Site Characterization in Fractured Bedrock for Source Identification and Commingled Plume Evaluation

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Background/Objectives. The subject site is located in a mixed use (residential/commercial/industrial) urban area near Newark, New Jersey. Several of the surrounding properties are currently conducting or have completed groundwater investigations for chlorinated volatile organic compounds (CVOCs) in multiple aquifer zones related to impacts from their site operations. The contaminants of concern identified in groundwater at the site include tetrachloroethene (PCE); trichloroethene (TCE); cis-1,2-dichloroethene (cis-1,2-DCE); 1,2-dichloroethane; 1,1-dichlorethene; and vinyl chloride. PCE, TCE, and cis-1,2-DCE are the most commonly detected CVOCs onsite and are found at the highest concentrations. As such, when anomalous results were observed in monitoring wells installed offsite, it suggested that another source of CVOCs unrelated to the identified source area may be present.

Approach/Activities. To assess the onsite source area and evaluate contaminant migration pathways for both site-related and other CVOC sources, several high-resolution site characterization techniques were used to focus data collection and develop a comprehensive conceptual site model (CSM) to address contaminant distribution. A layer of shallow unconsolidated sediments overlies the primary aquifer, mapped as the Passaic Formation sandstones (Drake et al., 1996). Site characterization work included the installation of monitoring wells, which involved collecting rock cores for evaluating lithology and fracture/bedding planes, and analyzing rock samples to determine if CVOCs were sorbed into the rock matrix. Subsequent over-drilling of the boreholes allowed for straddle packer vertical profile sampling and comprehensive borehole geophysical testing to determine fracture orientation and fracture flow. Monitoring wells were screened in key intervals based on the results of the testing and subsequent groundwater gauging and sampling. This work confirmed the distribution of CVOCs in the aquifer and groundwater flow paths. Key monitoring wells were then sampled and submitted for compound specific isotopes analysis (CSIA) to establish if the observed CVOCs in downgradient/offsite monitoring well samples were a result of biodegradation or were from a different source material of CVOCs. Samples from onsite source area wells, wells located in the mid-plume, and wells located downgradient and offsite were submitted to Zymax Forensics for isotopic ratios for PCE and TCE.

Results/Lessons Learned. The results of the site characterization activities enabled the development of a comprehensive CSM. The CSM was used to show the mechanisms that control the transport and migration of CVOCs (groundwater flow direction, lithology, contaminant gradients, etc.). The CSIA sampling indicated that while the isotopic ratios of the upgradient/onsite samples were different than the downgradient samples, this difference could not be attributed to the degradation of PCE. Using the CSM, combined with the CSIA, we clearly demonstrated that the downgradient portion of the plume was from more than one source with different points of release (i.e., a source unrelated to the site). Additional wells have been installed and will be sampled using CSIA to provide the regulatory agencies additional lines of evidence to demonstrate that there is a commingled plume.