High-Resolution Site Characterization (HRSC) and Three-Dimensional Data Visualization: A Path to Streamlined Closure

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Background/Objectives. Traditional site investigation data collection methodologies have historically provided inadequate data density, data quality and data interpolation to overcome site heterogeneity. This deficiency in data often leads to repeated and/or incomplete investigations during initial stages of a site's lifecycle and can result in the development of incomplete or an incorrect conceptual site model (CSM). Incomplete CSMs often lead to flawed environmental system interpolations of geologic/hydrogeologic and microbiological-biochemistry systems, leading to unsuccessful remedial strategies, yielding to a greater potential to extend lifecycles and costs.

A former specialty chemical manufacturing facility located in Edison, New Jersey was actively undergoing investigations since the late 1990s and remediation (P&T) from 2001 to 2006. Site investigations identified primary contaminants of concern as 1,1,1–trichloroethane (TCA) and its respective degradation products. Bench-scale testing identified a unique strain of *dehalococcoides* that naturally were degrading CVOCs at a low pH range of 5.8 to 6.0. As a result, multiple field pilot studies were designed and successfully implemented to evaluate in situ chemical reduction technologies and delivery methods for enhanced dechlorination biodegradation.

Approach/Activities. Results of geophysics and initial pneumatic injection pilot tests yielded significant positive results for injection delivery design and contaminant mass treatment, resulting in permanent shutdown of the P&T. Following the field pilot tests, a HRSC investigation in overburden was conducted to evaluate post pilot test performance and to determine the presence of any additional sources of TCA. Existing and new data were migrated to a Geographic Information System (GIS) and EarthSoft's EQuIS database and exported for data-visualization using C Tech's Earth Volumetric Studio (Studio).

HRSC and prior geophysical data were used to generate a geologic model of overburden and fractured rock including an interpreted 3-D fracture model. Following the generation of the geologic grid, 3-D kriging was completed for TCA and associated biodegradation dechlorinating daughter compounds as well as for MIP detector data. These data sets were analyzed using both traditional 2-D methods as well as using 3-D volumetric analysis. After completing the HRSC investigation, a single shallow source of TCA material was fully delineated at a former loading area and contaminant transport pathways were confirmed, that eliminated a hypothesized second source area. The remaining source was subsequently removed by soil excavation and treated with the placement of emulsified vegetable oil (EVO) and zero-valent iron (ZVI) to accelerate treatment of impacted groundwater in overburden and fractured rock. Soil closure was obtained with complete delineation utilizing both HRSC and traditional analytical data sets and residual soil sources remedied by engineered and institutional controls. Groundwater monitoring was reduced to an annual program and monitored natural attenuation (MNA) was selected as the final remedy.

Results/Lessons Learned. The incorporation of HRSC, geophysical data in bedrock as well as MIP data in overburden and incorporation of historical groundwater analytical data into a comprehensive 3-D CSM provided a tool for the design of more targeted investigations, focused

pilot studies, pneumatic injection delivery and more precise full-scale remediation implementations, proving a *“Best-In-Class”* solution that reduced project lifecycle and costs.