7.5 SOIL VAPOR OR INDOOR AIR SAMPLING METHODS

Due to the reactivity of chemical compounds in the gas matrix and sample interaction with sampling equipment and media, the collection of soil vapor or indoor air samples may be more involved and complex than soil or groundwater sample collection.

Soil vapor or indoor air sampling methods can be grouped into the following categories: (1) whole air sampling; (2) sorbent tube sampling; (3) passive sampling using sorbent materials; and (4) flux chamber sampling. Whole air sampling involves collecting a volume of gas in a sample container and analyzing the gas directly. Sorbent tube sampling involves passing the soil vapor or indoor air over a sorbent material (through the use of a pump or vacuum) and analyzing the sorbent material. Passive sampling using sorbent materials involves placing a sorbent material at a sample location for a period of time and analyzing the sorbent material. Flux chamber sampling involves collecting contaminants within an enclosed chamber.

Similar to soil and groundwater sample collection, a combination of sampling methods may be used if analyzing for a broad range of chemical compounds. For example, whole air sampling may be used to provide information on VOCs, and sorbent tube sampling may be used to provide information on semi-volatile organic compounds (SVOCs). Consultation with the analytical laboratory to discuss specific standard operating procedures and sampling methods is strongly recommended during the planning phase for each project requiring the collection of soil vapor or indoor air samples.

7.5.1 Whole Air Sampling

Whole air sampling collects a representative volume of the soil vapor or indoor air of interest in either Summa canisters or Tedlar bags. This method is recommended to quantify concentrations of vapor-phase chemicals for an exposure or risk assessment. Contaminant concentrations can be quantified in units of parts per million by volume (ppmv) or milligrams per liter (mg/L) for the samples. Whole air sampling is best suited to locations with relatively high soil permeabilities and contaminant concentrations (County of San Diego, 2002).

In general, target compounds conducive to whole air sampling are chemically stable and have a vapor pressure greater than 0.1 torr at 25 ˚ C and 760 millimeters of mercury (one atmosphere). Effective recovery of chemicals from active soil vapor samples depends on sample humidity, chemical activity of the sample matrix, and the sample container's degree of inertness.

When shipping whole air samples from Hawai`i, field readings should be used to determine if explosive gases are present at concentrations that require special shipping considerations.

7.5.1.1 Summa Canisters

A Summa canister is a stainless steel container that has had the internal surfaces specially cleaned using electropolishing and chemical deactivation to produce a surface that is nearly chemically inert. The degree of chemical inertness of a whole air sample container is crucial to minimizing reactions with the sample and maximizing recovery of target compounds from the container.

Summa canisters range in volume from less than one liter to greater than six liters. The larger canisters may be used to collect ambient air samples or integrated samples (i.e., composite samples through time). Smaller canisters may be used to collect high concentration grab samples.

The Summa canister is prepared for sampling by evacuating the contents to a vacuum of approximately 29.9 inches of mercury. The Summa canister is connected to the sampling device (see Subsection 7.5.1) and the valve is opened to allow the soil vapor or indoor air sample to enter the canister. When the target volume of sample is collected, the valve is closed and the canister returned to the laboratory for analysis.

As indicated above, the cleaning process to produce a chemically inert interior canister surface is crucial to the analysis of soil vapor or indoor air samples. Laboratories typically provide canister cleaning certification of Summa canisters. A minimum of 10% certification of Summa canisters is recommended when soil vapor or indoor air samples consist of ambient air applications or high concentration applications such as soil vapor or landfill gas monitoring. A 100% certification may be appropriate depending on project requirements, such as applications driven by risk assessment or litigation that require a high sensitivity for the data.

Summa canisters are typically used with flow controller devices that regulate the flow of gas during sampling into the evacuated canister. These allow for sample collection at a specified flow rate as the vacuum in the canister decreases during collection. The initial vacuum and final vacuum following sample collection for all Summa canisters should be measured and recorded.

7.5.1.2 Tedlar Bags

A Tedlar bag is made from two layers of Tedlar film sealed at the edges and containing a valve allowing for soil vapor or indoor air sample collection using a pump. Tedlar is a trade name for a polyvinyl fluoride film that exhibits a low permeability to gases, chemical inertness, weathering resistance, and low off-gassing.

Similar to canisters, Tedlar bags range in volume up to five liters, and may be used to collect high concentration grab samples or ambient air samples. The Tedlar bags may be used for projects involving analysis of low concentrations of compounds, in the ppmv range.

Soil vapor or indoor air samples are collected in Tedlar bags using a low flow rate pump, a lung sampler, or a pressurized sampling port. Generally, Tedlar bags are considered disposable following one sample collection since many VOCs may irreversibly absorb at low concentrations to the bag interior.

7.5.2 Sorbent Tube Sampling

Sorbent tube sampling involves collecting contaminants in the soil vapor or indoor air onto the surface of an adsorbent material, typically charcoal or a polymeric resin. The ability of the sorbent to remove and concentrate the contaminants is called the sorbent strength, which is a function of the surface area of the sorbent.

For this application, a pump (or a vacuum) is used to draw a known volume of air across the sorbent material during collection of either a subsurface soil vapor sample or indoor air sample. The sampling flow rate and duration are used to calculate the volume of gas sampled, which is used to calculate the mass per unit (i.e., micrograms per cubic meter [$\mu g/m^3$]).

A critical component when using adsorbents is to calculate the proper volume of the soil vapor or indoor air to be sampled. This volume depends on both the required reporting limit and the compound breakthrough volume on the sorbent being used. In addition, the reporting limit is a function of the sensitivity of the analytical system. Consultation with the analytical laboratory during the planning phase of projects using sorbent materials is strongly recommended.

7.5.3 Passive Sampling

Passive sampling involves using sorbent materials to collect vapor phase chemicals without the use of a pump or Summa canister. In general, target compounds conducive to passive sampling are reactive, have a vapor pressure below 10^{-8} millimeters of mercury, and are considered to be SVOCs. In addition, passive samplers are generally preferred when the target compounds are reactive in the presence of oxygen, nitrogen, or phosphorus.

Passive sampling using sorbent materials is commonly used to assess vapor phase chemical sources and the vapor intrusion to indoor air exposure pathway. Passive sample collection involves placing an adsorbent into the subsurface for a known exposure period (e.g., one to two weeks) to allow the flow of gas and the absorption of vapor phase chemicals onto the adsorbent material. Analysis of the adsorbent material entails estimating the total mass of chemicals collected in micrograms (µg). Since it is difficult to accurately estimate the volume of soil vapor that has passed through the sampler container, it is difficult to estimate the vapor phase concentration. Passive sampling using sorbent materials may be used to guide the installation of permanent soil vapor monitoring points or may be suitable in areas of relatively low soil permeability and contaminant concentrations.

Consider the following for the use of passive sampling using sorbent materials (API, 2005):

- Passive samplers are not typically used to develop vertical profiles.
- Passive samplers provide an alternative in very fine grained soils where practicality and integrity of samples from soil vapor probes may be in question (County of San Diego, 2002).
- Passive samplers can indicate whether the vapor intrusion to indoor air exposure pathway is incomplete if the masses detected in samplers located at various distances away from a vapor source decrease with distance at an acceptable rate.

- Passive samplers may be useful for identifying preferential pathways associated with utility conduits.

The use of data resulting from passive samplers should be adequately supported by whole air sampling or sorbent tube sampling data collected at the same site, when possible. Whole air sampling data from other similar sites may be considered with HEER Office input and approval.

7.5.4 Flux Chamber Sampling

Flux chambers are used to assess the mass flux emission of chemicals from the subsurface through a circular or rectangular surface area. Flux chambers are containers placed over a suspected foundation intrusion area or ground surface under a building. The chambers may be used with or without a flow of sweep gas (a static test), passing the effluent through a sorbent trap or into a large sample container (e.g., a Summa canister or Tedlar bag). The chambers are typically left in place for one to two weeks to allow the buildup of vapor concentration within the chamber, or to collect the effluent vapors. At periodic intervals or at the end of the test, the concentrations of target chemicals are assessed. Mass flux emission from the subsurface can be calculated using the time period for each measurement, the footprint area of the flux chamber, and the concentration and volume of effluent vapors (County of San Diego, 2002; Eklund, 1992; Hartman, 2002, 2003).

Extrapolation of the results from the relatively small footprint of the flux chamber to the footprint of a building may be complicated by soil vapor entry points within a building (API, 2005). A thorough survey of potential preferential pathways into a building should be performed to assist in chamber placement to assure collection of representative samples.

While flux chamber sampling can be used as a line of evidence for the vapor intrusion investigation, interpretation of flux chamber analytical results is often problematic. Investigators planning to use flux chambers should coordinate closely with the regulatory agency and toxicologists if they plan to use flux chamber results for risk-based vapor intrusion investigations.