Project Title: **Development of a Sub-Slab Gas Sampling Protocol to Support Assessment of Vapor Intrusion**

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Introduction to Problem: Vapor intrusion is defined as vapor phase migration of volatile organic and/or inorganic compounds into occupied buildings from underlying contaminated ground water and/or soil. Until recently, this transport pathway was not routinely considered in RCRA, CERCLA, or UST 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 or 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 Brownsfield sites where future development and subsequent potential exposure may occur. EPA's Office of Solid Waste and Emergency Response (OSWER) recently (2002) developed guidance to facilitate assessment of vapor intrusion at sites regulated by RCRA and CERCLA where halogenated organic compounds constitute the bulk of risk to human health. EPA's Office of Underground Storage Tanks (OUST) is considering modifying this guidance to include underground storage tank sites where petroleum compounds primarily determine risk and biodegradation in subsurface media may be a dominant fate process.

The 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 or Research and Development is developing a protocol for sub-slab gas sampling. When used in conjunction with indoor air, outdoor air, and soil gas and/or ground-water sampling, sub-slab gas sampling can be used to differentiate indoor and outdoor sources of volatile organic and/or 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 potential 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 purpose 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: (1) probe construction material as a source of VOCs, (2) VOC loss through Tedlar bags when used for screening purposes, (3) use of insufficient or excessive sample and purge volume, and (4) 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 concrete and into sub-slab material (e.g., sand or sand and gravel). Drilling into sub-slab material (illustrated in Figure 2) will create an open cavity to prevent obstruction of probes by small pieces of gravel. In homes near the Raymark site, probes will be constructed from small-diameter threaded brass pipe and connectors. At UST 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 which 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% 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 on-site by EPA's New England Regional Laboratory. Indoor and outdoor samples at the UST sites will be collected in 100% certified 6-L Summa canisters and analyzed for a list of ozone precursors (petroleum hydrocarbons) by a commercial laboratory using EPA Method TO-15. Sub-slab samples will be collected in 10% 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 on-site analysis of O_2, CO_2 and CH_4.

Accomplishments to Date: Sampling has been completed at both sites. EPA report preparation is in progress.

Figure 1. Drilling through slab

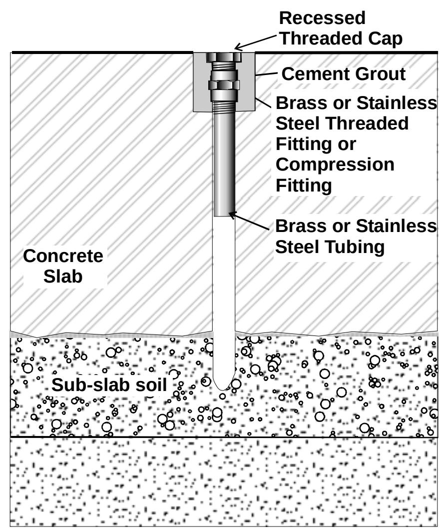

Figure 2. Schematic of sub-slab probe

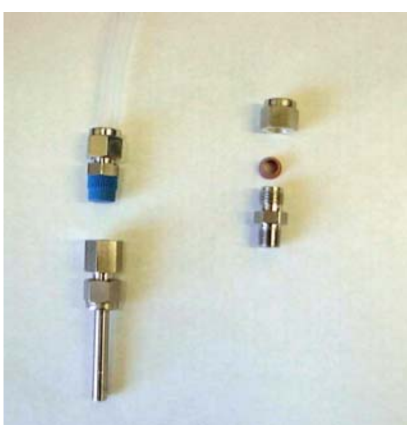

Figure 3. Probe construction

Figure 4. Sub-slab sampling with 1-L Canister