TCE Source Area Investigation in Fractured Bedrock Using Phytoscreening and Membrane Interface Probe Sampling at a Former Landfill

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Background/Objectives. Unapproved waste disposal at a former landfill site in Northern Virginia resulted in a dilute, 207-acre TCE plume that extends to a depth of 500 feet in fractured bedrock. The site is located in the Triassic-age Culpeper Rift Basin. Lithology consists of overburden and saprolite, underlain by red siltstones. Hydrogeologic conditions are dominated by fracture flow through low-angle bedding-plane partings and higher-angle tensional fractures. A biological and chemical reduction pilot study resulted in asymmetrical distribution of injected substrate and variable degrees of biodegradation of TCE. Elevated concentrations of TCE in the shallow bedrock were observed to be migrating into the pilot study area from the landfill during post-injection sampling. A full-scale chemical reduction remedy would not be effective until the source has been addressed. A source area investigation was performed to better define the shallow source of dissolved TCE mass migrating from the landfill. Phytoscreening, using tree core TCE analysis, membrane interface probing (MIP) technologies, and standard monitoring well installation was used to delineate the source area.

Approach/Activities. A phased approach was developed to identify the source area. The objective of the first phase was to narrow the investigation area. This was completed by correlating the geophysical gamma log data to better understand the bedding orientation. In addition, the gamma logs were used as a basis to subdivide the siltstone into multiple stratigraphic units. The units were projected three-dimensionally in a borehole database geologic modeling program to determine their extent and to identify preferential zones of contaminant migration. The objective of the second phase was to locate and define the TCE source in the up-dip and up-gradient (along strike) subcrop areas. A tree core TCE survey was conducted, consisting of multiple transects and 72 tree core samples, and then MIP was used to delineate the subsurface source area. The final phase of the investigation was to install source area monitoring wells at the locations and depths determined by stratigraphic and geophysical data.

Results/Lessons Learned. The correlated gamma logs showed that the orientation of bedding is relatively consistent across the area of evaluation. Projection of the bedding orientation from the well containing the elevated TCE concentrations in the up-dip and up-gradient direction focused the source investigation activities to the southern portion of the landfill. Tree core samples were collected along six transects around the western, southern, and eastern portions of the landfill. Multiple tree core samples were collected from each tree. Samples were submitted for TCE analysis using methanol extraction and selected ion monitoring mass spectroscopy. TCE was not detected in the tree core samples. To further locate and define the source area, 49 MIP locations were completed. MIP logs indicated a distinct zone of increased MIP instrument response in three locations near the southern area of the landfill at depths greater than 20 feet, within the saprolite directly overlying bedrock. Subsurface soil samples were collected in these three areas, and the results confirmed high TCE concentrations (25,000 mg/kg) at depths of 20 to 29 feet. Monitoring wells were installed upgradient and downgradient of the source area to monitor the TCE concentrations in the groundwater. Details of the investigation will be presented along with conclusions regarding the migration of TCE from the source area in the southern area of the landfill.