Groundwater Contamination Containment Evaluation

Proposed Modeling Path Forward

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Purpose of Cap Modeling Activities

- Screening evaluation
  - To determine if groundwater plume contaminants can be reliably contained within river sediments by a reactive cap
  - To determine whether the groundwater pathway poses a threat to the selected remedy
- Conditions specific to Rhone Poulenc site will be evaluated versus two PH FS process option capping technologies
  - Reactive cap and significantly augmented reactive cap

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Model Description

- Active Cap Layer Model v4.11 is a Microsoft Excel-based capping model developed by Danny Reible of Texas Tech University (https://www.depts.ttu.edu/ceweb/groups/reiblesgroup/downloads.html).
- Allows for the simulation of a contaminated sediment bed, an active cap layer, and a sand overlay ("conventional cap layer").
- Assumes linear adsorption of contaminants, which is often not a valid assumption for activated carbon.
- Still considered appropriate for developing screening level estimates of contaminant concentrations that can be reliably contained.
- The use of analytical models such as CAPSIM is not warranted at this stage of evaluation.

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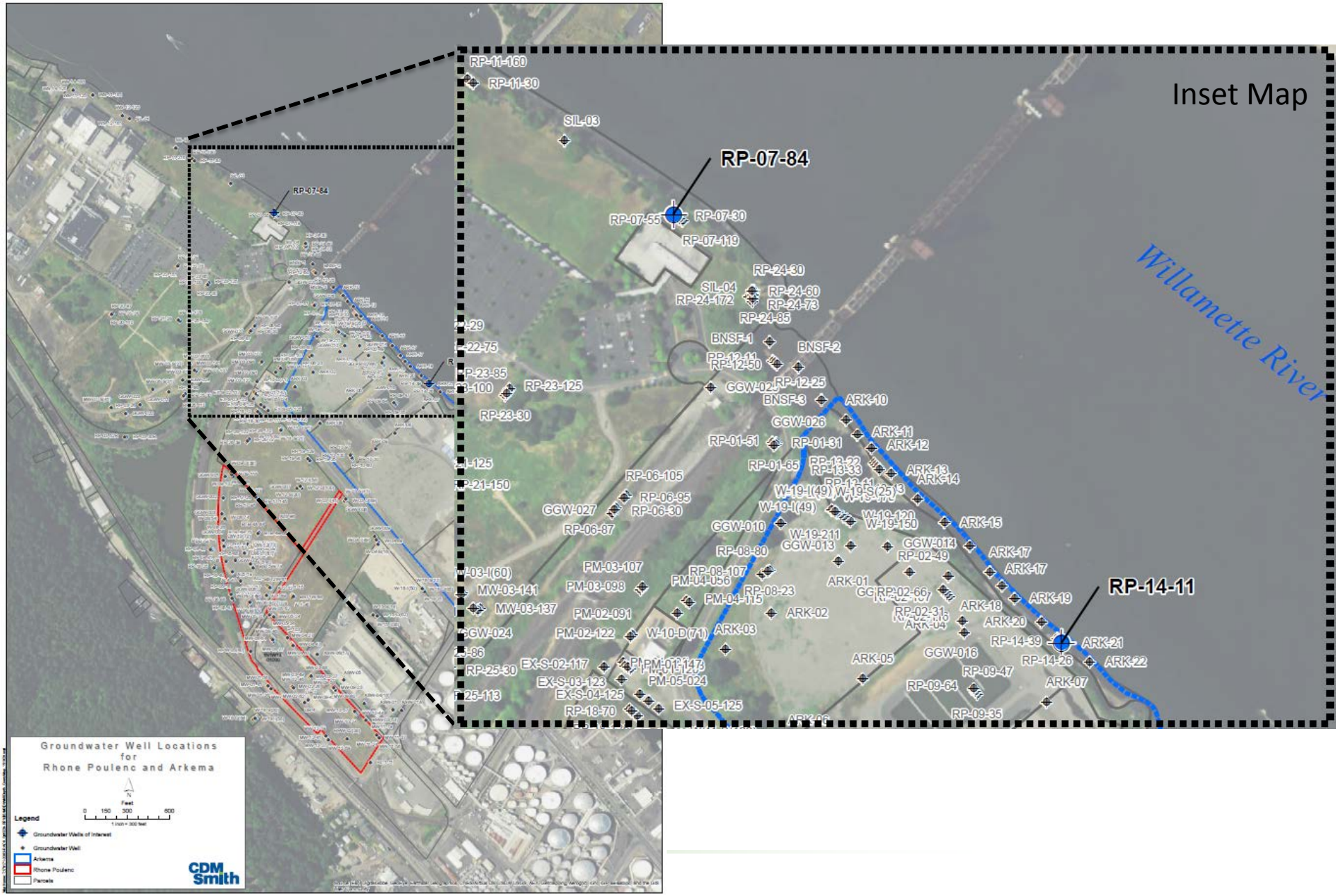
Rhone Poulenc Groundwater Wells



Model Inputs: Contaminants of Concern

- Chlorobenzene and DDx were selected as the modeled contaminants
  - Represent varied chemical properties, with chlorobenzene being more mobile
  - Are known to be present in conjunction with other contaminants at the Site
- Model input contaminant concentrations from RP-07-84 and RP-14-11 sample locations were selected
  - Provide highest chlorobenzene and DDx concentrations in the most recent year sampled
  - There are <u>no</u> non-detects of the modeled contaminants at these locations

Model Inputs: Site-specific Concentration Information

Contaminant	Well ID	Matrix for contaminant Concentration	contaminant Concentration	contaminant Porewater Concentration used as Model Input
Chlorobenzene	RP-07-84 (September 2007)	GW	140 ug/L	140 ug/L
DDx	RP-14-11 (January 2010)	GW	13.1 ug/L	13.1 ug/L

- Conservatively assume that no additional partitioning of contaminants occurs during transport from the upland source to the sediments
- Conservatively assume source concentrations are constant
- Therefore, porewater concentrations are assumed to be the same as groundwater concentrations

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Model Inputs: Chemical Property Information

Contaminant	log Kow (L/kg)	Koc (L/kg)	Water Diffusivity (cm^2/s)
Chlorobenzene	2.84	456	9.48E-06
DDE	6.51	938,700	4.76E-06

Values obtained from EPA table of contaminant parameters retrieved from http://www.epa.gov/region9/superfund/prg/

- DDE was chosen as the representative DDx component for determining DDx chemical properties due to its higher mobility
- DDx concentrations are calculated as the summed total of 2,4'-DDT, 4,4'-DDT, 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, and 4,4'DDE
- Model is conservatively set to assume 0 contaminant degradation

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Model Inputs: Seepage Velocity

- Model simulations will assume the following seepage velocities:
  - **30 cm/day** was the maximum recorded seepage velocity near Rhone Poulenc
  - **3 cm/day** is the approximate average seepage velocity for the Portland Harbor site
  - **0.3 cm/day** provides a lower bracket for seepage velocities coming out of the sediment bed (as a sensitivity analysis)

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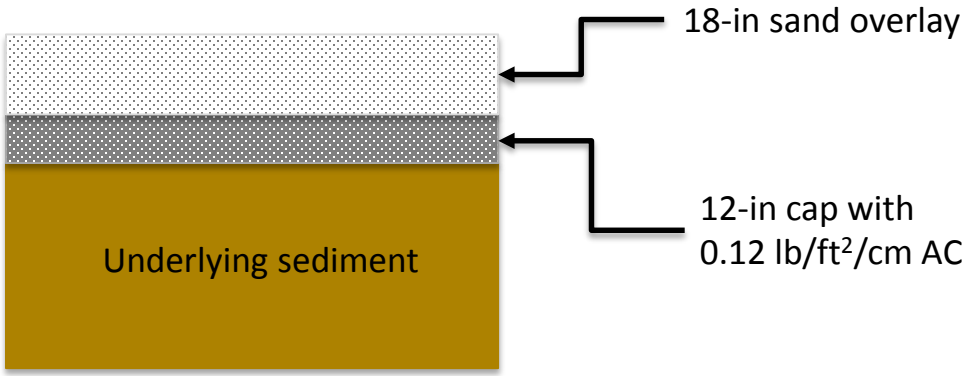
Model Inputs: Cap Scenarios

- Cap Scenario 1 – Reactive Cap
  - Cap assumed to have 0.12 lb/ft^2/cm activated carbon (AC)
    - Based on a 12-in cap with 50% Aquagate, and Aquagate being 10% AC
    - Equates to 5% AC in the active cap layer
    - Same percentage of carbon used in other Superfund caps (Berry's Creek in New Jersey and Bailey Creek, Fort Eustis in Virginia)
    - Consistent with the modeled reactive cap design in EPA's Portland Harbor FS
  - 18-in sand overlay above active layer



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Model Inputs: Cap Scenarios

- Cap Scenario 2 – Significantly Augmented Cap
  - 0.48 lb/ft^2/cm activated carbon (AC)
  - Low permeability layer
    - This layer is not physically represented as a separate layer in the model; rather, its effects are represented by limiting seepage velocity to 0.3 cm/day
  - Consistent with the modeled significantly augmented reactive cap design in EPA's Portland Harbor FS

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Model Assumptions

- Constant contaminant source in uplands
- No contaminant partitioning from groundwater plume until it reaches the reactive cap
- No contaminant degradation
- No sediment deposition on top of the cap
- No cap consolidation
- No underlying sediment consolidation

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Compliance Points

Contaminant	RAO 4	RAO 8
	Groundwater (µg/L)	Porewater (µg/L)
Chlorobenzene	74	64
DDx	-	0.001

Values obtained from Portland Harbor FS Table 2.2-1

- Contaminant breakthrough indicates that porewater concentration at the sediment cap-surface water interface has reached a concentration above zero
- RAO 4 – Reduce migration of contaminants in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for human exposure.
- RAO 8 – Reduce migration of contaminants in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for ecological exposure.

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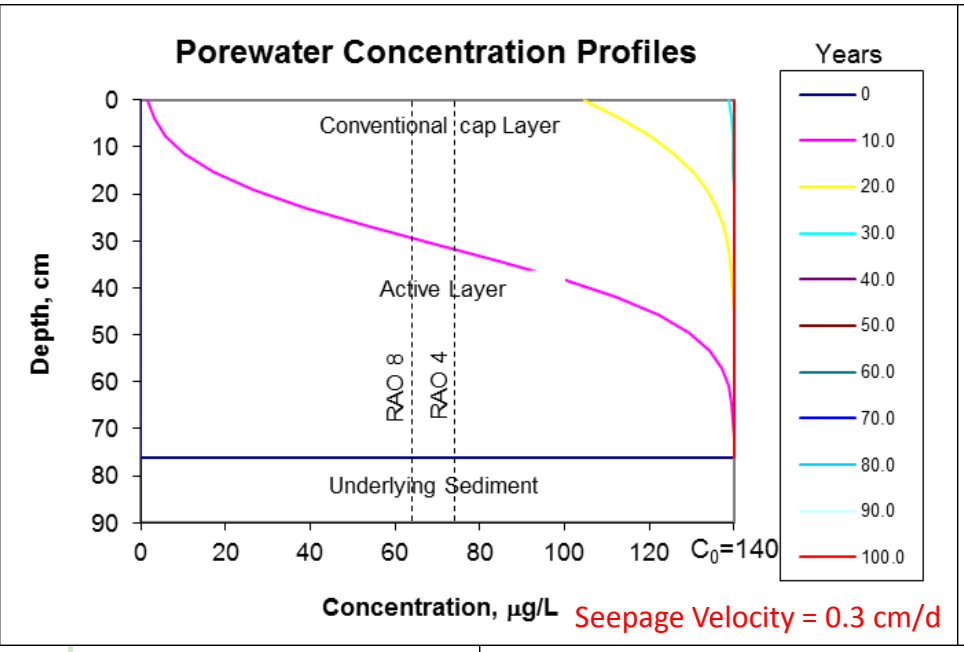
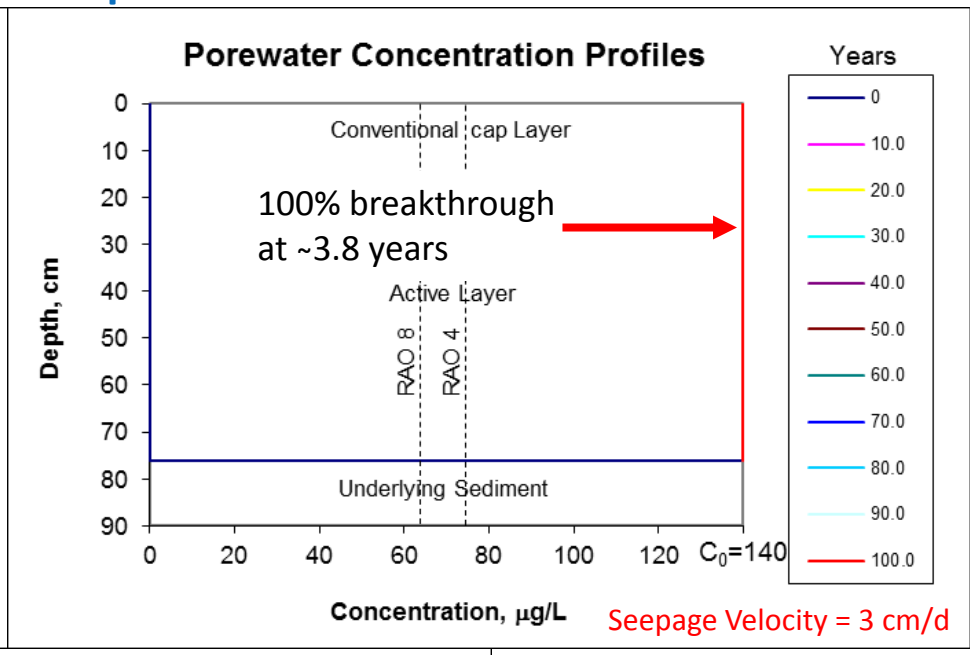
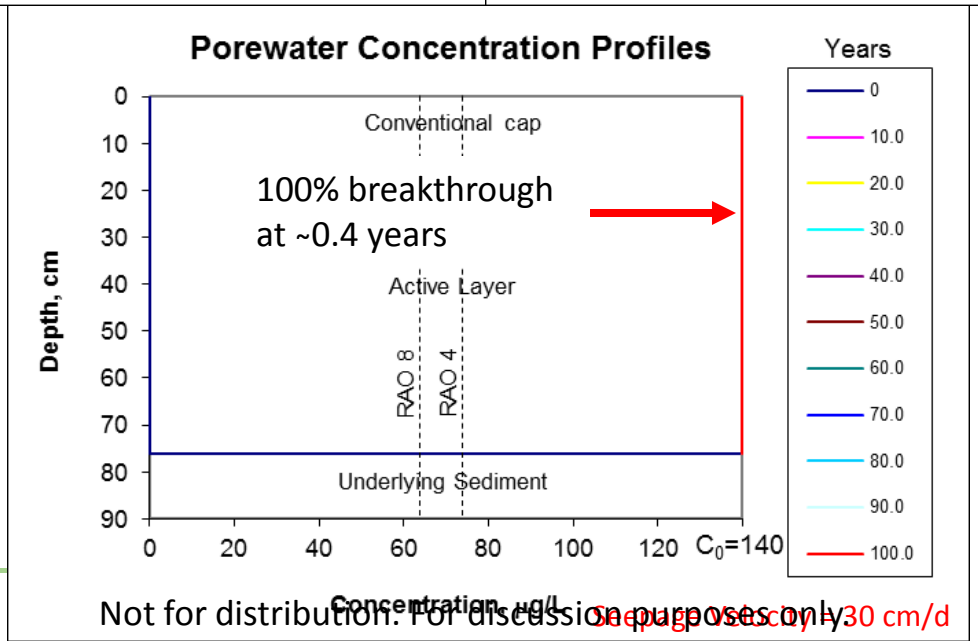
Preliminary Model Results: Chlorobenzene Cap Scenario 1



Seepage Velocity = 0.3 cm/d



Seepage Velocity = 3 cm/d



Seepage Velocity = 30 cm/d

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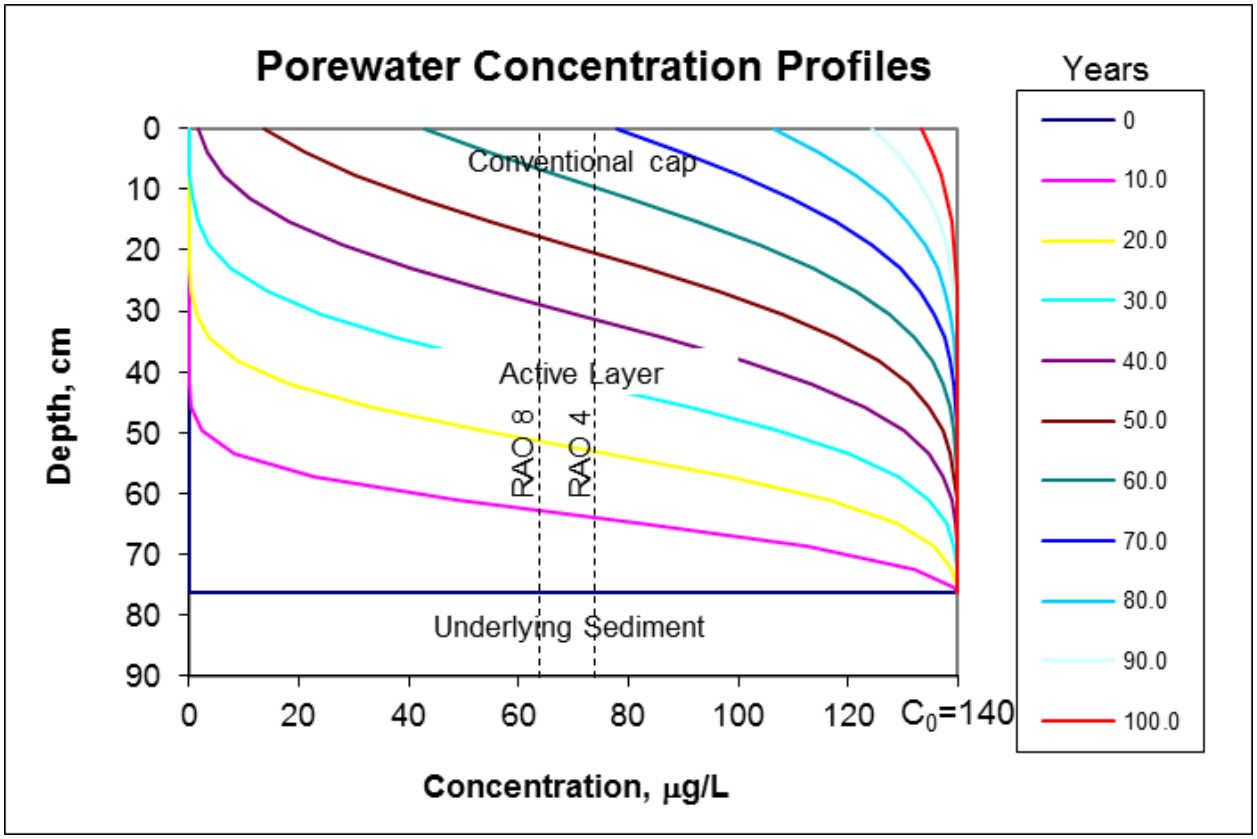
Preliminary Model Results: Chlorobenzene Cap Scenario 2



- Porewater concentration at surface of cap reaches RAO 8 PRG of 64 µg/L at ~66 years.

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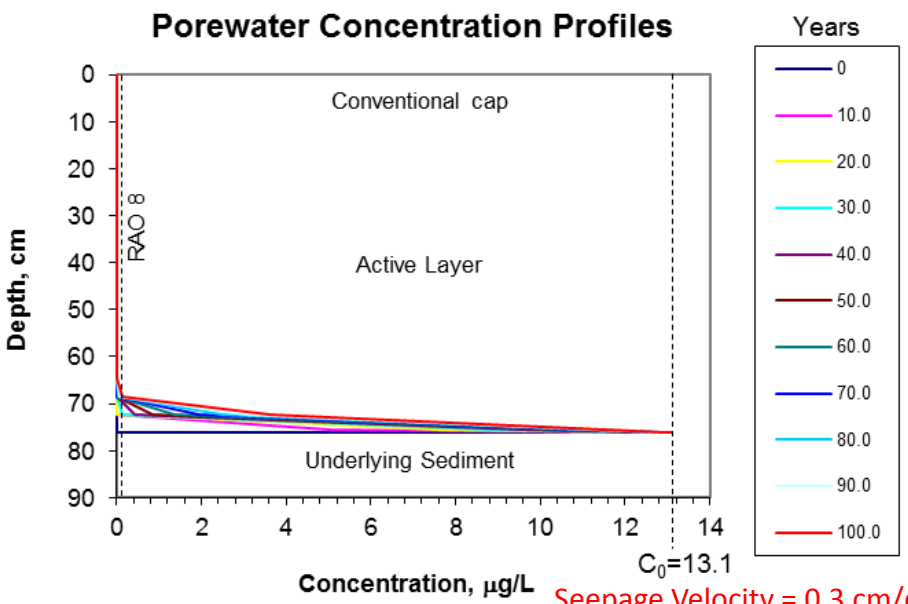
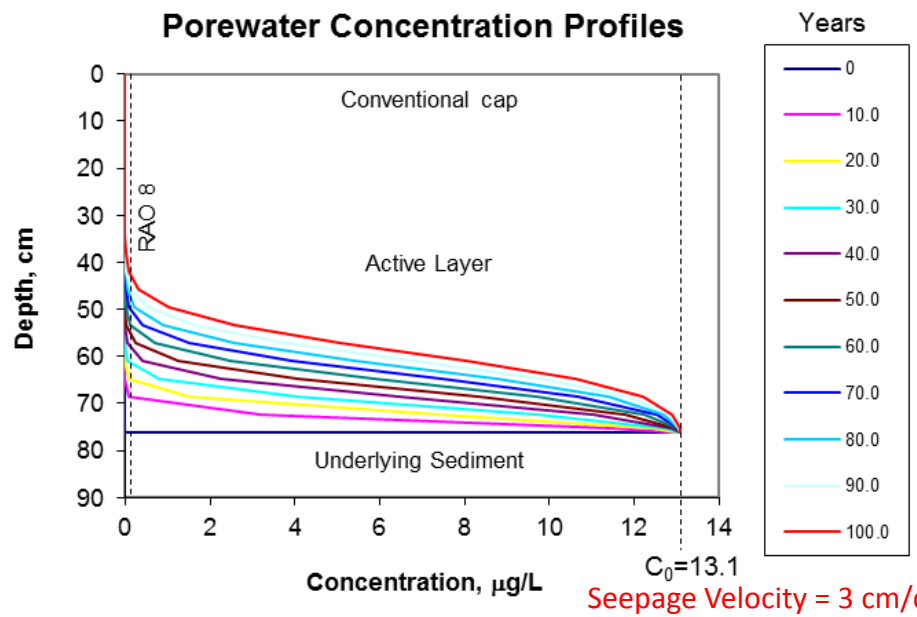
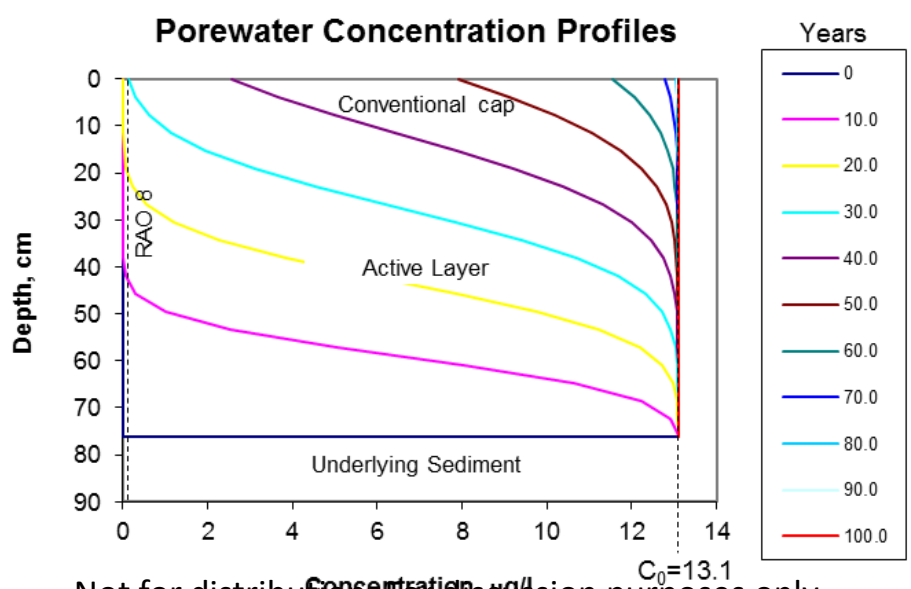
Preliminary Model Results: DDx Cap Scenario 1



Seepage Velocity = 0.3 cm/d



Seepage Velocity = 3 cm/d



Seepage Velocity = 30 cm/d

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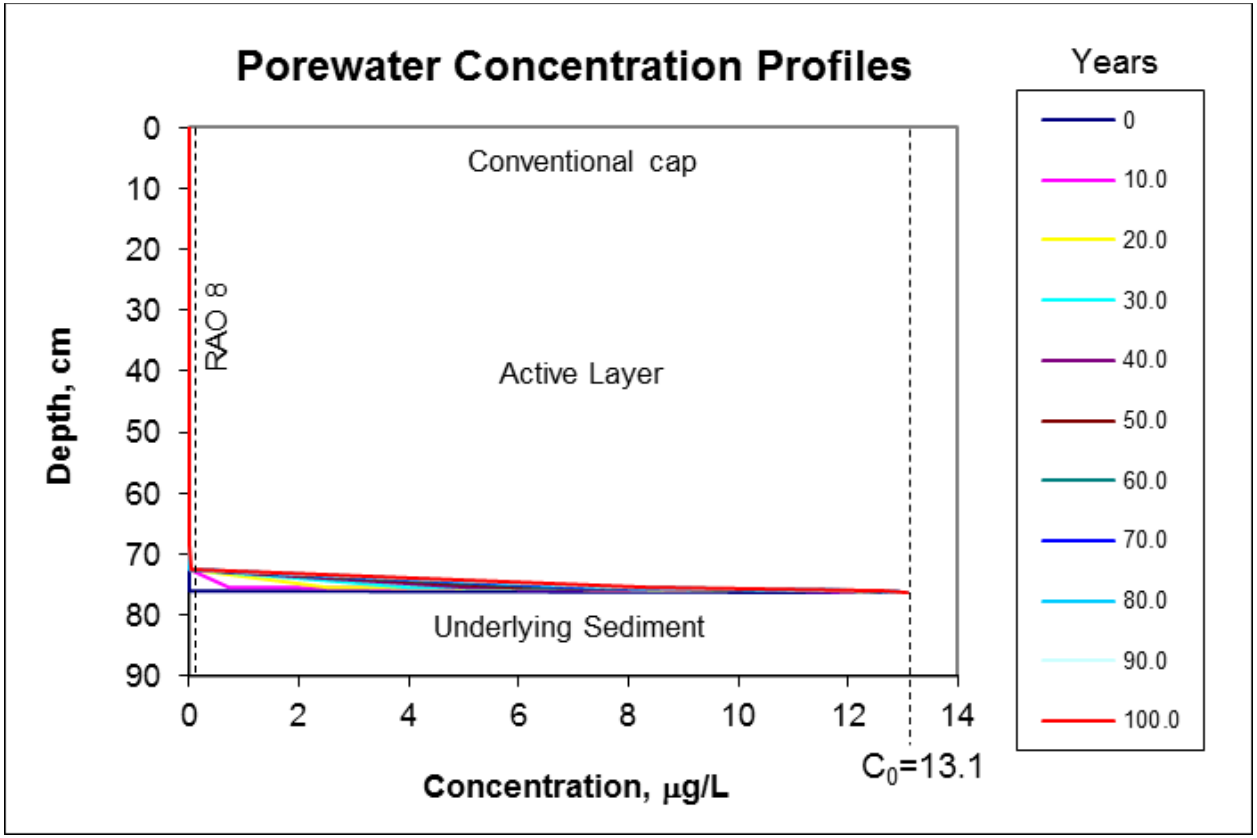
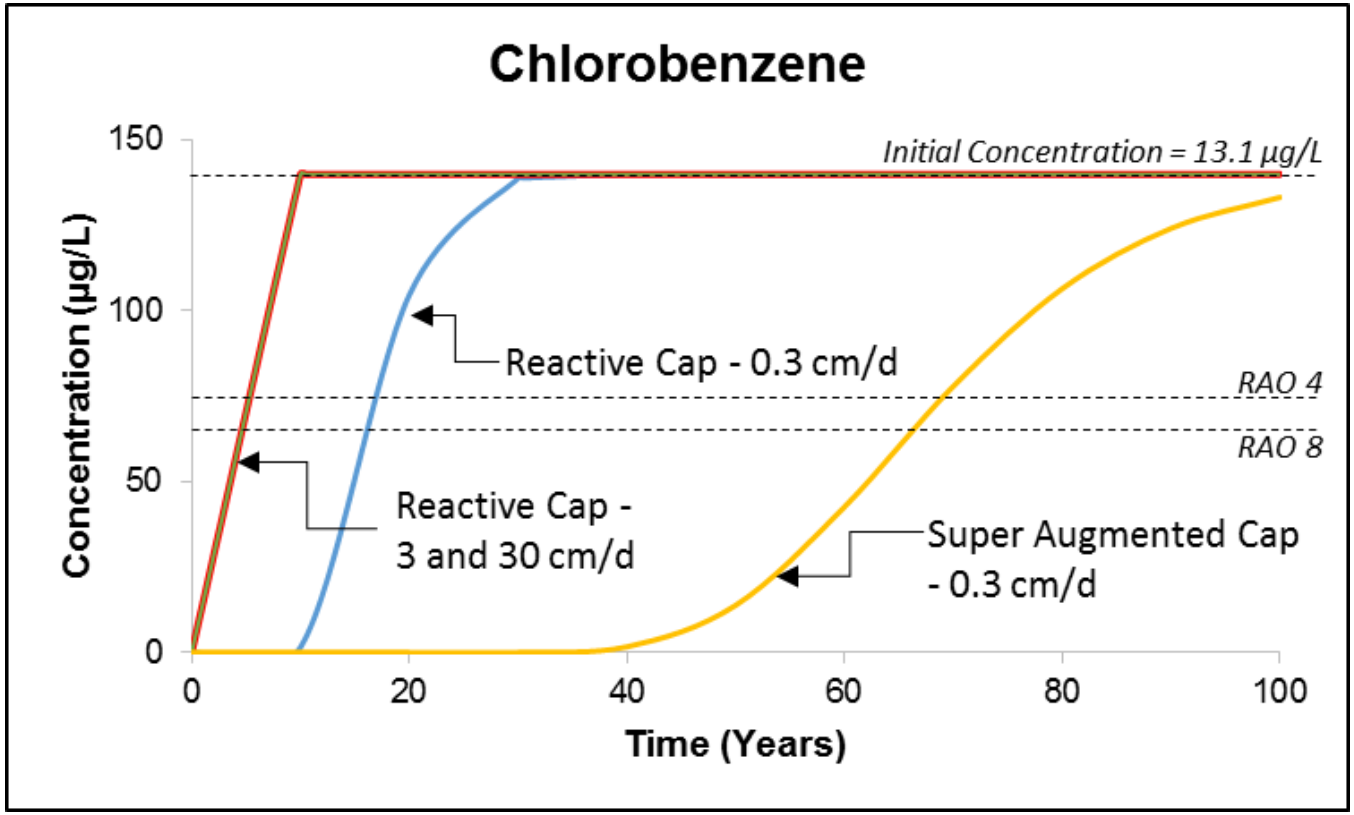
Preliminary Model Results: DDx Cap Scenario 2



- Porewater concentration near surface of cap does not reach RAO 8 PRG of 0.001 µg/L for the design period of 100 years.

Preliminary Model Results: Chlorobenzene at cap-surface water interface



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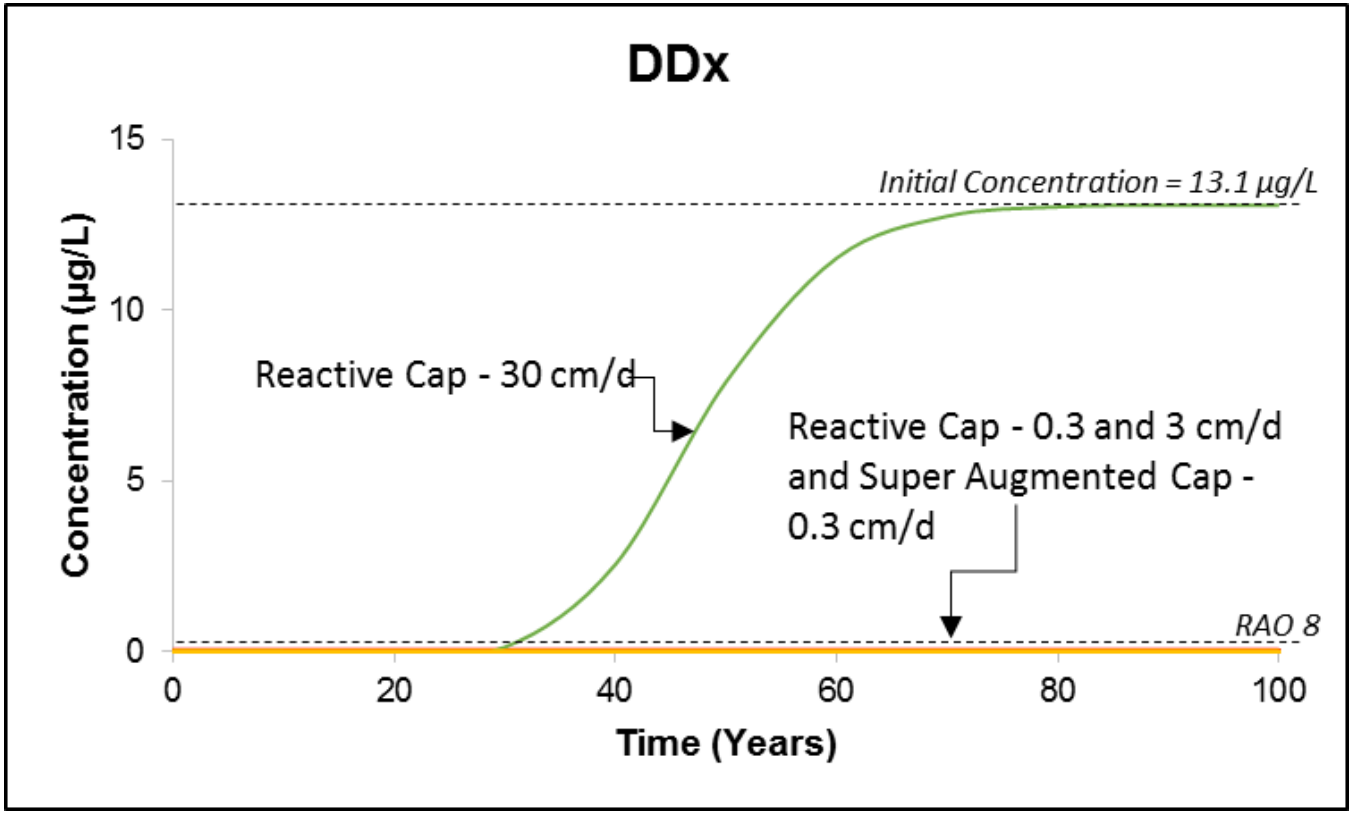
Preliminary Model Results: DDx at cap-surface water interface



Preliminary Results at 100 years

- Cap Scenario 1 – Reactive Cap:
  - Complete chlorobenzene breakthrough occurs for all seepage velocities
  - Complete DDx breakthrough for maximum seepage velocity only
- Cap Scenario 2 – Significantly Augmented Cap:
  - More than 90% breakthrough for Chlorobenzene at 100 years
  - DDx fully contained

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Preliminary Results at PRG Values

Type of Cap	Seepage Velocity (cm/d)	Chlorobenzene	DDx
Reactive Cap	0.3	RAO 8 exceeded @~17 years	No exceedance
Reactive Cap	3	RAO 8 exceeded @~1.7 years	No exceedance
Reactive Cap	30	RAO 8 exceeded @~62 days	RAO 8 exceeded @~23 years
Significantly Augmented Cap	0.3	RAO 8 exceeded @~66 years	No exceedance

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Preliminary Conclusions

- For both contaminants modeled using site specific worst case scenario (i.e. max observed concentration at the Site, 30 cm/d seepage velocity), the model shows cap failure prior to 100 years for the Reactive Cap
- Chlorobenzene concentrations at cap-surface water interface reach PRG values with both caps
- DDx concentrations at cap-surface water interface do not reach PRG values with Significantly Augmented Cap
- Chemical degradation in Significantly Augmented Cap had minimal effects on contaminant breakthrough during sensitivity analyses
  - Chlorobenzene concentration at the surface at 100 years is reduced but is still above RAO 8 concentration
  - DDx is fully contained with and without degradation

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