

Remedy Optimization through Use of a 3-D Model

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Background/Objectives. At complex sites, traditional data visualization tools may not be sufficient to understand plume architecture. Reprocessing existing data with 3-D visualization tools can lead to a better understanding of mass flux and optimization of soil and groundwater remedies.

ERM used 3-D visualization tools to better understand a chlorinated aliphatic hydrocarbon (CAH) plume present within several confined heterogeneous sandy to silty aquifer units extending to a depth of ~70 m below ground surface (bgs). The site had been investigated repeatedly and monitored for about 30 years. However, the location and architecture of the relevant contaminant hot spots were not understood. Traditional 2-D isocontour plots of at least six individual contaminants within five aquifers were created in the past resulting in a total matrix of more than 30 plots and maps depicting the distribution of contaminant concentrations. To fully understand the 3-D contaminant fate and transport and develop cost-effective remedial measures, ERM processed all existing and some newly collected data so that all of the stakeholders could easily understand the source and plume architecture as well as the proposed remedy.

Approach/Activities. ERM utilized the 3-D visualization software Mining Visualization System (MVS) of C Tech for analyzing and visualizing of all existing and newly collected site data to gain an understanding of the location and behavior of the contamination hot spots to ultimately tailor a site-specific remedial approach. This was the first time that the geological and contaminant data were analyzed and visualized in 3-D at this site. In a first step, the existing cone penetrometer test (CPT) point data were transformed into a continuous 3-D geological model comprising four major aquifers subdivided by five aquitards. Subsequently, the well screens of over 100 existing wells were assigned to the respective aquifer units. In a subsequent step, the data set was combined with the long-term CAH monitoring data to create a 3-D picture of the individual CAH contaminant source zones and associated plumes. Only minor investments in the form of a few new wells were required to complement the aforementioned 3-D data assessments and to calibrate the existing CPT data with regard to geology.

Results/Lessons Learned. The evaluation and visualization led to a sound understanding of the source zone architecture, which could easily be communicated to the stakeholders by using the freely available pdf and 4dim player formats. These formats allowed the concerned parties to choose the viewing perspective of the site in combination with any desired CAH contaminants, i.e., they were not restricted to fixed views of multiple maps of individual contaminants at multiple aquifers.

The 3-D analysis clearly illustrated that the pump and treat (P&T) measure that was in operation for the last decade in the most shallow aquifer had been placed in the wrong aquifer unit, thus not targeting the most relevant source zones. The latter were identified in the second and third aquifer unit, having CAH concentrations of up to 1.5 g/L and pooled DNAPL being associated with small-scale local geologic depressions.

In the revised RAP, this new 3-D understanding led to a complete re-design of the remediation strategy. The revised remedial approach proposed vertical groundwater circulation wells across

different aquifer units to stimulate enhanced anaerobic bioremediation by injecting an amendment and a focused P&T at certain source zones, particularly where DNAPL was present. The revised Remedial Action Plan was accepted by the regulator and is currently subject to implementation.