



In Situ Technologies for the Remediation of Contaminated Sediments

Federal Remediation
Technologies Roundtable Meeting
June 5, 2008



Kelly Madalinski
Office of Superfund Remediation and Technology Innovation
madalinski.kelly@epa.gov or 503-326-6831

In Situ Treatment and Reactive Capping

- Advantages
- Challenges
- Status
- Trends



In Situ Treatment – Continued Interest

- **Permanence and preference for treatment**
- **Perceived cost advantages and implementation time**
- **2006 National Institute of Environmental Health Sciences (NIEHS) Funding Opportunity – Superfund Basic Research Program**
- **2004 SERDP/ESTCP Expert Panel Workshop (Charlottesville, VA)**
- **2004 EPA Remediation Technologies Development Forum Workshop (Baltimore, MD)**

Means of Achieving Treatment

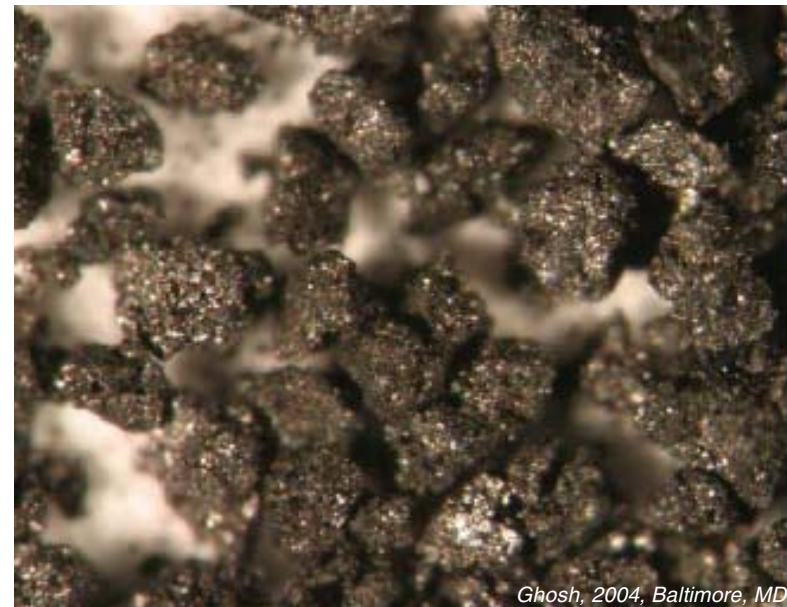
Based on mechanism

➤ Sequestration

- » Reducing contaminant exposure (bioavailability)
- » Focus on Activated Carbon
- » Hunters Point Naval Shipyard, San Francisco Bay, CA
- » Grasse River, Massena, NY

➤ Biological and Abiotic Degradation

- » Destroying/transforming contaminants
- » Biological
- » Abiotic degradation



Ghosh, 2004, Baltimore, MD

Challenges – Emplace, Contain, Assess

Engineering

- **Deliver amendments/reagents**
- **Ensure adequate mixing**
- **Keep amendments/reagents in place**

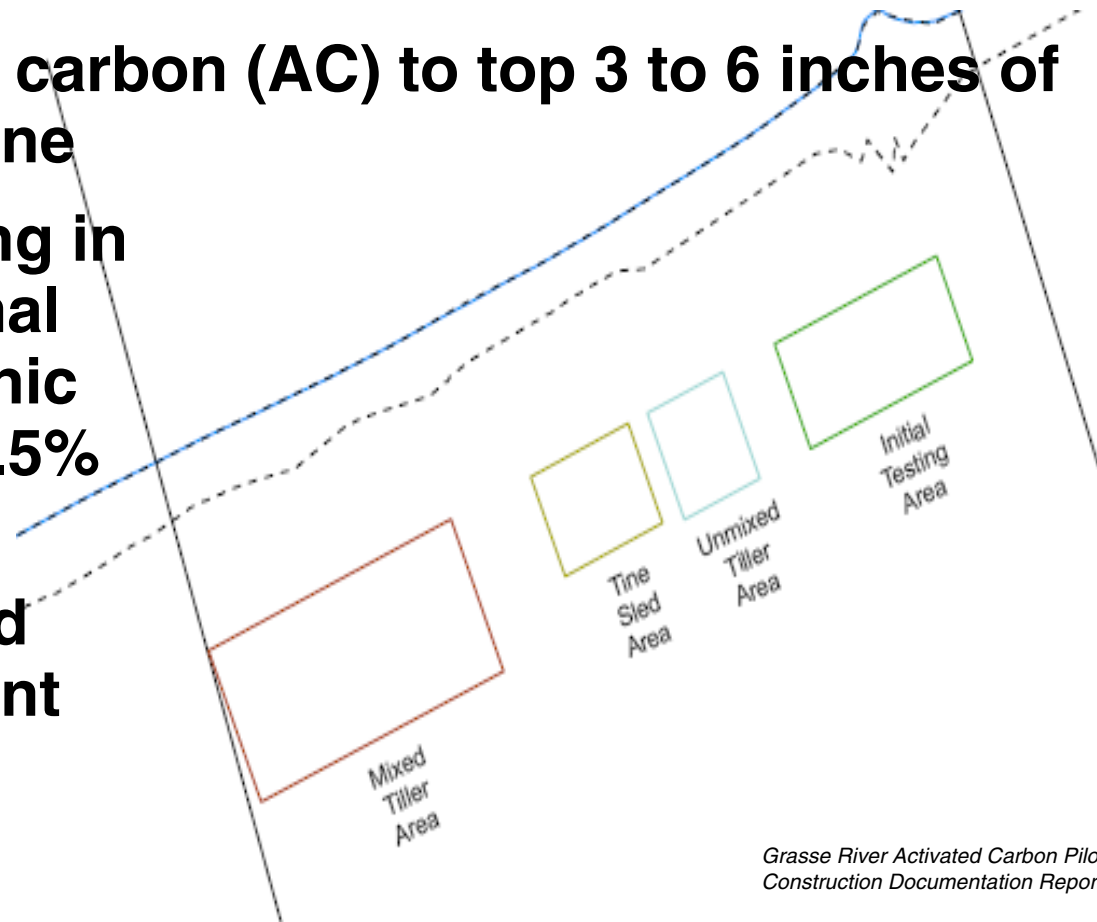
“Process Level” Challenges

- **Strong Adsorption**
 - » High organic content
 - » Hydrophobic chemicals
- **Low permeability**
 - » High percentage of silts/clays



Grasse River, NY Demonstration

- **PCB contamination (4-13 ppm) in 0.5 acre demonstration area**
- **Applied activated carbon (AC) to top 3 to 6 inches of biologic active zone**
- **PCB uptake testing in lab showed optimal reduction in benthic organisms with 2.5% AC (dry weight)**
- **Test roto-tiller and tine sled placement equipment**



Grasse River Demonstration

- **AC dosage ranged 3.2% to 5% (dry weight) in top 3 inches**
- **18,000 lbs of AC applied**
- **Water column PCB data indicated small increases adjacent and downstream of pilot study**
- **Greater small-scale variability observed with tiller than tine sled**
- **2 year post monitoring**



PRP sponsored web link:

http://www.thegrassriver.com/2006_ActCarbon_Pilot.htm

Status and Trends

- **Research efforts are underway (e.g., NIEHS SBRP and SERDP/ESTCP)**
- **Multiple field tests will continue to be necessary**
- **Questions (inevitable) on long-term performance**
- **Low-impact delivery systems being developed (e.g., SediMite™)**
 - » **Menzie, Ghosh, et al.**
 - » **Agglomerate containing treatment reagents**
 - » **Conceptually, sinks to sediment surface and resists resuspension**



Menzie et al, 2007

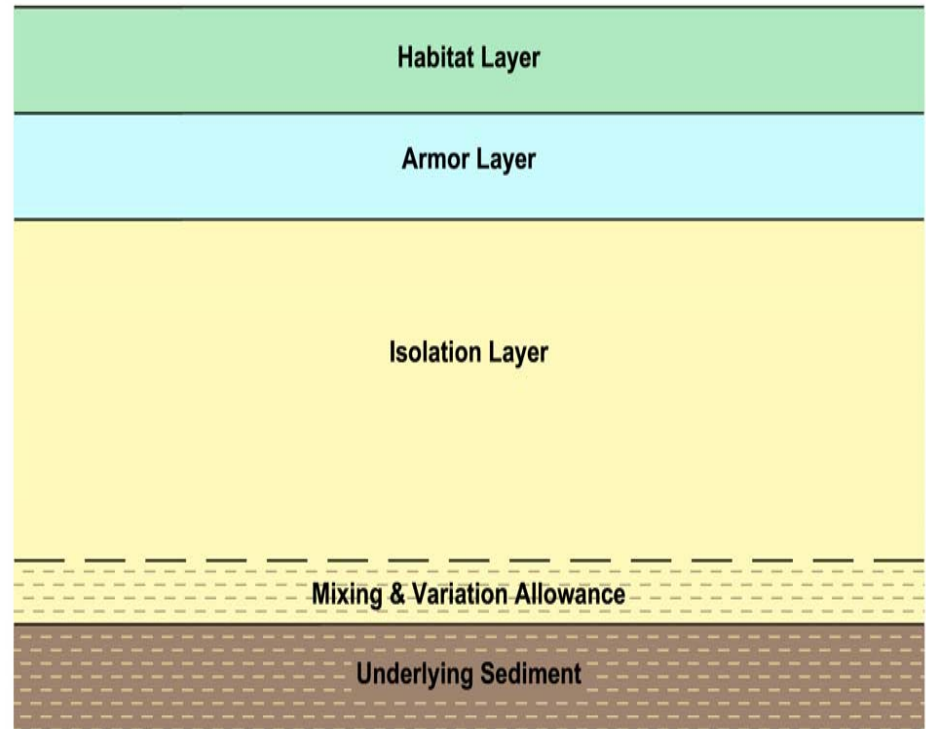
NIEHS – Superfund Basic Research Program

- Stanford: Activated Carbon as a Multifunctional Amendment to Treat PCBs and Mercury (Richard G. Luthy)
- UC Merced: Sequestration and Immobilization of Metal and Metalloid Contaminants in Sediments (Peggy A. O'Day)
- UM Baltimore County: Pilot-scale Research of Novel Amendment Delivery for In-situ Sediment Remediation (Upal Ghosh)
- UT Austin: Funnel and Gate Innovations - Stabilization and Treatment of Contaminated Sediments (Danny Reible)
- U Missouri Rolla: In-Situ Sediment Remediation Using Benthic Waterjet Amendment Placement (Joel G. Burken)
- Medical U South Carolina: Integrating microbial biostimulation and electrolytic aeration to degrade POPs (Harold May)
- Northeastern U: A reactive mat to remediate contaminated sediments and reduce health risks (Thomas Sheahan)

Capping

➤ Functions

- » Physically isolate contaminated sediments
- » Stabilize sediments
- » Reduce chemical flux to benthic organisms and water column



EPA Sediment Remediation Course 2005, Chicago, IL

➤ Sand material typical design

➤ Applied at a number of sites

<http://www.sediments.org/capping-chart.html>

Why Reactive Caps?

- **Enhance control of contaminant migration (flux)**
 - » Increase sorption capacity
 - » Facilitate degradation
- **Deliver amendments in a controlled manner**
- **Potentially address**
 - » NAPL residual present or expected
 - » Gas (NAPL) releases
 - » Manage consolidation effects
 - » Limit loss of water depth



*Second Five-Year Review Report
McCormick and Baxter, September 2006*

Reactive (Treatment) Materials

Demonstrated



- **Activated Carbon or other carbon sources**
- **Organoclays**
 - » NAPL control
- **Phosphate additives (Apatite)**
 - » Metals
- **Zero valent iron**
- **Oxygen or hydrogen release compounds**
- **Biopolymers** (*Knox research*)
 - » Can bind metals and organics

Speculative

Adapted from Reible 2008

Installation



http://www.aquatechnologies.com/projects_sedimentcap.htm



Cap Completion Report for Anacostia River, December 2004



Cap Completion Report for Anacostia River, December 2004

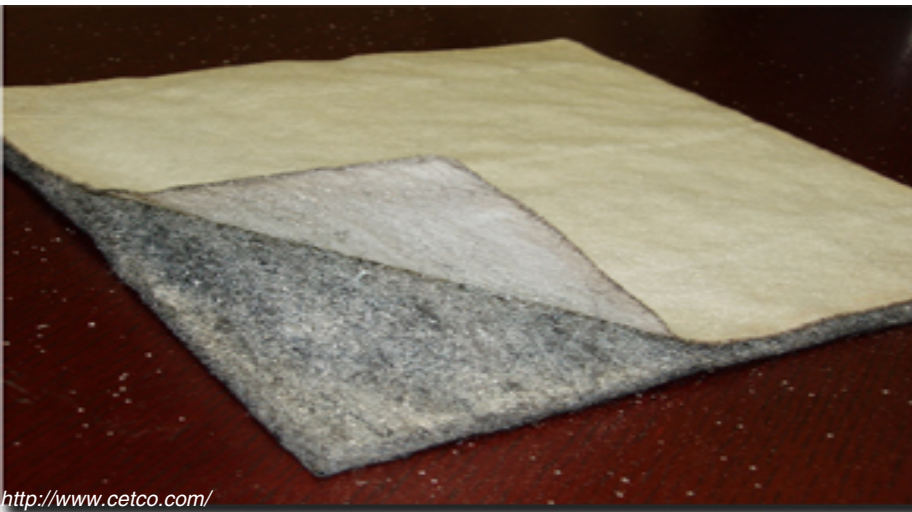
Reactive Core Mat™

← GEOTEXTILE

Nonwoven fabric filled with reactive material

← GEOTEXTILE

<http://www.sedimentremediation.com/rcm.htm>



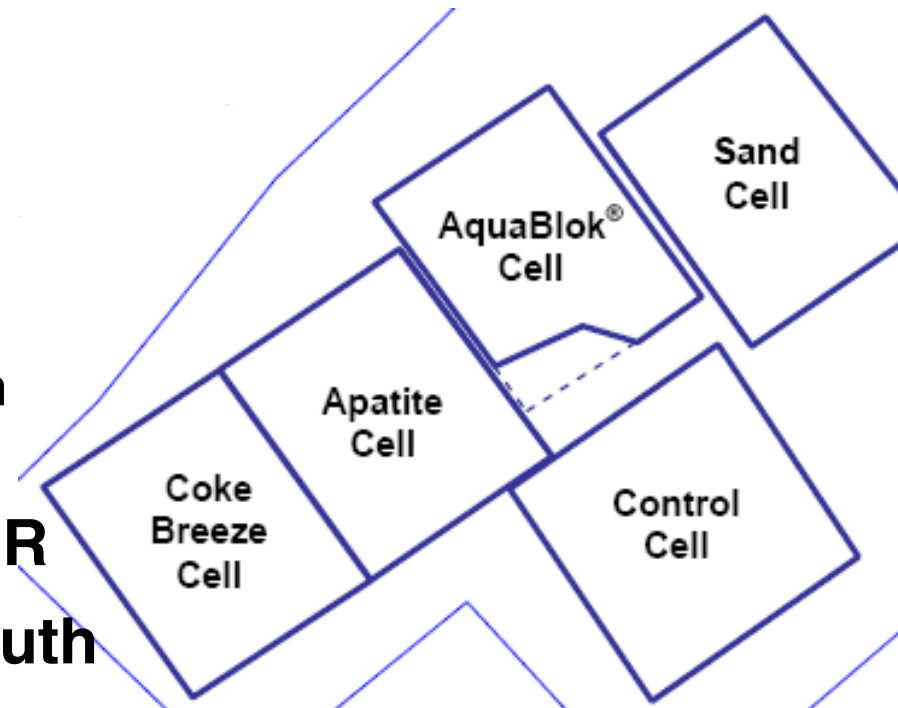
<http://www.cetco.com/>



Anacostia River March 31, 2004

Demonstrations and Applications

- **Anacostia River, Washington, DC**
 - » Demonstration of several materials/designs
 - » Implemented in 2004
 - » PAHs and metal contamination
- **McCormick and Baxter Creosoting Site, Portland, OR**
- **St. Louis River/Interlake/Duluth Tar Site, Duluth, MN**



EPA SITE Report (540R07008)

McCormick and Baxter Creosoting Company Superfund Site

- **Creosote NAPL contamination in soils, groundwater, and sediments**



- **Control of NAPL groundwater seeps**
 - » Organoclay applied in bulk
 - » 600 tons in 2004
- **Control of NAPL gas releases**
 - » Organoclay mats applied in 2005
 - » 35,000 square feet

Reactive Cap Layout at McCormick and Baxter



Stryker Bay

St. Louis River/Interlake/Duluth Tar Superfund Site

Adapted from Mike Bares, MN PCA August 23, 2007

4,000
Feet

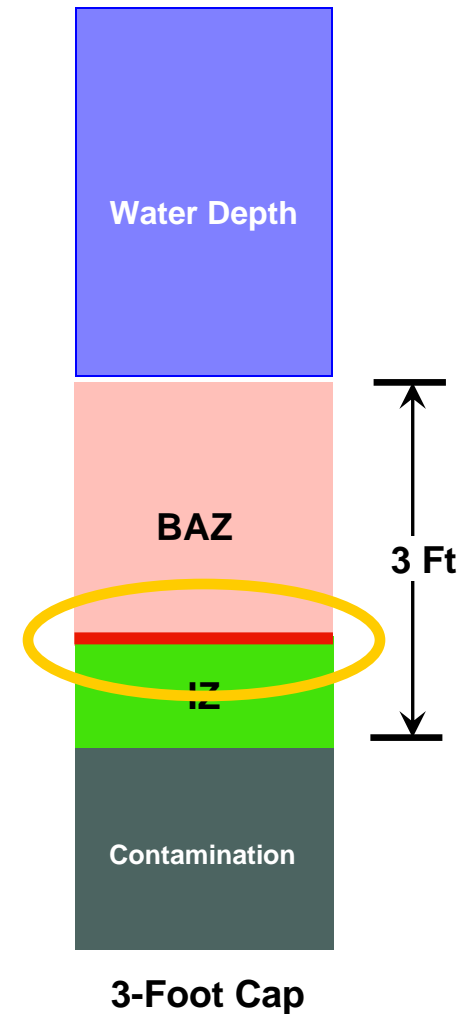


11-24-03 MHB

Reactive Cap Applied at Stryker Bay, MN



- **Activated Carbon**
- **550,000 ft²**



Surcharge Cap Material Placement at Stryker Bay, MN



10/14/2006

Status and Trends

- **Number of field applications**
 - » <10 (Reactive Mats)
 - » NAPL PAH contamination
 - » Beach heads/shallower depths
- **Research efforts underway**
- **Other “active” cap designs**
 - » Aquablok™ (SITE evaluation report)
 - » Geocomposite material
 - » Funnel and gate approach
- **Concerns**
 - » Seepage (not a substitute for source control)
 - » Monitoring/change out
- **Start-up of EPA project to summarize applications**

