Streamlining the Path to Site Closure Using a Two-Dimensional Spreadsheet Model and a Three-Dimensional Visualization Tool

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Background/Objectives. Light non-aqueous phase liquid (LNAPL) containing a trace of chlorinated ethenes was released from an underground storage tank in 1980 and discovered in 1985 at a hazardous waste facility. Historical excavations completed between 1987 and 1997 recovered a large volume of LNAPL impacted soil; however, LNAPL continued to enter one on-site monitoring well. A pump and treat system was installed in 1997 for hydraulic control of the dissolved phase total petroleum hydrocarbon (TPH) and chlorinated solvent impacts to groundwater. A 2014 request to shut down the pump and treat system was denied due to the presence of LNAPL. The cis-1,2-DCE regulatory standard in Minnesota was then reduced from 50 µg/L to 6 µg/L and resulted in exceedances at the compliance well. Dissolved phase concentrations were compared to the effective solubility of cis-1,2-DCE in LNAPL and suggested it served as a source. Excavation of the remaining LNAPL body was deemed cost beneficial and resulted in the transition from pump and treat to monitored natural attenuation (MNA). A two-dimensional spreadsheet model of the advection dispersion equation and a three-dimensional geologic model of the site were used to predict the maximum extent of the cis-1,2-DCE dissolved phase plume and accelerate the path to site closure. This paper presents the transition to MNA, results of a simplified two-dimensional modeling, and the three-dimensional site model emphasizing the complex nature of the environment.

Approach/Activities. Soils at the site were deposited in a complex glacial environment and consist of alternating till and outwash overlying slate bedrock. The leading edge of the cis-1,2-DCE dissolved phase plume exhibited early stage characteristics with apparent mass transport through the more transmissive outwash. A conceptual site model was used in development of a two-dimensional spreadsheet model of the advection dispersion equation. Available site specific parameters, including approximate LNAPL volume released, LNAPL composition, hydraulic conductivity, soil density, and total organic carbon were used to calibrate the solution for the mass transport zone. Data suggested anaerobic degradation of cis-1,2-DCE to vinyl chloride was not occurring, and therefore a conservative low decay rate was input. A plume delineation and stability investigation was completed to validate results of the modeling. A three-dimensional geologic model was developed using Leapfrog to aid in communication of the conceptual site model.

Results/Lessons Learned. The model predicted the maximum downgradient extent of cis-1,2-DCE concentrations above regulatory standards did not result in exposure of any additional potential receptors beneath the footprint. Plume delineation and stability results were compared to the model predictions and suggested it was conservative in predicting earlier arrival times. Based on the projected plume migration, the regulatory agency was comfortable with agreeing to a finite path to closure, but required confirmation of the model in 2020 to verify plume stability.