Fast-Tracking Aggressive Remediation in Clay Soils with a Challenging Site Setting

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Background/Objectives. Releases from a former dry cleaner resulted in chlorinated solvent impacts to soil and groundwater. Site geology consists of clayey silt and sandy clay with a shallow depth to groundwater of 4 to 6 feet bgs. Enhanced reductive dechlorination (ERD) was performed and was successful at reducing tetrachloroethene (PCE) concentrations. Sampling identified a 'hot spot' where elevated concentrations of lesser chlorinated ethenes were present, including 110,000 µg/L vinyl chloride in a grab sample. Such a high concentration was unexpected and could prevent planned redevelopment and the application of a Certificate of Satisfactory Completion. Additional targeted remediation was prescribed to be implemented as soon as possible. Only two months were needed from identification of the contamination to implementation.

Approach/Activities. Soil and groundwater analytical and membrane interface probe data identified the vertical interval to a depth of 18 feet below ground surface. Soil blending was considered for aggressive remediation. However, the 'hot spot' area was immediately adjacent to a building in an active parking lot with subsurface utilities. The shallow groundwater and low permeability soils would require any injection to be performed at low pressure injection with small volumes per point. An injection strategy was developed to maximize contact of the remediation reagents to the subsurface with grid spacing of 3 to 5 feet. Enhanced in situ dechlorination (EISD) reagents included 10-micron zero valent iron (ZVI), emulsified vegetable oil, aggressive dosage of *Dehalococcoides,* and sulfate for generation of iron sulfide in situ. The 'hot spot' remediation event was completed less than two months after the high concentrations of chlorinated volatile organic compounds were detected in the grab sample.

Results/Lessons Learned. The EISD injection was performed using 30 direct-push injection locations within the 750 square foot treatment area. In most points injection pressures were 25 to 45 pounds per square inch in the clayey soils, and injection flow rates were modulated to minimize daylighting through preferential pathways. The post-monitoring sampling events occurred 30 and 90 days after the completion of the EISD injection. Post-injection monitoring has observed significant end product formation, which is a strong indicator that complete dichlorination is occurring. Elevated total organic carbon (TOC) and ZVI in the subsurface indicated that the injection activities were successful in emplacing the injection amendments. The TOC concentration was high prior to the injection event; however, it was even higher during the first post-injection sampling event. The geochemistry indicated a strongly reducing environment and low concentrations of competing electron acceptors.

Continued reductions were exhibited following the 90-day post-injection sampling event, and geochemical parameters showed significant evidence of ongoing degradation within the treatment area, as well as the presence of residual electron donor to promote continued dechlorination. Ethene and ethane concentrations were elevated, indicating complete dechlorination throughout treatment area. Continued groundwater monitoring will be conducted to document the remediation progress over time.