Remediation of Contaminated Sediments:

Current Challenges and Emerging Technologies

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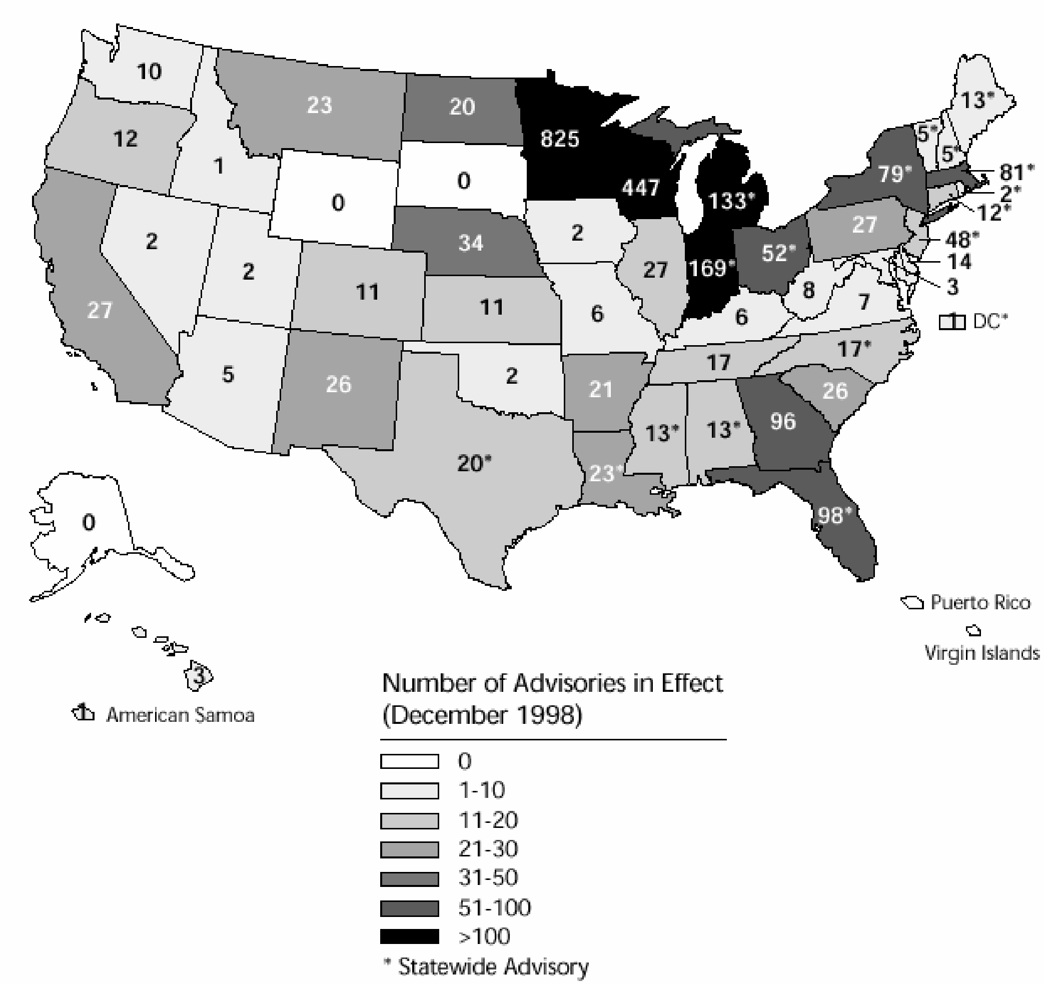
AN HONORS UNIVERSITY IN MARYLAND

Fish and Wildlife Consumption Advisories in the United States



Priority organic pollutants are the leading cause of concern

Current Sediment management practices:

- Dredging
- Capping
- Monitored Natural Attenuation
- Confined disposal facilities

The Quality of Our Nation's Waters: A Summary of the National Water Quality Inventory: Report to Congress, EPA, June 2000

Key Risk Management Principles for Contaminated Sediment Sites

1. Control sources early
2. Involve the community early and often
3. Develop and refine a conceptual site model that considers sediment stability
4. Use an iterative approach in a risk-based framework
5. Ensure that sediment cleanup levels are clearly tied to risk management goals
6. Design remedies to minimize short-term risks while achieving long-term protection
7. Monitor during and after sediment remediation to assess and document remedy effectiveness

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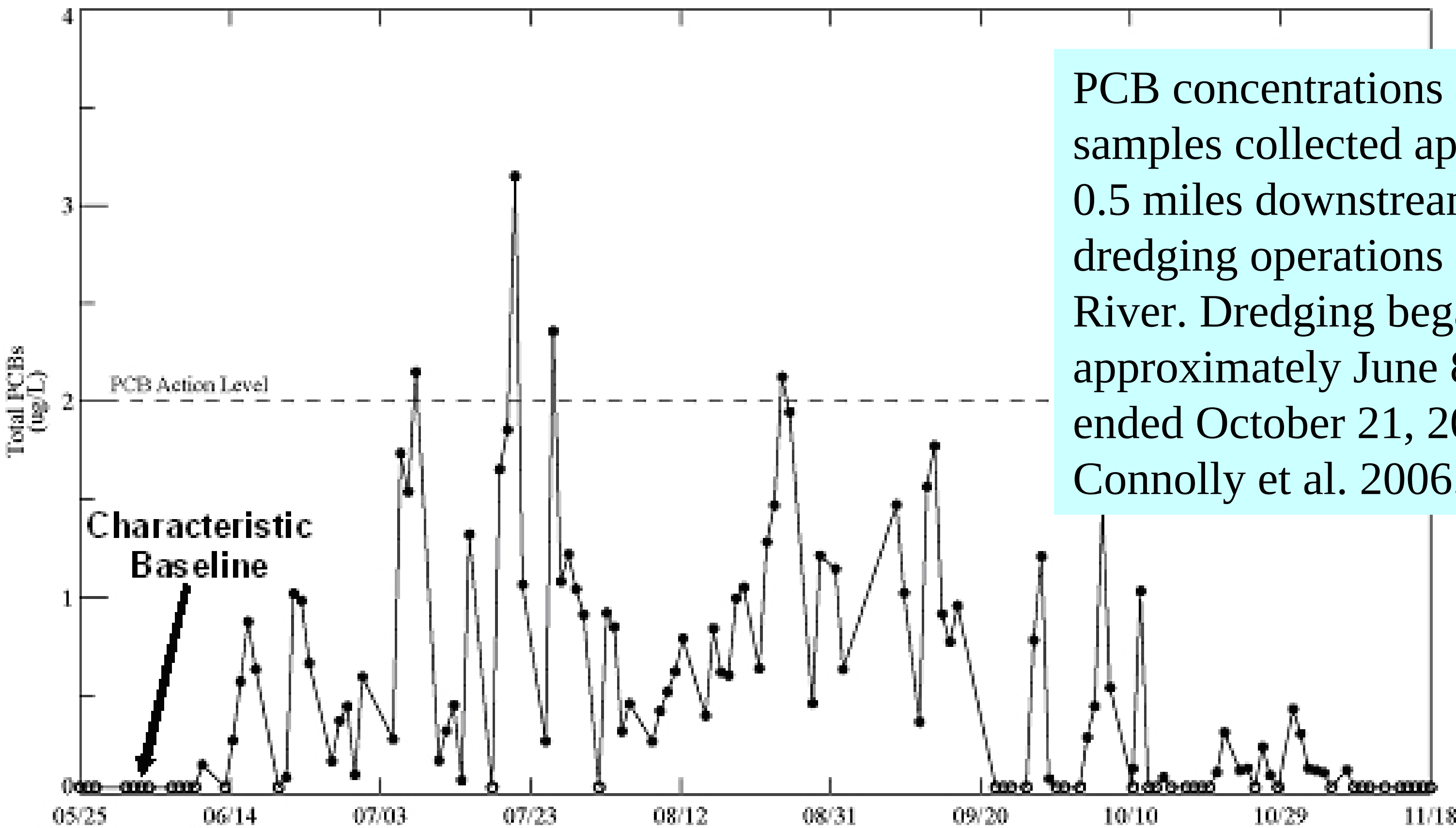
NRC Study on Effectiveness of Dredging



PCB concentrations in water samples collected approximately 0.5 miles downstream of the dredging operations in the Grasse River. Dredging began approximately June 8, 2005 and ended October 21, 2005. Source: Connolly et al. 2006.

Of the 20 megasites evaluated by the NRC committee:

- 25% achieved goals
- 50% did not achieve goals or were not monitored well
- 25% not enough time has elapsed to form judgment

(National Research Council June 2007)

The report urges EPA to step up its monitoring activities before, during, and after dredging efforts at all sediment megasites

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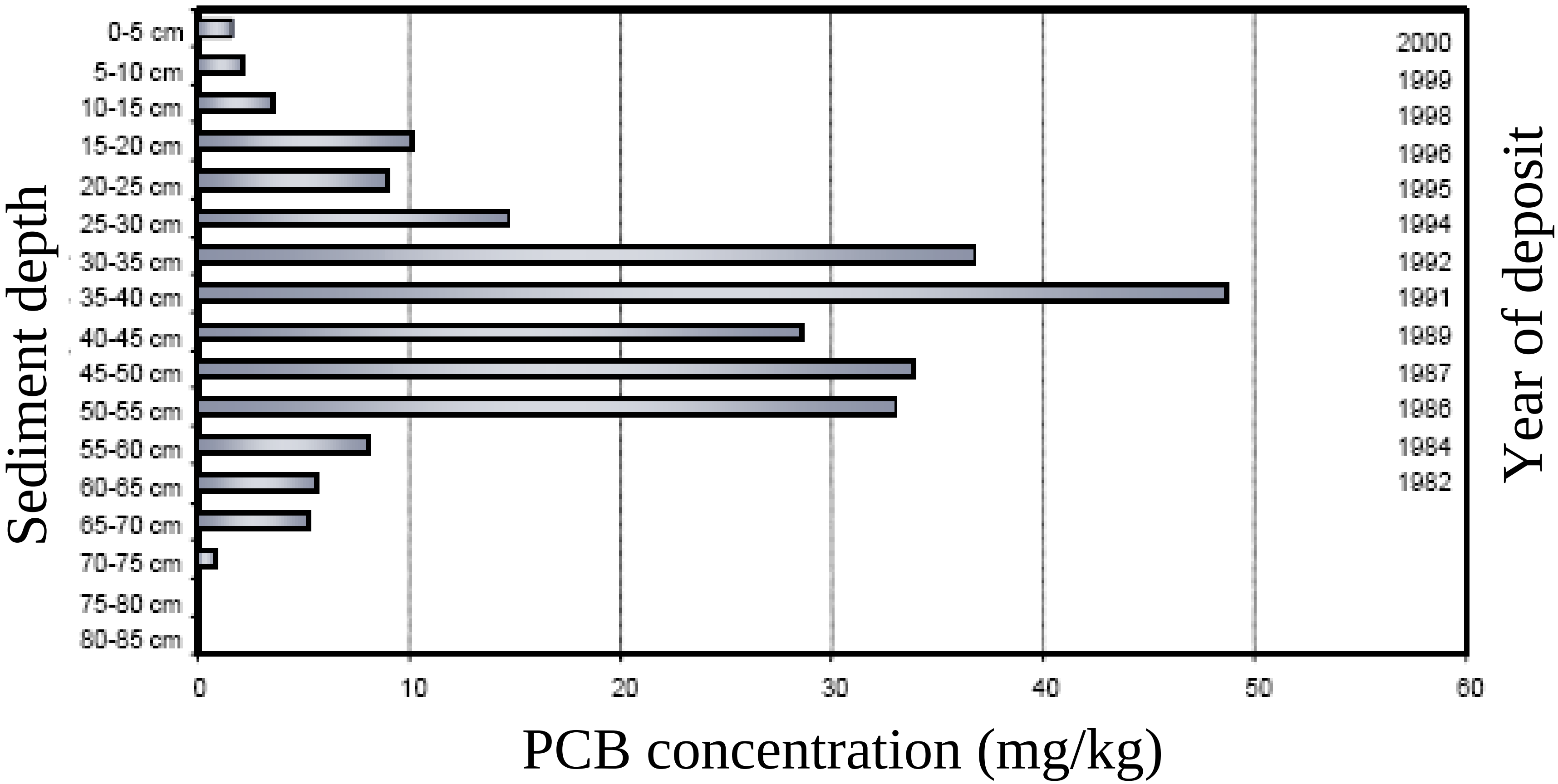
Typical depth profile of legacy contaminants in sediments



PCB concentration profile with depth in a sediment core from Lake Hartwell. Source: Battelle

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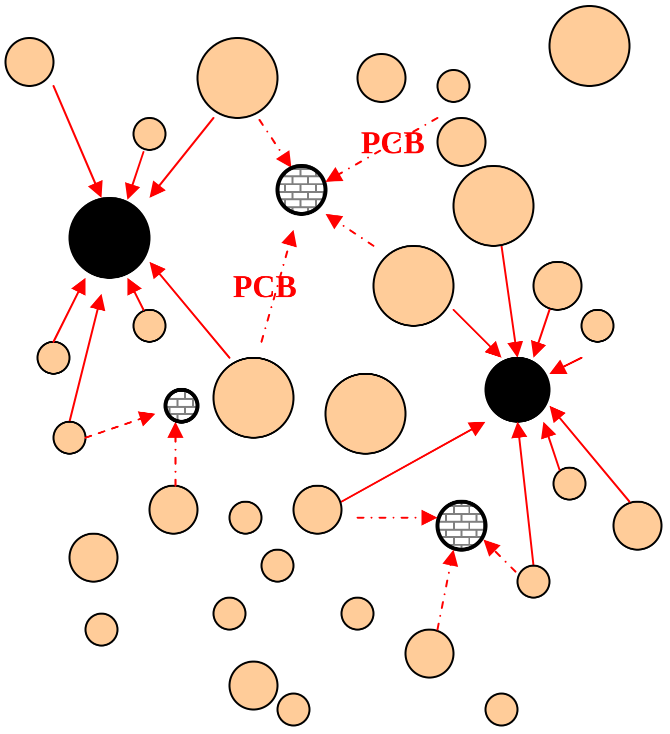
PCB bioavailability control



Sediment particles with PCBs

Natural carbonaceous particles

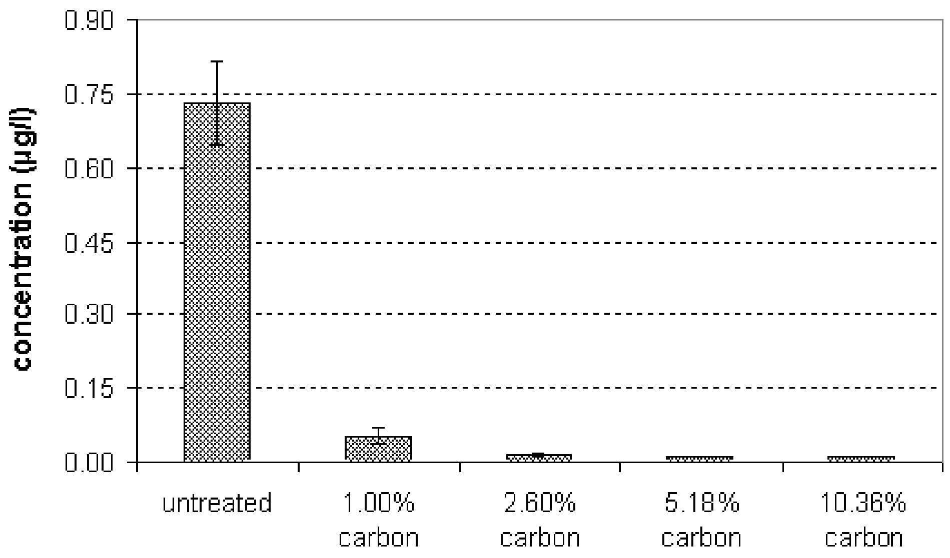
Introduced AC particles

- Bioavailability of PCBs, depends on sorbent particle type.
- Natural black carbon particles sequester PCBs, reduce bioavailability
- AC can alter PCB bioavailability.
- New strategy for sediment management using in situ stabilization
- Bioavailability reduction demonstrated for PCBs, PAHs, DDT and metals.

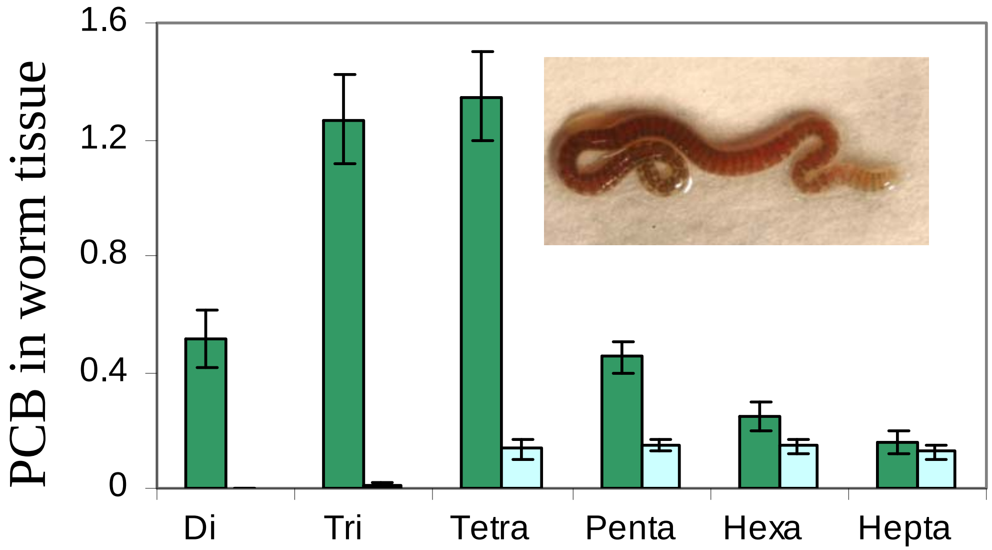
Published papers:

Ghosh et al., ACS Symp. paper, vol 43, 2, 2003
Zimmerman et al., ES&T, 2004
Millward et al., ES&T, 2005.
McLeod et al., ES&T, 2005
Werner et al., ES&T, 2006
Cornelissen et al., ES&T, 2006
Sun & Ghosh, ES&T 2007
Cho et al, MER 2007

PCB reduction in pore water and worm tissue



Pore water PCB concentration from Grasse River sediment with different doses of activated carbon



Amendment of sediment with 2.5% activated carbon reduced PCB biouptake in a freshwater oligochaete

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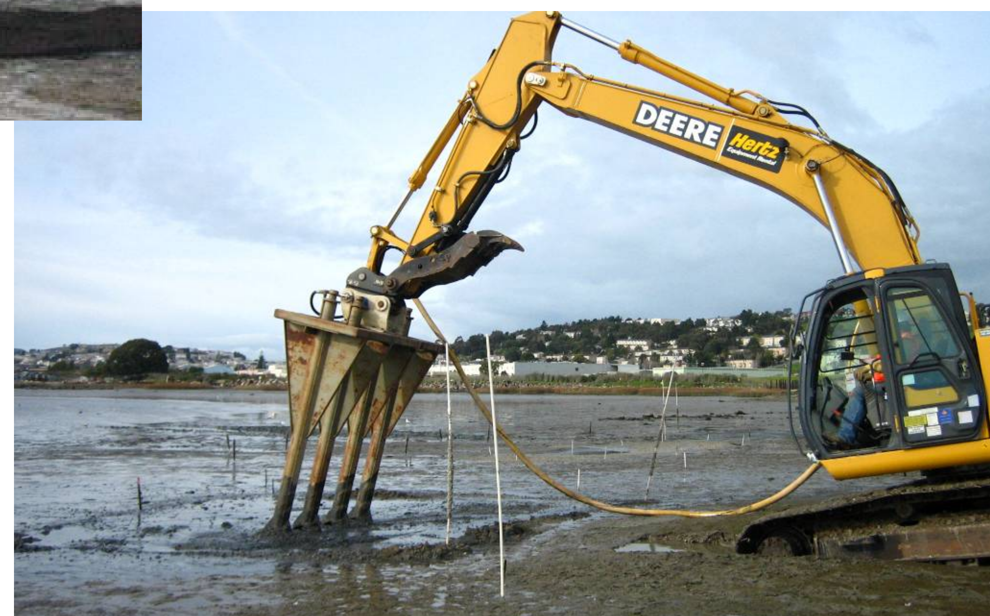
Demonstration Project at Hunters Point, CA

(Participants: Stanford University, UMBC, ERDC, Navy)

Aquamog with roto-tiller arm

(Aquatic Environments, Inc., Concord, CA)



Injection system

(Compass Environmental, Inc., Stone Mountain, GA)

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Application in the Grasse River

Mixed Tiller
(75’ x 100’)

Unmixed
(50’ x 50’)

Tine Sled
(50’ x 60’)

Initial testing area
(50’ x 100’)

- L-shaped silt screen to minimize suspended particle transport
- Equipment mobilized on barges
- Target dose of activated carbon = 2.5% in surficial sediments
- No measurable change in water-column PCBs downstream
- Post-treatment monitoring to continue for 2-3 years

Demonstration Project at Grasse River, NY

(Participants: Alcoa, EPA, UMBC, Stanford University, Anchor Env., Brennan, Tetra Tech, Arcadis-BB&L, QEA)

Tine injection system
Designed and built by Brennan with inputs from collaborators

Injection and mixing in an enclosed rototiller
Designed and built by Brennan with inputs from collaborators

In-Situ PCB Bioaccumulation Studies

In-river deployment of field exposure cages with *L. variegatus* for baseline study using a modified ASTM draft method (Burton et al. 2005)

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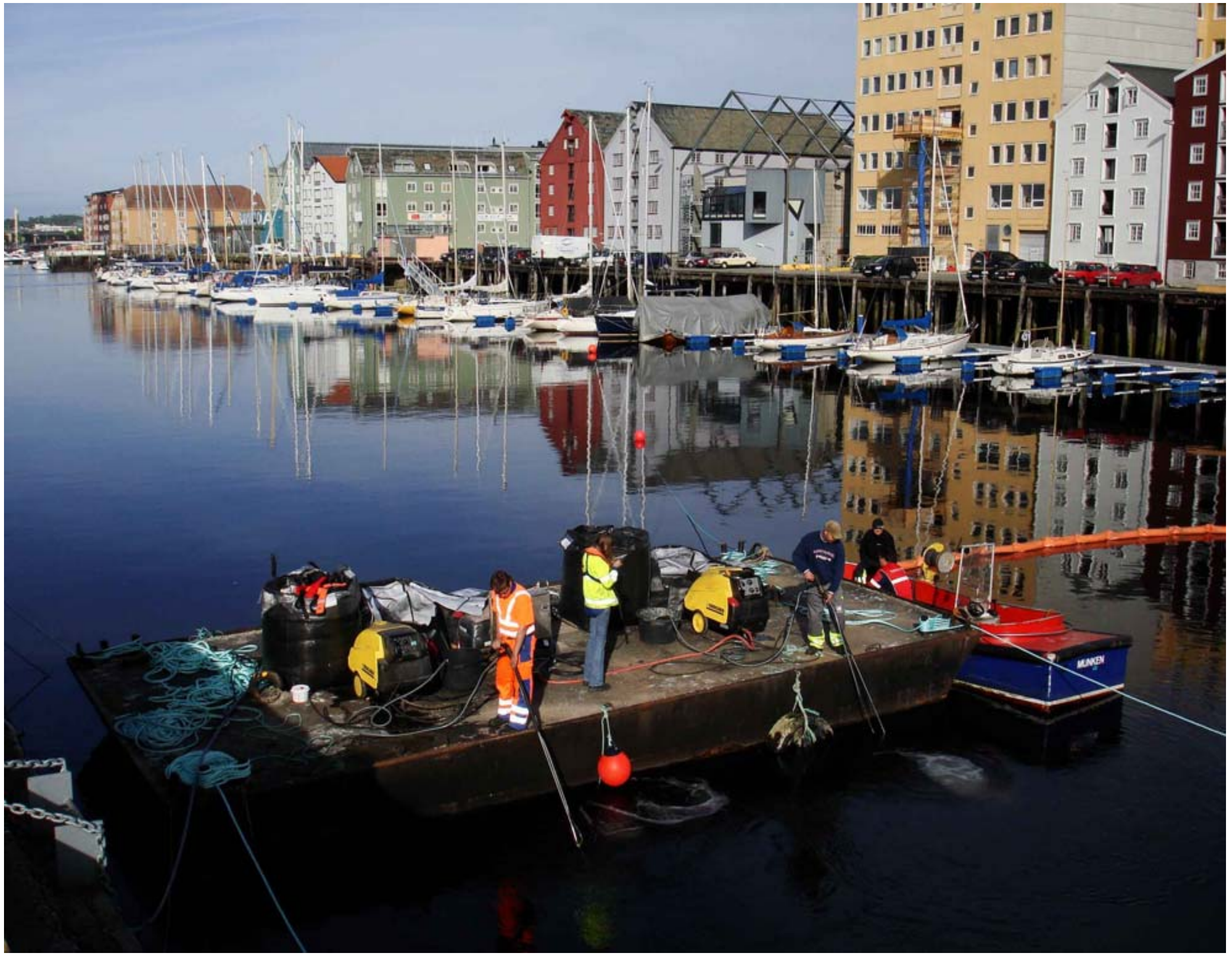
Demonstration Project at Trondheim Harbor, Norway

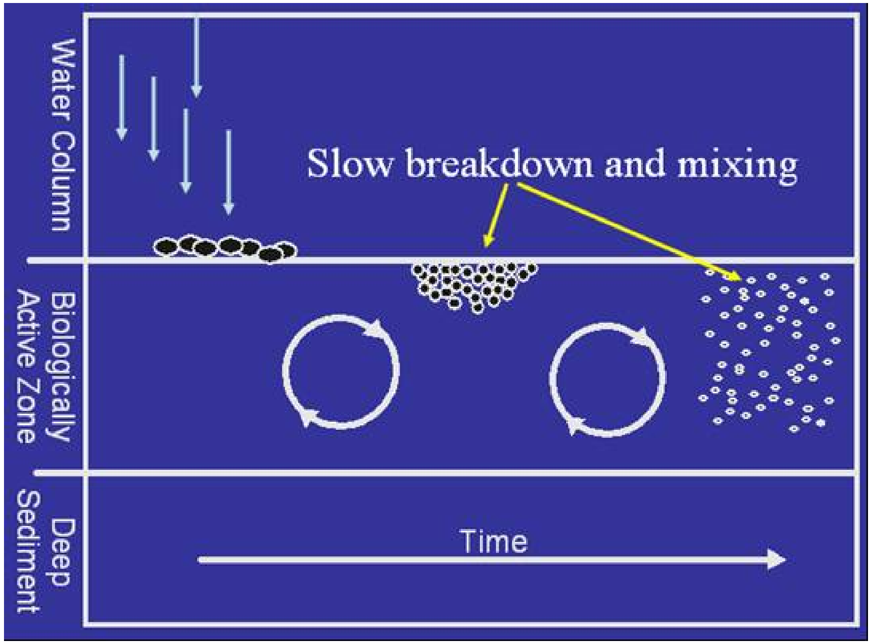
(Participants: Norwegian Geotechnical Institute, Stockholm University, and UMBC)

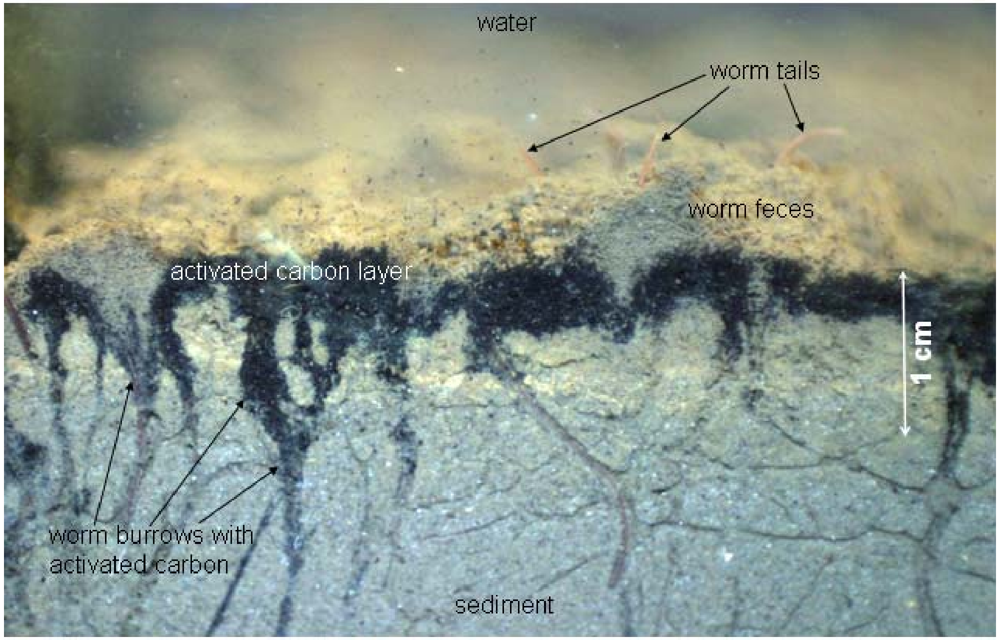


Platformen i Kanalen

- 2000 kg AC applied in a 2000 m^2 plot
- Application without mixing in May 2007
- Contaminants of interest: PCBs, PAHs, PBDEs, and DDT
- Performance monitoring in 08/09
- Distribution of AC, bioaccumulation tests, aqueous concentrations using POM-SPE

Low-Impact Amendment Delivery System (*SediMite*)





1. Agglomerates delivered from water surface
2. Sinks to sediment surface and resists resuspension
3. Breaks down slowly
4. Mixed into sediment by bioturbation
5. Developed at UMBC in collaboration with Dr. Charlie Menzie (Menzie Cura & Assoc.)

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Ghosh research group at UMBC