Application of In Situ Chemical Reduction (ISCR) to Treat Chlorinated Ethenes in Fractured Bedrock at a Redevelopment Site

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Background/Objectives. A former dry cleaner facility and surrounding properties in River Edge, New Jersey were being redeveloped into a retail mall. Discharge of PCE wastes directly onto the ground surface resulted in two source areas at the site. Since the removal of source material in early 2000s, concentrations of PCE, TCE and c-DCE (CVOCs) decreased but remained significantly above the NJDEP Ground Water Quality Standards (GWQS). Concentration of PCE in source area monitoring wells ranged from 5,000 to 25,000 µg/L. The subsurface geology consists of unconsolidated silt, sand and clay as the overburden ranging in thickness from 5 to 25 ft. Weathered and fractured rock is encountered underneath the overburden to almost 100 ft bgs. Groundwater is typically encountered at 15 ft bgs. A comprehensive subsurface investigation was conducted to map the site-specific geologic features, hydrogeology, geochemistry and contaminant distribution to develop a conceptual site model (CSM).

Approach/Activities. Remediation strategy was largely driven by the redevelopment aspects of the site in terms of timing and future access for continued treatment. The CSM indicated that the site conditions supported an in situ chemical reduction (ISCR) approach. Remediation goals were to achieve a significant reduction in mass of total CVOCs within four years. ISCR describes the synergistic effect of combining ZVI with an organic carbon substrate to significantly lower the redox state of an aquifer. EHC® is an ISCR amendment consisting of ZVI and organic carbon for treatment of CVOCs. A total of 17 injection points were installed in the two source areas based on an estimated radius of influence of 25 ft. EHC was injected via pneumatic fracturing by creating 175 fractures through these injection points. Approximately 1,500 lb of EHC was injected in each fracture. The injections were completed in March 2012. Significant reductions in CVOCs concentration were attained after the first ISCR event but after 4 years of monitoring, concentrations of CVOCs in two source area wells were still an order of magnitude higher than NJDEP GWQS. A second injection event was conducted around the source area wells in June 2017 with a revised formulation consisting of EHC, sulfate and emulsified lecithin substrate (ELS®) with the intent to promote biogeochemical formation of reactive iron sulfides. This formulation introduced an additional long-term reaction pathway for degradation of CVOCs.

Results/Lessons Learned. Pneumatic fracturing was very effective in achieving a ROI greater than 50 feet. Rapid reduction of PCE accompanied by temporal fluctuations of degradation products TCE, DCE and VC was observed. Complete reduction of PCE to below 1 µg/L was noted at several monitoring well locations but a second injection event was required in the source areas to treat CVOCs back diffusing from the matrix. Results from the two injection events and lessons learned will be presented.