DERR SAMPLING GUIDANCE
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STANDARD OPERATING PROCEDURES (SOP)
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Sample Collection Technique for Ground Water

1.0 Scope and Application

1.1 This sample collection technique is used when sampling groundwater with any sample collection device. Bottles are filled directly from the sampling device or spigot.

2.0 Health and Safety Warnings

2.1 Use caution when handling glass bottles and preservatives.

2.2 Refer to the site Health and Safety Plan for possible site hazards.

3.0 Cautions

3.1 Splashing and aeration of the water during bottle filling may cause loss of volatile organic compounds.

3.2 If bottles are pre-preserved, be careful not to flush the sample bottle.

3.3 The well will need to be purged prior to sampling. See SOP 2.2.4.

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Equipment and Materials

- Sample containers as specified by the laboratory
- Gloves
- Personal Protective Equipment
- Cooler and ice
- Analysis specific preservatives, i.e. HCl, HNO_3, NaOH, H_2SO_4
- Sample tags and/or labels
- Paper Towels
- Log book with waterproof pen
- Chain-of-custody

6.0 Summary of Method

6.1 Complete the bottle label before filling with water.

6.2 Bottles should be filled according to the volatility of the contaminants to be analyzed: Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs), PCB/Pesticides and Metals.

6.3 Don sampling gloves and appropriate protective equipment. Gloves need to be changed after each sample.

6.4 After proper well purging, sample by tilting the bottle and filling from the sampling devise or faucet. Try not to create foam or aerate the sample or touch the bottle to the faucet. Replace cap on sample bottle.

6.5 For VOA samples, fill the vial until there is a meniscus over the lip of the bottle. Replace cap, invert the VOA vial and gently tap to verify that there are no air bubbles entrapped in the sample vial. If air bubbles are present, refill or resample using a new VOA vial.

6.4 If sample bottles are not pre-preserved, preserve with the appropriate acid or other preservative according to analysis.

6.5 Preserve the sample on ice as soon as possible after filling, cooling to 4^0C. Some samples for organic analysis need to be protected from light by using amber bottles and/or by placing in a cooler. Since lids tend to loosen after containers are cooled, retighten after having been on ice for about 30 minutes.

6.6 Make sure all applicable sections in the log book are filled out properly. For documentation purposes, photograph the area with the sample containers next to sample location in accordance with SOP 1.2.3.

6.7 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011)

7.0 Instrument Calibration / Maintenance

N/A

Obtaining Water Level Measurements in Ground Water Wells

1.0 Scope and Application

1.1 Depth to water and total well depth must be made prior to well sampling. This information can be used for various purposes including calculating well volume (see SOP 2.2.3) and determining ground water flow direction.

1.2 The electronic tape is most accurate measuring device, it is also simplest to use and easiest to decontaminate.

1.3 When purging a well, floating and/or sinking immiscible layers should be identified when the water level is taken.

1.4 If water level measurements are to be used for hydro geological purposes, measure all wells within 24 hours to the nearest 0.01 foot before purging any wells nearby.

2.0 Health and Safety Warnings

2.1 Equipment should be monitored as it is raised out of the well with air monitoring instruments normally used at hazardous material sites, i.e. radiation and organic vapor meters, etc.

2.2 Refer to the site specific Health and Safety Plan for the possible hazards associated with the site.

3.0 Cautions

3.1 In some instances, water levels in nearby wells can be drawn down from well purging or sampling.

3.2 The measuring device must be decontaminated after each use.

3.3 Depth to water can change measurably with changes in barometric pressure.

3.4 The same measuring device and field team should measure all wells for comparability.

3.5 Chalked tape is accurate but unacceptable, because the chalk or paste will contaminate the water sample.

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Equipment and Materials

- Water level meter or device
- Deionized water and wipes
- Log book
- Pen

6.0 Summary of Method

6.1 After monitoring the air for hazardous constituents, open the well and continue monitoring.

6.2 To measure the static water level, lower the probe of the water level meter into the well until the water level is reached (indicated by a light, beep, pop or deflection of the needle). Measure water level from the top of the inner well casing to the nearest 0.1 to 0.01 foot (1/8 inch). The reference point should be marked on the inner casing.

6.3 To measure total well depth, lower the probe to the bottom of the well. Measure and record the depth of the well against the top of the casing.

6.4 Rinse the probe and tape with deionized water and wipe off.

7.0 Instrument Calibration / Maintenance

7.1 The measuring device must be decontaminated after each use.

Well Volume Calculation

1.0 Scope and Application

1.1 To determine the amount of water in the well for purge volume calculations.

2.0 Health and Safety Warnings

2.1 Refer to the site specific Health and Safety Plan for the possible hazards associated with the site.

3.0 Cautions

3.1 Accurate calculations are expected.

4.0 Personnel Qualifications

4.1 Must have simple math skills.

5.0 Equipment and Materials

- Log book with well measurements (see SOP 2.2.2)
- Calculator
- Pen

6.0 Summary of Method

6.1 Information needed to calculate one well volume includes depth to water, depth of well and diameter of well. Depth measurements should be taken from the top of the inner casing, and all units should be in feet, measured to hundredths of an inch.

6.2 The quick method for calculating one well volume is as follows:

One well volume = water column in feet to100ths of an inch X gallons/feet for inside diameter of well in inches using conversion factor below.

To calculate the water column, take the total depth of the well and subtract the distance to the depth to water.

Conversion Factors

Inside Diameter of Well (inches)	Gallons/Feet
1.0	0.041
1.5	0.092
2.0	0.163
3.0	0.367
4.0	0.653
6.0	1.470

6.5 The long method to for calculating one well volume is as follows:

One well volume (gallons) = $\pi \frac{D^2}{4} X (h_d - h_w) X (7.48)$

$\pi = 3.14$

D = diameter of well in feet

h_d = depth of well in feet

h_w = depth to water in feet

7.48 (gal/feet) = conversion factor from cubic feet to gallons

7.0 Instrument Calibration / Maintenance

N/A

Well Purging

1.0 Scope and Application

1.1 The objective of purging a well is to obtain a representative ground water sample by removing all stagnant water from the well and allowing fresh formation water to enter. Ground water that remains in a well casing for an extended period of time has had the opportunity to exchange gases with the atmosphere and to interact with the well casing material. The chemistry of the ground water stored in the well casing is unrepresentative of the water in the aquifer.

2.0 Health and Safety Warnings

2.1 Refer to the site specific Health and Safety Plan for the possible hazards associated with the site.

3.0 Cautions

3.1 Purge water must be containerized and preferably segregated from one well to another if there is a possibility that the water is contaminated. The water will need to be disposed of properly.

3.2 Purging the well at a rate faster than it can recover may cause water to cascade down the well screen, which may cause a loss of volatile organic compounds and/or oxidation of the sample.

3.3 If sediments have accumulated in the bottom of the well, additional purging may be needed to clear the water.

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Equipment and Materials

- Purging devise (There are several to choose from)
- Buckets to containerize purge water.
- Water quality meters to measure parameters. i.e. pH, specific conductivity, temperature and dissolved oxygen.
- Log book
- Pen

6.0 Summary of Method

6.1 Measure the water level (SOP 2.2.2) and calculate the volume of water in the well (SOP 2.2.3). Determine the appropriate volume to purge; generally it is at least 3 well volumes.

6.2 Measure and record initial water quality parameters such as pH, specific conductivity, temperature, dissolved oxygen, turbidity, etc.

6.3 Pump or bail the ground water into a graduated bucket, transferring into larger container as needed.

6.4 Measure and record the water quality parameters, preferably with the time and volume purged. Parameters should be recorded at a minimum of every well volume.

6.5 Ideally, continue purging until parameters have stabilized. In some situations, it may be very difficult to reach stabilization. In general, parameters are considered stable when the following is achieved over 3 consecutive readings. Below are the stabilization criteria for the most important parameters.

Parameter	**Stabilization Criteria**
pH	+/- 0.1
Specific Conductance	+/- 3%
Oxidation-Reduction Potential (ORP)	+/- 10 Millivolts
Turbidity	Below 10 NTUs Ideal +/- 10% if greater than 10 NTU
Dissoloved Oxygen (DO)	+/- 0.3 mg/L

6.5 Upon completion of purging the well, the ground water may be sampled using a pump or bailer for up to 24 hours.

6.6 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011).

7.0 Instrument Calibration / Maintenance

7.1 Refer to instrument specific SOP for calibration and maintenance schedule.

Filtering of Ground Water Samples

1.0 Scope and Application

1.1 Field filtration can be used to remove the immobile sediment fraction that may contribute to the turbidity of a sample. Turbidity is an important field concern for samples to be analyzed for metals (e.g. cadmium, nickel, zinc) or metalloids (e.g. arsenic, selenium).

1.2 There are two types of filtration that can be used in the field: In-Line Filtration (Closed System) in which a sampling pump provides positive pressure to force the sample through an attached filter into a sample bottle, and Pressure Filtration (Open System) in which the sample is either pulled through the filter by vacuum or is driven through the filter by an inert pressurized gas or a peristaltic-type pump. Pressure Filtration requires the sample to be transferred from the sampling device to the filtering apparatus, exposing the sample to the atmosphere.

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2.0 Health and Safety Warnings

2.1 See Site Health and Safety Plan for site specific safety considerations.

3.0 Cautions

3.1 Non-Filtered Ground Water Sampling Method

If immobile particles to which metals are bound are present in the preserved (acidified) sample, the true concentration of mobile species will be overestimated in laboratory analyses. The acidic preservative dissolves precipitates or causes adsorbed metals to desorb from immobile particles. This desorption is not representative of what may be occurring in the ground water.

3.2 Filtered Ground Water Sampling Method

Ground water sample filtration can potentially remove particles that may be mobile in certain hydro-geologic environments. If these mobile particles to which metals may be bound are removed from the sample, the altered sample becomes unrepresentative of the ground water.

Sampling technique, sampling device, filter clogging, variable particle size retention, filter media leaching and aeration are potential problems that occur when filtering ground water samples. Proper well installation, well development and sampling technique can greatly reduce sample turbidity, and eliminate the need for field filtration

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Equipment and Materials

5.1 There are several different filters available on the market.

- Sample collection supplies as outlined in SOP 2.2.1, Sample Collection Technique for Ground Water.
- Filtering apparatus

6.0 Summary of Method

6.1 **In-Line Filtration Method**

6.1.1. Calculate well volume, and determine purge volume (see SOP: 2.2.3 Well Volume Calculation).

6.1.2. Measure and record water quality parameters.

6.1.3. Set up the filtering apparatus using manufactures instructions

6.1.4. Pump the water directly through the filter into the sample bottle. Preserve the sample after it has been filtered.

6.1.5. Collect and handle samples following the procedures outlined in SOP: 2.2.1.

6.2 **Pressure Filtration Method**

6.2.1. Calculate well volume, and determine purge volume (see SOP: 2.2.3 Well Volume Calculation).

6.2.2. Measure and record water quality parameters.

6.2.3. Extract the ground water sample from the well with a bailer or pump. Discard the first 100-150 ml.

6.2.4. Filter the sample using manufactures instructions for the particular unit.

6.2.5. Collect and handle samples following the procedures outlined in SOP: 2.2.1.

6.3 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011).

7.0 Instrument Calibration / Maintenance

N/A

Ground Water Sampling using a Bailer

1.0 Scope and Application

1.1 Hand bailers are portable purging and sampling devices which do not require a power source. There are conventional and dual check valve bailers, and some have stopcock spigots. Bailers can be constructed of a variety of materials (polyethylene, teflon, stainless steel, PVC), and come in many sizes (lengths and diameters).

2.0 Health and Safety Warnings

2.1 See Site Health and Safety Plan for site specific safety considerations.

3.0 Cautions

3.1 A boline knot is recommended for tying the rope to the bailer. Other knots may slip and the bailer might be lost in the well.

3.2 Filling sample bottles from a bailer takes a steady hand.

3.3 Off-gassing of volatile organics must be minimized by reducing sample aeration.

3.4 Some bailers are disposable (polyethylene); some are expensive and require decontamination between wells (teflon, stainless steel).

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Equipment and Materials

- Bailer
- Rope
- Knife
- Sample collection supplies as outlined in SOP 2.2.1, Sample Collection Technique for Ground Water

6.0 Summary of Method

6.1 Calculate well volume, and determine purge volume (see SOP: 2.2.3 and 2.2.4)

6.2. Measure and record water quality parameters.

6.3 Attach bailer rope or cable to the bailer. Do not allow rope to touch the ground. Suspend the rope with your arms, or collect it in a bucket or on a piece of plastic sheeting.

6.4 Slowly lower the bailer down the well to the water level. Do not allow the bailer to free-fall into the water or touch the bottom of the well.

6.5 Lower the bailer to the same depth in the well each time, preferably within or just above the screened interval.

6.6 Allow the bailer to sink with a minimum of surface disturbance.

6.7 Raise the bailer slowly. Try not to allow the bailer rope to touch the sides of the well.

6.8 Whether water is discharged from a hole in the top of the bailer or from a spigot in the bottom of the bailer, slowly tip the bailer to empty.

6.9 After purging, collect and handle samples following the procedures outlined in Sample collection supplies as outlined in SOP 2.2.1, Sample Collection Techniques for Ground Water.

6.10 Decontaminate the bailer between each unique sample location, unless a new disposable is being used at each sample location.

6.11 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011)

7.0 Instrument Calibration / Maintenance

7.1 Non-disposable bailers will need to be decontaminated between wells. See SOP 1.3.1, decontamination.

Ground Water Sampling Using a Portable Bladder Pump

1.0 Scope and Application

1.1 Bladder pump sampling is an efficient and simple method to collect representative groundwater samples.

1.2 The bladder pump utilizes compressed air to expand and compress a bladder, which fills and subsequently empties itself of water.

1.3 This pump can be used to depths of up to 200 feet, and is used as a portable well sampling device.

2.0 Health and Safety Warnings

2.1 See Site Health and Safety Plan for site specific safety considerations.

3.0 Cautions

3.1 Long cycles needed for deep wells
3.2 Decontamination can be tedious and must be thorough to avoid cross contamination.

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Equipment and Materials

5.1 Stainless steel bladder pump, HDPE dual tubing, disposable bladders, o-rings, check valves, aluminum lock discs.

6.0 Summary of Method

6.1 Calculate well volume, and determine purge volume (see SOP: 2.2.3 Well Volume Calculation).

6.2 Measure and record water quality parameters

6.3 Assemble pump by connecting first installing a disposable bladder to the pump head.

6.4 Connect pump head to pump body ensuring a rubber o-ring is installed around the pump head.

6.5 Verify that a steel check valve ball is installed in the side and the top of the pump head.

6.6 Verify that two small o-rings are installed inside the inlet and outlet of the top of the pump head.

6.7 Place a thin metal lock disc on the pump head.

6.8 Slide the HDPE dual tube hose through the top of the pump cover.

6.9 Insert tubing through the lock disc and into the inlet and outlet of the pump head. Note that “W” stands for water and “A” indicates air line.

6.10 Lock the pump cover onto the pump head by twisting it in place securing the pump.

6.11 Lower the pump into the well.

6.12 Attach the compressor to the control box with the provided air line.

6.13 Connect the control box to the air line of the dual tube with the provided coiled air line.

6.14 On the control box, begin pumping water by pressing the “cycle” key.

6.15 Water will begin to flow within a few minutes. Adjust the cycles per minute button as needed to adjust flow rate.

6.16 After purging, collect and handle samples following the procedures outlined in SOP: 2.2.1.

6.17 Decontaminate between each unique sample location.

7.0 Instrument Calibration / Maintenance

N/A

Ground Water Sampling using a Peristaltic Pump

1.0 Scope and Application

1.1 This method of ground water sampling is advantageous for shallow wells less than 25 feet. The pump is portable and requires a power source. The tubing should be dedicated or it will need to be decontaminated for reuse.

2.0 Health and Safety Warnings

2.1 See Site Health and Safety Plan for site specific safety considerations.

3.0 Cautions

3.1 Sampling for volatile organic compounds (VOCs) is not recommended. Samples for VOCs should be collected with a bailer before any other samples are collected. The vacuum required to draw the water to the surface will strip the VOCs from the water sample.

3.2 The peristaltic pump cannot lift water in excess of approximately 25 feet.

3.3 This type of pump requires a power source, and is a relatively slow method of well purging.

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Equipment and Materials

- Peristaltic Pump
- Battery or power source
- Flexible tubing for pump
- Ridged Tubing for lowering into well
- Sample collection supplies as outlined in SOP 2.2.1, Sample Collection Technique for Ground Water.

6.0 Summary of Method

6.1 Calculate well volume, and determine purge volume (see SOP: 2.2.3 Well Volume Calculation).

6.2 Measure and record water quality parameters.

6.3 Connect the battery to the pump and attach the tubing.

6.3 Slowly lower the sample tubing to the middle of the well screen and turn on.

6.4 After purging the calculated purge volume and parameters have stabilized, collect and handle samples following the procedures outlined in SOP: 2.2.1. Sample Collection Technique for Ground Water.

6.5 Decontaminate tubing between each unique sample location, unless clean, dedicated tubing is used at each sample location.

6.6 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011)

7.0 Instrument Calibration / Maintenance

7.1 See instruction manual for maintenance.

Ground Water Sampling using a Submersible Grundfos Pump

1.0 Scope and Application

1.1 This pumping method is very versatile and suitable for purging a large volume of ground water. It can be used in deep wells down to 200-300 foot deep. The flow rate is adjustable and can be set as low as 100 ml/min for sampling. Disposable tubing is used with this pump.

2.0 Health and Safety Warnings

2.1 See Site Health and Safety Plan for site specific safety considerations.

3.0 Cautions

3.1 This type of pump requires a generator or a car battery with a converter for power.

3.2 Necessary precautions should be taken when working around electricity and water.

3.3 The pump head needs to be decontaminated between wells.

3.4 DO NOT lower or raise the pump by the power cord only.

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

4.2 Operator should be familiar with this equipment.

5.0 Equipment and Materials

- Grundfos pump
- Grundfos pump controller box
- Car battery with converter or generator
- Disposable tubing
- Sample collection supplies as outlined in SOP 2.2.1, Sample Collection Technique for Ground Water

6.0 Summary of Method

6.1 Calculate well volume, and determine purge volume (see SOP: 2.2.4 Well Volume Calculation).

6.2. Measure and record water quality parameters.

6.3 Connect the power source to the controller box and then to the pump. Attach disposable tubing.

6.4 Slowly lower the pump head to the middle of the well screen. Turn power on and adjust the flow rate as desired. The pump should operate continuously so water will flow back into well from the tubing and aeration in the return tube or upon discharge is minimized.

6.5 After purging the calculated purge volume and parameters have stabilized, turn the flow rate down to about 100 ml/min for sampling.

6.6 Collect and handle samples following the procedures outlined in SOP: 2.2.1 Sample Collection Technique for Ground Water.

6.7 Pull up pump and decontaminate the pump head, discard tubing. Wipe off the power cord.

6.8 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011)

7.0 Instrument Calibration / Maintenance

7.1 Check the pump wires occasionally to be sure they are not loosening from the pump head.

7.2 The pump head will need to be decontaminated between samples. See SOP 1.3.1, decontamination.

Ground Water Sampling from Faucets, Taps and Valves

1.0 Scope and Application

1.1 This sampling technique is used when sampling groundwater from a valve or faucet. The sample should be collected prior to any water treatment such as chlorination or softening.

2.0 Health and Safety Warnings

2.1 See Site Health and Safety Plan for site specific safety considerations.

3.0 Cautions

3.1 The sample water is subject to contamination from the pipes and valves, i.e. iron, copper, lead or plastics from pipes and oils or greases from valves and pumps.

3.2 Be sure to remove any aerating devise before sample.

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Apparatus and Materials

- Sample collection supplies as outlined in SOP 2.2.1, Sample Collection Technique for Ground Water.

6.0 Summary of Method

6.1 Examine the water lines and determine where the sample should be taken. Strainers, aerators and hose attachments should be removed and/or cleaned. Sample before the softener if one is present.

6.2 Open valve or faucet (cold water only). Adjust flow to a moderate pressure to prevent splashing or aeration of the water. Allow sufficient time for the well to be purged or the lines to be flushed clean of rust or residue (approximately 15 minutes). Do not adjust flow during sampling.

6.3 Collect and handle samples following the procedures outlined in SOP: 2.2.1.

6.4 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011)

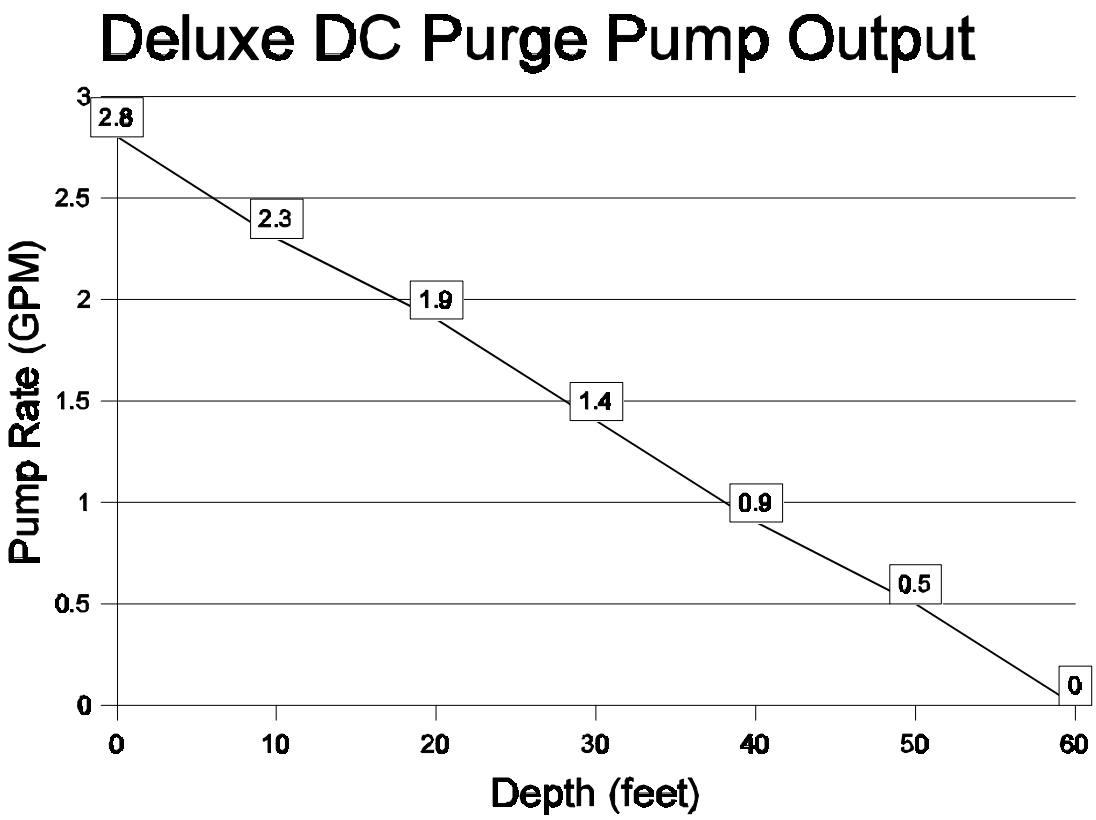
7.0 Instrument Calibration / Maintenance

N/A

Deluxe DC Purge Pump

1.0 Scope and Application

1.1 The Deluxe DC Purge Pump is a rotary stroke pump used for purging monitoring wells or shallow ponds. This pump is only effective at depths less than 60 feet. The pump rate varies with depth; 2.8 GPM maximum, 0.0 GPM at 60 feet (see graphic below).



2.0 Health and Safety Warnings

2.1 See Site Health and Safety Plan for site specific safety considerations.

2.2 This pump is not intrinsically safe.

3.0 Cautions

3.1 Sand and silt may permanently damage pump.

3.2 DO NOT run the pump dry.

3.3 DO NOT use with 12V vehicle battery while vehicle is running.

3.4 This pump is not for sampling, only purging. Use a bailer or other sampling devise to collect the samples.

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Equipment and Materials

5.1 The pump casing is made of ABS plastic with synthetic rubber seals. The impeller is made of stainless steel.

- DC Purge Pump
- Tubing (3/8" ID or ½" ID with adaptor)
- 12 volt vehicle battery or deep discharge marine battery
- Logbook
- Knife for cutting tubing

6.0 Summary of Method

6.1 Cut tubing to desired length and attach to pump (be sure tubing and pump do not touch the ground or become contaminated).

6.2 Lower pump into well and into the water column. Support pump by tubing and NOT by power line.

6.3 Connect the pump power line to the battery to start the flow.

6.4 Prime the pump by cycling the pump on and off in 4 second intervals several times.

6.5 When purging is complete, disconnect from battery before raising pump out of water column.

6.6 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011).

7.0 Instrument Calibration / Maintenance

7.1 The pump will need to be decontaminated between samples. See SOP 1.3.1, decontamination. Used tubing is discarded.

7.2 The pump is completely sealed and no attempt should be made to open the pump.

Micro Purging / Low Flow Ground Water Sampling

1.0 Scope and Application

1.1 The objective of micro purging/low-flow well sampling is to obtain a representative ground water sample by creating an environment conducive to the removal of water directly from the geologic formation with minimal disturbance to the water column.

2.0 Health and Safety Warnings

2.1 Refer to the site specific Health and Safety Plan for the possible hazards associated with the site.

3.0 Cautions

3.1 Purge water must be containerized and preferably segregated from one well to another if there is a possibility that the water is contaminated. The water will need to be disposed of properly.

3.2 Purging the well at a rate faster than it can recover may cause water to cascade down the well screen, which may cause a loss of volatile organic compounds and/or oxidation of the sample. Guidance dictates no more than 0.3 feet of drawdown while purging the well.

4.0 Personnel Qualifications

4.1 Personnel may need to be certified under OSHA regulations.

5.0 Equipment and Materials

- Purging pump
- Buckets to contain purge water.
- Flow –thru cell with data sonde installed to measure water quality parameters
- Water quality meters to measure parameters. i.e. pH, specific conductivity, temperature and dissolved oxygen.
- Log book
- Pen

6.0 Summary of Method

6.1 Measure the water level (SOP 2.2.2).

6.2 Measure the flow rate in a graduated cylinder (or similar device) at ensure that the rate is between 100 ml/min and 500 ml/min. In addition, monitor the static water level in the well to check for drawdown. Purge the well at a constant flow rate until no more than 0.3 feet of drawdown or equilibrium in the well has been achieved.

6.3 Use a flow-thru cell with data sonde to measure and record initial water quality parameters such as pH, specific conductivity, temperature, dissolved oxygen, turbidity, etc. These parameters should be recorded every 5 to 10 minutes depending on the purge rate thru the flow-thru cell.

6.4 Continue micro purging until parameters have stabilized. In some situations, it may be very difficult to reach stabilization. In general, parameters are considered stable when the criteria listed in the following table is achieved over 3 consecutive readings. Below are the criteria for the stabilization parameters. If stabilization can not be achieved thru micro purging, abandon low flow sampling and purge the well according to SOP 2.2.4 Well Purging.

Parameter	Stabilization Criteria
pH	+/- 0.1
Specific Conductance	+/- 3%
Oxidation-Reduction Potential (ORP)	+/- 10 Millivolts
Turbidity	Below 10 NTUs Ideal +/- 10% if greater than 10 NTU
Dissoloved Oxygen (DO)	+/- 0.3 mg/L

6.5 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011).

7.0 Instrument Calibration / Maintenance

7.1 Refer to instrument specific SOP for calibration and maintenance schedule.

SOP # 2.5.1 - Procedures for Active Soil Gas Collection Using Direct-Push Systems

1.0 Scope and Application

1.1 Vapor intrusion is defined as vapor phase migration of VOCs into occupied buildings from underlying contaminated ground water and/or soil. Soil gas surveys provide information on the soil atmosphere in the vadose zone that can aid in assessing the presence, composition, source, and distribution of contaminants. The purpose of this document is to provide guidance for conducting soil gas sampling, and shall pertain to active soil gas surveys, whereby a volume of soil gas is pumped out of the vadose zone into a sample collection device for analysis.

1.2 Detection of individual constituents by active soil gas sampling is limited by the physical and chemical properties of individual contaminants of concern* and the soil characteristics of the site. In general, chemical parameters or criteria to be considered prior to selecting soil gas sampling activities are as follows:

- Vapor Pressure > 0.1 mm Hg
- Henry's Law Constant > 0.1
- Degree of soil saturation (chemical and/or water) < 80%
- Sampling zone is permeable and permits vapor migration

*Please refer to **Appendix A**, Chemicals of Concern for Vapor Intrusion, in the *"Sample Collection and Evaluation of Vapor Intrusion to Indoor Air, Guidance for Ohio EPA'S Remedial Response and Voluntary Action Programs"* for a complete list of the volatile chemicals which can be detected using soil gas sampling techniques.

1.3 Results from soil gas surveys are used in both qualitative and quantitative evaluations. The quality and application of the data is dependent upon many factors, including but not limited to: the DQO's used to develop the sampling plan, the number of sample locations and data points, the selection of the sample locations, the soil characteristics of the site, the distribution of the contaminants in both the vadose and saturated zones, the equipment and personnel used to gather the data, etc. The work plan should be finalized before any sampling is conducted. The work plan will provide specific information on the type and quality of data gathered during the soil gas sampling event. Any questions regarding data needs and usage should be resolved prior to sampling.

1.4 The evaluation of the indoor inhalation pathway at contaminated sites is a relatively recent development. As a result, procedures and technology related to evaluating the pathway continue to evolve. This guidance pertains to the active collection of soil gas using direct-push systems (*i.e.* driven probe rod) [see also ITRC Vapor Intrusion Guidance: A Practical Guide, January 2007, Appendix D, Section 4]. Ohio EPA does not intend for this guidance to be overly limiting with respect to the use of other appropriate methods, procedures, and equipment for measuring concentrations of chemicals of concern in soil gas.

1.5 Limitations

1.5.1 A soil gas survey is only applicable to volatile contaminants;

1.5.2 Barriers exist that interfere with vapor migration such as perched water, clay or man-made structures can lead to non-representative sampling with low or false negative readings, or may produce localized areas of high concentrations;

1.5.3 Soil gas readings taken within 24 to 48 hours of heavy precipitation can produce drastically reduced or non-existent readings;

NOTE: Separation between the contamination source and the sample location increases the influence due to biodegradation or abiotic transformation.

2.0 Health and Safety Warnings

2.1 Overhead and Buried Utilities

The use of direct push systems on a site within the vicinity of electrical power lines and other utilities requires that special precautions be taken by the operators. Underground electrical utilities are as dangerous as overhead electricity. Be aware and always suspect the existence of underground utilities (water, natural gas, cable/phone lines, fiber optic cables, storm water & sewer lines, etc.).

REMEMBER.....Call B-4-U Dig:

Ohio Utilities Protection Service (OUPS): 800-362-2764
&
Oil & Gas Producers Underground Protection Service (OGPUPS):
800-925-0988

2.2 Operators must wear OSHA-approved Personal Protective Equipment (PPE). Refer to the site specific Health and Safety Plan.

3.0 Apparatus and Materials

3.1 The following is a list of equipment, tooling, and supplies typically used for soil gas sample collection:

PPE:

- Hearing protection
- Nitrile (or similar) disposable gloves
- Steel-toed boots
- Safety glasses
- Leather gloves
- Hard hat

Equipment/Tooling/Supplies needed for all probing:

- 4-foot probe rods
- Inner Extension Rods (48")
- Drive Cap
- Miscellaneous tools
- Bentonite granules
- 2-foot probe rods
- Rod Grip Pull System
- Pull Cap
- Logbook

Soil Gas Sampling:

- Expendable Point Holder
- Expendable Drive Points w/ O-ring
- Adapter for ¼“ tubing w/ O-ring
- Tedlar® gas sampling bags (1 L) w/ bag sampler (*e.g.* Lung Box)
- Implant Expendable Point Holder
- Air tight fittings/valves
- Expendable Point Popper
- Plastic or stainless 3-way valves
- Equipment for leak testing
- ⅛” -¼“ Tubing (Teflon, Nylon or PEEK)
- 20/40 grade sand
- Implants (stainless steel aluminum, ceramic, or plastic)
- Funnel
- Vacuum canisters (*e.g.* Summa®)
- 60cc Syringe
- Multi-gas meter

Equipment Clean-Up:

- Decontamination Supplies
- Various Brushes
- Pressurized Sprayer
- Polyethylene Sheeting
- Non-phosphate Soap
- Tap & ASTM Water
- Wash Tubs/Buckets

4.0 Summary of Probe Installation Methods

4.1 Post-Run Tubing System

This is a temporary, single use application for collecting a grab soil gas sample. Using the post-run tubing system (PRT), probe rods are driven to the desired depth, and then internal tubing is inserted and sealed for soil gas sampling. Using the inner tubing for soil gas collection has many advantages - potential for leakage is reduced, dead air volume that must be purged is reduced, and decontamination problems are reduced as the sample does not contact the rod bore.

4.1.1 Clean all parts prior to use. Inspect all probe rods and clear them of obstructions. Install O-rings on the PRT expendable point holder and the PRT adapter.

4.1.2 Test fit the adapter with the PRT fitting on the expendable point holder to assure that the threads are compatible and fit together smoothly.

NOTE: PRT fittings are left-hand threaded and must be rotated counter-clockwise to engage the point holder threads.

4.1.3 Push the PRT adapter into the end of the selected tubing. Tape may be used on the outside of the adapter and tubing to prevent the tubing from spinning freely around the adapter during connection - especially when using Teflon tubing.

REMEMBER: The sample will not come into contact with the outside of the tubing or adapter.

4.1.4 Attach the PRT expendable point holder (with O-ring) to the female end of the leading probe rod.

4.1.5 Attach an O-ring to an expendable drive point and insert into the expendable point holder. Attach the drive cap to the male end of the drive rod and position rod under probe.

4.1.6 Drive the PRT rod configuration into the ground, connecting probe rods as necessary to reach the desired depth.

4.1.7 After desired depth has been achieved, disengage the expendable drive point. Using the inner rods, insert the expendable point popper to the bottom of the rod string and then slowly pull up on the probe rods using the rod grip pull system. Retract the rods approximately 4"- 6" up to create a void from which to sample the soil gas. Position the probe unit to allow room to work around the sample location.

4.1.8 Insert the PRT adapter end of the tubing down the inside diameter of the probe rods.

4.1.9 Feed the tubing down the rod bore until it hits bottom on the expendable point holder. Allow approximately 4-6 ft. of tubing to extend out of the hole before cutting it. Grasp the excess tubing end and apply some downward pressure while turning it in a counter-clockwise motion to engage the adapter threads with the expendable point holder. Continue turning until the PRT adapter O-ring bottoms out in the expendable point holder.

4.1.10 Pull up lightly on the tubing to test the engagement of the threads. Failure of the PRT adapter to thread could mean that intrusion of soil may have occurred during driving of the rods or disengagement of the expendable drive point. At this time, the sample train should be tested for leaks.

4.1.11 Sampling the location can commence following an equilibrium period (minimum of 15 minutes). Connect the sampling tubing and follow appropriate purging and sampling procedures. Refer to Section 5.1 for sampling procedures using the bag sampler.

4.2 Installation of Soil Gas Implants

For long-term soil gas monitoring applications (multiple sampling events from the same location) or when using evacuated canisters, a stainless steel, aluminum, plastic or ceramic implant can be installed at any depth by direct push. Implants are inserted down inside the probe rods when the appropriate sampling depth has been achieved.

4.2.1 Drive probe rods to the desired depth using the implant point holder and an implant anchor point or expendable drive point. If using steel implants that attach (screw-in) to the drive point, DO NOT disengage the drive point when depth of interest has been reached. If using implants which do not need to be attached to the drive point, the drive point may be disengaged using the point popper. Pull the tool string back approximately 1”- 2” to push the expendable point out with the point popper.

4.2.2 Attach appropriate sample tubing (Teflon, nylon, or PEEK). Depending on implant type and diameter of sample tubing, Tygon® tubing of appropriate size may be used to securely connect the implant to the sample tubing. If sample tubing is pre-cut, allow it to be approximately 48 inches longer than required depth of the implant (*e.g.*, if the sampling depth is at 6.5 feet then tubing should be cut at 10.5 feet). Cover or plug the open end of the tubing with a sealed fitting or valve.

4.2.3 Lower the implant and tubing down the inside of the probe rods until the implant hits the top of the anchor/drive point. Note the length of the tubing to assure that proper depth has been reached.

4.2.4 If using attachable steel implants, rotate tubing (and attached steel implant) counter-clockwise while exerting a gentle downward force to engage the implants threads into the threads of the expendable point. Pull up on the tubing lightly to test the connection. DO NOT cut the excess tubing at this time.

4.2.5 Position the rod grip pull system or rod pull plate on the top probe rod. Exert downward pressure on the tubing while slowly pulling the probe rods up. Pull up about 12 inches (or twice the distance of the implant length) to create an annulus for backfilling with sand or rounded glass beads.

4.2.6 If using ¼” O.D. tubing or smaller, thread excess tubing through a funnel and position it over the top of the probe rod. If using larger tubing (*i.e.*, ⅜”), it may not be possible to install the sand since the spacing between the outside of the larger tubing and the probe rods has been reduced and may not allow sand to sufficiently flow to the bottom of the tool string. Bridging of the sand is most likely to occur in this scenario.

4.2.7 Pour sand down the inside diameter of the probe rods around the outside of the tubing so that the sand extends several inches above the implant. Use the tubing to “stir” the sands into place around the implant. Do not lift up on the tubing. It should take less than 150 mL of sand to fill the space around the implant. The sand therefore will act as a grout barrier, inhibiting the grout from impacting the implant.

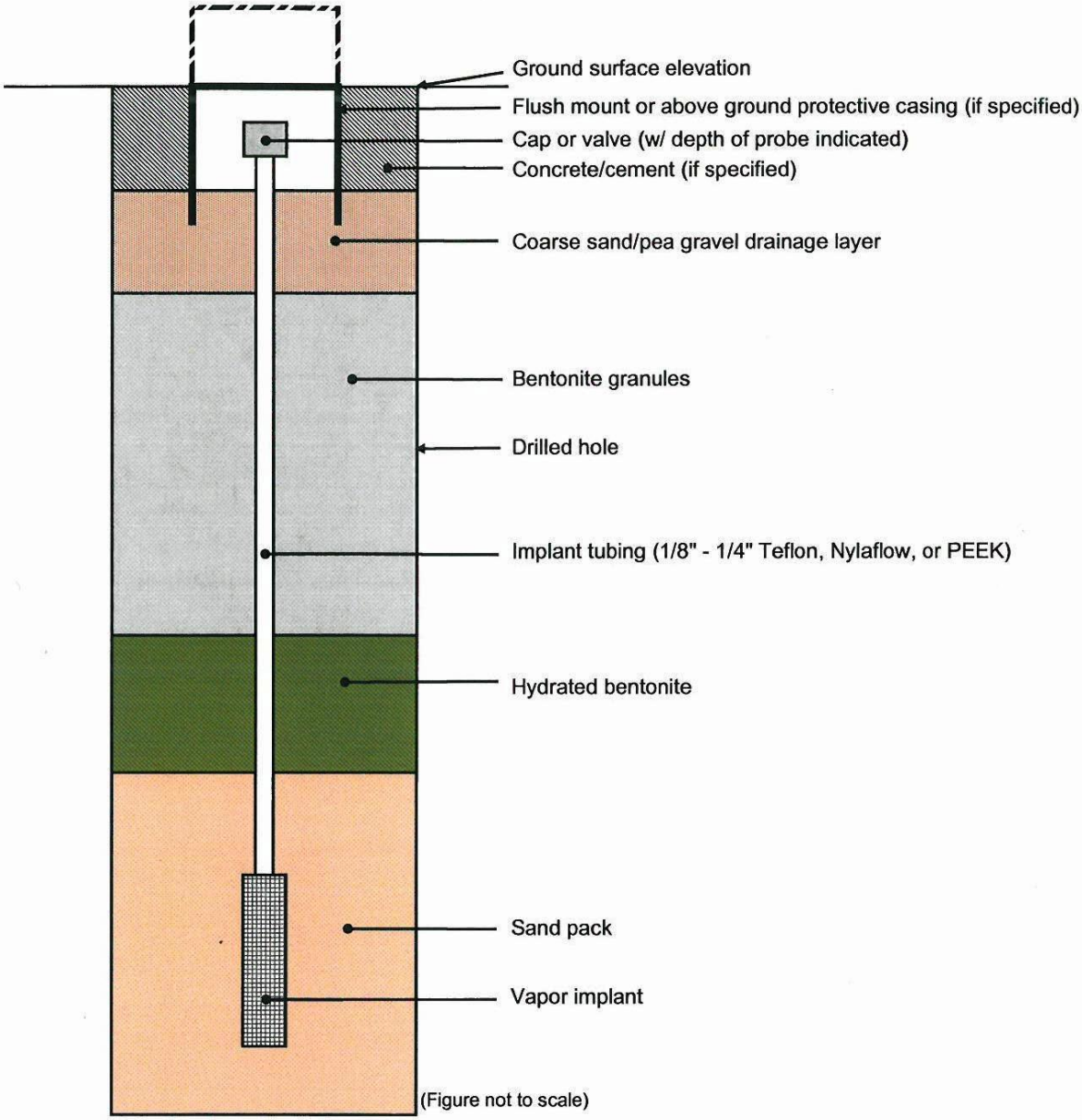
NOTE: Implants come in various sizes and the drive rods can vary in diameter, so it is best to calculate the necessary volume of sand for each implant installation. Placement of the grout barrier by backfilling through the rods with sand can only be performed in the vadose zone, not below the water table.

4.2.8 Lift the probe rods up an additional 18-24 inches and pour the bentonite granules granules into place as in Step 4.2.7. The volume to be filled is about 154 mL per foot. It may be necessary to “chase” the seal mixture with distilled water to initiate a seal. This results in a tight seal preventing gas migration down the column.

4.2.9 After the probe rods have been removed, cut the tubing to a manageable length, attach a 3-way valve connector or air tight (*e.g.* Swagelok®) plug, and mark the location with a pin flag or stake. Attach a piece of tape to the tubing indicating the depth at which the implant was set for future reference when sampling. At this time, the sample train should be tested for leaks.

4.2.10 A minimum equilibrium time should be established to prior to sampling the implant. While a 24-hour equilibrium period will ensure adequate equilibration, three to four hours is generally sufficient. After equilibration, the implant is ready for sampling. Refer to Section 5.0 for sampling procedures using the bag sampler (*e.g.* Lung Box) or vacuum canister (*e.g.* Summa® or Silco).

4.2.12 To provide long term security to the sampling port, the installation of a riser pipe protector with cap can be installed and finished with a concrete pad. If desired, less secure finishing of a sampling port can be completed using 2”-4” (ID) PVC pipe sections with associated caps.



Example of a Soil Gas Implant

5.0 Sample Collection Methods

Four common methods of sample collection for COCs are discussed in this SOP. Two of the methods use Tedlar bags as sample containers while the third method uses evacuated canisters and the last method adsorbents. DQOs for the project should determine which sample collection method is used.

5.1 The Lung Box Sampler (Bag Samplers)

The Lung Box allows direct filling of a Tedlar® air sample bag using negative pressure without passing gas through the pump. This eliminates the risk of contaminating the pump or the sample. The Lung Box pictured below includes an in-line pump. Other types of bag samplers may require the use of a separate air pump or hand pump.

Semi-permanent soil gas probe location with multi-depth implants. The blue bag sampler is used to collect soil gas samples using 1-liter Tedlar bags. Note that each tube is labeled with the sampling depth; the PVC pipe is used to protect the soil gas tubing.

5.1.1.1 Prior to sampling, and after an appropriate equilibrium period, ambient air needs to be removed from the sample train by purging. Purging of the filter pack is required if sampling occurs within 24 hours of installation. At least three volumes should be removed. For example, the sample tubing can be purged using a 60 cc syringe with an attached 3-way valve (~4 cc/ft for ¼" ID tubing/volume). Other methods may be used as long as a minimum of 3 volumes are purged from the tubing. Once purging is complete, the sample may be collected. Field screening may be performed using a direct reading instrument.

5.1.1.2 Install new tubing in the bag sampler before collecting each sample. Place a new Tedlar sample bag (already labeled) inside the bag sampler. Attach the inside portion of the tubing to the inlet valve on the sample bag. Open the sample valve on the sample bag following the manufacturer's instructions. Close sampler lid and secure.

5.1.1.3 Attach external part of the inlet tubing to the sample tubing. Make sure that the purge valve is closed (closed for fastest fill rate, open for slower fill rate).

5.1.1.4 Turn on the sample pump or initiate hand pumping. While filling, watch through the observation window of the Bag sampler as the Tedlar® bag fills with gas. Avoid filling bag more than 80% of its maximum volume. Turn the pump off when the bag has filled to the desired volume. Do not over fill sample bags. The vacuum pump may be strong enough to break a sample bag.

NOTE: Be sure to watch the sample line for the first sign of water coming up the line. Pulling water up the line is not uncommon, especially in cases where the position of the water table is unknown. This is a good reason why ample lengths of tubing should be used for the sample line. If water is drawn up the tubing, the tubing can be cut before the water reaches the sampling equipment.

NOTE: Exercise extreme caution if filling sample bags with explosive gases.

5.1.1.5 Once filling of the sample bag is complete, turn off the pump, open the purge valve to equalize the pressures, unlatch the bag sampler lid and open. Close the sample bag inlet valve by holding the side stem and turning the entire upper portion of the fitting clockwise until snug. Remove the filled sample bag from the internal inlet tubing.

5.1.1.6 If measurements with a portable meter are to be made (*e.g.*, oxygen), conduct measurements after collecting the soil gas sample(s).

5.2 Peristaltic Pump

5.2.1 Connect the Teflon sample tubing to the peristaltic pump tubing. The exact tubing connection method is up to the sampler. However, ensure that all connections are secure (without leaks). Use hose clamps to secure tubing if needed or desired.

5.2.2 Turn on the peristaltic pump and set the pumping rate such that the Tedlar bag fills at approximately one minute (1 liter/min pump rate).

5.2.3 Once the gas sample is collected, turn off the pump, close the valve on the bag and then detach the bag from the tubing.

5.2.4 Complete the Sample Data Sheet with all applicable information.

5.3 Evacuated Canister

5.3.1 Follow the procedures described in Ohio EPA DERR SOP #2.5.3

5.4 Collection of Samples on Adsorbents

5.4.1 An alternative approach to collecting soil gas in a sample container is to concentrate the soil gas on an adsorbent. This type of method is required for SVOCs and is often used for mercury (generally compounds heavier than naphthalene). Typically, a pump is used to draw soil gas through the

adsorbents, and the adsorbent is then analyzed by a laboratory. A variety of adsorbent cartridges and pumping systems are available from commercial vendors. In addition, it is essential that the soil gas be drawn through the adsorbent by the pump, not pumped through the adsorbent to eliminate the chance for cross-contamination by the pump. It is often recommended that two tubes be used in series to avoid breakthrough losses in areas of suspected higher concentrations. The adsorbent, purge rate, and sample volume must be determined by discussion with the analytical laboratory.

SOP # 2.5.2 - Construction and Installation of Permanent Subslab Soil Gas Ports

1.0 Scope and Application

This standard operating procedure (SOP) outlines the procedure used for the construction and installation of permanent subslab soil gas ports. The ports are used to sample gas beneath the floor slab of dwellings and other structures.

2.0 Method Summary

Using an electric hammer drill or rotary hammer, an inner or pilot hole is drilled into the concrete slab to a depth of approximately 2" with the ⅜" diameter drill bit. Using the pilot hole as the center, an outer hole is drilled to an approximate depth of 1⅜" using the 1" diameter drill bit. The 1" diameter drill bit is then replaced with the ⅜" diameter drill bit. The pilot hole is then drilled through the slab and several inches into the subslab material. Once drilling is completed, a stainless steel probe is assembled and inserted into the pre-drilled hole. The probe is mounted as flush as possible with the surrounding slab so it will not interfere with pedestrian or vehicular traffic and cemented into place. A length of Teflon® tubing is attached to the probe assembly and to a sample container or system.

3.0 Sample Preservation, Containers, Handling and Storage

3.1 SUMMA® Canister Sampling

After the subslab soil gas sample is collected, the canister valve is closed, an identification tag is attached to the canister and the canister is transported to a laboratory under chain of custody for analysis. Upon receipt at the laboratory, the data documented on the canister tag is recorded. Sample holding times are compound dependent, consult with the laboratory for holding times. Refer to Ohio EPA SOP # 2.5.3 for details on sampling using a Summa Canister.

3.2 Tedlar® Bag Sampling

Tedlar® bags most commonly used for sampling gas have a 1-liter volume capacity. Typically, Tedlar® bags are filled using a lung box. After sampling, the Tedlar® bags are stored in a clean cooler (without ice), a cardboard box or an opaque plastic bag at ambient temperature to prevent photodegradation. It is essential that sample analysis be undertaken within 24 to 48 hours following sample collection since VOC's may escape or become altered. Refer to Ohio EPA SOP # 2.5.1, Section 5.1.1, "Sample Preparation and Collection using a Lung Box" for more details.

4.0 Interferences and Potential Problems

The thickness of a concrete slab will vary from structure to structure. A structure may also have a single slab where the thickness varies. A slab may contain steel reinforcement (*e.g.*, rebar). Drill bits of various sizes and cutting ability may be required to penetrate slabs of varying thicknesses or those that are steel reinforced. Ensure that all subslab utilities (public and building specific) have been located and marked prior to installation.

5.0 Equipment/Apparatus

- Hammer drill or Rotary Hammer
- Alternating current (AC) extension cord
- AC generator, if AC power is not available on site
- Hammer or Rotary Hammer drill bit, ⅜" diameter
- Hammer or Rotary Hammer drill bit, 1" diameter
- Portable vacuum cleaner
- 1 – ¾" open end wrench or 1 – medium adjustable wrench
- 2 – $^{9}/_{16}$" open end wrench or 2 – small adjustable wrenches
- Hex head wrench, ¼"
- Tubing or pipe cutter
- Disposable cups, 5 ounce (oz.)
- Disposable mixing implement (*i.e.,* popsicle stick, tongue depressor, etc.)
- Swagelok® SS-400-7-4 Female Connector, ¼" National Pipe Thread (NPT) to ¼" Swagelok® connector
- Swagelok® SS-400-1-4 Male Connector, ¼" NPT to ¼" Swagelok® connector
- Hose barb adapter, brass, 3/16" barb x ¼" MIP (Male Iron Pipe)
- ¼" NPT flush mount hex socket plug
- ¼" outer diameter (OD) stainless steel tubing, pre-cleaned, instrument grade
- Teflon washer ID ¼", OD ¾"
- ¼" OD Teflon® tubing
- Teflon® thread tape
- ⅛" OD stainless steel rod, 12" to 24" length
- Swagelok® Tee, optional (SS-400-3-4TMT or SS-400-3-4TTM)

6.0 Reagents

- Anchoring cement/grout – quick-setting, contaminant free
- Tap water, for mixing anchoring cement/grout

7.0 Procedures

7.1 Probe Assembly and Installation

7.1.1 Drill a ⅜" diameter pilot hole approximately 2 inches in depth (**Figure 1** in the attached schematic drawings).

7.1.2 Using the ⅜" pilot hole as your center, drill a 1" diameter outer hole to a depth of approximately 1 ⅜". Vacuum any cuttings out of the hole (**Figure 2**).

7.1.3 Continue drilling the ⅜" inner or pilot hole through the slab and a few inches into the subslab material (**Figure 3**). While drilling, carefully vacuum out any cuttings from the outer hole. (Note: if area highly contaminated with volatiles, volatiles may be drawn into the building, use caution).

7.1.4 Determine the length of stainless steel tubing required to reach from the bottom of the outer hole, through the slab and into the open cavity below the slab. To avoid obstruction of the probe tube, ensure that it does not contact the subslab material. Using a tube cutter, cut the tubing to the desired length.

7.1.5 Attach a measured length (typically 3"-4") of ¼" OD stainless tubing to the female connector (SS-400-7-4) with the Swagelok® nut. Make sure that the tubing rests firmly in the fitting body and that the nut is finger tight. While holding the fitting body firmly, tighten the nut 1¼ turns.

7.1.6 Insert the ¼" hex socket plug into the female connector. If using a stainless steel socket plug, wrap one layer of Teflon® thread tape around the threads to prevent binding. If using a brass socket plug, no Teflon® tape is needed. Tighten the plug slightly. Do not over tighten. If excessive force is required to remove the plug during the sample set up phase, the probe may break loose from the anchoring cement.

Assembled subslab port ready for installation

7.1.7 Place the completed probe into the outer hole to check fit and to ensure that stainless steel tubing is not in contact with the subslab material. Make necessary adjustments to the hole or probe assembly.

7.1.8 In a disposable cup or other container, mix a small amount of the anchoring cement or grout. Add water sparingly to create a mixture that is fairly stiff and moldable. Place a spoonful or two of the cement/grout around the stainless steel tubing adjacent to the female connector nut. Mold the cement/grout into a mass around the connector nut and up around the main body of the probe assembly. Slide the Teflon washer onto the stainless steel tube so that it rests next to the cement/grout mixture. The washer will prevent any anchoring cement/grout from flowing into the inner hole during the final step of probe installation.

7.1.9 Carefully place the probe assembly into the drilled hole, applying light pressure to seat the assembly. While inserting the probe assembly, work the concrete/grout mixture to fill voids. Clean up cement/grout that discharged out of the hole during placement; avoid getting any of the concrete/grout into fittings or on fitting threads. Allow the cement/grout to cure according to manufacturer's instructions before sampling (**Figure 4**).

7.2 Sampling Set-Up

7.2.1 Wrap one layer of Teflon® thread tape onto the NPT end of the male connector, OR wrap one layer of Teflon® tape onto the threaded end of the hose barb adapter (3/16" barb x ¼" MIP).

7.2.2 Carefully remove the ¼" hex socket plug from the female connector. Refer to Section 7.3 if the probe breaks loose from the anchoring cement/grout during this step.

7.2.3 To ensure that the subslab port has not been blocked by the collapse of the inner hole below the end of the stainless steel tubing, a stainless steel rod, ⅛" diameter, may be passed through the female connector and the stainless steel tubing. The rod should pas freely to a depth greater than the length of the stainless steel tubing, indicating an open space or loosely packed soil below the end of the stainless steel tubing. Either condition should allow a soil gas sample to be collected. If the port appears blocked, the stainless steel rod may be used as a ramrod in an attempt to open the well. If the well cannot be opened, the probe should be reinstalled or a new probe installed in an alternate location.

7.2.4 Screw and tighten the Teflon® taped male connector into the female connector, OR screw and tighten the hose barb adapter (3/16" barb x ¼" MIP) into the female connector. Do not over tighten. This may cause the probe assembly to break loose from the anchoring cement/grout during this step or when the male connector/hose barb adapter is removed upon completion of the sampling event (**Figure 5**). Refer to Section 7.3 if the probe breaks loose from the anchoring compound during this step.

7.2.5 If a co-located subslab soil gas sample or split sample is desired, a stainless steel Swagelok® tee, may be used in place of the male connector (**Figure 6**).

7.2.6 Attach a length of ¼" Teflon® tubing to the sampling container (*e.g.*, SUMMA canister) or system (*e.g.*, lung box for Tedlar® bag) to be used for sample collection. Connect the other end of the Teflon® tubing to the male connector with a Swagelok® nut, or connect to the barbed hose adapter.

SUMMA canister connected to port and ready for sampling

7.2.7 After sample collection, remove the male connector or barbed hose adapter from the probe assembly and reinstall the ¼" hex socket plug. Do not over tighten the hex socket plug. If excessive force is required to remove the plug during the next sampling event, the probe may break loose from the anchoring compound. Refer to Section 7.3 if the probe breaks loose from the anchoring compound during this step.

7.3 Repairing a Loose Probe Assembly

7.3.1 If the probe assembly breaks loose from the anchoring compound while removing or installing the hex socket plug, the Swagelok® male connector, or the barbed hose adapter, lift the probe assembly slightly above the surface of the concrete slab.

7.3.2 Hold the female connector with the ¾" open end wrench.

7.3.3 Complete the step being taken during which the probe broke loose, following the instructions contained in this SOP (*i.e.,* Do not over tighten the hex socket plug, the male connector, or the barbed hose adapter).

7.3.4 Push the probe assembly back down into place and reapply the anchoring cement/grout.

7.3.5 Modeling clay (verified to be VOC free) may be used as a temporary patch to achieve a seal around the probe assembly until the anchoring cement/grout can be reapplied.

8.0 Quality Assurance/Quality Control

An additional co-located soil gas port is installed at a frequency of 10% (1 in 10) or as specified in the site-specific Quality Assurance Project Plan (QAPP). The following general Quality Assurance (QA) procedures apply:

8.1 A rough sketch of the area is drawn where the ports are installed, with the major areas noted on the sketch.

8.2 A global positioning system (GPS) unit may be used to document coordinates outside of a structure as a reference point.

8.3 Equipment used for the installation of sampling ports should be cleaned by heating, inspected and tested prior to deployment.

9.0 Health & Safety

When working with potentially hazardous materials, follow site specific health and safety procedures. All site activities should be documented in the site-specific Health and Safety Plan (HASP).

FIGURE 1

INNER or PILOT HOLE

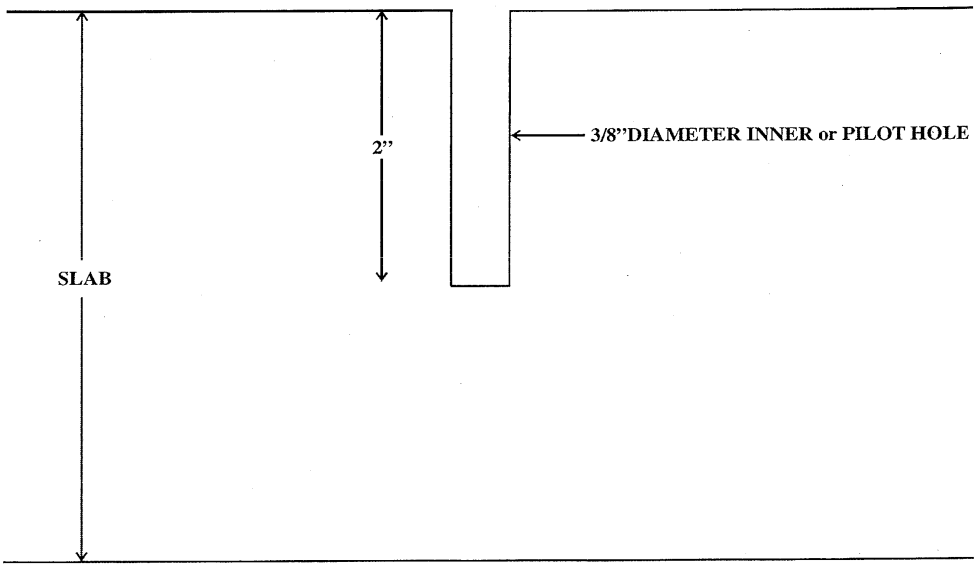
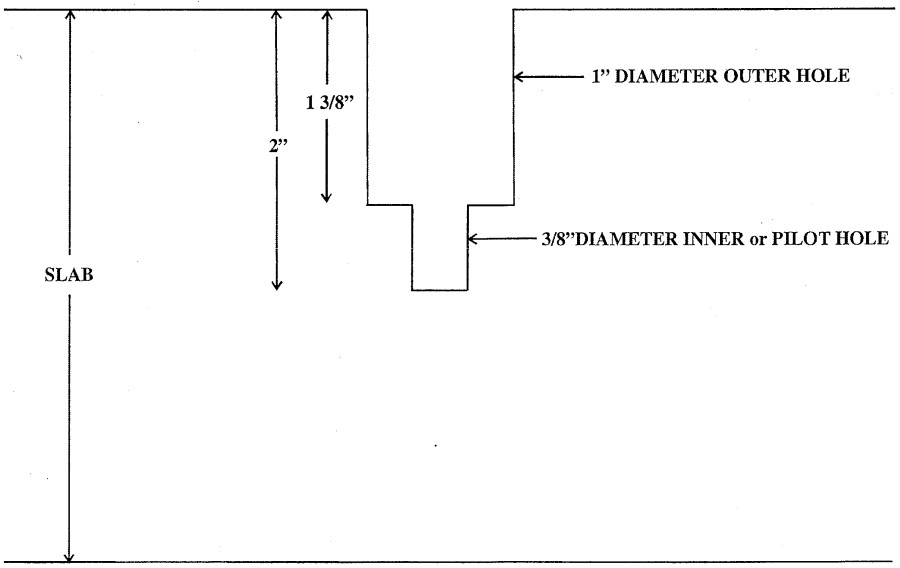


FIGURE 2

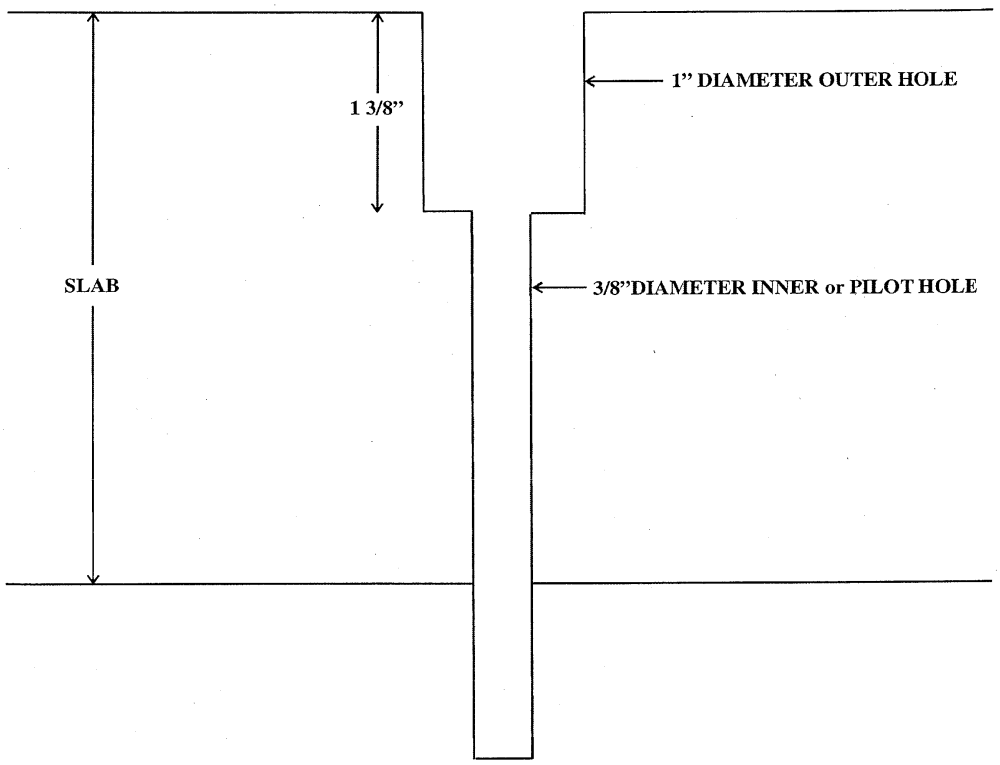
OUTER HOLE



CONSTRUCTION AND INSTALLATION OF PERMANENT SUB-SLAB SOIL GAS WELLS

FIGURE 3

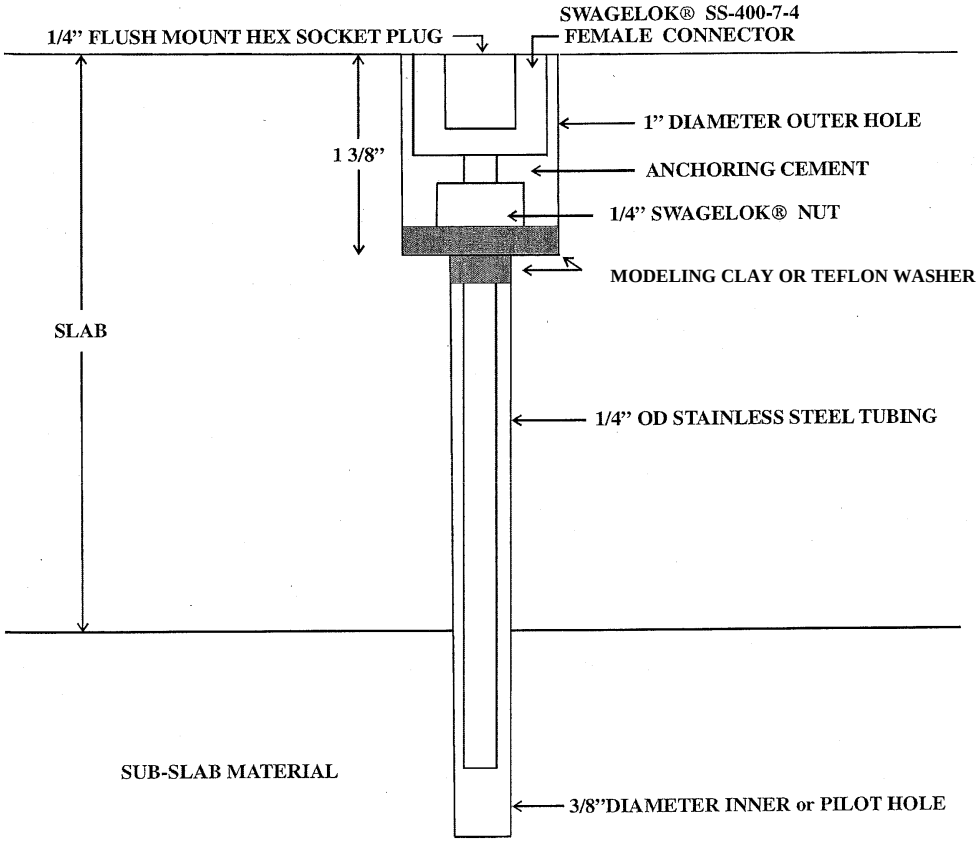
COMPLETED HOLE PRIOR to PROBE INSTALLATION



CONSTRUCTION AND INSTALLATION OF PERMANENT SUB-SLAB SOIL GAS WELLS

FIGURE 4

SOIL GAS PROBE INSTALLED



CONSTRUCTION AND INSTALLATION OF PERMANENT SUB-SLAB SOIL GAS WELLS

FIGURE 5

SOIL GAS PROBE PREPARED FOR SAMPLING

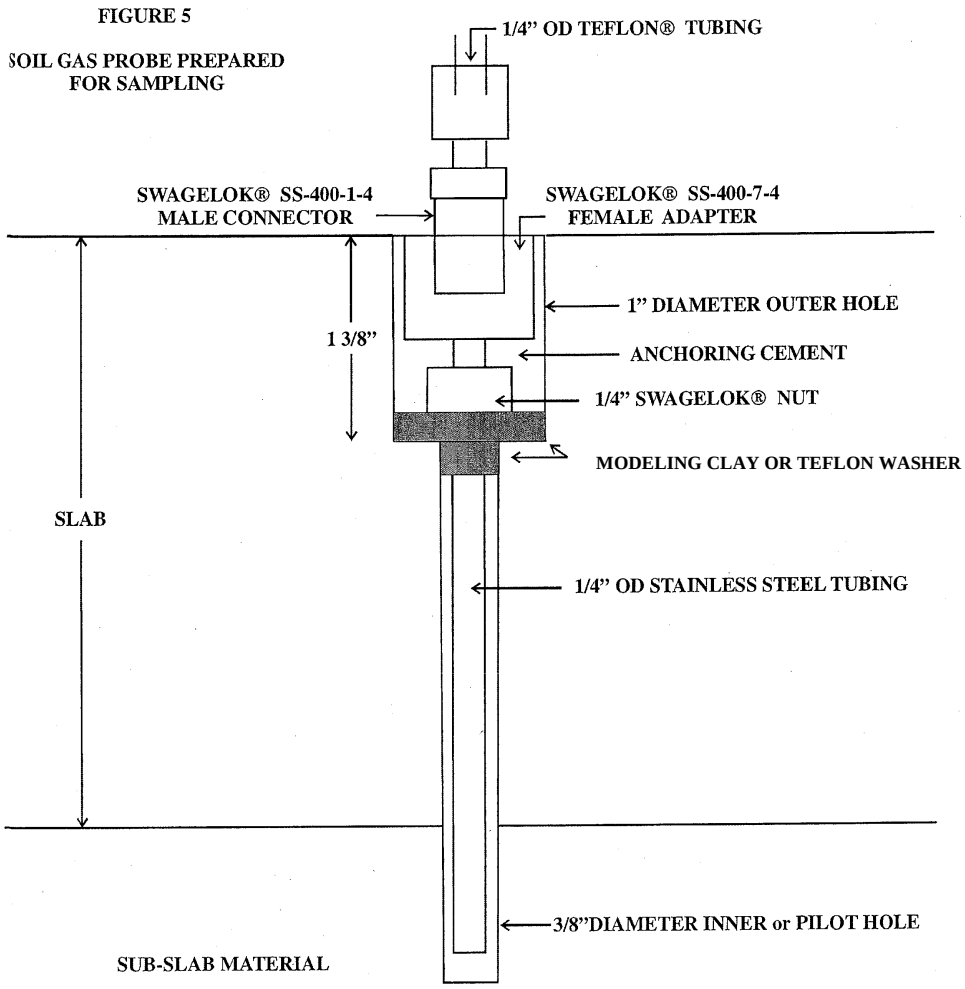
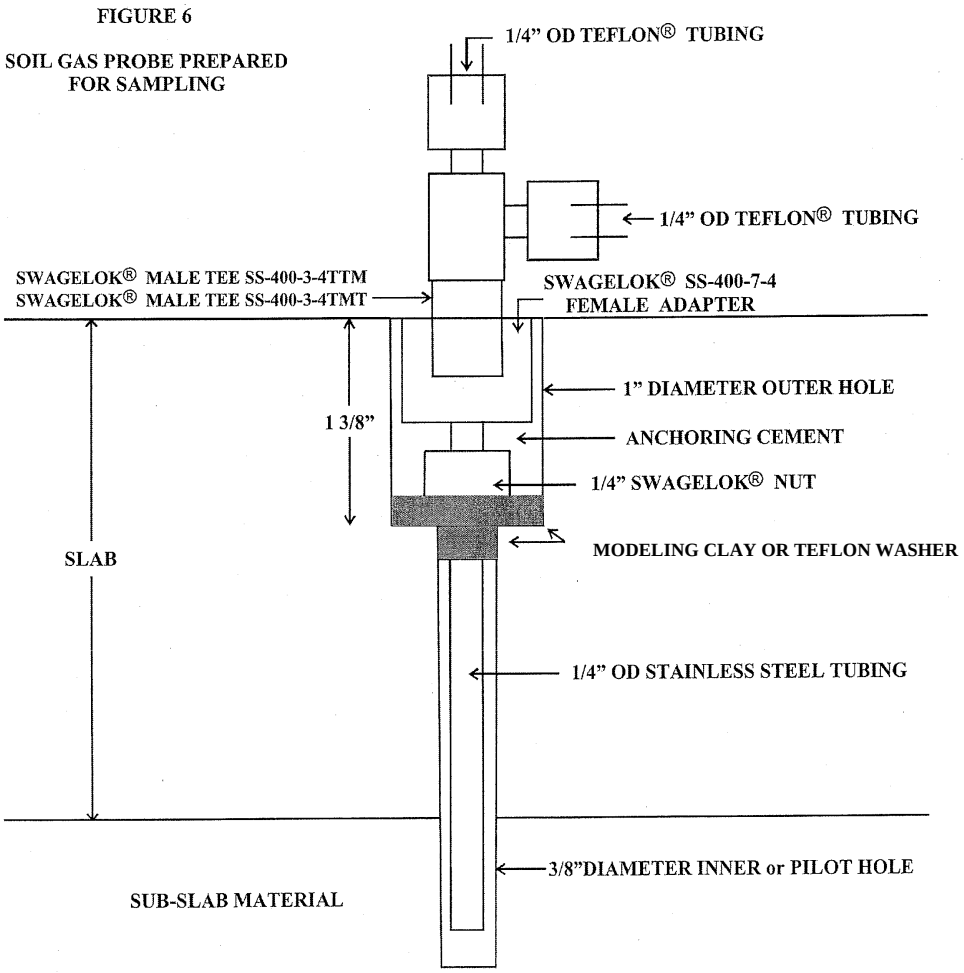


FIGURE 6

SOIL GAS PROBE PREPARED
FOR SAMPLING



SOP 2.5.3 - Procedures for Collection of Indoor Air

1.0 Scope and Application

This standard operating procedure (SOP) describes the procedures used for the collection of ambient and indoor air vapor samples. Indoor air samples are collected from predetermined locations within buildings and structures and are typically analyzed for volatile organic compounds (VOCs) using U.S. Environmental Protection Agency Method TO-15. Ambient air samples are collected at the same time, and for the approximate same duration, as the indoor air sample(s).

2.0 Method Summary

This method uses an evacuated 6-liter SUMMA® passivated stainless-steel canister for sample collection. A flow regulator with vacuum gauge is attached to the canister in order to collect a volume of sample over a pre-determined time span. Location(s) for the placement of the canisters within the building(s) or structure(s) are also pre-determined in order to focus sampling efforts on potential receptors within the building(s)/structure(s). The outdoor, ambient sample must be collected at approximately the same time and for the same time interval as the indoor air samples (see section 8.0). Oral interviews and a written questionnaire for building inhabitants are required prior to the sampling event (this step is necessary to reduce and/or eliminate the impact of inhabitant activities on the analytical results – see Indoor Air Sampling Form). Once the flow regulator is attached to the canister, the valve on the regulator is opened. Notes are made regarding the project, building, location (address of building and placement of canisters), canister ID number, flow regulator ID number, sample start time, canister pressure (inches of Hg), and the samplers performing the sampling event (see Attachment 2 “Canister Sampling Data Sheet”).

Ambient air sample locations should be in an area that has unobstructed airflow, especially in the direction of any recognized sources of the materials being sampled. Locations should be avoided that will potentially have a negative effect on the sample collection activities. Additionally, avoid locations where reactive surfaces may cause chemical changes in the air sampled, directly above contaminated soil, or locations what may influence the ability to collect a representative sample (such as nearby hills, structures, bodies of water, etc.).

Intake probes for the ambient air sample(s) should be placed at a representative height, such as breathing zone height, or between 6 to 8 feet (3 to 15 meters) above the ground. Locations near the structures should extend at least 3 to 4 feet (1 to 2 meters) away from the structure. If located on a building, the sample equipment should be mounted on the windward side. Additional considerations

for the collection of ambient air sample(s) are located in section 8.0.

Sample collection times may vary depending on the scope of the project. It is important to return to the sample location at least 30 to 60 minutes prior to the end of the sample collection time. Sampling stops when the flow regulator valve is turned off. Final notes are made regarding the sample stop time and final vacuum pressure.

3.0 Sample Preservation, Containers, Handling and Storage

3.1 SUMMA® Canister Sampling

After the indoor air/soil gas sample is collected, the canister valve is closed, an identification tag is attached to the canister and the canister is transported to a laboratory under chain of custody for analysis. Upon receipt at the laboratory, the data documented on the canister tag is recorded. Sample holding times are compound dependent, consult with the laboratory for holding times.

4.0 Interferences and Potential Problems

Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

Care should be taken to ensure that the flow regulator is pre-calibrated to the proper sample collection time (confirm with laboratory). Correctly connecting the flow regulator to the sample canister is vital to eliminate the potential for leaks. Sample integrity is maintained if the sampling time is slightly shorter than the planned sampling time. In other words, if the SUMMA® canister is allowed to completely fill such that there is no pressure/vacuum left in the canister then it may be very difficult for the laboratory technician to extract a sample aliquot for analysis. Sample integrity can also be compromised if the sample event is extended to a point where the canister reaches atmospheric pressure.

Certain activities within the building(s)/structure(s) can interfere with the collection of a representative indoor air sample. For example, storage of paints, varnish, adhesives, gasoline, and/or oils may create false-positive results during sample collection. Smoking, certain hobbies, and/or equipment maintenance are examples of activities which may impact the ability to collect a representative sample. Conducting a pre-sampling on-site survey and completing a written questionnaire is important to address such potential inferences.

Ambient air sample location(s) should be pre-selected with the aforementioned site selection criteria taken into consideration.

5.0 Equipment/Apparatus

- Stainless steel SUMMA® canister(s) (request at least one additional canister as a backup, if possible and make sure that the canisters are labeled with the decontamination information);
- Appropriate flow regulator (properly calibrated for the specified sample collection duration *e.g.*, 30 minutes, 8 hours, 24 hours) with in-line particulate filters and vacuum gauges (request at least one additional gauge, if possible).
- Appropriately-sized open-end wrench, typically 9/16-inch (may want two wrenches so that you can tighten the fitting in two directions at the same time);
- Copy of building survey and resident questionnaire(s);
- PID;
- Sample collection log (Canister Sampling Data Sheet);
- Chain-of-custody (COC) form;
- Field notebook;
- Digital camera.

6.0 Reagents

- N/A

6.0 Reagents

- N/A

7.0 Procedures

7.1 Sample Location Determination

7.1.1 Indoor Air - conduct a building/structure survey **(Appendix F)** to determine potential target receptors and identify potential interferences to sample collection. A pre-sampling inhabitant/worker questionnaire should also be completed at this time. It is important to recognize and eliminate potential interferences to the sample collection process. This should be done at least 48 to 72 hours prior to sample collection.

Ambient Air – survey the exterior area outside the structure and/or equipment. Sample location should be on the windward side of the structure with the intake probe set to an appropriate, representative height and without the potential for interference and/or biased by vapor flux from contaminated soil surface(s).

Discretion to avoid potential equipment theft or vandalism should also be taken into consideration when determining sample location/placement.

7.1.2 Sample canisters should be placed at appropriate breathing-zone heights

7.1.3 Special consideration must be given to dirt basements and crawl spaces within the structures.

7.1.4 Indoor Air sampling should be conducted in the lowest indoor areas or areas that are likely to capture highest concentrations.

7.2 Sampling Set-Up

7.2.1 Document appropriate information on field log sheet ("Canister Sampling Data Sheet").

7.2.2 Remove brass plug from the SUMMA® canister and connect the flow regulator with in-line particulate filter and vacuum gauge to the SUMMA® canister. Use the open-end 9/16" wrench to gently tighten the connection between the flow regulator and the canister. Do not over-tighten this connection. Do not open the valve on the SUMMA® canister (if one is present). Record both the SUMMA® canister number and the flow regulator number on the "Canister Sampling Data Sheet". The canister number can be used for sample identification on the COC form (refer to Attachment 1 "Sampling Instructions for Canisters with Pneumatic Flow Controllers")

7.2.3 Open the canister/regulator valve. Record the sample start time and the canister pressure.

7.2.4 Take a photograph of the canister and surrounding area.

7.3 Termination of Sample Collection

7.3.1 Arrive at the sample location approximately 10 to 15 minutes prior to the end of the sampling interval. An examination of the flow regulator should show a slight vacuum left on the gauge (preferably between 2 to 10 inches of Hg on the regulator flow dial). Document this final vacuum pressure and stop sample collection by closing the flow regulator valve.

SUMMA® canister with flow regulator attached and placed at appropriate breathing zone height - ready for sampling.

7.3.2 Complete the documentation by recording the stop time on the Canister Sampling Data Sheet as well as any additional field logs.

7.3.3 Remove the flow regulator from the SUMMA® canister using the 9/16 open-end wrench. Place the flow regulator into the proper shipping container provided by the lab. Re-install the brass plug on the canister fitting, and tighten with the open-ended wrench.

7.3.4 Package the canister and the flow regulator into the shipping container provided by the lab. Note: the SUMMA® canister does not require preservation.

7.3.5 Complete the appropriate forms and sample labels as directed by the laboratory. Use the sample start time when completing the laboratory COC and double check canister identification numbers for accuracy.

7.3.6 Ship the canisters to the laboratory for analysis.

8.0 Quality Assurance/Quality Control

Most ambient and indoor air sample analysis will be performed using U.S. EPA TO-15 methodology. Canisters used for sample collection are typically 6-liters and thoroughly cleaned by the laboratory prior to use. Flow regulators will also be thoroughly cleaned by the laboratory. An additional co-located indoor air sample is recommended at a frequency of 10% (1 in 10) or as specified in the site-specific Quality Assurance Project Plan (QAPP). The outdoor, ambient sample must be collected at approximately the same time and for the same time interval as the indoor air samples. The following general Quality Assurance (QA) procedures apply:

8.1 A rough sketch of the area is drawn where the samples are collected, with the major areas noted on the sketch.

8.2 A global positioning system (GPS) unit may be used to document coordinates outside of a structure as a reference point.

8.3 Proper completion of associated data sheets, log books and COC is vital to the overall success of the sampling effort.

8.4 Photographs showing proper function of the flow regulators at the start and end of the sample time period are recommended. Additional photos of the surrounding area where the samplers are placed are also recommended.

9.0 Health & Safety

When working with potentially hazardous materials, follow site specific health and safety procedures. All site activities should be documented in the site-specific Health and Safety Plan (HASP).

Attachment 1
for DERR SOP 2.5.3

Sampling Instructions for Canisters With Pneumatic Flow Controllers

1. Inspect your canister shipment once received from the lab and/or equipment provider. Compare contents with the packing slip and notify the lab/supplier of any discrepancy or damage.

2. Familiarize yourself with the diagram located on this page and the equipment you received for sampling. The flow controller/regulator will be set for the appropriate sampling rate in the lab and should not require adjustment.

3. Remove the brass caps from the flow controller/regulator and canister. Connect the flow controller to the canister by inserting the "canister connection" into the "canister inlet" and hand tighten the Swagelok® nut being careful not to cross the threads. Using two open end wrenches (1/2" & 9/16") tighten the nut no more than 1/8 turn past finger tight. DO NOT use adjustable wrenches or pliers.

4. The fittings are swage lock compression fittings. Do not use Teflon tape or other sealants, they are not necessary. DO NOT over-tighten any connection. Over-tightening may potentially cause leaks.

5. The canister and controller are now ready for sampling. If you intend to sample a source location, you will need to attach a sampling line. This should be ¼" outer diameter tubing (virgin Teflon® recommended) or cleaned stainless steel.

6. If possible, coordinate with the lab to supply a Swagelok® nut and set of nylon ferrules for connecting line. Slide the nut, the back ferrule, then the front ferrule onto the tubing. Insert the tubing into the sample inlet and slide the ferrules into the fitting. Secure the nut being careful not to cross the threads. Note: when using nylon ferrules, a snug finger-tight should be sufficient for a leak-free connection.

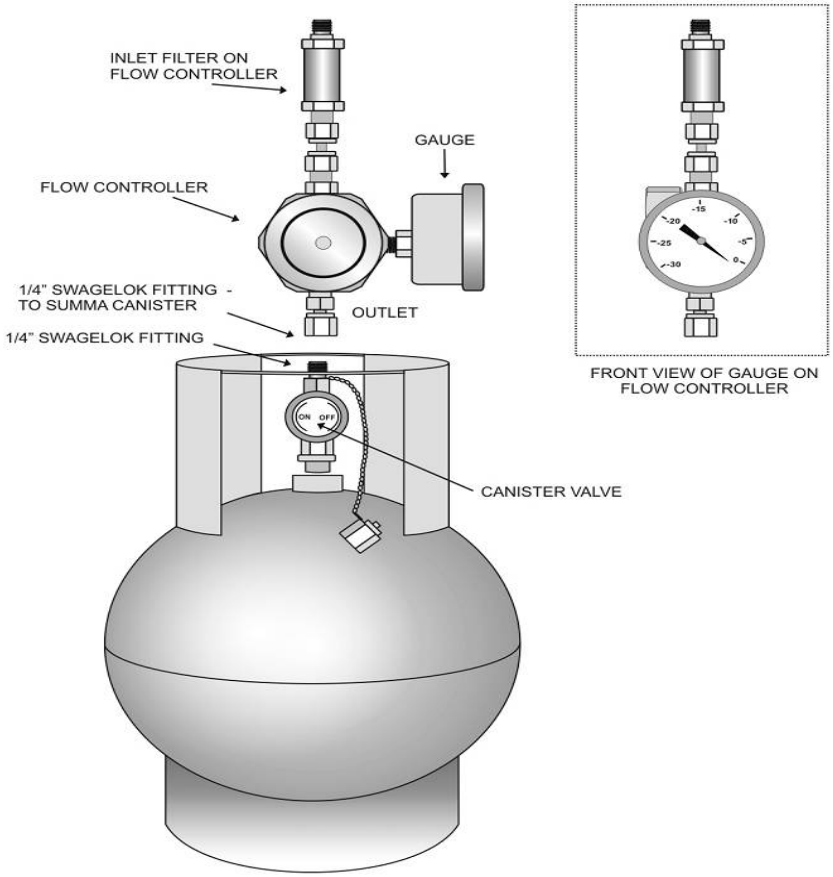
7. To begin sampling, open the canister valve by turning counter-clockwise. One full turn is sufficient. Observe and note the vacuum gauge reading on your field log form. Take photos of the sample location and close-up of the properly functioning sampling equipment.

8. Observe the decline in the vacuum to gauge the sampling rate. This is especially significant for grab samples. In a one hour sample duration the gauge should drop in vacuum at a rate of 0.5" Hg per minute (*i.e.* 30"/60 min). Note that is condition is a rough estimate and may not necessarily be reflective of your particular equipment. Sampling rate(s) are established before sampling and are set by the laboratory supplying the equipment. Contact the lab immediately for assistance if your equipment demonstrates any malfunctioning. As a consequence for the potential for a malfunction, it is advisable to request one or two back-up/additional canisters and flow regulators when coordinating with the lab.

9. After sampling is complete, note the time and final vacuum gauge reading on your field log sheet. Close the canister valve by turning clockwise until finger tight. DO NOT over-tighten as this will damage the valve. .

10. Disassemble the components in reverse order of the above assembly instructions. Return all components to the original shipping containers and package them as received. Verify that all parts are packed for return by referencing the packing slip.

11. Review and complete the field sampling log form. Complete the appropriate Chain-of-Custody record (as supplied to you by the lab) and return the sample to the laboratory for analysis.



Schematic of Summa Canister

Attachment 2
For DERR SOP 2.5.3

CANISTER SAMPLING DATA SHEET

OPERATOR (print): _____

GENERAL INFORMATION

Site Location: _____
Site Address: _____
_____
City: _____
County: _____
LAT: _____ LONG: _____
UTM: ↑Northing↑ ↑Easting↑

Canister EPA ID#: _____
Grab Sample Regulator SN#: _____
_____ **Ambient** _____ **Sub-Slab**
_____ Other (specify): _____

Sampling Information

Sample Setup: Date: _____ Time: _____
Date: (mm/dd/yy) Time: (military)

Sampler Start Time: Date: _____ Time: _____

Sample End Time: Date: _____ Time: _____

Sample Delivery: Date: _____ Time: _____

* Initial canister vacuum:
_____ " Hg or mm Hg

* Final Canister Pressure:
_____ psi or mm Hg

Interior Temperature:
_____ ° F

Sampler Calibrated
Flow rate: _____ cc/min

* Total Elapsed Sample Time: _____ hours

***Sub-slab Screening Info:**
PID (ppm): _____
% O_2: _____

AVERAGE REPORTED METEOROLOGICAL CONDITIONS FOR SAMPLING DAY:

Ambient Temperature: High _____ Low _____
Average Wind Direction: _____
Average Wind Speed: _____ mph

Barometric Pressure: _____mm Hg
Average Humidity: _____ % (percent)

NOTES: (Any Sampler or Canister problems or significant sampling details)

As operator, I certify that a valid canister sample has been collected and that this form has been completed.

Operator signature: _____ Phone #: _____

SAMPLE RECEIVING

Date Received: _____ Pressure Check: _____ psi
Date Submitted: _____ Analytical Lab: _____

Sketch sampler location(s) in map on back of this data sheet

Multi-Incremental Sampling for Soils and Sediments

1.0 Scope and Application

1.1 Overview

Environmental samples are collected to gain information that will help us and make good decisions. Samples are collected to "represent" a determined area, and the results are used to estimate the contaminant concentrations over that area. It is vitally important that the samples are representative, or an average, of the area so good decisions can be made. Errors in sampling will create incorrect information, and incorrect estimations of contaminant concentrations over an area will occur. You cannot make good decisions from poor samples!

A large focus of sample error has historically been with the analysis. However, analytical error is very small compared to field collection of the samples.

Sources of Error

Sample Collection	Up to 1000%
Sample Preparation	Between 100 to 300%
Analysis	Between 2 and 20%

Winfried Raseman, Industrial Waste Dumps, Sampling and analysis, Encyclopedia of Analytical Chemistry, 2000

1.2 Types of sampling

There are two main types of environmental samples, probabilistic and non-probabilistic. It is important to know the difference so the proper type of sample is collected.

1.2.1 Non-Probabilistic or Judgment or Grab Sampling

- Uses the samplers' judgment on where to sample
- Provides information on sample only
- Results cannot be extrapolated beyond sample point
- Sample error cannot be estimated

1.2.1.1 When to Use

- Confirm identity (Listed Waste/Characteristic Waste)
- Determine presence of contaminant
- Match source and receptor

- Sample most contaminated area to determine if it is below the defined project limit.
- Sample least contaminated area to determine if it is above the defined project limit.

1.2.2 Probabilistic or Statistical or Incremental Sampling

- Results are independent of the sampler, random
- Results can be expressed with scientific degree of confidence
- Results can be extrapolated to locations not sampled.
- Sample error can be estimated

1.2.2.1 When to use

- Need representative samples
- Need the "average" concentration of an area
- Estimate the population based on sample results
- Repeatable, defendable results

1.3 Sources of Sample Collection Error

All sample error is caused by Heterogeneity!

Heterogeneity is the normal state of nature. Everything is heterogeneous.
If everything was homogeneous, there would be no sample error. Even though something may look homogenous to the eye it is not, think about what it looks like under a microscope.

There two types of heterogeneity: compositional and distributional.

1.3.1 Compositional Heterogeneity (also called constitutional heterogeneity)
This is the difference in composition of the particles or molecules. It describes the variability of concentration between particles. A sample needs to include some of all of the particles of all the different concentrations in the exact proportion as they exist in the population or the sample is not representative. The larger the particles or the rarer the occurrence requires more mass to represent the population. The error of not completely representing all the particles in the population is the fundamental error (FE). This error can be controlled by sample mass. It cannot be eliminated completely, but it can be estimated statistically prior to sampling.

1.3.2 Distributional heterogeneity
This is cause by non-random distribution of particles through time and space. Particles of different size, shape, and contaminant concentrations vary across the population. This may be due to gravity, chemistry or movement by people. If sample collection does not adequately address the change across the population, the grouping and segregation error (GSE) will result. This error is controlled by collecting random increments to sample through the heterogeneity. Grab samples that are collected from one location will have GSE error.

1.4 Major Sampling Errors

There are six major sampling errors

1.4.1 Fundamental Error (FE)

The error of not completely representing all the particles in the population. It is a function of sample mass. It can be estimated but cannot be eliminated. Mixing has no effect.

Sample Mass - Sampling error depends on the mass of the sample.

6	6	9	7
5	9	7	8
6	5	7	7
8	9	6	7

If the entire square is collected as a sample, the average is 7. This is the true average. If only one small spot is sampled, the error is +/-2 from the true average. If a larger sample mass of 4 spots is collected, the error is reduced to 0.75. The larger the sample mass, the smaller the error.

1.4.2 Grouping and Segregation Error (GSE)

The error that results from the uneven distribution of particles from gravity, chemistry, process changes, movement by people. It is a function of the number of sub-samples. Mixing may reduce this error or it may promote segregation.

1.4.3 Materialization Error (ME)

The error from the use of sampling tools. The proper tool and increment shape must be selected. For soil sampling, the increment should be a thin cylinder, for sub sampling, it should be a square scoop.

1.4.4 Preparation Error (PE)

The error caused by ignorance or careless. It is a function of proper training and equipment, ex sample preservation, filtering, documentation, etc.

1.4.5 Trends (CE2)

The error from changes in contaminant concentrations with respect to time and space.

1.4.6 Cycles (CE3)

The error from changes in contaminant concentrations with respect to time and space.

1.5 Mitigating Sample Error

1.5.1 Fundamental Error (FE)

Primarily pertains to particulate matter. Liquids and gasses have very small particles, so FE error is almost 0.

1.5.1.1 Collect Correct Sample Mass
There must be adequate representation of all the particles. The larger the particle, the more mass is needed. However, refer to the site specific DQO. If you're only looking at soil, which has a general definition of 4 mm, the larger stones and debris may be sieved and thrown out. If replicates agree, the sample mass is sufficient. If they do not more mass and/or increments are needed.

1.5.1.2 Grinding the sample
This will create a more uniform particle size

1.5.2 Grouping and Segregation Error (GSE)

1.5.2.1 Collect Random Multi-Incremental (MI) Samples
MI samples will allow you to sample through the heterogeneity. Thirty (30) to fifty (50) increments are needed to reduce the GSE to a point where its contribution is not significant to the overall error. The more heterogeneous the material, the more increments are needed.

1.5.2.1 Mixing
Mixing will only work if the particle size, shape, and density is uniform. Mixing heterogeneous materials may actually increase the GSE. If mixing does reduce the segregation, it may be an unstable state.

1.5.3 Materialization Error (ME)
Use the correct increment shape for equiprobable selection of all the particles. For soil sampling, the increment should be a thin cylinder, for sub sampling, it should be a square scoop.

1.5.4 Preparation Error (PE)
The PE error is reduced by proper training, equipment maintenance, and controlling dust during sample processing.

1.6 Decision Unit or MI Areas
Determination of decision units is critical to MI sampling. Most sites need to be broken down into areas about which a decision needs to be made. Examples are fill area, set of drums, area of a particular use, different process areas, etc. MI samples are collected in a particular decision unit, **not** across units. They can have temporal as well as spatial components.

2.0 Health and Safety Warnings

2.1 Slips, trips and falls are the biggest hazard while sampling.

2.2 Read the site specific Health and Safety Plan prior to site work.

3.0 Cautions

3.1 The Project Manager must use the Data Quality Objectives (DQO) process and fully understand the data needs of the project. See USEPA document QAG-4.

3.2 The Project Manager should get risk assessor input on whether data will be acceptable for Remedial Assessments.

3.3 Chain of Custody issues while drying and working with the samples should be planned and addressed.

4.0 Personnel Qualifications

4.1 Personnel must be certified under OSHA regulations.

5.0 Equipment and Materials

Documentation Materials
- Logbook
- Chain of custody Forms
- Global Positioning System (GPS)
- Flags or stakes

Soil Collection Equipment
- Soil corers or Step Probe
- Soil Remover Tool
- Baggies for MI samples
- Shovel

Sediment Collection Equipment
- Eckman
- Teaspoons
- Pans
- Boat
- Vibercore unit
- Corers
- Waders

Sample Processing Equipment
- Tray holder
- Bags to cover trays
- Trays for drying
- Oven or microwave
- Sieves (#10 & #4)
- Grinders
- Scoops
- Sample jars
- Field Screening Equipment (if needed)
- Decontamination Supplies

Other
- Personal Protective Equipment
- Gloves

6.0 Summary of Method

6.1 Determine MI Sample Areas or Decision Unit
The site must first be broken down into decision units. The decision units are determined on a site by site basis for any given investigation. They can be based on land use, physical/chemical/operational characteristics, potential exposure, etc. MI samples are then collected in each decision unit, NOT across decision units.

6.2 Determination of Sub-Sample Locations within the Decision Unit

A very effective, inexpensive, and easy method of locating sub-sample locations is the “drunken sailor” method. With this approach, the sample collector wanders over the sample area and randomly grabs a small increment of soil.

Generally, 30 sub-samples should be collected in the decision unit. If replicates yield a variability that is too great, then the number of sub samples would have to be increased and more sample mass would be required.

6.3 Collection of Soil and Sediment MI Samples

A stainless steel 7/8” step probe is the preferred method of collecting increments. The depth of the increment is decided on a unit by unit basis, and should be part of the DQO process. For sediments, the Eckman Dredge or small scoops work well.

If the equipment is not disposable, decontamination must be performed between areas, not increments.

For all analysis but VOC’s, the sub-samples collected from the sample area are placed in a container, like a large baggie or bowl and transported to the sample processing location.

If samples are collected for VOCs, the sub-samples must be placed in a solution of methanol.

6.4 Sample Processing

6.4.1 Overview

The overall goal of the field collection is to collect sufficient material over the sample area to account for both compositional and distributional heterogeneity. Much more sample material will be collected in the field than will be analyzed at the lab, thus correct sample processing must be performed. Generally, laboratories do not process the sample to be representative, but some laboratories are currently generating a method.

Field sample processing should be performed prior to shipment to the lab. The correct sample processing must be performed on the field collected sample to provide a representative, uniform, and repeatable sample for lab analysis.

6.4.2 Processing Method

They type of material collected will determine the type of processing required.

6.4.2.1 Non-Saturated Soils and Sediments

The entire sample is laid out on a pan and dried. Drying should be done overnight using a dehumidifier. If only metals are to be analyzed, a warm oven can be used.

The dried sample is the sieved according to the needs of the DQO. For soils, the typical size is a #10 sieve (2 mm). A larger sieve, like #4 (4.75 mm) can be used first if there is a large amount of larger material. The larger material is discarded. This should be performed under a hood to prevent cross contamination.

The remaining sample is then ground (a stainless steel coffee grinder works well) for a consistent partial size. This should be performed under a hood to prevent cross contamination.

The ground material is then laid out and 30 small increments collected randomly to fill each sample jar.

6.4.2.2 Saturated Sediments

If the sample contains stone and organic debris, the sample can first be sieved. Then the remained of the sample is laid out and at least 30 small increments are randomly collected to fill the sample jars.

6.5 Quality Control/Assurance

To measure the repeatability of the field collection techniques, a duplicate sample should be collected for every 10 field samples. The results of these duplicative samples can then be used to measure repeatability. If such samples are similar, their accuracy can be inferred.

In the lab, replicated can be analyzed. If the variability is great, the number of increments, mass or both must be increased.

6.6 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011).

7.0 Instrument Calibration / Maintenance

7.1 Refer to instrument specific SOP for calibration and maintenance schedule.

Geoprobe™ Procedures for Collection of Environmental Samples

1.0 Scope and Application

1.1 The Geoprobe Model 5400/5410 are hydraulically powered, truck-mounted percussion driven subsurface sampling devices capable of collecting subsurface soil samples (continuous core or discreet depth samples) and in situ ground water samples. The information obtained from a Geoprobe investigation can be used to define the limits of subsurface contaminant investigations and assist in determining placement of monitoring wells.

2.0 Health and Safety Warnings

2.1 Ensure that all overhead and buried utilities (i.e., electrical lines, telephone lines, gas lines, fiber optic lines, etc.) have been identified and located prior to commencing subsurface investigation activities.

Call B-4-U Dig @ 1-800-362-2764

2.2 Operators should wear OSHA-approved steel-toed shoes and keep feet clear of probe foot.

2.3 Operators should wear OSHA-approved safety glasses.

2.4 Operators must wear hearing protection (OSHA-approved for levels exceeding 85 dB is recommended).

2.5 Only one person should operate the Geoprobe at one time.

2.6 Never place hands on top of the probe rod while the rod is under probing machine.

2.7 Turn off the hydraulic system at the control panel while changing probe rods, inserting the hammer anvil, or attaching any accessories.

2.8 Never exert downward pressure on the probe rod so as to lift the probe foot over six inches off the ground.

2.9 Always take the Geoprobe carrier vehicle out of gear and set emergency brake before engaging the remote ignition.

2.10 Operators must stand to the control side of the probe machine, clear of the probe foot and derrick, while operating the controls.

2.11 Never exert down pressure on the probe rod so as to lift the rear tires of the carrier vehicle off the ground.

3.0 Cautions

3.1 In dry loose soil, the Geoprobe can penetrate much further than in tightly bound clay; however, it is not recommended for use in rocky soils or tightly compacted glacial till deposits.

3.2 Other subsurface investigation methods should be considered for sampling consolidated deposits. Use of the Geoprobe in these situations may result in either damage to the unit or possible injury.

3.3 The vehicle's catalytic converter is hot and may present a fire hazard when operating over dry grass or combustibles.

3.4 Shut down the hydraulic system and stop the vehicle before attempting to clean or service the equipment.

3.5 Use caution when carrier vehicle is parked on a loose or soft surface, especially on an incline. Do not apply enough force to the probe foot to lighten the load on the carrier vehicle suspension. Reduced weight on the vehicle tires may allow the vehicle to shift or slide on the loose surface.

3.6 Do not wear loose clothing while operating this machine. Severe injury will result if clothing becomes entangled in moving parts.

3.7 Avoid hydraulic fluid leaks. Pressurized fluid may be injected into the skin resulting in serious bodily injury. In the event of an accident, seek medical attention immediately.

3.8 In the event of a problem, the operator should release all control levers. The spring-loaded levers will automatically return to the neutral position and machine operation will cease.

3.9 Geoprobe machines are equipped with a remote starting system. Ensure that everyone is clear of all moving parts before starting the machine.

3.10 Do not make modifications or add attachments to this machine which are not approved by Geoprobe Systems.

4.0 Personal Qualifications

4.1 Geoprobe operators should, at a minimum, receive some form of training from Geoprobe Systems. In the event that such training is not available, on-the-job training with an experienced operator could suffice. Workshops and training events are available annually to keep operators updated on using the latest tools and technology in the field.

4.2 Personnel may need to be certified under OSHA regulations for work on certain sites.

5.0 Apparatus and Materials

5.1 The Geoprobe Model 5400/5410 units consists of a powered percussion hammer which is slide mounted on a derrick and has a 54 inch stroke. The derrick assembly hydraulically folds and unfolds from the traveling/storage position in the back end of the carrier vehicle.

The derrick is also hydraulically adjustable in both the fore and aft directions as well as the angle to insure the derrick is vertical. On the 5400 Model, side to side adjustment can be made manually. On the Model 5410, side to side adjustments can be performed hydraulically.

5.2 The Geoprobe Models 5400 & 5410 utilizes the weight of the truck and a powered percussion hammer to advance four-foot long rods into the ground. The drive rods are hardened steel with an outside diameter (O.D.) of 1.25 inch and an inside diameter (I.D.) of 0.625 inch. The operator controls the hydraulic hammer through the use of levers and the helper assists by adding sections of rod. Depending on the purpose of the investigation, the lead rod will be connected to a specific tool to collect continuous soil cores, discreet depth soil cores or ground water.

5.3 The three primary probing tools used to collect environmental subsurface samples are the Macro-Core® soil sampler, the large bore sampler for discreet depth samples, and the screen point sampler for collection of ground water samples.

5.4 The following is a list of equipment, tooling, and supplies typically utilized for sample collection:

Personal Protective Equipment (PPE):

- Hearing protection
- Hard Hat
- Nitrile (or similar) Disposable Gloves
- Safety glasses
- Leather Gloves
- Steel-toed boots

Equipment/Tooling needed for all probing:

- 4-foot probe rods
- Inner Extension Rods (48")
- Drive Cap
- Miscellaneous tools
- Bentonite pellets/granules
- 2-foot probe rods
- Rod Grip Pull System
- Pull Cap
- Logbook

Soil Sampling:

- Macro Core (MC) Drive Head
- MC Sampler Tube
- MC PETG/PVC Heavy-Duty Liner
- MC Vinyl End Caps
- Large Bore (LB) Sample Tube
- LB Cutting Shoe
- LB Piston Stop Pin, w/ O-ring
- LB Cutting Shoe Wrench
- MC Closed Piston System
- MC Cutting Shoe
- MC Combination Wrench
- MC Core Catcher (optional)
- LB Drive Head
- LB Piston Tip & Rod
- LB CAB Clear Plastic Liners
- LB Vinyl End Caps

Ground Water Sampling:

- GW Sampler Sheath
- PVC Screen (10-slot)
- Wire-Wound Stainless Steel Screen
- Polyethylene tubing - ¼" O.D.
- O-ring Service Kit
- GW Drive Head
- Expendable Drive Points
- Screen Push Adapter
- Static Water Level Indicator

Soil Gas Sampling:

- PRT Expendable Point Holder
- PRT Adapter
- Implant (Stainless, aluminum, ceramic, or plastic)
- Swagelok® fittings or valves
- Expendable Drive Points
- Tubing (Nylon or Polyethylene)

Equipment Clean-Up:

- Decontamination Supplies
- Various Brushes
- Pressurized Sprayer
- Polyethylene Sheeting
- Liqui-Nox Soap (or similar)
- Tap & ASTM Water
- Wash Tubs/Buckets

6.0 Summary of Method

6.1 Overhead and Buried Utilities

The use of the Geoprobe on a site within the vicinity of electrical power lines and other utilities requires that special precautions be taken by the operators. Determine what the minimum distance from any point on the unit to the nearest power will be when the derrick is raised and/or being raised. **Do not raise the derrick or operate the unit if this distance is less than 25 feet, or if known, the minimum clearance stipulated by federal, state, and local regulations.** In order to avoid contact with power lines, only move the unit with the derrick down.

Underground electrical utilities are as dangerous as overhead electricity. Be aware and always suspect the existence of underground utilities (water, natural gas, cable/phone lines, fiber optic cables, storm water & sewer lines, etc.)

REMEMBER: Call B-4-U Dig @ 1-800-362-2764

6.2 Visual Inspection

At the start of each work day, the operator must visually inspect the Geoprobe, which includes: (1) checking the hydraulic fluid levels, and the hydraulic lines for fraying, cuts or leaks; (2) checking the derrick and attachments assembly for adequate grease, and for damage , nicks, burrs, and leaks; (3) removing any unnecessary dust, dirt, or oil to prevent jams or damage to the equipment; (4) checking the nuts and bolts; and (5) checking the sampling equipment (e.g. drive rods, anvil, drive caps/heads, sampling tools) for damage such as stress cracks, burrs, and bends.

6.3 Set-up of the Geoprobe

Following the visual inspection and routine maintenance, the unit is ready for operation. The following steps describe the set-up procedure for the Geoprobe 5400/5410:

6.3.1 Position the vehicle at the sample location. Park the truck as level as possible; the truck must be level in the side-to-side aspect to drive the rods properly. If on an incline, point the front of the truck up-gradient. If possible, face the truck downwind to avoid potential cross contamination from the vehicle's exhaust and to prevent exhaust fumes from entering the work area.

6.3.2 Put the vehicle transmission in **PARK**, set the parking brake, and shut off engine at ignition switch in the truck cab.

6.3.3 Set the Master Control Switch, located on the side of the driver's set, to the **ON** position.

6.3.4 Open and secure the rear doors with the bungee cords provided so that the wind and/or vibrations will not cause the doors to swing shut into the work area during operation.

6.3.5 If available, attach an exhaust hose to the tailpipe and direct the exhaust downwind, away from the work area.

6.3.6 Ensure that the Hydraulic Speed Control Switch is in the **OFF** position prior to starting the unit. Start the vehicle engine with the remote ignition switch located on the Control Panel.

6.3.7 Place the Hydraulic Speed Control Switch in the **SLOW** position to activate the hydraulic clutch system. Allow the unit to warm-up in this position. This is especially true in colder weather, where the unit should warm-up for approximately 15-20 minutes.

6.3.8 Pull the **EXTEND** control lever toward the rear of the vehicle and laterally extend the probe unit as far as possible. Using the **FOOT** control lever, lower the derrick assembly so that it is below the top of the foot cylinder. This will ensure Clarence at the roof when unfolding the probe.

6.3.9 Pull the **FOLD** control lever down to pivot the probe unit until it is perpendicular to the ground.

6.2.10 At this time, if desired, swing the probe manually by disengaging the swing mount latch lever.

6.3.11 Lift up on the **EXTEND** control to move the probe back toward the vehicle. Stop when the foot cylinder is approximately 8-10 inches from the vehicle bumper.

6.3.12 Push down on the **FOOT** control to extend the foot and put the vehicle weight on the probe unit. Stop when the foot just contacts the ground. It is not necessary to significantly raise the rear of the vehicle.

6.3.13 Lift up on the **PROBE** control and raise the derrick to its maximum height. Check that the derrick is true vertical and adjust as necessary.

6.3.14 Shut off the hydraulics by placing the control switch in the **OFF** position. Assemble the desired lead tool and attach a drive cap to the top of the tool.

6.3.15 Place the lead tool beneath the hammer assembly, and switch the hydraulic control to the **SLOW** position. The lead tool should be centered between the foot supports and parallel with the derrick. Push down on the **PROBE** control to lower the hammer unit on top of the lead tool. Ensure that the drive cap is seated in the anvil. The Geoprobe is now ready to advance the sampler into the ground.

6.4 <u>Rod Advancement</u>

Probing operations often require the simultaneous operation of two hydraulic levers; the **PROBE** control lever and the **HAMMER** control lever. Because of this, probing operations require some manual coordination and practice in order to yield smooth, trouble free operation. Beginners should be given a day of practice in the field with an experienced probe operator before attempting to use a probe machine on an actual site investigation.

To advance the lead sampling tool to the desired project depth, the following procedures should be followed when using the Geoprobe:

6.4.1 Make sure the **HAMMER/ROTATION** lever is in the horizontal position.

6.4.2 Screw a drive cap onto the male end of the lead sampling tool or probe rod. **Make sure all threaded parts are completely threaded together before driving. Failure to do so may permanently damage the equipment.**

6.4.3 Position the lead tool in the center of the derrick foot and directly below the hammer anvil. **Positioning of the first tool/rod is critical in order to drive the probe rod vertically. Both the probe rod and derrick must therefore be in a vertical position.**

6.4.4 Many times the probe rods can be advanced using only the static weight of the vehicle. When advancing the first tool/rod, always select **SLOW** on the speed control. To begin probing, activate the hydraulics and push down on the **PROBE** control lever. The lead tool/rod will be slowly pushed into the ground. This procedure allows the operator to gauge the soil resistance and avoid deflection.

6.4.5 In some soil types, the probe rods cannot be advanced by using only the static weight of the vehicle. At the point where the lead tool/rod does not advance and the weight of the vehicle is placed on the rod, move the toggle switch to the **FAST** position. Push down again on the **PROBE** lever and continue to push the lead tool/rod. Allow the rear of the truck to rise 6 inches off the ground. When the weight of the truck is insufficient to push the rod into the ground, push down on the **HAMMER** lever. When the rod has advanced to the point where the derrick foot is again on the ground, release the **HAMMER** lever, push the **PROBE** lever down until the truck again rises 6 inches. Repeat this process until the rod is driven into the ground.

<u>CAUTION:</u> Always keep static pressure on the probe rod (with the PROBE lever) or the rod will vibrate and chatter while hammering, causing rod threads to fracture and break.

6.4.6 A good technique for driving probe rods is to hold down on the **HAMMER** control and advance the probe cylinder downward in 2-inch increments with the **PROBE** control.

6.4.7 Periodically, stop hammering and check to see if the prob rods can be advanced with static force only.

6.4.8 As the **HAMMER** control is used to apply percussion to the probe rods, the rods will tend the unscrew slowly. If this happens, the chance of breaking threads is greatly increased. To keep from breaking rods, simply tighten the rods by hand or with a pipe wrench while driving the rods.

6.4.9 Once the lead tool/rod has been driven into the ground, raise the hammer anvil to it's full height by lifting on the **PROBE** lever and turn the hydraulics to the **OFF** position. <u>Never reach into or around the hammer anvil while the hydraulic switch is in the **ON** position</u>. The helper then removes the drive cap from the lead tool/rod and attache the drive cap to the next rod to be used. The helper then attaches the next 4-foot rod section to the tool/rod that has just been driven.

6.4.10 Now that the Geoprobe has driven rods to the desired sampling depth, it is ready for the crew to perform the required sampling activities. Depending on the specific method of sampling being performed, refer to the specific Geoprobe sampling FSOP's.

6.5 Rod Removal

Probe rods, once driven to depth and upon completion of desired sampling activities, can also be pulled using the Geoprobe. The unit uses the rod grip pull system, mounted on the hammer attachment, to pull the tool string from the ground. Make sure that at least 1 foot of probe rod is left above ground to the rod grip can grab the rod.

6.5.1 Lift the **FOOT** control lever to raise the derrick foot a few inches off the ground.

6.5.2 Lift the **EXTEND** lever down to the derrick back about a foot.

6.5.3 Move the hammer latch to the down position so it does not interfere when the rod is up against the toothed plates when pulling.

WARNING: When moving the hammer latch, do not place thumb or fingers between latch and bottom plate of the rotation member.

6.5.4 Hold down on the **PROBE** control and move the probe cylinder down all the way to the base.

6.5.5 If not already off, remove (unscrew) the drive cap from the last probe rod which has penetrated the soil.

6.5.6 Push down the **EXTEND** lever to bring the derrick towards the rod and situate the rod into the V-shaped block with embedded grip jaws. Make sure the derrick and the rod are square to one another so as not to be pulling the rod at an angle.

6.5.7 Push down on the **FOOT** control to extend the foot to the ground and put the vehicle weight on the probe unit. Stop when the foot just contacts the ground.

6.5.8 Attach the Rod Grip Pull Handle Assembly: slide the handle assembly over the two socket head cap screws connecting the rod grip support brackets to the hammer attachment. The handle assembly accepts 2 sizes of drive rods. Ensure that the larger, grooved indentation of the handle assemble is facing the rod. Once attached, the rod grip pull should be in a down position, pinching the rod into the V-shaped block with embedded grip jaws.

6.5.9 Turn on (activate) the hydraulic control to **SLOW**.

6.5.10 Set the hydraulic control switch to **FAST** and retract the probe rods by pulling up on the **PROBE** control lever.

6.5.11 Once the probe cylinder has reached it uppermost limit, slightly push down on the **PROBE** control lever and lift up on the Grip Pull Handle Assembly. Keep the handle assembly held in a level position as the prob cylinder travels downward. Once the V-block passes a rod connection point, the pulled rod can be unscrewed from the tool string.

6.5.12 Continue these steps until all rods are extracted from the hole.

6.5.13 Upon completion, lower the probe cylinder to its lowermost position and turn off (deactivate) the hydraulic control switch.

6.5.12 At times, the rods may have the tendency to slide back into the hole from which they came. **Please be aware of this fact; rods and tools are difficult, if not impossible, to retrieve once lost down a deep hole.** Before completely lifting the Grip Pull Handle, ensure that the rods are not sliding back. Should the rods be observed sliding back down the hole, use a pipe wrench to hold the rods to prevent backward movement while lowering the probe cylinder.

6.6 Geoprobe Unit Shutdown

After the rods have been extracted from the ground, the Geoprobe is ready to be shutdown and moved to the next sampling location.

6.6.1 Turn on the hydraulics and set the control toggle switch to **SLOW**, push down on the **PROBE** control lever and lower the probe cylinder to the bottom of the derrick.

6.6.2 Lift the **FOOT** control lever to raise the derrick foot a few inches off the ground.

6.6.3 Push the **EXTEND** lever down to ensure that the derrick is fully extended.

6.6.4 Check to make sure that all hydraulic and electrical lines, as well as stray pieces of equipment at clear of the derrick storage area.

6.6.5 Lift the **FOLD** lever to fold the derrick assembly to the horizontal position.

6.6.6 Lift the **FOOT** lever to bring the derrick foot all the way up to its storage position.

6.6.7 Lift the **EXTEND** lever to bring the entire derrick assembly into the truck storage area.

6.6.8 Turn off (deactivate) the hydraulics by placing the toggle switch in the **OFF** position. Shut off the vehicle engine using the remote ignition switch on the control panel.

6.6.10 Ensure that all hardware and tools are returned to the back of the truck. Secure doors.

6.6.11 Set the Master Control switch, located on the side of the driver's seat to the **OFF** position. The Geoprobe 5400/5410 is now ready to be moved to the next sampling location.

6.7 Sampling Procedures

6.7.1 The Ohio EPA, Division of Emergency & Remedial Response (OEPA-DERR) has adopted the Standard Operating Procedures developed by Geoprobe Systems for use in sample collection. These SOP's are in addition to the 5400/5410 Model Geoprobe Operations Manuals. For more technical instructions, system or equipment specifications or component information, refer to the 5400/5410 Model Geoprobe Operations Manual.

The following is a list of the Standard Operating Procedures adopted for sampling methodologies with the Geoprobe:

6.7.2 For collecting discreet depth soil samples: **Technical Bulletin No. 93-660, "Geoprobe AT-660 Series Large Bore Sampler Standard Operating Procedure"**;

6.7.3 For collecting continuous four-foot cores: **Technical Bulletin No. 95-8500, "Geoprobe Macro-Core® Soil Sampler Standard Operating Procedure";**

6.7.4 For collecting ground water samples: **Technical Bulletin No. 95-1500, "Geoprobe Screen Point 15® Ground Water Sampler Standard Operating Procedure."**

6.7.5 For installing 0.5 " & 0.75" prepacked monitoring wells: **Technical Bulletin No. 96-2000, "Geoprobe PrePacked Screen Monitoring Well."**

6.7.6 Refer to the following website for PDF versions of the Technical Bulletins mentioned above: http://www.geoprobe.com/literature/pdfdownload.htm.

6.8 Investigation Derived Waste should be disposed of following the Ohio EPA Division of Emergency and Remedial Response (DERR) Investigation Derived Waste Guidance (DERR-00-RR-011).

7.0 Instrument Calibration / Maintenance

7.1 Refer to instrument specific SOP for calibration and maintenance schedule.

Garmin Global Positioning System (GPS)

1.0 Scope and Application

1.1 The Garmin Global Positioning System (GPS)is a satellite tracking device which enables you to obtain a rough estimate of latitude and longitude.

2.0 Health and Safety Warnings

2.1 Refer to the site specific Health and Safety Plan for the possible hazards associated with the site.

3.0 Cautions

3.1 These units are expensive. Do not drop the unit or kink the cables.

3.2 Electrical lines and buildings may interfere with signal reception.

3.3 Accuracy for this unit is approximately 5-10 meters depending on number of satellites tracked, signal strength, and topography.

4.0 Personnel Qualifications

4.1 The user should be familiar the operation of the unit.

5.0 Equipment and Materials

5.1 Garmin GPS 75 unit

6.0 Summary of Method

6.1 Obtain Geographical Coordinates:

6.1.1 Press Pwr/Stat key to turn unit on.

6.1.2 Raise antenna to a vertical orientation.

6.1.3 Place GPS unit on a vehicle or on a protective cloth on the ground and stand back while the unit acquires satellites. Bars representing acquired satellites will appear on the screen. Signal strength is proportional to bar height. Once the GPS acquires enough satellites (usually 4)the screen will automatically display the geographic coordinates. No calibration or maintenance is required for the unit.

6.1.4 For an estimate of position error, press the Pwr/Stat switch once and note the Estimated Position Error(EPE). This should be noted in the log book. (Leaving the GPS to track satellites for a longer period of time does not necessarily mean that you will get a more accurate reading. To return to the coordinate display screen, press Nav.

6.1.5 To turn the unit off, press and hold the Pwr/Stat switch for 3 seconds.

6.2 Storing Waypoints: A waypoint is a geographical coordinate that is entered into the GPS. It becomes an established, computer logged position that can be navigated to or from.

6.2.1 Obtain a lock on geographical coordinates as described above in item 3.

6.2.2 Press the Auto Sto button.

6.2.3 The unit will automatically assign a numerical name to the waypoint. This number can be changed to a user assigned name by using the arrow keys to highlight the waypoint name. Change each character by toggling one key at a time using the arrow keys. For example: Press the"2" key to select either a 2, D, E,or F character using the arrow keys.

6.3 Navigating to a Waypoint:

6.3.1 Press the Goto/Mob button.

6.3.2 When the "Go To" field appears, press WPT (waypoint) to retrieve your first waypoint. You may then use the arrow keys to toggle through the stored waypoints. You may also type the waypoint name in as mentioned above.

6.3.3 Once your waypoint is displayed on the screen press enter. A navigation summary page will appear which displays BRG(bearing), TRK (track), RNG (range to destination)and GS(ground speed). BRG is the direction from your position to the "active" waypoint. TRK is the direction of your movement.

6.3.4 Start by walking a short distance while monitoring your TRK bearing. Adjust your direction of travel so that the TRK bearing matches or comes close to the direction to destination (BRG) bearing. Proceed toward your destination making course corrections along the way. RNG will decrease as you approach your destination.

6.3.5 As you approach your destination an "MSG" signal indicating a message will appear in the lower left corner of the screen. To view it, toggle the pwr/stat button. It should say "approaching destination."

7.0 Instrument Calibration / Maintenance

7.1 No calibration is required.

7.2 Batteries must be kept charged or replaced.

Collecting a Latitude and Longitude Using the Trimble Pro XRS Global Positioning System (GPS)

1.0 Scope and Application

1.1 These are basic instructions for collecting a geographic coordinate with the Trimble Pro XRS Global Positioning System (GPS). For more advanced applications, see manual.

2.0 Health and Safety Warnings

2.1 Refer to the site specific Health and Safety Plan for the possible hazards associated with the site.

3.0 Cautions

3.1 These units are expensive. Do not drop the unit or kink the cables.

3.2 When removing cables, grab the cable by the silver wire instead of pulling on the cable.

3.3 Electrical lines and buildings may interfere with signal reception.

4.0 Personnel Qualifications

4.1 The user should be familiar the operation of the unit.

5.0 Equipment and Materials

- Trimble Pro XRS GPS unit with Data logger.
- Spare batteries.

6.0 Summary of Method

6.1 Connect Data logger to GPS unit using the coiled data cord.

6.2 Make sure that you are standing with a clear view of the open sky.

6.3 Turn GPS on by pressing the green power button on the Data logger.

6.4 After initialization, the Data logger will default to the Main menu and begin collecting signals from satellites.

There are 3 indicators to monitor at the bottom of the screen.

6.4.1 PDOP indicator must be below 6.0

6.4.2 The number inside the circle is the satellite indicator and shows how many satellites are being tracked. This number must be 4 or greater to achieve an accurate signal.

6.4.3 Beside the satellite indicator is a radio icon. If this icon is present, then an active signal is being received. If not, then the GPS is still acquiring.

6.5 Using the circular arrow keypad near the top of the Data logger, highlight the ■GPS position• field and press ■Enter.•

6.6 The Latitude and Longitude should be displayed. If not, press the ■mode• key at the bottom of the screen.

7.0 Instrument Calibration / Maintenance

7.1 Two batteries are good for approximately 4 hours of GPS work. No calibration is necessary. A service that transmits correction signals to the Trimble GPS must be renewed on an annual basis if real time sub-meter accuracy is desired.

Collecting a Coordinate using the Trimble GeoXT or the Pro XH

1.0 Scope and Application

1.1 These are basic instructions for collecting a geographic coordinate with the Trimble Pro XH or the GeoXT Global Positioning System (GPS). Both units utilize the same operational software, Terrasync, for coordinate collection so the procedures for both units are identical.

2.0 Health and Safety Warnings

2.1 Refer to the site specific Health and Safety Plan for the possible hazards associated with the site.

3.0 Cautions

3.1 These units are expensive. Do not drop the unit or kink the cables.

3.2 When removing cables, grab the cable by the plug instead of pulling on the cable.

3.3 Electrical lines and buildings may interfere with signal reception.

3.4 Use only a plastic stylus pen to operate the touch screen.

4.0 Personnel Qualifications

4.1 The user should be familiar the operation of the unit.

5.0 Equipment and Materials

- Trimble Pro XH GPS unit with Data logger, or Trimble GeoXT.
- Stylus pen.

6.0 Summary of Method

6.1 If using the Trimble ProXH, connect the serial cable between the receiver unit and the Ranger datalogger. Otherwise, the procedures are the same for both units.

6.2 Turn the unit(s) on.

6.3 Using the stylus pen, tap on the “Terrasync” icon to open the Terrasync data collection program.

6.4 From the pulldown menu in the top left hand corner of the screen, select *setup*.

6.5 If there is not already a satellite icon across the top, click on the GPS button to connect to the GPS. Satellite acquisition will begin.

6.4 After initialization, the unit will begin collecting signals from satellites. The flashing number across the top indicates how many satellites have been acquired and locked. At least 4 satellites must be present to provide a coordinate.

6.5 Once at least 4 satellites are confirmed, select *status* from the pull-down menu. Your coordinates in state plane northing and easting will be displayed.

6.6 To change the coordinate reading from state plane to latitude and longitude, go back to *setup* in the main pull-down menu and select *coordinate system*.

6.7 If you want to create a file and record a point, select *data* from the pull-down menu. Highlight filename, and click on the keyboard icon below to name your file, and then press *create.*

6.8 Verify your antenna height.

6.9 Begin to collect features by highlighting point, area, or line and then pressing *create*.

6.10 Repeat this process for each feature and you will begin to build a list of features that are automatically stored in the resident memory.

6.11 Estimated accuracy can be obtained by going back to the satellite icon under *status* and taking note of the accuracy value estimated in “feet.”

6.12 Under the *status* menu, there is a productivity/precision slider bar. If there is difficulty obtaining a satellite lock, slide the bar closer to productivity. However, the closer the slider is to productivity, the less accurate the results may be.

7.0 Instrument Calibration / Maintenance

7.1 No calibration of the instrument is required.