Capping to Remediate Contaminated Sediments

Presented by
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July 26, 2023

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Photo by Bill Rhodes

Purpose of Tonight's Presentation

- The Focused Feasibility Study for an Early Action in East Branch will include the evaluation of capping as an integral component of a sediment-based remedy in East Branch
- The CAG is interested in learning more about cap design and performance, particularly with respect to the following important issues:
  - NAPL
  - Ebullition
  - Erosion
  - Chemical migration from underlying contaminated sediments
- Tonight's presentation will provide information on these topics and provide references where additional information can be found

Outline

- Introduction
- Capping experience at contaminated sediment sites
- Cap functions and layers
- Cap design evaluations
  - Erosion protection
  - Chemical isolation
- Lessons learned from post-construction monitoring
- Monitoring cap effectiveness

Capping at Sites Around the United States

- Capping has been accepted as a remedial technology by various state agencies, USEPA regions, and U.S. Army Corps of Engineers
- Capping has been implemented at more than 40 sites across the United States in a variety of aquatic environments with a range of contaminants, including those present in Newtown Creek
  - Hudson River (New York)
  - Grasse River (New York)
  - Onondaga Lake (New York)
  - Fox River (Wisconsin)
- Some of these caps have been in place and effective for more than 30 years

Note: Multiple projects are associated with some locations

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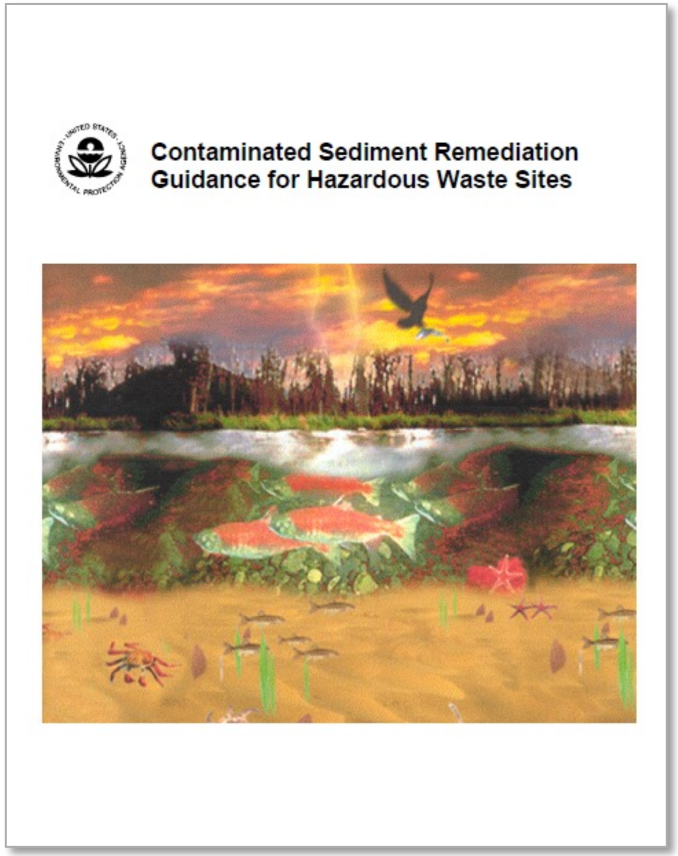
Applicability of Capping at Newtown Creek

- Capping would be effective in Newtown Creek because chemical exposures would be reduced to protective levels
- The cap would represent a new, clean surface that supports ecological recovery
- Caps can be designed to control/mitigate ebullition
- Caps would be designed to allow future maintenance dredging

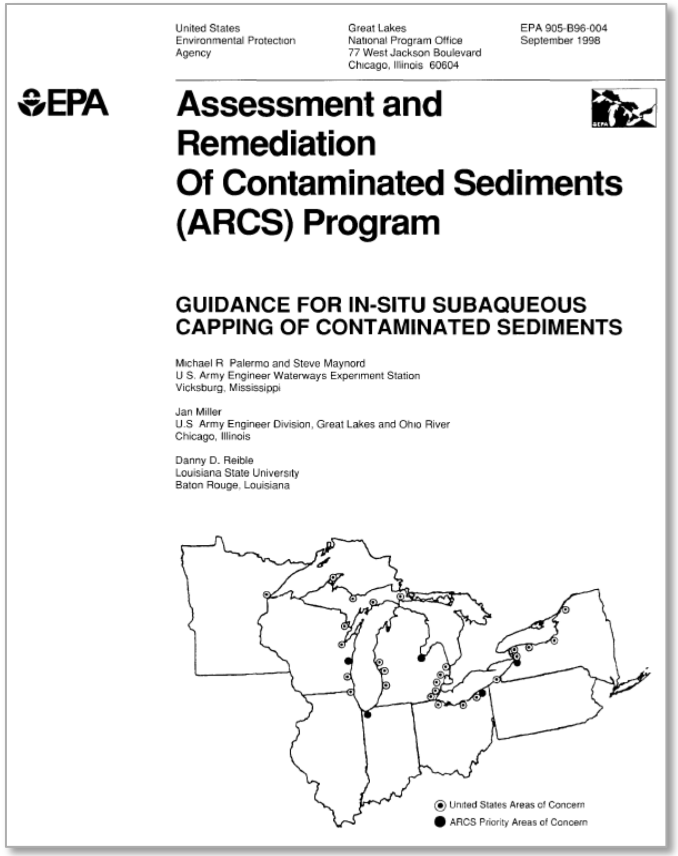
What Guidance Is Used to Design Caps?



(USEPA 2005)

From USEPA 2005:
"At some sites, in-situ capping has served as the primary approach for sediment, and at other sites it has been combined with sediment removal (i.e., dredging or excavation) and/or monitored natural recovery (MNR) of other sediment areas. In-situ capping has been successfully used at a number of sites in the Pacific Northwest, several of which were constructed over a decade ago"*

* As of 2023, these caps have now been in place for more than 30 years



(Palermo et al. 1998)

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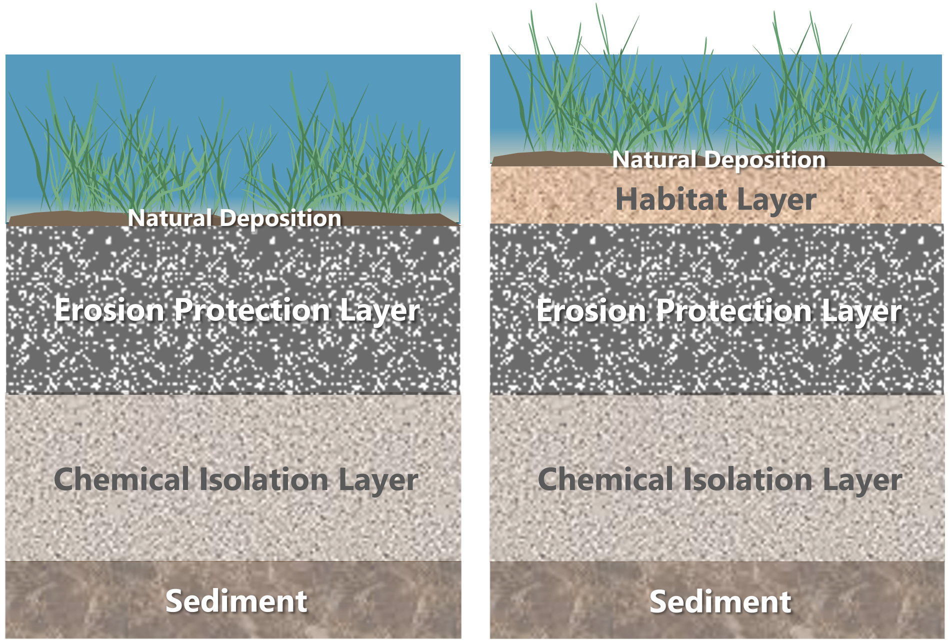
How Caps Function

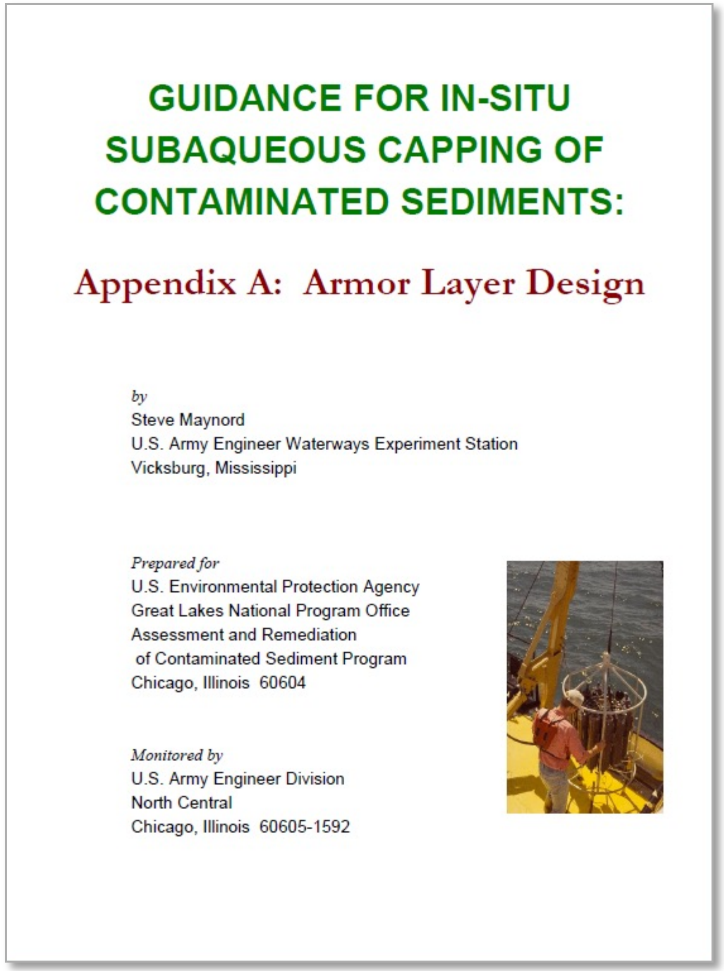
- Primary cap functions/layers
  - Erosion protection
    - Erosion protection provided by layer of material that withstands scouring forces
    - Provides opportunity to restore/improve habitat depending on desired water depths and surface (separate habitat layer can be placed)
  - Chemical isolation
    - Dedicated layer(s) that prevent and/or reduce fluxes of contaminants to levels that provide overall protection of human health and the environment
- A single layer can provide one or more functions (e.g., erosion protection and habitat)

Habitat Restoration



Designing an Erosion Protection Layer

- Design cap to withstand erosive forces in the waterbody
  - Currents
  - Vessel propwash
  - Vessel wakes
  - Wind waves
  - Ice impacts
  - Outfall discharges
- Determine armor material needed to resist these forces using USEPA design guidance (Appendix A, Palermo et al. 1998)


GUIDANCE FOR IN-SITU SUBAQUEOUS CAPPING OF CONTAMINATED SEDIMENTS:

Appendix A: Armor Layer Design

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Monitored by
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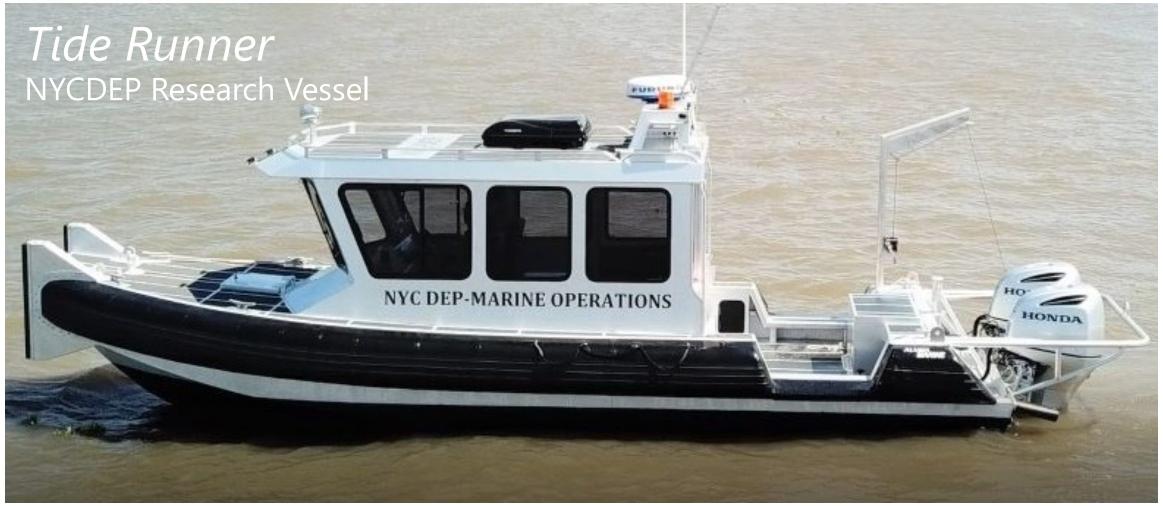
Types of Boats in East Branch



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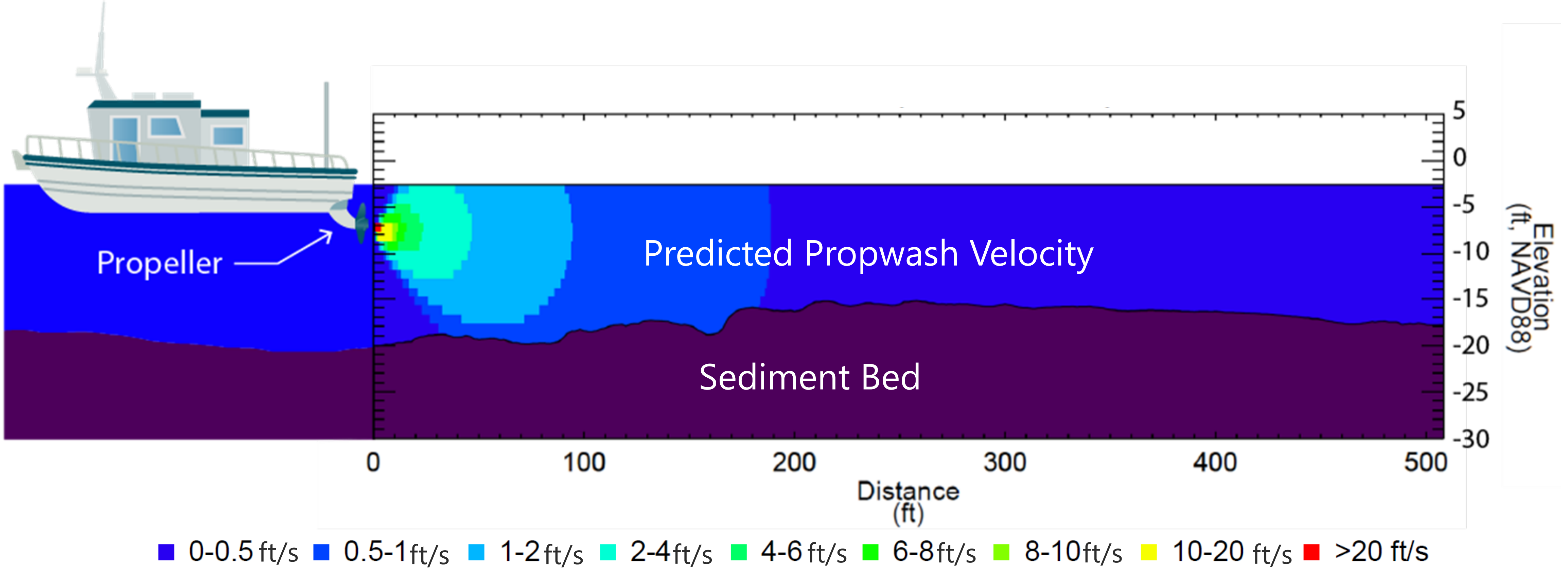
Sample Propwash Model Output



Example Erosion Protection Materials

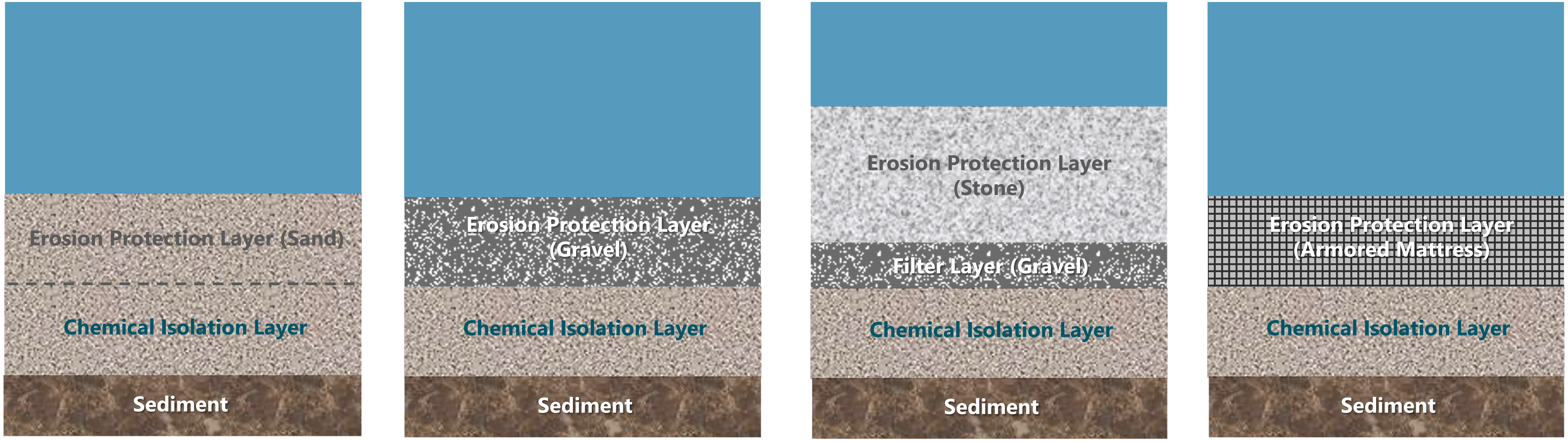
Cobbles

Gravels

Sands

Armored Mattress

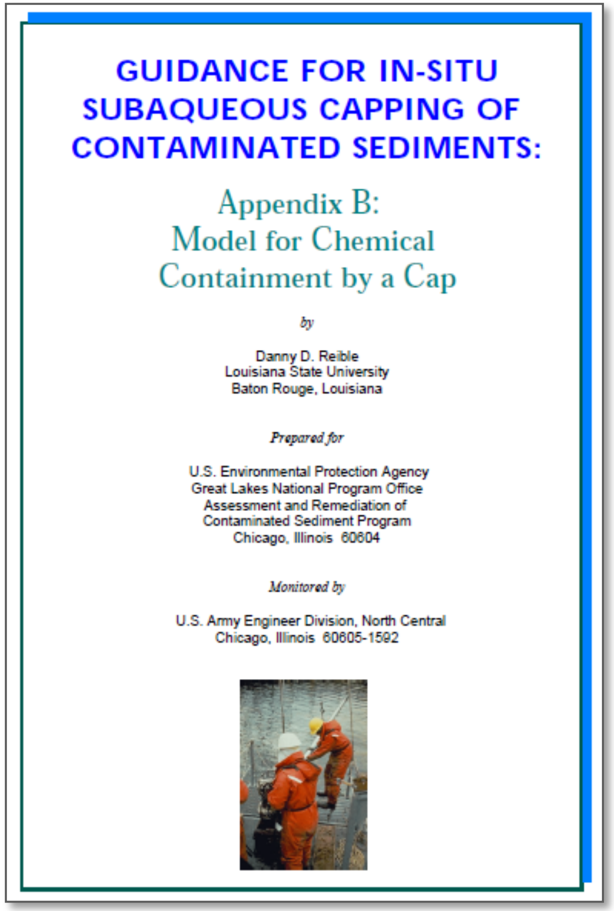
Example Erosion Protection Layer Configurations



Note:
Cap design for Newtown Creek has not yet been designed. Cap designs above are typical options for consideration.

Isolating Chemicals from the Environment

- Caps designed to be protective: maintain protective (risk-based) concentrations at top of cap
- Contaminant transport model used to identify composition/thickness of the cap layers needed to prevent or reduce contaminant fluxes
  - Dissolved phase
  - NAPL (if applicable)


GUIDANCE FOR IN-SITU SUBAQUEOUS CAPPING OF CONTAMINATED SEDIMENTS:

Appendix B:
Model for Chemical Containment by a Cap

by

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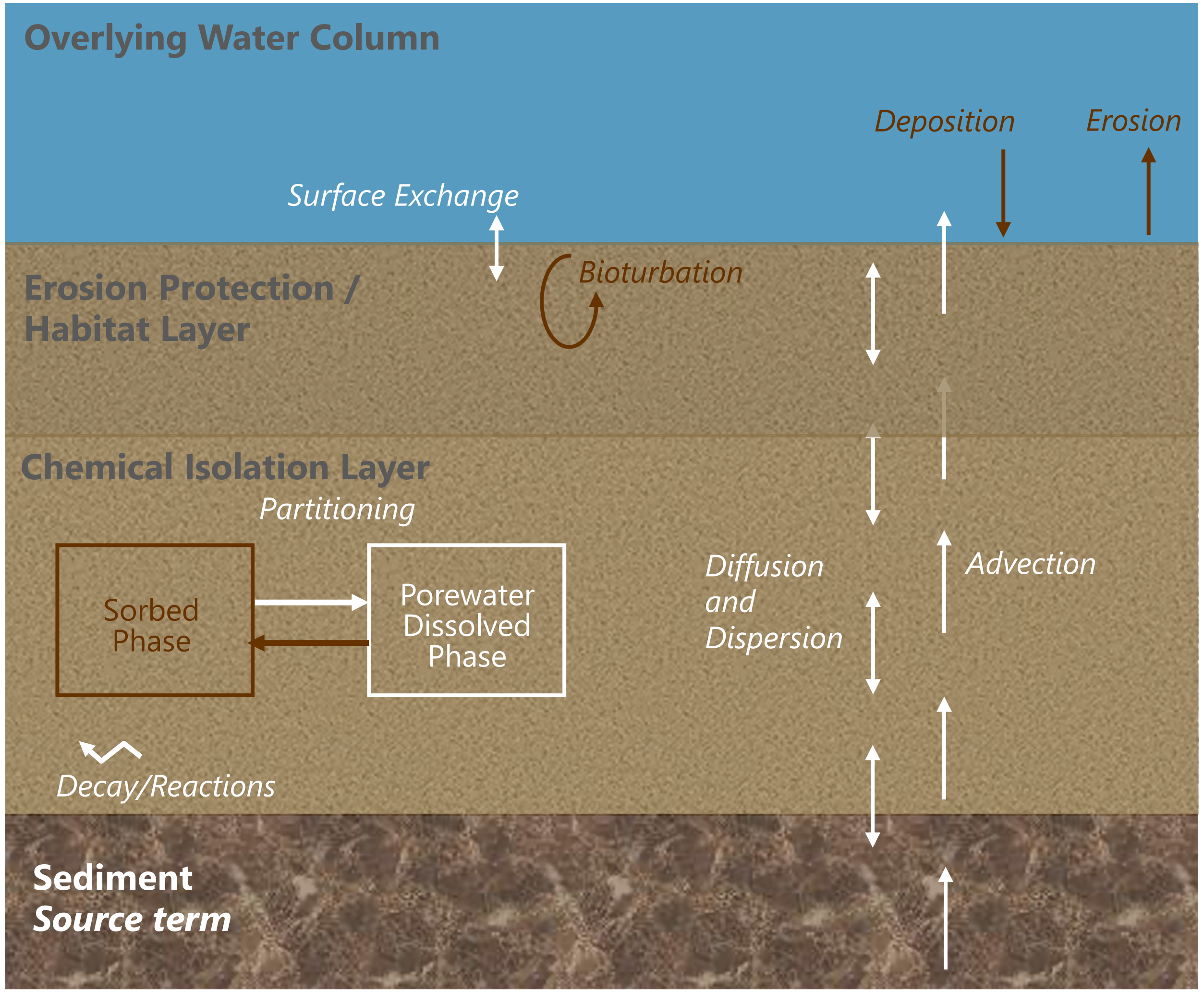
(Palermo et al. 1998)

Chemical Isolation Design Evaluations

- Industry standard model (Shen et al. 2018)
  - Predicts contaminant fluxes and concentrations at cap surface for comparison to design targets
  - Model inputs based on site data
    - Sediment and porewater concentrations
    - Groundwater seepage rate
    - Chemical partitioning and diffusion coefficients

Dissolved Phase Transport Model Processes



Chemical Isolation Layer Materials

- Sand only
- Sand blended with amendment
- Amendment incorporated into mat (e.g., geotextile fabric)
- Example amendments
  - Activated carbon (granular or powdered; GAC or PAC) for organic chemical sorption
  - Organoclay for NAPL sequestration
  - Others (e.g., zero valent iron for metals precipitation; siderite for pH buffering)

Example Cap Profile

How Caps Are Installed

Hydraulic Placement

Mechanical Placement

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Lessons Learned from Caps Around the Country

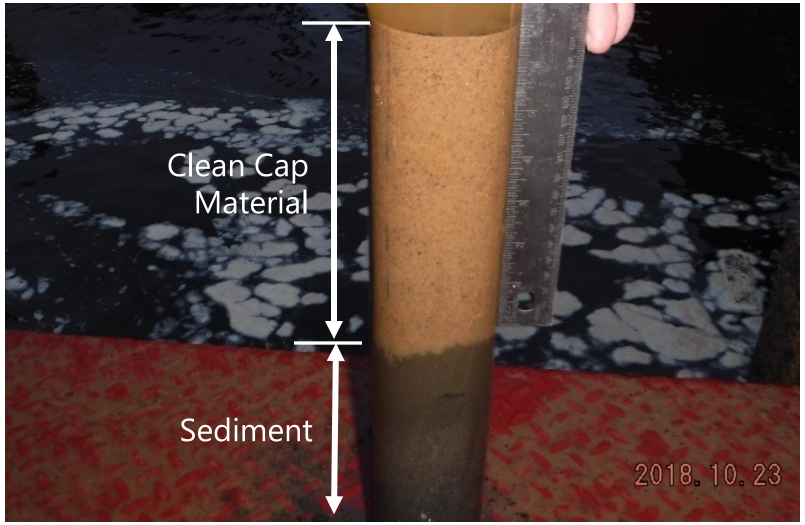
- Numerous caps have been successfully designed, constructed, and monitored
- Each site has unique site-specific conditions
  - Distribution of contaminants and contaminant phases (sediment, porewater, and NAPL)
  - Sediment strength properties
  - Vessel activity
  - Gas ebullition
  - Groundwater seepage
- Armored caps designed for episodic events often accumulate overlying soft sediment over time (see photographs)

Armored Cap Placed in 2005

Armored Cap Area 2009

Post-installation Cap Monitoring

- Monitoring involves measuring physical and chemical components over multiple years
  - Physical: bottom topography surveys and probing
  - Chemical: cap material or porewater sampling
- Allowance for maintenance in project planning
  - If maintenance is required, it typically occurs in the first few years after construction as system comes to equilibrium
  - Typically required in localized portions of cap



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Topics for Future Discussion

- NAPL: mobility, sources, and loading
- New York City Department of Environmental Protection updates
- East Branch Early Action Focused Feasibility Study
- Additional suggested topics
  - Dredging
    - Design and implementation considerations
      - Potential releases of sediments and contaminants during dredging
    - Post-dredge residuals management
    - Lessons learned
  - In situ stabilization/solidification
  - Long-term monitoring

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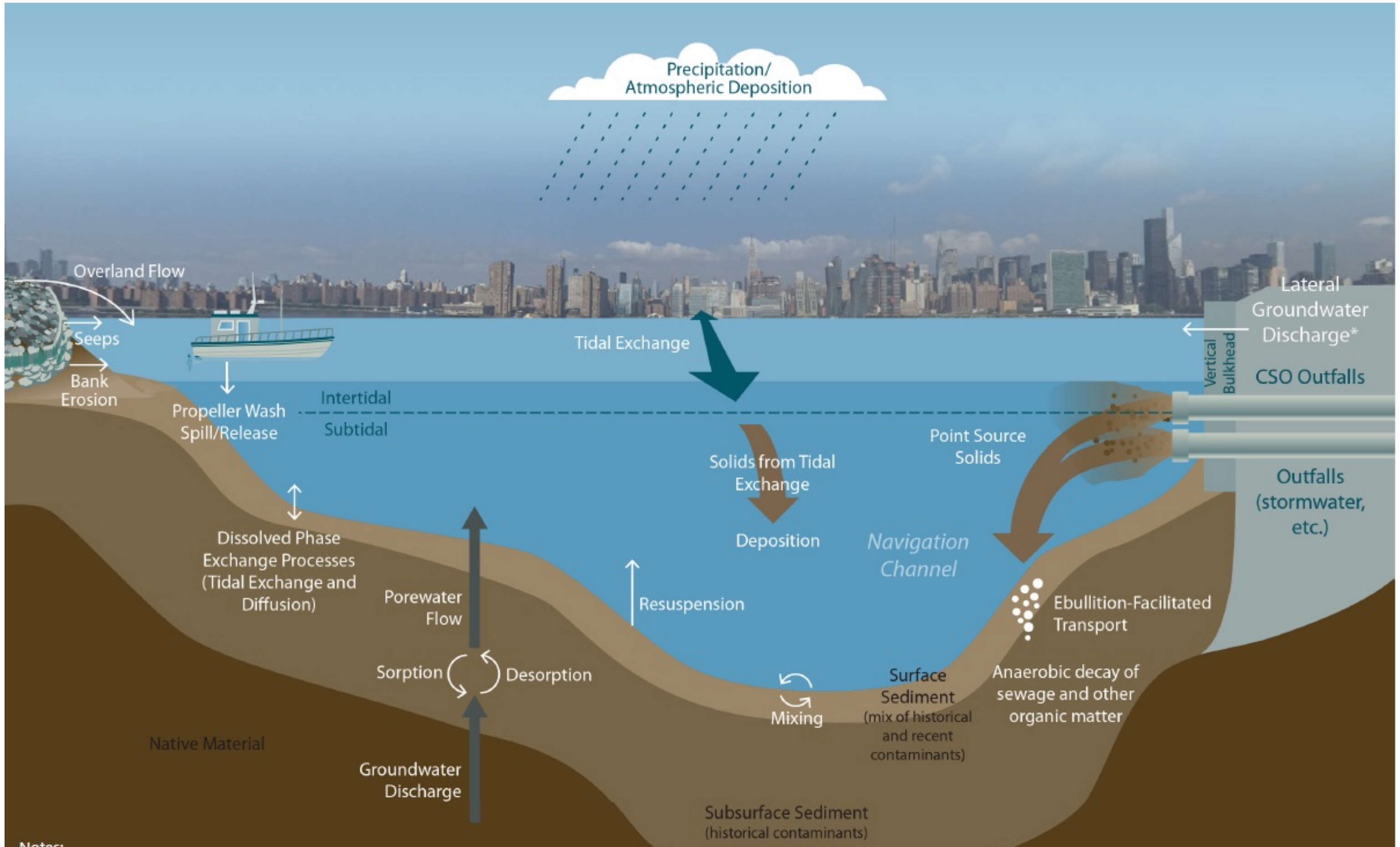
References

- ITRC (Interstate Technology and Regulatory Council), 2014. *Contaminated Sediments Remediation: Remedy Selection for Contaminated Sediments (CS-2)*. Washington, DC: Interstate Technology and Regulatory Council, Contaminated Sediments Team. Available at: https://clu-in.org/download/contaminantfocus/sediments/Sediment-ITRC-CS-2.pdf.
- ITRC [in preparation]. Sediment Cap Update. Anticipated release: September 2023. Proposal available at: https://itrcweb.org/teams/active/sediment-cap.
- Palermo et al. (Palermo, M., S. Maynord, J. Miller, and D. Reible), 1998. *Assessment and Remediation of Contaminated Sediments (ARCS) Program: Guidance for In-Situ Subaqueous Capping of Contaminated Sediments*. Appendix A: Armor Layer Design. Appendix B: Model for Chemical Containment by a Cap. USEPA 905-B96-004. Great Lakes National Program Office. Chicago, Illinois. June 1998. Available at: https://semspub.epa.gov/work/HQ/189670.pdf.
- Shen et al. (Shen, X., D. Lampert, S. Ogle, and D. Reible), 2018. "A Software Tool For Simulating Contaminant Transport And Remedial Effectiveness In Sediment Environments." *Environmental Modelling and Software* 109(2018):104–113. Available at: https://www.depts.ttu.edu/ceweb/research/reiblesgroup/docs/Research_paper.pdf.
- USEPA (U.S. Environmental Protection Agency), 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*. Office of Solid Waste and Emergency Response. EPA-540-R-05-012; OSWER 9355.0-85. December 2005. Section 5. Available at: https://semspub.epa.gov/work/11/174464.pdf.

Questions

East Branch – Conceptual Site Model



Notes:
This figure is intended to illustrate ongoing external inputs of solids and contaminants to the East Branch and in-creek processes that affect the redistribution of solids and contaminants in East Branch.
Tidal exchange represents a mix of East River surface water and surface water from the Newtown Creek Study Area outside of East Branch.
* Lateral groundwater discharges occur in vertical permeable shoreline areas that include vertical wood, wood, precast concrete, and pile-supported concrete bulkheads.