Managing Unknown and Uncertain Chemistry Results with High-Resolution Investigation

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Background/Objectives. 1,4-Dioxane is a common co-contaminant with chlorinated solvents; therefore, more and more site investigations are including analysis of 1,4-dioxane alongside chlorinated volatile organic compounds. High-resolution site investigation is an effective way to quickly understand the lateral and vertical extent of constituents of concern (COCs) without leaving the long-term management/cost burden associated with traditional groundwater investigation programs that rely on monitoring wells for characterization. This approach was used at a manufacturing plant in the Piedmont Physiographic Provence of North Carolina to more fully understand the extent of impacted soil and groundwater and devise a remedial approach focused on source area treatment and downgradient risk mitigation.

Approach/Activities. This work includes an eleven-month, high-resolution site investigation focused on the characterization of the saprolite, partially weathered rock (PWR) and fractured metamorphic bedrock. Data collection included a combination of soil sampling and vertical aquifer profiling to characterize the saprolite and PWR and borehole geophysics and packer testing in the bedrock. The investigation included data collection at 79 locations with a maximum depth of approximately 240 feet below ground surface. At the completion of the investigation a total of 46 new groundwater monitoring wells were installed based on the investigation analytical results and augment the existing 25 wells present before. Additionally, in anticipation of future remedial activities, bench-scale testing was conducted to determine the efficacy of chemical oxidation to destroy COCs while minimizing production of undesired byproducts. This work was conducted in the Arcadis treatability laboratory in Durham, North Carolina. Site soil/groundwater samples were amended with up to 40 grams per liter sodium persulfate, utilizing various activation methods (i.e., alkaline activation, ambient activation, and heat activation).

Results/Lessons Learned. High-resolution site investigations provide invaluable information, commonly under the guise of unexpected results. The adaptive and high-resolution nature of this investigation resulted in identification and delineation of a significant source zone (360,000 µg/L 1,4-dioxane) compared to previous well data that indicated 1,4-dioxane concentrations at a high of 26,000 µg/L. Additionally, the bedrock portion of the investigation revealed a complex structure with a ductile shear zone intersecting the western portion of the site and a synclinal feature creating an unexpected flow direction. The bedrock structure and high-resolution data also resulted in in confirmation and segregation of a separate plume in bedrock, from offsite.

While higher (i.e., percent-level) concentrations of 1,4-dioxane are observed at sites where it was used directly, or where it was a byproduct of the manufacturing processes employed, it was surprising to find this high of a concentration at a site where it is present because of chlorinated solvent use. Luckily, the results of bench-scale treatability testing indicate that chemical oxidation can be an effective approach to treat all COCs in groundwater, even at the high concentrations found in the source areas. As is a common storyline, while the results of this high-resolution site investigation revealed some unexpected results, the data have proven invaluable during the remedial action evaluation phase of the work.