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

Joshua Orris (Joshua.Orris@anteagroup.com) (Antea Group, Berwyn, PA, USA)
Jason C. Ruf (S2C2 Inc., Raritan, NJ, USA)

Background/Objectives. Traditional site investigation and data collection methodologies have historically provided inadequate data density to overcome site heterogeneity. This lack of data density coupled with often disjointed and repeated investigations during initial stages of a site's lifecycle can result in the development of incomplete or worse, an incorrect Conceptual Site Model (CSM). This is especially true when managing sites with impacted fractured rock where limited data sets are often the norm due to the difficulty and cost of collecting data. In these instances, incomplete CSMs often lead to flawed environmental interpolations of geo/hydrogeologic and biochemistry systems and have a greater potential to extend lifecycles and increase project costs.

A former specialty chemical manufacturing facility located in Edison, New Jersey had been an actively undergoing investigations and remediation since have been completed since 1998 and an Interim Remedial Measure (IRM), groundwater recovery and treatment system was operational from 2001 to 2006. The results of ongoing site investigations had identified the primary contaminants of concern as chlorinated volatile organic compounds (CVOCs), notably 1,1,1–trichloroethane (TCA), trichloroethylene (TCE) and their respective degradation products. Site investigation and bench scale testing activities confirmed evidence that naturally occurring microbes were degrading the CVOC contamination. As a result, multiple field pilot studies were developed and implemented to evaluate a combination of in-Situ remedial technologies and delivery techniques for enhanced biodegradation.

Approach/Activities. The results of initial pneumatic injection field pilot tests yielded significant positive results for delivery and contaminant mass treatment, resulting in the permanent shut-down of the IRM. Following the field pilot tests, a HRSC investigation in overburden was conducted to determine the presence of any additional sources of TCA in overburden soil and groundwater. Historical groundwater analytical data, geophysical data, water level data, CAD maps, historic aerial photographs) and new HRSC data were migrated to a Geographic Information System (GIS) and EarthSoft's EQuIS database and exported for visualization using Ctech's Mining Visualization Software (MVS).

HRSC data were used to generate a geologic model of overburden and fractured rock including an interpreted 3D fracture model. Following the generation of the geologic grid, 3D kriging was completed for TCA and associated daughter compounds as well as for MIP detector data. These data sets were analyzed using traditional 2D mapping applications as well as fully three-dimensional volumetric analysis to evaluate analytical data trends and the effectiveness of the remedial actions. After completing the HRSC investigation and creating the initial refined CSM, 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. The remaining source was subsequently removed by soil excavation and treated with the placement of Emulsified Vegetable Oil (EVO) and zero-valent iron (ZVI) at the base of the excavation prior to backfilling 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 for monitored natural attenuation (MNA) remedy was initiated and subsequently selected as the final remedy for the Site.

Results/Lessons Learned. The incorporation of HRSC geophysical data in rock as well as MIP data in overburden and incorporation of historical groundwater analytical data into a comprehensive 3D CSM provided for more targeted investigations, successfully designed injection wells, pilot studies, pneumatic injection designs and more precise full-scale remediation implementations. HRSC and development of a 3D CSM enabled a “Best-In-Class” solution for enhancing insights into the fractured bedrock environment, refined targeted remediation strategy implementation and performance monitoring that facilitated a reduced lifecycle and cost savings.