# Starting Soon:
# ITRC Sediment Cap Chemical Isolation

- Sediment Cap Chemical Isolation Guidance Document, sd-1.itrcweb.org
- CLU-IN training page at **https://clu-in.org/conf/itrc/sd-1/**. Under “Webinar Slides & References”, you can download the slides

Use “Join Audio” option in lower left of Zoom webinar to listen to webinar
Problems joining audio? Please call in manually

Dial In 301 715 8592
Webinar ID: 843 4195 4595#

# Housekeeping

- This event is being recorded; Event will be available On Demand after the event at the main training page: **https://clu-in.org/conf/itrc/sd-1/**
- If you have technical difficulties, please use the Q&A Pod to request technical support
- Need confirmation of your participation today?
    - Fill out the online feedback form and check box for confirmation email and certificate

# ITRC – Shaping the Future of Regulatory Acceptance

- Host Organization
  ECOS
- Network - All 50 states, PR, DC
- Federal Partners
  **DOE** **DOD** **EPA**
- ITRC Industry Affiliates Program
  IAP
- Academia
- Community Stakeholders

- Disclaimer
  - https://sd-1.itrcweb.org/about-itrc/#disclaimer
- Partially funded by the US government
  - ITRC nor US government warranty material
  - ITRC nor US government endorse specific products
  - ITRC materials available for your use – see usage policy

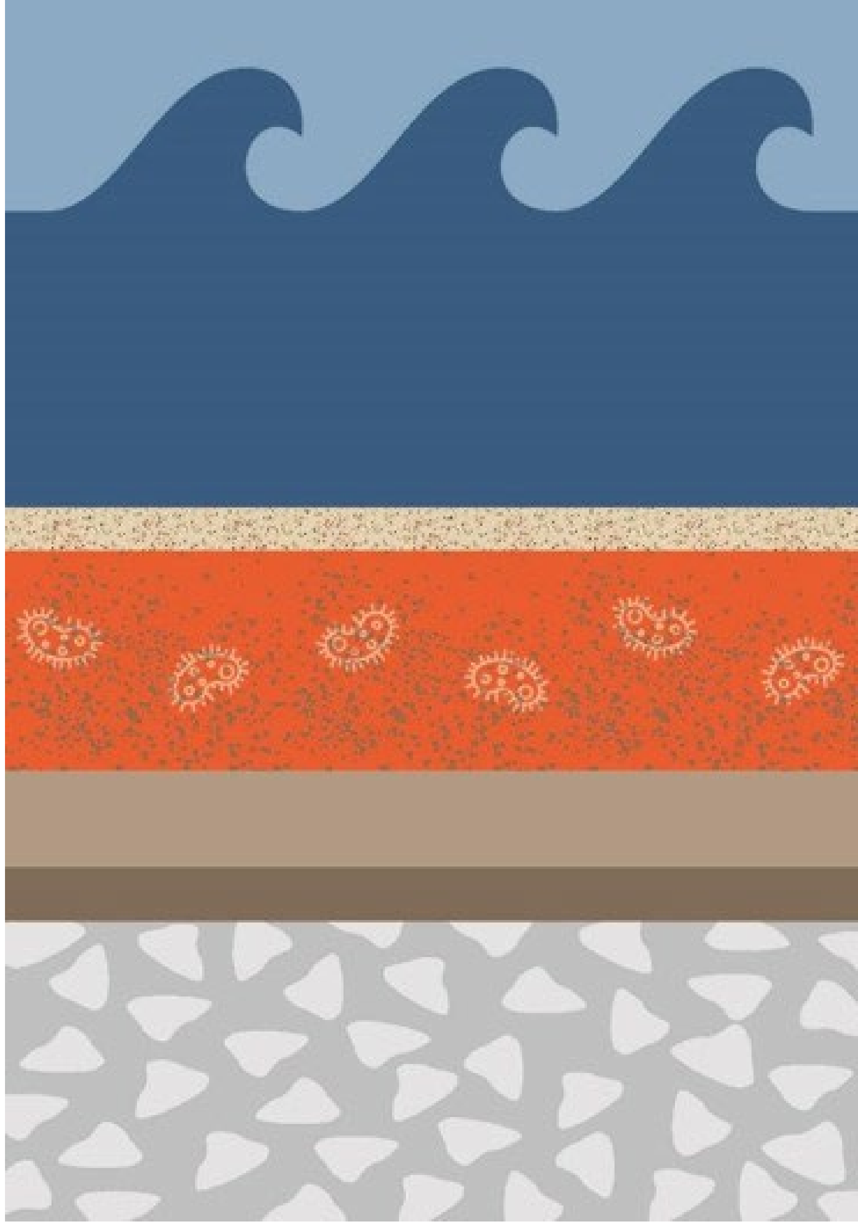
itrcweb.org

facebook.com/itrcweb

@ITRCWEB

linkedin.com/company/itrc

# ITRC: Sediment Cap Chemical Isolation Training



**Sponsored by**: Interstate Technology and Regulatory Council
(www.itrcweb.org)

**Hosted by**: US EPA Clean Up Information Network
(www.cluin.org)

https://sd-1.itrcweb.org/

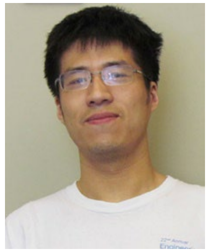
# Meet the ITRC Trainers

**Wesley Thomas**
**Oregon Department of Environmental Quality**
Wesley.Thomas@deq.oregon.gov

**Deirdre Reidy**
**Anchor QEA, LLC**
dreidy@anchorqea.com

**Tamara Sorell, Ph.D**
**Brown and Caldwell**
tsorell@brwncald.com

**Wardah Azhar, Ph.D**
**CDM Smith**
azharw@cdmsmith.com



**Xiaolong Shen**
**Arcadis**
Xiaolong.shen@arcadis.com

**Danny Reible**
**Texas Tech University**
Danny.reible@ttu.edu

**Bhawana Sharma, Ph.D**
**Jacobs**
bhawana.sharma@jacobs.com

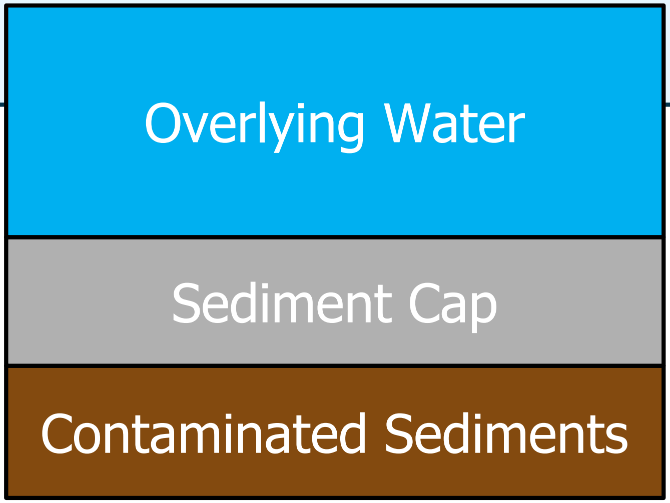
**Erik Bakkom, P.E.**
**Maul Foster & Alongi**
ebakkom@maulfoster.com

**Read trainer bios at https://clu-in.org/conf/itrc/sd-1/**

# ITRC: 2014 Guidance vs. 2023 Guidance

## Contaminated Sediments Remediation (2014)

- Guidance on contaminated sediment selection of remedial technologies
- Section 5 provides an overview of Amended and Unamended Capping



## Sediment Cap Chemical Isolation (2023)

- Design, construction, and monitoring of the cap chemical isolation function
- Design approach for physical stability or erosion protection layer not discussed in this guidance

Sediment Cap Chemical Isolation Guidance

Welcome

Sediment Cap Chemical Isolation Guidance

Design, Construction, and Monitoring Approach

# Training Roadmap

**Introduction (Section 1)**

Capping Overview (Section 2)

Performance Objectives & Design Concepts (Section 3)

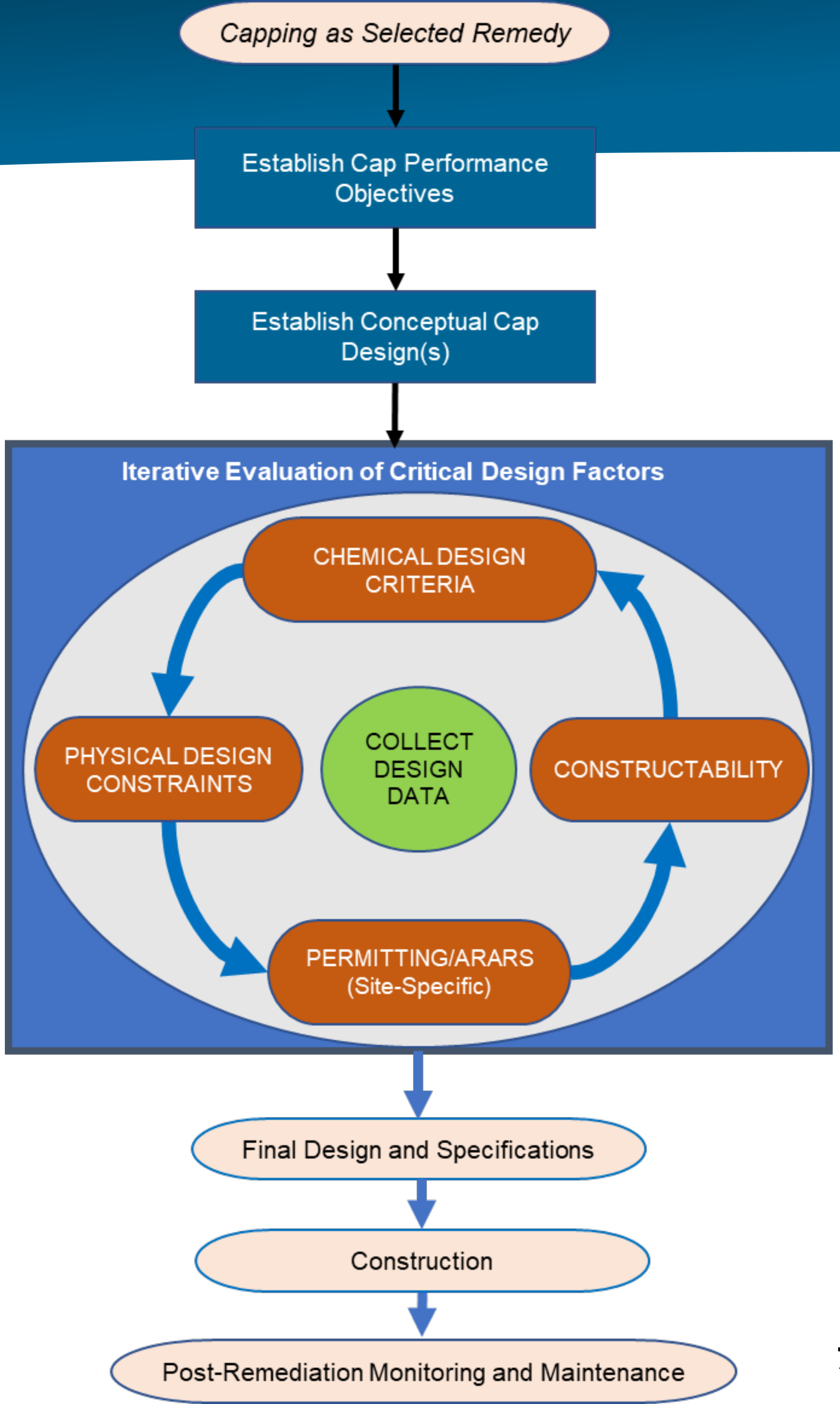
Chemical Isolation Layer Modeling (Section 5)

Q&A Break

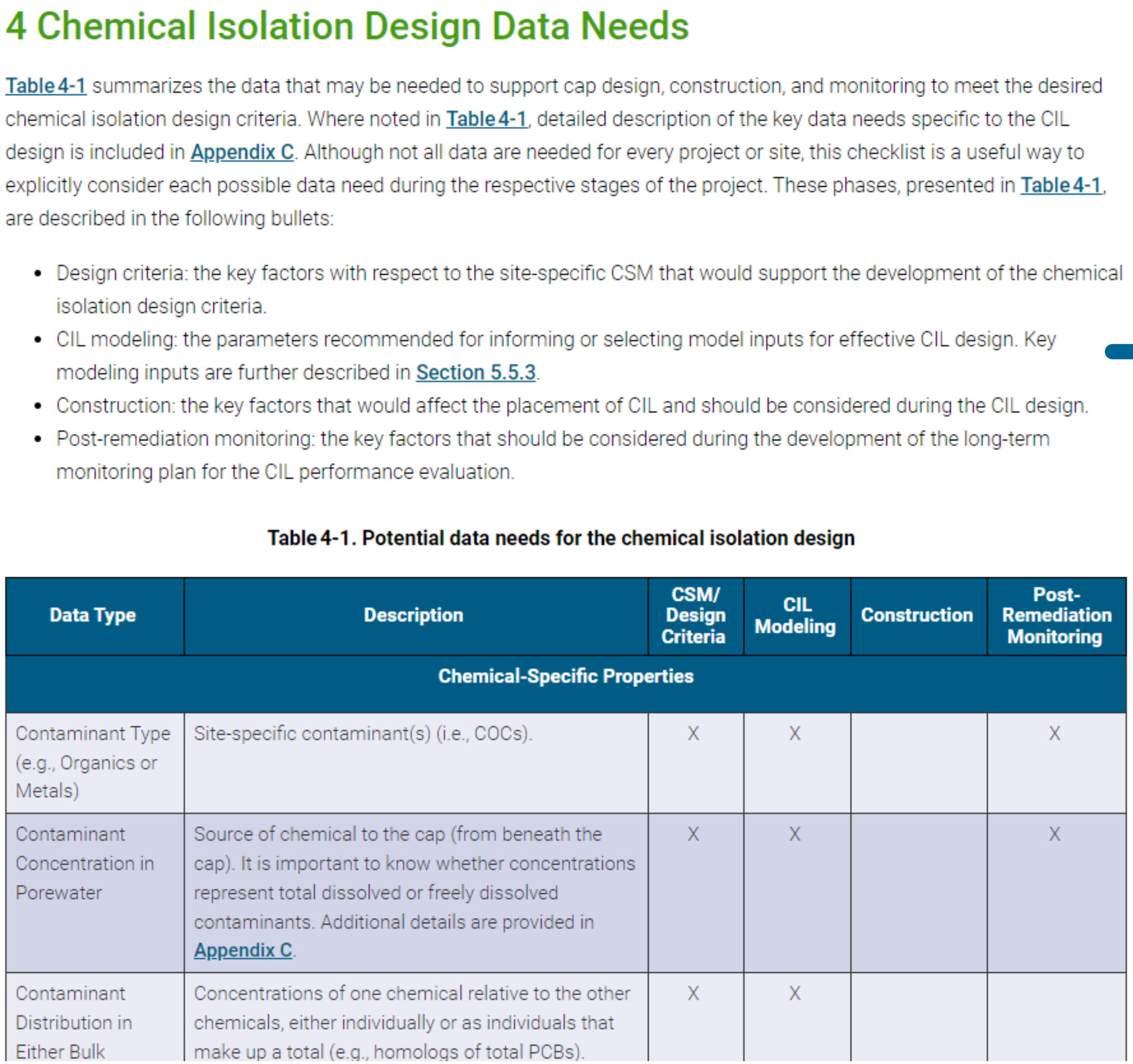
Chemical Isolation Construction Considerations (Section 6)

Monitoring & Maintenance Objectives and Approaches (Section 7)

Q&A Break



# Section 4: Chemical Isolation Design Data Needs



## 4 Chemical Isolation Design Data Needs

Table 4-1 summarizes the data that may be needed to support cap design, construction, and monitoring to meet the desired chemical isolation design criteria. Where noted in Table 4-1, detailed description of the key data needs specific to the CIL design is included in Appendix C. Although not all data are needed for every project or site, this checklist is a useful way to explicitly consider each possible data need during the respective stages of the project. These phases, presented in Table 4-1, are described in the following bullets:

- Design criteria: the key factors with respect to the site-specific CSM that would support the development of the chemical isolation design criteria.
- CIL modeling: the parameters recommended for informing or selecting model inputs for effective CIL design. Key modeling inputs are further described in Section 5.5.3.
- Construction: the key factors that would affect the placement of CIL and should be considered during the CIL design.
- Post-remediation monitoring: the key factors that should be considered during the development of the long-term monitoring plan for the CIL performance evaluation.

**Table 4-1. Potential data needs for the chemical isolation design**

| Data Type | Description | CSM/ Design Criteria | CIL Modeling | Construction | Post-Remediation Monitoring |
|---|---|---|---|---|---|
| **Chemical-Specific Properties** | | | | | |
| Contaminant Type (e.g., Organics or Metals) | Site-specific contaminant(s) (i.e., COCs). | X | X | | X |
| Contaminant Concentration in Porewater | Source of chemical to the cap (from beneath the cap). It is important to know whether concentrations represent total dissolved or freely dissolved contaminants. Additional details are provided in Appendix C. | X | X | | X |
| Contaminant Distribution in Either Bulk | Concentrations of one chemical relative to the other chemicals, either individually or as individuals that make up a total (e.g., homologs of total PCBs). | X | X | | |

Design Criteria

CIL Modeling

Construction

Post-Remediation Monitoring

https://sd-1.itrcweb.org/4-chemical-isolation-design-data-needs/

# Sediment Capping Objectives

Focus of Training & Resources is Chemical Isolation

1 Physical stabilization (stability) to prevent contaminant transport

2 Chemical isolation to contain or limit contaminant migration and exposure to contaminants of concern from the underlying sediments

3 Protection of benthic community by preventing direct contact with the underlying contaminated sediments

# Training Roadmap

Introduction (Section 1)

**Capping Overview (Section 2)**

Performance Objectives & Design Concepts (Section 3)

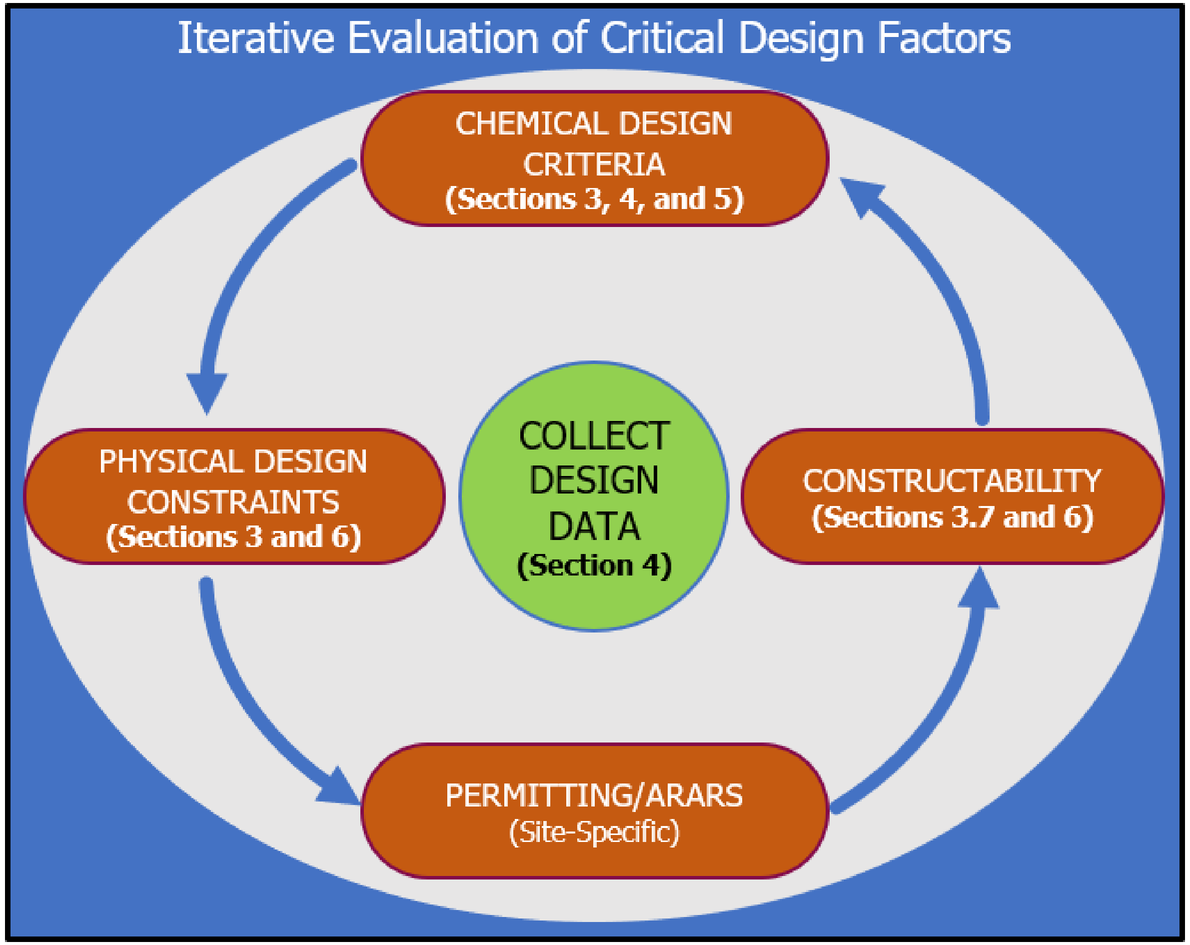
Chemical Isolation Layer Modeling (Section 5)

Q&A Break

Chemical Isolation Construction Considerations (Section 6)

Monitoring & Maintenance Objectives and Approaches (Section 7)

Q&A Break



Iterative Evaluation of Critical Design Factors

CHEMICAL DESIGN CRITERIA
**(Sections 3, 4, and 5)**

PHYSICAL DESIGN CONSTRAINTS
**(Sections 3 and 6)**

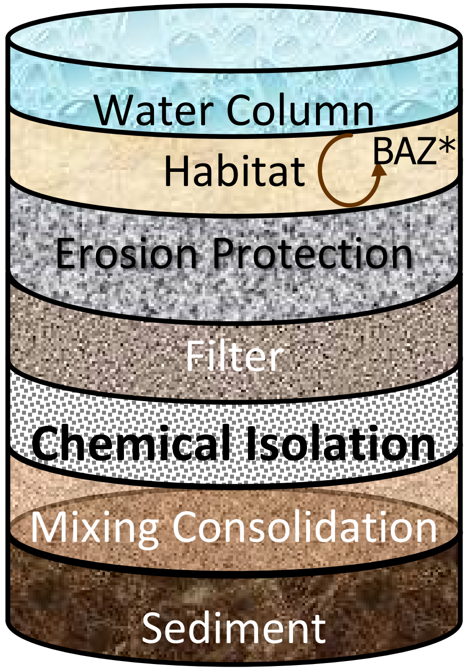
COLLECT DESIGN DATA
**(Section 4)**

CONSTRUCTABILITY
**(Sections 3.7 and 6)**

PERMITTING/ARARS
(Site-Specific)

# Capping Overview

## Cap objectives can be achieved with a single cap layer or *combination of multiple cap layers*



- Accommodates the benthic and aquatic communities and vegetation

- Stabilizes and protects CIL from erosive forces (e.g., waves, tides, current, prop wash)

- Buffers mixing of CIL and erosion protection layer

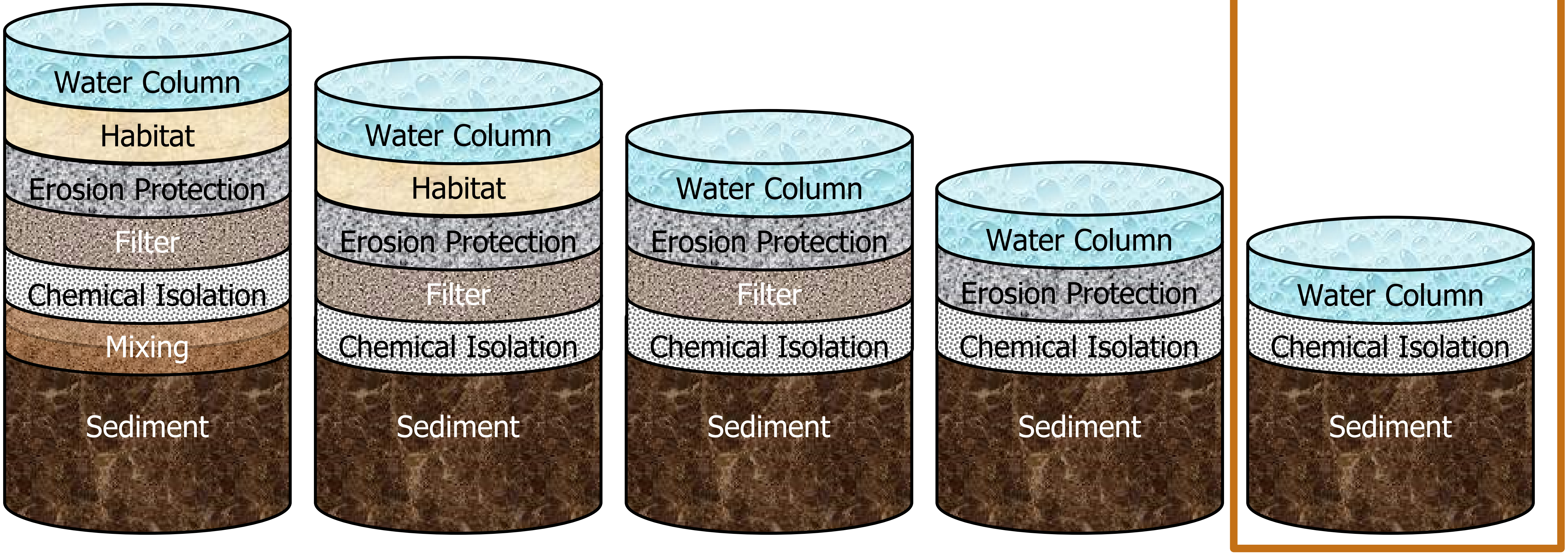
**- Provides chemical isolation**

- Creates level / stable base layer; prevents CIL from mixing with sediment

* The surface layer usually includes the biologically active zone (BAZ)

Source: Jeffrey Hale, Kleinfelder (used with permission)

# Cap Layer Configurations



All functional layers

Base layer *(mixing)* not required

Base layer and habitat layer not required

Base layer, habitat layer, and filter layer not required

Single cap layer

Source: Jeffrey Hale, Kleinfelder (used with permission)

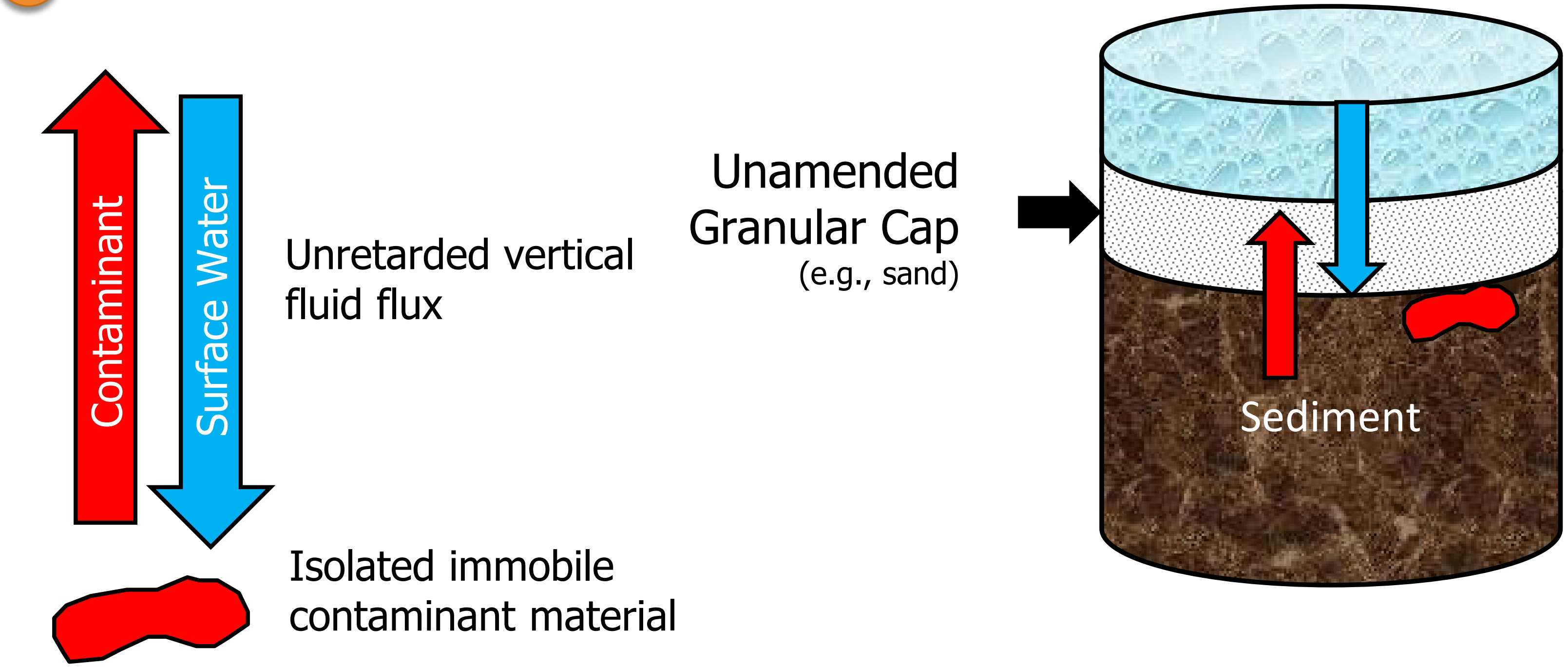
# General Cap Types

Unamended Granular Caps

Low-permeability Caps

Amended Caps

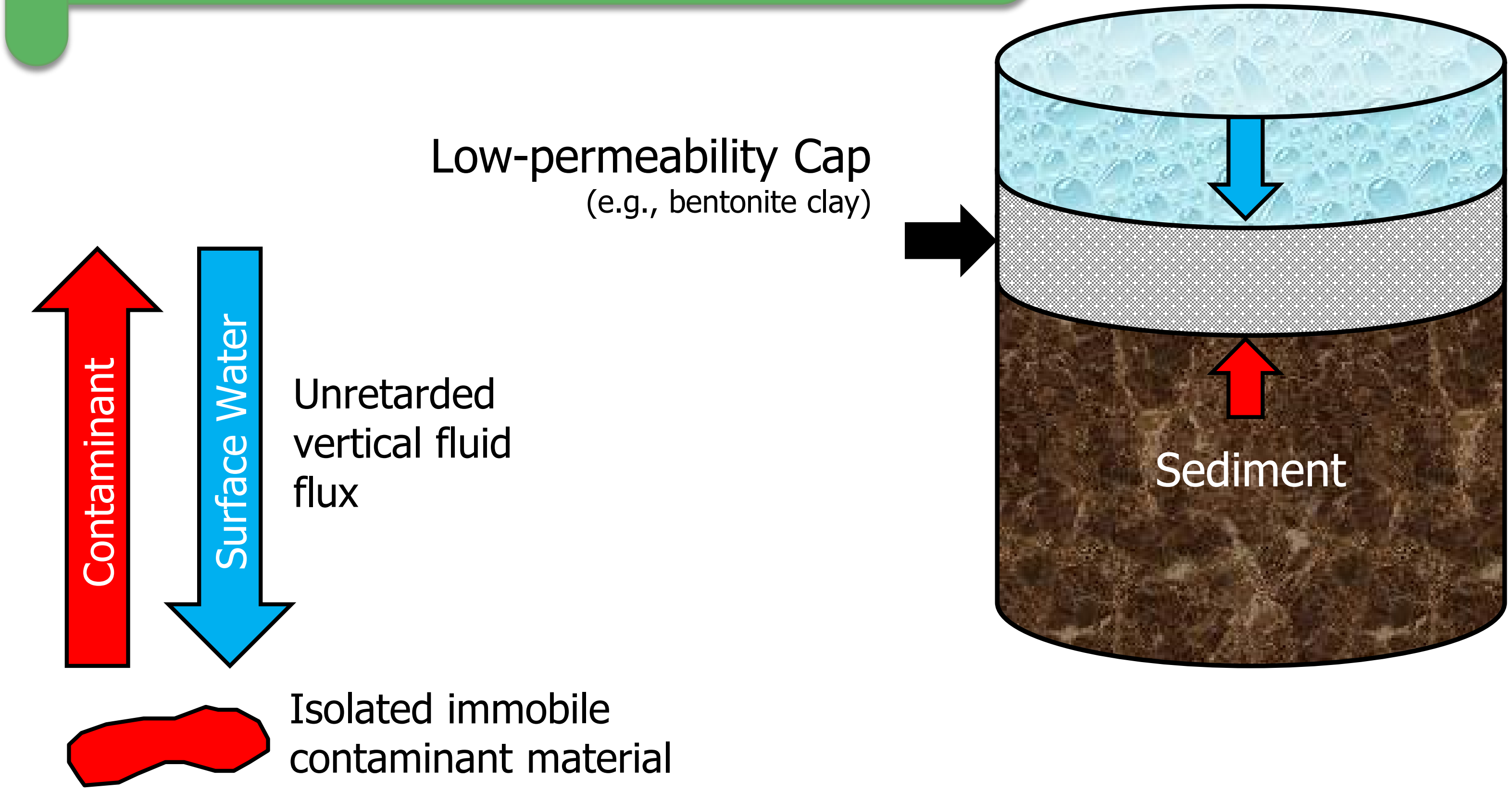
# Unamended Granular Caps



- Physical Separation
- Permeable
- Increased Attenuation Thickness
- Isolates Immobile Material

Source: Jeffrey Hale, Kleinfelder (used with permission)

# Low-permeability Caps



Low-permeability Cap
(e.g., bentonite clay)

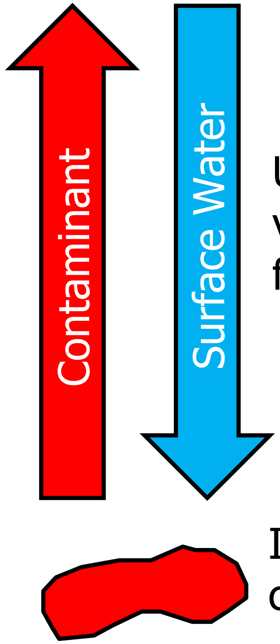
Unretarded vertical fluid flux

Isolated immobile contaminant material

- Physical Separation
- Low-permeability Impedes Fluid Flow & Migration of Contaminants

Source: Jeffrey Hale, Kleinfelder (used with permission)

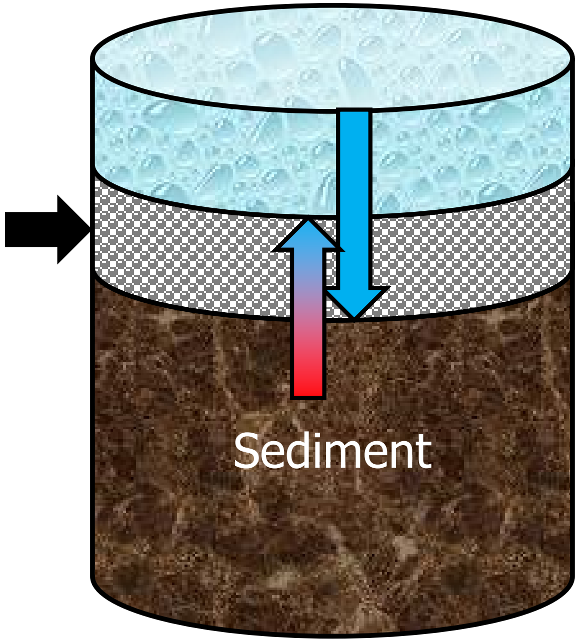
# Amended Caps



Unretarded vertical fluid flux

Isolated immobile contaminant material

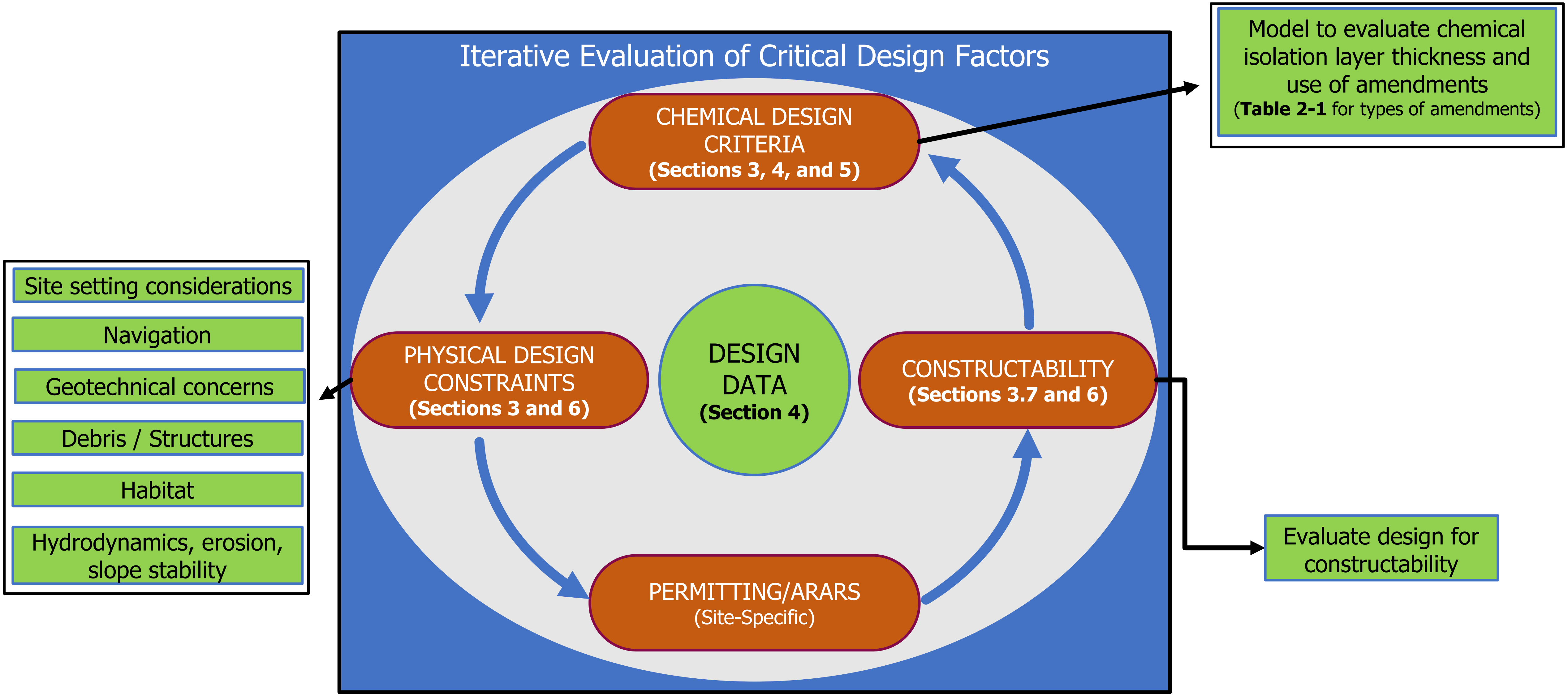
Amended Cap
(e.g., sand and activated carbon)



- Physical Separation
- Permeable – Allows Upward Porewater Migration into Surface Water
- Sorptive or Reactive to Retard COC Migration

Source: Jeffrey Hale, Kleinfelder (used with permission)

# Cap Design Considerations



Iterative Evaluation of Critical Design Factors

CHEMICAL DESIGN CRITERIA
**(Sections 3, 4, and 5)**

PHYSICAL DESIGN CONSTRAINTS
**(Sections 3 and 6)**

DESIGN DATA
**(Section 4)**

CONSTRUCTABILITY
**(Sections 3.7 and 6)**

PERMITTING/ARARS
(Site-Specific)

Model to evaluate chemical isolation layer thickness and use of amendments
(**Table 2-1** for types of amendments)

- Site setting considerations
- Navigation
- Geotechnical concerns
- Debris / Structures
- Habitat
- Hydrodynamics, erosion, slope stability

Evaluate design for constructability

Figure 2-1: Sediment Cap Chemical Isolation Guidance (SD-1), 2023 (Modified)

# Training Roadmap

Introduction (Section 1)

Capping Overview (Section 2)

**Performance Objectives & Design Concepts (Section 3)**

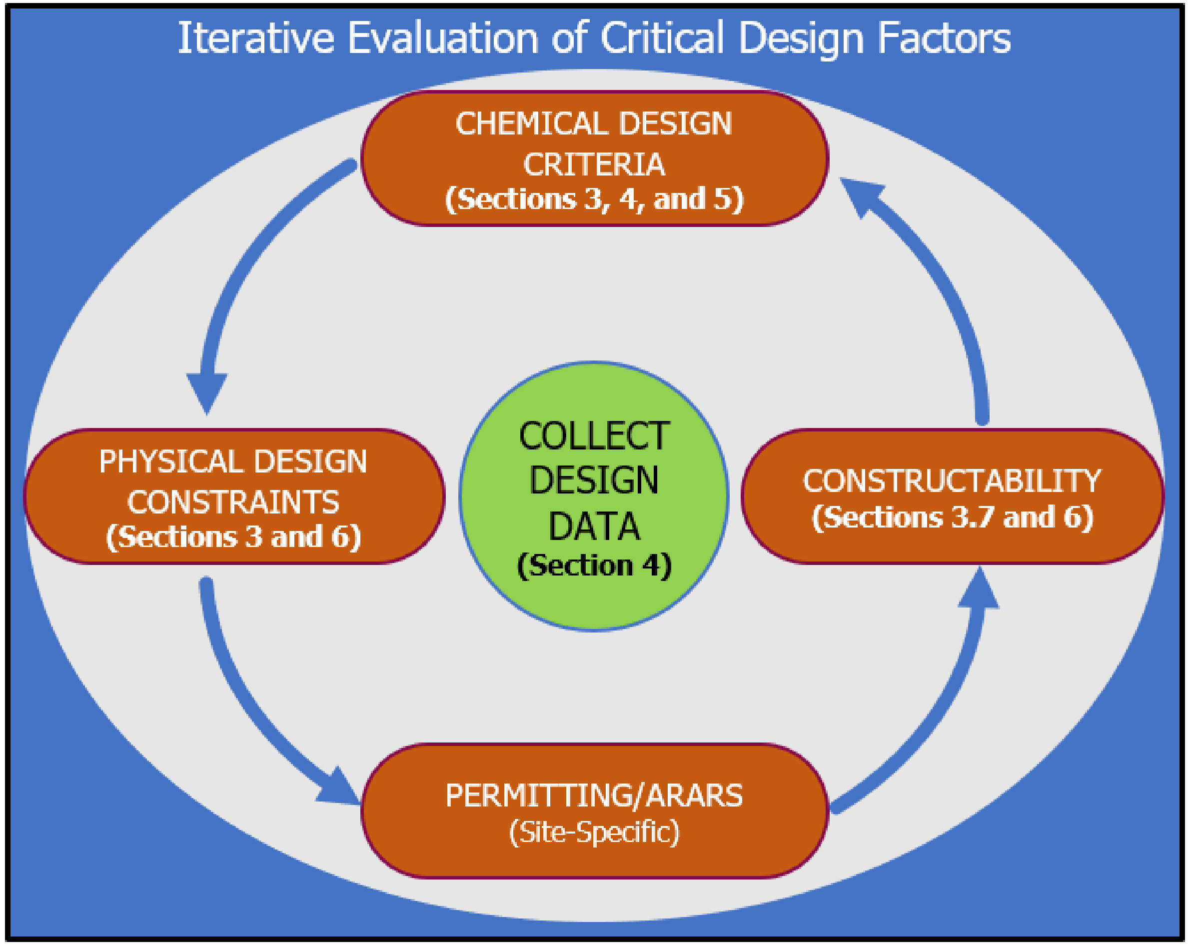
Chemical Isolation Layer Modeling (Section 5)

Q&A Break

Chemical Isolation Construction Considerations (Section 6)

Monitoring & Maintenance Objectives and Approaches (Section 7)

Q&A Break



https://sd-1.itrcweb.org/3-performance-objectives-and-design-concepts/

# Chemical Isolation Performance Targets

Sediment remedy objectives are developed to achieve the Remedial Action Objectives (RAOs) and/or other project-specific risk reduction goals

**Human Health**

Reduce risks to adults and children from:
- incidental ingestion and dermal exposure
- consuming contaminated fish and shellfish

**Ecological Risks**

Reduce environmental toxicity to:
- benthic organisms
- higher trophic organisms

https://sd-1.itrcweb.org/3-performance-objectives-and-design-concepts/#3_1

# Chemical Isolation Design Criteria

Components of chemical isolation performance targets

- Concentrations/fluxes
- Depths that the chemical isolation performance targets apply (Point of Compliance)
- Spatial scales
  - Surface weighted average concentration (SWAC) basis over specified area
  - Point-by-point basis
- Timeframe that the chemical isolation performance targets apply (Design Life)

# Example Chemical Isolation Performance Targets

The porewater concentration of contaminant X shall not exceed 1 ng/L at a depth of 10 cm from the cap surface over 100 years

The flux of pollutant Y shall not exceed 1 µg/ m$^2$/yr at the bottom of the bioturbation zone over 100 years

The SWAC of pollutant Z shall not exceed 1 ng/L over 100 years

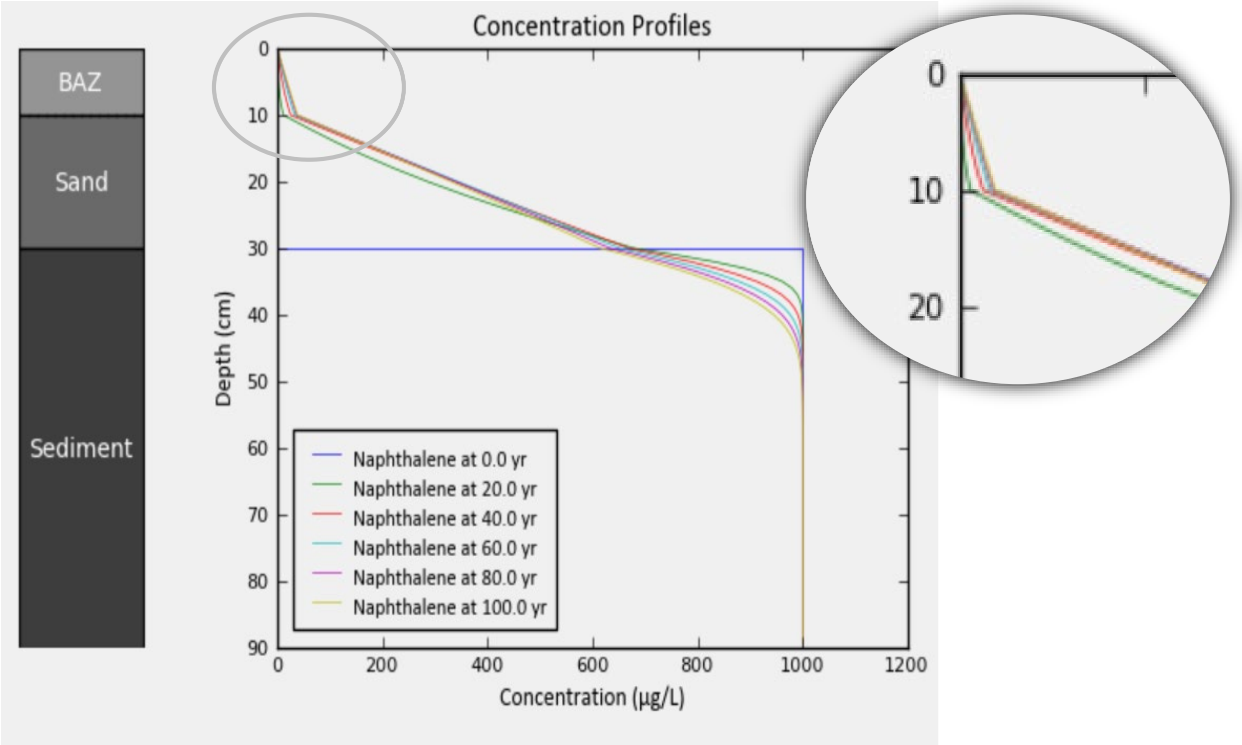
# Discussion Topic

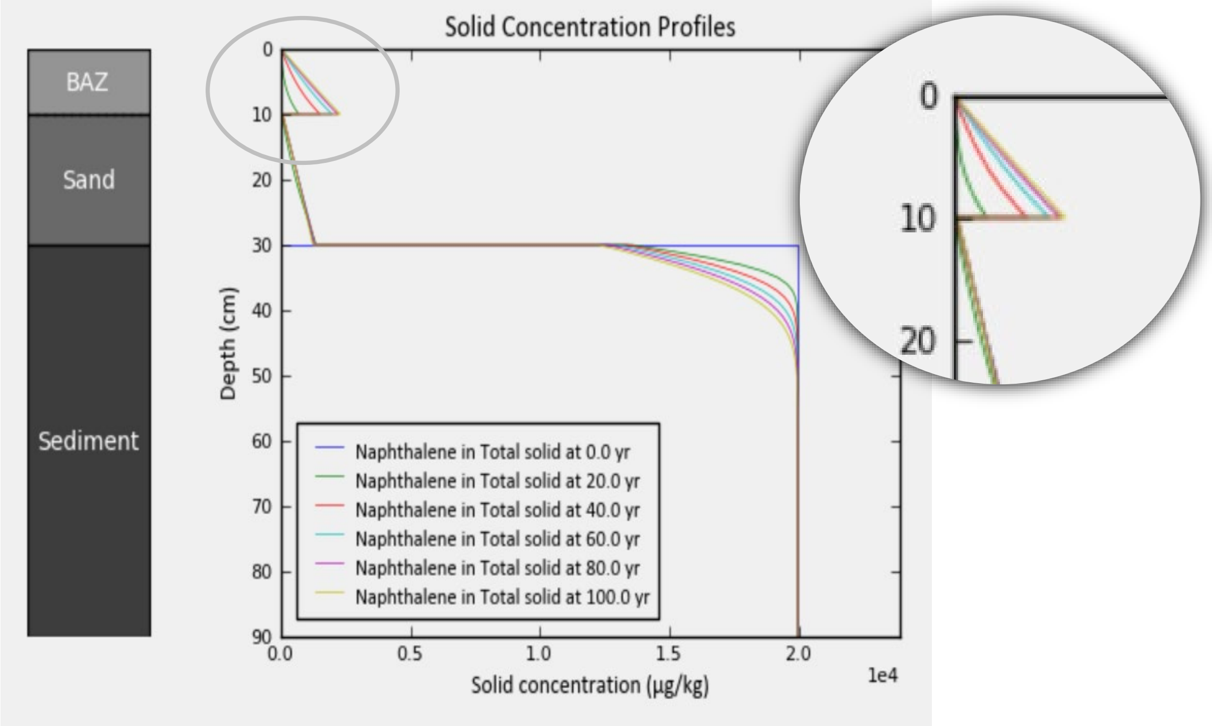
What are potential issues you encountered with establishing your remedial goals?

https://www.shiksha.com/

# Performance Targets

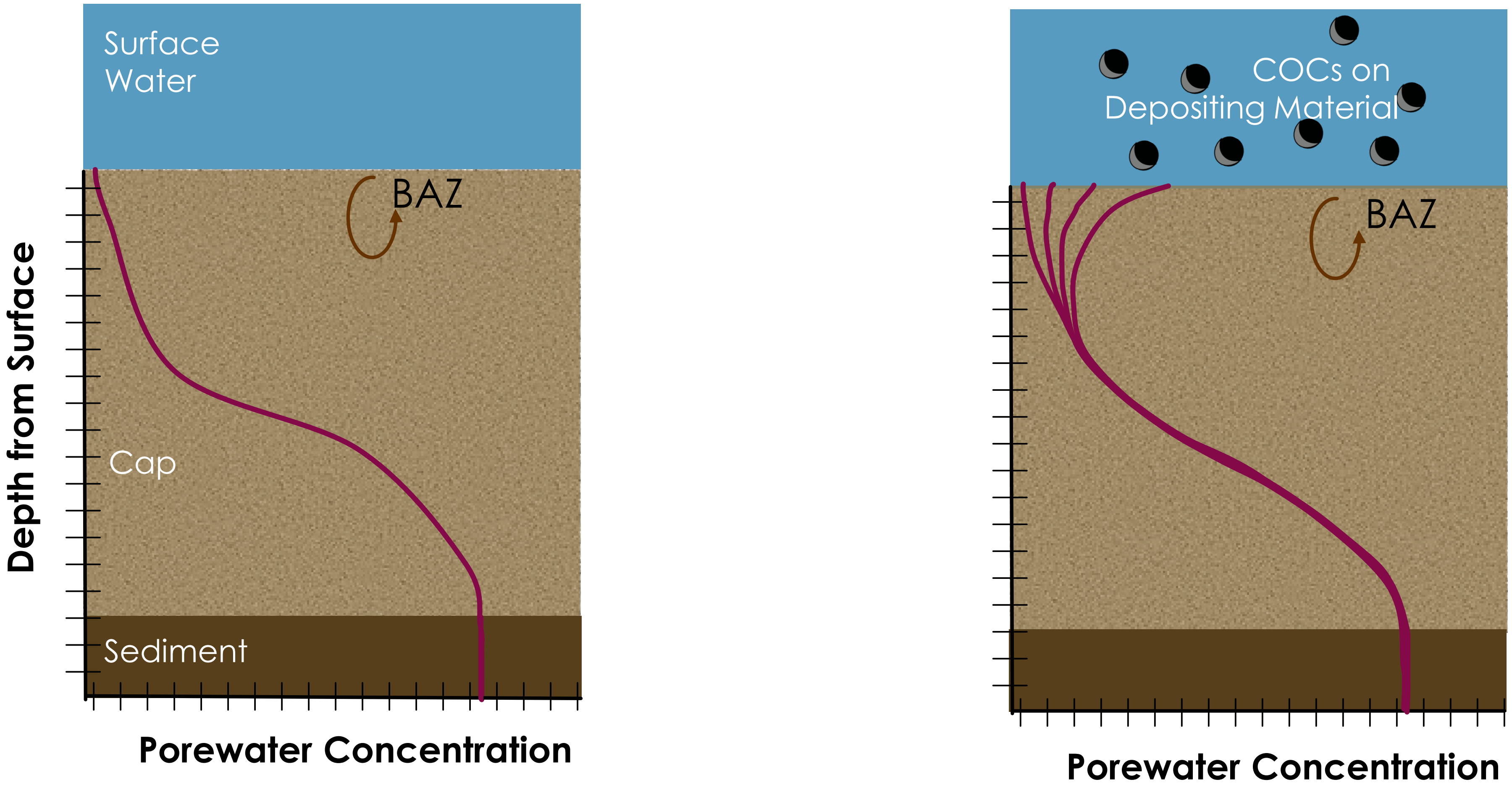
It is helpful to evaluate the performance of the cap (design and monitoring) on a porewater concentration basis





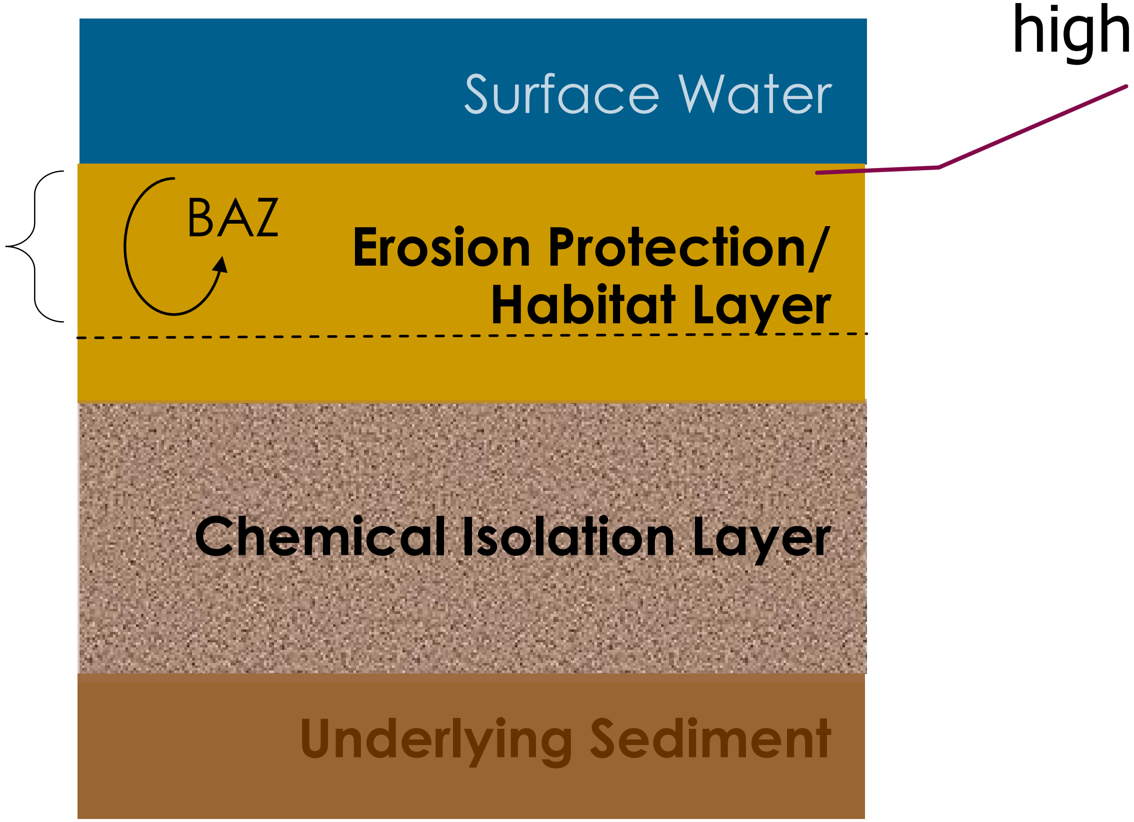
Source: CapSim 4.1 Software (used with permission)

# Importance of Background Conditions



Source: Deirdre Reidy, Anchor QEA (used with permission)

# Point of Compliance Directly Related to RGs

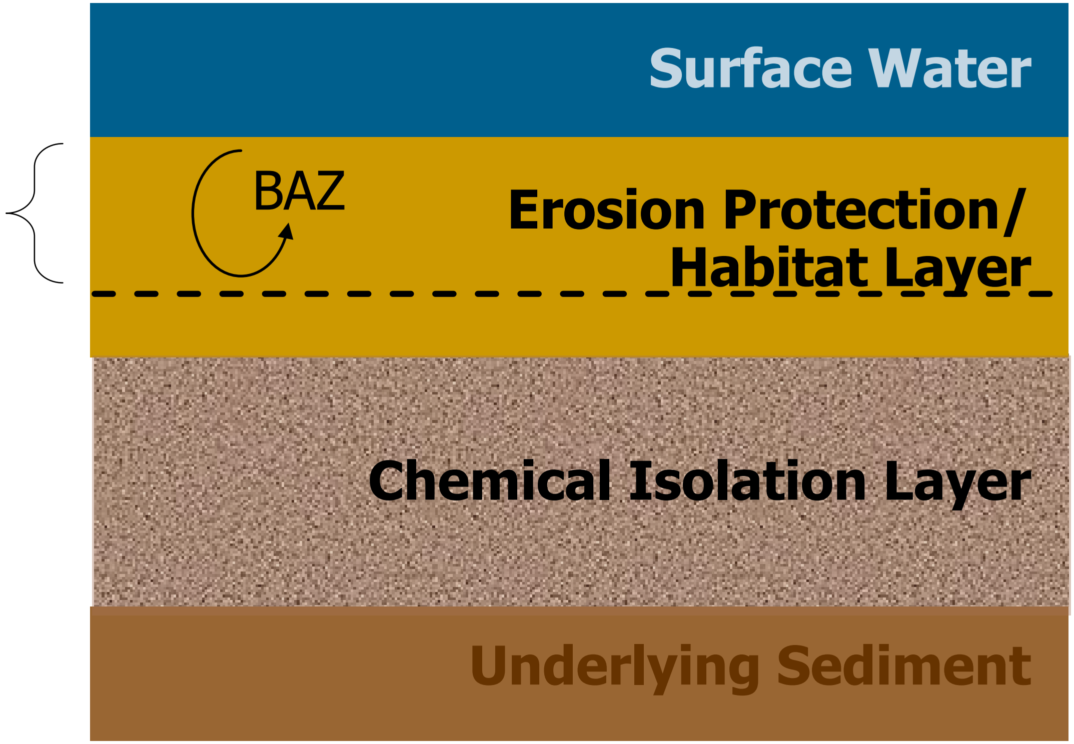


RGs established to be protective of **ambient water quality or fish** at higher trophic levels

RGs established to be protective of **benthic organisms**

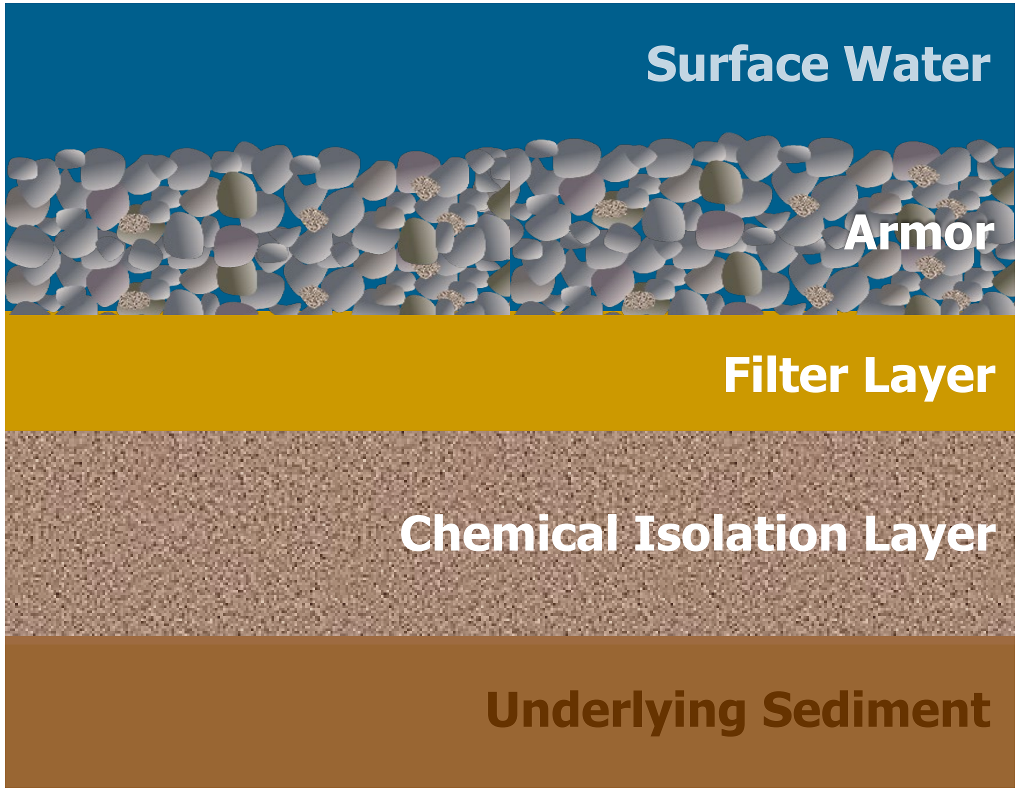
Source: Modified from Arcadis U.S., Inc. (used with permission)

# Design Evaluation Depth



Source: Modified from Arcadis U.S., Inc. (used with permission)

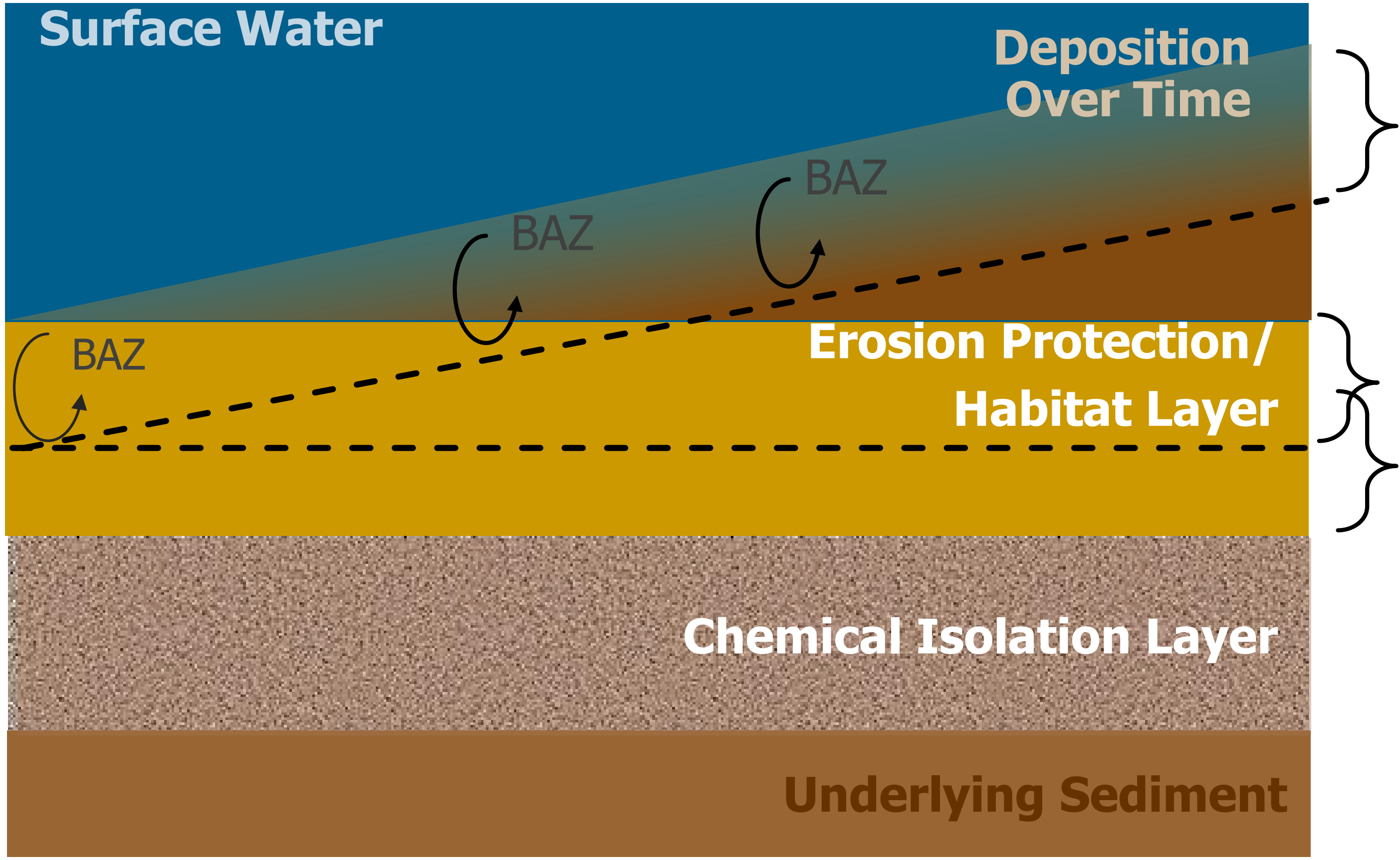
# Design Evaluation Depth – Large Armor Stone Scenario



**More appropriate to evaluate cap effectiveness below the armor stone**

Source: Modified from Arcadis U.S., Inc. (used with permission)

# Design Evaluation Depth – Deposition Scenario

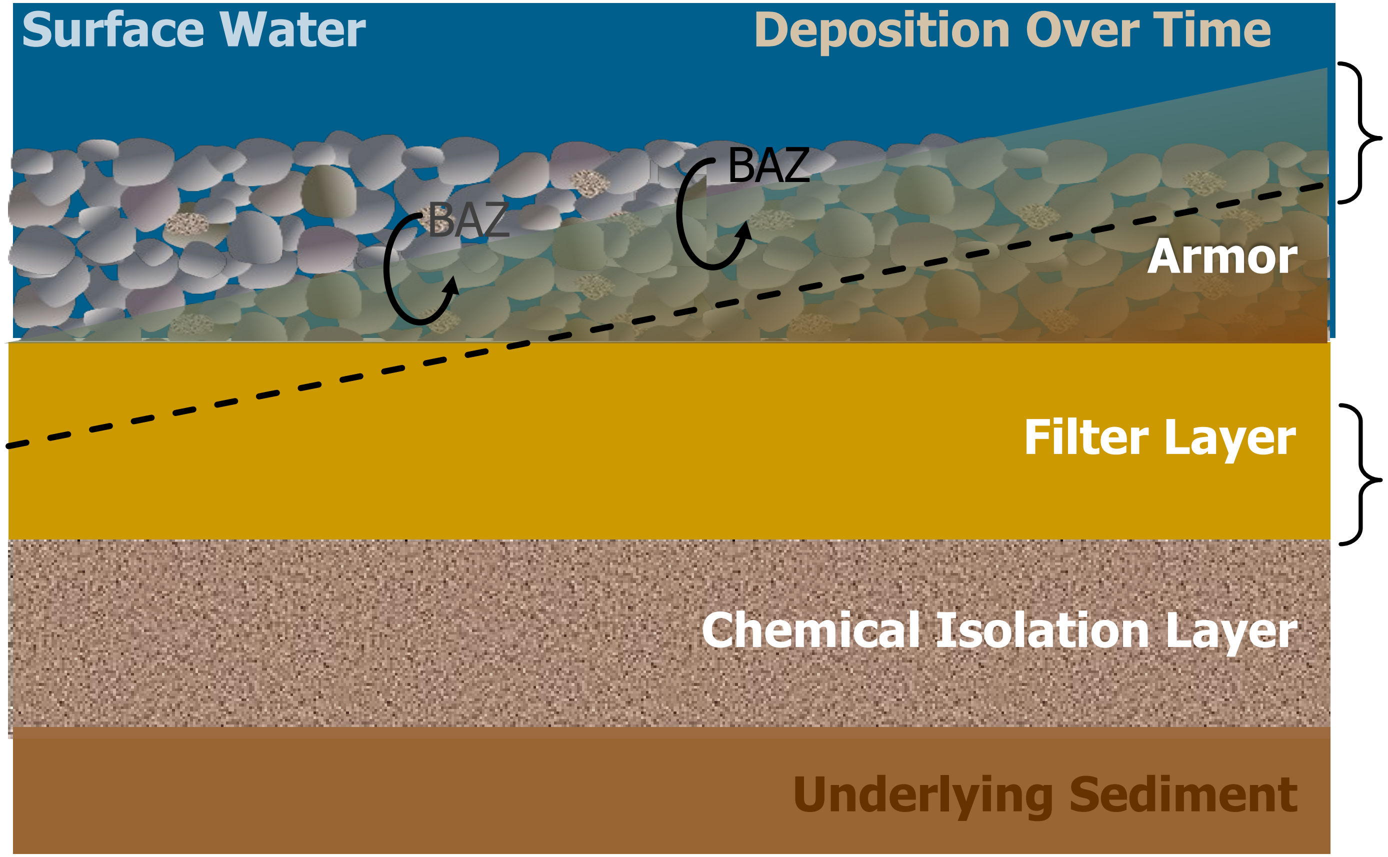


Point of Compliance/
Design Evaluation Depth A
**Considers additional attenuation provided by deposition**

Point of Compliance/
Design Evaluation Depth
Design
Evaluation Depth B
**Avoids influence of depositing material**

Source: Modified from Arcadis U.S., Inc. (used with permission)

# Design Evaluation Depth – Large Armor Stone Scenario & Deposition



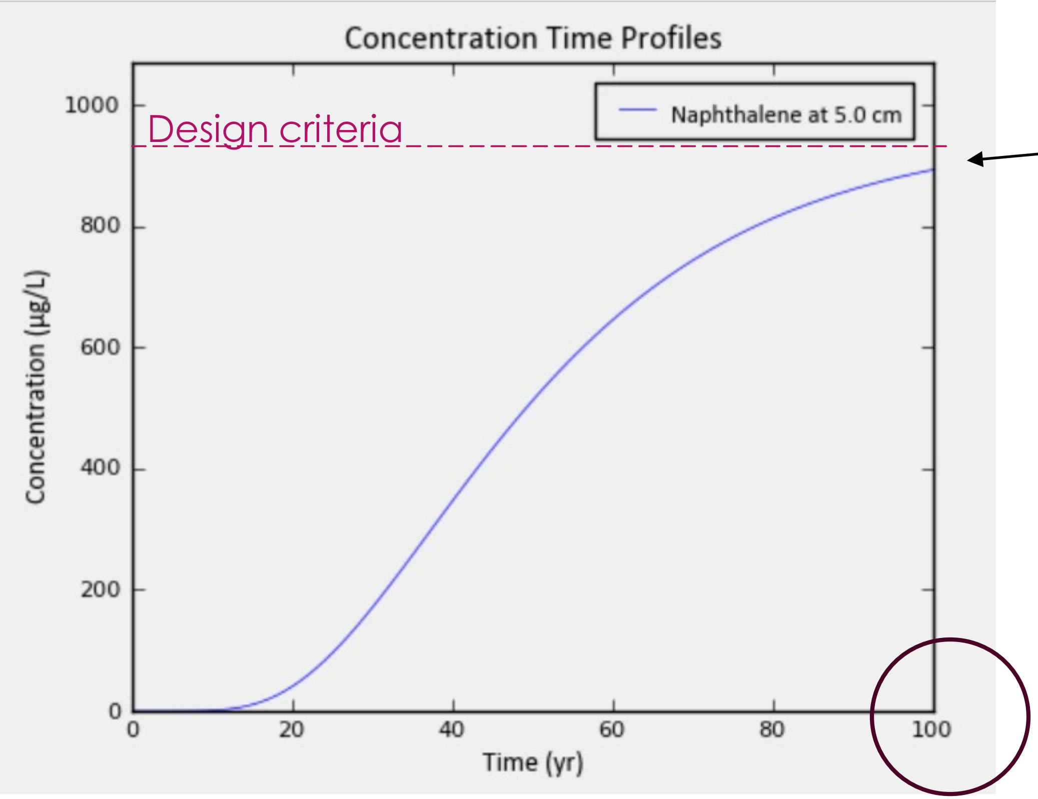
Point of Compliance/
Design Evaluation Depth (A)
**Considers additional attenuation provided by infilling deposition**

Design
Evaluation Depth (B)
**Avoids influence of depositing material**

Source: Modified from Arcadis U.S., Inc. (used with permission)

# Design Life

The minimum period over which the cap is designed to meet the design criteria



Note, **performance life** of cap expected to be longer due to conservativism in the design process

Typical design life = 100 years

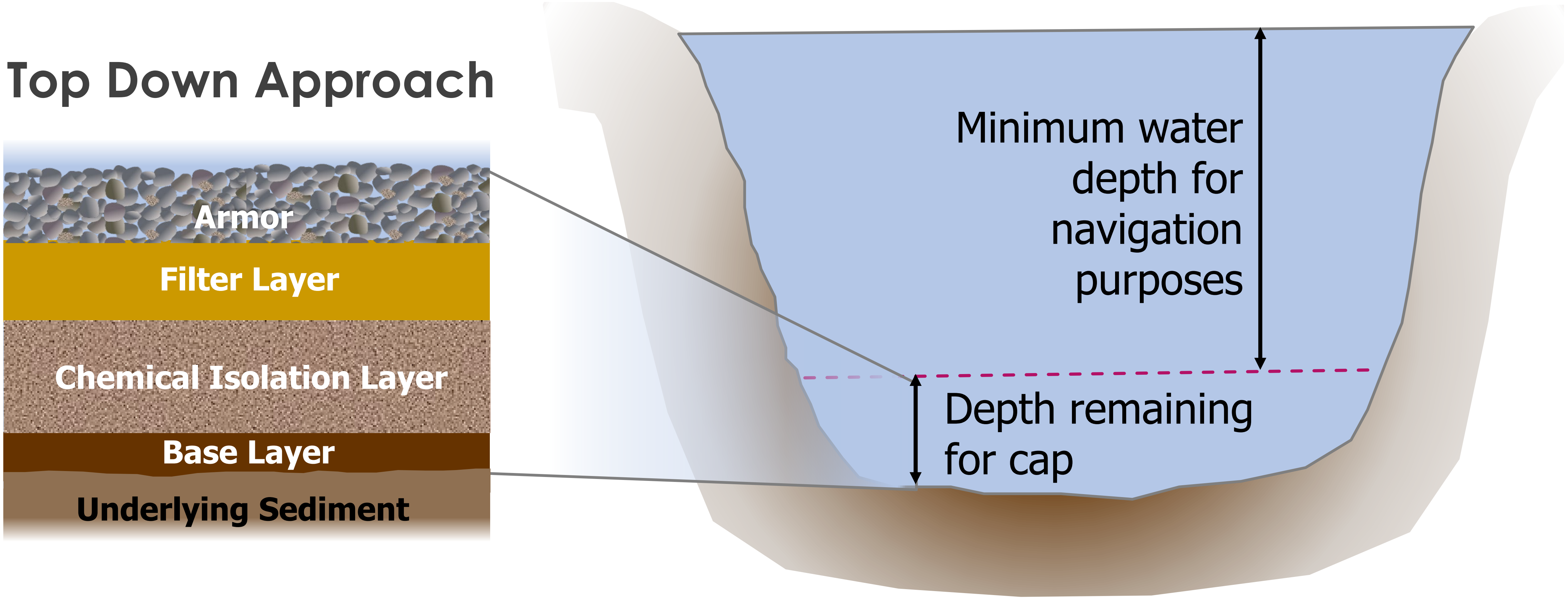
Source: CapSim 4.1 Software (used with permission)

# Cap Design – Conservativism

- Design criteria (e.g., conservativism built into risk assessments)
- Input parameter values used in model evaluations
  - Inputs with the largest influence on model results:
    - Groundwater seepage rates
    - Contaminant concentrations in porewater
    - Partitioning characteristics
    - Deposition rates
- Material specifications during design
  - E.g., minimum thickness and amendment dose to meet criteria
- Material placement during construction
  - E.g., the contractor material placement quantities may exceed the design specifications

# Constraints on Chemical Isolation Layer Thickness

## Top Down Approach



Source: Deirdre Reidy, Anchor QEA (used with permission)

# Cap Amendments

- Cap amendments are often required to meet performance targets
- Amendment types depend on the CoCs
    - A combination of amendments may be needed
    - Can be added as discrete layers, mixed with other cap materials, or direct addition to sediment
- Data collection is recommended to support modeling for cap design
- Benthic community impacts should be considered

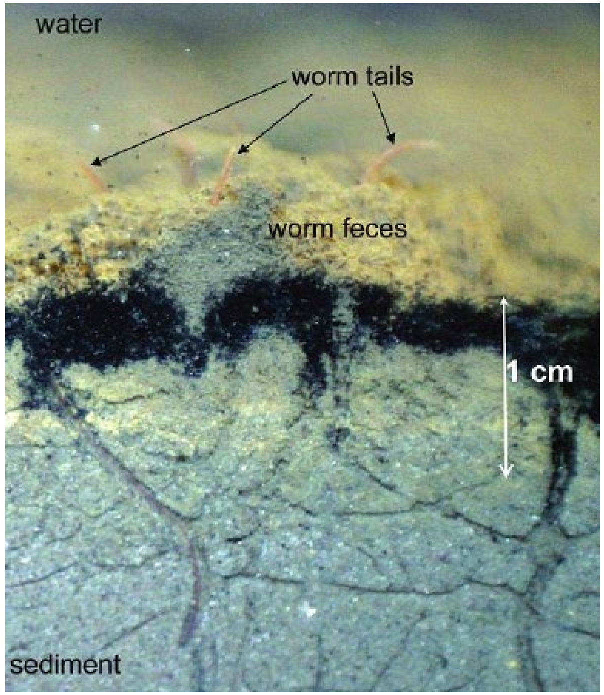
# Site Characteristics for Chemical Isolation Design

## Understand spatial differences in site characteristics that affect CIL design

- Chemical concentrations and contaminant distribution
  - Includes geochemistry, which may be important for some contaminants of concern
- Presence of NAPL
- Seepage rates
- Deposition/erosion potential

## Benthic community structure and bioturbation

- Bioturbation depths of 5-10 cm are common, but site-specific data may be needed from benthic surveys to inform models
- May inform point of compliance



Sun and Ghosh 2007

# Performance Objectives & Design Concepts – Wrap Up

Understanding what we are designing the cap to protect

- Defining design criteria – the “what”, “where” and “how long”

Design constraints

- e.g., surface elevation requirements

Site characteristics for chemical isolation design

# Training Roadmap

Introduction (Section 1)

Capping Overview (Section 2)

Performance Objectives & Design Concepts (Section 3)

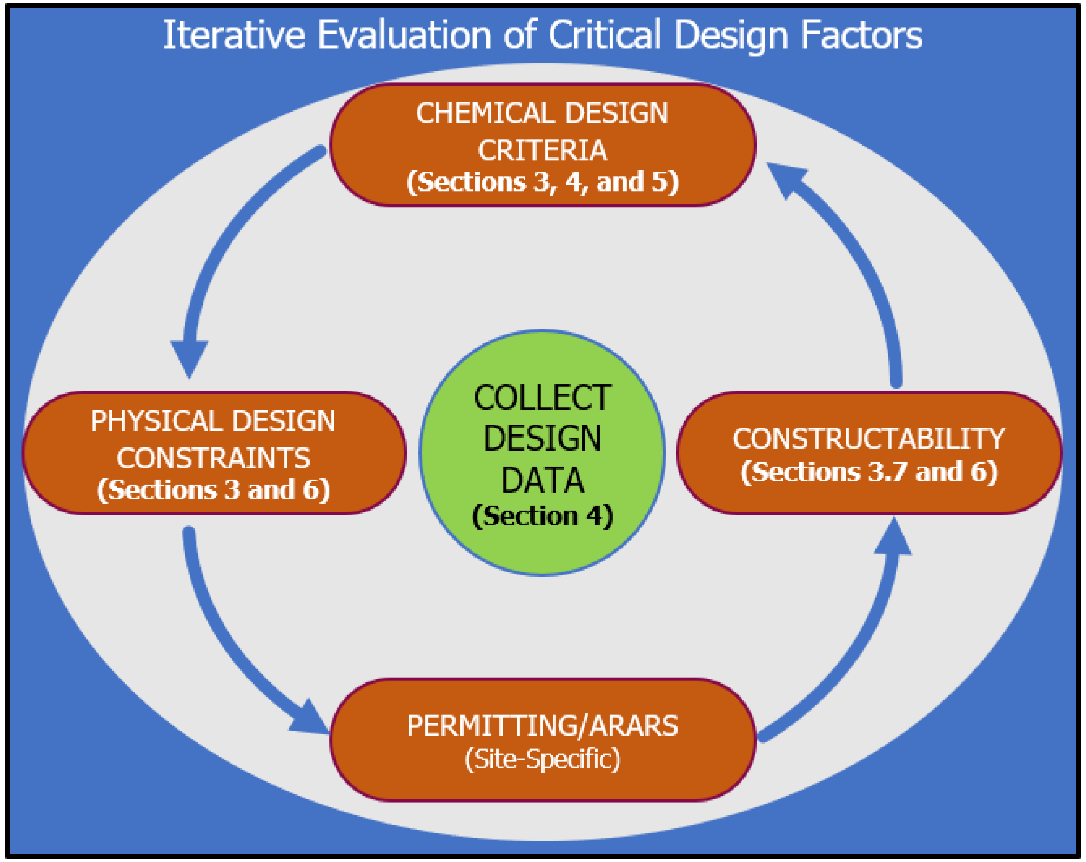
**Chemical Isolation Layer Modeling (Section 5)**

Q&A Break

Chemical Isolation Construction Considerations (Section 6)

Monitoring & Maintenance Objectives and Approaches (Section 7)

Q&A Break


Iterative Evaluation of Critical Design Factors

CHEMICAL DESIGN CRITERIA
**(Sections 3, 4, and 5)**

PHYSICAL DESIGN CONSTRAINTS
**(Sections 3 and 6)**

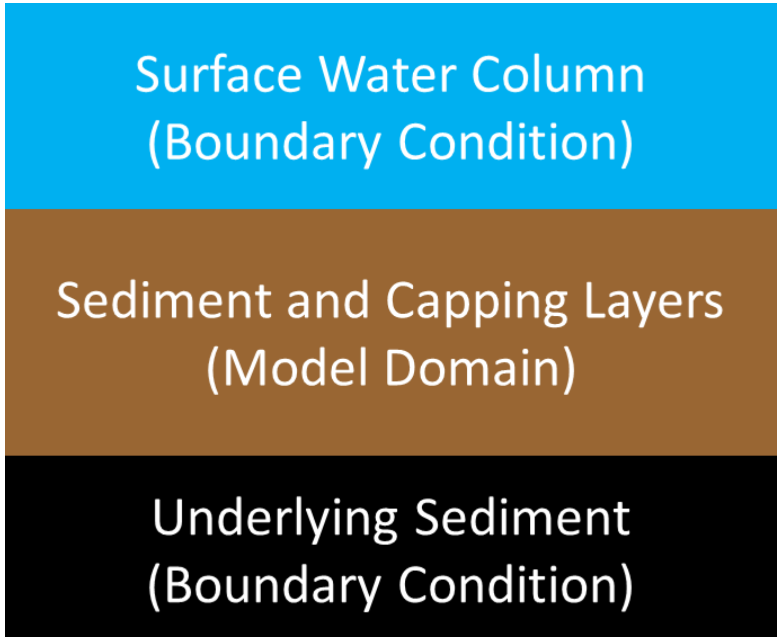
COLLECT DESIGN DATA
**(Section 4)**

CONSTRUCTABILITY
**(Sections 3.7 and 6)**

PERMITTING/ARARS
(Site-Specific)

# Chemical Isolation Layer Modeling

- Purpose of Modeling
- Why a cap model?
- What models are available?
- What are important parameters?
- Sensitivity and Uncertainty



Surface Water Column
(Boundary Condition)

Sediment and Capping Layers
(Model Domain)

Underlying Sediment
(Boundary Condition)

# Purpose of Cap Modeling

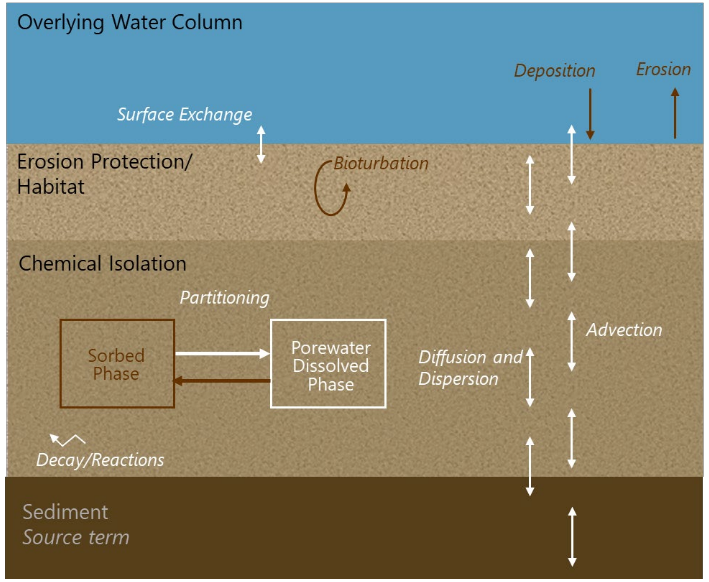
Predict performance of a cap into the future for purposes of evaluating designs

- How thick of a CIL?
- Composition of the CIL?
- Sensitivity to key model uncertainties?
- Compare to monitoring data after construction?

Source: Danny Reible, Anacostia demonstration project (used with permission)

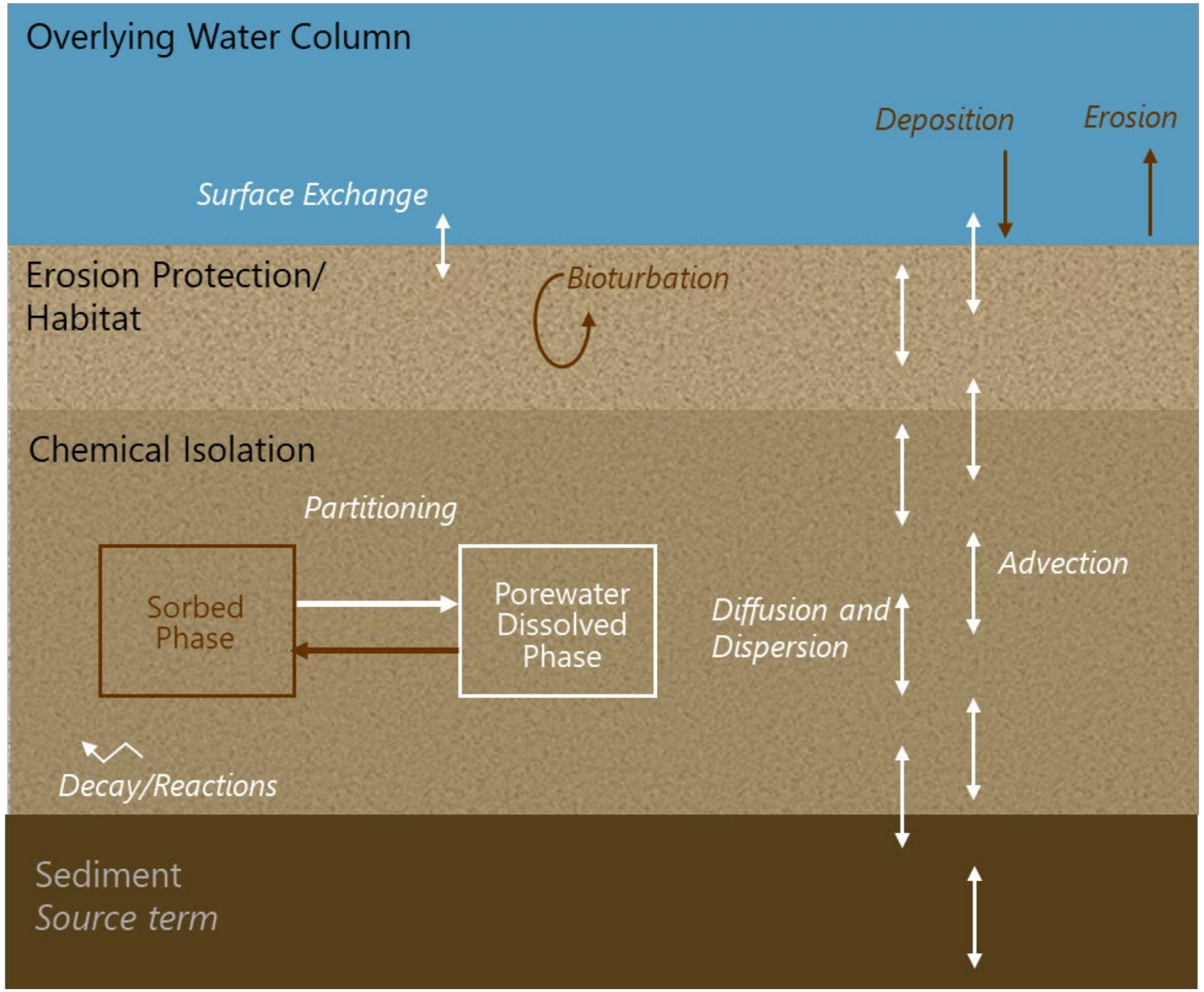
# Why Cap Models?

- Surface water quality and hydrodynamic models describe water column processes and interactions with the sediment boundary
- Groundwater models describe processes in adjacent aquifers
- Neither address the unique processes that occur in the upper 10-100 cm of the sediment



# What Are Those Processes in Surficial Sediments?

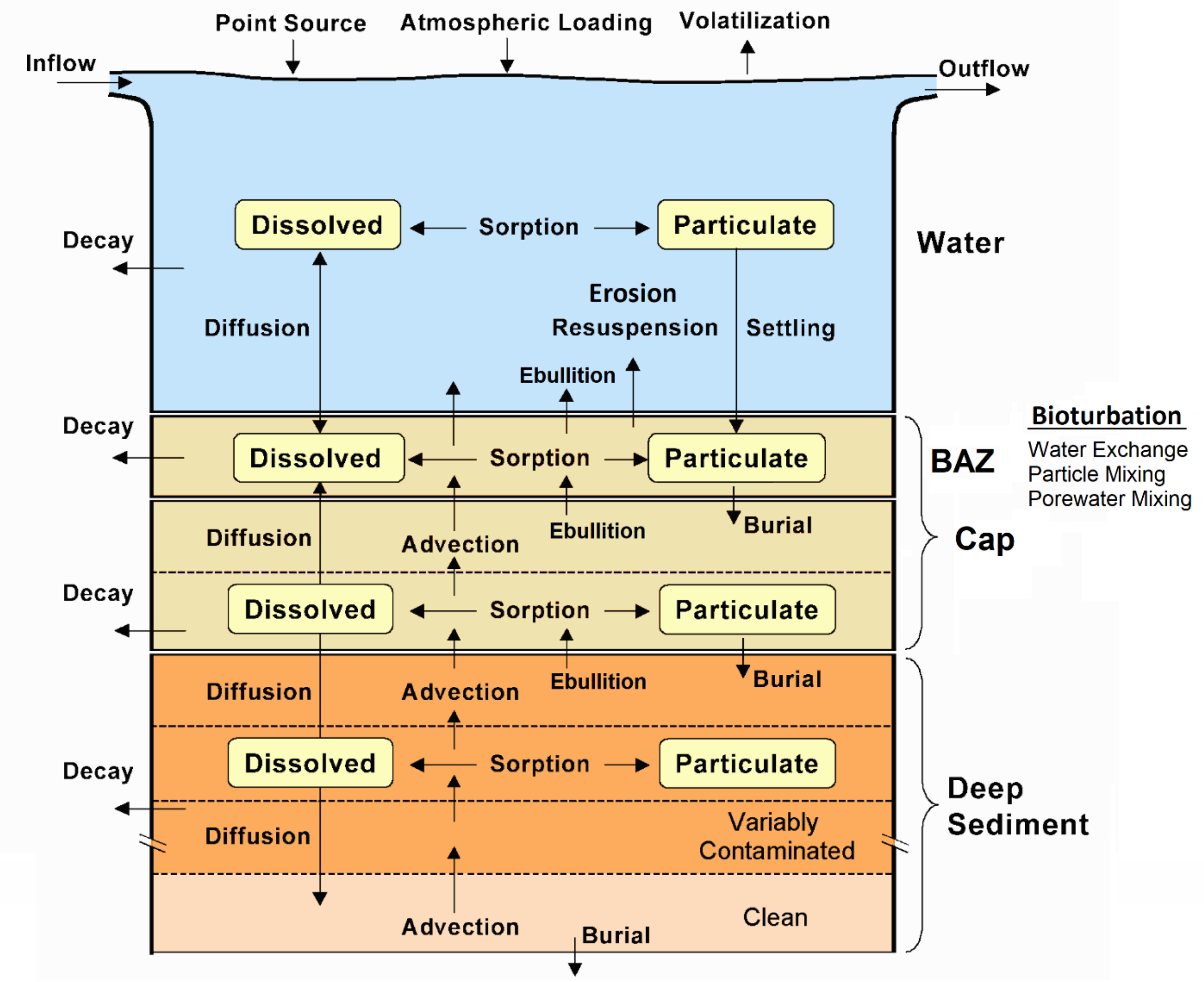
- Erosion protection to ensure cap stability
- Mobile contaminants in porewater
- Redox changes with depth
- Bioturbation by near surface benthic organisms
- Benthic boundary layer
- Hyporheic exchange



# What Tools Are Available – Recovery (USACE ERDC ERDC/EL SR-D-00-1)

- Models a mixed sediment layer and deeper sediment layers
- Dissolved & particulate contaminants

  Migration, Resuspension, Burial
- Simple overlying water conditions



Source: Modified from Ruiz et al., 2007 (used with permission)

# What Tools Are Available – CapSim (Texas Tech University)

Model sediment as layers of different depths and conditions

Graphical User Interface

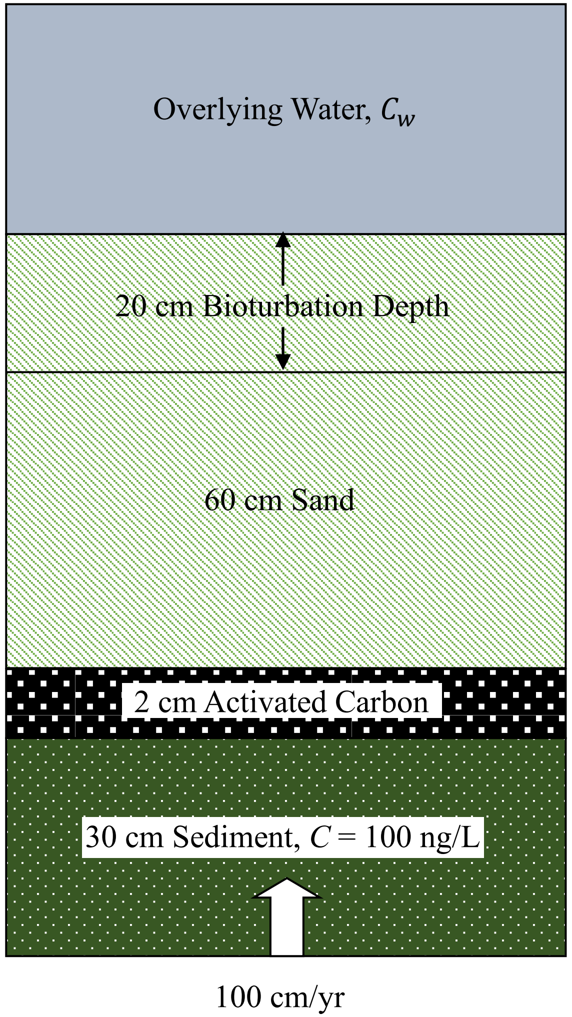
Explicitly models bioturbation, hyporheic exchange

Capable of modelling sorption kinetics or equilibrium

Capable of modeling multiple reactions (contaminant as well as biogeochemical conditions)

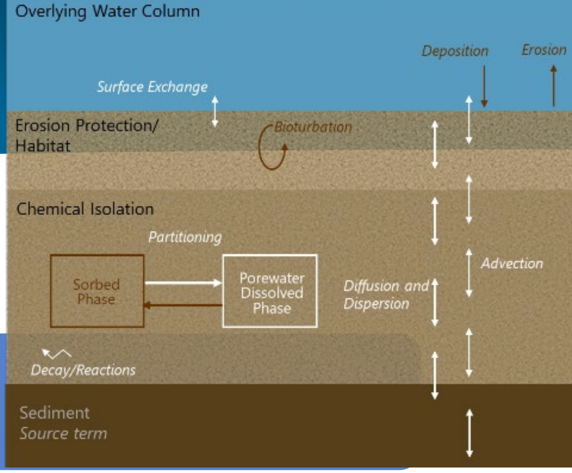
Commercial cap materials available

Tools for estimating a variety of model parameters



www.depts.ttu.edu/ceweb/research/reiblesgroup/capsim.php

# Key Model Inputs That **ARE** Important



## Contaminant of Concern (CoC) & concentration

- Chosen by significance, importance to design, spatial distribution and mobility
- Porewater concentration modelled, but input could be sediment concentration

## Sorption coefficients of CoC in CIL

## Groundwater seepage rates

## Sediment deposition rates

## Depth within cap for evaluating design (may be point of compliance)

https://sd-1.itrcweb.org/

Source: Modified from Anchor QEA (2019) (used with permission)

# Model Inputs That **MAY BE** Important

## Intensity of sediment-water exchange

➓Especially if design evaluation depth near sediment - water interface

## Kinetics of sorption onto strongly sorbing phases

➓e.g., granular activated carbon

## Reactivity of non-conservative contaminants

➓Often assumed negligible due to slow rate and uncertainty but likely important over cap design life

# Interpreting Model Results

**REMINDER: Capping is an areal remedy!**

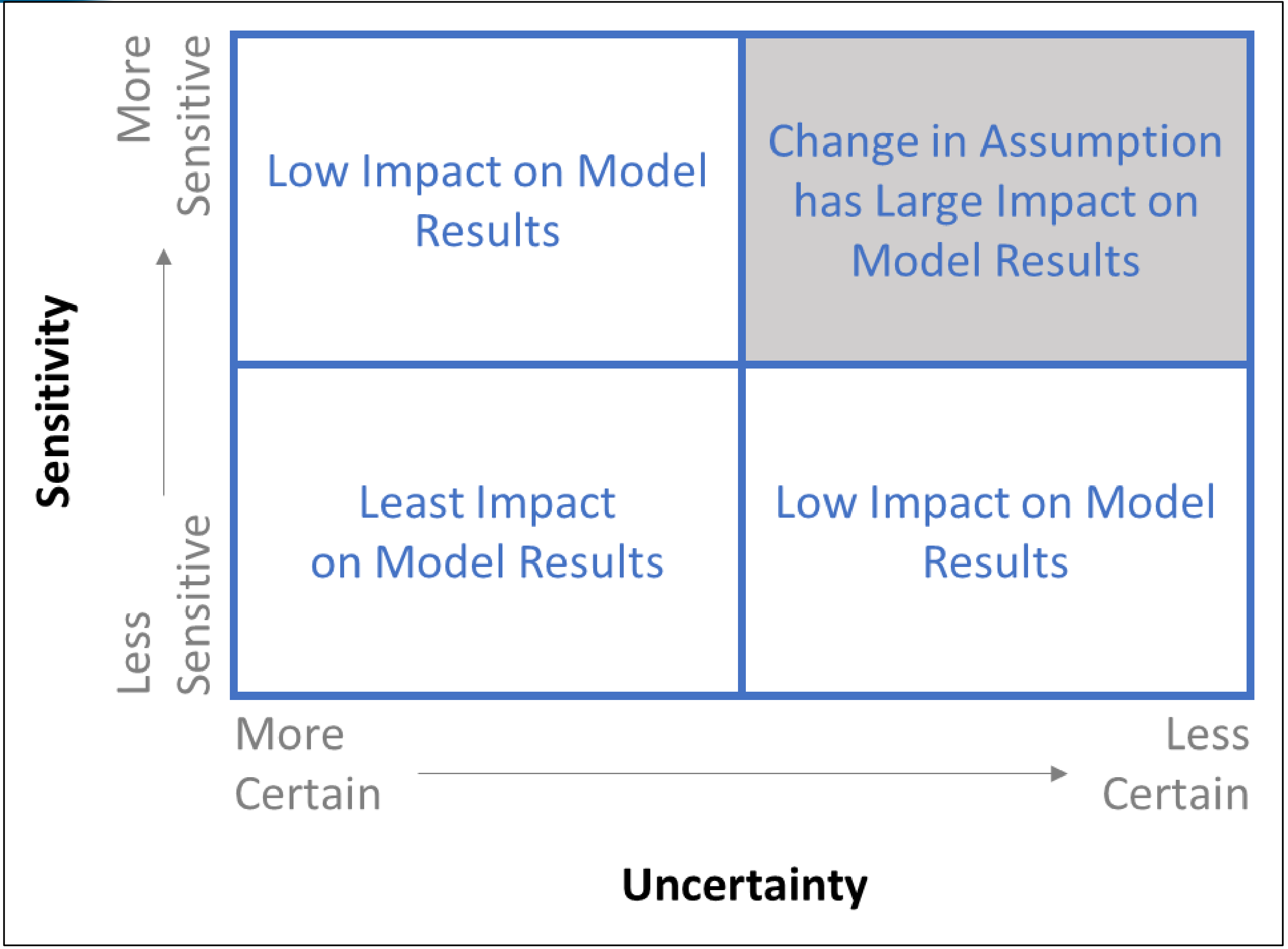
Be careful of interpreting concentrations at cap-water interface

Concentrations at cap-water interface generally controlled by water column dynamics, not CIL

Flux at cap-water interface is controlled by cap design and is useful

# Model Uncertainty and Sensitivity

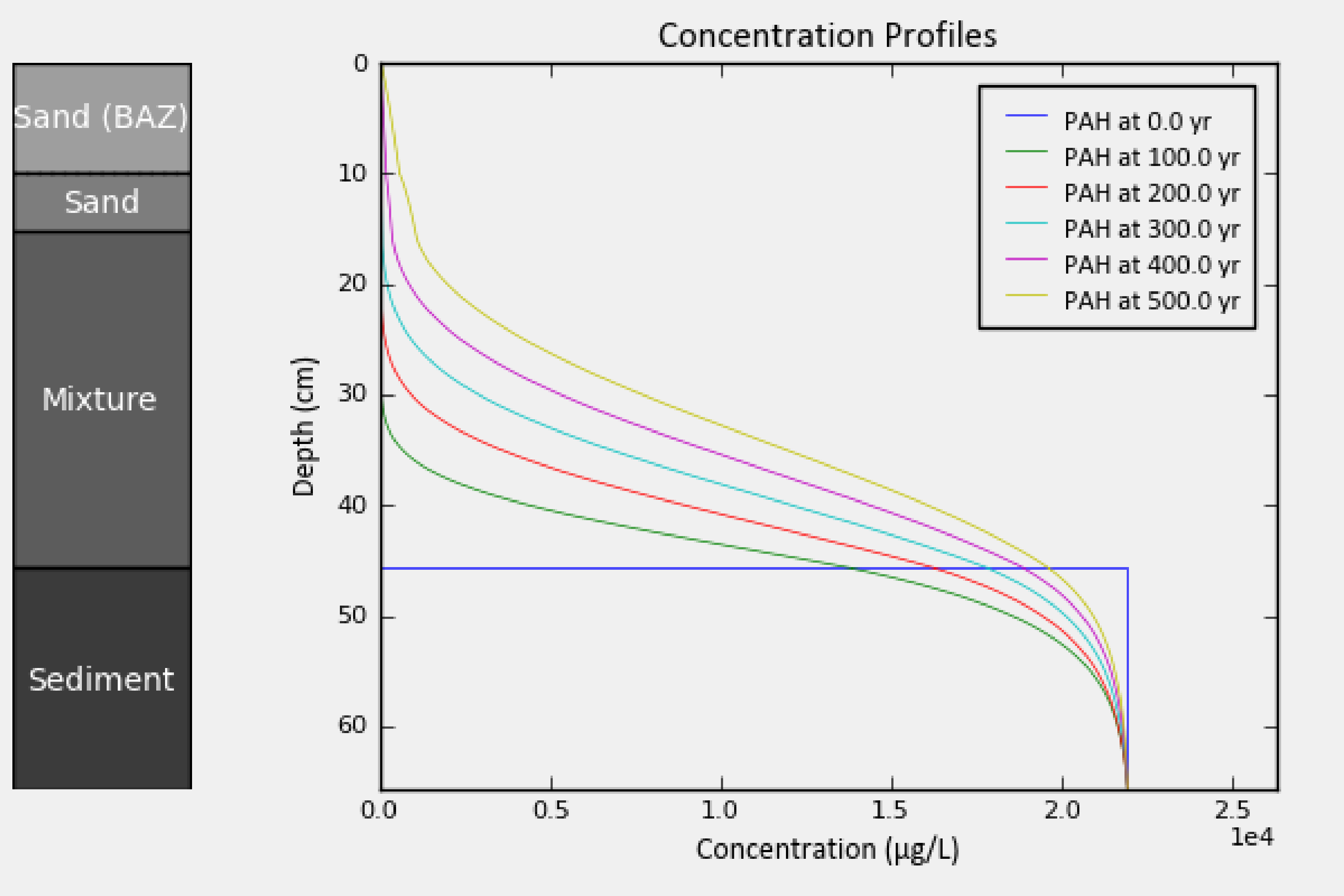
Focus on issues that are uncertain & affect the results



| Sensitivity \ Uncertainty | More Certain | Less Certain |
|---|---|---|
| More Sensitive | Low Impact on Model Results | Change in Assumption has Large Impact on Model Results |
| Less Sensitive | Least Impact on Model Results | Low Impact on Model Results |

Source: Deirdre Reidy, Anchor QEA (used with permission)

# Model Output



Source: CapSim 4.1 Software (used with permission)

# Questions

# Training Roadmap

Introduction (Section 1)

Capping Overview (Section 2)

Performance Objectives & Design Concepts (Section 3)

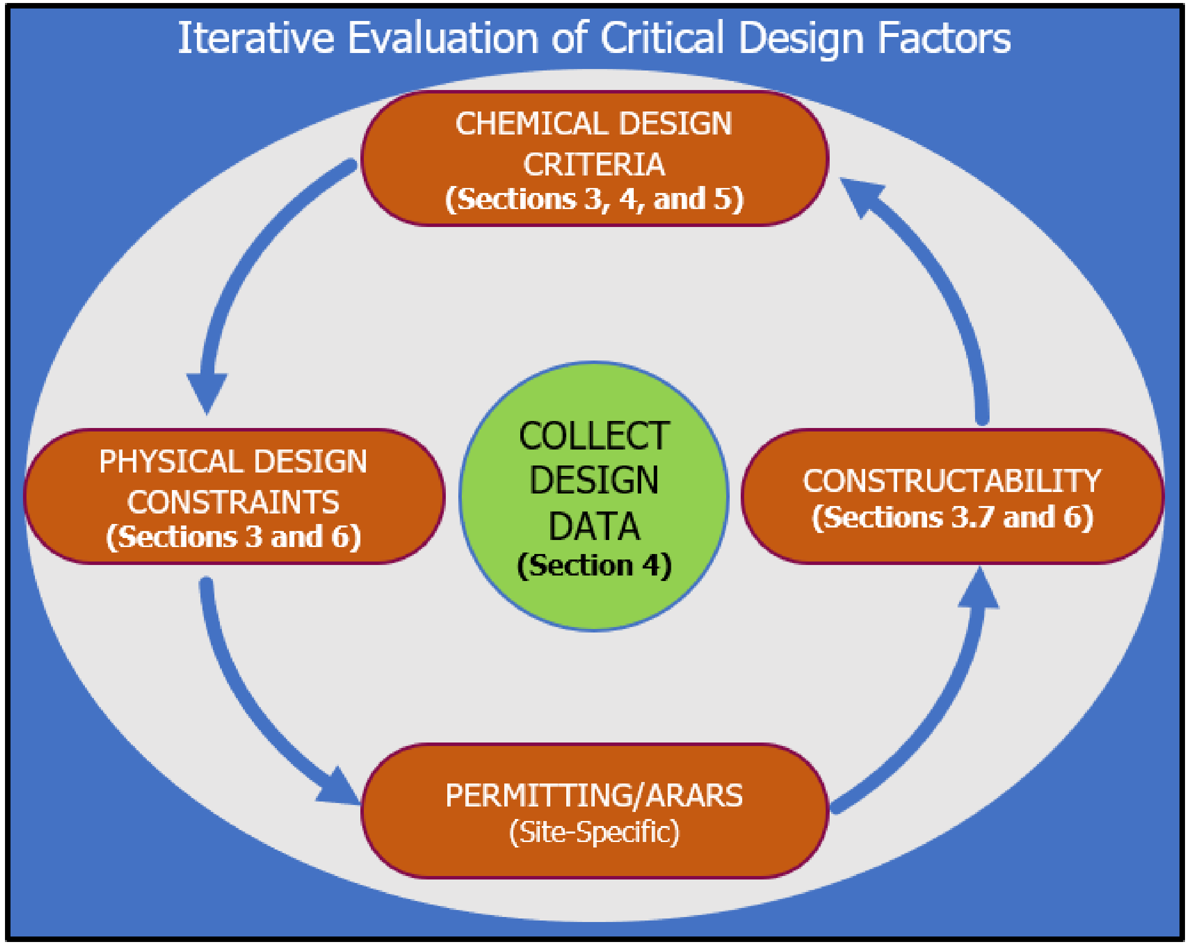
Chemical Isolation Layer Modeling (Section 5)

Q&A Break

**Chemical Isolation Construction Considerations (Section 6)**

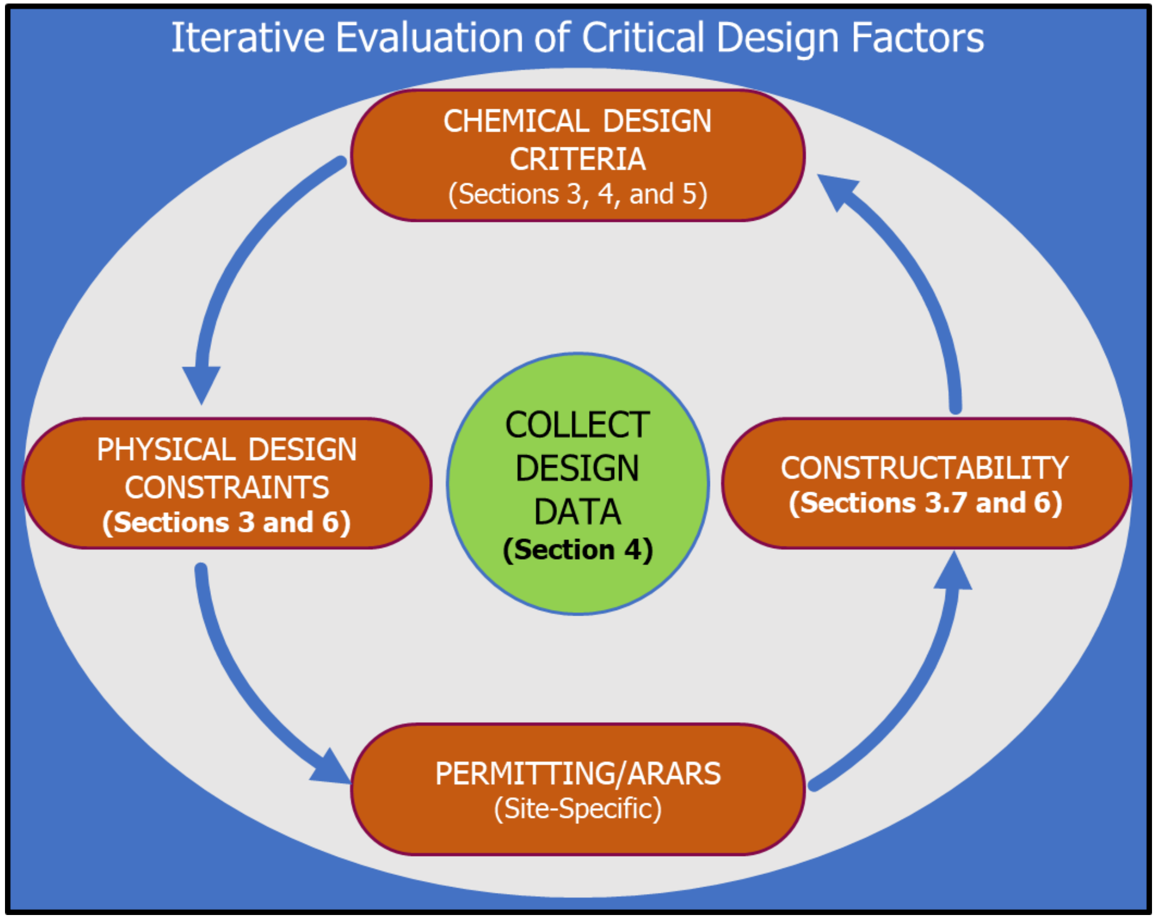
Monitoring & Maintenance Objectives and Approaches (Section 7)

Q&A Break



https://sd-1.itrcweb.org/6-chemical-isolation-construction-considerations/

# Construction Considerations – Overview


Iterative Evaluation of Critical Design Factors

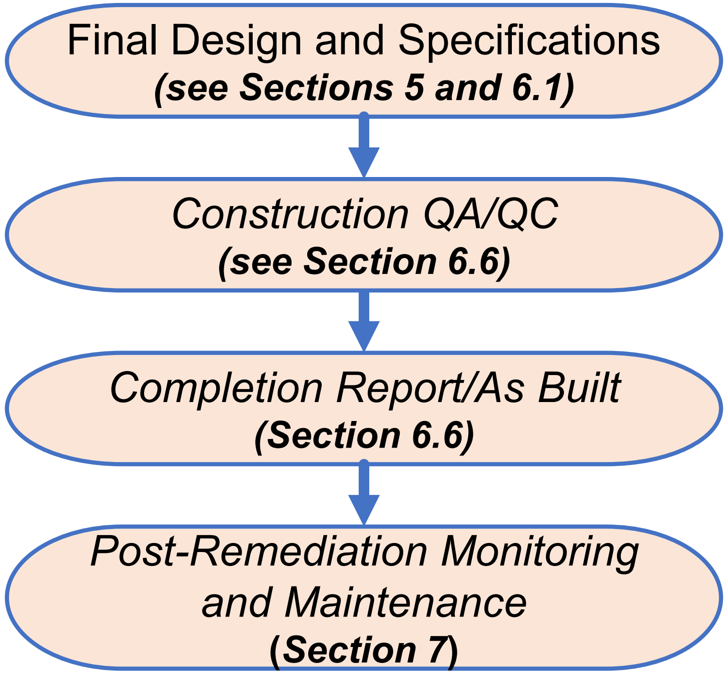
CHEMICAL DESIGN CRITERIA
(Sections 3, 4, and 5)

PHYSICAL DESIGN CONSTRAINTS
**(Sections 3 and 6)**

COLLECT DESIGN DATA
**(Section 4)**

CONSTRUCTABILITY
**(Sections 3.7 and 6)**

PERMITTING/ARARS
(Site-Specific)


Final Design and Specifications
***(see Sections 5 and 6.1)***

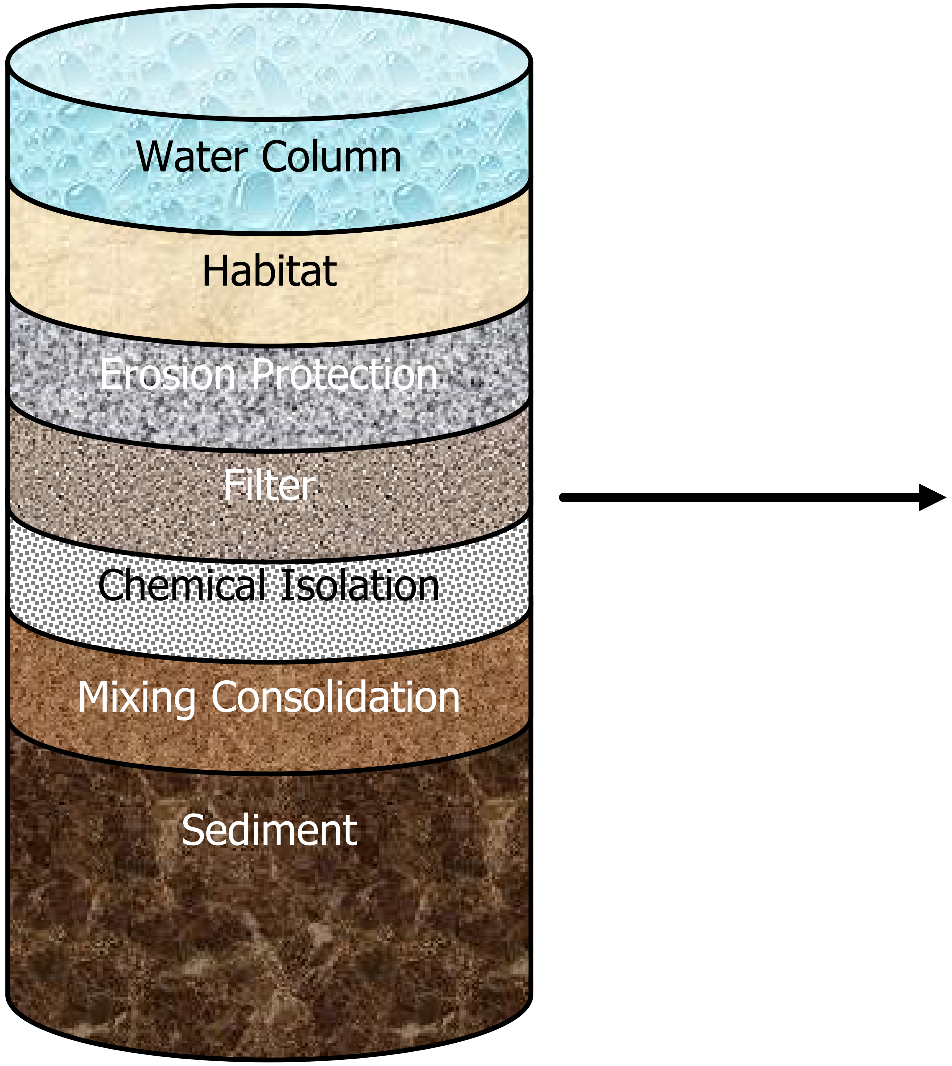
*Construction QA/QC*
***(see Section 6.6)***

*Completion Report/As Built*
***(Section 6.6)***

*Post-Remediation Monitoring and Maintenance*
***(Section 7)***

Source: Modified from Figure 2-1 of Guidance Document

# Construction Considerations

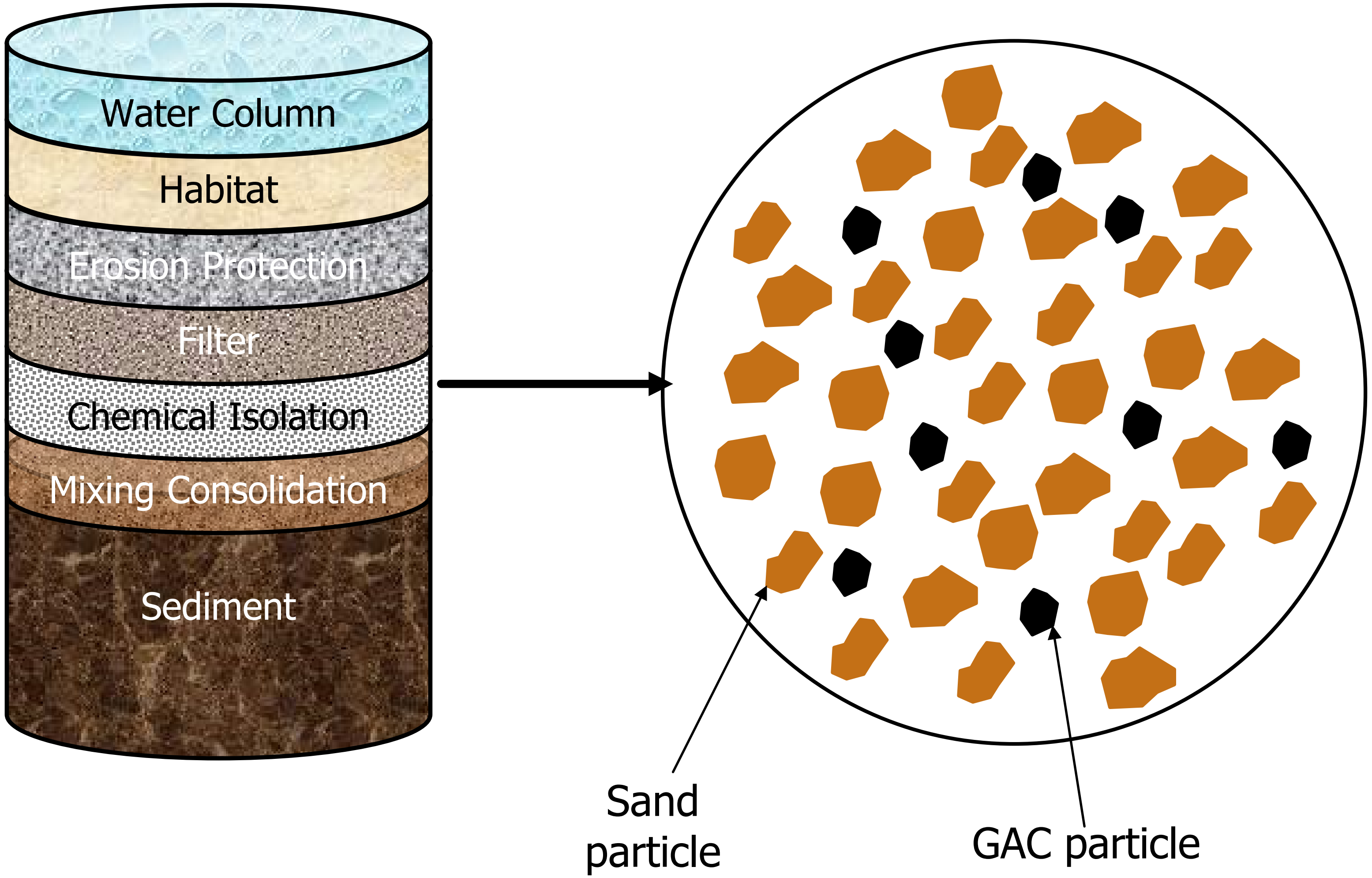


## Material Placement

- Materials Spread
- Riverward to Shoreward
- Upstream to Downstream

## Mixing Consolidation Layer

# Construction Considerations – Cap Amendment



Dosing and Mixing Considerations:

- Dose Requirements
- Well-mixed Distribution
- Amendment Integrity

Source: Jeffrey Hale, Kleinfelder (used with permission)

# Placement Methods: Conventional Broadcast

**Concrete Bucket**

*Advantages:*
Low-cost method
Shoreline or barge based

*Disadvantages*:
Crew access
Lift control

**Excavator**

*Advantages:*
Commonly available
Shoreline or barge based

*Disadvantages*:
Lift control
Low production rate

**Clamshell**

*Advantages:*
Commonly available marine equipment
High production rates

*Disadvantages*:
Lift control challenging
Overhead obstructions

**Conveyor Delivery**

*Advantages:*
High production rate
Available in most cities

*Disadvantages*:
Material delivery access needed

Sources: Oregon Department of Environmental Quality (used with permission); Maul Foster & Alongi, Inc. (used with permission)

# Placement Methods: Proprietary

## Spreader with Hydraulic Delivery

*Advantages:*
Hydraulic delivery, dry spreading
High production rate

*Disadvantages:*
Hard to reach tight areas
Water column effects

## Hydraulic Placement and Delivery

*Advantages:*
Hydraulic delivery and spreading
High production rate

*Disadvantages:*
Hard to reach tight areas
Water column effects

Sources: J.F. Brennan Company, Inc. (used with permission); Sevenson Environmental Services Inc. (used with permission)

# Placement Related Issues – Key Considerations

## Placement Accuracy and Tracking

- Operator experience is a major factor
- Bucket type placement tend toward less uniform (smooth lipped excavator, clamshell, others)
- High accuracy achieved with conveyor delivery and certain proprietary systems
- Essential QC measures include where lifts are placed, what quantity is placed, and the uniformity of material placement
- Best practices include RTK-GPS, routine bathymetric survey, and direct measurement

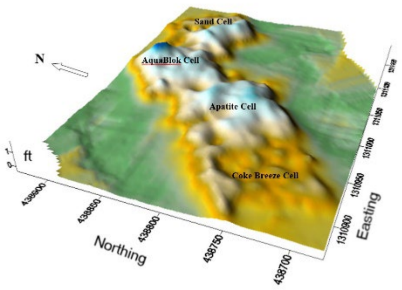
## Material Loss During Placement

- Material loss during placement is a function of three factors: (a) material properties, (b) equipment accuracy, and (c) the placement conditions
- Managing material loss includes: realistic expectations; evaluating water column dynamics; and continual operator optimization of placement technique
- Fine grain and low bulk density materials are especially challenging due to particle drift
- Reactive materials may separate from sand during placement. Consider wetting, overdosing, or other practical means to deliver target dose

# CIL Placement Quality Assurance Methods

- Weight of evidence approach, as no one method provides sufficient verifiable data
- Verify important design & construction specifications, including thickness, delivery of amendment material, and tolerances.

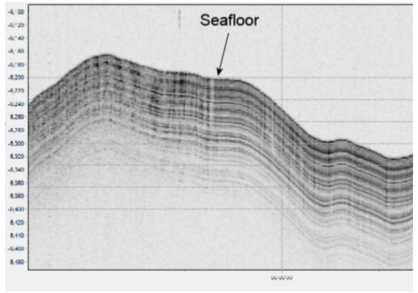
### Bathymetric Survey



*Advantages:*
Area-wide Analysis
Commonly Available

*Disadvantages*:
No Settling or Mixing Layer
No Amendment Info

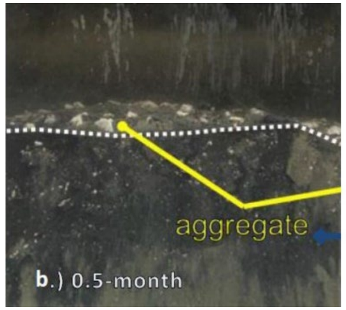
### Sub-Bottom Profile



*Advantages:*
Approx Cap Thickness
Includes Settling

*Disadvantages*:
Location Specific - Line
No Amendment Info

### Sediment Profile Imaging



*Advantages:*
View In-Place Material
View Amendments

*Disadvantages*:
Location Specific - Point
Limited Thickness

### Settling Pans

*Advantages:*
View Placed Materials
Assess Amendments

*Disadvantages*:
Location Specific - Point
No Settling or Mixing Layer

### Core Collection

*Advantages:*
View Placed Materials
Assess Mixing Layer
Assess Amendments

*Disadvantages*:
Location Specific - Point
Subject to Drawdown

Source: Barth; NOAA Office of Exploration: Sub-Bottom Profiler, Battelle 2018 Chlorinated Conference Proceedings, Dalton Olmsted Fuglevand, Battelle 2017 Remediation and Management of Contaminated Sediments Conference Proceedings

# Chemical Isolation Construction Considerations – Wrap Up

## Important Concepts

- ✓ Evaluate Proposed Equipment
- ✓ Controlled Placement of Layers
- ✓ •Amendment Delivery
- ✓ •Quality Assurance Program

# Training Roadmap

Introduction (Section 1)

Capping Overview (Section 2)

Performance Objectives & Design Concepts (Section 3)

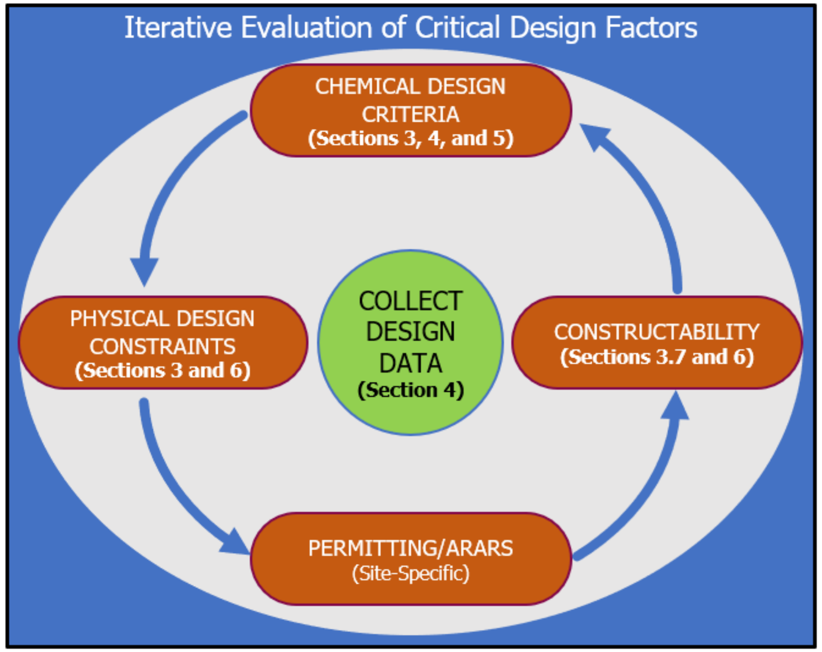
Chemical Isolation Layer Modeling (Section 5)

Q&A Break

Chemical Isolation Construction Considerations (Section 6)

**Monitoring & Maintenance Objectives and Approaches (Section 7)**

Q&A Break



Iterative Evaluation of Critical Design Factors

CHEMICAL DESIGN CRITERIA
**(Sections 3, 4, and 5)**

PHYSICAL DESIGN CONSTRAINTS
**(Sections 3 and 6)**

COLLECT DESIGN DATA
**(Section 4)**

CONSTRUCTABILITY
**(Sections 3.7 and 6)**

PERMITTING/ARARS
(Site-Specific)

Final Design and Specifications
(see Sections 5 and 6.1)

*Construction QA/QC*
(see Section 6.6)

*Completion Report/As Built*
(Section 6.6)

*Post-Remediation Monitoring and Maintenance* ***(Section 7)***

# Cap Performance Monitoring

How can monitoring help assess cap performance?

Compare actual performance to design

Distinguish chemical migration from deposition

Evaluate natural recovery processes

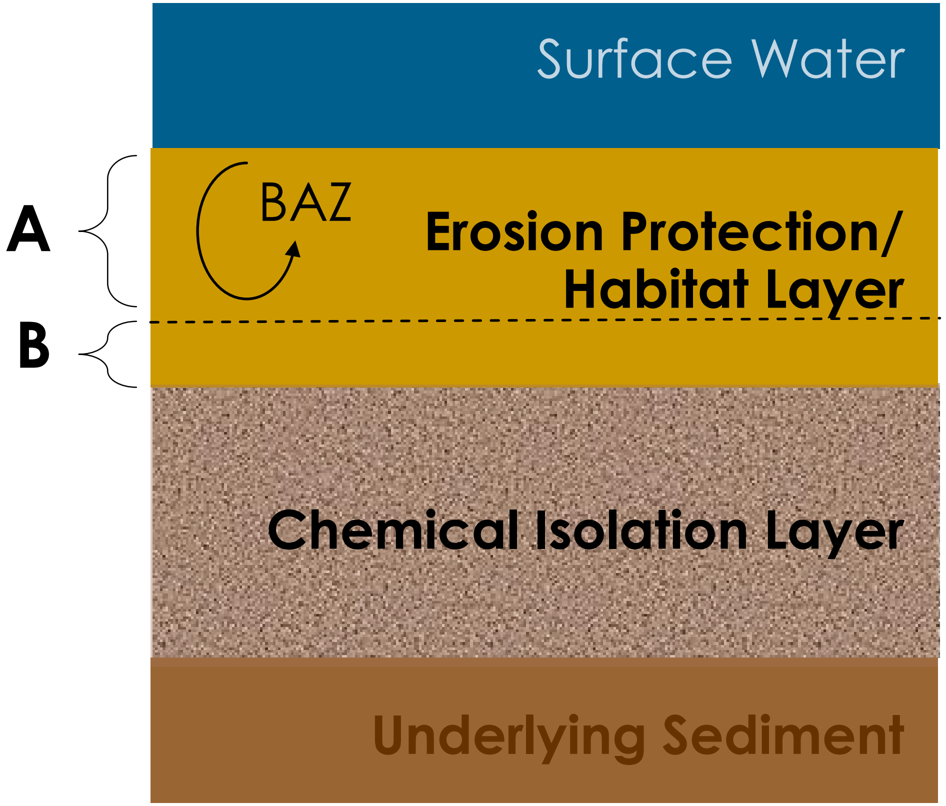
Inform cap maintenance

Update anticipated cap lifespan

# Monitoring Cap Performance – Chemical Isolation

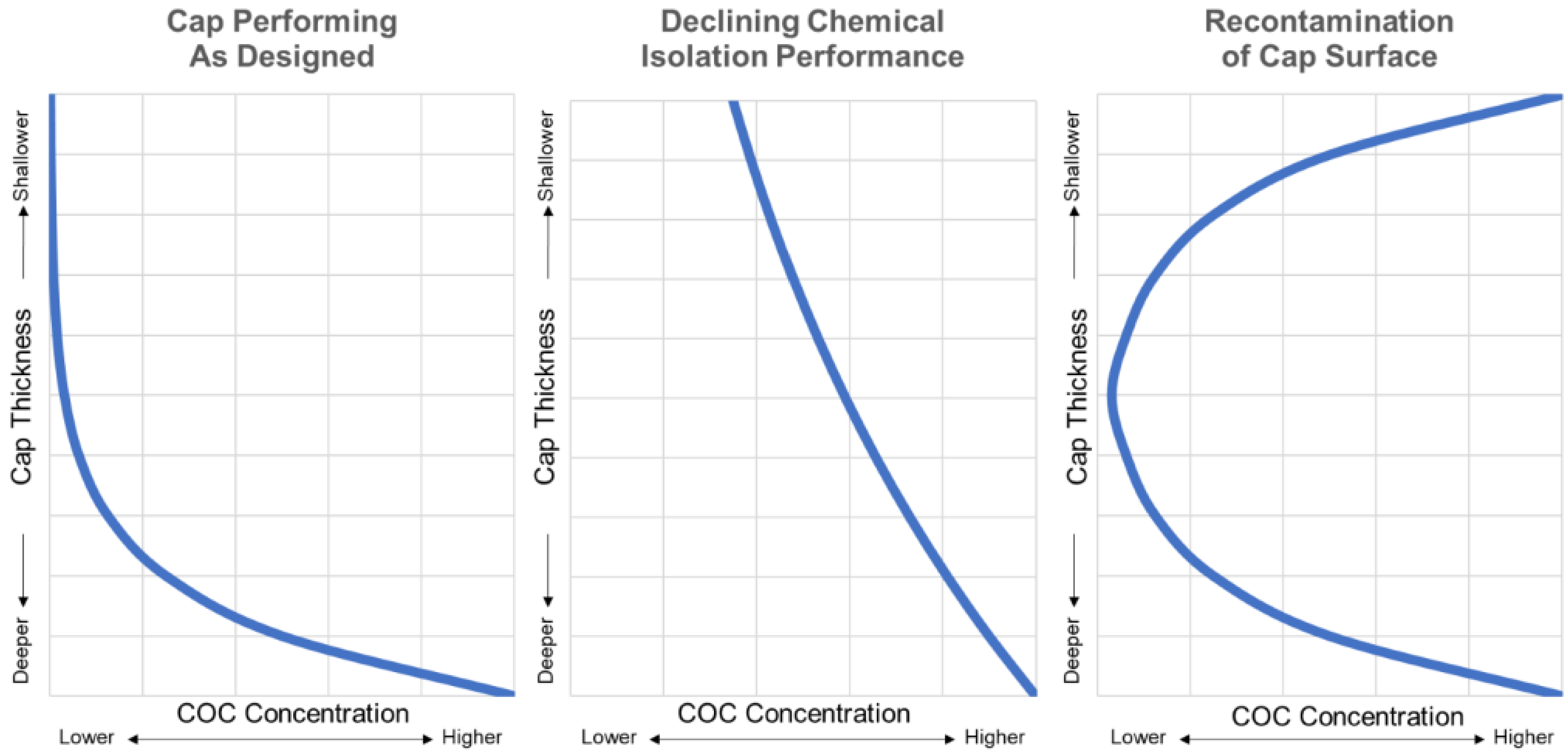
## Sampling Depths

- At a minimum, sample at the point of compliance (A), and if different, the design evaluation depth (B)
- Multiple depths throughout cap is helpful for understanding transport mechanism
- A sample within the chemical isolation layer can serve as an "early warning" of potential issues in the future



# Monitoring Cap Performance – Chemical Isolation

Evaluate COC concentrations at multiple depths (vertical profiling)


Cap Performing As Designed

Declining Chemical Isolation Performance

Recontamination of Cap Surface

Figure 7-2. Conceptual illustration of vertical concentration profiles

# Monitoring Cap Performance – Chemical

## Porewater

- **Direct indicator of CIL performance**

## Solid Phase

- **Commonly used to evaluate CIL performance**

## Surface Water

- **Not a straightforward indicator of CIL performance**

## Biota

- **Not a straightforward indicator of CIL performance**

https://sd-1.itrcweb.org/7-monitoring-and-maintenance-objectives-and-approaches/#7_4

# Maintenance Triggers

**When do caps need repair?**

- COC migration through cap
- Excessive consolidation
  - Of cap material
  - Of underlying sediment
- Slope instability
- Erosion; high energy events
- Current and future uses
  - Prop wash scour
  - Anchoring
  - Sunken vessels

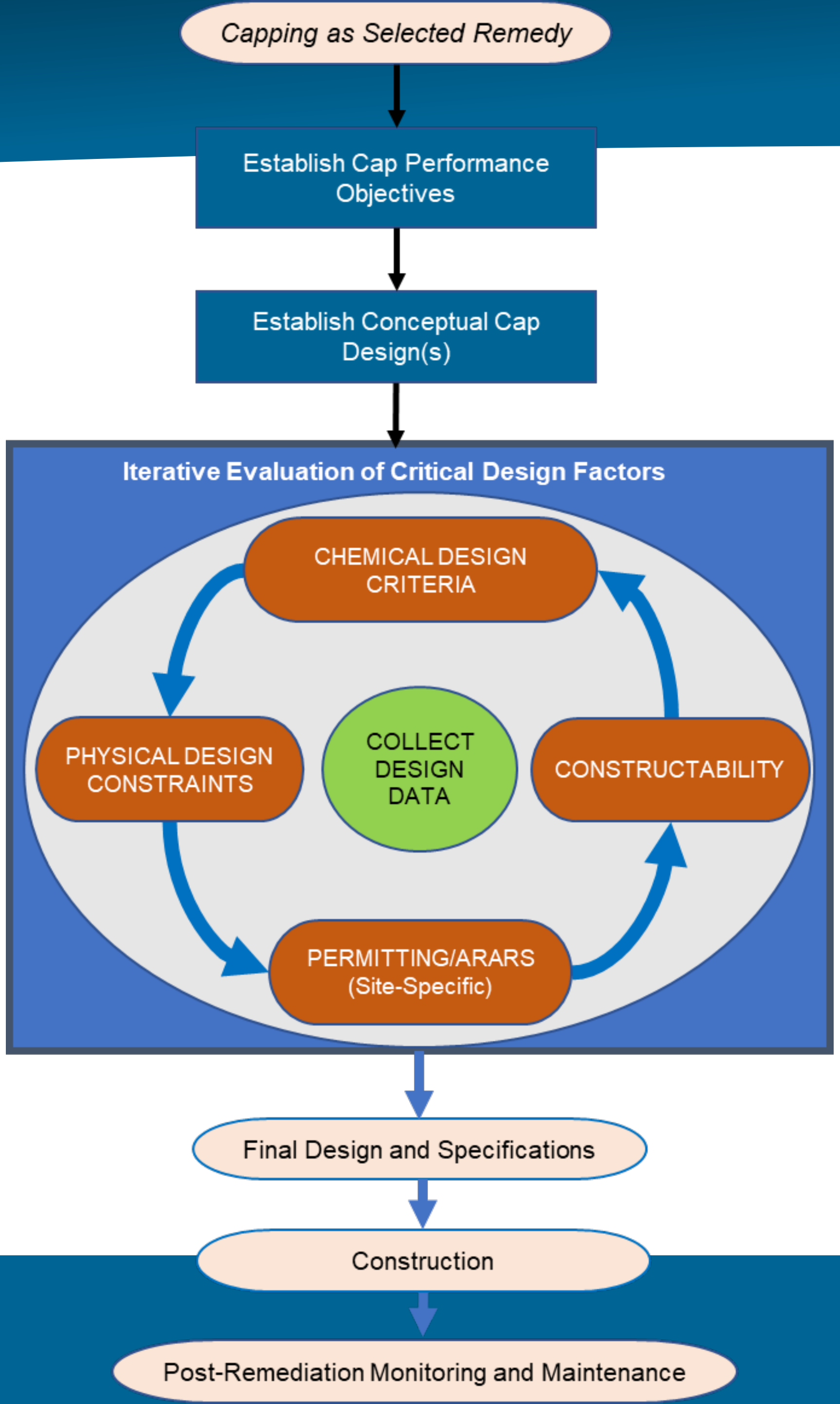
Source: Louisiana Department of Environmental Quality (used with permission)

# Monitoring & Maintenance Objectives/Approaches

- Plan for cap maintenance in the same manner as any built asset
- Maintenance plans should include "trigger" criteria for action
    - physical criteria (e.g., thickness)
    - chemical criteria (e.g., COC concentrations)
- Response may include increased frequency of monitoring, diagnostic investigation, or repairs
- Consider whether minor or localized deviations are likely to reduce cap effectiveness

# Summary

- Chemical isolation is achieved through various mechanisms (impeding fluid flow, addition of sorbents, physical attenuation distance)
- Chemical isolation cap design is an iterative process that considers risk reduction goals, contaminant properties, fate and transport characteristics, physical constraints, constructability, and permitting requirements
- Construction quality assurance is critical to demonstrate that the chemical design criteria are achieved in the field
- Monitoring should include approaches to evaluate RAO attainment and assess cap performance monitoring
- Maintenance needs should be tied to pre-determined 'triggers' informed by cap performance monitoring results



# Questions

ITRC Sediment Cap Chemical Isolation Guidance Document sd-1.itrcweb.org

Certificate of Completion

https://clu-in.org/conf/itrc/sd-1/

*(emailed after you complete the Feedback Form)*