

Trichloroethene-Contaminated Soil Gas as a Source of Groundwater Contamination in a Deep Vadose Zone Environment

Glen P. Gordon (glen.gordon@amecfw.com) and Scott F. Calkin (scott.calkin@amecfw.com)
(Amec Foster Wheeler, Portland, ME, USA)
Darrell A. Moore (darrell.a.moore@usace.army.mil) and
Daniel M. Groher (Daniel.m.groher@usace.army.mil) (United States Army Corps of Engineers
New England District, Concord, MA, USA)

Overview. The objective of this presentation is to describe phase partitioning of trichloroethene (TCE) from soil gas to the capillary fringe in a deep vadose zone. Releases of TCE to shallow soils at the Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire resulted in a large, persistent soil gas plume. The plume has spread vertically to the water table in vapor phase through diffusion and partitions into groundwater. Additionally, TCE partitions from soil gas into infiltrating precipitation, and is carried in the dissolved phase to the water table. Strong evidence exists that soil gas is the primary source of contamination to groundwater through these pathways.

Approach: Data collected during a high resolution characterization of the groundwater plumes and during a soil vapor extraction (SVE) pilot tests have provided multiple lines of evidence to understand transport dynamics for TCE in the subsurface. Vertical groundwater profile samples and water table monitoring well samples collected prior to initiation of SVE. These provided a baseline vertical concentration gradient below the water table. These groundwater concentrations were compared to TCE concentrations in soil gas at varying distances above the water table. During the SVE pilot tests, TCE soil gas and groundwater concentrations were measured to assess if changes in soil gas concentrations would result in changes in groundwater concentrations.

Results: Pre-SVE baseline groundwater profiler data show TCE concentrations ranging from 65,000 µg/L at the water table to 310 µg/L five feet below the water table. Data from a closely located monitoring well with a 10-foot screen bridging the water table had a concentration of 23,000 µg/L. These concentrations match what would be expected based on a soil gas concentration of 3,000,000 µg/m³ in equilibrium with groundwater concentrations at the water table with a diffusion limited concentration gradient below the water table.

Following the start of the SVE pilot test, soil gas concentrations dropped significantly as relatively clean soil gas was drawn into the source area from surrounding soil. This resulted in decreased TCE concentration in both soil gas and infiltrating water, and the water came into equilibrium with the lower soil gas TCE concentrations. Monitoring of the groundwater wells showed a three order of magnitude reduction in the TCE concentration to 83 µg/L after approximately two months of SVE operation.

Subsequent groundwater and soil gas sampling have continued to show good correlation between soil gas concentrations and groundwater concentrations following predicted Henry's Law equilibrium concentrations including increased groundwater concentrations follow shut-down of the SVE system for a rebound study. This confirms that the source of contamination to groundwater is partitioning from vadose zone soil gas and pore water.