BATTELLE 2023 SEDIMENTS CONFERENCE

The Use of Cap Modeling in an Adaptive Management Approach for the Life of a Project: Design, Construction, and Long-Term Monitoring

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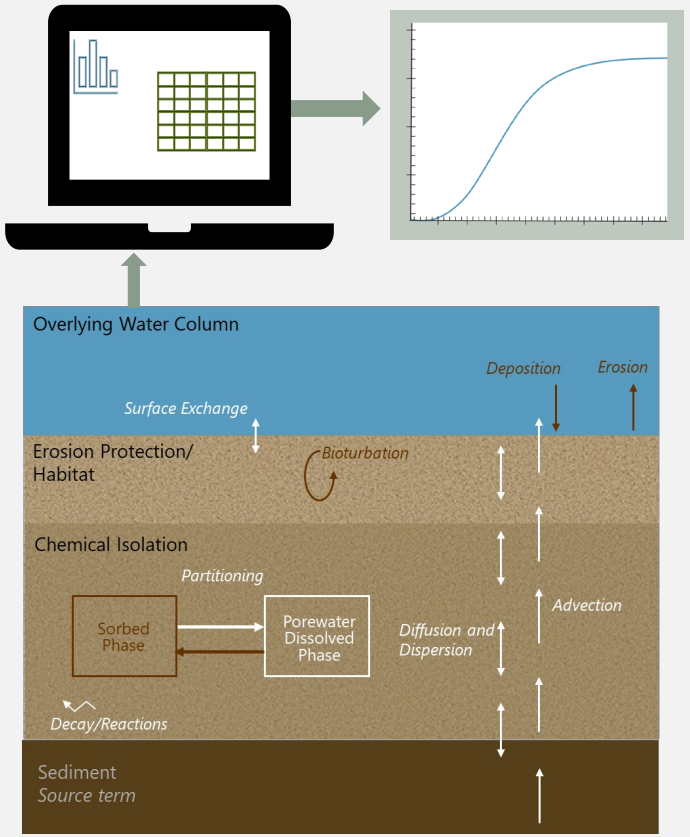
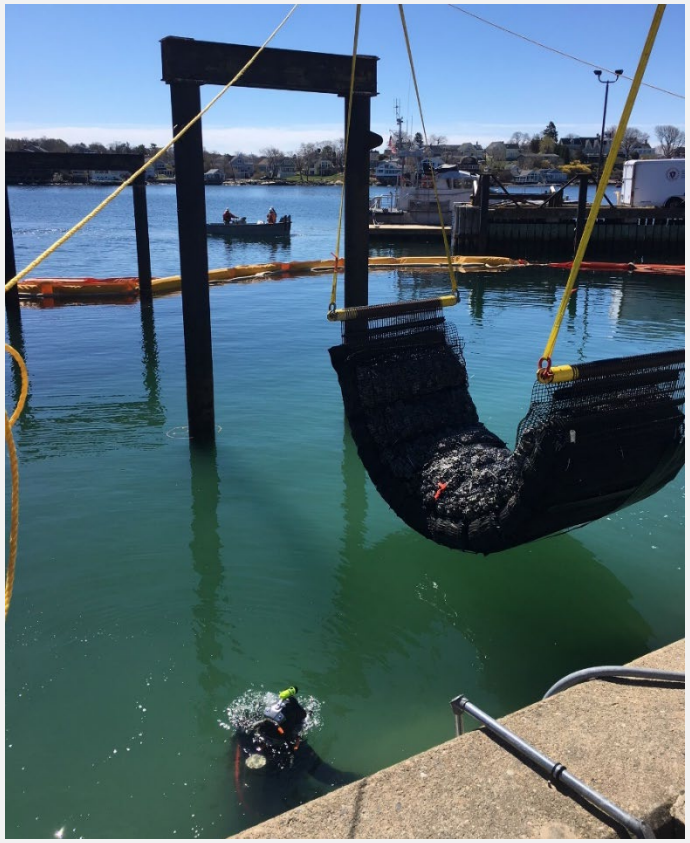
ANCHOR QEA

IN A PERFECT WORLD

Design



Construct

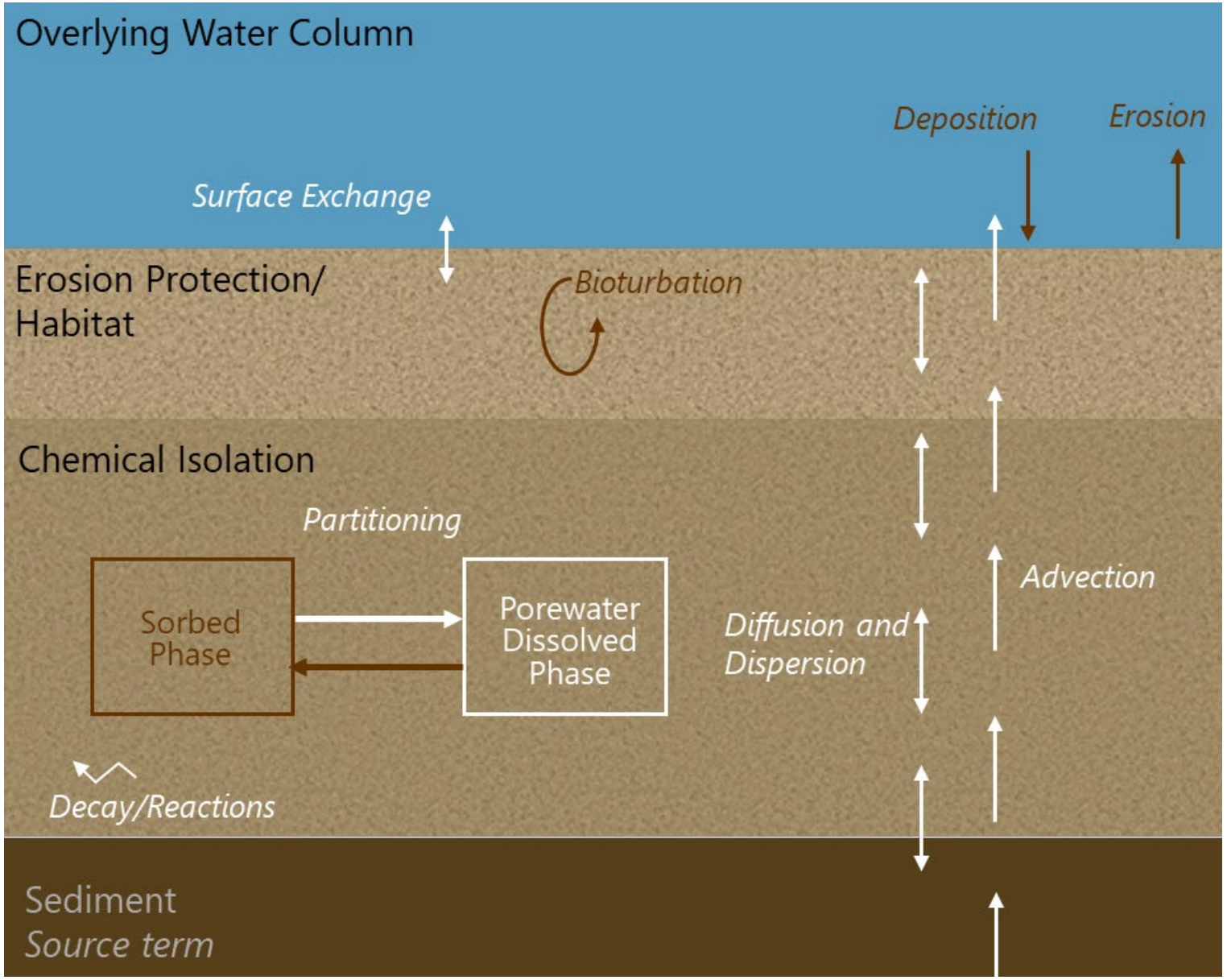


Monitor

CHALLENGE

How do we adapt to less-than-ideal conditions of design, construction, and long-term monitoring?

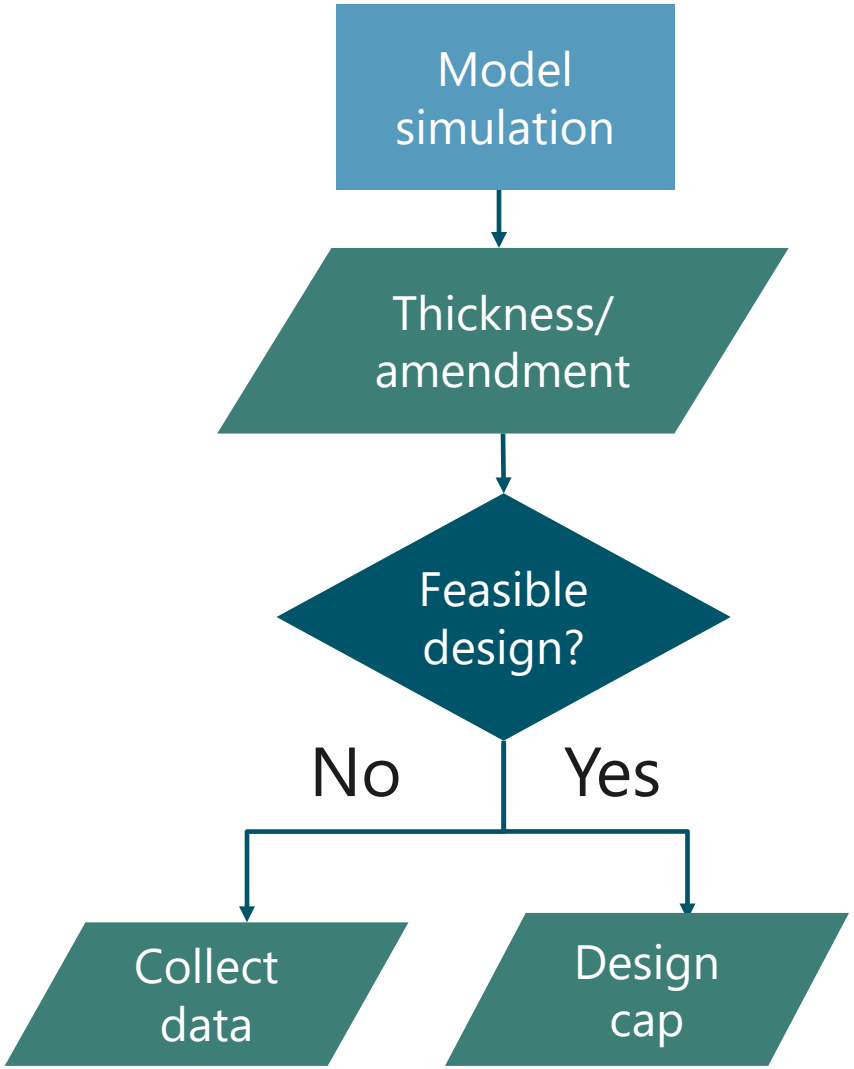
Design


Overlying Water Column
Deposition
Erosion
Surface Exchange
Erosion Protection/
Habitat
Bioturbation
Chemical Isolation
Partitioning
Sorbed
Phase
Porewater
Dissolved
Phase
Advection
Diffusion and
Dispersion
Decay/Reactions
Sediment
Source term

DESIGN EXAMPLE 1

Limited Data

- No data or sparce spatial coverage can be challenging when designing a cap
- Cap models can be used to define the bounds or thresholds that matter for cap design



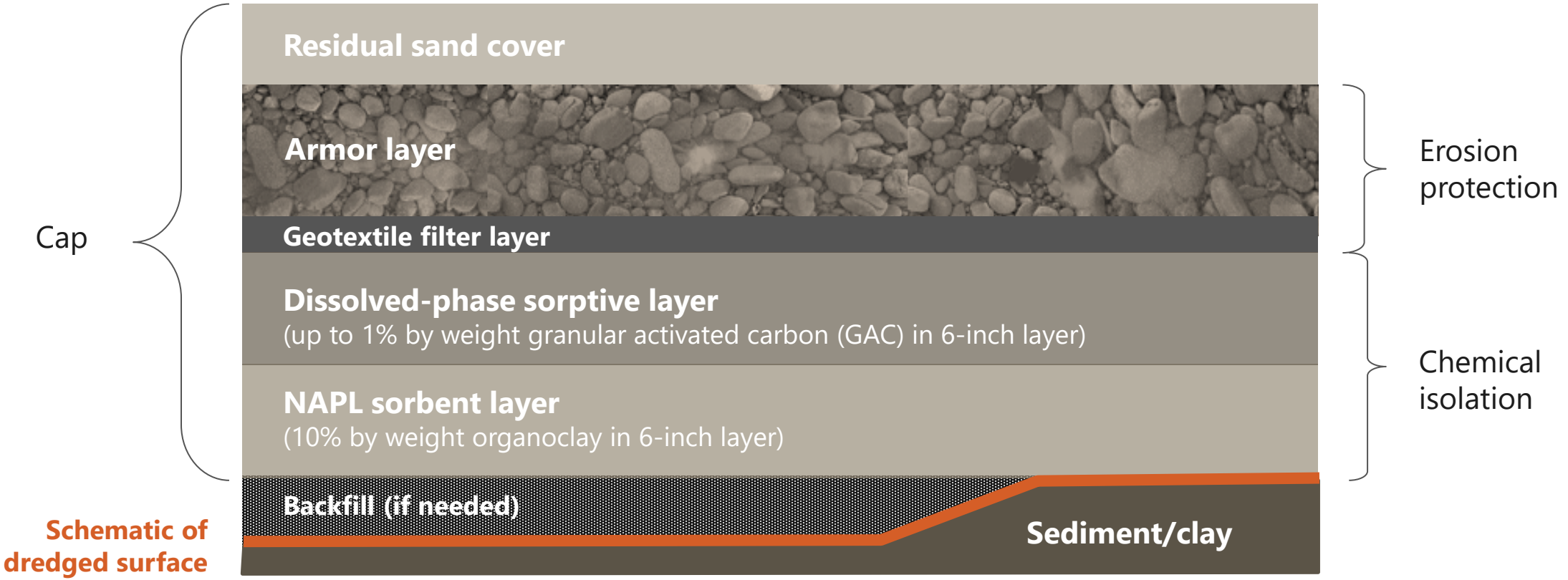
CHALLENGE

Construction

- Unforeseen site conditions or variations in cap layer placement during construction
  - Modifications to cap designs that will provide equivalent protectiveness
  - Rapid evaluations to avoid contractor and equipment standby costs

CONSTRUCTION EXAMPLE 1

Polycyclic aromatic hydrocarbon (PAH)-impacted sediments in river adjacent to manufactured gas plant site



Model Scenarios to Evaluate Potential Change in Cap Configuration

Scenario	Dissolved Phase Chemical Isolation Layer Configuration	Predicted Time to Exceed Design Criteria
Design modeling	6 inches sand/GAC (0.7% by weight)	100 years
Design specifications	6 inches sand/GAC (3% by weight)	405 years
Modified configurations	3 inches sand/GAC (5.5% by weight)	227 years
	4 inches sand/organoclay (10% by weight)	122 years
	8 inches sand/organoclay (10% by weight)	>405 years

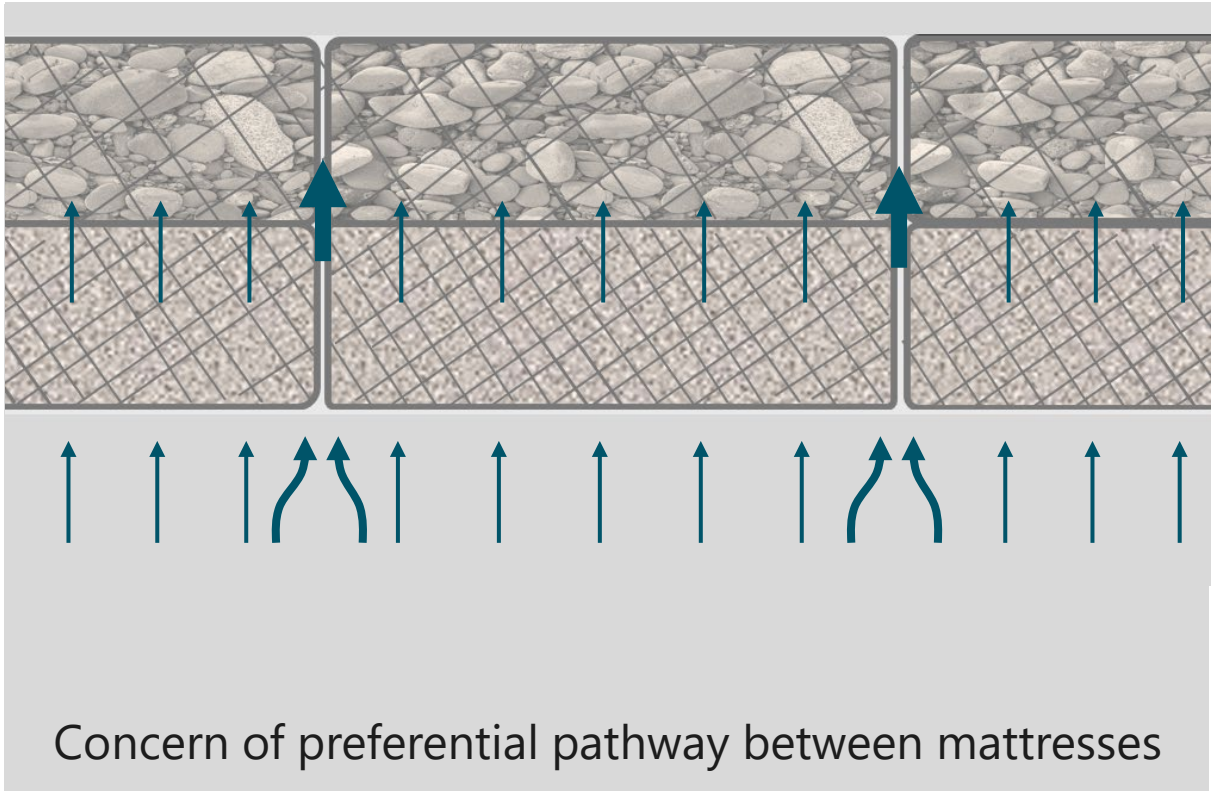
CONSTRUCTION EXAMPLE 2

Amended cap to address PAH-impacted sediments in a Marine Harbor

- A dual-compartment marine armor mattress (MAM) cap with a containment layer underlying an armor stone layer

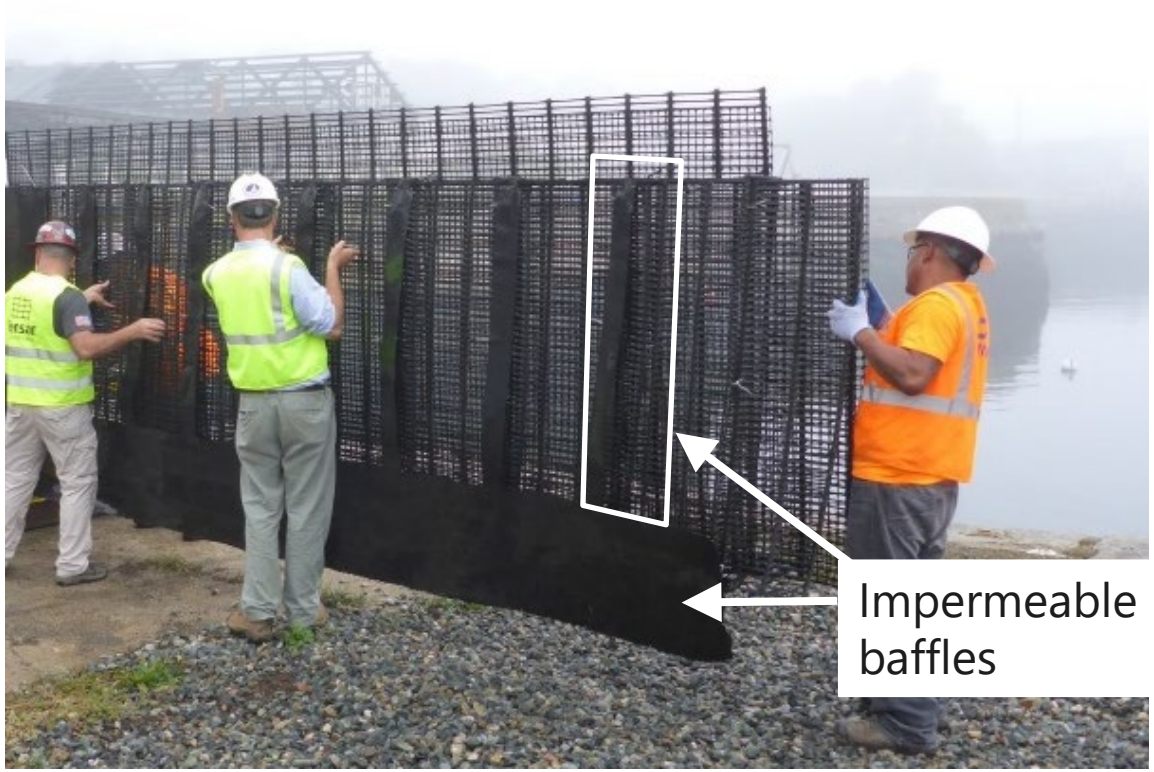
MAMs

MAM filled with armor material (left) and sand/organoclay in geotextile bag (right)

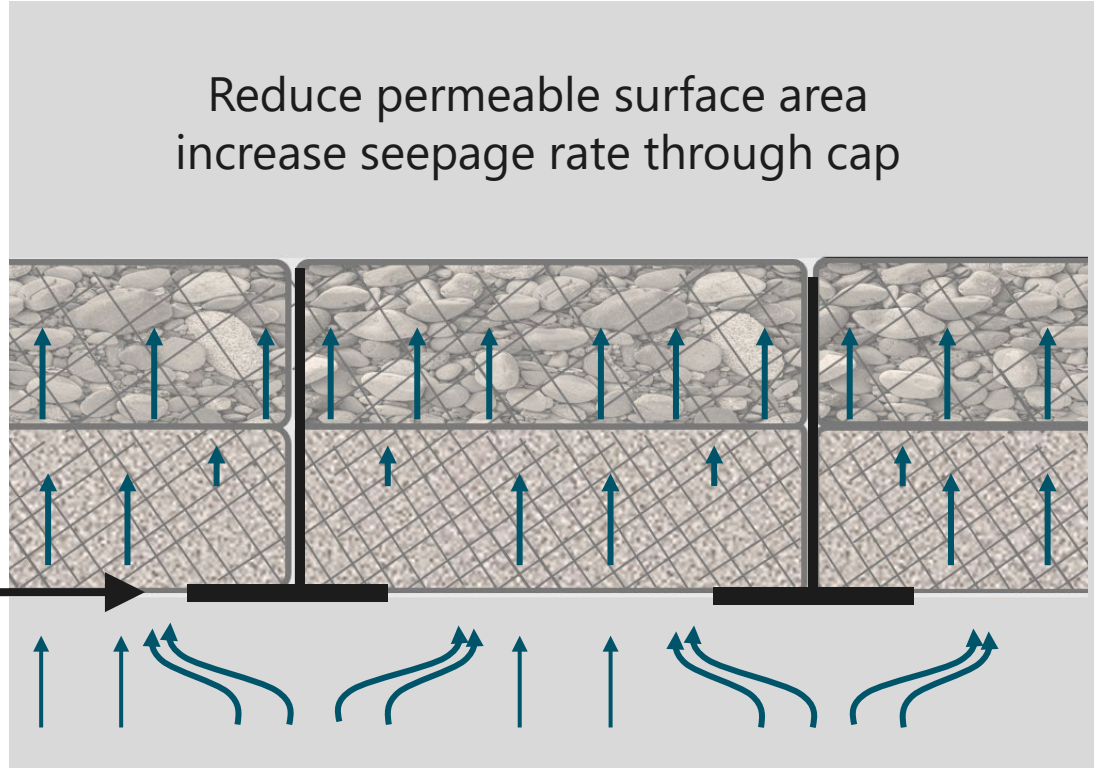


Schematic of MAM at site

How the Presence of Baffles Change Design



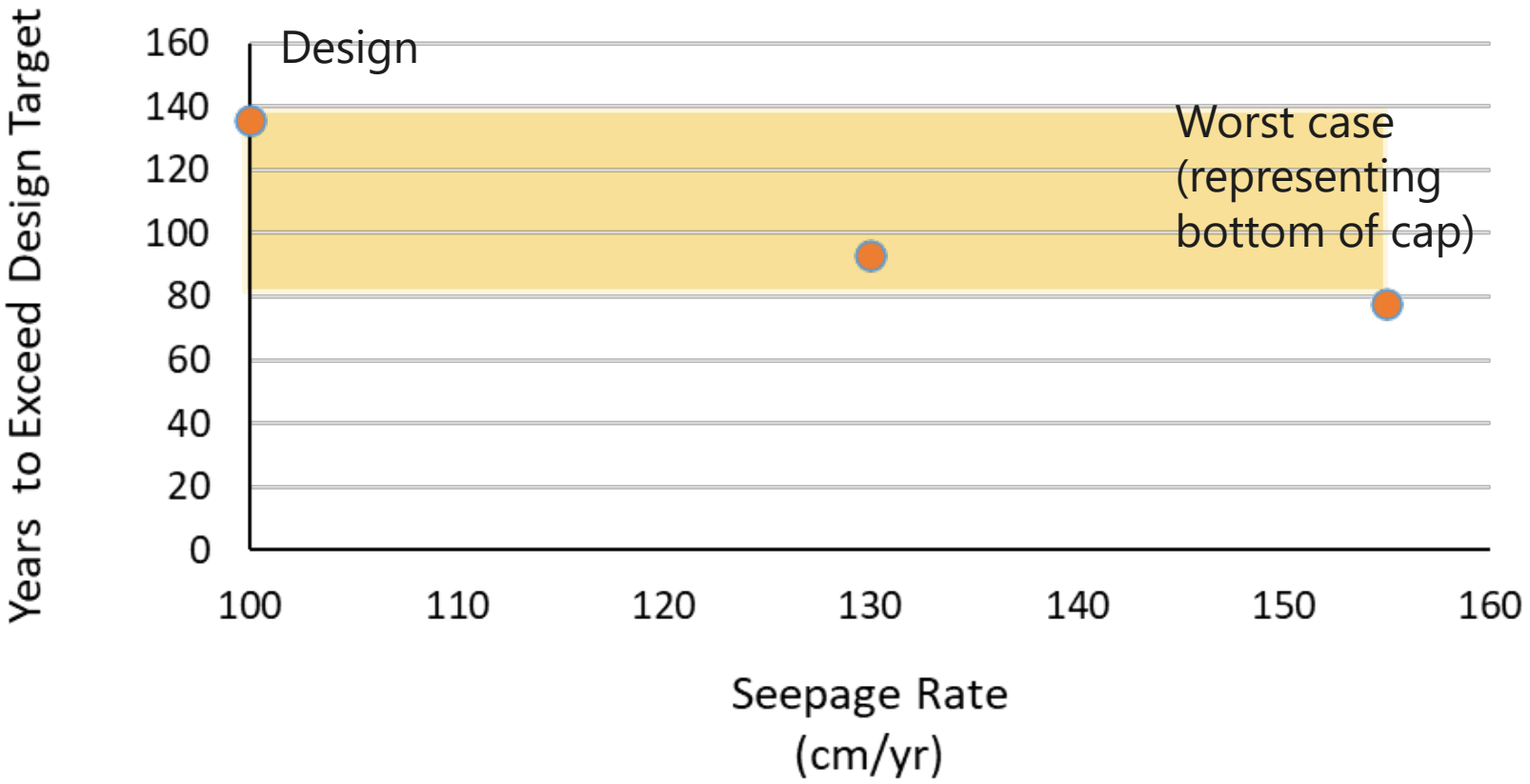
Unfilled MAM with baffles



Schematic of expected groundwater flow path in presence of baffles

Impact of Impermeable Baffles on Predicted Performance of Cap

- Calculated increase in groundwater seepage rates based on reduction in permeable surface area
- Evaluated impact on time to exceed target criteria

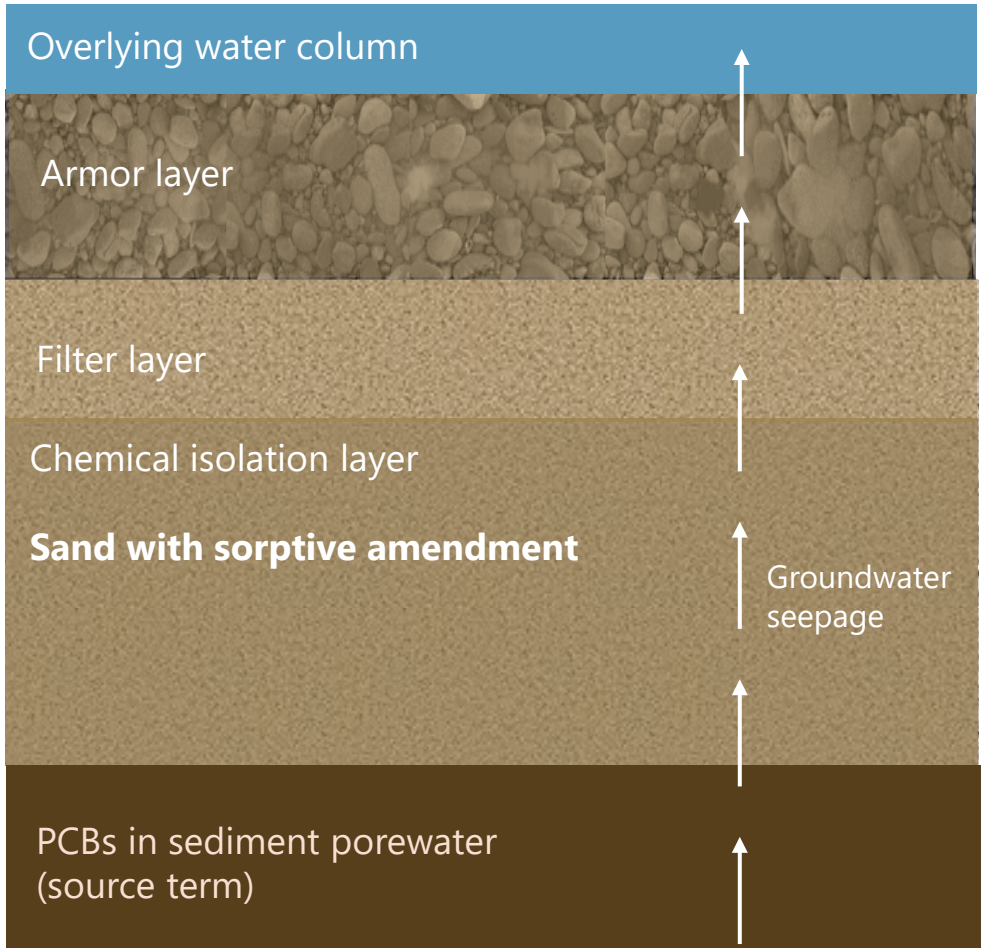


CHALLENGE

Postconstruction Long-Term Monitoring

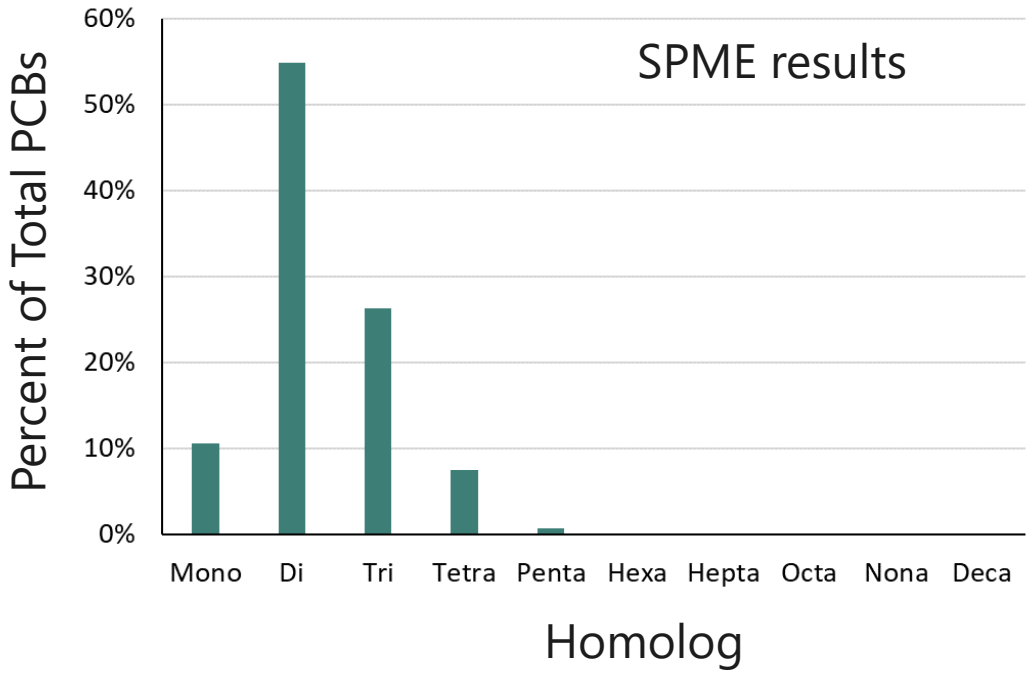
- Confirm cap is performing as designed
  - Results can be confounded by other factors (e.g., background)
  - Models can be used to understand results and guide future monitoring

Amended Cap Placed in a Freshwater River to Address Polychlorinated Biphenyl (PCB)-Contaminated Sediment



Long-Term Monitoring Post-Cap Construction

- Measured PCB congeners above the chemical isolation layer via solid-phase microextraction (SPME)
  - SPMEs deployed in situ for 3 months (approximately 100 days)
  - PCBs were detected at concentrations greater than expected



Conditions That Need to Be Present to Produce Measured PCB Concentrations

- Modeling conducted to evaluate a range of conditions to produce PCB concentrations observed above the chemical isolation layer
- Key model parameters evaluated
  - Groundwater seepage rate
  - Underlying porewater concentration
  - Amount of amendment in isolation layer

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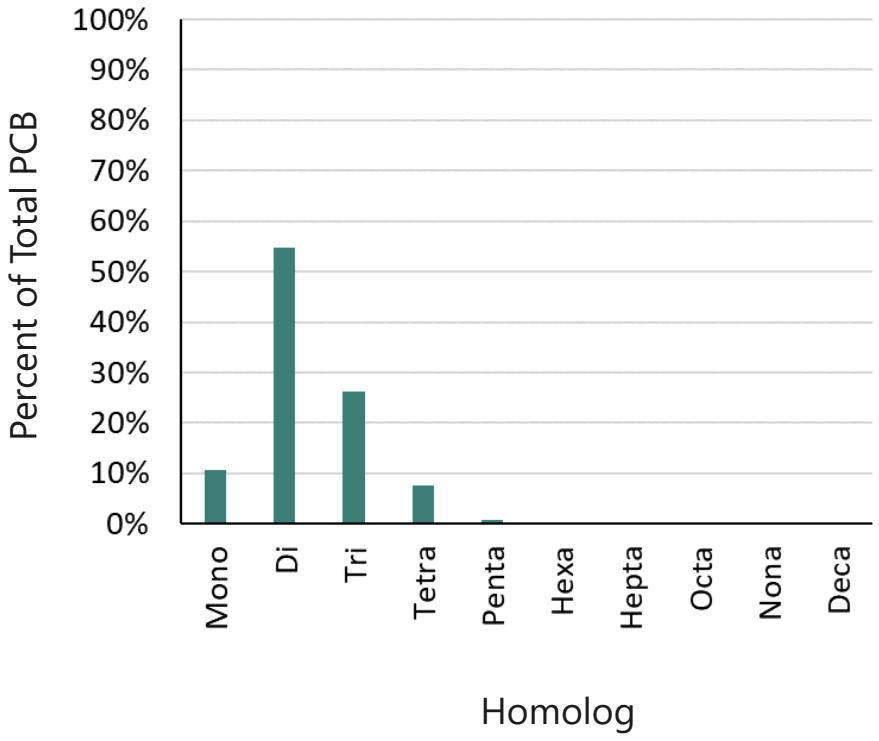
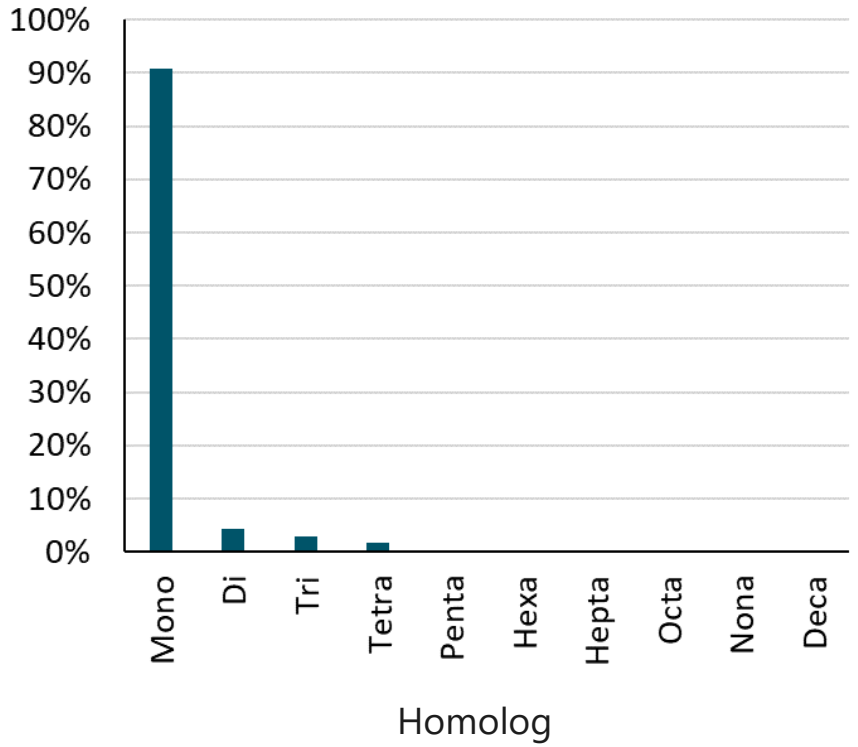
Expected PCB Homolog Pattern

Measured PCBs



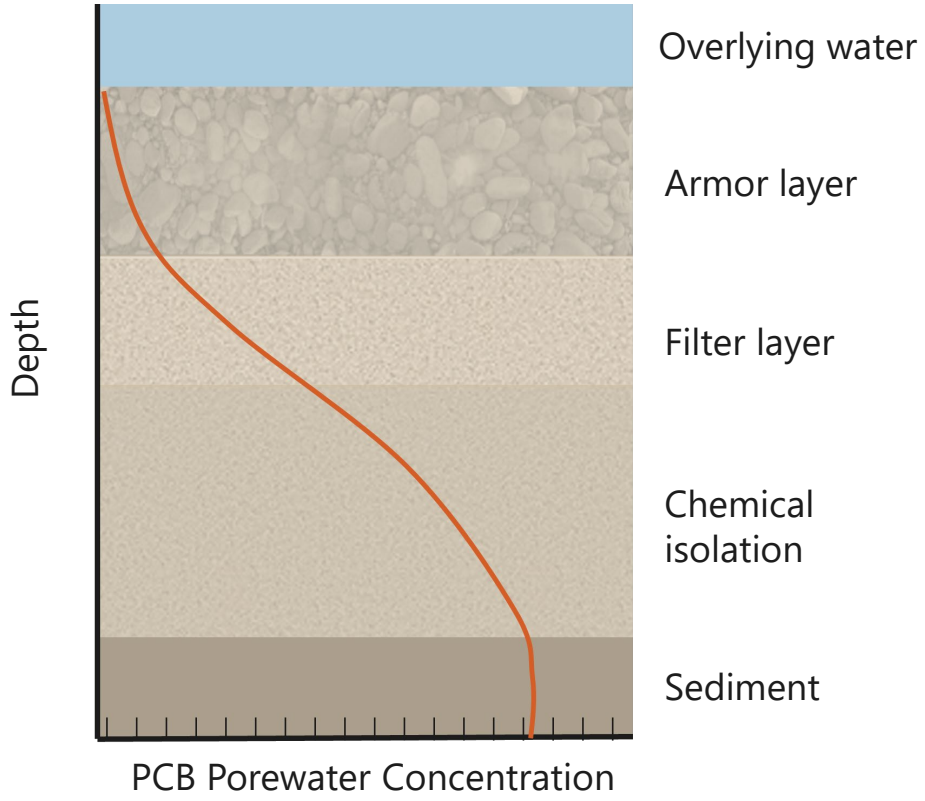
Model-Predicted PCBs, No Amendment



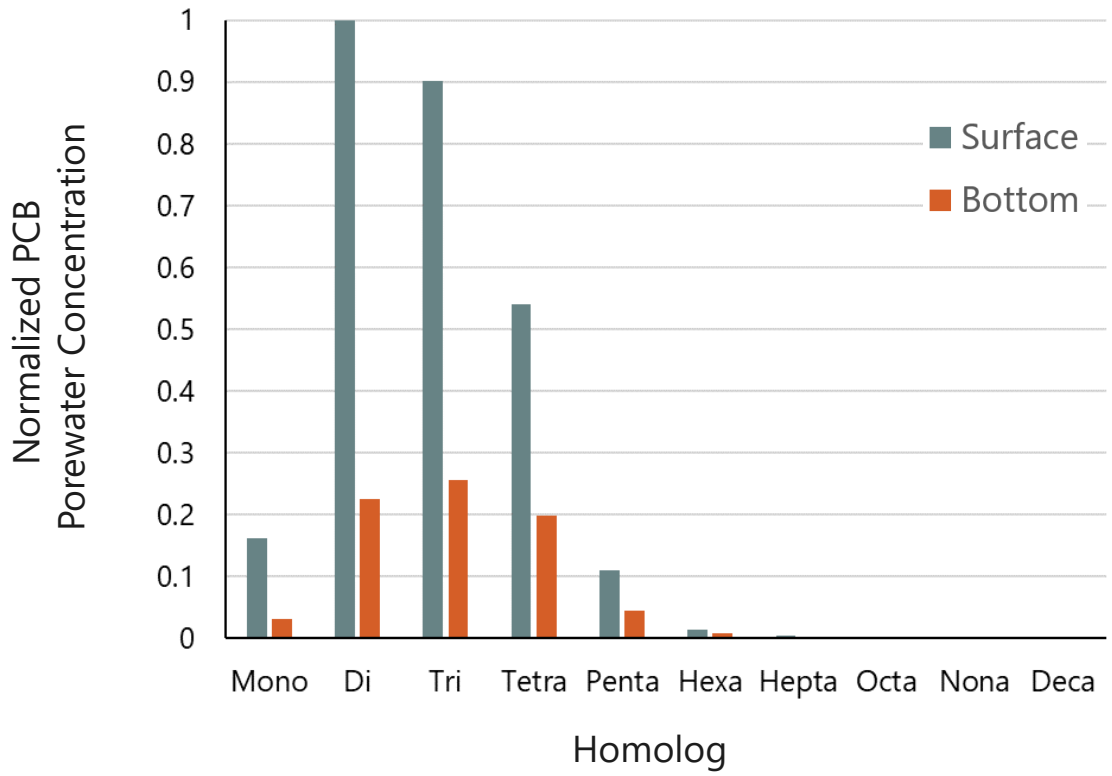
Cannot reproduce observed porewater homolog pattern

Porewater Concentration Vertical Profile

Expected “Bottom-Up” Concentration Profile



Measured PCB Concentrations at Two Depths



Additional sampling at multiple depths showed evidence of top-down source

SOLUTION / LESSONS

Lessons Learned

- Plan for the unexpected
  - Continuous team communication
  - Efficient process to evaluate multiple scenarios in short time frame
    - Avoid contractor and equipment standby costs
- Learn from each project and bring lessons forward to the next project
  - Conservative assumptions during design or safety factors can be helpful

THANK YOU

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