Standard Operating Procedure for the Collection of Soil Gas Samples from Temporary and Permanent Soil Gas Probes using SUMMA Canisters and a Helium Leak Check

1. Scope and Application

This procedure offers a practical approach for the collection of soil gas samples from GeoProbe Systems (or equal) direct push soil gas probes with post-run tubing (PRT) adapters or from permanently installed vapor points into SUMMA canisters. Soil gas sample integrity is verified by using a real time helium leak checking procedure before taking each sample. This must be done after probe installation and before sampling as well as before each subsequent sample for permanent probes. This standard operating procedure (SOP) should be used in conjunction with CH2M HILL's SOPs: "Soil Gas Probe Installation SOP" or "Soil Gas Implant Installation SOP," and when its application is consistent with the project's data quality objectives. It is the responsibility of the project team to make sure this procedure meets all applicable regulatory standards and receives approval/concurrence from the leading regulatory agency for the project. Only persons trained in the collection of soil gas samples should attempt this procedure.

2. Site-Specific Considerations

2.1. Prior to attempting soil gas sampling there should be an understanding of subsurface conditions at the site.

2.1.1. Depth to Groundwater – soil gas samples should be collected in the vadose zone (and above the capillary fringe). Generally, soil gas samples should not be collected at a depth above 5 feet below ground surface (bgs). Sampling at multiple depths should be considered.

2.1.2. Soil permeability **-** It may not be feasible to collect soil gas from tighter grain soils with little pore volume, such as clays; if there are clay layers present in the subsurface, these intervals should be avoided. For sampling in these soils, it is recommended to uses soil gas implants with a wider bore hole. Care should be taken during purging and sampling so that the vacuum in the sampling system never exceeds 7 "Hg (100 "water).

3. Other Considerations

3.1. A utility clearance should be performed prior to mobilization, as with all intrusive site work.

3.2. Soil gas sampling should not be performed until 48 hours after a significant rain event (>1 inch of rainfall).

4. Apparatus and Materials

4.1. The soil gas probes should be installed by a licensed driller.

4.2. Teflon tubing, ¼-inch outer diameter sample tubing.

4.3. Swagelok® ¼-inch nut and ferrule sets for connecting the probe tubing to the sampling manifold.

4.4. The helium leak check equipment, including the enclosure, helium cylinder (high purity helium), and helium detector (Dialectric MGD is preferred). The enclosure may be provided by the driller or can be constructed from polyvinyl chloride (PVC) pipe. The helium detector can be rented from an equipment rental company.

4.5. MultiRae five gas meter. (Optional if onsite atmospheric gas analysis is required)

4.6. Air pump for purging and electric supply for the pump (either generator or power inverter with adapter for car battery). Must be capable of a flow of 200 mls/min and a vacuum of 20 "Hg.

4.7. Sampling manifold consisting of Swagelok® gas tight fittings with three valves and one pressure gauge to attach the probe to the air pump and the sample canister. This manifold must be clean, free of oils, and flushed free of volatile organic compounds (VOCs) prior to use.

4.8. Canister, SUMMA polished, certified clean and evacuated. (Canisters are typically provided by the laboratory.)

4.9. Flow controller or critical orifice, certified clean and set at desired sampling rate. These are typically provided and set by the laboratory.

4.10. Negative pressure gauge, oil-free and clean, to check canister pressure. The pressure gauges are typically provided by the laboratory. The laboratory may either provide one pressure gauge to be used with all of the canisters, or a pressure gauge for each canister to be left on during sample collection. Sometimes the canisters are fitted with built-in pressure gauges that are not removable.

4.11. Shipping container, suitable for protection of canister during shipping. Typically, strong cardboard boxes are used for canister shipment. The canisters should be shipped back to the laboratory in the same shipping container in which they were received.

4.12. Wrenches and screw driver (clean and free of contaminants), various sizes as needed for connecting fittings and making adjustment to the flow controller A 9/16-inch wrench fits the ¼-inch Swagelok® fittings, which most canisters and flow controllers have.

5. System Set-up

5.1. Acquire all the necessary hardware and sampling equipment shown in Figure 1. Be sure to use ¼-inch outside diameter Teflon sample tubing. ***Do not connect the canister at this time***.

5.2. Assemble or obtain the necessary fittings and vacuum gauge to create a soil gas probe and sampling manifold as shown in Figure 1. This manifold must be clean, free of oils, and flushed free of VOCs prior to use. Note: use only gas tight fittings such as Swagelok® or equivalent. Be sure to place the helium leak check enclosure over the probe, and push the sample tubing through the hole in the cap before attaching the sampling manifold.

5.3. Adjust the purge system evacuation pump sampling rate to achieve the desired flow rate of 200 milliliters/min. This should be performed at the outlet of the vacuum pump prior to purging, either by using a suitable flow meter, or determining the amount of time required to fill a 1-liter Tedlar bag.

5.4. Summa canisters are pre-evacuated by the laboratory. The vacuum will need to be verified in the field prior to use with a pressure gauge.

5.5. Flow controllers (if used) should come pre-set by the laboratory to sample at a pre-determined rate based on specific project requirements (see Table 1 for the most common options). In some cases [that is, project-specific quality assurance (QA)], the flow rate will need to be verified in the field prior to use. This is accomplished with a bubble meter, vacuum source, and instructions supplied by the laboratory.

6. System Leak Checking and Purging

6.1. ***Physical Leak Check*** - Perform a leak check of the sample manifold system by:

6.1.1. Make sure valve #1 is closed and valve #2 is open.

6.1.2. Open the purge valve (valve #3) and start the purge pump. Verify that the flow is set to 200 milliliters per minute (ml/min).

6.1.3. Close the valve #2 and achieve a vacuum gauge reading of approx. 15 inches of mercury ("Hg).

6.1.4. A leak-free system will be evident by closing off the purge valve (valve #3), turning off the purge pump, and observing no loss of vacuum within the sampling manifold system for a period of 30 seconds. Repair any leaks prior to use.

6.1.5. Record the leak check date and time on the field sampling log.

6.2. ***System Purge and Helium Leak Check*** -A purge of the soil gas probe and sampling manifold system is required before taking each sample. The helium leak check procedure is also performed during this step. This leak check will verify the integrity of the PRT adapter seal as well as the probe and ground interface. This is accomplished by:

6.2.1. Where the ground surface is soft, the helium leak check enclosure is pressed down slightly into the ground surface. In situations where the ground surface is hard (for example, asphalt), apply a slight downward pressure to achieve a buildup of helium in the leak check enclosure.

6.2.2. Start the flow of helium under the leak check enclosure at 200 ml/min. Try and position the tube so the helium is directed at the interface of the probe and the ground. Let the helium fill the enclosure for a couple of minutes.

6.2.3. Turn the helium leak detector on and make sure that the detector is not reading any helium before proceeding. Verify that the helium concentration inside the leak check enclosure is >10% by placing the probe of the helium detector into the hole where the sample tubing comes out or under the enclosure wall. It is not necessary to verify that the helium concentration is 100% as this is bad for the detector. Safety factors will be incorporated into measured purge gas helium concentration to verify the probe seal integrity.

6.2.4. Purging is carried out by pulling soil gas through the system at a rate of 200 ml /min for a time period sufficient to achieve a purge volume that equals at least 3-5 dead volumes (internal volume of the in-ground annular space, sample line, and sampling manifold system). When calculating the dead volume, be sure to take into account the inside diameter and length of the Teflon sample tubing, as well as the probe outside diameter and retract distance for the annular space for temporary probes. For permanent probes, calculate the volume of the annular space using a nominal 30% porosity for the sand or glass bead pack. If during the purge (or sampling) the vacuum exceeds 7 "Hg, then reduce the pump flow rate. The system vacuum must stay below this level at all times.

6.2.5. Open valve #2 and the purge valve (valve #3) and start the purge pump. Verify that the flow rate is still 200 ml/min.

6.2.6. To start the soil gas probe purge, open valve #1 and close valve #2 at the same time, and start timing.

6.2.7. During the last 5 minutes of the purge (or the entire purge time if less than 5 minutes), attach a Tedlar bag to the purge pump exhaust on open the bag's valve.

6.2.8. If the vacuum gauge reads >7 "Hg during the purge, then close the purge valve (valve #3) and monitor the vacuum in the manifold and probe. If there is no significant change after a minute, then there is an insignificant amount of soil gas and the vacuum is too great to take a soil gas sample. Several things can cause this. Consult with the project manager and take corrective action.

6.2.8.1. The soil formation is too 'tight' (that is, high clay or moisture content). Try using a lower flow rate. (temporary or permanent probe)

6.2.8.2. The soil formation is too 'tight'. Try a different depth or location. (temporary probe)

6.2.8.3. With a temporary probe system, the expendable tip may not have released when the probe was retracted. Try retracting the probe a little further, or use a long thin rod to poke the tip loose.

6.2.8.4. If water is visible in the flexible soil gas tubing, stop the purging immediately. It is not possible to take a soil gas sample at that depth or location.

6.2.9. At the end of the pre-determined purge time and after the system is verified to be leak free, close the purge valve (valve #3), close the valve to the Tedlar bag, and turn off the pump. Do not open the purge valve (valve #3) again. Doing so will result in loss of the purge integrity and will require re-purging.

6.2.10. Attach the Tedlar bag to the helium detector using a piece of flexible rubber tubing and open the valve. If a helium reading of >0.1%, or 1000 ppmv, is observed, then the probe leak check has failed and corrective action should be taken. This includes first checking the fittings and connections and trying another purge and leak check. It may also be necessary to remove the soil gas probe and re-install it in a nearby location. Using a limit of 0.1 % allows for a 10x safety margin to verify that the leak check was <1% (verify that this limit is consistent with appropriate project-specific agency guidance).

6.2.11. Remove Tedlar bag and turn off the helium leak detector.

6.2.12. Record the purge date, time, purge rate, leak check result, and purge volume on the field sampling log.

6.2.13. Immediately move on to the sampling phase. Little to no delay should occur between purging and sampling.

7. Sample Collection

7.1. 'Clean' sampling protocols must be followed when handling and collecting samples. This requires care in the shipping, storage, and use of sampling equipment. Cleanliness of personnel who come in contact with the sampling equipment is also important: no smoking, no eating, no drinking, no perfumes, no deodorants, no dry cleaned clothing, etc. Canisters should not be transported in vehicles with gas-powered equipment or gasoline cans. Sharpie markers should not be used for labeling or note-taking during sampling.

7.2. The SUMMA canisters are certified clean and evacuated by the laboratory to near absolute zero pressure. Care should be used at all times to prevent inadvertent loss of canister vacuum. ***Never open the canister's valve unless the intent is to collect a sample or check the canister pressure.***

7.3. Verify that the vacuum pressure of the canister is between 28 – 30 inches Hg. Do not use a canister that has an initial pressure less than 28 inches Hg because that canister likely leaked during shipment.

7.3.1. Remove the protective cap from the valve on the canister.

7.3.2. If using an external gauge, attach the gauge to the canister and open the valve. If the pressure gauge has two openings , make sure that the other opening is closed; the canister cap can be used for this. After taking the reading, close the canister and remove the gauge.

7.3.3. If using assigned pressure gauges, attach the pressure gauge to the canister, then attach the flow controller. When sample collection begins, record the initial pressure.

7.4. Leaving valve #1 closed and connected to the soil gas probe, disconnect the remaining sampling manifold from valve #1.

7.5. Attach the canister to the flow controller and then connect the flow controller to the sample valve (valve #1) as shown in Figure 2. Open the sample valve (valve #1)

7.6. Slowly open the canister's valve approximately one full turn.

7.7. After sampling for the appropriate amount of time (determined from project instructions, see Table 1), close the sample valve (valve #1) and the canister's valve. If the canister has a built-in or assigned pressure gauge, allow the canister to fill until the vacuum pressure reaches 0 – 10 inches Hg. Remove the canister from the sample valve (valve #1).

7.8. If using an external vacuum gauge, re-attach it, open the canister valve, and record the final pressure. Close the valve, remove the gauge, and replace and tighten the cap on the canister. Ideal pressure in the canister is between 0-10 inches Hg. More than 10 inches Hg can greatly increase reporting limits. Consult with the project team if this condition is encountered.

7.9. Record the sampling date, time, canister identification (ID), flow controller ID, and any other observation pertinent to the sampling event on the field sampling log. The temperature and barometric pressure should be recorded.

7.10. Fill out all appropriate documentation (sampling forms, sample labels, chain of custody, sample tags, etc.).

7.11. Before collecting a sample from the next soil gas probe, reassemble the sampling manifold (as in Figure 1), replacing valve #1 with an unused certified clean valve. If the sampling is complete, disassemble the sampling system.

8. Sample Handling and Shipping

8.1. Fill out all appropriate documentation (chain of custody, sample tags) and return canisters and equipment to the laboratory

8.2. The canisters should be shipped back to the laboratory in the same shipping container in which they were received. The samples do not need to be cooled during shipment. DO NOT put ice in the shipping container.

8.3. When packing the canisters for shipment, verify that the valve (just past finger tight) and valve caps are snug (1/4 turn past finger tight), and use sufficient clean packing to prevent the valves from rubbing against any hard surfaces. Never pack the cans with other objects or materials that could cause them to be punctured or damaged.

8.4. Do not place sticky labels or tape on any surface of the canister!

8.5. Place a custody seal over the openings to the shipping container.

8.6. Make sure to insure the package for the value of the sample containers and flow controllers.

8.7. Ship canisters for overnight delivery.

9. Quality Control

9.1. Canister supplied by the laboratory must follow the performance criteria and quality assurance prescribed in U.S. Environmental Protection Agency (EPA) Method TO-14/15 for canister cleaning, certification of cleanliness, and leak checking. SOPs are required.

9.2. Flow controllers supplied by the laboratory must follow the performance criteria and QA prescribed in EPA Method TO-14/15 for flow controller cleaning and adjustment. SOPs are required.

Table 1 – Common Sampling Rates for Soil Gas Sampling

Can Size	Length of sampling time	Sampling Flow Rate (ml/min)
6 Liter	1 hour	90
6 Liter	8 hours	11.25
6 Liter	24 hours	3.75
1 Liter	5 minutes	180
1 Liter	1 hour	15
850 ml	5 minutes	150
850 ml	1 hour	12

CH2MHILL *Applied Sciences Laboratory*

Indoor Vapor Intrusion Assessment
Soil Gas Sampling Field Log

Project Info

Project Name: _____ **Project # :** _____

By: _____ **Date:** _____

Structure

Identification: _____

Address: _____

Sample Location type:

- ☐ concrete slab on grade
- ☐ concrete footing w/crawl space
- ☐ basement
- ☐ Yard or Driveway
- ☐ other (describe) _____

Soil Gas Sampling System

Probe type (describe): _____

Probe to sample interface system (describe): _____

Sample collection type: ☐ Syringe ☐ Tedlar bag ☐ Summa canister

Other info (describe other aspects) _____

Soil Gas Probe Purging & Sampling Log

Sample location (show in diagram)	1	2	3	4
Sample Identification (field ID)				
Time Installed				
Depth of installed probe (feet bgs)				
Leak check, vacuum (probe/sampling interface)				
Calculated dead volume (1 purge volume), cc				
Calculated purge volume (3 purge volume), cc				
Purge rate, cc/min.				
Purge duration, min.				
Purge started (time of day)				
Purge vacuum, " Hg				
Max Helium Leak Check Reading				
Purge completed (time of day)				
Sampling period started (time of day)				
Sampling rate, cc/min				
Sampling vacuum, " Hg				
Sampling period ended (time of day)				

Observations and Comments: _____

Figure 1 - Purge Set-up

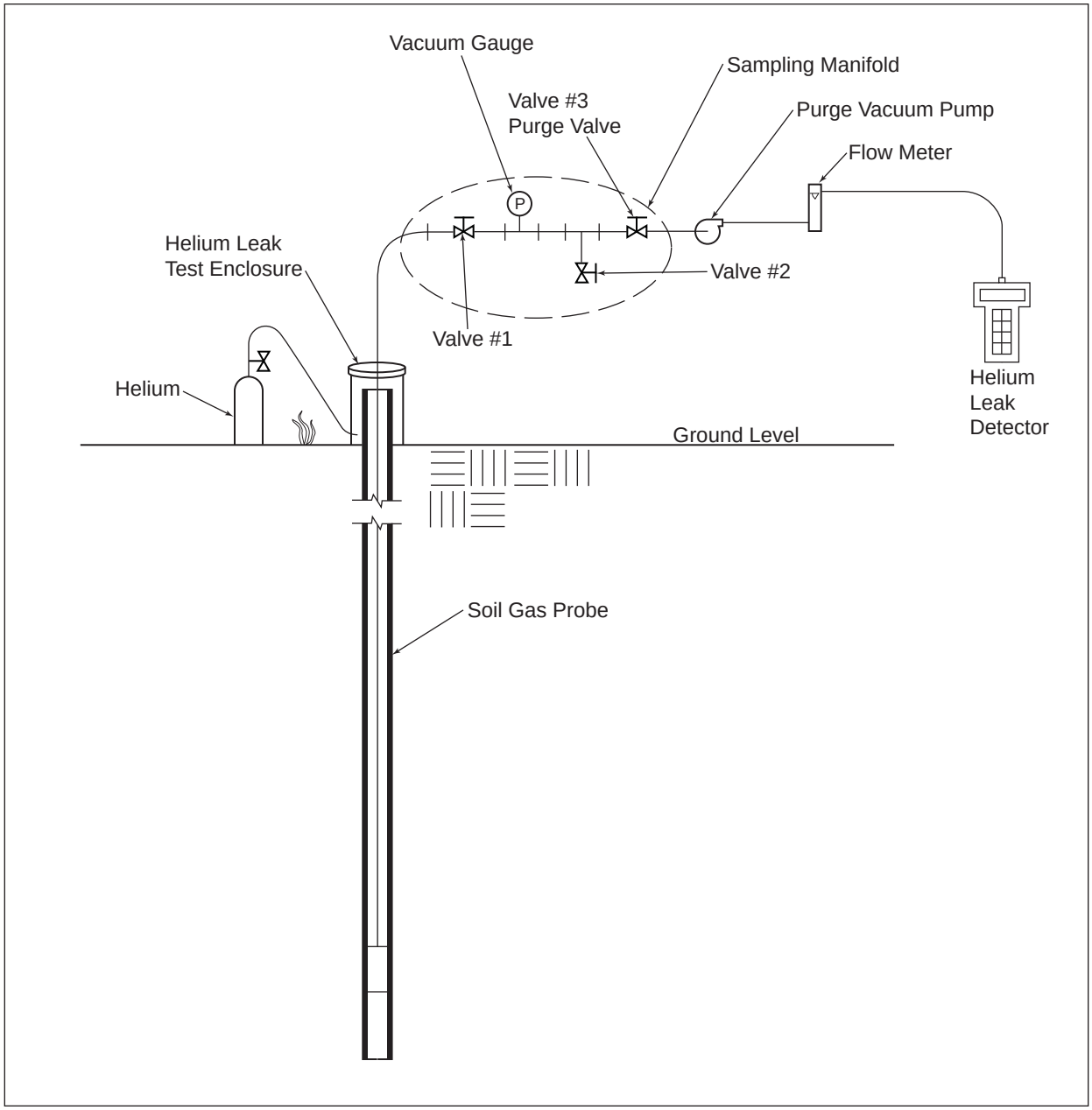

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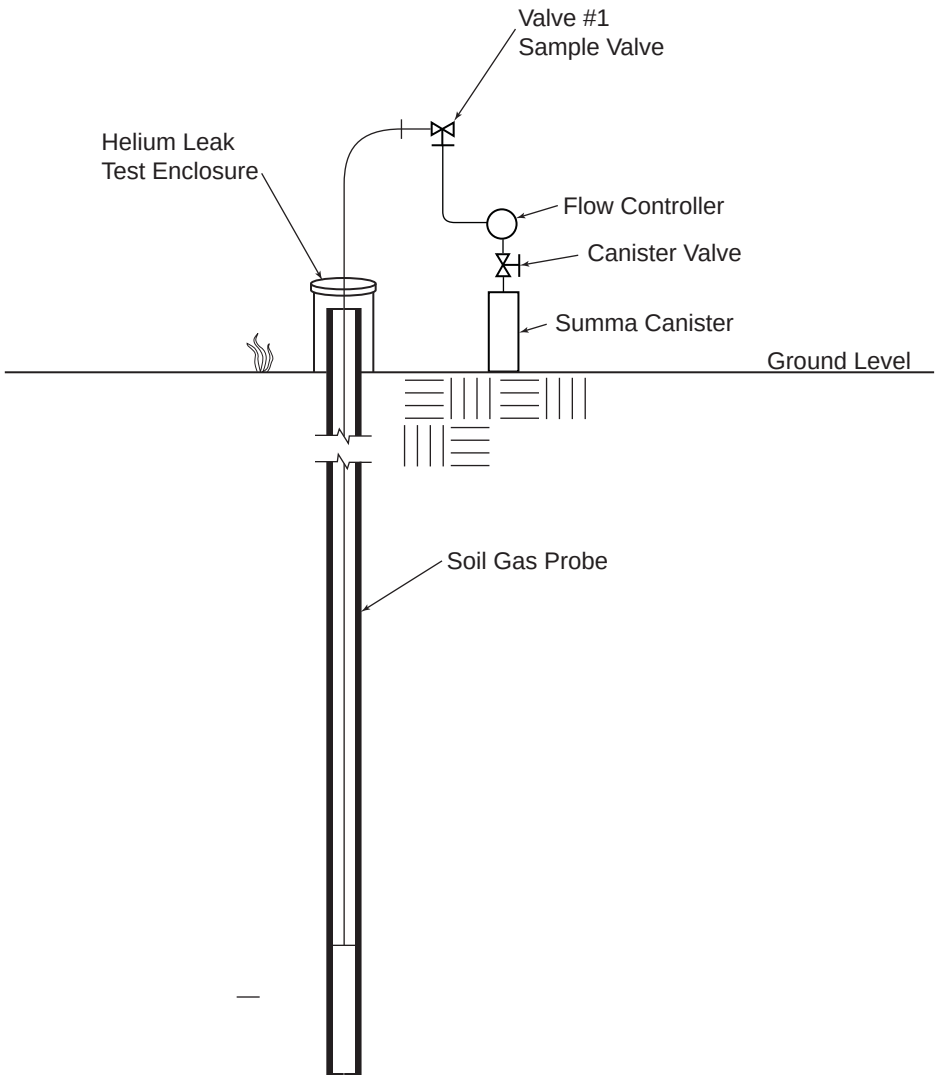
Figure 2 - Sample Collection



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