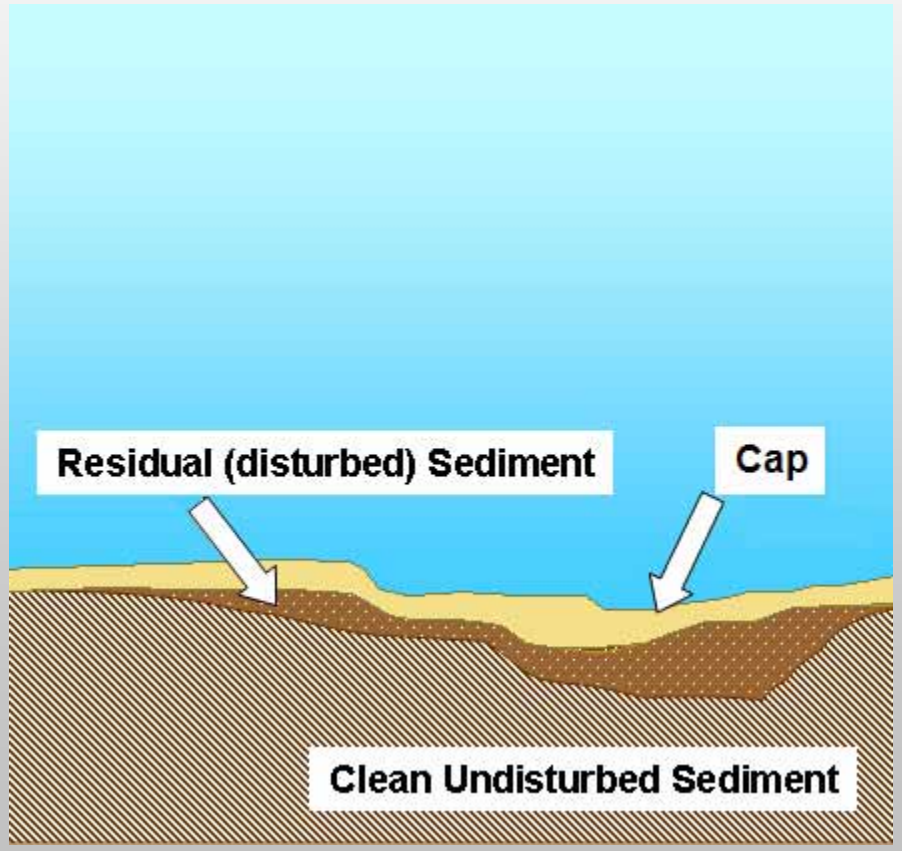
Capping Residuals from Environmental Dredging



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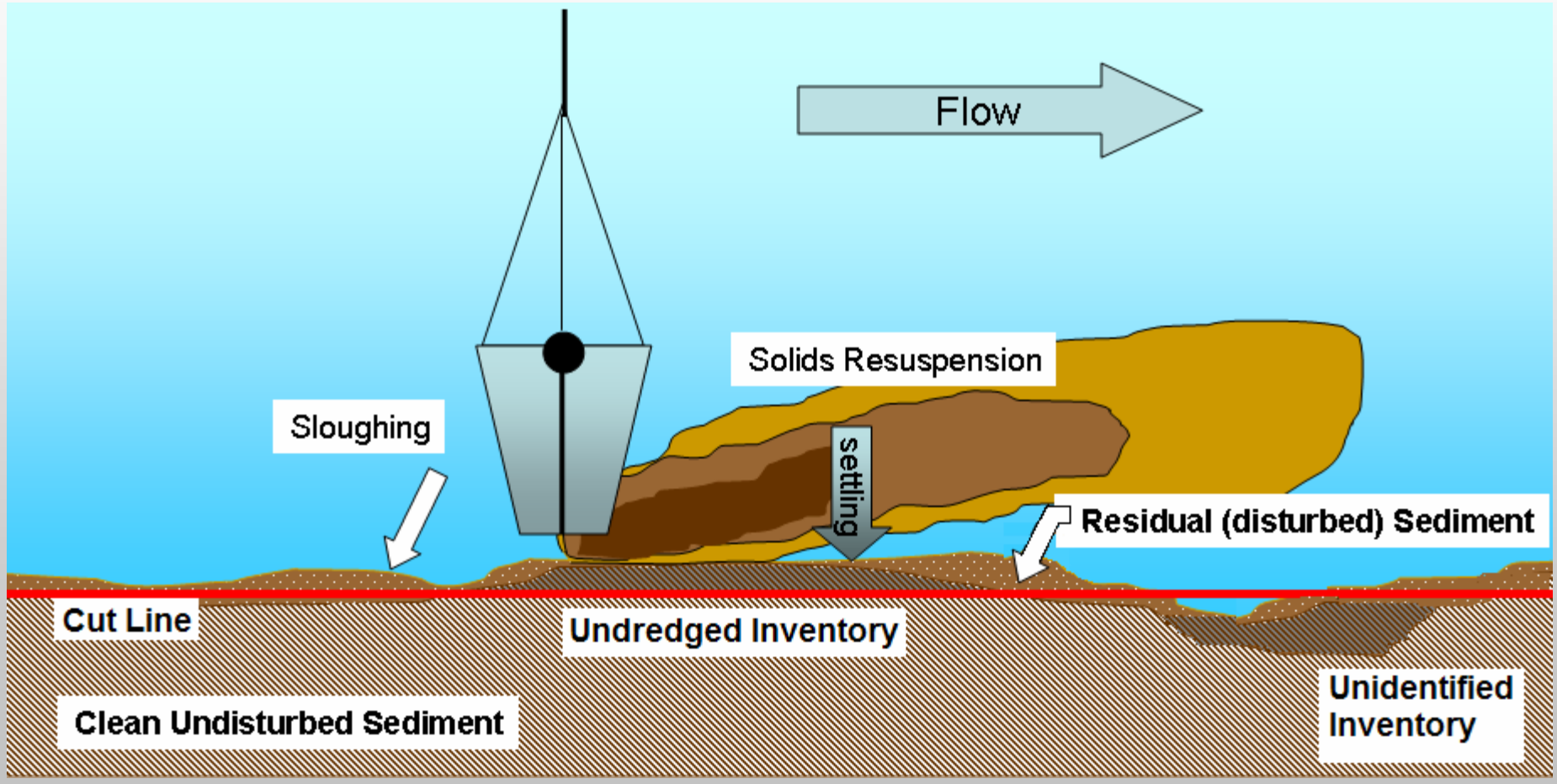
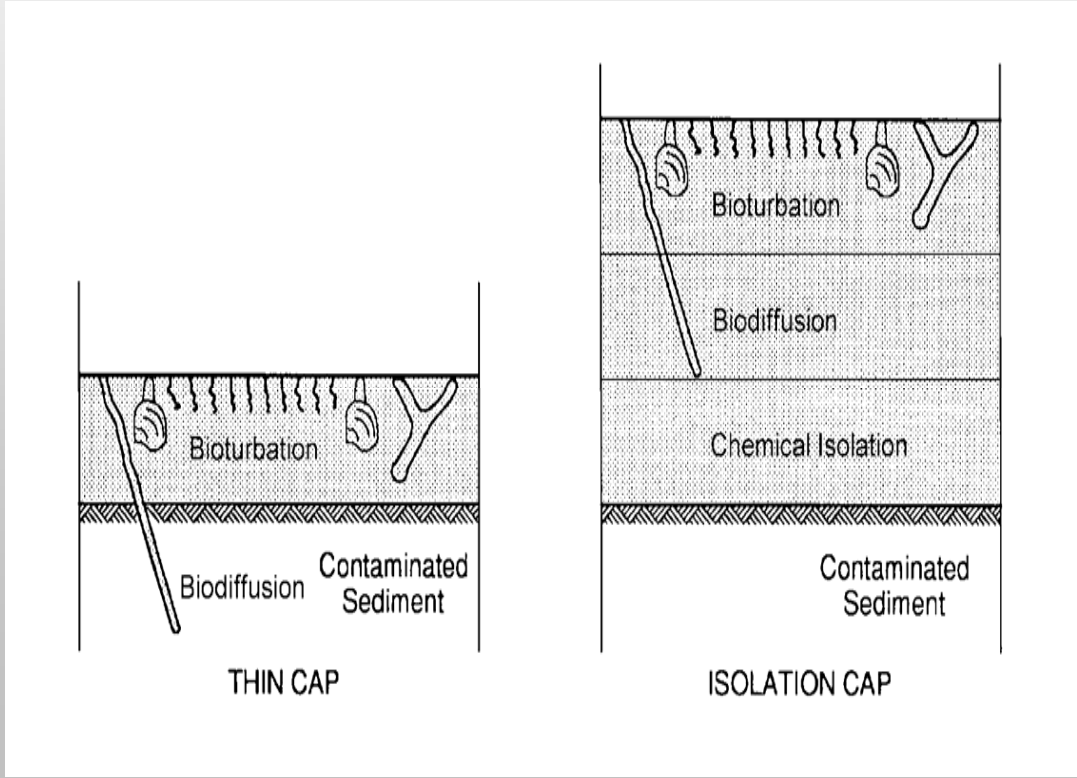
What are Residuals?



What is Capping?

- **Placement of Media on Surface to**
  - **Provide Isolation**
  - **Reduce Bioavailability**

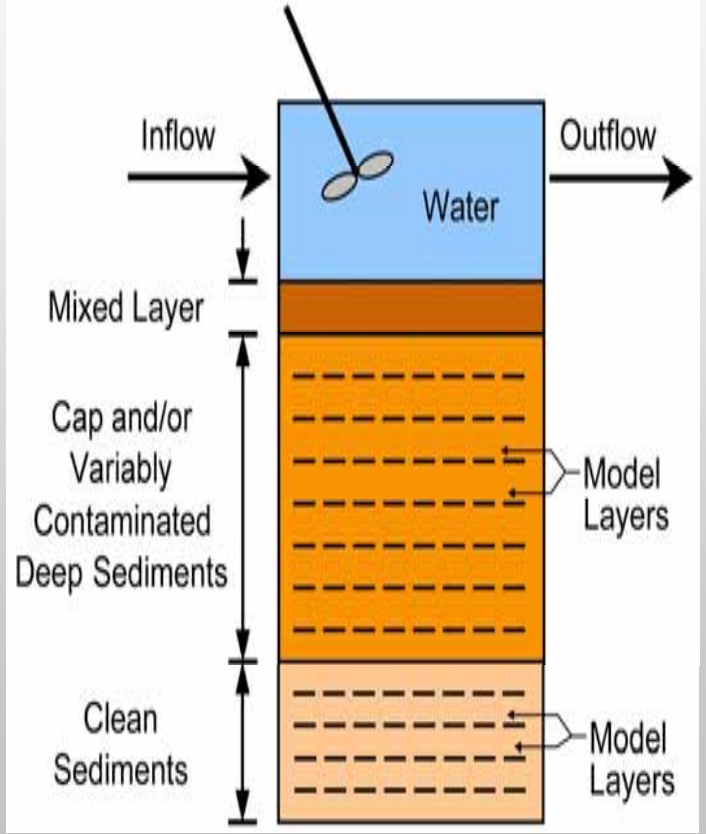


Evaluation Process

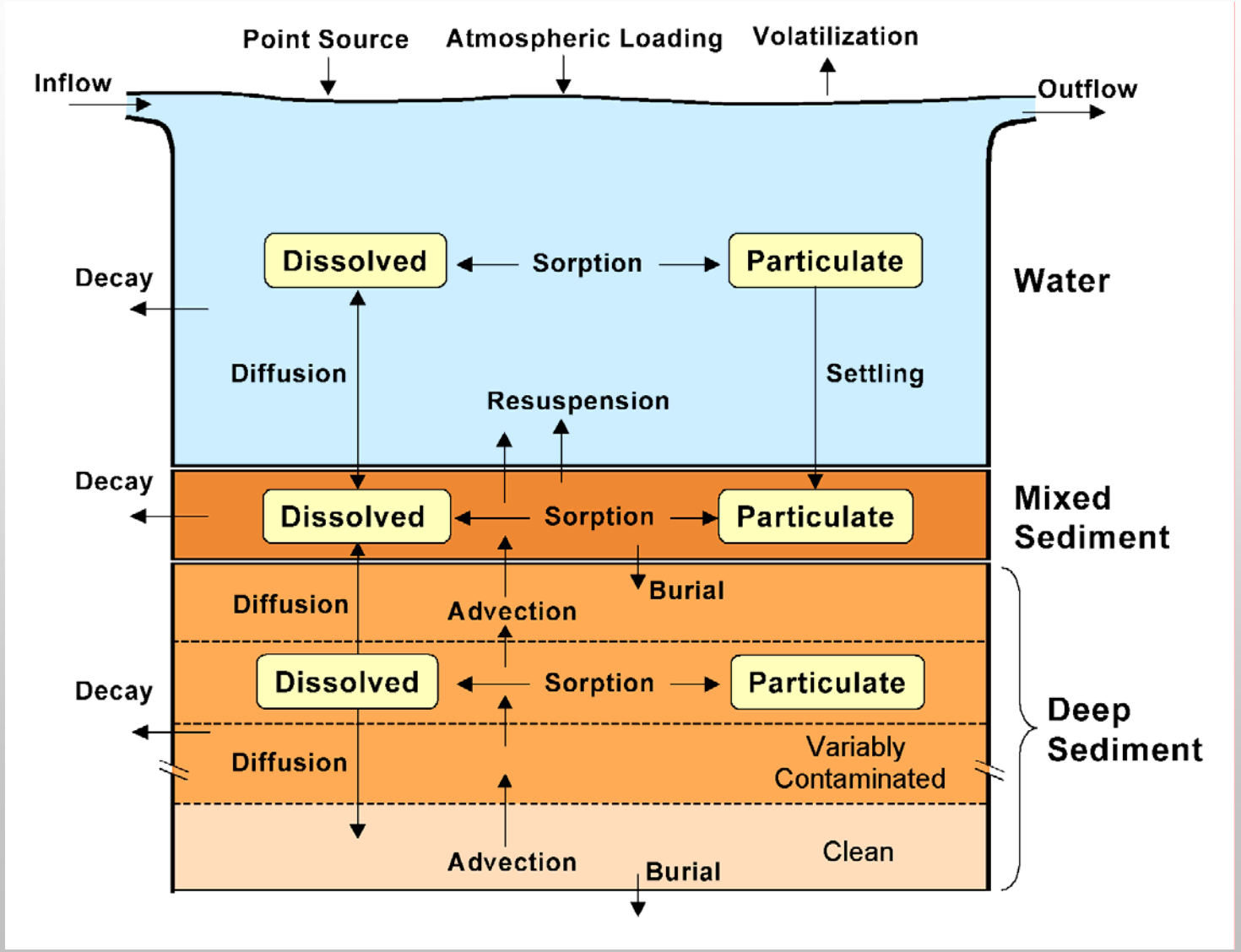
- **Should be risk-based**
  - Ecological – benthic and water column impacts
  - Human health
- **Management needed if risk is significant and long-term**
- **Evaluated by comparative assessment of exposure with and without management**
  - Contaminant flux to water column
  - Pore water concentration in bio-active zone
  - Contaminant concentration in bio-active zone

RECOVERY

- PC Based, User Friendly
- Fully Mixed Water Body and Layered Bottom Sediments
- Time-variable
- Organic Contaminants Database
- Computes Sediment and Water Contaminant Concentrations and Fluxes vs Time



Schematic of Processes



Design Sensitivity

- **Baseline and Design Assumptions**
  - Physically stable site (no erosion events)
  - Chemically stable (no contaminant degradation)
  - 5 cm consolidated generated residual layer
  - No pore water advection
  - 5 cm of cap materials mixes with residuals yielding at a concentration of 10% of residuals (in mg/kg)

Design Sensitivity

Material Properties		
Material	**Porosity**	**FOC**
Residuals	**0.85**	**0.05**
Dirty Sand	**0.6**	**0.008**
Dirty Topsoil	**0.8**	**0.05**
Clean Sand	**0.6**	**0.003**
Clean Topsoil	**0.8**	**0.05**

Design Sensitivity

Design and Site Variables	
Parameter	**Values**
Burial Velocity	**0.01, 0.5, 2.5, 7.5 (cm/yr)**
Cap Thickness	**0, 5, 10, 20 (cm)**
Capping Media	**Sand, Topsoil**
Contaminant	**PCBs & Acenaphthylene**
Kow	**1,100,000 & 5,010**

Effects of Burial Rate

Sand	Rate	Time When Concentration Falls Below Following Percent of Initial Residual Pore Water Concentration **(years)**			
cm	**cm/yr**	**10%**	**1%**	**0.1%**	**0.01%**
0 or 5	**7.5**	1.5	3.0	4.5	6.0
0 or 5	**2.5**	4.6	9.2	14	19
0 or 5	**0.5**	~20	~40	~60	~80
0 or 5	**0.01**	--	--	--	--
10	**2.5**	0, 1.4	0, 6.5	2.7, 1	7, 15
10	**0.5**	0, 9.4	0, 28	28, --	--
10	**0.01**	0, 28	0, --	--	--

PCB, Acenaphthylene

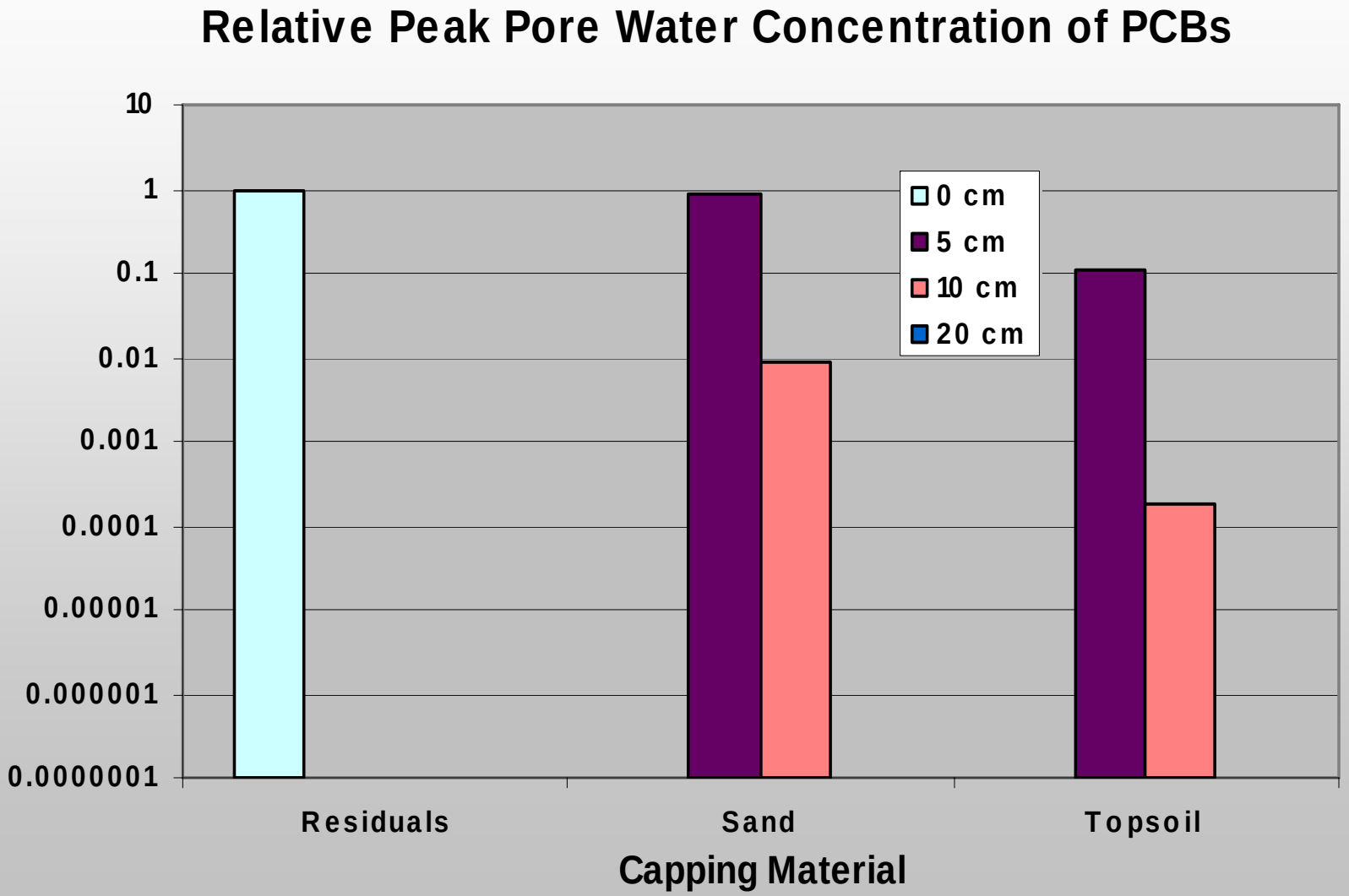
Analysis of Burial Effects

- **Natural Recovery**
  - Sites with burial rates > 5 cm/yr of clean material will reduce risk quickly (90% in < 2 years, 99% in < 4 years) without a cap
- **Minimal Isolation Caps (Thin Caps)**
  - Sites with burial rates less than 1.5 cm/yr of clean material will not reduce exposure risk quickly without at least a minimum isolation cap (dirty cap maintained below the bioactive zone)
  - Minimal isolation caps (10 to 15 cm) provides large risk reduction at low burial rates (less than 1.5 cm/yr) only for contaminants with high partitioning coefficients

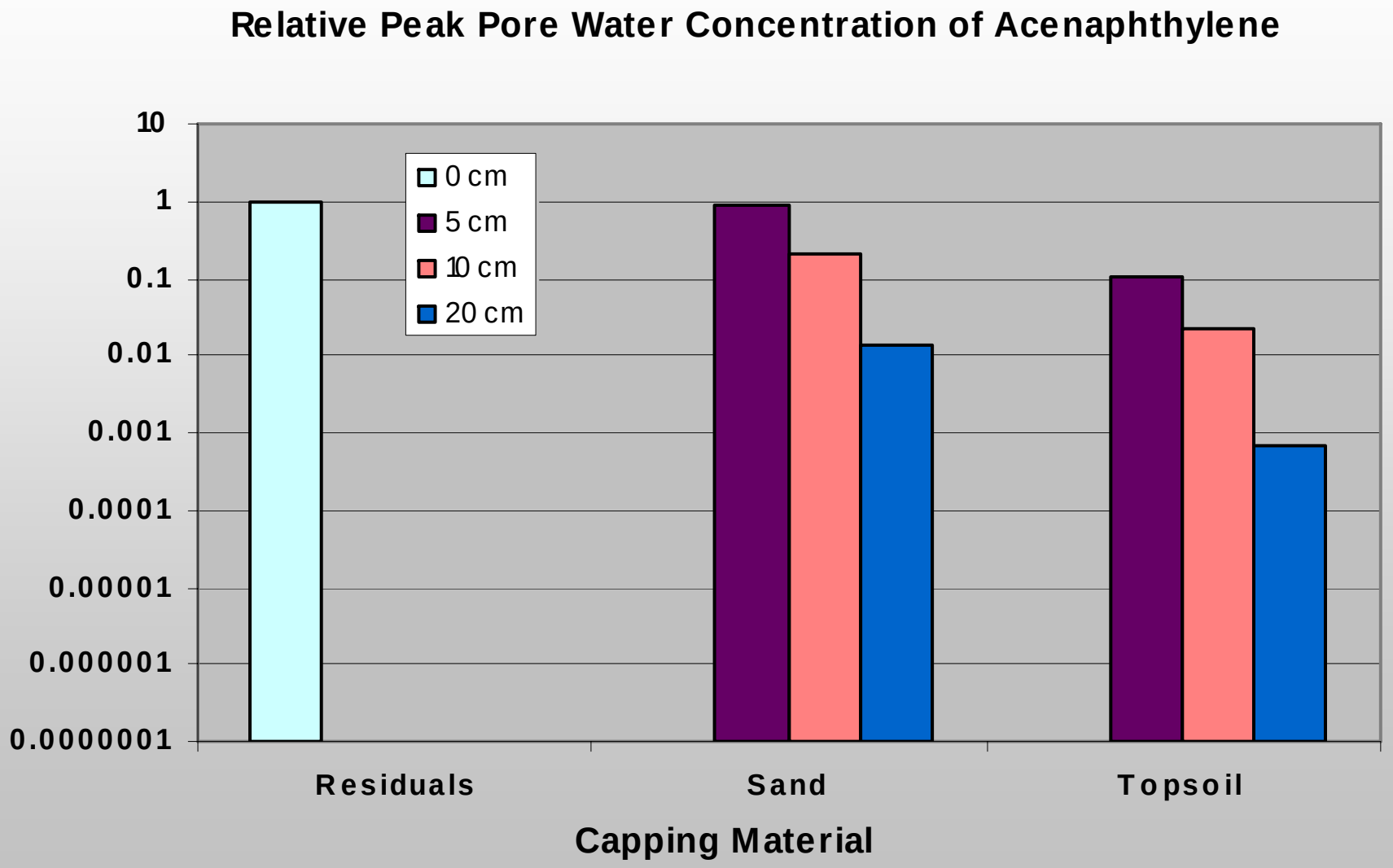
Analysis of Burial Effects

- **Dilution Caps (Enhanced Natural Recovery)**
  - Dilution caps with significant carbon content reduces risk relatively quickly for burial rates greater than 1.5 cm/yr
  - Dilution caps (5 cm) do not improve recovery without a significant carbon content

Effects of Cap Thickness



Effects of Cap Thickness



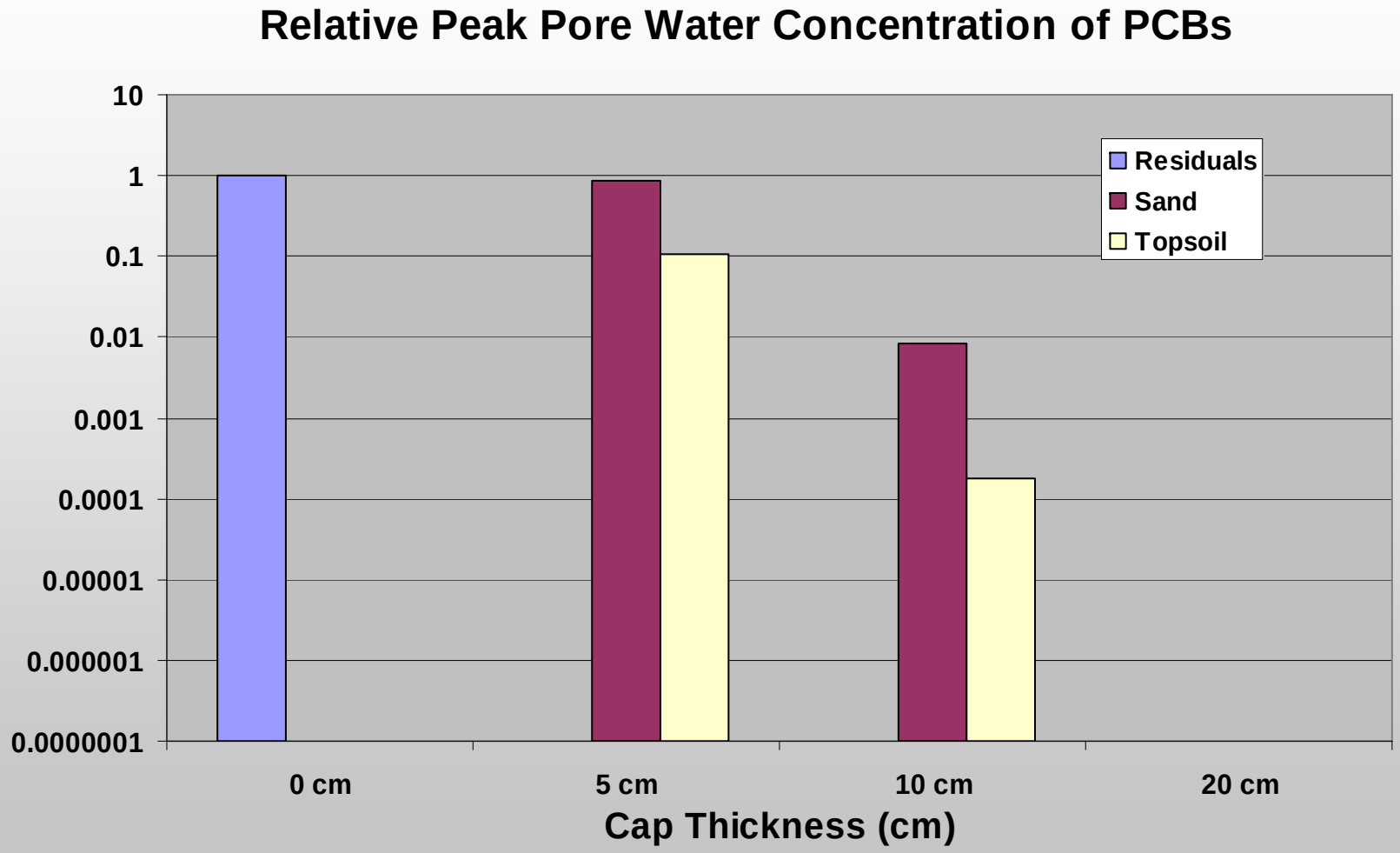
Analysis of Cap Thickness

- **Dilution Caps (5 cm)**
  - Dilution caps reduce exposure as a function of carbon content in the capping media
- **Minimal Isolation (Thin) Caps (10 to 15 cm)**
  - Reduces exposure 1 order of magnitude more than a dilution cap for mobile materials, weak function of carbon content
  - Reduces exposure 2 to 4 orders of magnitude more than a dilution cap for immobile materials, strong function of carbon content

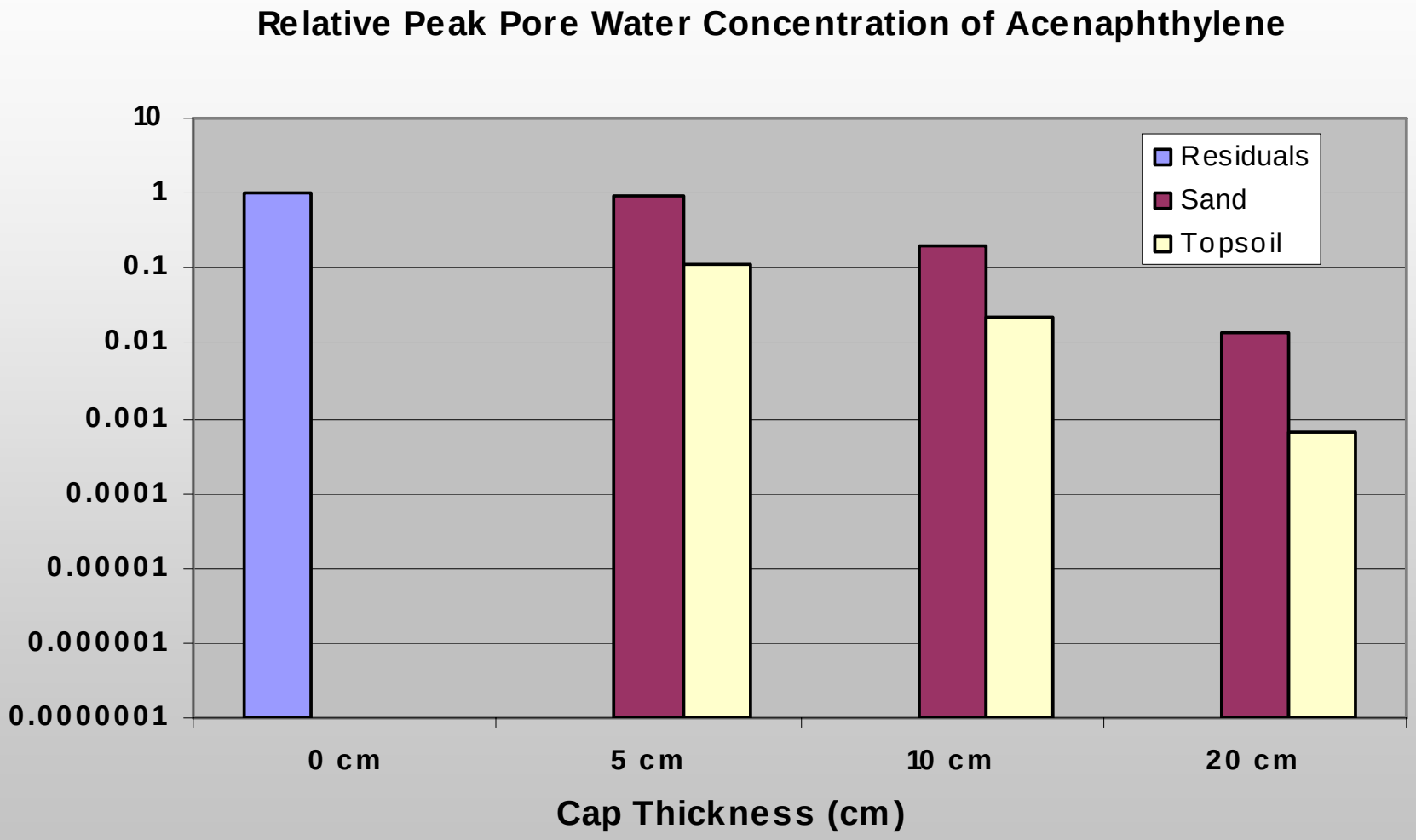
Analysis of Cap Thickness

- **Full Isolation Caps (minimum of 20 cm)**
  - Reduces exposure 2 orders of magnitude more than a minimum isolation cap (thin cap) for mobile materials, weak function of carbon content
  - Reduces exposure >6 orders of magnitude more than a minimum isolation cap for immobile materials, strong function of carbon content

Effects of Capping Media



Effects of Capping Media



Analysis of Cap Material

- **Function of Retardation Capacity**
  - Near linear function of carbon content for dilution and minimal isolation caps
  - More than linear function of carbon content for full isolation caps
  - Effects greater on low mobility contaminants

Analysis of Contaminant Effects

- **Caps are more effective for immobile contaminants.**
- **Full isolation caps are needed for mobile contaminants to perform as well as minimal isolation caps for immobile contaminants.**

Conclusions

- >5 cm/yr burial rates are needed to achieve rapid, significant risk reduction from residuals in the absence of management actions such as capping or amendments
- Capping material properties are important for mobile contaminants and for all dilution and minimal isolation caps
- Isolation is important for sites with low burial rates (less than 1.5 cm/yr); clean material should be placed above dirty cap material.
- Greater cap thickness and retardation capacity should be provided for mobile contaminants.