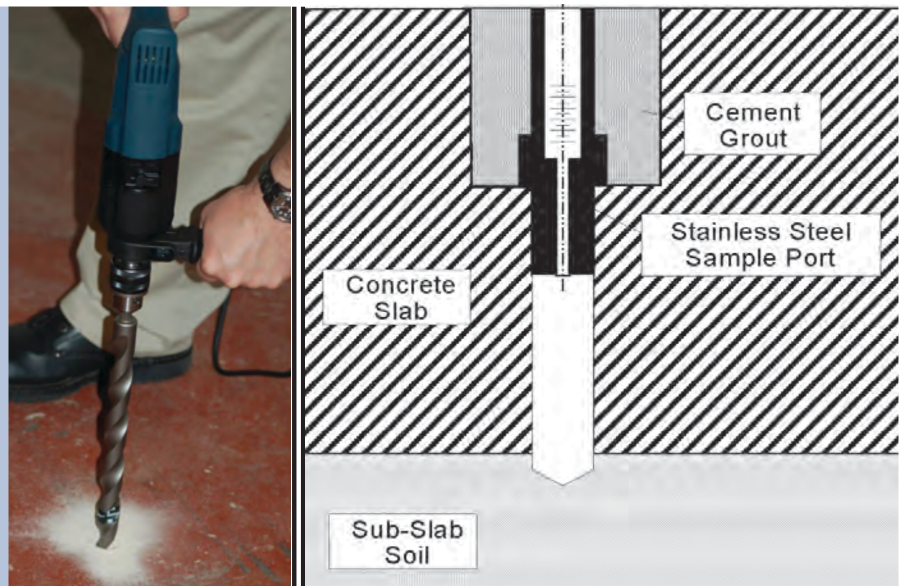

Probe hole is drilled (left). Cutaway of sub-slab sample (right) (graphic courtesy Wisc. DHS).

Detecting Air Leaks When Collecting Sub-slab Vapor Samples

Collection of vapor samples in order to assess the vapor intrusion pathway has become a routine part of contaminated site investigations for most consultants in Wisconsin, particularly at those sites contaminated with chlorinated volatile chemicals. There are important laboratory and field quality control measures, however, that must be taken in order to ensure that vapor sample results are representative of the media being tested. One aspect of quality control for vapor sample collection is minimizing ambient air leaks into the sample container when collecting sub-slab samples.

Sub Slabs and Air Leaks

Sub-slab samples are particularly sensitive to air leaks because the space for placing a seal around the sub-slab vapor probe is usually very limited and it is hard to get sealing material that will bond tightly to both the concrete floor and the probe material. There are also several compression fittings between the sub-slab probe and the collection container (usually a Summa canister). These fittings, along with the probe seal, must be air tight, or ambient air can leak into the Summa canister and significantly bias the sub-slab vapor concentration results.

Several methods for detecting air leaks at the probe seal are available. The methods can be divided into two main categories, pre- and post-sampling leak detection. The two most common approaches include the following.

1) Pre-Sampling

Pre-screening the sub-slab gases from the probe with a PID and/or O_2/CO_2 meter prior to taking the sample and looking for changes in concentration might indicate a leak at the probe seal. A series of several volumes of sub-slab vapor are drawn from the probe and then monitored with handheld meters. If all of the gases are found to change – for instance, O_2 increases by a 1/3 and CO_2 and PID reading decrease by 1/3 – then it may be deduced that a leak is present and the probe needs to be resealed.

The vacuum applied to the probe during the screening phase should approximate the vacuum that will be applied during the sampling phase. The advantage of this technique is that the investigator can identify and fix a leak in the seal before sampling. This technique may not reliably identify small leaks and it may be difficult to interpret results because sub-slab gas concentrations aren't necessarily uniform. By itself, this technique does not identify leaks in the fittings along the sample line.

2) Post Sampling

Post sampling leak detection is accomplished by introducing a tracer gas not associated with the contamination near the probe seal, and perhaps near the compression fittings, during sample collection. Compounds such as isopropyl alcohol (IPA) or 1,1-difluoroethane (DFE) are commonly used for this purpose. If a leak occurs, the laboratory will detect the tracer gas in the Summa canister – if there is no leak, the tracer gas will be absent. This technique is fairly easy to use because towels soaked in IPA or shrouds with DFE can easily be placed over the sampling probe and tubing.

However, it has several disadvantages – the first and most important being that the leak isn't discovered until after the sampling is finished and the laboratory analysis received.

Second, while the tracer gas may be identified in the Summa canister, it is very difficult or impossible to determine how big the leak was – that is, how much ambient air entered the Summa canister versus vapor from the sub-slab probe. Therefore the data quality can be significantly compromised.

Alternative: 2-Step Method

An alternative to the above methods is to use a two-step leak detection process – first, pre-screen with a tracer gas (helium) that can reliably pre-screen and detect low-level leaks at the probe seal is, and, secondly, a leak test of the compression fittings – called a "shut-in" test – is conducted.

Helium is non-toxic, readily available, easily field–screened gas that is absent from the subsurface environment. As with any pressurized gas, tanks must be carefully handled during transport and use. Helium gas is introduced at about 10 percent by volume into a shroud covering the sub-slab probe. Sub-slab vapor samples are withdrawn and screened with a handheld helium detector. Low level leaks through the probe seal can be detected and it is easier to interpret results than with the O2/CO2 and PID method.

A shut-in test measures the air tightness of the compression fittings. A vacuum gauge must be connected into the sampling line between the sub-slab probe and the Summa canister. Valves to the probe and Summa canister are shut and air is removed from the sampling line, inducing a vacuum in the line of 50 to 100 inches of water. When all the external valves to the sampling line are shut, the vacuum gage should remain steady – indicating no leaks at any compression fitting – for at least one minute. Loss of vacuum indicates a leak and the fittings need to be adjusted until the line can hold a vacuum.

After the helium shroud and shut-in test are performed, a sub-slab vapor sample can be drawn into the Summa canister. A flow controller is needed to ensure that an excessive vacuum is not placed on the sampling probe. Typically, 100 to 200 ml/min of flow are recommended for sub-slab sampling, which means that a six liter canister will take 30 to 60 minutes to fill.

Pictures and a discussion of both the helium shroud and shut-in test can be found in Appendices E & F of the Reference Handbook for Site Specific Assessment of Subsurface Vapor Intrusion to Indoor Air, by Todd McAlary and Rob Ettinger, which can be downloaded via the web.

In addition, a discussion of these techniques can be found in:

McAlary, T.A., P. Nicholson, H. Groenevelt, and D. Bertrand, 2009. A Case-Study of Soil Gas Sampling in Silt and Clay-rich (Low-Permeability) Materials, Groundwater Monitoring and Remediation, 29, no. 1/ Winter 2009/pages 144–152.

Work Plan Requirements

Site investigation work plans must include a description of the sampling methods, parameters to be analyzed, procedures to prevent cross-contamination, and a quality control/quality assurance program used to collect environmental samples, among other things – please see NR 716.09(2)(f), Wis. Adm. Code, for more information.

When submitting sub-slab vapor results to the DNR, report results must include these items so that RR Program staff can assess whether sample results are reflective of the media tested. If appropriate quality control procedures have not been applied, or laboratory data indicates that a sample is significantly biased, then sampling may need to be repeated. Conducting good quality control/quality assurance procedures in the field help save time and money and reduce sample bias.

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