In Situ Stabilization (ISS) Treatability Test to Remediate NAPL-Impacted Sediments at a Superfund Site

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Background/Objectives. The Operable Unit 2 of a Superfund site located along a major river consists of river sediments and the overlying surface water. The upland area (OU1), immediately west of the river shoreline, has a history of industrial operations, including the manufacturing of paving and roofing materials and oil recycling. These historical activities resulted in the presence of polycyclic hydrocarbons (PAHs) and non-aqueous phase liquids (NAPLs) within the 26-acre OU2 Study Area. An Early Action Engineering Evaluation/Cost Analysis (EE/CA) was prepared to address immediate, near-term risks associated with PAHs and advection- and ebullition-facilitated NAPL sheening. The EE/CA identified in situ stabilization (ISS) for the most significantly impacted nearshore area containing NAPL, combined with a reactive cap outside the ISS footprint. ISS performance was evaluated in a bench-scale treatability study performed at Rutgers University, New Jersey. A bench-scale treatability test was conducted to demonstrate ISS feasibility and to identify and optimize reagent dosages. Chemicals of concern included PAHs expressed as naphthalene; benzene, toluene, ethylbenzene, and xylene; and arsenic. The ISS treatability study tested varying ratios of reagent-sediment mixtures and measured performance metrics of unconfined compressive strength (UCS), hydraulic conductivity (K_h), and chemical leachability. This presentation discusses the treatability study results and the efficacy of using ISS to treat NAPL-impacted saturated sediment.

Approach/Activities. Approximately 335 kg of sediment was collected for the treatability testing, from within the most significantly NAPL-impacted area in OU2. Samples were homogenized and tested for baseline total PAH, BTEX, and arsenic concentrations before initiating the ISS Treatability Study. USEPA Method 1316 and Synthetic Precipitation Leaching Procedure (SPLP) also were performed on baseline samples to compare with ISS-treated material. The reagents included Type II Portland Cement, Ground Granular Blast Furnace Slag, organophilic clay, and powdered activated carbon. The treatability test used an iterative process, performed in three tiers, to screen the reagent mixtures and to narrow the final (Tier 3) test to design mixes that can achieve UCS, K_h, and leachability goals. The design mixes were cured and those passing the initial UCS and K_h requirements were screened for leaching using SPLP and 5-Day ANSI 16.1 tests. US EPA Method 1315 (also known as the LEAF method) was performed at Tier 3, on the final design mixes, to access leaching and to select the final mix design for full-scale implementation. Method 1315 is a 63-day, non-destructive, semi-dynamic progressive leaching test that evaluates contaminant leachability from intact sediment cylinders.

Results/Lessons Learned. The total PAH concentration in the untreated baseline sample was 20,861 mg/kg. The high total PAH concentrations were consistent with the area targeted for the test, where NAPL was observed and where total PAH concentrations were highest. Virtually all design mixes tested achieved the UCS goal of 40 pounds per square inch (PSI) – most exceeded 100 PSI within 7-day cure. Baseline K_h values ranged from 10^{-6} to 10^{-7} cm/s; after treatment, K values reduced approximately an order of magnitude, asymptotically approaching

10^{-8} cm/s. Preliminary leaching results show an order-of-magnitude reduction in leachability – final tests will be completed summer 2018. The ISS Treatability Test, a) demonstrated that ISS could contain NAPL and reduce the mobility of dissolved COCs, and b) provided information to optimize the reagent mix at full scale, to meet the performance criteria.