

Evaluation of a New Passive Diffusion Sampler for Improving the Calibration of Models to Evaluate Vapor Movement at UST Sites

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Abstract

Understanding transport of volatile contaminants in soil gas and ground water, particularly those associated with underground storage tanks (USTs), requires a detailed knowledge about the depth-dependent distribution of chemical species in the subsurface. A risk assessment of the movement of vapors of volatile organic contaminants (VOCs) from ground water through the unsaturated zone and into living spaces usually involves a transport and fate model such as the Johnson and Ettinger model. The concentration of VOCs in ground water is needed to calibrate these models. EPA recommends that ground water samples should be obtained from the uppermost portions of the ground water and/or capillary fringe (Appendix G of EPA OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway, November, 2002). Historically, samples have not been obtained from these zones. Generally, samples have been acquired from conventional wells screened across the water table. A conventional well produces a composite sample. The average concentration across the screened interval may not be representative of the concentration at the top of the aquifer or in the capillary fringe. Conventional practice assumes that the concentration of contaminants in the capillary fringe that are available to diffuse upward into the building is the average concentration of contaminants produced from the monitoring well. If oxygen is available at the capillary fringe, biodegradation may remove the fuel vapors before they have a chance to diffuse upward into buildings.

Generally, screening models, such as the Johnson & Ettinger, are used to estimate the affect of biodegradation on removal of hydrocarbon vapors. A simple and affordable passive diffusion sampler (PDS) was developed that can be used to estimate depth-discrete concentrations of contaminants in soil gas and ground water. This approach replaces the estimates of a mathematical model with monitoring to see if there are vapors in the soil gas immediately above the capillary fringe that can diffuse into buildings. The PDS consists of a 40-ml VOA vial fitted with a modified cap where the Teflon-lined septa is replaced by a permeable membrane to allow contaminants to diffuse into the water-filled VOA vial. The PDS is inserted into a holder or “messenger” for deployment down monitoring wells.

A field study was conducted to provide three-dimensional site characterization of gasoline plumes at two UST sites to evaluate the effectiveness of the PDS for determining BTEX concentrations. PDS concentrations were compared with those obtained with traditional ground water and soil gas sampling techniques. The messengers containing the PDS were lowered into each monitoring well so that the cap of the PDS was exposed within the well screened interval. The PDS was left in the monitoring wells for approximately one month. Previous laboratory studies showed that one month was sufficient time for BTEX compounds to diffuse across the membrane and reach equilibration. Results of this study show that the PDS provides a simple and affordable alternative to traditional sampling techniques at UST sites. The PDS provides an effective method of sampling both ground water and soil gas in low permeability formations. Additionally, results of discrete depth contaminant concentrations may be used to provide information on whether natural attenuation processes are controlling risk associated with the site.

This is an abstract of a proposed poster presentation and does not necessarily reflect EPA policy.