Use of Mass Flux Site Characterization Approach to Support Bioremediation System Optimization

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Background/Objectives. The former Ashland LLC Facility in Rensselaer, New York (site) implemented enhanced reductive dechlorination (ERD) for chlorinated volatile organic compounds (CVOCs) groundwater remediation in 2010. ERD infrastructure consisted of two shallow injection well transects along the downgradient portion of the site to treat CVOC mass thought to be migrating offsite and reduce concentrations in downgradient monitoring wells located offsite. Groundwater monitoring results demonstrated successful treatment results for ERD at the property boundary but indicated that downgradient treatment effects were limited. The results suggested that the site conceptual site model (CSM) needed refinement and that a previously unidentified source area or mass flux pathway was sourcing offsite impacts. A “Smart Characterization” approach was implemented to evaluate onsite source area mass and define mass flux pathways to the downgradient receptors to support potential ERD expansion. Smart Characterization combines the use of high-resolution data collection technologies with data visualization tools and an adaptive decision-making process to develop flux-based hydrostratigraphic CSM that can be used to support remedial design.

Approach/Activities. The approach at the site included onsite delineation of lateral and vertical extent of CVOC sources and evaluation of mass flux pathways for downgradient migration. A 3-D model and a virtual reality interface were utilized to support the adaptive investigation and data analysis and communicate results and proposed path forward to project stakeholders.

A combined membrane interface probe and hydraulic profiling tool (MiHPT) and follow up grab soil and groundwater sampling was used to complete the investigation. MiHPT borings provided high-resolution, real-time site hydrostratigraphy data and a simultaneous evaluation of CVOC source extent. Subsequent follow-up borings provided quantitative data for soil and groundwater impacts from likely source areas and mass flux zones. A 3D site model was used to complete a site-wide interpretation of lithology and CVOC impacts for mass flux analysis. CVOC source mass was identified in deeper zones than previously understood, and a deep mass flux pathway of higher relative permeability was identified below the current treatment transect interval. Based on these results, three injection wells were installed in the deeper source mass and utilized for a limited scale injection event using an ERD reagent and rhodamine dye tracer. Tracer was detected in offsite wells, confirming the mass flux pathway from the deeper onsite source to offsite monitoring wells and providing a basis to support ERD system expansion.

Results/Lessons Learned. The Smart Characterization approach resulted in delineation of CVOC mass and the identification of mass flux pathways not targeted by the current ERD remedy and provided data to support remedy expansion. The creation of a 3-D model and virtual reality interface with lithology and impacts was critical to support real-time data analysis and communication of the revised CSM to project stakeholders for remedy optimization approval. As a result of the Smart Characterization approach, the project received regulatory approval for an expansion of the site ERD program including 17 injection wells to target source mass and deeper mass flux pathways, currently being implemented.