Anacostia Active Capping Demonstration Status

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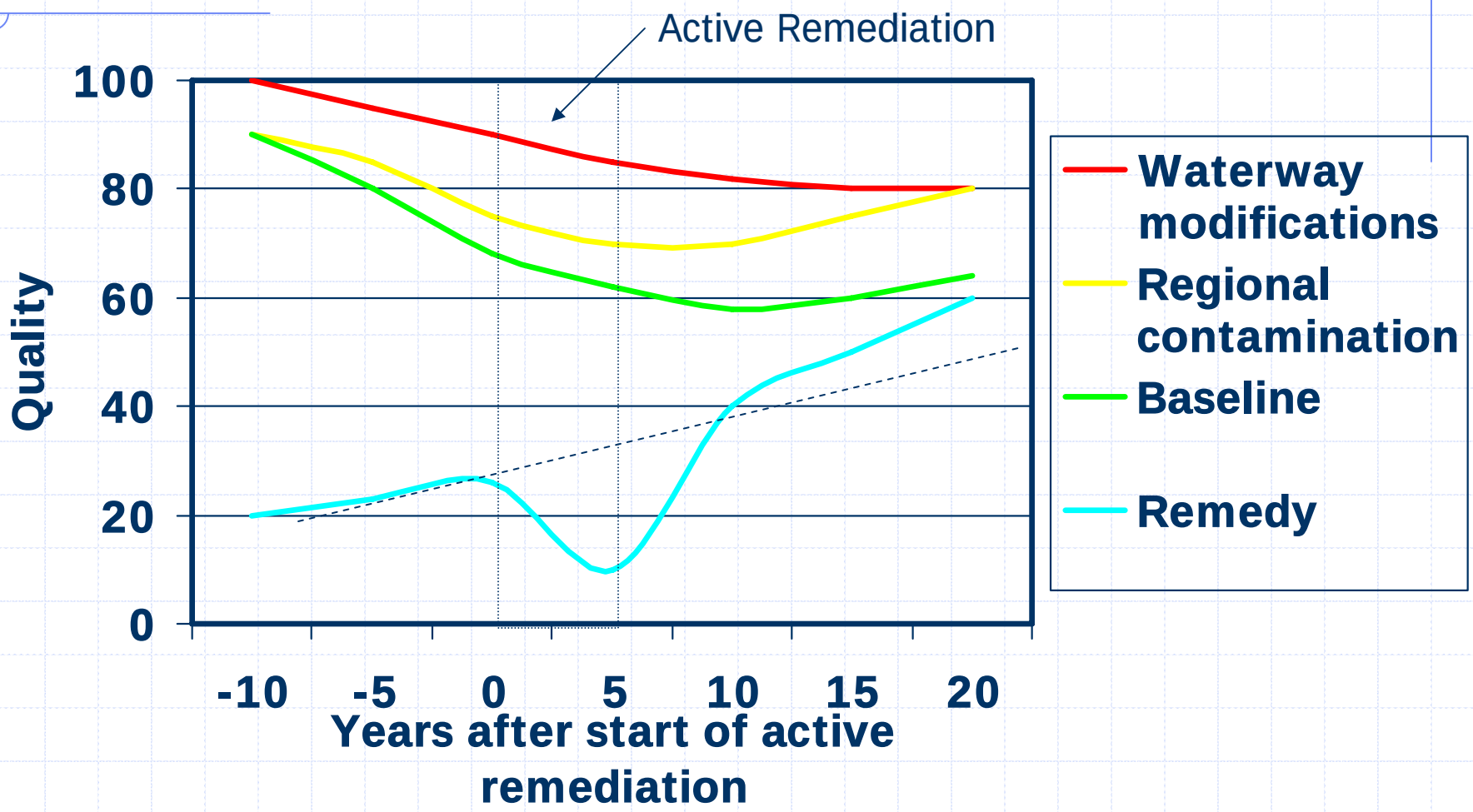
Remedy Performance and Effectiveness

- Short-term remedy performance.
  - Have sediment cleanup levels been achieved after implementation?
- Long-term remedy performance.
  - Have sediment cleanup levels been maintained for at least 5 years, and thereafter as appropriate?
- Short-term risk reduction.
  - Have remedial-action objectives been achieved?
  - Do data demonstrate or at least suggest a reduction in fish tissue concentrations, a decrease in benthic toxicity, or an increase in species diversity or other community indexes after 5 years?
- Long-term risk reduction.
  - Have remedial-action objectives been maintained for at least 5 years, and thereafter as appropriate?
  - Has the predicted magnitude and timing of risk reduction been achieved or are they likely to be achieved?

Ideal Recovery Scenario



Background

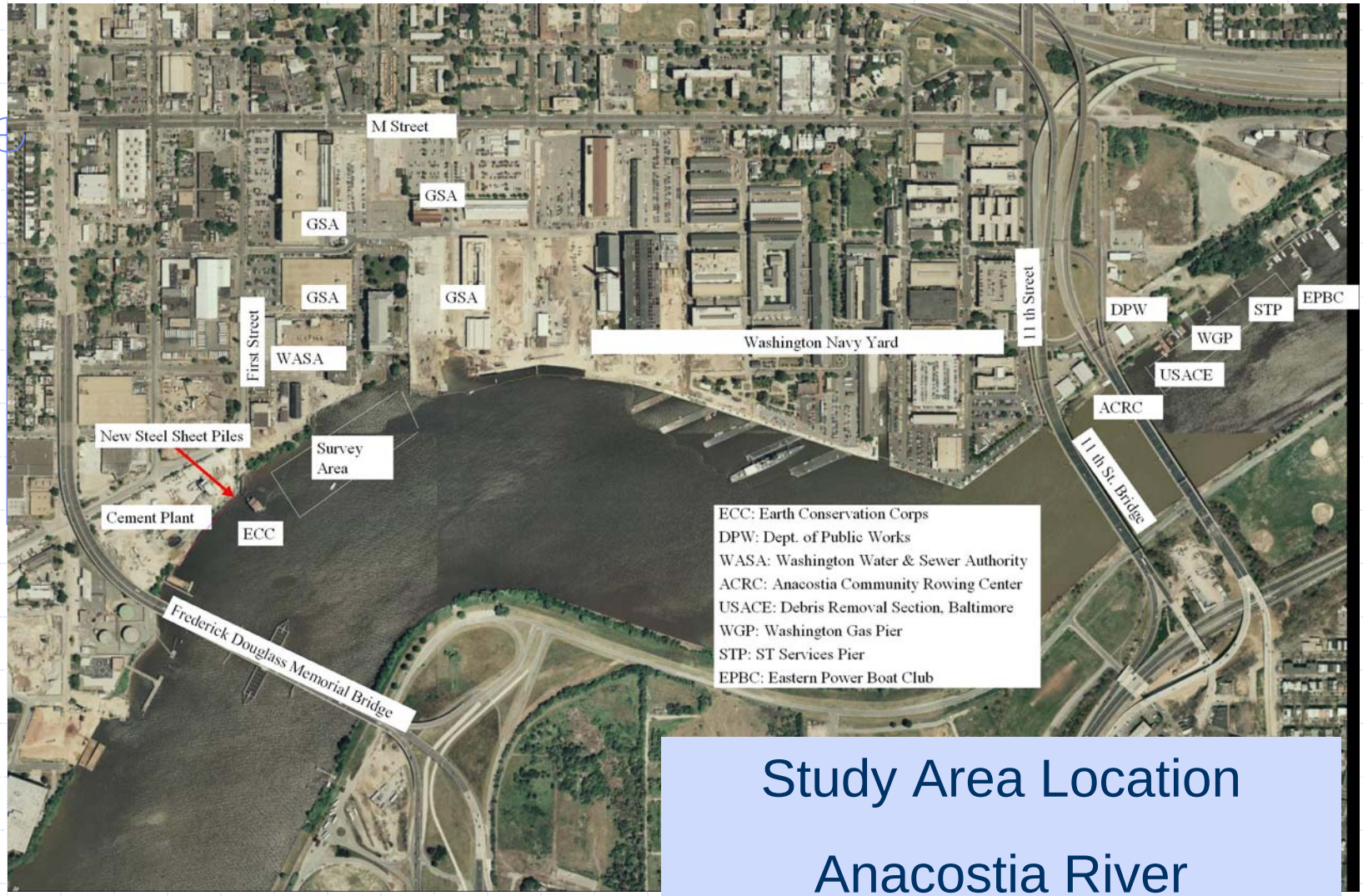
- Dredging effectiveness uncertain
  - *Sediment Dredging at Superfund Megasites:Assessing the Effectiveness,* National Research Council Report 2007
  - Site factors reduce effectiveness (e.g. debris)
  - Monitoring has been inadequate to demonstrate effectiveness
- Capping with sand easy to implement but may not be sufficiently protective (e.g. groundwater upwelling)
- Alternative – “active” capping
  - Capping with sequestering or reactive components to aid cap effectiveness
  - Demonstration of placement and containment effectiveness in Anacostia River, Washington DC
  - Demonstration of organoclay for NAPL containment
    - Creosote- Portland, Oregon
    - Manufactured gas plant wastes – New York

EPA Hazardous Substance Research Center

South and Southwest

Louisiana State University
Georgia Institute of Technology
Rice University
Texas A&M University
University of Texas
www.hsrc-ssw.org www.sediments.org

- Research and Technology Transfer
  - Contaminated sediments and dredged material
  - Historically focused on in-situ processes and risk management
  - Unique regional (4&6) hazardous substance problems
- Outreach
  - Primarily regional in scope
  - Driven by community interests and problems
- Courses - Application of US Sediment Remediation Guidance
  - Next Course, September 5-7,2007 Portland, Oregon, USA



Study Area Location

Anacostia River

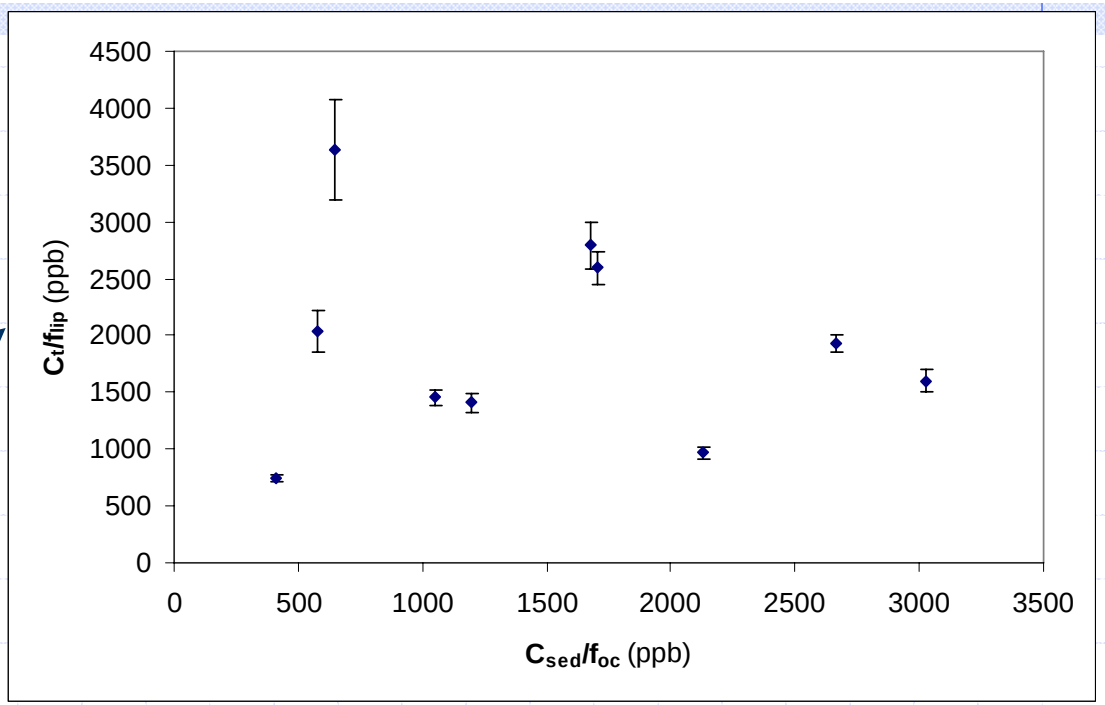
Washington DC

Project Tasks

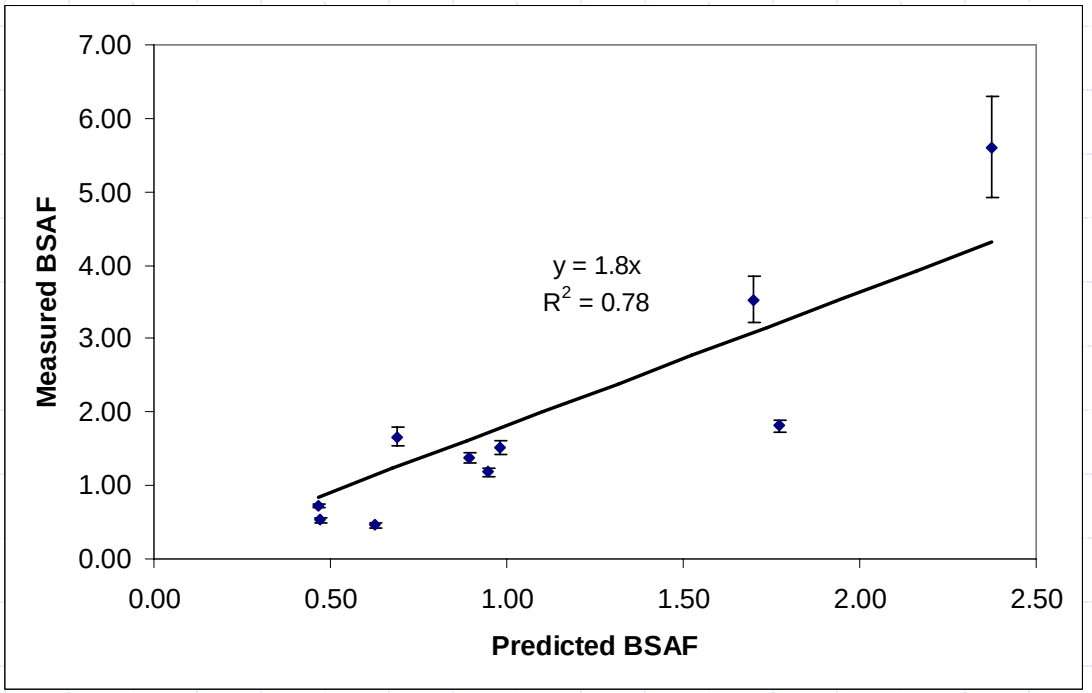
- Lab Testing/Selection of materials (2002-2003)
- Site Characterization (2003)
- Cap Placement (March-April 2004)
  - Apatite, Aquablok, Sand placed via clamshell
    - Goal – place thin (6”) active layer overlain by 6” sand with conventional equipment using gravity settling to control disturbance of soft sediment
  - Coke Breeze placed in laminated mat
    - Goal- test placement of neutrally buoyant or expensive materials in controlled manner
    - Coke originally chosen as one of few bulk carbon sources economically feasible
      - Also employed activated carbon and organoclays both in bulk and in mat
- Monitoring performance (Ongoing through 2008)

Bioaccumulation

Little or no correlation with bulk solid phase concentration



Significant correlation with dissolved phase concentration

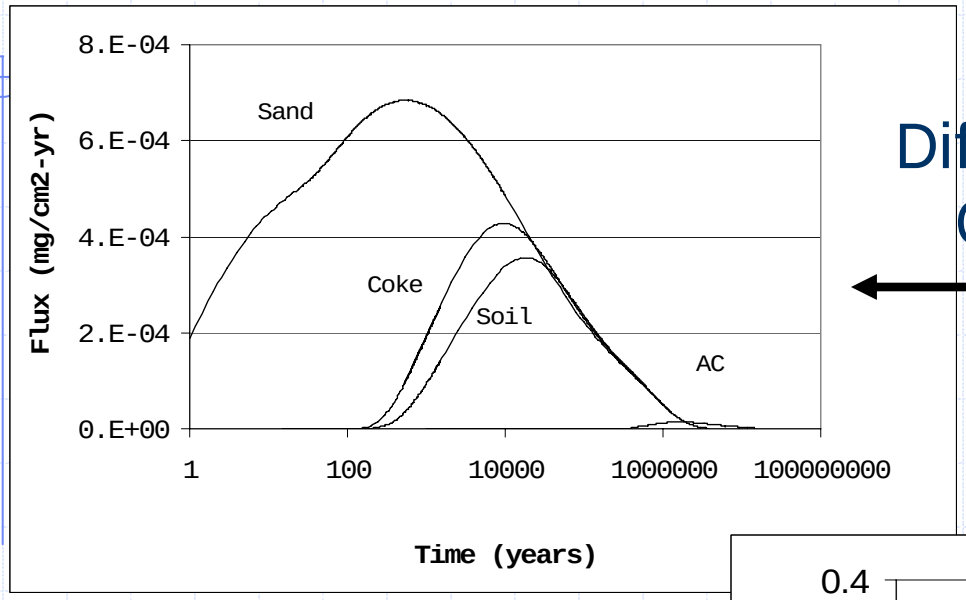


Sorbents for Sequestration and Bioavailability Reduction

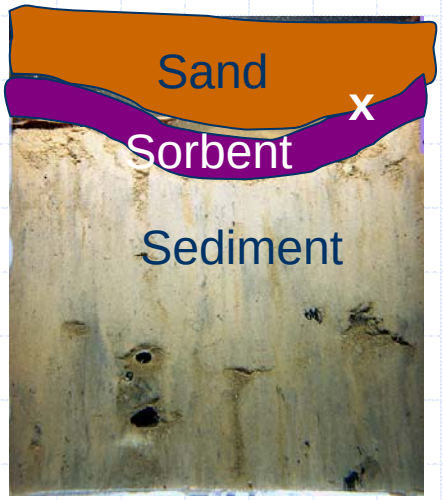
- PAHs/PCBs sorbed to sorbing organic phase is less bioavailable
  - Reduces porewater concentrations
  - Reduces potential for accumulation in organisms
- R.G. Luthy – developing method of direct addition of activated carbon (AC) to sediments
- Our work -use of organoclays (OC) & other amendments in caps

Measured PCB sorption coefficient (K_f)

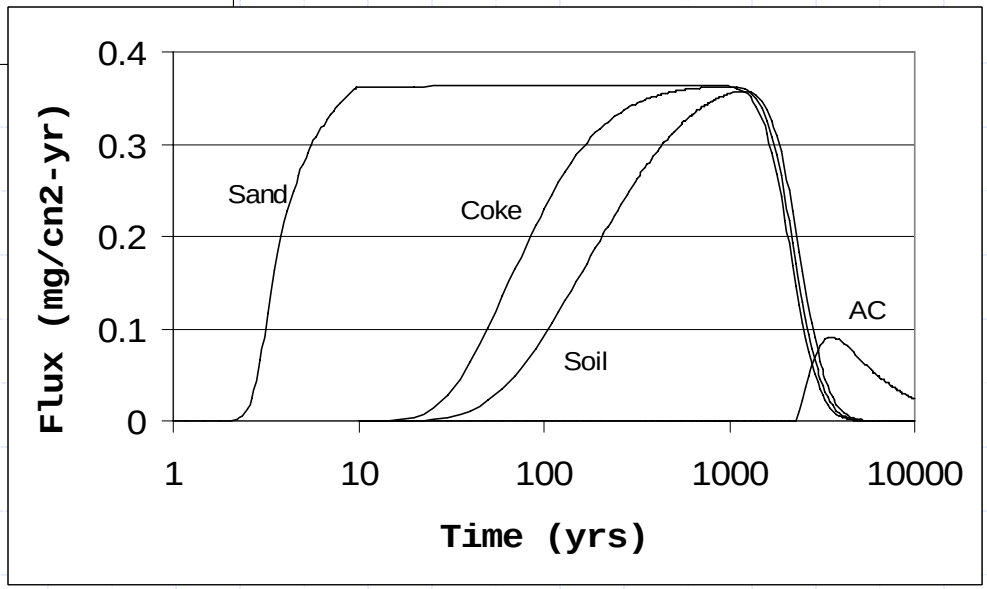
2,4,5-PCB Isolation Provided by Sorbent-amended Thin Layer (1.25-cm) Caps



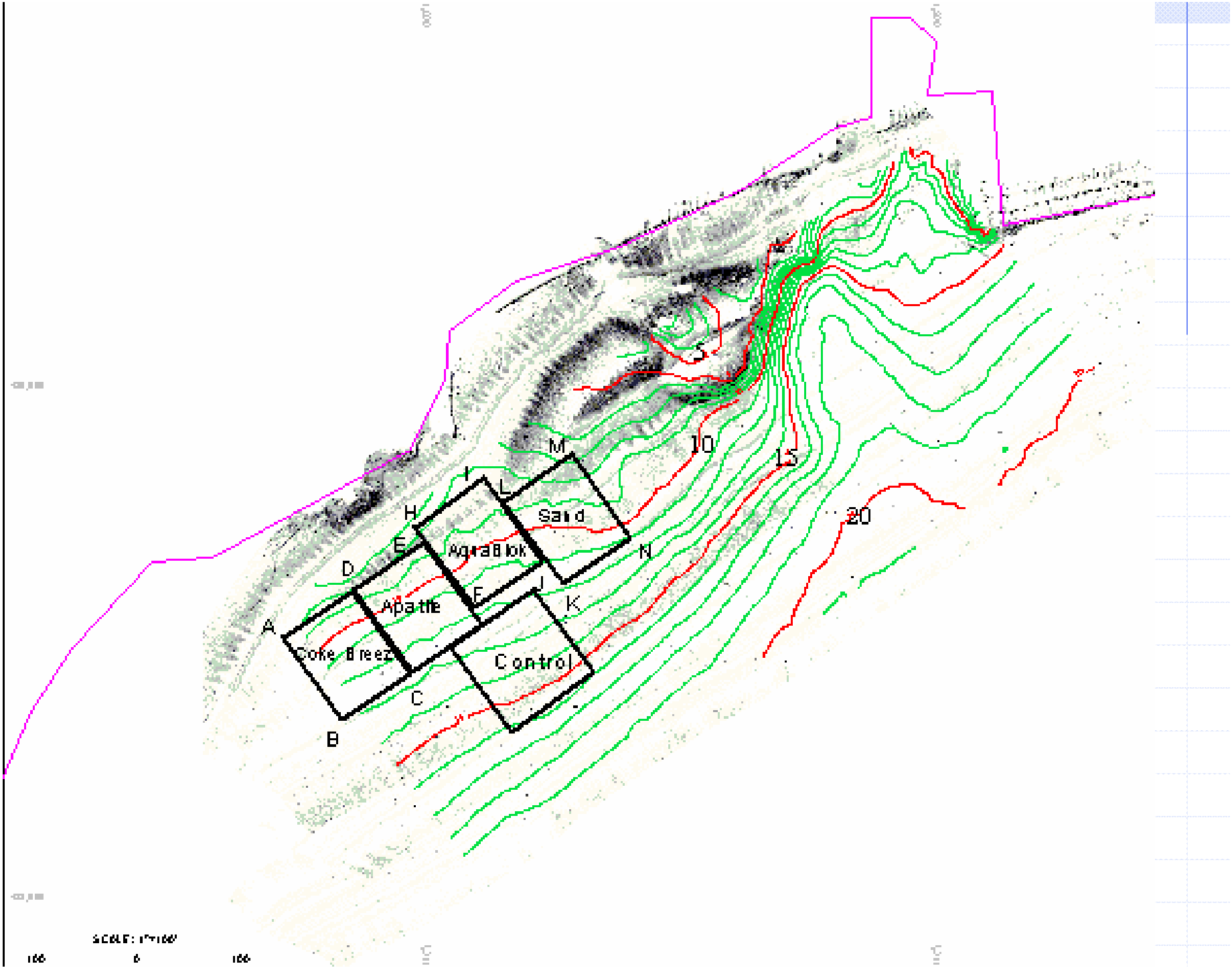
Diffusion Only



Advection and Diffusion



(Murphy et al., 2005)


A
B
C
D
E
F
G
H
I
J
K
L
M
N
Coke Breeze
Apatite
Agrabiok
Sand
Control
5
10
15
20

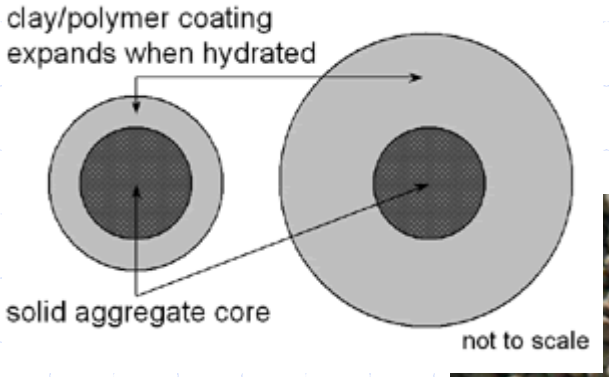

JLG

Reactive Core Mat (RCM) Production

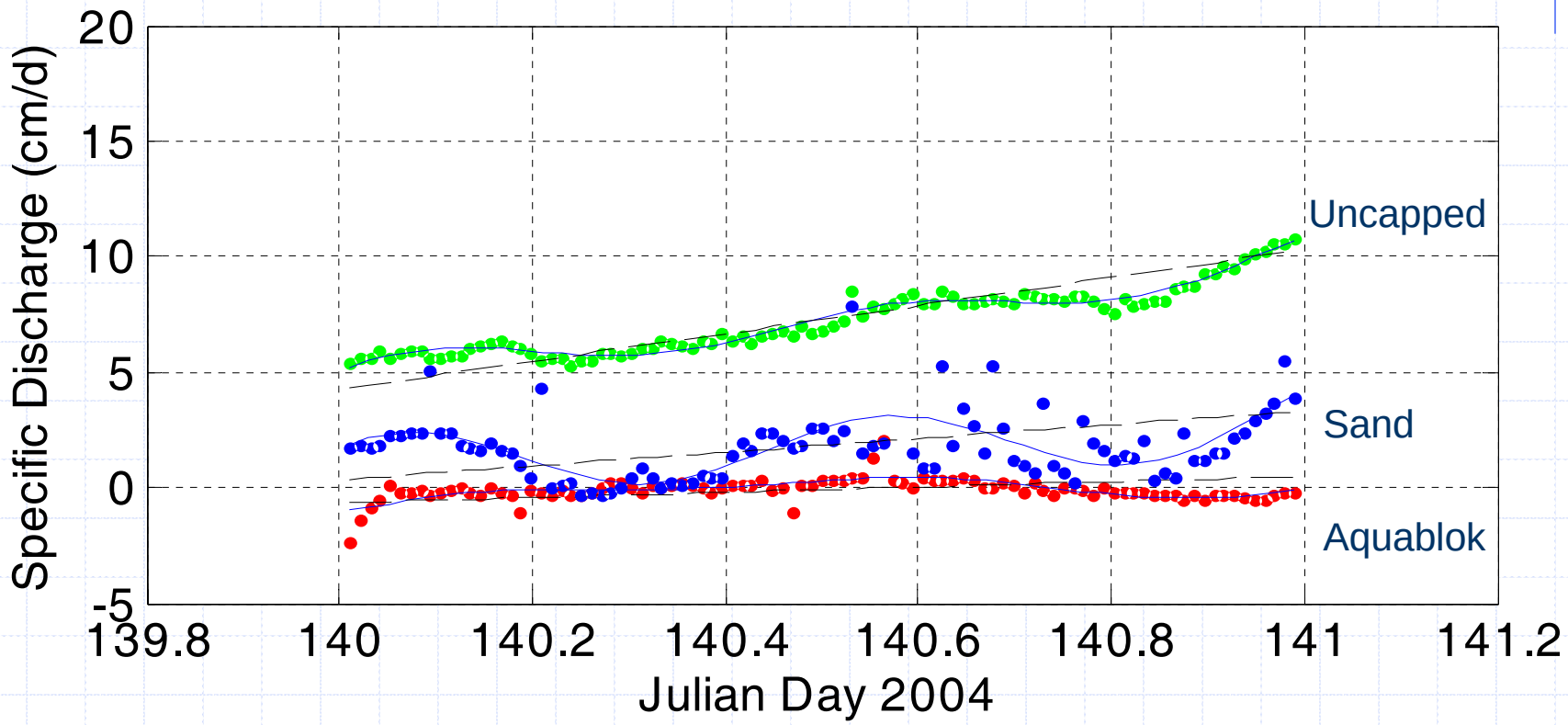
RCM Placement

Organoclay filled mats for oil seep control- M&B Site

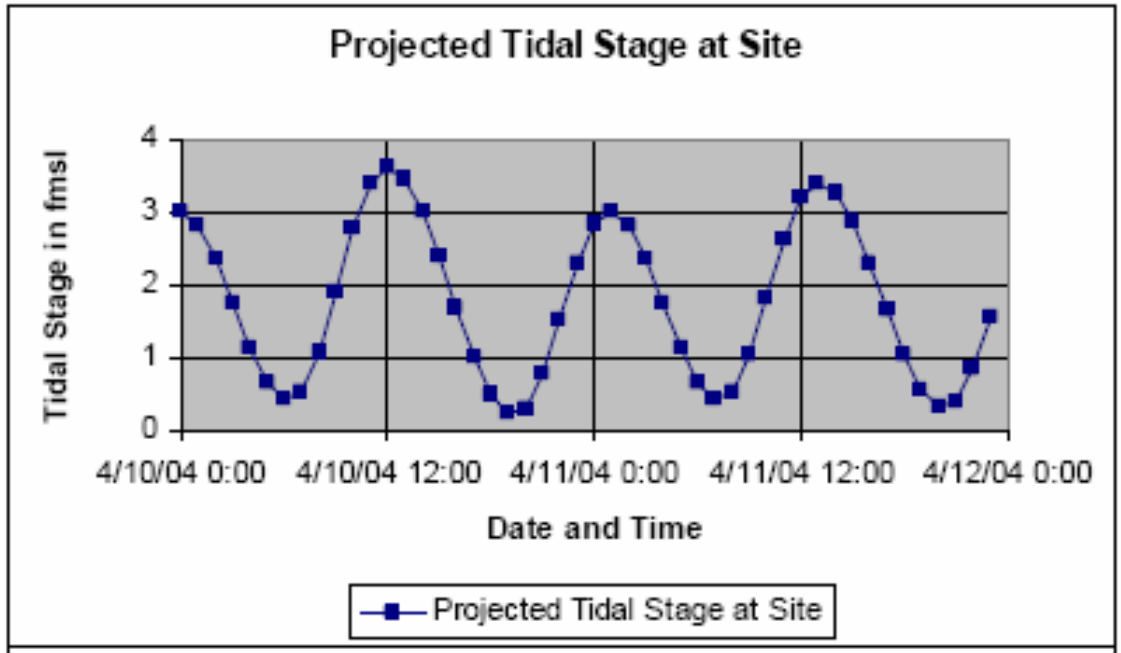
AquaBlok -Clay Polymer Material for Permeability Control

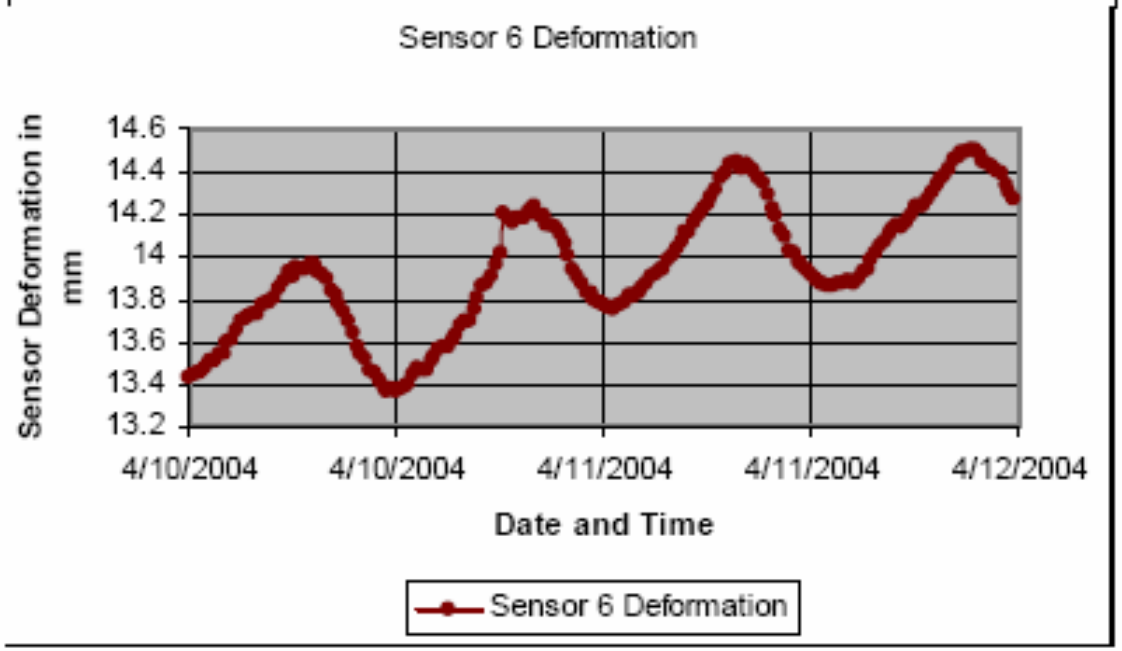


Seepage Rates – Post Placement



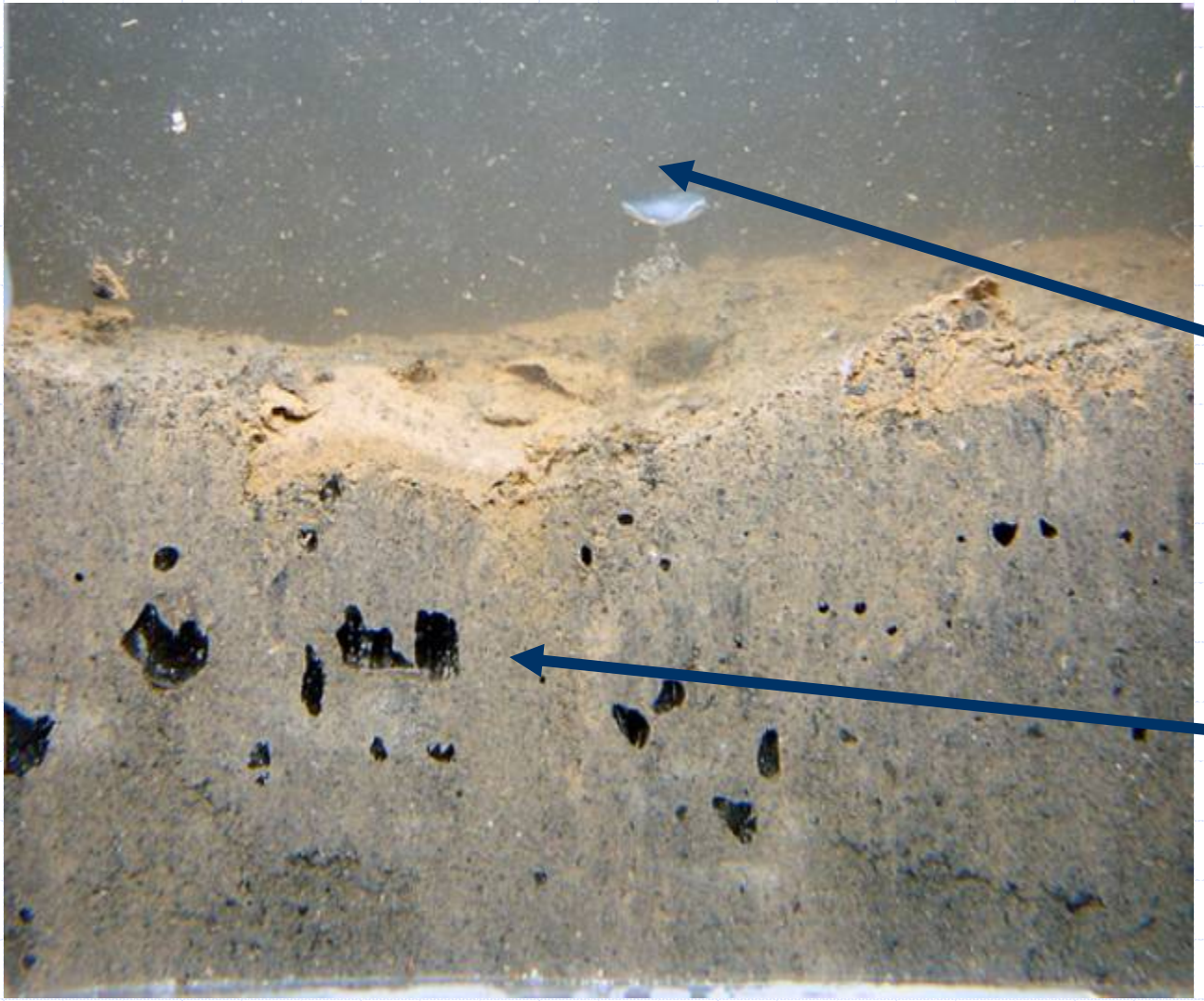
Smith, 2004





Uplift in direct response to tidal forcing with little or no lag time

Sediment Camera Image – Anacostia River



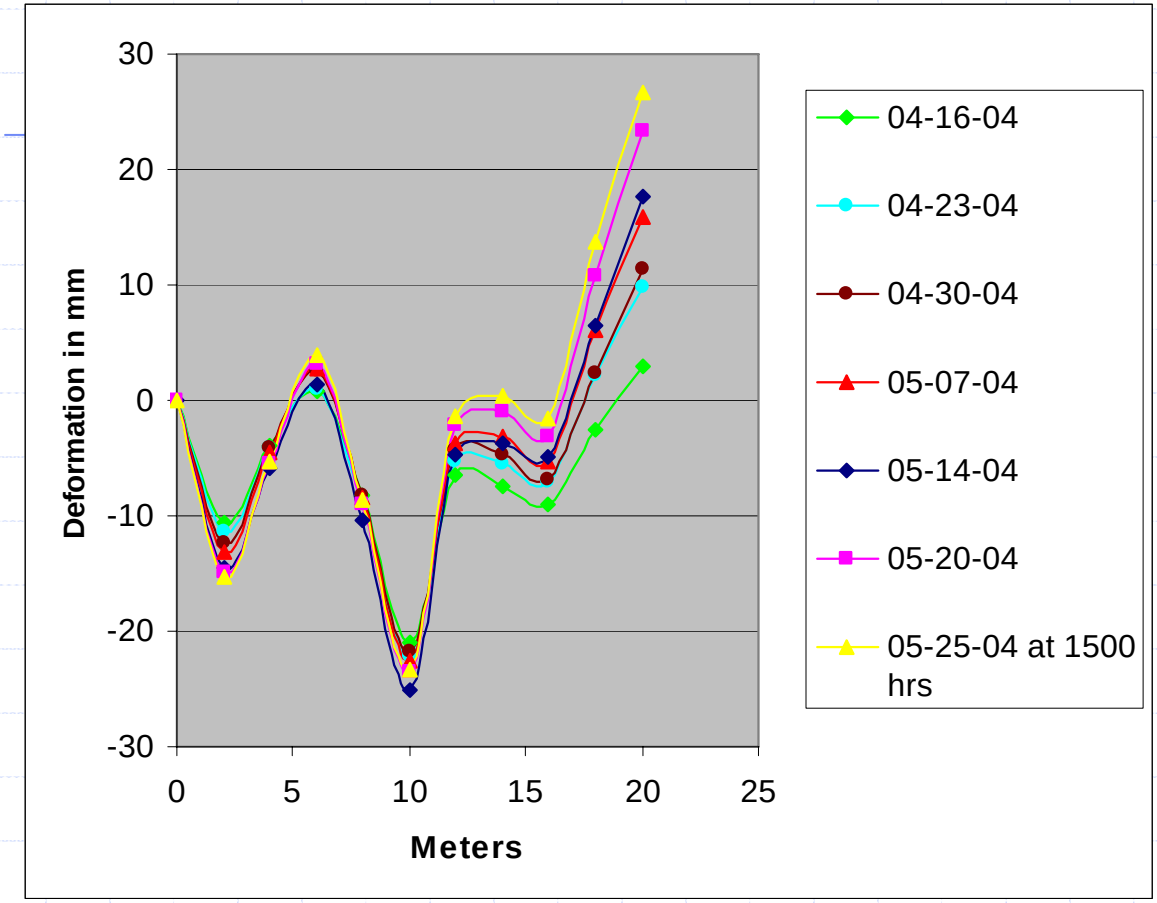


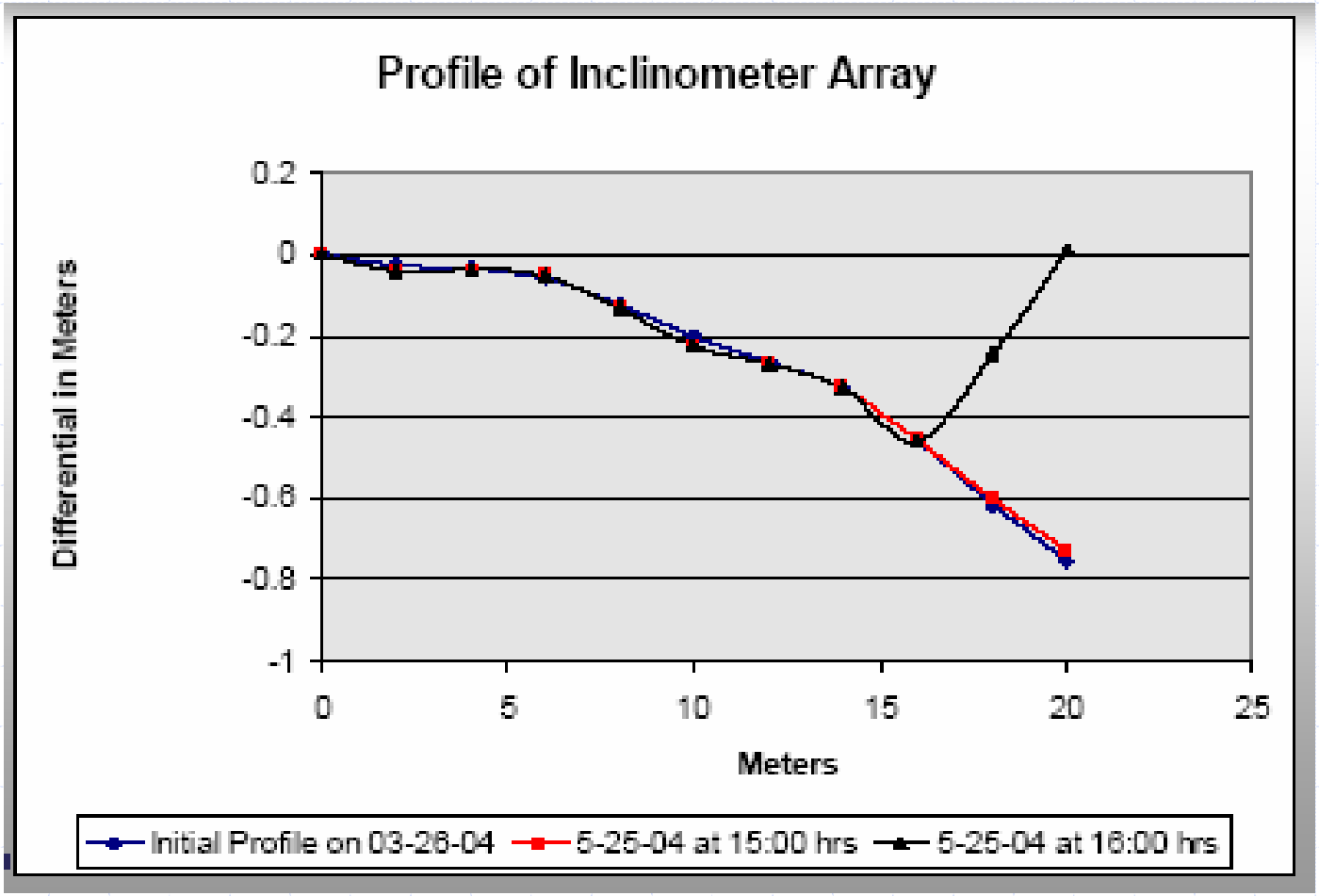
FIGURE 2

Cap Deformation During the Period 4/16/4004 through 5/25/04 1500 hrs

Anacostia River Sediment Capping Research Project
Washington, D.C.

HydroQual, Inc.

Gas related uplift of impermeable cap (AquaBlok)



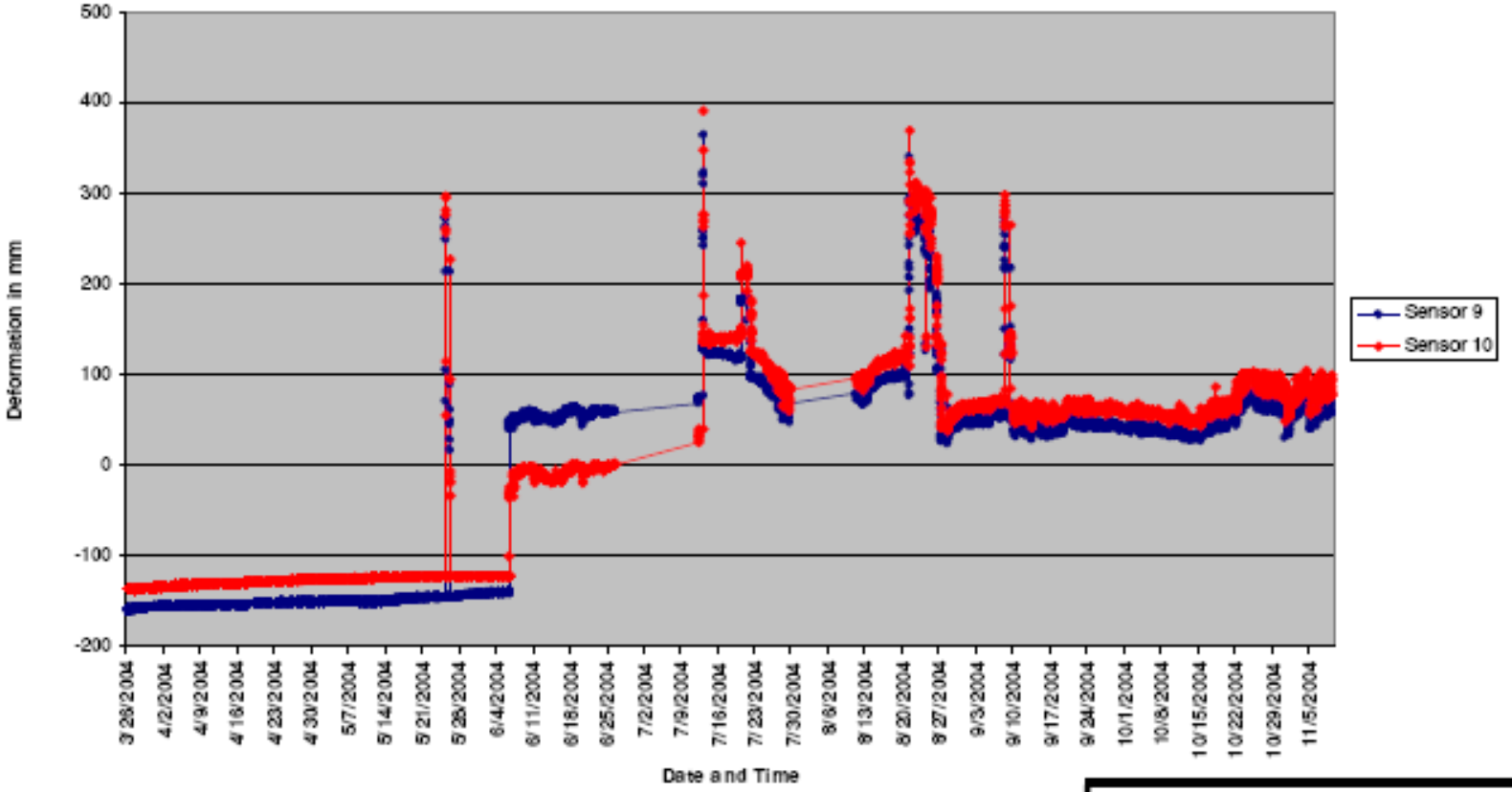


FIGURE 3-9

Deformation of Sensors 9 and 10 over Time

Anacostia River Study
Washington, D.C.

HydroQual, Inc.

AquaBlok Cap

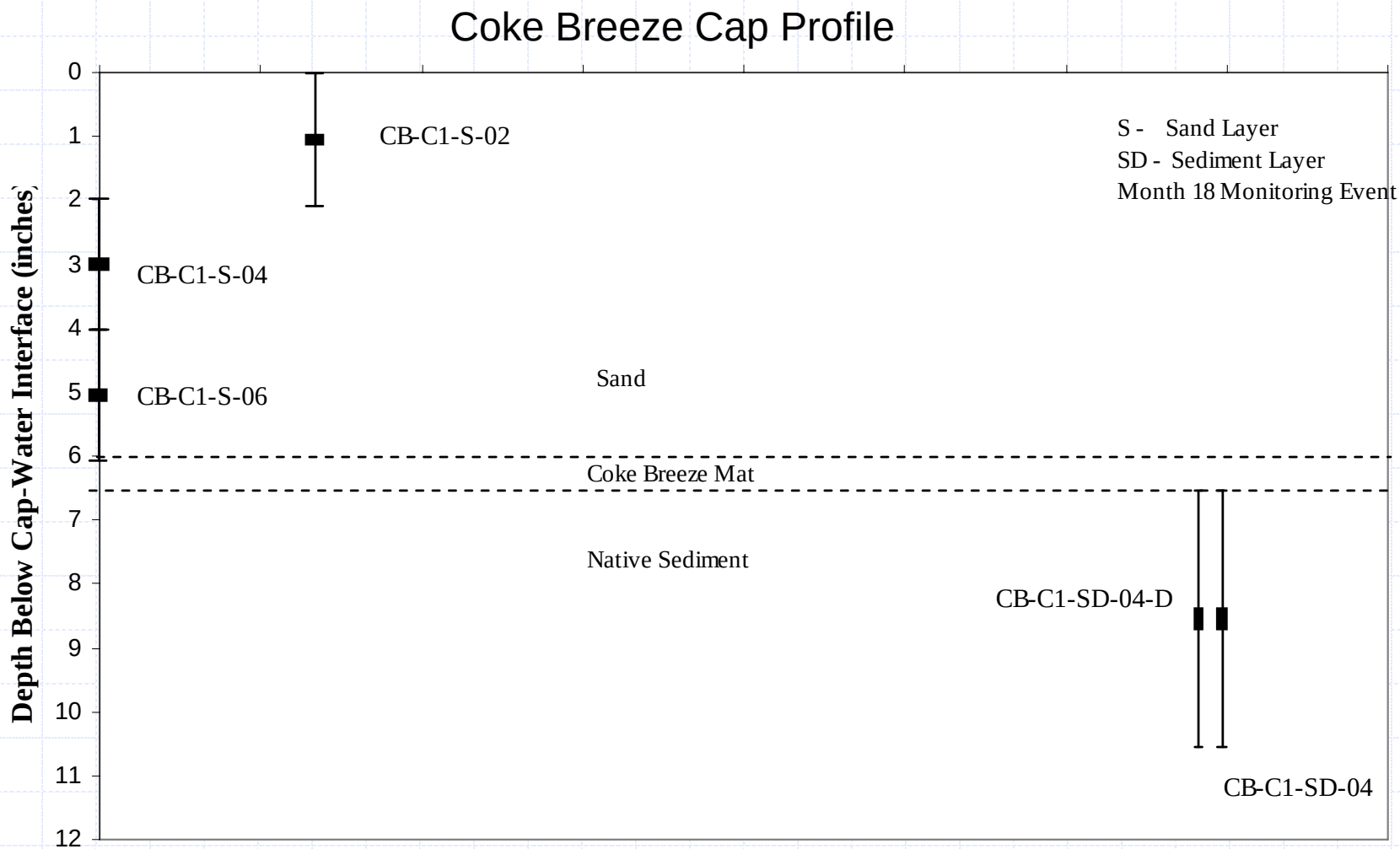
- Successful at diverting groundwater upwelling
- Some heaving due to tidal pressure variations
  - Uplift ~ 1 mm
  - No observable impacts
- Gas accumulation led to cap uplift
  - Uplift approximately 20 mm before rapid release
  - Accumulation and release on 14-60 day cycle
  - Gas release decreased significantly by second season (labile organic carbon reduction)
  - Suggests 2 stage capping could be effective
    - Sand capping to exhaust labile organic carbon
    - Clay placement in 2nd season to divert upwelling from contaminated sediment

Effectiveness of other caps?

Basic Question

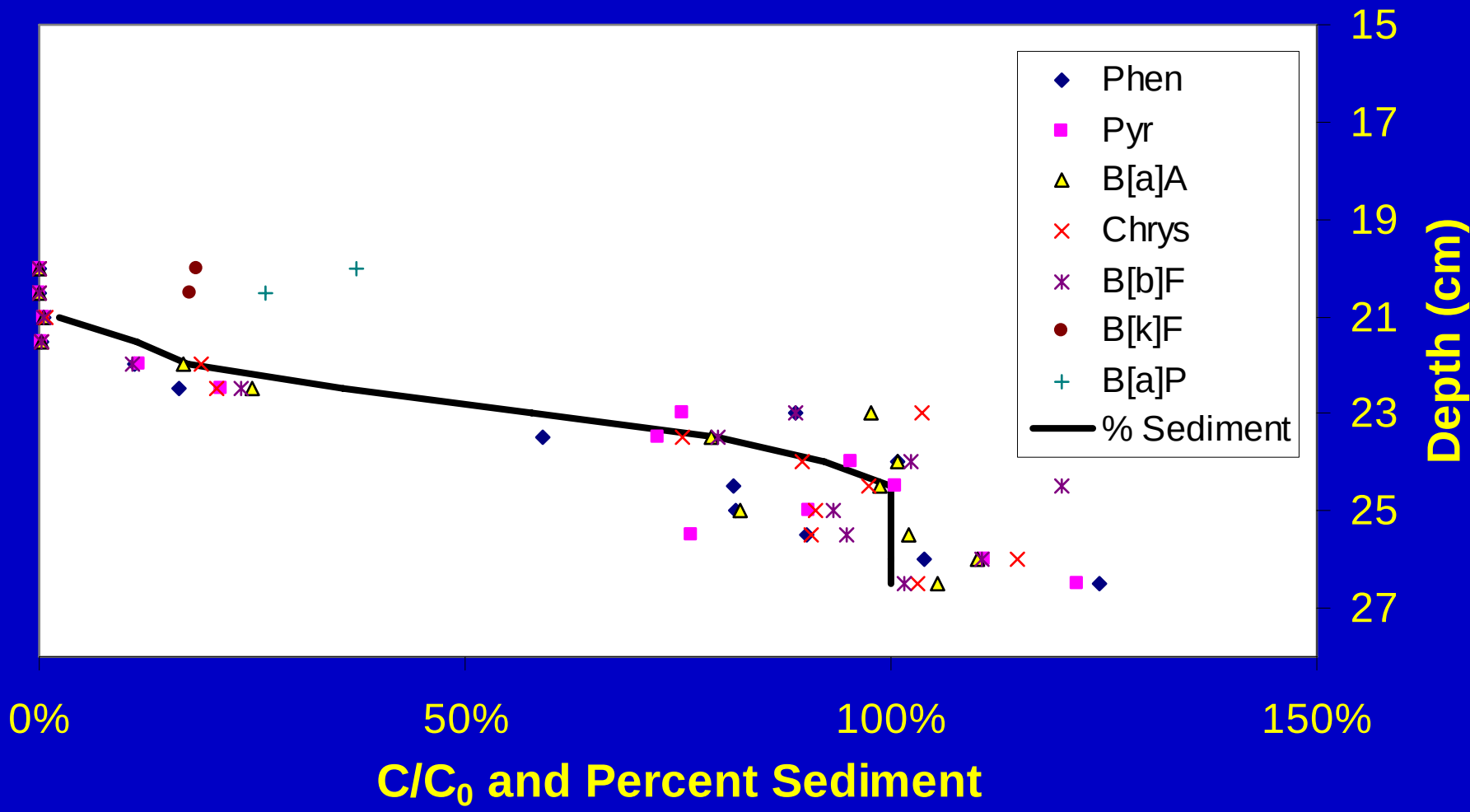
Are organic and metal sequestration layers more effective than sand?

Caps Effective but Continuing Sources have led to Surface Recontamination



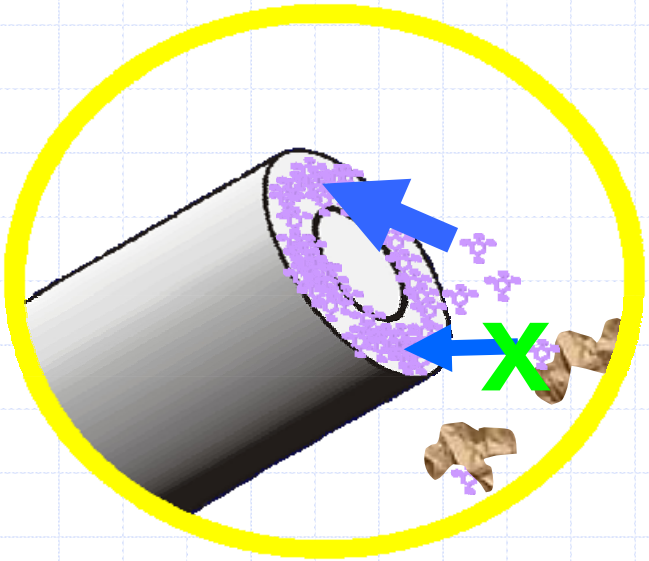
But all caps effective - hard to differentiate

Cap PAHs Percent Sediment and C/C_0 versus Depth

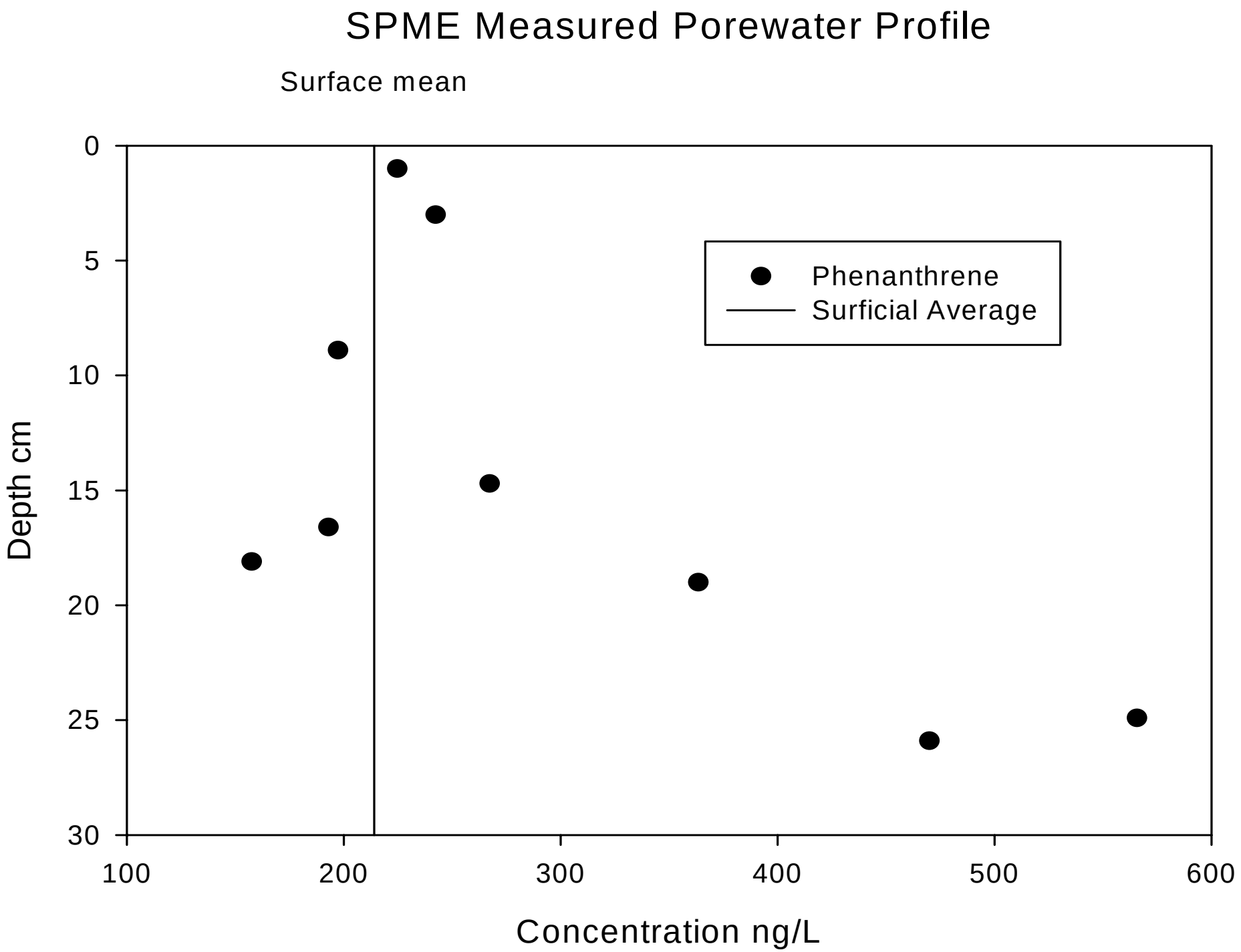


Solid Phase MicroExtraction Sorbent Polymer

- PDMS (poly-dimethylsiloxane)
  - Thickness of glass core: 114-108 µm
  - Thickness of PDMS coating: 30-31 µm
  - Volume of coating: 13.55 (±0.02) µL PDMS per meter of fibre



Field Deployment System


SPME Measured Porewater Profile
Surface mean
Phenanthrene
Surficial Average
Depth cm
0
5
10
15
20
25
30
100
200
300
400
500
600
Concentration ng/L

Lessons being Learned

- Innovative cap materials possible to place in thin layers (15cm) using conventional equipment with experienced contractor
- A laminated mat provides opportunities for controlled placement of light and/or high value materials
- Low permeability AquaBlok cap
  - Evidence of “heaving” with tidal fluctuations- no apparent impact
  - Effectively diverted seepage further into river
  - Trapped gas leading to irregular release
- Conventional sand caps very effective
  - Difficult to differentiate effectiveness of active caps
  - Current pore water sampling initiative expected to better demonstrate effectiveness of active caps
- Surficial sediments can be recontaminated w/o source control

Active Capping Status Summary

- Active capping can provide greater effectiveness for specific problems
  - Mobile dissolved contaminants
    - Activated carbon/coke
    - Organoclay
  - Mobile NAPL
    - Organoclay
  - Control of upwelling
    - Clay polymer (AquaBlock or benthonite in mat)
- Effectiveness likely better measured by dissolved concentrations, not bulk sediment concentrations
- Conventional sand capping effective for typical sediment contaminants
  - Hydrophobic, strongly sorbed contaminants
- Summary in Journal *Remediation* Dec 06