Special delivery using SediMite a new low-impact tool to get in-situ treatment amendments into contaminated sediment.

Presentation through NAPRM
May 26, 2010

Charles Menzie, Ph.D., Exponent
camenzie@exponent.com
571-214-3648

Exponent®

Opportunities to use In-situ treatment arise, in part, from lessons learned and recent guidance

PREPUBLICATION COPY

Sediment Dredging at Superfund Megasites: Assessing the Effectiveness

Committee on Sediment Dredging at Superfund Megasites

Board on Environmental Studies and Toxicology

Division on Earth and Life Studies

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

THE NATIONAL ACADEMIES PRESS
Washington, D.C.
www.nap.edu

United States
Environmental
Protection Agency

Contaminated Sediment Remediation Guidance for Hazardous Waste Sites

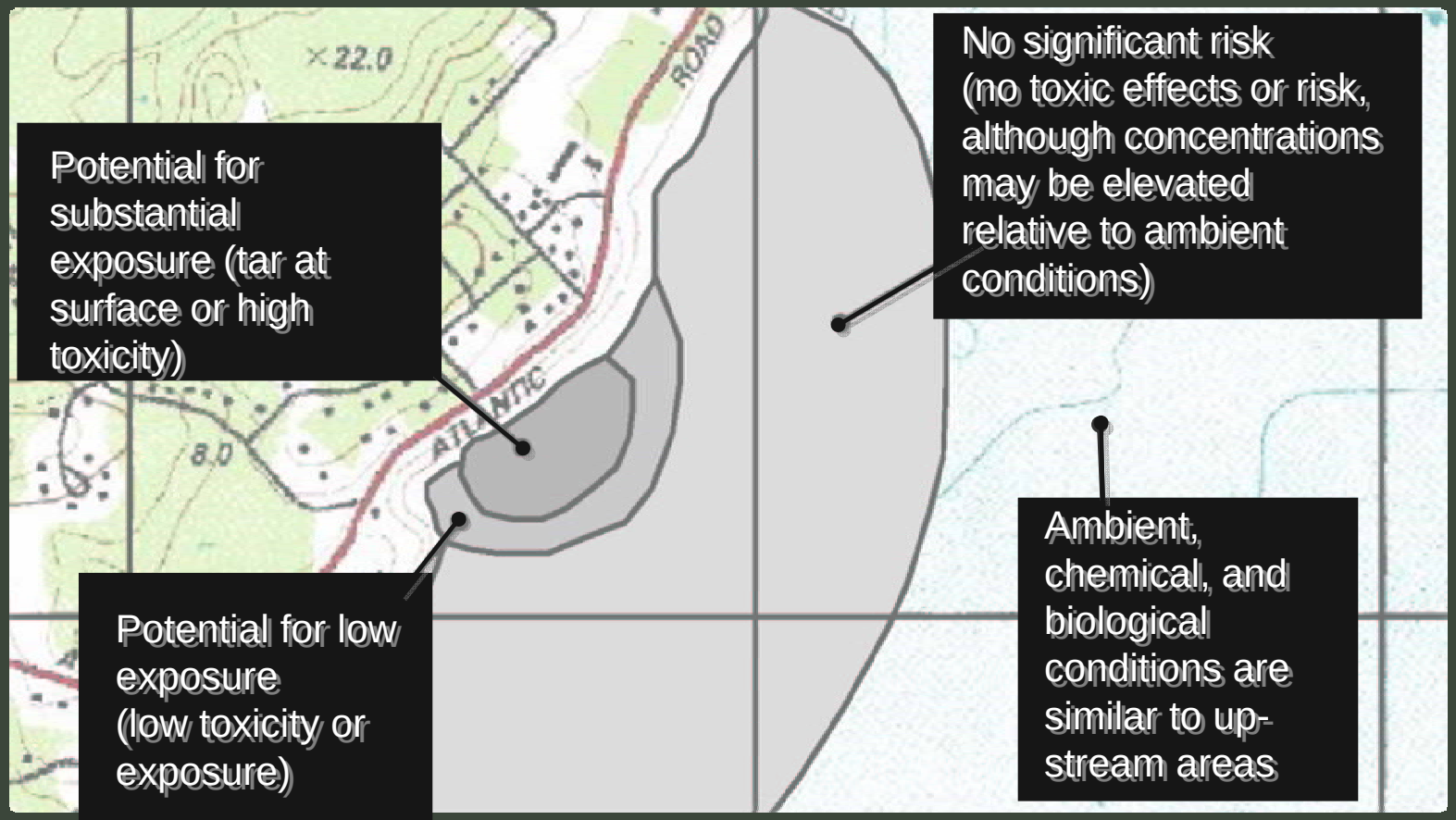
The USEPA guidance offers insights into how to compare alternative remedial measures

Monitored Natural Recovery	In-situ Capping	Dredging/Excavation
Expected human exposure is low and/or reasonably controlled by ICs Site includes sensitive, unique environments that could be irreversibly damaged by capping or dredging	Expected human exposure is substantial and not well-controlled by ICs Long-term risk reduction outweighs habitat disruption, and/or habitat improvements are provided by the cap	Expected human exposure is substantial and not well-controlled by ICs Long-term risk reduction of sediment removal outweighs sediment disturbance and habitat disruption

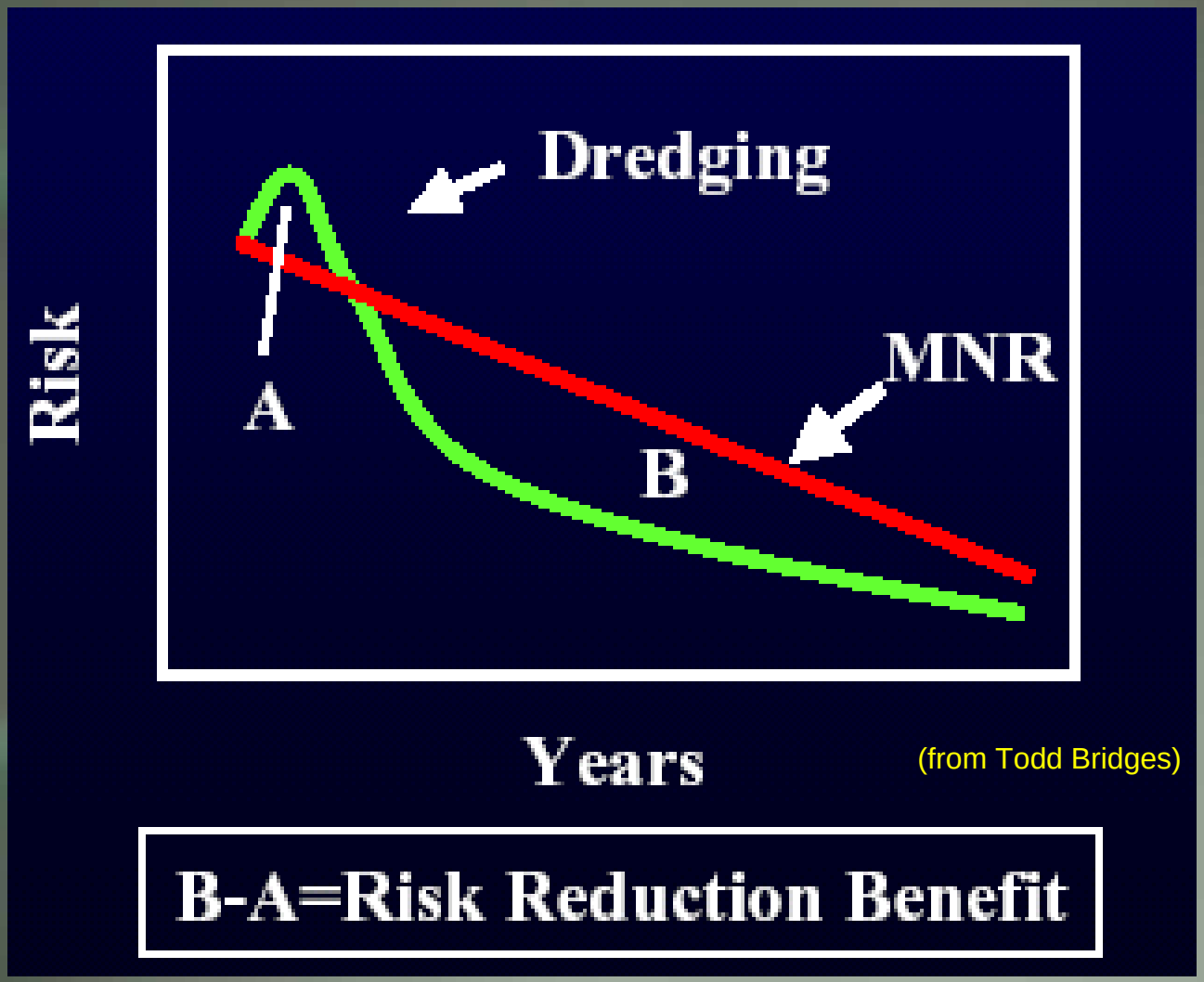
Comparative approaches …

Monitored Natural Recovery	In-situ Capping	Dredging/Excavation
Contaminant concentrations in biota and in the biologically active zone of sediment are moving towards risk-based goals Contaminants readily biodegrade or transform to lower toxicity forms Contaminant concentrations are low and cover diffuse areas Contaminants have low ability to bioaccumulate	Contaminants have low rates of flux through cap Contamination covers contiguous areas (e.g., to simplify capping)	Higher contaminant concentrations cover discrete areas Contaminants are highly correlated with sediment grain size (i.e., to facilitate separation and minimize disposal costs)

The exposure zone concept helps guide selection of remedial approaches including MNR and in-situ



Remedial alternatives can be compared by considering risk reduction trajectories over time



What is an acceptable timeframe?

Most *In Situ* Approaches Rely on Mechanical Mixing

Slurry Injection System
(Williams Environmental Services, Stone Mountain, GA)

Limnofix *In Situ* Sediment Treatment Technology (LIST)
(Golder Associates)

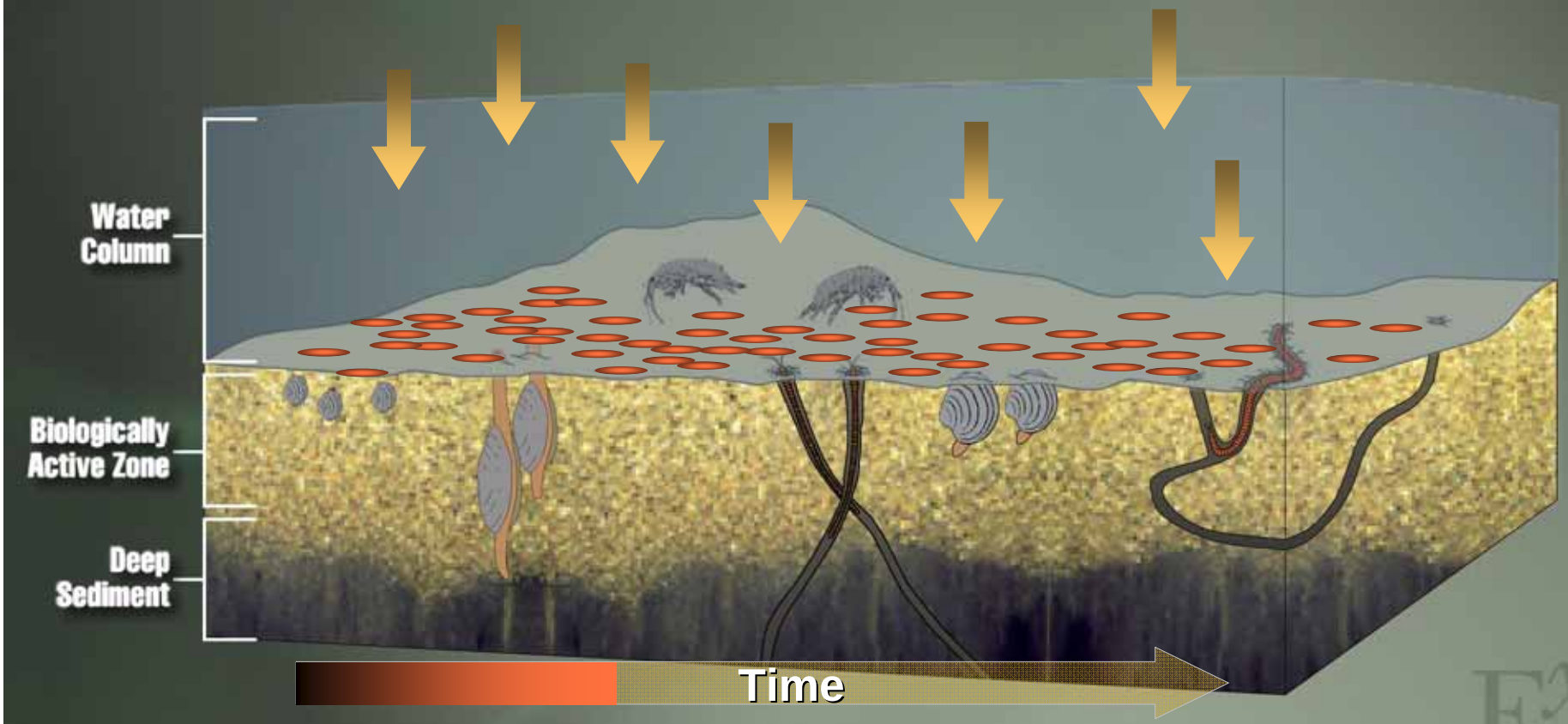
Hunters Point, August 31, 2004

SediMite™ as a means of delivering in-situ treatment materials

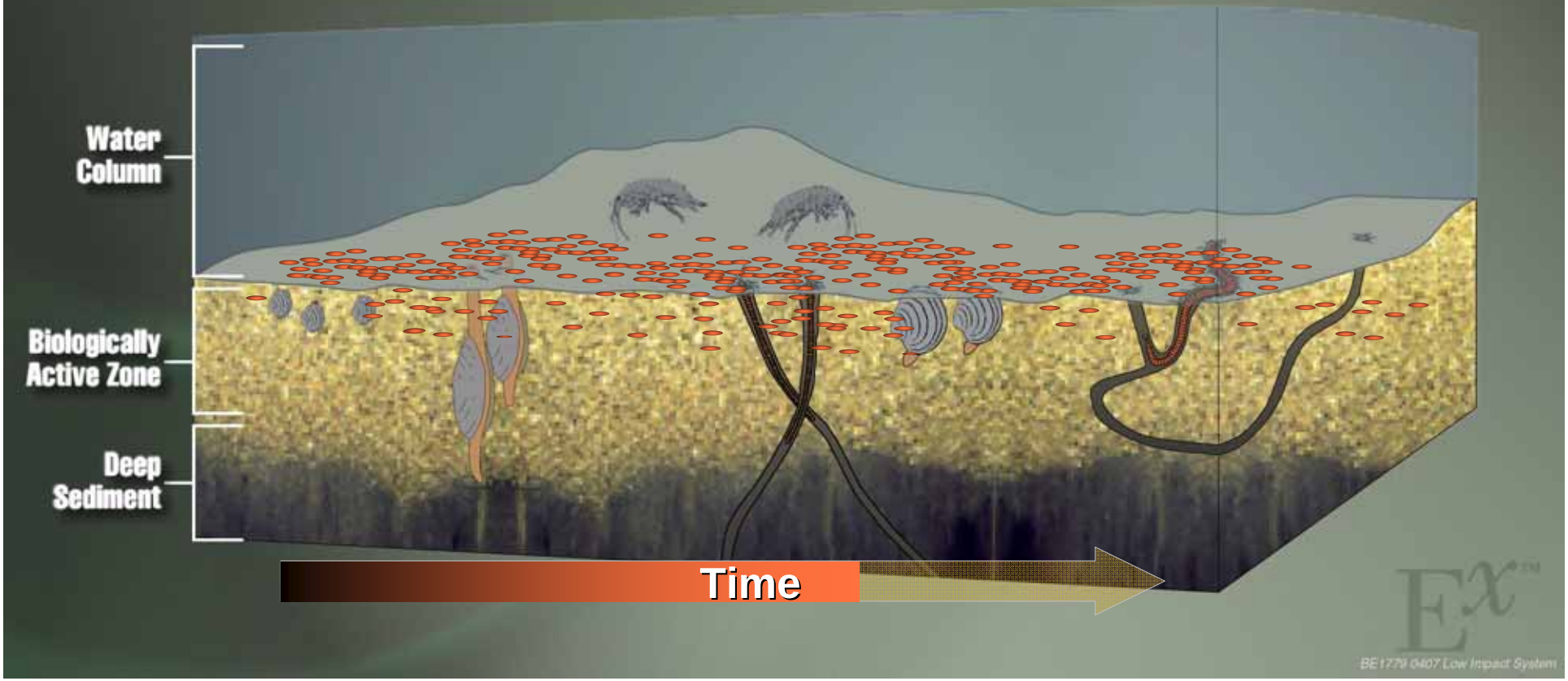
Tens of grams/day production in the laboratory

2-5 Million lb/year at a production facility

SediMite™ Is Designed to Provide a Low-Impact Delivery System

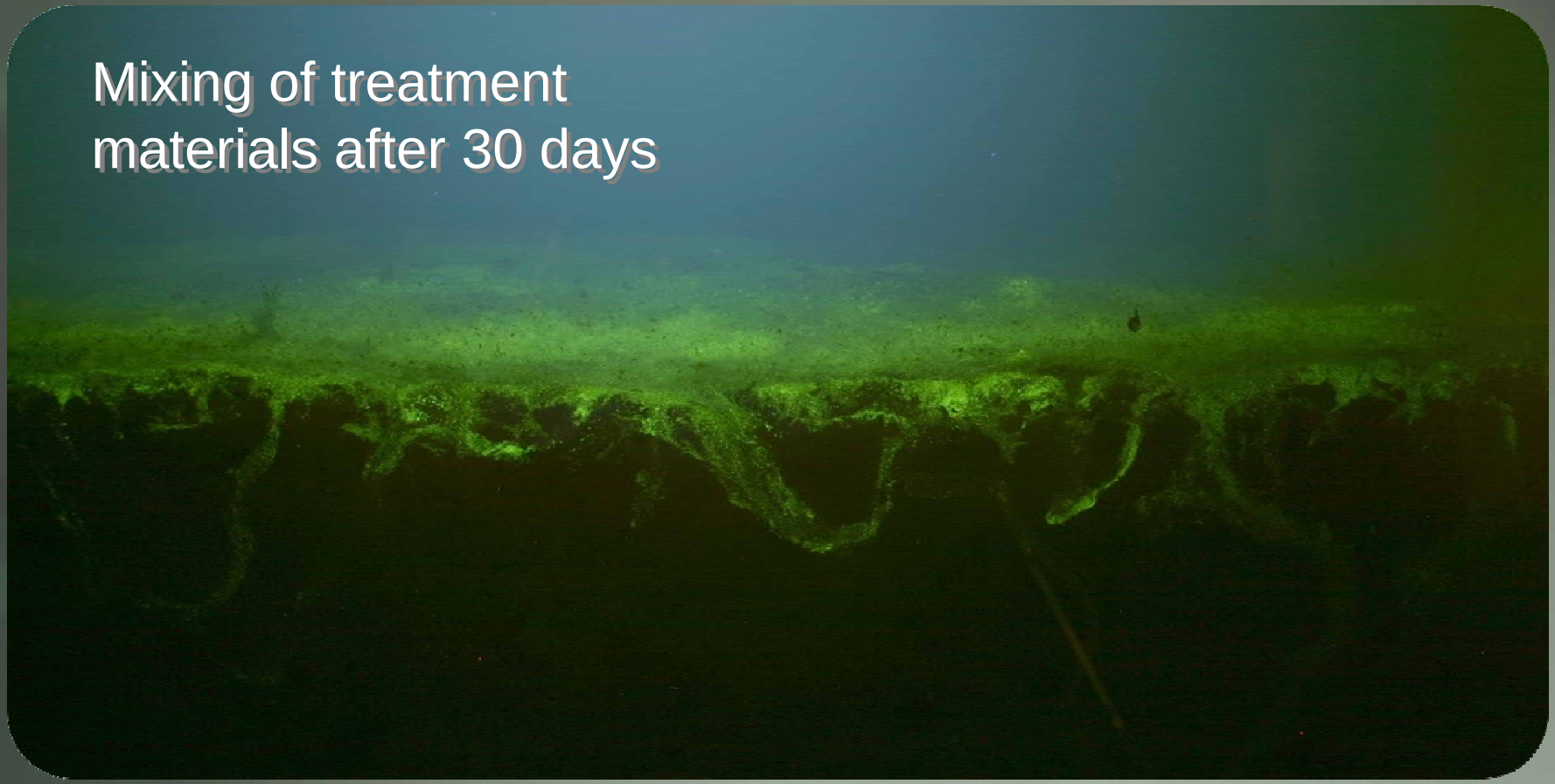


SediMite™ Granules Break Down over Time



And Are Mixed by Bioturbation, Thus Targeting the Biologically Active Zone

Biological Mixing of SediMite™ Treatment Materials into Sediments



The Workers

(burrowing depth increases left to right)

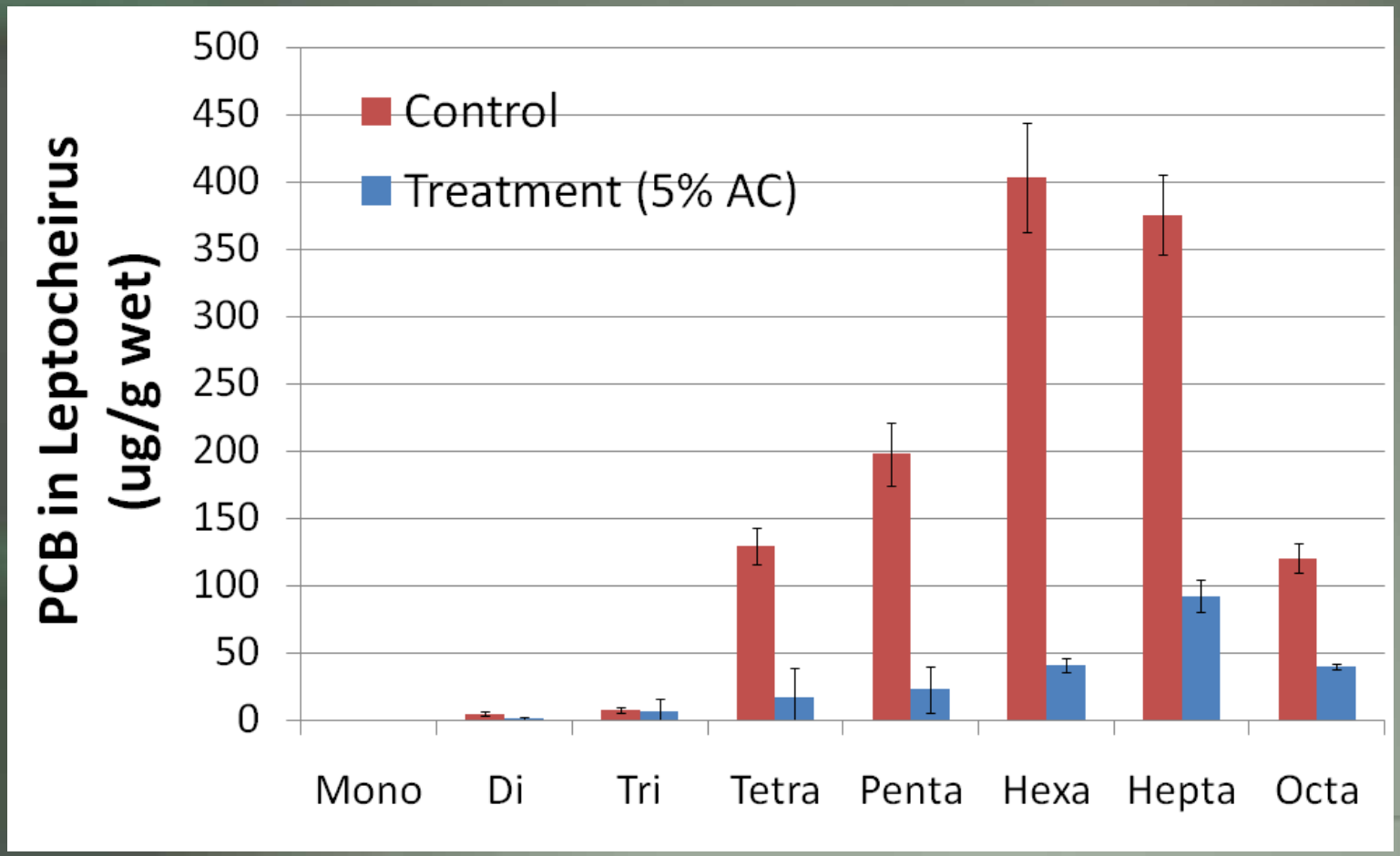
A low-impact in-situ approach is attractive when natural resources may be impacted by more invasive methods (dredging and capping)

Note: these same areas are often the most productive regions of a lake or river and can make a proportionally greater contribution to chemicals in pelagic food webs

Case 1: SEDIMITE™ application in a tidal creek and wetland contaminated with PCBs

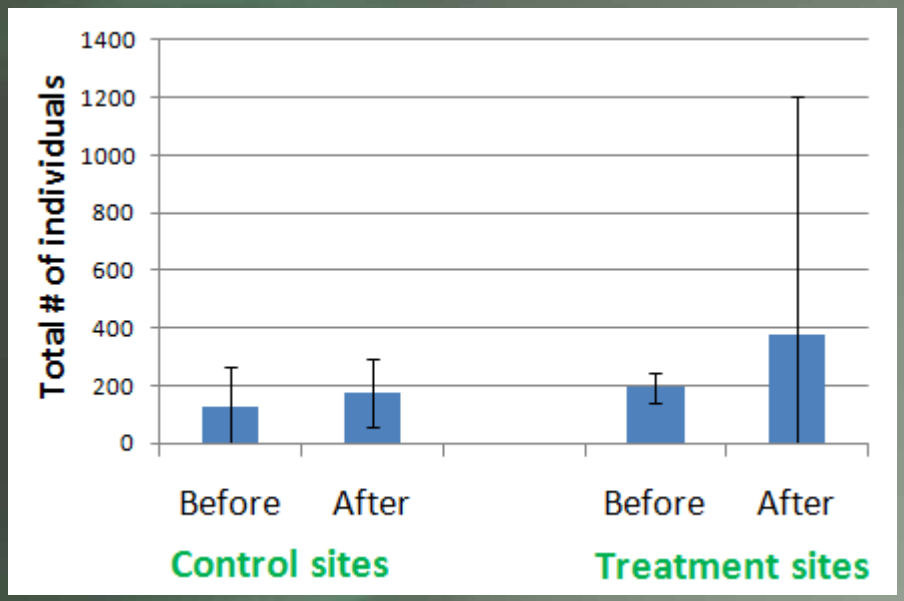
August, 2009

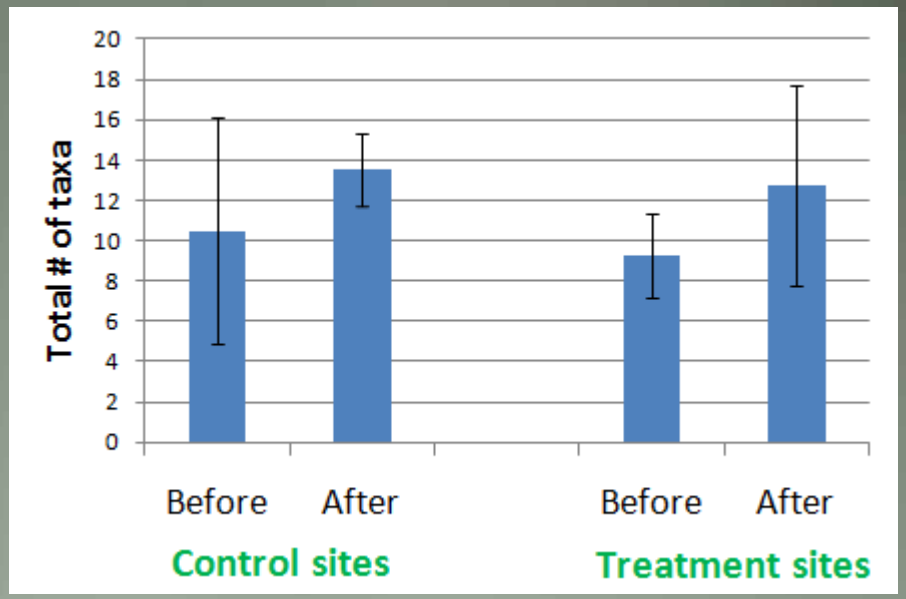
Field application reduces bioavailable PCBs (2 months)



Effects on Benthic Community

Comparison of pre-treatment and 2-months post-treatment benthic community at a field demonstration site





Error bars indicate ±95% CI

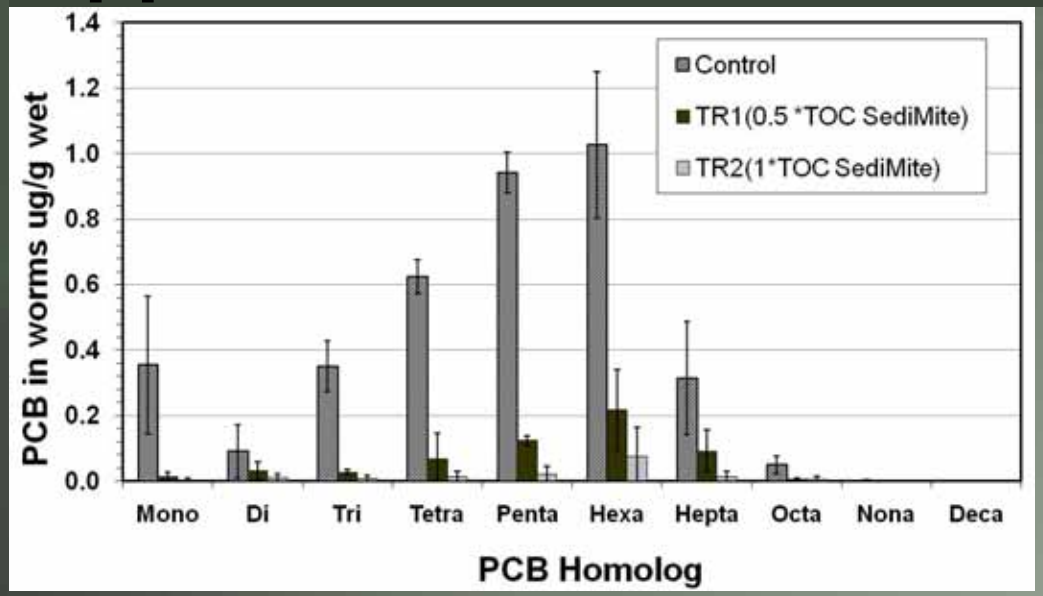
Data courtesy of Dr. Upal Ghosh, UMBC

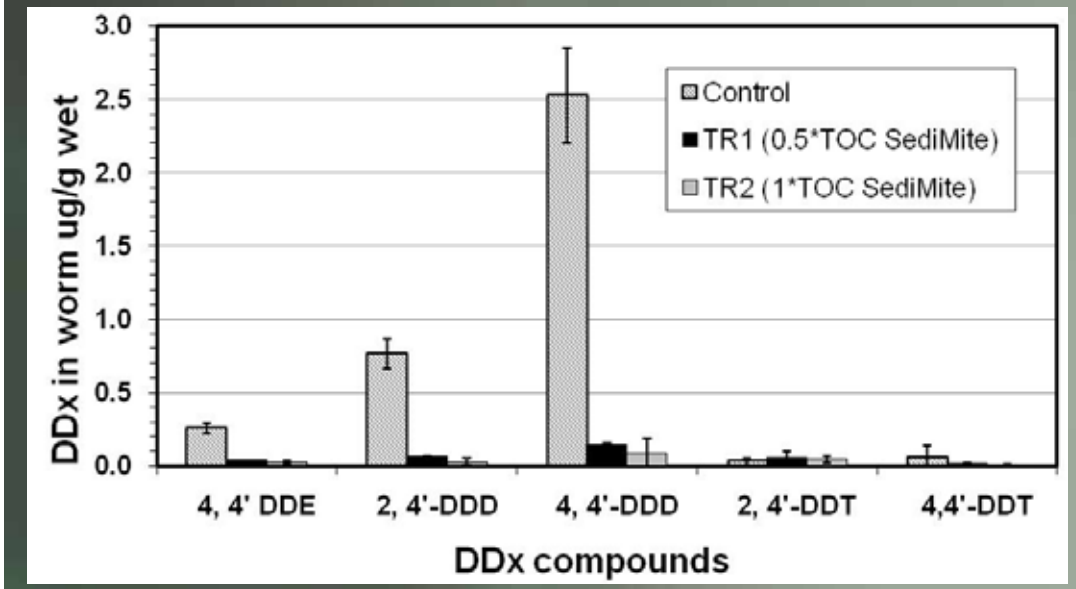
Case 2: SEDIMITE™ application in a tidal creek contaminated with PCBs and mercury

Canal Creek, Edgewood Area of Aberdeen Proving Ground (APG)

Site Description

Treatability results for PCBs and DDxin upper Canal Creek sediments



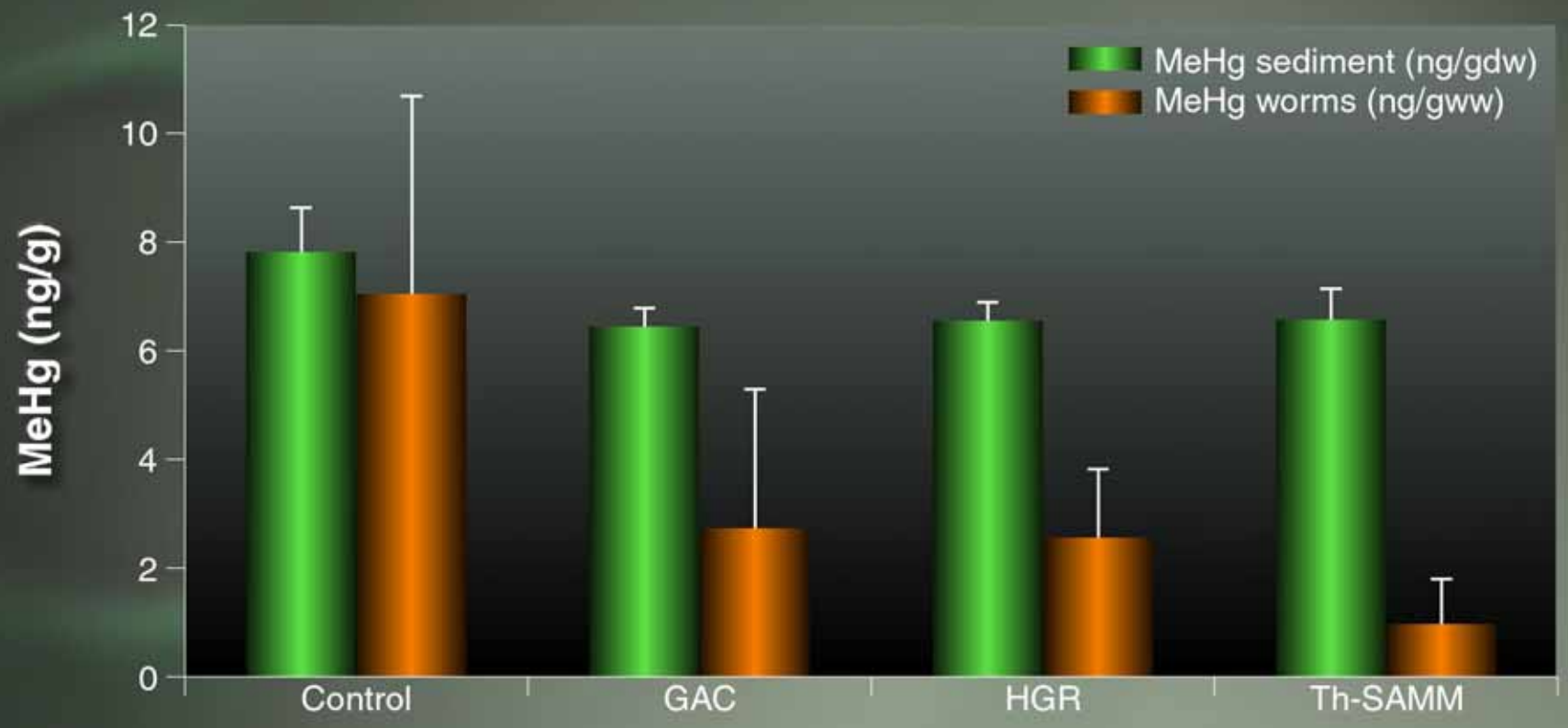


14-day bioaccumulation studies with *L. variegatus*

Treatment at the low dose of SediMite (0.5xTOC as carbon) reduced total PCB bioaccumulation by 81% and total DDx bioaccumulation by 87%

At the higher dose of SediMite (1xTOC as carbon), PCB bioaccumulation was reduced by 95% and DDx bioaccumulation by 92%

Reducing Methylmercury Formation and Bioaccumulation



Notes: Methylmercury concentrations in sediments and in worm bodies, by treatment.
Error bars represent the standard deviation of triplicate experiments.

Test Design

- Distribute SediMite™ over test plots and control plots in Upper and Lower Canal Creek
- Monitor efficacy of treatment over 8-10 months (through summer of 2009)
- Compare test plots to control plots
  - Measure changes in sediment mercury and DDT/DDx
  - Measure changes in pore water mercury and DDT/DDx
  - Measure impacts to benthic invertebrate community
  - Measure impacts to wetland plant community

SediMite Application planned for lower Canal Creek – access via Gunpowder R

- Deployment of SediMite™:
  - Barge-mounted spreader (Millcreek "Turf Tiger")
    - Thin-layer cap placement barge
    - Deposition rate and position can be controlled
    - Can access shallow areas
    - Field test completed:
      - minimal breakage of pellets
      - 23 kg/min application rate
      - 10 ft. wide application area

Test Design: Sampling Plan

- Pre- and post-treatment monitoring to assess effectiveness of SediMite™
  - Pre-treatment
  - 2-Month post-treatment
  - 8 to 10 Month post-treatment (no later than end of Summer)
- Comparison of treated plots to untreated control plots

Sediment Colonization Study

And other studies of effects

Examining the compatibility of site conditions with sediment management alternatives

	MNR	Capping	Dredging	In-Situ	Reactive Caps
Site Characteristics					
Human and Ecological Environment					
Hydrodynamic Conditions					
Sediment Characteristics					
Contaminant Characteristics					
Compatible					
Moderate					
Low to Moderate					
Not Compatible					

Examining the compatibility of site conditions with sediment management alternatives at a site in Pennsylvania

	MNR	Capping	Dredging	In-Situ	Reactive Caps
Site Characteristics	Compatible	Uncertain	Low to Moderate	Compatible	Uncertain
Human and Ecological Environment	Compatible	Not Compatible	Not Compatible	Compatible	Not Compatible
Hydrodynamic Conditions	Moderate	Moderate	Moderate	Moderate	Moderate
Sediment Characteristics	Moderate	Compatible	Low to Moderate	Moderate	Compatible
Contaminant Characteristics	Moderate	Compatible	Low to Moderate	Moderate	Compatible
Compatible					
Moderate					
Low to Moderate					
Not Compatible					

Key challenges and possible steps

- Need to consider longer timeframes to let nature and/or in-situ accomplish healing
- Need to broaden the dimensions of the project to consider overall goals, consequences, and benefits
- May need additional regulatory guidance along with regional workgroups