Fractured Bedrock Remediation: Multiple Pilot Test Program Produces Cost Effective Site-Wide Remediation

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Background/Objectives. An active manufacturing facility located in southeast has operated over 40 years producing razor blades and assembled disposable razors. These historical operations resulted in the release of hazardous waste streams from TCE still bottoms, TCE contaminated solids, and plant-related oil waste. In addition to storage and use of TCE-containing solvents, the facility experienced multiple TCE releases which resulted in groundwater contamination at the site. After a series of phased investigations were conducted to assess the groundwater impacts near the source area, a remediation plan was developed which included hydraulic control utilizing a pump and treat system to limit plume migration. This system has been in operation for over 25 years with little to no significant mass removal. In 2012, the site moved into the state's Voluntary Remediation Program, and the 30-acre site was assessed in its entirety. This assessment revealed the presence of dissolved phase constituent plumes at several locations as well as the presence of comingled DNAPL/LNAPL (COCs). Based on the presence of multiple plumes in a complex fractured bedrock geology, an integrated remediation approach was proposed to address the groundwater impacts in several media including soil, groundwater and air vapor and therefore, pilot testing was required. Pilot testing was used to evaluate the feasibility in treating different phases of COCs across the site using multiple technologies to treat sources areas, mobilize and recover NAPL, and treat dissolved phase constituents.

Approach/Activities. Due to the complex geology across this large site, a customized pilot testing program was developed for each representative area of impact that was reflective of the different levels of mass present and the concentration ranges evaluated across the site. Pilot testing was further complicated by cross-bed communication between the shallow saprolitic/partially weathered rock water bearing zone and the deep fractured bedrock that causes vertical movement of contaminants between stratigraphy. Prior to implementation of the multiple pilot tests, a dye tracer study and groundwater model was developed to understand how fractures transmit groundwater at the site. Using this information, several technologies were piloted to address the COCs including aggressive fluid vapor recovery (AFVR), surfactant enhanced aquifer remediation (SEAR), chemical oxidation, and enhanced bioremediation. During the pilot testing, vapor assessments were also conducted to evaluate the potential for vapor to be released to outdoor air and to indoor air from groundwater source off-gassing. Data from pilot testing was managed using an access database to process and organize data for evaluation and analyses is underway.

Results/Lessons Learned. Currently, the multi-pilot test program results suggest that the proposed integrated approach to remediating the COCs at the site can be successful. The results of the multi-pilot test program will be used to further define a full-scale groundwater treatment remedy which will consist of a combined remedies and treatment trains in various areas to temporarily optimize the current treatment system and future replacement with more efficient and cost effective solutions.