Evaluation of PCB Availability in Sediment after Application of an Activated Carbon Amendment at an Active U.S. Naval Shipyard

Victor Magar[1], Melissa Grover[2], Elisa Bizzotto[3], Gunther Rosen[4], Victoria Kirtay[4], D. Bart Chadwick[4]

[1] Ramboll Environ, Chicago, IL, USA
[2] Ramboll Environ, San Diego, CA USA
[3] Ramboll Environ, Milan, Italy
[4] SPAWAR SSC Pacific, San Diego, CA, USA

[1] Phone: +001 (312) 288-3840
E-mail: vmagar@environcorp.com

Introduction: Active harbor areas with complicated infrastructure and logistical requirements pose a number of significant challenges to management of sediment containing elevated concentrations of PCBs and other chemicals. Targeted placement of *in situ* treatment materials (e.g., thin layers of activate carbon) represents a promising and cost-effective new remediation technology to address this challenge. This presentation reports the approach and results of an activated carbon amendment application to reduce PCB availability under an operational pier (Pier 7) at the Puget Sound Naval Shipyard and Intermediate Maintenance Facility, Bremerton, Washington USA.

Methods: For this project, a thin (2- to 3-inch) layer of an activated carbon treatment (AquaGate+PAC™) was added to a half-acre area underneath and adjacent to Pier 7 (Figure 1). Addition of activated carbon was expected to reduce PCB availability by ~50 to 90%, based on bench scale tests and reports by others.

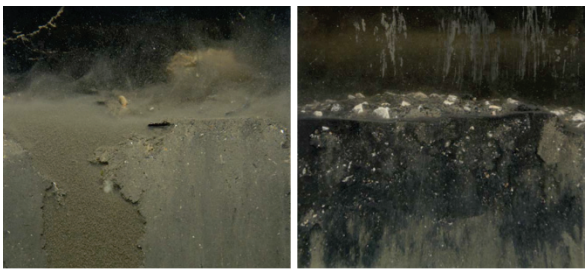

Fig. 1. Carbon-amended sediment, before and after application, visualized using Sediment Profile Images.

Pre- and post-amendment availability of PCBs in the amendment area was evaluated via measurement of concentrations of PCBs in benthic invertebrate tissue (2-week in situ exposure of *Macoma nasuta* (bivalve) and *Nephtys caecoides* (polychaete) via sediment ecotoxicity assessment (SEA) Ring protocol) and sediment porewater (2-week in situ deployment of Solid Phase Microextraction (SPME) fibers). Measurements were made at nine stations prior to and ten months following the amendment placement.

Results: Post-amendment monitoring showed that the concentration of total PCBs in organisms decreased approximately 80% after 10 and 22 months (Figure 2). The concentration of total PCBs in *M. nasuta* significantly decreased on average by 74%, from an average concentration of 930 to 250 ng total PCBs/g, lipid weight (lw). Total PCBs in *N. caecoides* significantly decreased on average by 87%, from an average concentration of 2100 to 280 ng total PCBs/g, lw. Concurrent with bioaccumulation results, the concentration of total PCBs in surface sediment porewater decreased by 90% (from an average concentration of 0.165 to 0.017 ng total PCBs/L).

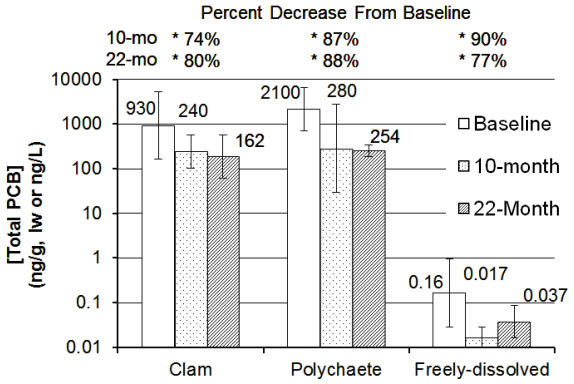

Fig. 1. Activated carbon amendment results after 10 and 22 months, in clams, polycheates, and freely dissolved porewater. Asterisk denotes significant difference from baseline to 10-month or 22-month monitoring events.

Discussion: Activated carbon amendment resulted in a significant reduction in bioavailable total PCBs. The concentration decreases observed in bioaccumulation and porewater data were consistent with bench scale tests, and indicate the remedy was effective in reducing PCB availability in and beneath Pier 7 surface sediments. Furthermore, synchronous use of SPME and SEA Ring technologies provided a robust design for evaluating PCB availability.

Funding: US Department of Defense Environmental Security Technology Certification Program (ESTCP), Project ER-201131.