Deriving Cleanup Goals for Soil Gas for the Protection of Groundwater

Glen P. Gordon (glen.gordon@amecfw.com) (Amec Foster Wheeler, Portland, ME, USA)
Lawrence G. Cain (lawrence.g.cain@usace.army.mil) (United States Army Corps of Engineers New England District, Concord, MA, USA)

Objectives. This presentation is intended to provide an overview of methods that were used to develop cleanup goals for soil gas. TCE in soil gas has been shown to be the primary source of contamination to groundwater at the CRREL Site. Partitioning from soil gas has resulted in TCE in groundwater at concentrations over 20,000 µg/L. A method was needed to estimate the cleanup goal for soil gas that will result in a groundwater TCE concentration of 5 µg/L. There are not, however, published cleanup standards for soil gas, and CERCLA does not provide guidance for developing these goals. Additionally, the highly variable soil types at the Site make the use of models based upon soil leaching unreliable.

Approach. Soil gas contaminant concentrations at the CRREL Site have been extensively studied both for evaluation of vapor intrusion and as part of soil vapor extraction (SVE) pilot studies. These data show that TCE concentrations in groundwater at the water table are near equilibrium with soil gas, but concentrations decrease rapidly with depth once below the water table. Monitoring wells, however, average concentrations over their screen length, and are the standard for determining compliance with cleanup standards. Three methods were explored to project future monitoring well groundwater contaminant concentrations based on a change in soil gas concentrations.

The first method, the concentration profile method (CPM), used groundwater profile data to predict a depth-concentration relationship and then integrate the results over a defined well screen interval. The second method, the direct mixing method (DMM), assumed TCE entered groundwater dissolved in infiltrating storm water and completely mixes with groundwater over a selected depth equal to the compliance well screen length. The third method used the Soil Vapor Extraction Endstate Tool (SVEET), which estimates partitioning from soil gas and infiltration and the resulting mixing in the aquifer based on Darcy groundwater velocity.

Results. Advantages and disadvantages were identified for each method. CPM provided good results at concentrations similar to those that existing prior to implementation of SVE. However, the pre-SVE depth-concentration curve reached asymptotic levels at a concentration above the target concentration, making the results unusable for establishing soil gas cleanup levels for the target groundwater concentration.

DMM assumes partitioning via groundwater infiltrations, without consideration for direct partitioning from soil gas to groundwater. Furthermore, the depth of the mixing zone must also be estimated, and if data is not available to support this estimation it's selection is arbitrary. The SVEET model predicts the mixing zone and considers both infiltration and direct soil gas to groundwater partitioning, but restricts infiltration rates to those that would be present in desert climates or capped sites and requires modeled compliance wells to have longer screens then permitted by some regulatory programs. For conditions present at CRREL, realistic infiltration rates required multiple iteration of the model and extrapolation of results outside the model limits. Despite using different methods, both DMM and SVEET predicted similar soil gas concentration would result in achievement of target groundwater cleanup goals.