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NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION RESEARCH



# Development of a Sub-Slab Gas Sampling Protocol to Support Assessment of Vapor Intrusion

## Introduction

Vapor intrusion is defined as vapor-phase migration of volatile organic compounds (VOCs) or inorganic compounds into occupied buildings from underlying contaminated ground water or soil. Until recently, this transport pathway was not routinely considered in RCRA (Resource Conservation and Recovery Act), CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act), or underground storage tank investigations. Therefore, the number of buildings or homes where vapor intrusion has occurred or is occurring is undefined.

However, considering the vast number of current and former industrial, commercial, and waste-processing facilities in the United States capable of causing volatile organic/inorganic ground water or soil contamination, contaminant exposure via vapor intrusion could pose a significant risk to the public. Also, consideration of this transport pathway may necessitate review of remedial decisions at RCRA and CERCLA sites, as well as implementation of risk-reduction technologies at brownfield sites where future development and subsequent potential exposure may occur.

EPA's Office of Solid Waste and Emergency Response (OSWER) developed guidance to facilitate assessment of vapor intrusion at sites regulated by RCRA and CERCLA, where halogenated organic compounds constitute most of the risk to human health. EPA's Office of Underground Storage Tanks is considering modifying this guidance to include underground storage tank sites where petroleum compounds that primarily determine risk and biodegradation in subsurface media may be a dominant fate process.

OSWER guidance recommends indoor air and sub-slab gas sampling in potentially affected buildings at sites containing elevated levels of soil-gas and ground water contamination. To support the guidance and improve site characterization and data interpretation methods to assess vapor intrusion, EPA's Office of Research and Development is developing a protocol for sub-slab gas sampling. When used with indoor air, outdoor air, and soil-gas or ground water sampling, sub-slab gas sampling can be used to differentiate indoor and outdoor sources of volatile organic and inorganic compounds from compounds emanating from contaminated subsurface media. This information can then be used to assess the need for sub-slab depressurization or other risk-reduction technologies to reduce present or future indoor air contamination due to vapor intrusion.

## Background

Sub-slab sampling will be conducted at four sites. The first site consists of 11 houses near the Raymark Superfund site in Stratford, Connecticut. The primary VOCs of concern are 1,1,1-trichloroethane, trichloroethene, 1,2-cis-dichloroethene, 1,1-dichloroethene, and benzene. The other three sites are in Oklahoma and consist of buildings near present and former underground petroleum storage tanks.

## Objectives

The primary objective of this research is to develop a methodology and subsequent data interpretation strategy for sub-slab sampling to support the EPA guidance and vapor intrusion investigations after vapor intrusion has been established at a site. Methodologies for sub-slab gas sampling are currently lacking in referred literature.

## Approach

Protocol development will involve assessment of four potential sources of systematic error:

- Probe construction material as a source of VOCs
- VOC loss through Tedlar bags when used for screening purposes
- Use of insufficient or excessive sample and purge volume
- Placement and number of sub-slab probes in a basement or foundation

An algorithm or flowchart will be developed to incorporate outdoor air, indoor air, sub-slab gas, and subsurface ground water or soil-gas data to differentiate sources of VOCs in indoor air.

## Experimental Design

At least three sub-slab vapor probes will be installed in each house potentially affected by vapor intrusion. A rotary hammer drill (Figure 1) will be used to create small diameter holes through the concrete and into the sub-slab material (i.e., sand or sand and gravel). Drilling into the sub-slab material (Figure 2) will create an open cavity to prevent obstruction of probes by small pieces of gravel.

**Figure 1:** Drilling through slab

In homes near the Raymark site, probes will be constructed from small-diameter threaded brass pipe and connectors. At underground storage tank sites in Oklahoma, probes will be constructed from chromatography-grade 316 stainless-steel tubing and Swagelok stainless-steel connectors (Figure 3). The top of the probes will be completed flush with the top of the concrete slab with recessed brass plugs so as not interfere with day-to-day use of the basements. A quick-drying portland cement that expands upon drying (to ensure a tight seal) will be mixed with water to form a slurry and injected into the annular space between the probe and outside of the hole.

Indoor, outdoor, and sub-slab samples at the Raymark site will be collected in 100 percent certified 6-L Summa canisters and analyzed for a list of halogenated and non-halogenated compounds by EPA's New England Regional Laboratory using EPA Method TO-15. Sub-slab samples will also be collected in 1-L Tedlar bags, using a peristaltic pump and dedicated tubing, and analyzed for a list of target compounds onsite by EPA's New England Regional Laboratory. Indoor and outdoor samples at the underground storage tank sites will be collected in 100 percent certified 6-L Summa canisters and analyzed for a list of ozone precursors (i.e., petroleum hydrocarbons) by a commercial laboratory using EPA Method TO-15. Sub-slab samples will be collected in 100 percent certified 1-L Summa canisters (Figure 4) and analyzed for ozone precursors, using EPA Method TO-15. Samples will also be collected in Tedlar bags for onsite analysis of oxygen, carbon dioxide, and methane.

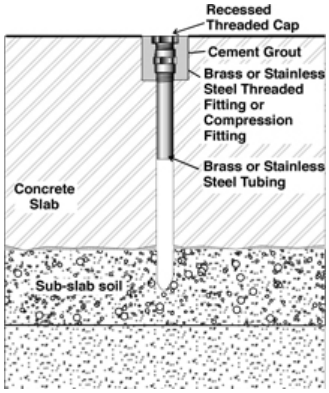


**Figure 2:** Schematic of sub-slab probe

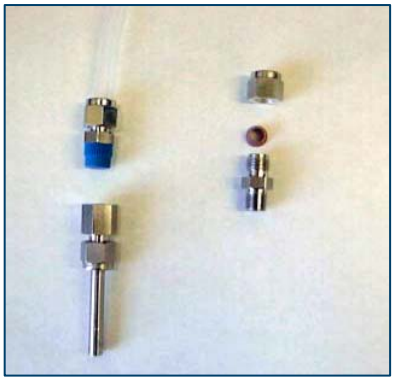

**Figure 3:** Probe construction

**Figure 4:** Sub-slab sampling with 1-L Canister

## Accomplishments

Sampling has been completed at both sites. EPA report preparation is in progress.

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