Evaluation of PAH Bioavailability and Uptake into Tissue from a Predominantly Carbon Black Matrix

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Background/Objectives. Remedial investigation, feasibility study and supporting evaluations are being performed on waste from a former solid waste management unit in northern California. The sediment matrix of the site is predominantly composed of a carbon black waste material from an ammonia plant that discharged process water into the wastewater pond. Polycyclic aromatic hydrocarbons (PAHs) are present in this waste material, and high molecular weight (HMW) PAHs comprise the primary risk drivers at the site. Current bioavailability research recognizes that the composition of the sediment matrix can affect contaminant sorption/desorption processes. Sediments with high concentrations of black carbon (such as coke and soot, which contain high levels of organic carbon) have higher PAH sorption capacity than sediments with lower concentrations. However, little is known about the specific sorption capacity of sediments containing carbon black, which is created by the partial combustion of oil or natural gas and has lower extractable organic compounds than black carbon. Therefore, to support the ecological risk assessment, bioaccumulation assays with the polychaete worm, Nereis, were performed using site solid waste as it was recognized that literature-based models would not be relevant for this unique matrix. These assays provide an opportunity to evaluate how sediment with a high carbon black content affect bioaccessibility and uptake of PAHs in benthic infauna.

Approach/Activities. Twelve solid waste samples from the wastewater pond were collected and used in 28-day laboratory bioaccumulation assays with Nereis virens. Solid waste used in the assays targeted the range of PAH concentrations measured at the site. Analyses of solid waste and tissue included PAHs (8270D SIM), total organic carbon (waste), and percent lipid (tissue). The bioaccumulation potential of the carbon black was evaluated three ways: (1) bioaccumulation uptake factors (BAFs) were calculated for each sample and compared to matrix properties (total organic carbon [TOC] and grain size); (2) regression analysis was used to compare PAH uptake relationships between solid waste and Nereis across the range of sediment concentrations; and, (3) biota-solid waste accumulation factors were calculated with organic carbon-normalized solid waste and lipid-normalized Nereis data.

Results/Lessons Learned. The bioaccumulation potential of the carbon black matrix (as estimated via BAFs, regressions and BSAFs), was compared to estimates from other contaminated sites across the United States reported in publicly available databases. This evaluation provided context on how PAH uptake from a matrixes with high concentrations of carbon black compared to sites with differing concentrations of black carbon (or other forms of total organic carbon) in their matrix. These evaluations concluded that the carbon black material has unique characteristics compared to other sediment types. Based on the unique characteristics of the carbon black matrix, it was important to have site-specific estimates of bioavailability to reduce uncertainty in the ecological risk assessment.