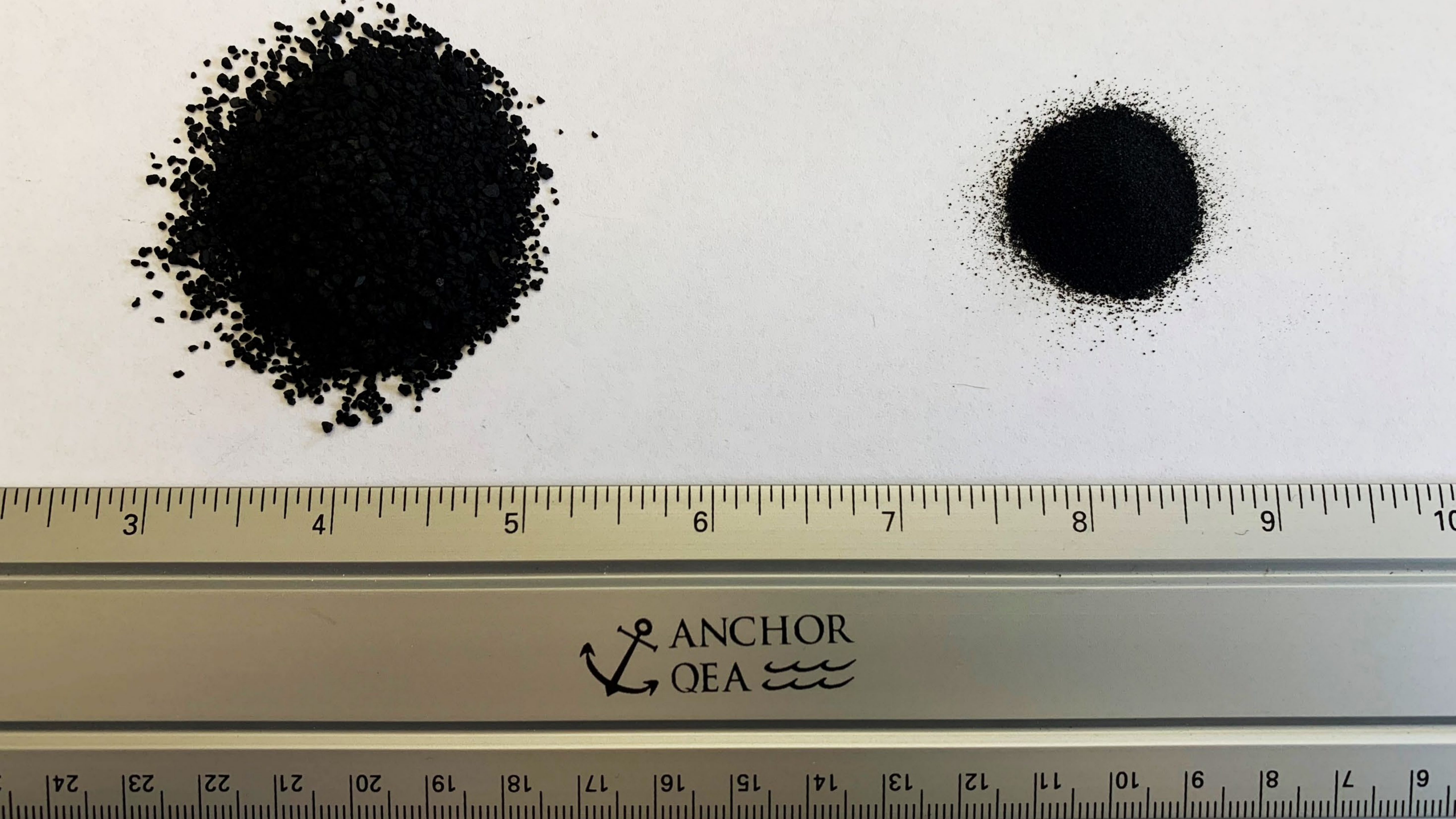
BATTELLE 2023 SEDIMENTS CONFERENCE

Optimizing Full-Scale Activated Carbon Placement and Cost-Effectiveness

Presented by: Paul LaRosa, PE, Anchor QEA
Collaborators: Clay Patmont, Anchor QEA; John Collins, AquaBlok Ltd.; Upal Ghosh, University of Maryland, Baltimore County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CHALLENGE

Activated carbon (AC)-based remedies require optimization of the installation and verification approach based on site- and contaminant-specific considerations.

Publication in *Integrated Environmental Assessment and Management*

- “In Situ Sediment Treatment Using Activated Carbon: A Demonstrated Sediment Cleanup Technology” (Patmont et al. 2015)
- Review of design and implementation approaches
- Coauthors:

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John Collins and John Hull, AquaBlok

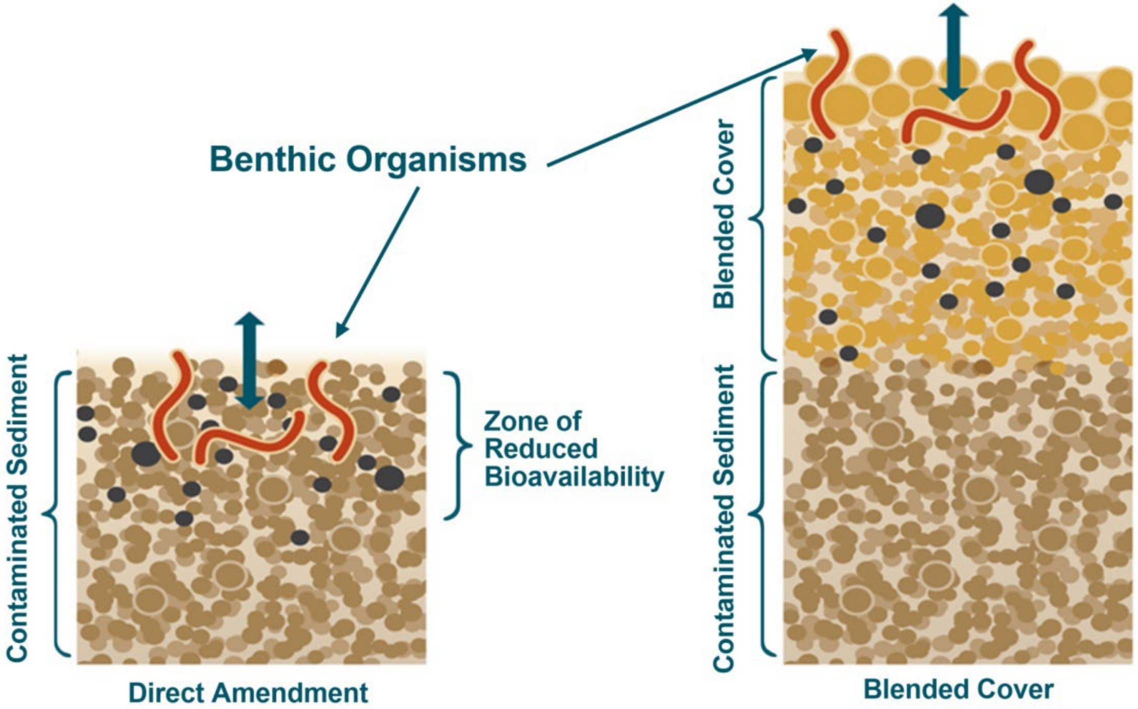
Tore Hjartland, Biologge

Ed Glaza, Parsons

John Bleiler, AECOM

Remedial Approaches with Activated Carbon

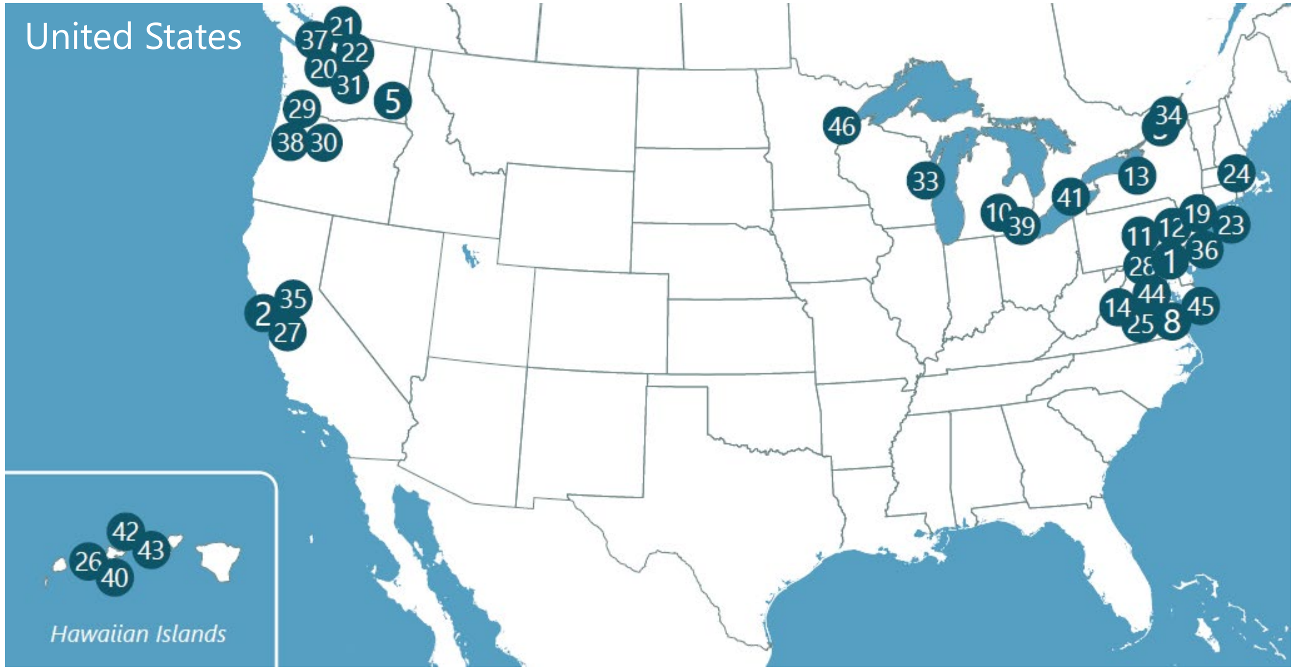
- Direct amendment (in situ treatment)
  - Thin layer (<1 centimeter) of AC applied directly to surface sediment, with or without initial mixing
- Blended cover/cap (amended capping)
  - Uniform premixing of AC with clean sand applied to surface sediment



Source: Patmont et al. (2015)

>45 Carbon Amendment Applications Completed to Date

Several very recent and ongoing projects



Adapted from Patmont et al. (2015)

Binder and Weighting Agent Amendments

- Allows delivery of fine-grained AC that is more effective than coarse AC
- When used for in situ treatment, the binder breaks down over time, allowing AC to mix into the biologically active zone via bioturbation
- When used for blended cover/cap, easily mixed with sand or other bulking material without need for pre-saturation

Source (photographs): Menzie and Ghosh (2011)

Onondaga Lake, New York: Amended Cap (2011 to 2016)

- Blended cover/cap over 300 acres
- Direct amendment in limited areas with geotechnical restrictions
- Granular activated carbon (GAC): 12 X 40 mesh (0.55 to 0.75 millimeter)
- GAC presoaked in agitated mix tanks
- GAC and sand mixed in slurry and pumped to hydraulic spreader barge

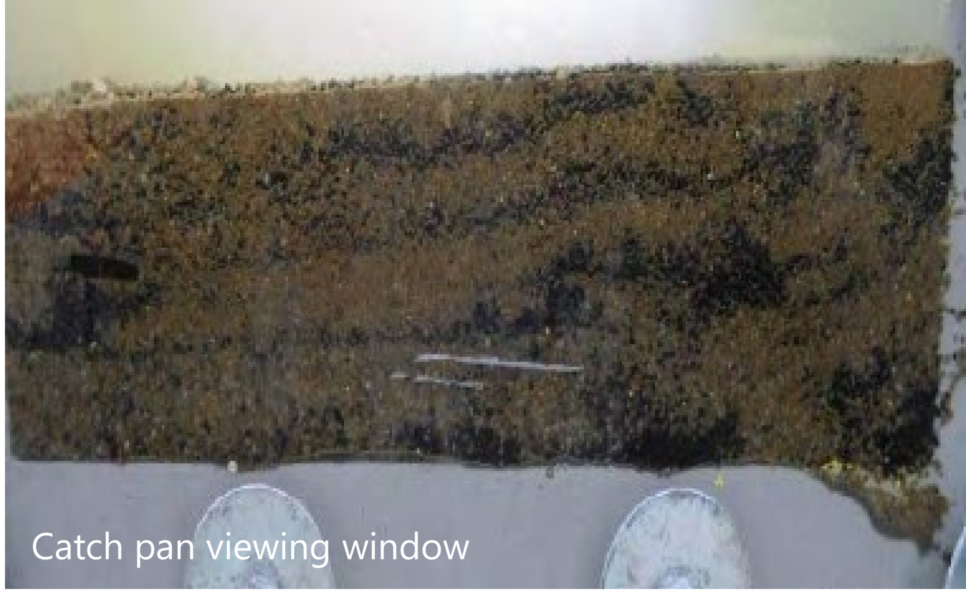
Sevenson's hydraulic spreader barge


GAC mix tanks

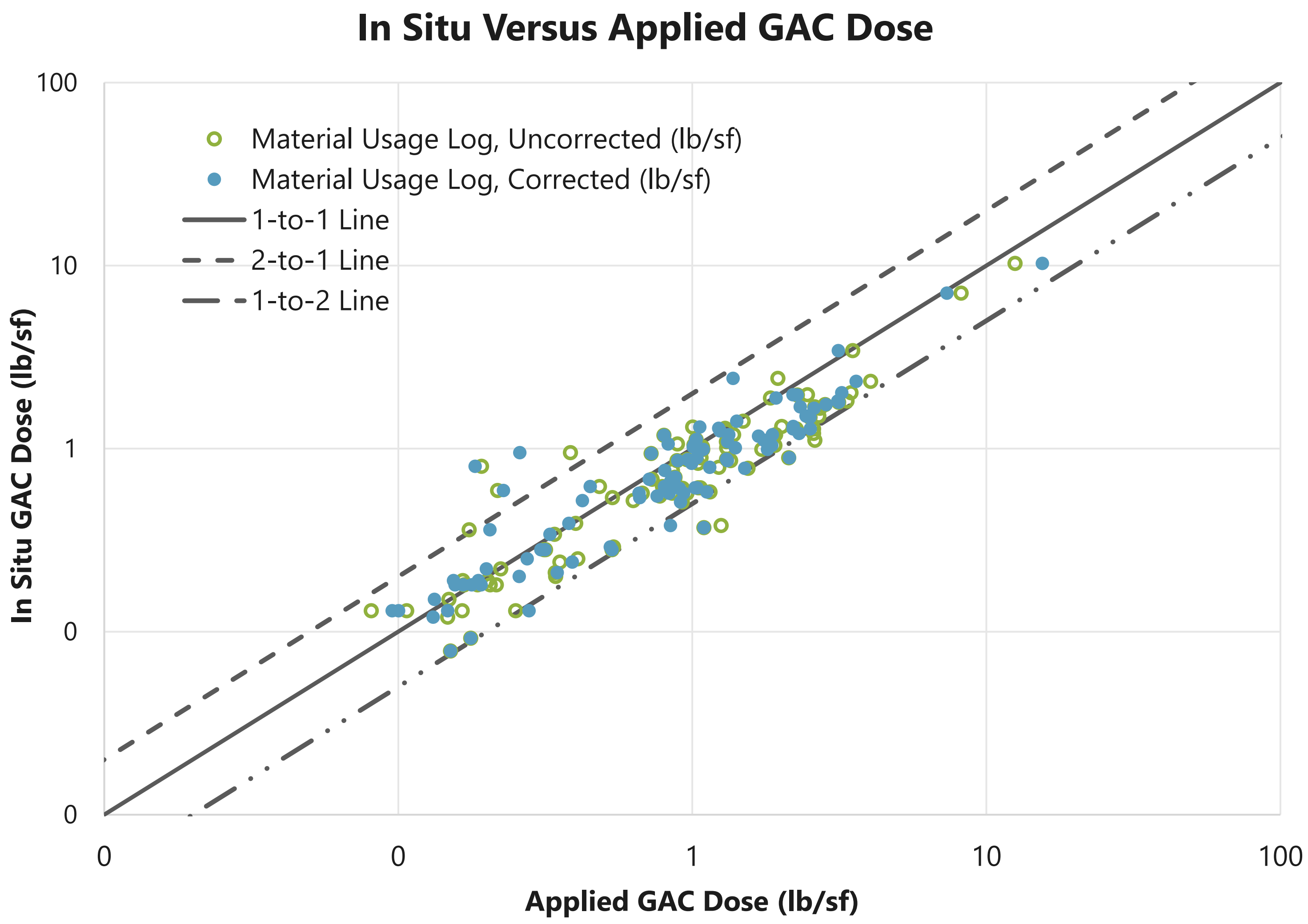
Source: Parsons and Anchor QEA 2012

Onondaga Lake, New York: Placement Summary

- Hydraulic placement verified with catch pans and cores
- GAC dose verification
  - Calibrated additive control program
  - Physical sample testing using thermal laboratory test
- In situ samples indicated approximately 75% recovery of applied GAC

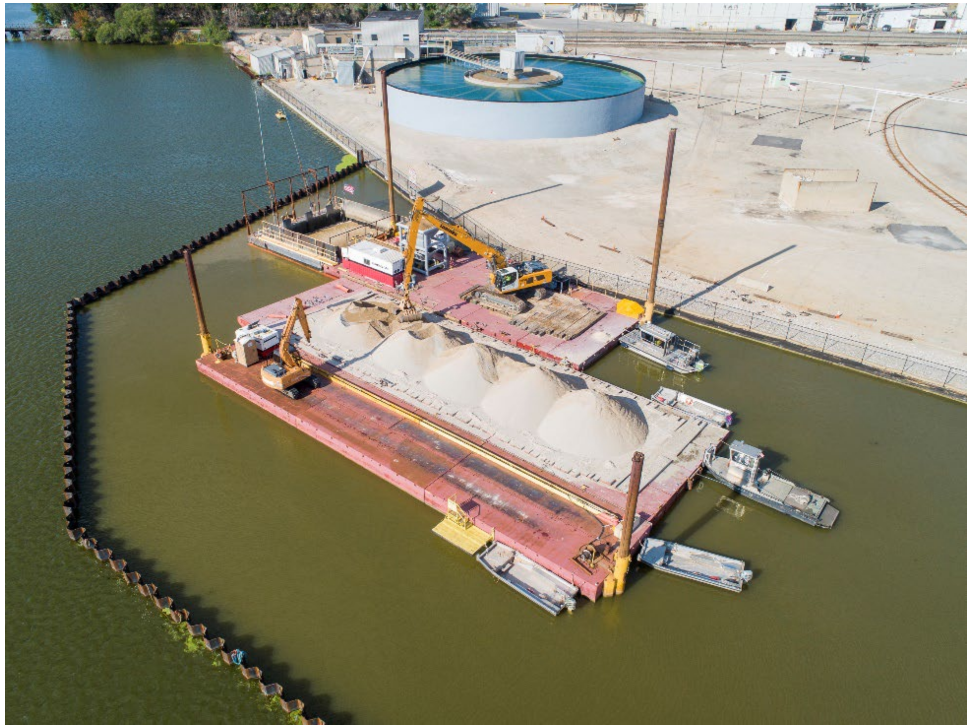

Catch pan viewing window

Onondaga Lake, New York: GAC Dose Verification



Fox River, Wisconsin: Amended Cap (2017 to 2020)

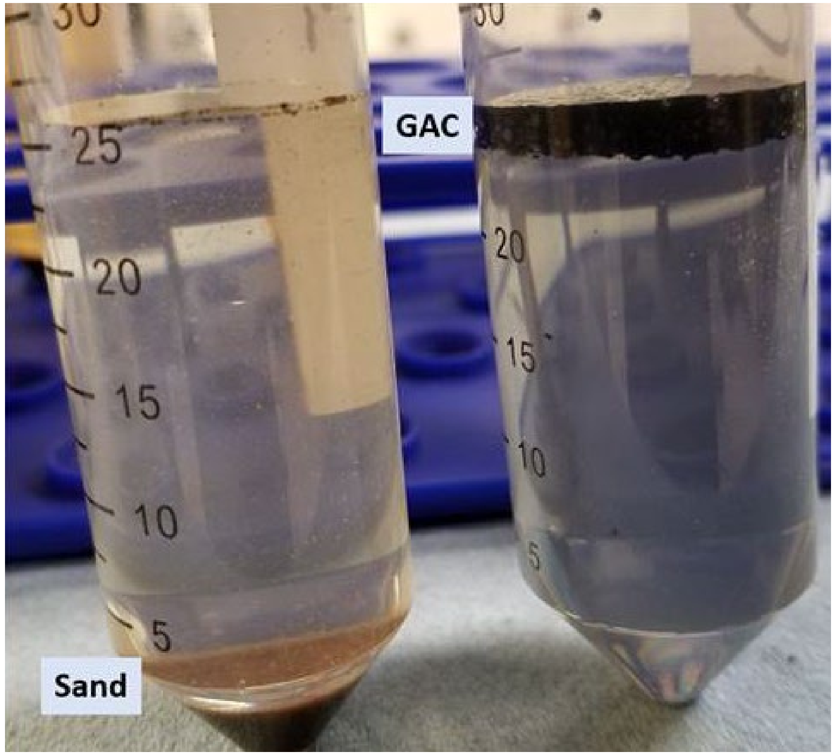
- Multilayer cap over 1.25 acres at former MGP site with PAH, NAPL, and PCBs
  - Sand amended with 10% organoclay for residual NAPL
  - Sand amended with 3% GAC (12 X 40 mesh) for dissolved PAHs
  - Concrete mattress for erosion protection
- Quality control (QC) checks to verify accurate mixing of amendments
  - Mass balances for each barge
  - Post-placement cores and laboratory testing (density separation)
- Observation
  - In situ average GAC content exceeded design



J.F. Brennan's Broadcast Capping System

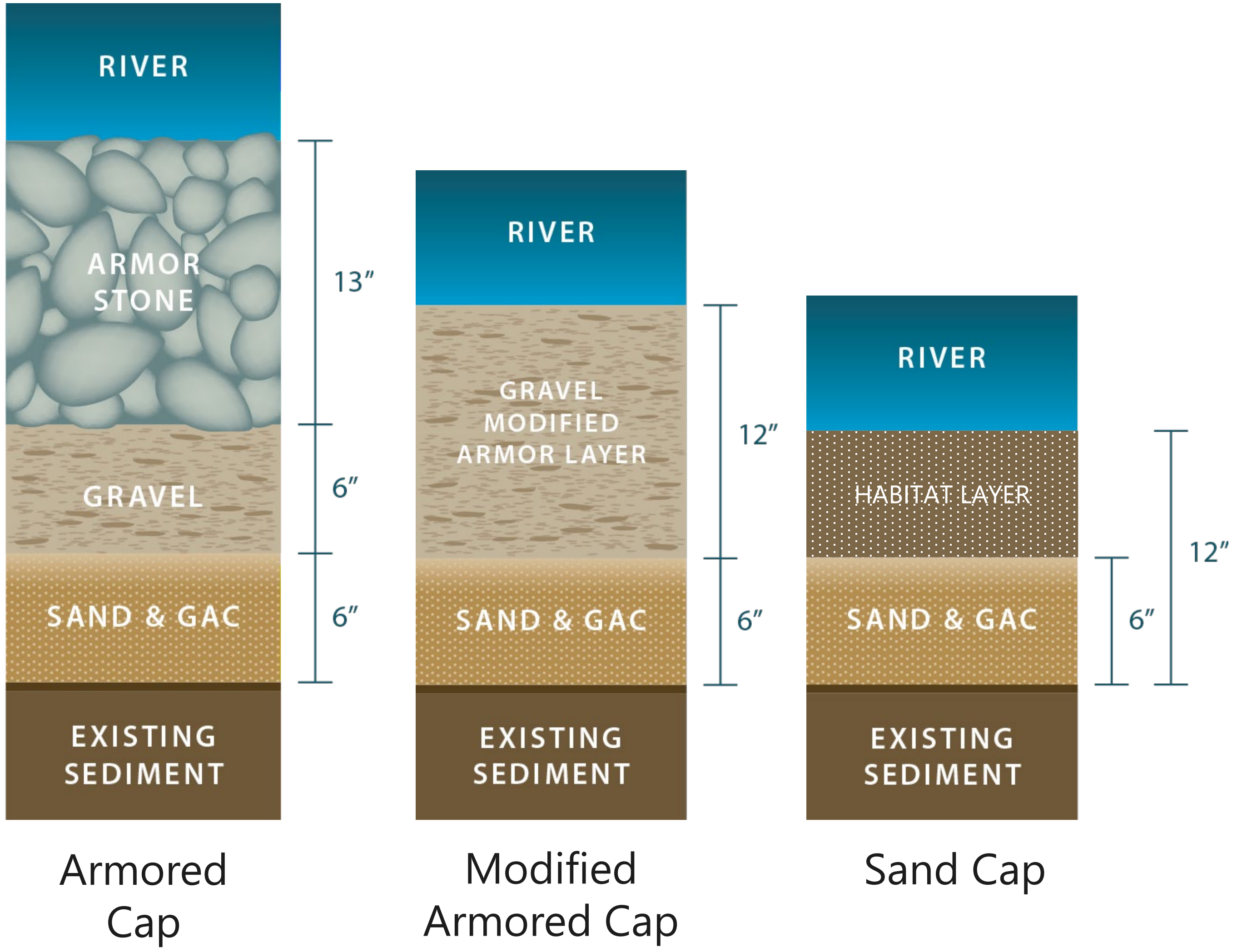
Fox River, Wisconsin: Amended Cap (2017 to 2020)

- Special remediation areas (e.g., utility crossings)
  - Sand amended with 4.2% GAC (12 X 40 mesh) for PCBs
  - Location-specific erosion protection
- QC checks to verify accurate mixing of amendments
  - Mass balances for each barge
  - Post-placement samples and laboratory testing (thermal analysis)
  - Post-placement cores and laboratory testing (thermal analysis)
- Observations
  - Contractor targeted 4.7% to 5.5% GAC
  - In situ average GAC content exceeded design, with limited spatial variability



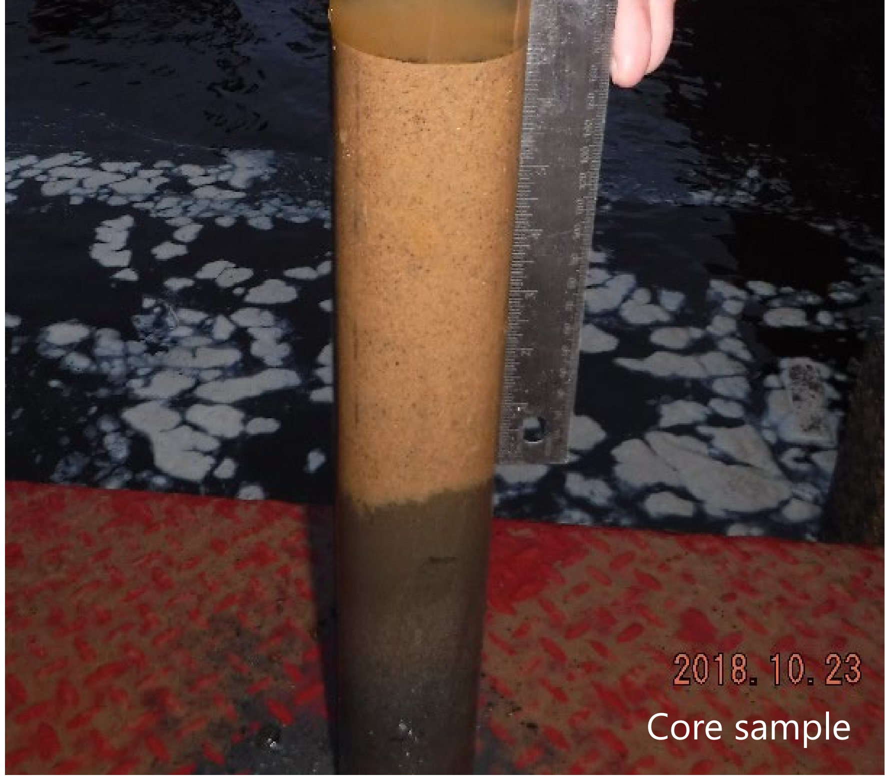
Grasse River, New York (2019 to 2021)

- Cap types
  - Armored cap (47 acres)
  - Modified armored cap (10 acres)
  - Sand cap (200 acres)
- GAC
  - 0.1% design minimum (0.3% to 0.5% placed)
  - 12 X 40 mesh
- Sand and presoaked GAC mixed using metered hoppers



Grasse River: GAC Verification

- Mass balance tracking
- Pre-placement (ex situ samples)
  - 95% recovered
- Post-placement (in situ) cores and catch pans
  - 83% recovered
- All samples achieved design dose



Core sample

Catch pan

Mirror Lake, Delaware: Direct AC Amendment (2013)

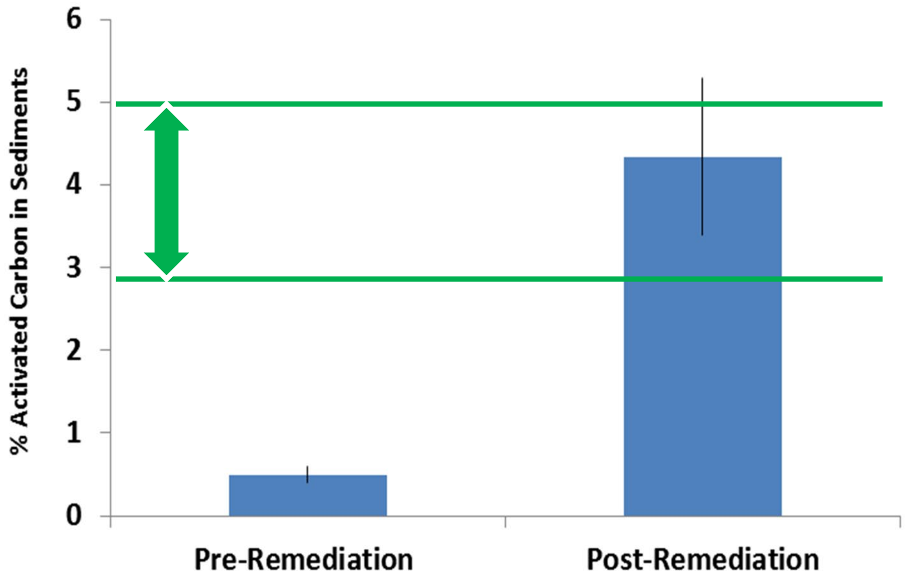
- 5-acre urban lake impacted with PCBs and PAHs
- SediMite (PAC) applied as direct amendment via Telebelt from shore
- PAC application verified by measuring AC in sediments

Source: http://www.youtube.com/watch?v=I88oE6aTHK8

Mirror Lake, Delaware: Results

- Optimum dose of 3% to 5% AC met based on in situ measurements
- 70% reduction of PCBs in resident fish (brown bullhead and bluegill)
- Resident fish PCB levels now below consumption advisory for Delaware
- Less reductions in migratory white perch and blueback herring

AC in top 4 inches of sediment core after 1 year



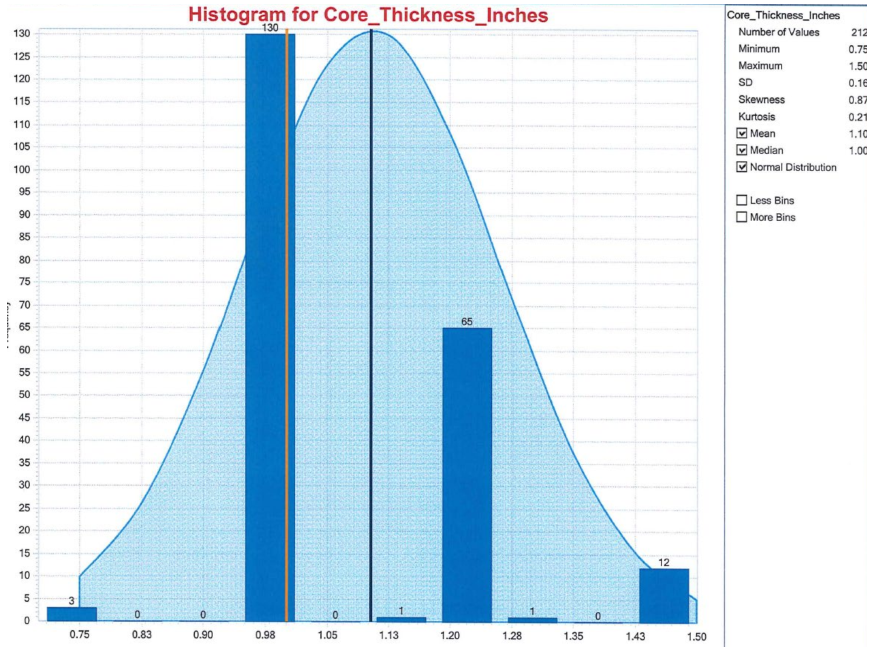
Middle River, Maryland: Direct Amendment (2016)

- In situ treatment of 13.7 acres of embayment at mouth of river
- Direct amendment with 2,500 tons of AquaGate+PAC 10%
- Target 1- to 2-inch-thick application
- Barge-based hopper placement verified with cores

Source: Tetra Tech, Inc.

Middle River, Maryland: Direct Amendment (2016)

- Uniform placement was achieved within a 0.95- to 2.0-inch range (average of 1.1 inches)
- The quantity of AquaGate+PAC purchased/applied was equal to the target PAC design dose
- Post-placement analysis indicated >98% of the design PAC dose successfully placed



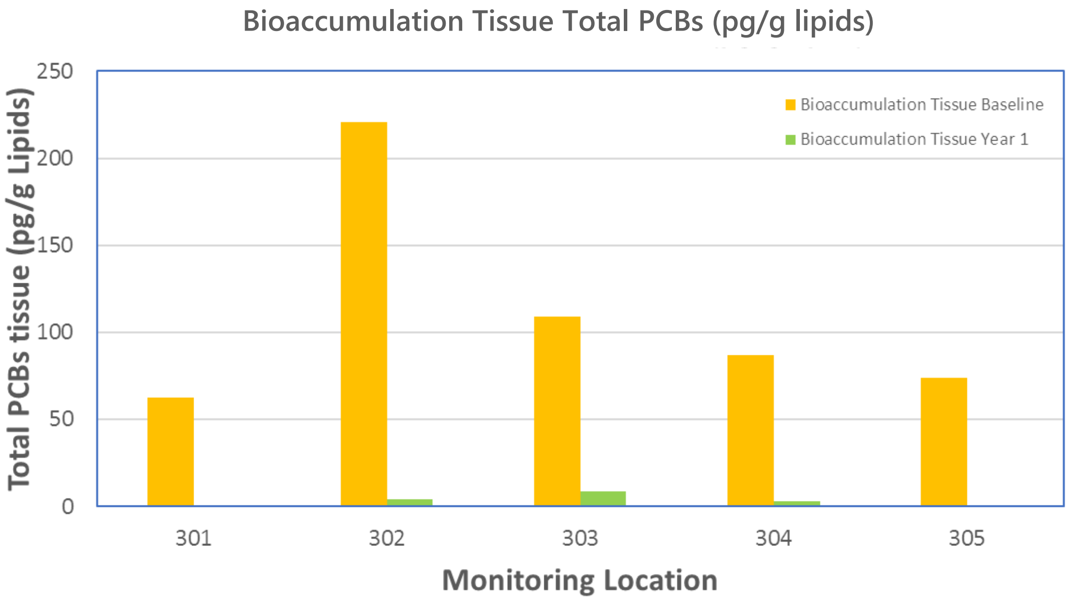
Post-placement AC verification

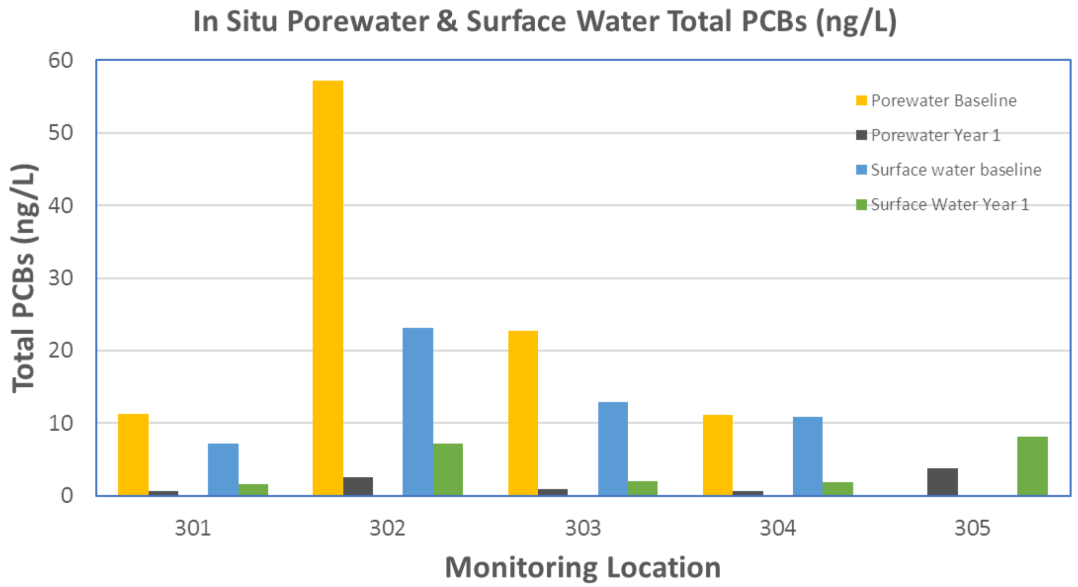
Middle River, Maryland: Direct Amendment (2016)

- 28-day bioaccumulation testing: 85% reduction in total PCB tissue concentrations from baseline
- In situ porewater: >90% reduction in total PCB sediment porewater concentrations from baseline

Source: Tetra Tech, Inc.

Monitoring Year 1: Preliminary Results





Hunters Point Naval Shipyard, California: Direct Amendment (2015)

- PCB-contaminated sediment offshore of shipyard
- Site-specific studies demonstrated higher effectiveness of fine-grained AC
- Large pilot: 0.8 acre

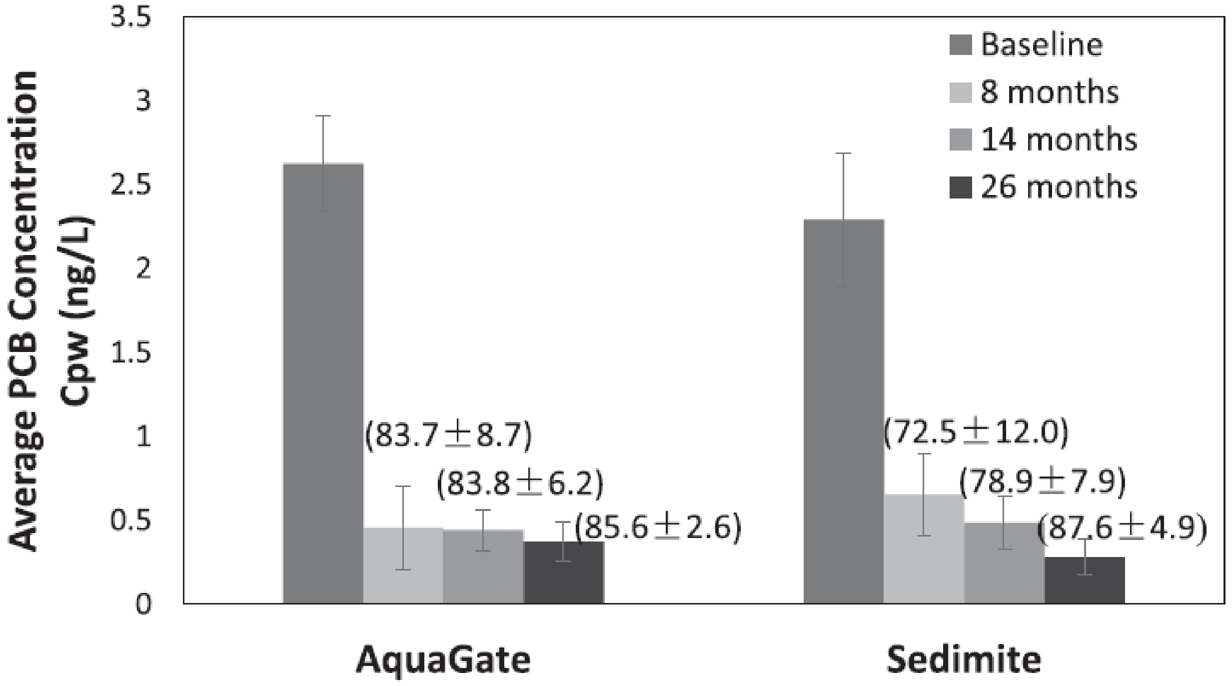
Source: Strategic Environmental Research and Development Program/Environmental Security Technology Certification Program

Hunters Point Naval Shipyard, California: Direct Amendment (2015)

- AC applied as AquaGate+PAC (86 tons) and SediMite (24 tons)
- Application used barge-mounted Telebelt conveyor with diffuser; diffuser was critical
- Verified by measuring total organic carbon in sediment: 4% and 5% in the 10- to 15-centimeter depth for AquaGate+AC and SediMite plots, respectively, after 26 months
- AC amendments via AquaGate and SediMite were stable in an open-water tidal environment

Hunters Point Naval Shipyard, California: Direct Amendment (2015)

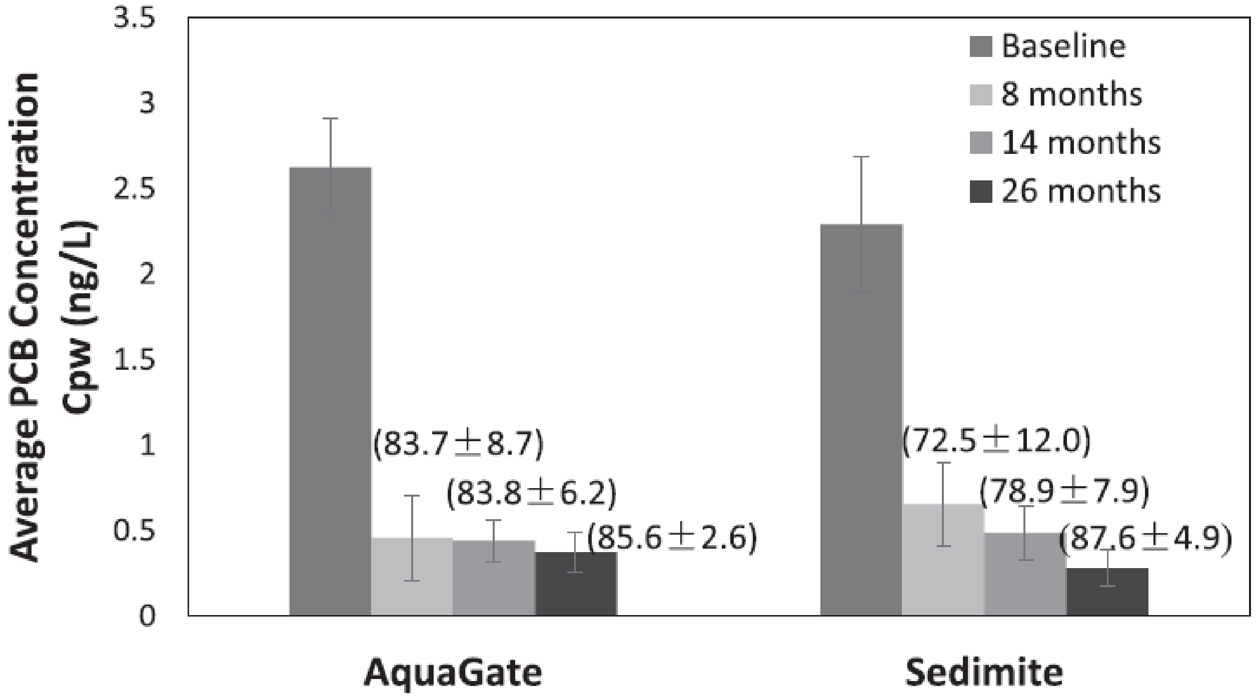
- Reduction in porewater PCBs (84% to 86%) was noted in first 8 months following amendment



Source: Yan et al. (2020)

Hunters Point Naval Shipyard, California: Direct Amendment (2015)

- PCB bioaccumulation in bent-nose clams was reduced 75% to 80% during in situ pilot study 8 months after AC amendment
- These strong reductions of PCBs in porewater and bioaccumulation in clams continued throughout the 26-month study period



Source: Yan et al. (2020)

Engineering Methods Developed for Large-Scale AC Application to Sediments

- Thin-layer placement over large areas for in situ treatment is challenging but has been demonstrated
- Preparation, mixing, and delivery of amendment should be selected based on site conditions (e.g., energy level, currents, and water depth), particle size of AC, and approach (i.e., in situ treatment versus active cap)
  - Pre-soaking of GAC is required (without weighting agents)

LESSONS LEARNED

- Verification methods should be established and calibrated based on objectives and site conditions
  - Recovery and measurement of carbon content requires advance planning
  - Need to account for natural organic carbon in sediment or sand in blended cover
- Amount of AC required (i.e., overdosing) is dependent on size and type of AC utilized, site conditions, and placement methods
- Placement of correct type and dose of AC is effective in reducing pollutant bioavailability in sediments

THANK YOU

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