



February 1, 2024

Kevin Dana  
Oregon Department of Environmental Quality – Northwest Region  
700 NE Multnomah Street  
Portland, Oregon 97232

Via email: Kevin.DANA@deq.oregon.gov

Regarding: Soil Gas Assessment Work Plan  
Oregon DEQ ECSI Site No. 2424  
3720 NW Yeon Avenue  
Portland, Oregon  
PBS Project 20125.011

Dear Mr. Dana:

PBS Engineering and Environmental Inc. (PBS) is submitting this work plan to perform a soil gas assessment at Environmental Cleanup Site Inventory (ECSI) site number 2424. The assessment is designed to evaluate vapor intrusion risk from residual dissolved halogenated solvents in shallow groundwater following in-situ remedial injection treatments. Results from the assessment will be used to evaluate potential exposure from both the Vapor Intrusion into Buildings and Volatilization to Outdoor Air Pathways.

## **BACKGROUND**

Soil gas sampling was historically completed by PBS at the site in 2014; however, the chemical composition of the contaminant mass has undergone significant alteration resulting from the remedial injections. Given these chemical changes and the amount of time elapsed since the 2014 assessment, a new soil gas assessment is warranted.

The following section presents an abbreviated background for the site. More detailed information can be found in PBS' August 2023 Site Closure Report<sup>1</sup> and from DEQ's ECSI database.

### **Site Description and Ownership**

The site is located within Multnomah County in the NE  $\frac{1}{4}$  of the NW  $\frac{1}{4}$  of Section 29 of Township 1 North, Range 1 East of the Willamette Meridian. A site vicinity map is included as Figure 1. A 57,750-square-foot (sf) warehouse building is currently situated on the site, occupied by Convoy Supply Ltd., a roofing, siding, and fencing distributor. The property has been owned by Conax Properties USA Inc. since 2010.

### **Site Hydrogeology**

The subject property is in the Guilds Lake area. This area was an intermittent lake and marsh until extensive filling and grading occurred in preparation for the 1905 Lewis and Clark Exposition, which was constructed on the lake and grounds south and southeast of the lake. Additional filling and grading occurred through the 1940s to create

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<sup>1</sup> PBS Engineering and Environmental Inc. (2023). *Site Closure Report, Oregon DEQ ECSI Site No. 2424, 3720 NW Yeon Avenue, Portland, Oregon 97210*. Prepared for Conax Properties, Inc. PBS Project 20125.011.

land for industrial use. Fill materials included incinerator ash in some locations. Underlying the site is an undetermined amount of fill with possible subordinate amounts of gravel.

Underlying fill at a depth of 20 to 30 feet are fine-grained to sand-sized periglacial deposits from the glacial outburst floods of Glacial Lake Missoula. Beneath the flood deposits are poorly consolidated sands and gravelly sands of the Troutdale Formation. Underlying the Troutdale Formation are approximately 200 feet of siltstone, sandstone, and mudstone of the Sandy River Mudstone. Basalt lava flows of the Columbia River Basalt Group are at depth.

The shallowest occurrence of groundwater is expected to be at approximately 5 to 10 feet below the ground surface (bgs). The shallow groundwater flow direction varies, extending to the south at a relatively flat hydraulic gradient. Topography suggests relatively flat gradients across this large level area of historical fill at the base of Willamette Heights, so shallow groundwater flow direction varies based on location. Deeper groundwater would be expected to flow to the north/northeast toward the Willamette River.

### **Post In-Situ Remediation Findings**

In May 2022, PBS completed 53 gridded injections into the subsurface of the site. The injections were comprised of three remedial compounds designed to dechlorinate and degrade halogenated volatile organic compounds (VOCs). Post-treatment performance groundwater monitoring results indicated that significant dechlorination of the primary halogenated solvents tetrachloroethene (PCE) and trichloroethene (TCE) has occurred. Cumulative PCE and TCE concentrations across the monitoring well network decreased 37.6% and 68.2%, respectively, based on a comparison of sampling data from the May 2022 pre-injection groundwater monitoring event and the final post-treatment (Q4) monitoring event. Excluding monitoring well MW-8, PCE and TCE concentrations reduced 98.4% and 91.9%, respectively. Reduction of halogenated solvents in MW-8 is expected to be slower due to the lower mobility of the remedial chemicals and MW-8's location outside of the gridded treatment area.

An increase of several compounds associated with the degradation of TCE and PCE occurred following the injections. Breakdown compounds commonly associated with TCE and PCE were detected including cis-1,2 dichloroethene (cis-1,2-DCE) and vinyl chloride with secondary breakdown compounds of 1,2-trans dichloroethene (trans-1,2-DCE) and 1,1 dichloroethene (1,1-DCE). Monitoring wells MW-3, MW-5, MW-6, MW-7, and MW-9 indicated concentrations of one or more breakdown compounds that exceeded DEQ risk screening criteria during the final monitoring event. The detections are indicative that dechlorination is occurring. Over time, the remedial compounds are anticipated to further degrade and reduce the concentrations of breakdown compounds into harmless byproducts, resulting in a complete dechlorination process.

During the most recent monitoring event completed in May 2023, breakdown compounds in monitoring wells MW-3 and MW-5 through MW-9 exceeded the Vapor Intrusion into Buildings Risk Based Concentration (RBC) protective of occupational receptors. Monitoring well MW-6 detected the highest concentrations of both vinyl chloride and cis-1,2-DCE.

### **SOIL GAS ASSESSMENT SCOPE OF WORK**

The following scope of work is proposed to evaluate concentrations of PCE, TCE and their breakdown products in soil gas within and adjacent to the area of dissolved contaminants present following remedial injections.

### **Preparatory Activities**

A site-specific health and safety plan (HASP) was previously prepared for the site—the HASP will be updated to reflect new activities and personnel slated for this project. The HASP will include a map to the hospital, will be reviewed with field personnel on a daily basis, and will be maintained on site throughout the duration of field activities. Work will be conducted by experienced PBS personnel and supervised by an Oregon registered geologist (RG).

### **Field Activities**

PBS is proposing to collect six soil gas samples from the locations indicated on the attached figure (Figure 2). Soil gas samples will be collected using a Post Run Tubing (PRT) sampler advanced to at least 5 feet below ground surface (bgs). Deeper advancement of the PRT system is not recommended due to the proximity of shallow groundwater. The PRT system will be advanced using a direct-push track mounted drilling rig operated by a licensed driller. Helium will be used as a tracer gas for leak detection at each sampling location. Soil gas sampling will occur at least 2 days or more following a significant (greater than 0.1 inches) rainfall event.

Soil gas samples will be collected from the following locations:

- SV-1 and SV-2 will be collected near monitoring wells MW-6 and MW-9, respectively, to evaluate source-area soil gas concentrations.
- SV-3 through SV-5 will be collected near the northwestern and northern extent of the LOF, respectively, in proximity to the site warehouse and west-adjacent warehouse (SV-3). Each location will be situated near the storm sewer utility to account for soil gas migration through utility backfill. SV-4 and SV-5 are also located in the vicinity of buried storm sewer lines to address this potential preferential pathway.
- SV-6 will be collected near the southern property boundary to assess potential offsite migration as well as soil gas concentrations in proximity to MW-8. SV-6 will also be situated near the storm sewer utility in order to address this potential preferential migration pathway.

The samples will be collected in accordance with PBS' Standard Operating Procedure (SOP) for sub slab and soil gas sampling, which is attached. PBS will use laboratory-certified Summa canisters connected to flow regulators set to a rate of no more than 200 milliliters per minute. Each sample will be analyzed for the following analyses:

- Halogenated volatile organic compounds (VOCs) by EPA Method TO-15 including PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE and vinyl chloride.
- Helium by ASTM D-1946

### **Reporting**

PBS will prepare an addendum to the Closure Report that summarizes the results of the sampling and our findings. If sampling confirms the absence of vapor intrusion risk, PBS will request conditional regulatory closure be issued from DEQ following the implementation of site controls.

Please feel free to contact me at 503.417.7610 or [nick.thornton@pbsusa.com](mailto:nick.thornton@pbsusa.com) with any questions or comments.

Sincerely,

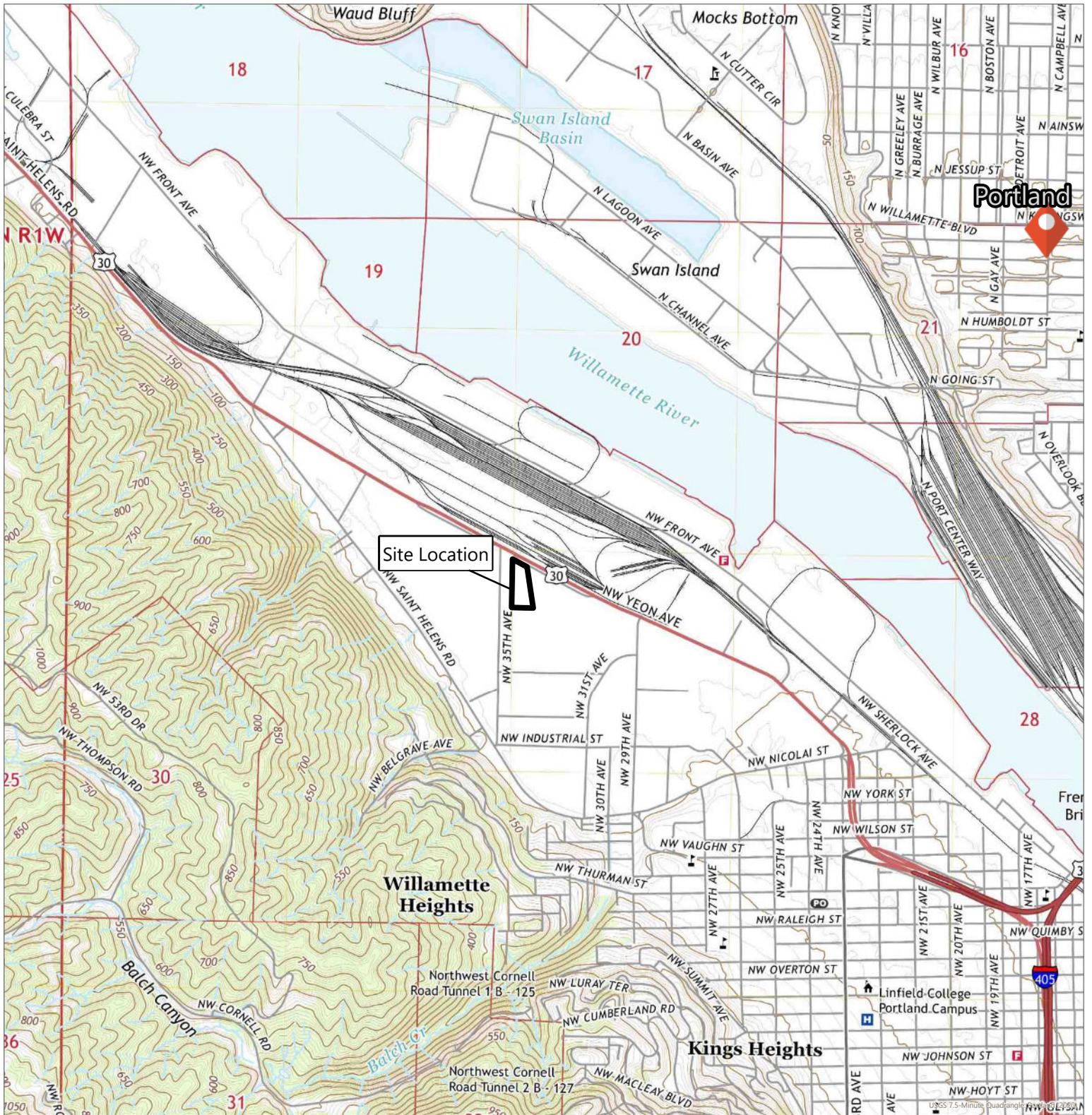
Nick Thornton  
Project Manager  
PBS Engineering and Environmental Inc.

Dennis Terzian, RG  
Senior Geologist  
PBS Engineering and Environmental Inc.

Attachment(s): Figure 1. Site Vicinity  
Figure 2. Proposed Soil Gas Sampling Locations  
Standard Operating Procedure – Sub Slab and Soil Gas Sampling

cc: Conax Properties, Inc.  
Davis Wright Tremaine LLP

NT: DT



## Site Vicinity

3720 NW Yeon Avenue, Portland, Oregon

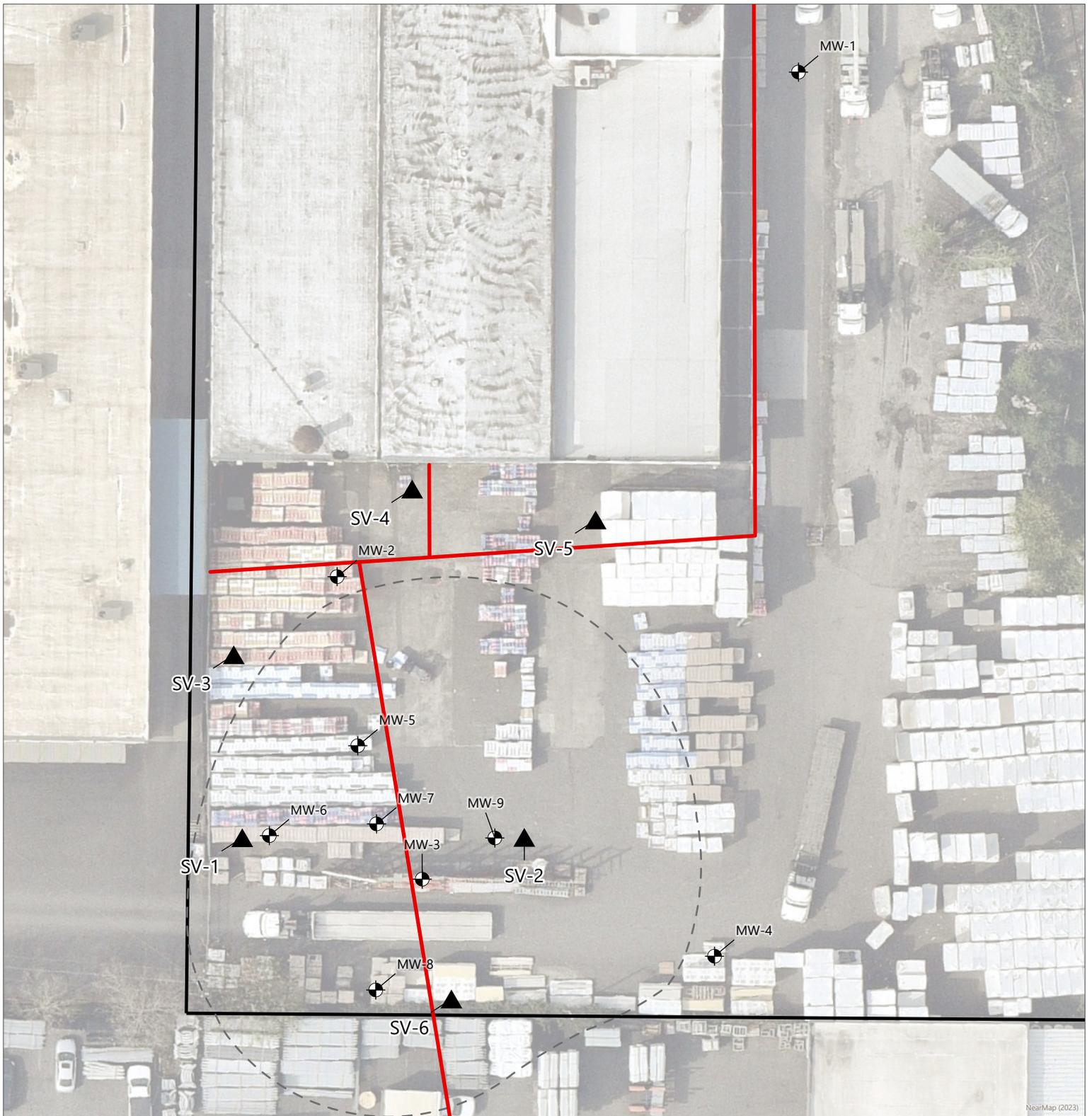
Date: February 2024 | Project: 20125.011

Figure: 1

 Site Boundary



This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.



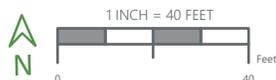
## Proposed Soil Gas Sampling Locations

3720 NW Yeon Avenue, Portland, Oregon

Date: February 2024 | Project: 20125.011

**Figure: 2**

- ▲ Proposed Soil Gas Sampling Location
- ⊕ Monitoring Well
- Storm Sewer Utility (approximate)
- - - Locality of Facility (LOF)
- ▭ Site Boundary



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## STANDARD OPERATING PROCEDURE Sub-Slab Vapor and Soil Gas Sampling

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### PURPOSE

Vapor intrusion of volatile organic compounds (VOCs) into occupied structures is considered a critical migration pathway requiring assessment at contaminated sites. Specifically, regulators may require property owners to sample soil gas, sub-slab vapor, or indoor air to assess risk to building occupants.

This standard operating procedure (SOP) is intended to guide soil gas or sub-slab vapor sampling efforts when creating temporary sampling points when Method TO-15 or other analytical methods utilizing a Summa canister as the sampling media are required. The sampling points can be modified to produce a permanent sampling location. The sampling protocols for analysis of soil gas or sub-slab vapor by Method TO-17, which utilizes a sorbent tube as the sampling media (instead of a Summa canister), as well as the sampling of indoor air are presented as separate SOPs.

Soil gas and sub-slab vapor sampling is typically conducted based on prior results from other environmental studies, such as soil or groundwater sampling, or if historical uses indicate a human health risk could be present. A variety of issues can significantly affect the results of soil gas and sub-slab vapor sampling. Adherence to this SOP will help ensure that sampling results are valid and reliable. This SOP assumes that samples will be collected in Summa canisters. If other sampling media is used (such as tedlar bags), some of the steps in this SOP may not apply or may need to be modified.

*Use one of the following two methods to conduct the sub-slab vapor or soil gas sampling*

### METHOD 1 – VAPOR PIN

#### 1 EQUIPMENT LIST

The following table lists standard equipment and tools needed for soil gas and sub-slab vapor sampling. When renting a helium meter, ask the vendor for one that is intended for use in leak detection testing (e.g., MGD-2002 multi-gas leak locator). It should have the ability to purge the line quickly (the equipment company may provide a special filter for this), and preferably, a meter with an active pump (as opposed to passive venting). It does not need to be intrinsically safe UNLESS site conditions require this feature.

<b>Equipment to get from lab</b>	<ul style="list-style-type: none"> <li>• 1 or 6 liter (L) Summa canister.</li> <li>• One extra Summa canister in the event that a canister fails in the field.</li> <li>• Flow regulator (also known as critical orifice) preset by lab for pre-determined sampling time, not to exceed a flow rate of 200 mL/min.</li> <li>• Vacuum gauge (for verifying vacuum prior to sampling, flow regulator may act in this role).</li> <li>• Tubing (new for each sample location). Must be Teflon, Nylaflo, Peek, or stainless tubing. Do NOT use polyethylene tubing.</li> <li>• Chain of custody and identification tags.</li> <li>• T-fitting (need one for each sampling location, including ferrules and hex nuts for each leg of T).</li> </ul>
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<p><b>Other equipment</b></p>	<ul style="list-style-type: none"> <li>• Purging syringe (calibrated, typically for 50 to 60 milliliters [mL]).</li> <li>• Granular bentonite.</li> <li>• Disposable or washable containers (~16 ounces) for mixing bentonite and/or cement.</li> <li>• Water for mixing bentonite and cement.</li> <li>• Sand.</li> <li>• Silicone tubing.</li> <li>• Helium gas tank with regulator.</li> <li>• Helium meter (make sure that it measures in ppm by volume).</li> <li>• On-off valve (two per sampling location).</li> <li>• Vapor Pin with a silicon sleeve (or similar equipment).</li> <li>• Vapor Pin tool and hammer for installation and removal (or similar equipment).</li> <li>• Vapor Pin drill guide (for permanent installations).</li> <li>• Field notebook and/or field forms.</li> <li>• Helium shroud.</li> <li>• Weight for shroud, if needed.</li> <li>• Nuts and ferrules (if you did not receive from lab).</li> <li>• Cap for "shroud air tubing."</li> <li>• Water dam (e.g., 1.5-inch PVC coupler).</li> </ul>
<p><b>Tools</b></p>	<ul style="list-style-type: none"> <li>• Scissors.</li> <li>• Rotohammer/drill for drilling through concrete.</li> <li>• Drill bits (0.625-inch, 1.5-inch).</li> <li>• Crescent wrench (1/2 and 9/16 inch).</li> <li>• Whisk broom/dust pan.</li> <li>• Wet-dry vacuum.</li> <li>• Extra-thin knife/screwdriver.</li> <li>• Extension cord for rotohammer.</li> <li>• Wrench for helium regulator.</li> <li>• Generator (if power is not available)</li> </ul>
<p><b>Supplemental supplies</b></p>	<ul style="list-style-type: none"> <li>• Teflon tape (if seal leaks are sustained).</li> <li>• Purging pump with tubing (if purging syringe not used) and charging cord.</li> <li>• Fast setting concrete to patch floor.</li> <li>• Adhesive to repair carpet or tile.</li> </ul>

## 2 LABORATORY

The lab will supply the Summa canisters, flow regulators, gauges, and tubing, and can also provide the purging syringe, if needed. Have the equipment arrive TWO business days prior to sampling, if possible. This allows the lab time to express-mail any additional, broken, or forgotten equipment.

As soon as the shipment is received, ensure that all equipment was provided and verify the vacuum of all Summa canisters. Order an extra gauge, if needed, to check the canisters for pressure prior to leaving the office. Knowing that the canister has sufficient initial vacuum allows for better trouble shooting in the field.

The following information must be provided to the lab to ensure shipment of the correct equipment:

- Size of canister (400 mL, 1 L, 6 L). A 1 L Summa will require a minimum of two times dilution of reporting limits. If this will cause your sample reporting limits to exceed screening criteria, use a larger Summa canister. You MUST know your reporting limits to determine the canister size.
- Type of canister certification (batch vs. individual). Batch certification is usually sufficient for sub-slab vapor and soil gas sampling projects.
- Method reporting limits.
- Tracer gas to be used (the lab must certify container for this prior to shipping). PBS uses Helium as a tracer gas.
- Sample time/flow rate.

Samples should be collected at a rate between 100 and 175 mL per minute (most guidance documents recommend that samples not be collected faster than 200 mL per minute). A flow rate greater than 200 mL/min runs the risk of introducing ambient air dilution to the sample. The sample time for grab samples is calculated by determining an acceptable sample flow rate (perhaps 150 mL/min) and multiplying that by the sample container size. For a 150 mL/min rate, a 1 L Summa canister would require approximately seven minutes. A 6 L Summa canister would require 40 minutes.

### 3 SUB-SLAB VAPOR INITIAL PROCEDURES

Order equipment as previously identified, and do the following prior to field activities:

- Determine the proposed locations for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Confirm with the property owner/occupant that subsurface utilities will not be impacted when drilling through the slab in these locations.
- Conduct a private utility locates for your locations to check for subslab or subgrade obstructions.
- If possible, determine the slab thickness to confirm that a hand-operated drill can drill through it.
- Determine if carpeting or other flooring will need to be removed prior to drilling, or will require patching.
- Have the helium meter arrive the day before sampling.

Once at the site, sampling should occur as described below.

#### Drill Hole and Seal Tubing

These instructions assume that all samples will be collected using a Vapor Pin or similar equipment.

- Confirm concrete thickness, if possible, so you'll know when to expect the drill bit to break through bottom of slab.
- If the Vapor Pin will be installed for on-going monitoring (i.e., permanent installation), begin by drilling a hole 2 inches into the concrete using the 1.5-inch drill bit. This larger hole will be used to install a flush-

mount cover. Then insert the Vapor Pin drill guide into this hole so that the smaller diameter drill hole will be centered. Continue with the directions below.

- Drill a hole through the slab using the 0.625-inch drill bit. Drill 1 to 3 inches into backfill or native material beneath the concrete slab.
- Use a 0.625-inch tube brush to clean concrete dust from the hole.
- Use the whisk broom or vacuum to remove concrete dust or loose material from around the drill hole.
- Install a Vapor Pin with a silicon sleeve (the silicon sleeve provides the seal) into the 0.625-inch drilled hole utilizing a dead weight hammer and the Vapor Pin installation/extraction tool (or similar equipment).
- If not drilling the 1.5-inch hole, place a small amount of hydrated bentonite on the concrete surface around the Vapor Pin and insert a water dam into the bentonite.
- Place a silicon mat with a circular cut-out for the Vapor Pin on the concrete surface around the sample point and water dam.
- Add a small piece of silicone tubing to the top of the Vapor Pin for attaching tubing later.
- Add a small amount of water to the inside of the water dam to ensure a good seal is in place.
- Place the shroud over the sample point and thread 0.25-inch tubing through a stopper in the shroud.
- Place a weight on the shroud to prevent it from being moved and compromising the seal integrity, if needed.

For temporary holes, allow 20 to 30 minutes for the hole to equilibrate. If collecting sub-slab gas samples at multiple locations, consider performing these initial activities at each location prior to continuing with the sampling.

#### **4 SOIL GAS INITIAL PROCEDURES**

Order equipment as previously identified. Prior to field activities, the following should occur:

- Determine the locations and depths for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Determine if equipment, vehicles, or other stored items will need to be moved prior to the field event.
- Call in a public utility notification.
- Conduct a private utility locates for your locations to check for subgrade utilities/obstructions.
- Arrange for a driller to deploy a Post Run Tubing (PRT) sample system, or equivalent, or arrange with the driller to install a sample point using a hand auger.

Once at the site, sampling should occur as described below.

##### **Drill Hole and Seal Tubing**

- Drill a borehole hole using a PRT system, or equivalent. The bottom of the hole should be at least 5.5 feet below ground surface (bgs), as long as this is above the water table.
- Lift up on the drilling rod approximately 6 inches to create a void in the subsurface.
- Insert the PRT fitting to the 0.25-inch tubing and place down the hole. Once it reaches the bottom, screw the fitting onto the PRT sample point (note: the fitting uses left-hand threads).

- Determine the length of 0.25-inch tubing needed to conduct sampling at this location and cut it to that length. Do not forget that there must be enough tubing to go through the helium shroud, connect to the purging T-valve and connect to the Summa canister. Be sure to cut the ends straight with no burrs or jagged edges.
- Mix bentonite with water for sealing.
- Place bentonite around the rod protruding from the ground.
- Insert bentonite evenly around tubing exiting the drill rod, making sure it penetrates fully into the rod. Thread the other tubing end through the helium shroud/stopper. Cover the loose tubing end with a plastic bag or cap to ensure it remains clean until it is connected to the Summa canister.
- Place the shroud over the drill rod and place more bentonite around the base to seal the shroud to the ground.

### Sample Train Assembly

- Place the shroud over the sample point, and thread tubing through the shroud and shroud stopper.
- Place a weight on the shroud to prevent it from being moved and compromising the seal integrity, if needed.
- Attach an on-off valve to the end of the tubing, then place additional tubing on the other side of the valve. Turn the valve off.
- Install a T-fitting and a second on-off valve in-line with the sample tubing to allow for purging. Add tubing from the third leg of the T-fitting to the Summa canister.
- Connect the gauge and flow regulator to the Summa canister and tubing. Do not over tighten the fittings.
- Record the canister and flow regulator serial numbers on the field form.
- Ensure that all connections are tight and all valves are closed.

For temporary holes, wait 20 to 30 minutes to allow the hole to equilibrate. If a hand auger was used to install the sample point you must wait 48 hours.

## 5 LEAK DETECTION TESTING

Shut-in test and field/laboratory test for helium are two testing methods performed for leak detection.

### Shut-in Test

Evaluate the integrity of the sample train by performing a vacuum shut-in test. Remove a sufficient volume of air from the sample train using the purging syringe to provide a vacuum of at least -15 inches of mercury (Hg). Observe the gauge for at least two minutes to detect any decrease in measured vacuum. The vacuum must be maintained for at least two minutes. If the vacuum is not maintained, check the fittings and retest.

### Helium Test

At this point, you should have the shroud in place with the tubing from the Vapor Pin or soil gas sample point extending from the shroud, and the inlet hose from the helium tank extending into the shroud. Perform these actions:

- Fill the shroud with helium for several seconds and turn off the tank.

- Using the helium meter (meter), measure and record the helium concentration in the shroud in percent (%) or parts-per-million-volume (ppmv) (1% is equivalent to 10,000 ppmv). The target helium concentration is 70 to 90%. Remove the meter from the shroud air tubing and cap the tubing. *Allow meter to clear back to zero.*

### Sample Train Purging

- Open the on-off valve to the Vapor Pin or PRT sampling point tubing. The Summa canister remains closed.
- Determine the amount of air that requires purging within the sampling tubing.
  - Determine how much tubing you need to purge (round up to whole feet).
  - Multiply the number of feet by the volume of air within one unit foot of tubing (see multipliers below for various tubing sizes).
  - Determine how much you need to purge from the hole drilled through the concrete slab or PRT sampler (usually 6 inch length).
  - Add the tubing and hole purge volumes together.
  - You want to remove a minimum of two purge volumes, so multiply volume calculated by two.

Size of tubing (inches)	Air volume in mL per one unit foot
1/4	9.7
3/8	21.7
1/2	38.6
5/8	60.3
3/4	86.9
1	154.4

- Connect the purging syringe and turn the on-off valve to ON.
- Purge the calculated volume of air. Draw the air slowly through the syringe, approximating the sample collection flow rate, to minimize the effect of creating a vacuum that could compromise the connections or seals. If your sample collection rate is 150 mL/min, and you need to purge 50 mL, then take approximately 20 seconds to purge the 50 mL or as slowly as possible.
- If you need to purge more than one syringe volume, complete the first purge, turn the valve on the syringe to OFF, depress the syringe to purge the air out of the syringe, turn syringe valve to ON and repeat the purging process.
- When done purging, turn the on-off valve to OFF.
- Connect the meter to the sample point tubing (Vapor Pin or PRT) and allow the meter to run for approximately one minute. Measure the helium concentration.
- If elevated readings on the helium meter (greater than 5,000 ppmv [0.5%]) are detected, make adjustments to seals.
- Once all necessary adjustments have been made, record the helium measurement in the shroud on field sheet following adjustment to seals.

Once the leak detection testing has confirmed the Vapor Pin or PRT seal is sufficient, proceed to sample collection.

## 6 SAMPLE COLLECTION

- Confirm that all connections remain tight and all valves are closed.
- Close the on-off valve connected to the purging syringe.
- Open the Summa canister by turning its valve approximately one-half turn.
- Immediately record the vacuum on the gauge (it should stabilize very quickly) and the time. The gauge should measure approximately -30 inches Hg (please note that some gauges may read greater than -30 inches Hg). If the vacuum is less than -27 inches Hg, the canister may not have sufficient vacuum for sampling. In this case, select another canister. If another canister is not available, call the project manager and ask how they would like you to proceed.
- Allow the Summa canister to fill, keeping in mind the amount of time determined for sample collection (i.e., what you told the lab to set for a flow regulator time)
- At the mid-point of the sample collection, record the helium concentration in the shroud. Add additional helium if shroud concentration is below 50%, and record the new reading.
- The vacuum gauge should never drop below -5 inches Hg. If the vacuum readings are not matching up with the expected sampling time (the gauge is dropping faster or slower than expected), you will need to use your best judgment as to when to stop the sample collection (or call the lab or project manager to discuss).
- Once the sample has been collected, close the canister valve, be sure it is tightly closed (but do not over tighten), and record the vacuum reading and time.
- Record the helium concentration in the shroud.
- Remove the gauge and flow regulator and replace the canister fitting.
- Fill out the chain of custody and return the containers to the lab with the original chain of custody. Retain a copy of the chain of custody for the project files.

When collecting 6 L Summa canister samples, it is recommended that you monitor the vacuum gauge during the entire sample duration, which can take up to 50 minutes. If the gauge should drop below -5 inches Hg, the sample may be considered void; this can be prevented by watching the gauge. If the gauge drops to 0 inches Hg the sample will need to be re-taken using a new canister.

### Drill Hole Abandonment

Once soil gas sampling is completed, the boring will be abandoned by the licensed drilling subcontractor who completed the borehole following applicable state requirements.

Once sub-slab vapor sampling is completed, the following should occur:

- Remove the water from the water dam.
- Clean out the remaining bentonite, cleaning as much as possible from the floor.
- If the sampling location is for one-time use, deploy the Vapor Pin extraction tool to remove the pin.

- Add a small amount of sand to fill the drill hole approximately 1 to 2 inches below the concrete surface (approximately 1 to 2 inches below the bottom of the “seat”). Do NOT overfill with sand as this may compromise your patch.
- Use the whisk broom to remove any loose material at the surface.
- Fill the upper 1 to 2 inches with a quick setting cement grout. Smooth or feather the surface to help create a bond between the slab and the grout.

If the Vapor Pin or similar equipment is for a permanent installation, the following should occur:

- Place a white cap over the tip of the Vapor Pin.
- Install a permanent cover over the capped Vapor Pin (plastic or metal).

**7 POST FIELD ACTIVITIES**

- Retain all paperwork provided by the lab, including the packing list and certifications. This information must be retained in the permanent project file.
- Decontaminate reusable fittings owned by PBS following the *Standard Operating Procedure for Vapor Pin Decontamination for Vapor Intrusion Assessments*. This includes the Vapor Pin drill guide and any brushes or other tools used for cleaning.
- Return all rental equipment.

**Confirming Helium Detections Meet Regulatory Requirements**

- Calculate average helium concentration in shroud by taking two or more readings before, during, and after sampling (be sure that meter is reading in ppm by volume).
- When lab results are received, if helium is detected, use this formula to confirm level of leakage:  
**Level of leakage** = lab-detected concentration / shroud concentration
- Be sure you are using the same units (ppm may not always equal ppmv – check your units).
- Some regulatory guidance documents allow up to 5 to 10% helium within a sample. Be sure to check your state’s guidance for allowable levels. Oregon and Washington both allow up to 5% helium for a valid sample.

**METHOD 2 – SEALED TUBING**

**1 EQUIPMENT LIST**

The following table lists standard equipment and tools needed for soil or sub-slab gas sampling. When renting a helium meter, ask the vendor for one that is intended for use in leak detection testing. It should have the ability to purge line quickly (the equipment company may provide a special filter for this) and preferably, a meter with an active pump (as opposed to passive venting). It does not need to be intrinsically safe UNLESS site conditions require this feature.

<p><b>Equipment to get from lab</b></p>	<ul style="list-style-type: none"> <li>• 1 or 6 liter (L) Summa canister.</li> <li>• One extra Summa canister in the event that a canister fails in the field.</li> <li>• Flow regulator (also known as critical orifice) preset by lab for pre-determined</li> </ul>
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	<p>sampling time.</p> <ul style="list-style-type: none"> <li>• Vacuum gauge (for verifying vacuum prior to sampling).</li> <li>• Tubing (new for each sample location). Must be Teflon, Nylaflow, Peek, or stainless tubing. Do NOT use polyethylene, silicone, or any other type.</li> <li>• Chain of custody and identification tags.</li> <li>• T-valve (need one for each sampling location, including ferrels and hex nuts for each end of T).</li> </ul>
<b>Other equipment</b>	<ul style="list-style-type: none"> <li>• Purging syringe (calibrated, typically for 50 to 60 milliliters [mL]).</li> <li>• Granular bentonite.</li> <li>• Disposable or washable containers (~16 ounces) for mixing bentonite and/or cement.</li> <li>• Water for mixing bentonite and cement.</li> <li>• Sand.</li> <li>• Silicone tubing.</li> <li>• Weight for shroud.</li> <li>• Helium gas with regulator.</li> <li>• Helium meter (make sure that it measures in ppm by volume).</li> <li>• On-off valve (two per sampling location).</li> <li>• Vapor Pin with a silicon sleeve (or similar equipment).</li> <li>• Vapor Pin tool and hammer for installation and removal (or similar equipment).</li> <li>• Field notebook or field forms.</li> <li>• Helium shroud.</li> <li>• Nuts and ferrels (if you did not receive from lab).</li> <li>• Cap for "shroud air tubing."</li> <li>• Water dam (1.5-inch PVC coupler).</li> </ul>
<b>Tools</b>	<ul style="list-style-type: none"> <li>• Scissors.</li> <li>• Rotohammer/drill for drilling through concrete.</li> <li>• Drill bits (0.625-inch, 1.5-inch).</li> <li>• Crescent wrench (9/16 inch).</li> <li>• Whisk broom/dust pan.</li> <li>• Wet-dry vacuum.</li> <li>• Extra-thin knife/screwdriver.</li> <li>• Extension cord for rotohammer.</li> <li>• Plumber's wrench for helium regulator.</li> </ul>
<b>Supplemental</b>	<ul style="list-style-type: none"> <li>• Teflon tape (if seal leaks are sustained).</li> </ul>

**supplies**

- Purging pump with tubing (if purging syringe not used) and charging cord.

**2 LABORATORY**

The lab will supply the Summa canisters, flow regulators, gauges, and tubing, and can also provide the purging syringe, if needed. Have the equipment arrive TWO business days prior to sampling, if possible. This allows the lab time to express-ship any additional or forgotten equipment.

As soon as the shipment is received, ensure that all equipment was provided and verify the vacuum of all Summa canisters. Order an extra gauge, if needed, to check the canisters for pressure prior to leaving the office. Knowing that the canister has sufficient initial vacuum allows for better trouble shooting in the field.

The following information must be provided to the lab to ensure shipment of the correct equipment.

- Size of canister (400 mL, 1 L, 6 L). A 1 L Summa will require a minimum of two times dilution of reporting limits. If this will cause your sample reporting limits to exceed screening criteria, use a larger Summa canister. You MUST know your reporting limits to determine the canister size.
- Type of canister certification (batch vs individual). Batch certification is usually sufficient for sub-slab or soil gas sampling projects.
- Method reporting limits.
- Tracer gas to be used (the lab must certify container for this prior to shipping).
- Sample time.

Samples should be collected at a rate between 100 and 175 milliliters (mL) per minute (most guidance documents recommend that samples not be collected faster than 200 mL per minute). A flow rate greater than 200 mL/min runs the risk of introducing ambient air dilution to the sample. The sample time for grab samples is calculated by determining an acceptable sample flow rate (perhaps 150 mL per minute) and multiplying that by the sample container size. For a 150 mL per minute rate, a 1 L Summa canister would require approximately seven minutes. A 6 L Summa canister would require 40 minutes.

**3 SUB-SLAB GAS INITIAL PROCEDURES**

Order equipment as previously identified, and do the following prior to field activities:

- Determine the proposed locations for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Confirm with the property owner/occupant that subsurface utilities will not be impacted when drilling through the slab in these locations.
- Conduct a private utility locates for your locations to check for sub-slab or sub-grade obstructions.
- If possible, determine the slab thickness to confirm that a hand-operated drill can drill through it.
- Determine if carpeting or other flooring will need to be removed prior to drilling, or will require patching.
- Get the lab equipment delivered two days prior to sampling and ensure that all equipment was provided.

Once at the site, sampling should occur as described below.

### Drill Hole and Seal Tubing

- Confirm concrete thickness, if possible, so you'll know when to expect the drill bit to break through the bottom of slab.
- Drill a hole using the 0.25-inch or 0.5-inch drill bit. Drill approximately two inches into slab backfill or native material beneath the concrete slab.
- Using a 0.5-inch or 0.75-inch drill bit, overdrill the hole by approximately one inch to create a "seat" for sealing the tubing. The drill bit used for overdrilling should be one size larger than the original hole (0.5-inch for a 0.25-inch initial hole, etc.).
- Use the whisk broom to remove concrete dust or loose material from around the drill hole.
- Test the 0.25-inch tubing to ensure it can be pushed completely down the hole. Once it reaches the bottom, keep track of that tubing length as you pull it back out. Ensure there is no material stuck in the bottom of the tubing (if there is, cut the tubing end off and repeat this step). Re-insert the tubing so that the bottom rests approximately one inch from the drilled bottom, making sure it is below the bottom of the slab. If the tubing rests at the bottom of the hole that is okay.
- Determine the length of 0.25-inch tubing needed to conduct sampling at this location and cut it to that length. Do not forget that there must be enough tubing to go through helium shroud, connect to the purging T-valve and connect to the Summa canister. Be sure to cut the ends straight with no burrs or jagged edges.
- Thread the other tubing end through the helium shroud/stopper, leaving enough tubing within the shroud to allow you to install the sealing material. Cover the loose tubing end with a plastic bag to ensure it remains clean until it is connected to the Summa canister.
- Mix bentonite to an appropriate consistency for sealing.
- Insert bentonite evenly around tubing, making sure it penetrates fully into the larger drill hole. Push down with fingers or appropriate tool to ensure a good seal. Take care not to scrape or puncture the tubing.
- At the surface, mound the bentonite against the tubing and smooth away from it to create a tight seal. It is appropriate to moisten the top of the bentonite mound to aid in creating a good seal.

For temporary holes, allow approximately 20 to 30 minutes for the bentonite to seal and the hole to equilibrate. If collecting sub-slab gas samples at multiple locations, consider performing these initial activities at each location prior to continuing with the sampling.

## 4 SOIL GAS INITIAL PROCEDURES

Order equipment as previously identified. Prior to field activities, the following should occur:

- Determine the locations and depths for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Determine if equipment, vehicles, or other stored items will need to be moved prior to the field event.
- Arrange for a utility locate.
- Arrange for a driller to deploy a Post Run Tubing (PRT) sample system, or equivalent.

Once at the site, sampling should occur as described below.

### **Drill Hole and Seal Tubing**

- Drill a hole using a PRT system, or equivalent. The bottom of the hole should be at least 5.5 feet below ground surface (bgs).
- Lift up on the drilling rod approximately 6 inches to create a void in the subsurface.
- Insert the screw on end to the 0.25-inch tubing and place down the hole. Once it reaches the bottom, screw the fitting onto the PRT sample point (note: the fitting uses left-hand threads).
- Determine the length of 0.25-inch tubing needed to conduct sampling at this location and cut it to that length. Do not forget that there must be enough tubing to go through the helium shroud, connect to the purging T-valve, and connect to the Summa canister. Be sure to cut the ends straight with no burrs or jagged edges.
- Mix bentonite to appropriate thickness for sealing.
- Insert bentonite evenly around tubing exiting the drill rod, making sure it penetrates fully into the rod. Thread the other tubing end through the helium shroud/stopper. Cover the loose tubing end with a plastic bag to ensure it remains clean until it is connected to the Summa canister.
- Place the shroud over the drill rod and place more bentonite around the base to seal the shroud to the ground.

For temporary holes, allow approximately 20 to 30 minutes for the bentonite to seal and the hole to equilibrate.

## **5 LEAK DETECTION TESTING**

In order to perform the leak detection testing, have the shroud in place with the following setup and procedure:

- Tubing from drill hole.
- Tubing for measuring air within shroud (attach tubing onto appropriate fitting if not attached previously).
- Inlet hose from helium tank.
- If needed, place a brick or other weight on the shroud to prevent it from being moved and compromising the seal integrity.
- Fill the shroud with helium for several seconds and turn off the tank.
- Using the helium meter (meter), measure and record the helium concentration through the shroud air tubing in parts-per-million-volume (ppmv) (or know how to readily convert the reading to ppmv). The target helium concentration is 70 to 90 percent. Remove the meter from the shroud air tubing and cap the tubing. Allow meter to clear back to zero.
- Remove the helium tubing from the shroud and put a cap on the brass air fitting immediately.
- Connect the meter to the drill hole tubing and allow the meter to run for approximately a minute. Measure the helium concentration.
- Spray helium around fittings (T, on-off valve and flow regulator connections to Summa canister) and use the helium meter to monitor if any leaks are associated with these fittings.
- If indicated by elevated readings on the helium meter, make adjustments to seals.

- Once all necessary adjustments have been made, record the helium measurement in the shroud on field sheet following adjustment to seals.

Once the leak detection testing has confirmed the drill-hole seal is sufficient, proceed to sample collection.

## 6 SAMPLE COLLECTION

### Sample Train Assembly and Purging

- Install the T-valve and on-off switch in-line with the sample tubing to allow for purging.
- Connect the gauge and flow regulator to the Summa canister and tubing. Do not overtighten the fittings.
- Record the can and flow regulator serial numbers on the field form.
- Ensure that all connections are tight and all valves are closed.
- Determine the amount of air that requires purging within the sampling tubing.
  - Determine how much tubing you need to purge (round up to whole feet).
  - Multiply the number of feet by the volume of air within one unit foot of tubing (see multipliers below for various tubing sizes).
  - You want to remove a minimum of two purge volumes, so multiply volume calculated by two.

Size of tubing (inches)	Air volume in mL per one unit foot
1/4	9.7
3/8	21.7
1/2	38.6
5/8	60.3
3/4	86.9
1	154.4

- Connect the purging syringe and turn the on-off switch to ON.
- Purge the calculated volume of air. Draw the air slowly through the syringe to minimize the effect of creating a vacuum that could compromise the connections or seals. If your sample collection rate is 150 mL per minute, and you need to purge 50 mL, then take approximately 20 seconds to purge the 50 mL or as slowly as possible.
- If you need to purge more than one syringe volume, complete the first purge, turn the switch on the syringe to OFF, depress the syringe to purge the air out of the syringe, turn syringe valve to ON and repeat the purging process.
- When done purging, turn the on-off switch to OFF.

### Sample Collection

- Confirm that all connections remain tight and all valves are closed.
- Open the Summa canister by turning its valve approximately one-half turn.

- Immediately record the vacuum on the gauge (it should stabilize very quickly) and the time. The gauge should measure approximately -30 inches mercury (Hg). If the reading is not close to this value, the canister may not have sufficient vacuum for sampling. In this case, call the lab or select another canister.
- Allow the Summa canister to fill, keeping in mind the amount of time determined for sample collection (i.e., what you told the lab to set for a flow regulator time).
- The vacuum gauge should not drop below 3 inches Hg. If the vacuum readings are not keeping pace with the expected sampling time (either the gauge is dropping faster or slower than expected), you will need to use your best judgment as to when to stop the sample collection (or call the lab or project manager to discuss).
- Once the sample has been collected, record the vacuum reading and time.
- Close the canister valve. Be sure it is tightly closed (do not overtighten).
- Remove the gauge and flow regulator and replace the canister fitting.
- Fill out the chain of custody and return the containers to the lab with the original chain of custody. Retain a copy of the chain of custody for the project files.

When collecting 6L Summa canister samples, it is recommended that you watch the vacuum gauge the entire time (which can be up to 50 minutes). If the gauge should drop below 3 inches Hg, the sample may be considered void; this can be prevented by watching the gauge during sampling. If the gauge drops to 0 inches Hg the sample will need to be re-taken using a new canister.

### **Drill Hole Abandonment**

Once sampling is completed at a sub-slab gas location, the following should occur:

- Clean out the remaining bentonite, scraping as much as possible from the drill hole "seat" and sidewalls (do not push down hole but instead place in bag for disposal).
- Add a small amount of sand to fill the drill hole to approximately two inches below the concrete surface (approximately two inches below the bottom of the "seat"). Do NOT overfill with sand as it may compromise your seal.
- Use the whisk broom to remove any loose material at the surface.
- Fill the upper three inches with a quick setting cement grout. Smooth or feather the surface to help create a bond between the slab and the grout.

For soil gas sampling locations, the drill rig operator should abandon the sample point as required by state regulations (Oregon Administrative Rule 690-240 or Washington Administrative Code 173-160).

### **POST FIELD ACTIVITIES**

Retain all paperwork provided by the lab, including the packing list and certifications. This information must be retained in the permanent project file.

Reusable fittings owned by PBS must be decontaminated following PBS' *Standard Operating Procedure for On-Off Valve Decontamination for Vapor Intrusion Assessments*.

### **ASSESSING LEAK DETECTION RESULTS**

Regulatory guidance in Oregon and Washington allow up to 5 percent helium within a sample. To confirm that helium detections meet this regulatory requirement, the following will occur:

- Calculate average helium concentration in shroud ("shroud concentration") by taking two or more readings before and after sampling (the measurements should have been recorded in ppmv).
- When we receive lab results, if helium is detected, use this formula to confirm level of leakage.  
**Level of leakage** = lab-detected concentration / shroud concentration
- Be sure you are using the same units (ppm may not always equal ppmv: check your units).