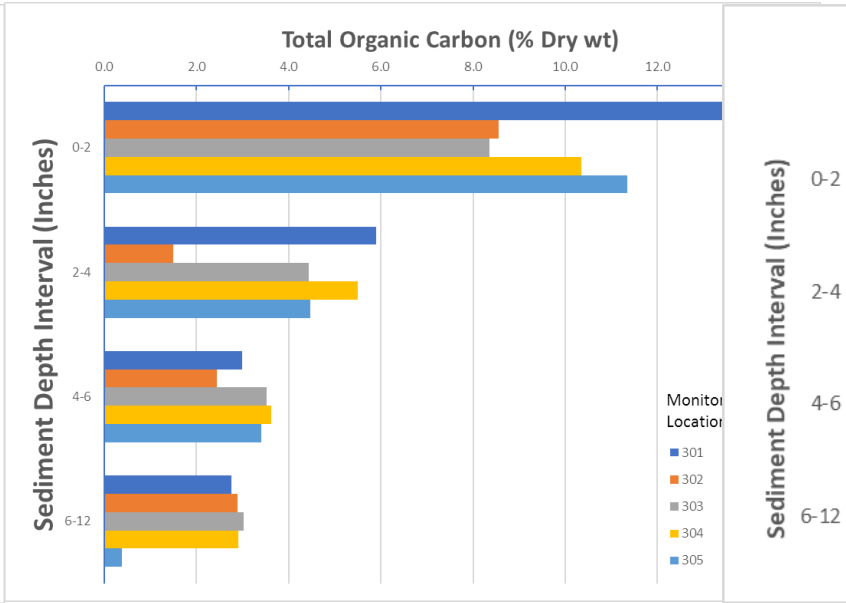


Monitoring years 1 and 3 – total organic carbon by sediment depth intervals

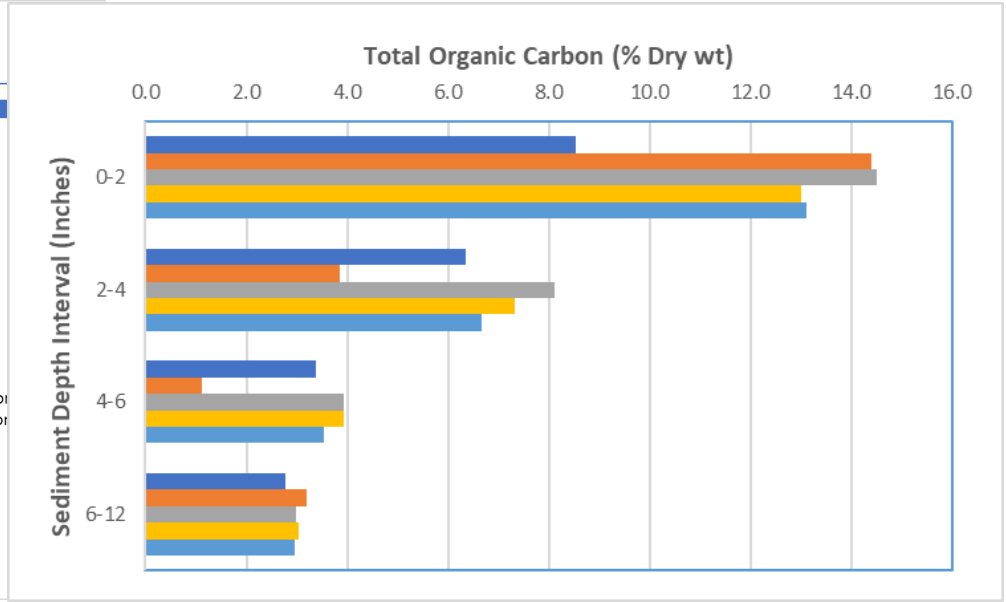
Baseline



Year 1



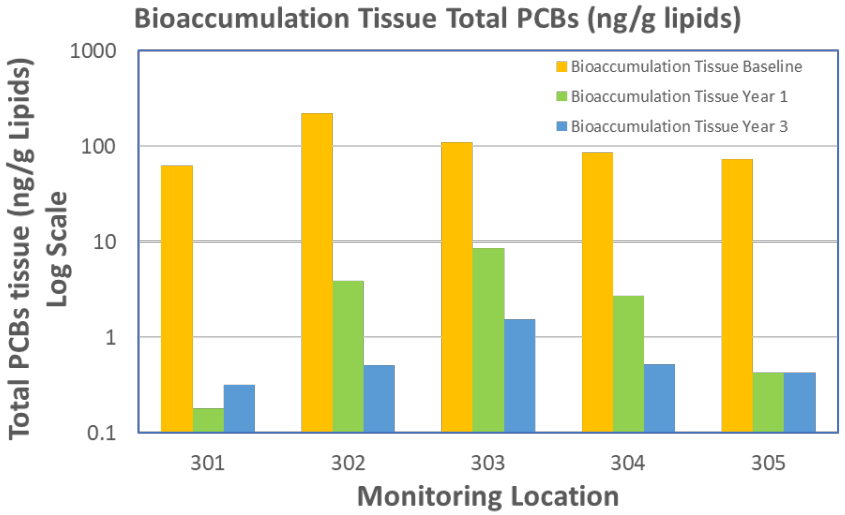
Year 3

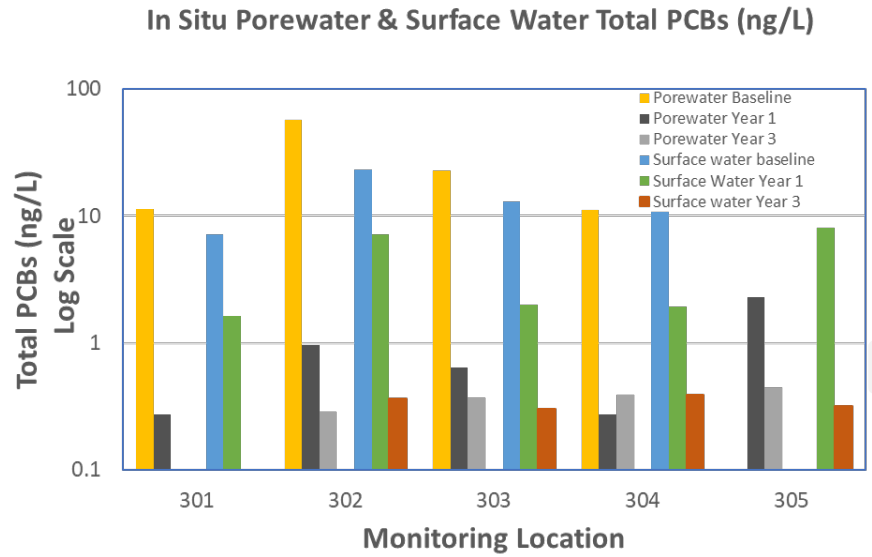


- Three cores collected from each monitoring location. Composite samples for each interval collected and analyzed for total organic carbon (TOC) and black carbon
- Year 1 results show presence of activated carbon and mixing to a depth of 4 inches based on increase in TOC above baseline
- Year 3 results continue to show the presence of activated carbon and continued mixing to deeper depths based on the increase in TOC above baseline and Year 1 results.

Monitoring years 1 and 3 - results

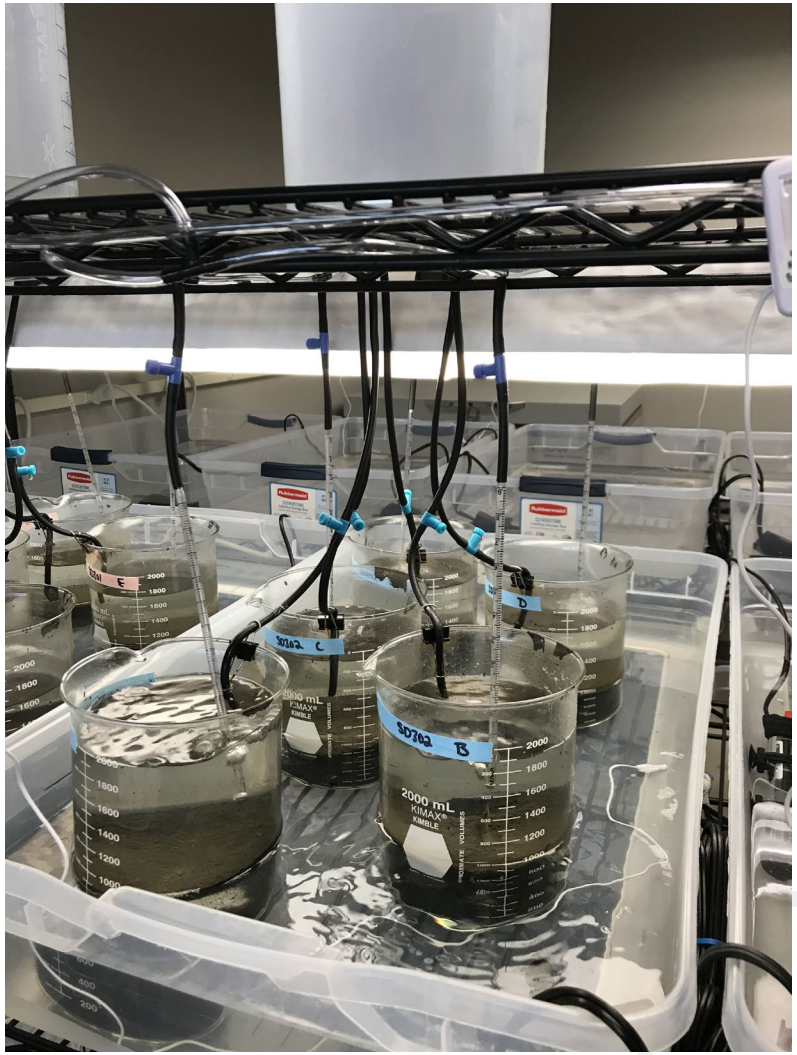
- 28-day bioaccumulation tissue
  - > 93 % reduction in total PCB tissue concentrations from baseline
- *In-Situ p*orewater
  - > 96 % reduction in total PCB sediment porewater concentrations from baseline
- Surface water
  - > 65 % reduction in total PCB surface water concentrations from baseline





In-situ treatment summary

- Reduction in bioavailability of PCBs from sediment as measured by worm tissue meet the objective of 70% within the 5-year target period.
  - Reduction in total PCB concentrations from Baseline monitoring of 95% and 98.7% at Year 1 and Year 3 respectively on a wet weight basis and 97.1% and 99.4% on a lipid basis.
- Reduction in bioavailability of PCBs from sediment as measured by sediment porewater meet the objective of 80% within the 5-year target period.
  - Sediment porewater reduction in total PCB concentrations from Baseline monitoring of 96.5% and 98.5% for the in-situ monitoring at Year 1 and Year 3 respectively and 96.9% and 99.5% for the ex-situ monitoring.



Remediation of an urban creek and habitat restoration

- Public value boating, birding, fishing, water quality
- Restore and improve fish habitat
- Consider vegetated buffer for stormwater management
- Re-construct stream
- Restore wetlands
- Plant shoreline vegetation, tidal marsh fringe
- Re-establish submerged aquatic vegetation

Before remediation and restoration

Remediation construction

Reconstruction of creek

Revegetation

Restoration – year 1

Five-year monitoring of habitat restoration areas showed that functional goals of erosion protection, nutrient removal, and creating ecological diversity have been achieved.

Summary

- Combined remedies can optimize cleanup of impacted sediments while minimizing the impacts to existing habitat and the environment.
  - In-situ treatment of contaminated sediments is a sustainable risk management approach to restore the health of sediment if applicable to the site conditions.
- A well-designed habitat restoration is a nature-based solution to restore health of sediments by promoting natural recovery.

Thank You

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