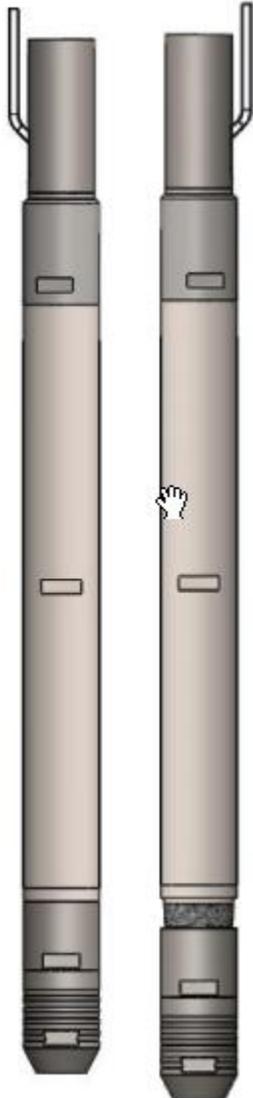




# BESST INC.

**GLOBAL SUBSURFACE  
TECHNOLOGIES**



## BESST MiniProbe

Illustrated Mini SimulProbe SOP

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## The SimulProbe (Mini-Probe) SOIL VAPOR SAMPLING GUIDANCE

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### **Section 1.1: Introduction and Background:**

The Mini SimulProbe (Mini Probe) was developed primarily with a dual purpose in mind. 1) To obtain high quality field screening data of meaningful and useable substance and 2) to provide very accurate quantitative data for the design of soil vapor monitoring (SVM) and soil vapor extraction systems (SVE).

#### **Definition**

The Mini Probe is a split spoon sampler and a soil vapor probe combined into a single sampler. The process that the sampler performs is called "Simulphasic Sampling". Simulphasic sampling permits exact co-location of the soil sample with the vapor (or groundwater) sample. Sampling in parallel versus traditional sampling in series (soil sample followed vertically and sequentially by a soil vapor sample) provides rigorous environmental engineering data that yields better design and right-sizing of soil vapor extraction systems and dual phase extraction systems.

#### **Ex-Situ Head Space Test: Standard Practice**

Traditional VOC soil vapor field screening has consisted of collecting soil samples from split spoon and other types of soil samplers. The industry normal consists of bringing core samples to the surface and then placing a section of the core inside of a plastic bag or covered glass jar. Following some period of time, a field VOC monitoring device such as a PID, FID, OVA, etc. is then used to "sniff" the head space of the container. The readout from the portable screening device is then recorded in a column located on the drilling and geologic field log. We classify this procedure as an EXSITU HEADSPACE TEST (EHT). A soil syringe is then used to take a sub-core of the soil sample itself from one of the core sleeves. The soil aliquot is then sent to the lab for VOC analysis. Being that Henry's law predicts a large percentage of vapor phase VOC loss from coarse grained sediments, the representativeness of sub-cored samples from core sleeves are likely compromised; perhaps significantly so. A way to address disequilibrium effects such as significant VOC loss prior to taking sub-core samples for VOC analysis is by using the SimulProbe In-Situ Head Space Test (SPIHT).

#### **The SimulProbe In-Situ Head Space Test**

The SimulProbe is specifically designed for Rapid Site Characterization (RSC) and facilitates a procedure called the SIMULPROBE INSITU HEADSPACE TEST (SPIHT). SPIHT means that the soil sample is screened up-hole while the sampler is still buried in the ground – down-hole – below the down-hole drill bit; using any of the VOC monitoring devices listed above. A subtle but key point is that the vapor "TEST" sample (typically collected in a Tedlar bag) is not taken from the core itself – but from the lithologic materials surrounding the outside of the Mini Probe core barrel. This procedure is fully explained in Section 1.6. The accuracy and superiority of the data from the SPIHT (in comparison to the EHT) provides environmental field scientists with the ability to design and install SVM wells, well in advance of receiving lab results from the Tedlar, Summa Canister or syringe vapor samples.

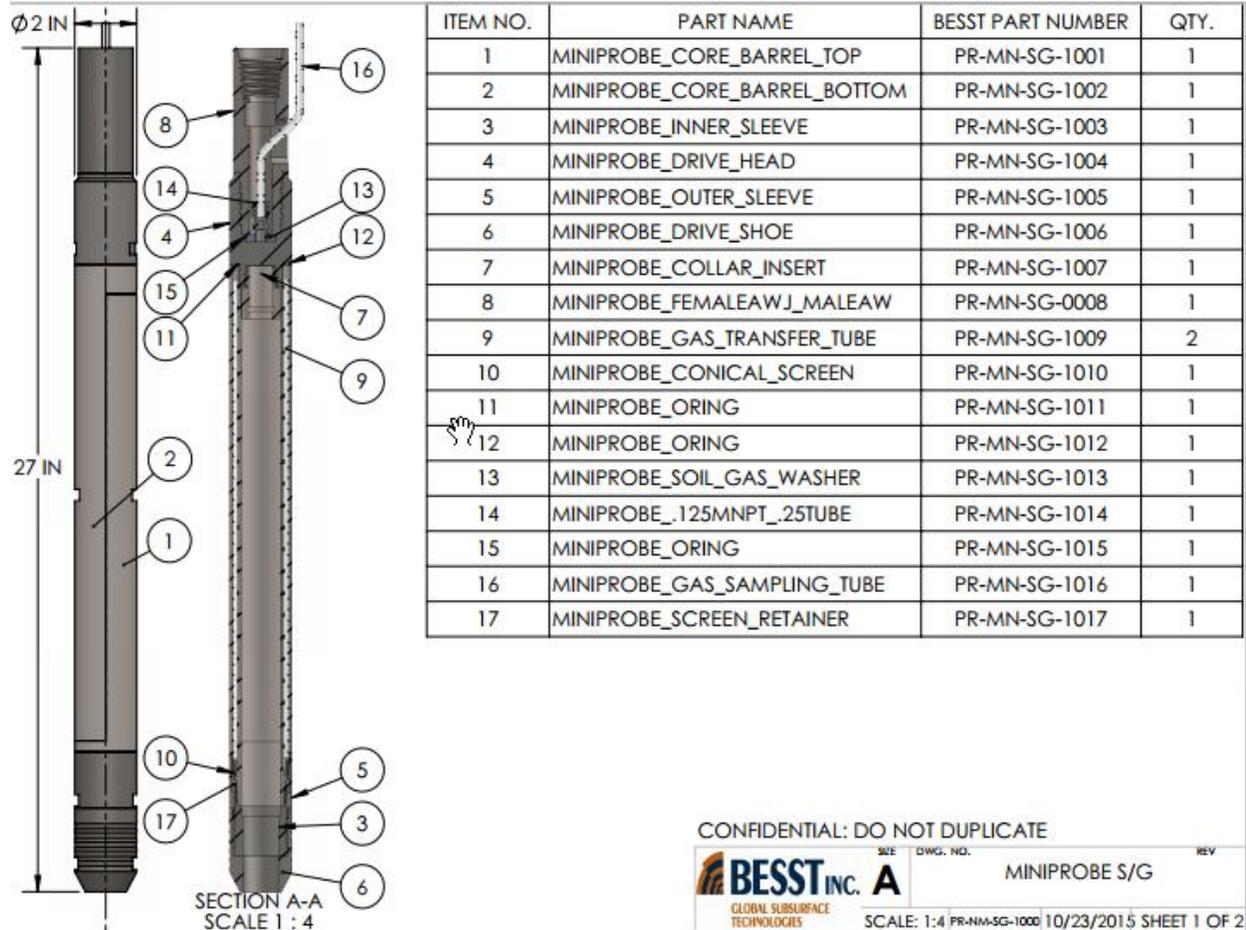
From the SVE point of view, the Mini Probe was developed with the equations in mind that govern the equilibrium partitioning between organic contaminant phases; the linear sorption partitioning equation normalized with respect to organic carbon (Karichoff et al.,1979) and Henry's Law:

$$C_t = \frac{C_g [K_{oc} f_{oc} \rho_b / H_o + \theta_w / H_o + (\theta_t - \theta_w)]}{\rho_b}$$

This topic is covered in more detail in Section 1.8.

**Section 1.2: Illustrated Mini Probe Schematic and Parts Diagram**

Figures 1 and 2 below show the construction details for the assembled and disassembled Mini Probe in the soil/soil gas sampling mode with all of the parts listed in Figure 1.

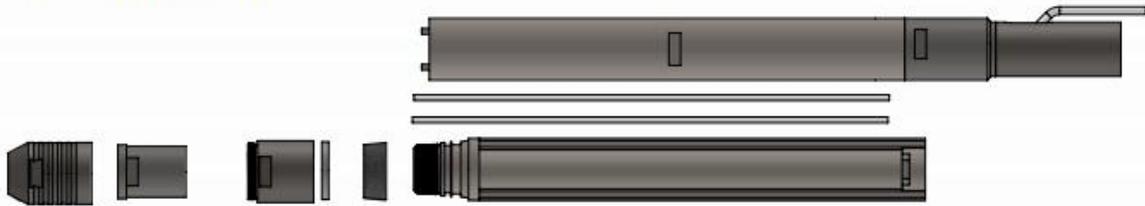


**Figure 1 - Assembled Mini Probe Schematic**

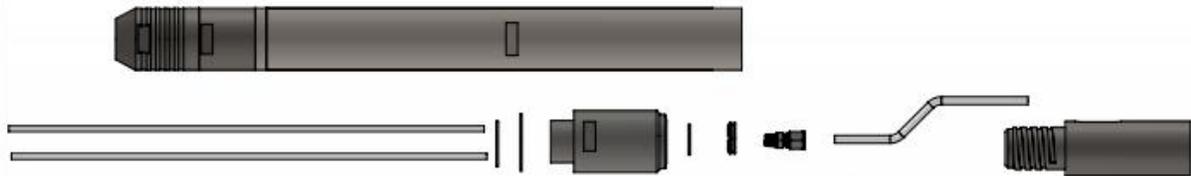
MINIPROBE SOIL GAS MODE



CORE COMPARTMENT



GAS COMPARTMENT



CONFIDENTIAL: DO NOT DUPLICATE



SIZE DWG. NO. REV

MINIPROBE S/G

SCALE: 1:4 PR-MN-SG-1000 10/23/2015 SHEET 2 OF 2

Figure 2 - Disassembled Mini Probe Schematic

### **Section 1.3: Written and Photographic Assembly and Disassembly of Mini-Probe**

The Mini Probe should be assembled and disassembled according to the following guidelines:

1. Insert 3 core sleeves into the threaded half of the core barrel. Place the first 2 core sleeves into the upper half of the core barrel and the 3<sup>rd</sup> core sleeve through the open end at the bottom of the core barrel half.
2. Insert Teflon soil gas tubes into the split half grooves of the threaded half of the core barrel.
3. Both Teflon tubes should both be inserted first into the lower end of the threaded core barrel half; pushing each tube into the receiving hole until it stops.
4. Take the non-threaded half of the core barrel and lay it over the threaded half, with both concave sides facing each other.
5. Use of the 2 Teflon tubes in the core barrel grooves will help to align the non-threaded core barrel half with the threaded core barrel half.
6. When the two halves are conformably aligned, slide the non-threaded half until the 2 ¼-inch guide pins are near the corresponding receiving holes for the pins on the threaded core barrel half.
7. Most of the time, the non-threaded core barrel half will slide to a stop just before the guide pins slide into their 2 corresponding holes on the threaded core barrel section; because the up-hole end of the Teflon tubes are hitting the outer edge of the 2 Teflon tube receiving holes at the upper end of the non-threaded core barrel half.
8. Turn the Mini Probe vertically and gently tap the bottom of the core barrel to allow the Teflon tubes to insert into the upper holes of the non-threaded core barrel half.
9. Before screwing on the Drive head, make sure that the two sealing o-ring are installed on the inner and outer o-ring grooves on the underside of the Drive Head. The large o-ring needs to be incrementally pressed into the outer o-ring groove and the smaller o-ring into the groove at the base of the Drive Head neck.



**Figure 3: Disassembled Mini Probe with Consumable Parts**



**Figure 4: Mini Probe Sliding Drive Shoe Assembly**



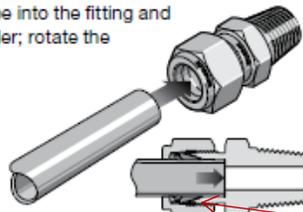
**Figure 5: Mini Probe Tools**

10. Screw on the Drive Head. Screwing on the Drive Head will help to seat the two o-rings placed on the underside of the Drive Head. The purpose of the two o-rings is to “isolate (“sandwich”) the 4 soil vapor pathway holes located on the underside of the Drive Head. These four holes allow the soil vapor to be transferred from the Teflon side tubes in the core barrel grooves to the Soil Gas washer connection on the inside of the Drive Head.
11. Assemble the Drive Shoe Assembly.
  - a. First place the conical wire mesh screen onto the front side of the threaded core barrel half.
  - b. Second, screw on the black plastic screen retention ring which holds the conical screen in place.
  - c. Third, slide on the Outer Sleeve of the Drive Shoe Assembly.
  - d. Fourth, then screw the Inner Sleeve onto the bottom thread of the Core Barrel and hand tighten.
  - e. Lastly, screw on the Drive Shoe to the Outer Sleeve
12. Slide the Drive Shoe Assembly (Outer Sleeve and connected Drive Shoe) up and down to make sure it opens and closes.
13. Once the Drive Shoe is successfully test, take the large black rubber band (Gooch tube) and roll it over the front of the Drive Shoe until the Gooch Tube covers the seamed juncture between the Outer Sleeve and the Core Barrel. Make sure the Gooch tube straddles the seam approximately equidistant (about half on the side of the Core Barrel and the other half covering the Outer Sleeve). The Gooch Tube maintains the Drive Shoe in the closed position while the Mini Probe is transited to the bottom of the borehole. As the Mini Probe is driven into the subsurface below the bottom of the borehole, the Gooch Tube rides and rolls up the side of the Core Barrel.
14. Attach the ¼” Tube x 1/8” Male NPT connector into the Soil Gas Washer. Use Teflon tape around the Male 1/8” NPT thread. Tighten with a box wrench. Use the directions shown in Figure 6 to attach the tubing and secure the tubing with ferrules.

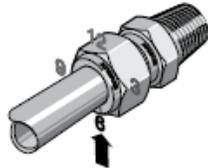
These instructions apply both to traditional fittings and to fittings with the advanced back-ferrule geometry.

Fully insert the tube into the fitting and against the shoulder; rotate the nut finger-tight.

**High-pressure applications and high safety-factor systems:**  
Further tighten the nut until the tube will not turn by hand or move axially in the fitting.



Mark the nut at the 6 o'clock position.



While holding the fitting body steady, tighten the nut one and one-quarter turns to the 9 o'clock position.

For 1/16, 1/8, and 3/16 in.; 2, 3, and 4 mm tube fittings, tighten the nut three-quarters turn to the 3 o'clock position.



**Figure 7: Stainless Steel Ferrules. There is a top and bottom to each ferrule set (Conical Top and Beveled Ringed Bottom). See circle**

**Figure 6: How to insert and tighten tubing into a tube connector.**

15. Place the small o-ring around the external o-ring groove of the Soil Gas Washer.
16. Attach the soil gas tubing to the ¼" tube connector on the Soil Gas Washer Fitting (1.25 turns to tighten).
17. Place the tubing into the slotted AW pin (with 1/8" Pin Nubs facing to the Soil Gas Washer and the inside of the Drive Head. The Soil Gas Washer should lay flat against the bottom of the slotted AW pin.
18. With one person holding the Slotted AW Pin, tubing and Soil Gas Washer, the second person then threads the assembled Mini Probe onto the AW pin. Make sure that the slotted AW pin provided by BESST, Inc. is used and screwed into the Drive Head (with the 1/8" thick tri-nubs facing down towards the Soil Gas



**Figure 8: Attaching Mini Probe to Slotted AW Pin**

Washer. Continue to rotate until you can feel the external o-ring of the Soil Gas Washer seat into the bottom receiving hole of the Drive Head.

19. The Mini Probe is ready to be lowered into the borehole and transited to the borehole bottom where it is set in a stationary position before being driven into the subsurface.

#### **Section 1.4: Maintenance and Normal Wear and Tear of the Mini Probe**

The Mini Probe is a durable sampling probe. It is typically used with a variety of drive hammers, ranging in weight between 140 lbs. to 5,000 lbs. Standard care that should be taken to extend the life of the Mini Probe tools is the following:

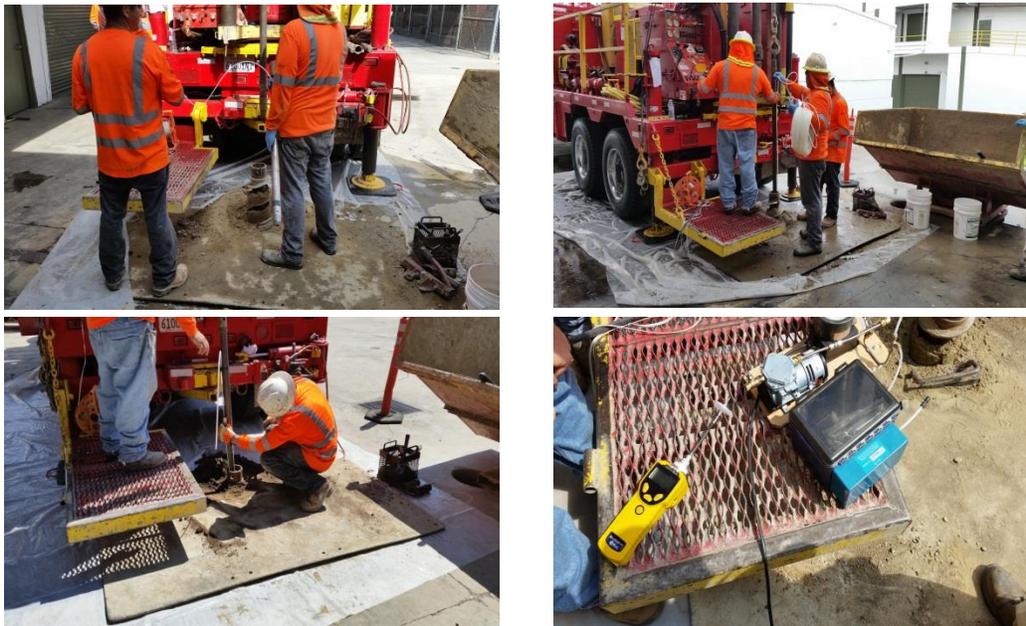
- Do not store the Mini Probe in a moist or wet place.
- If the Mini Probe becomes wet or moist between or after a sampling event, then the probe should be dried off in preparation for the next event or following the end of the field day.
- Do not force threads to screw together. Each part should screw together effortlessly.
- If burrs develop on the Mini Probe threads and/or other parts, then carefully use a file to remove. If threads are severely damaged then it is recommended to either use a local machine shop to attempt repair of the threads, send to BESST to repair threads, or order a new part.
- Do not use thick-walled core sleeves. Doing so may damage the core barrel section of the Probe. The Mini Probe core sleeves should be ordered from the manufacturer and are fabricated to the correct wall thickness.
- The Mini Probe soil gas washer should be removed from the Drive Head when not in use. The washer should be thoroughly cleaned between sampling events so that dirt does not wedge between the washer and the washer's seat inside the Drive Head.
- The Mini Probe should not be run without core sleeves. Doing so could over compact sediment into the core barrel section of the tool and cause the section halves of the core barrel to spread apart while the sampler is screwed together. Doing so can damage the core barrel as well as the threads in the Drive Shoe Assembly.
- If the front cutting edge of the Drive Shoe becomes damaged, assess the degree of damage and replace if necessary. Otherwise, light filing and grinding could be performed in order to maintain its functionality.

- Periodically inspect the external surface of the Drive Head in the vicinity of the large outer o-ring seal on the underside of the Drive Head. Over time, the outer metal edge may become damaged and compress the o-ring groove. Therefore, it is advisable to always use the prescribed box wrench tooling shown in Figure 5 to loosen and tighten the Drive Head – as well as other parts on the Mini Probe.
- Always use the prescribed tools on the Mini Probe for assembling and disassembling the Mini Probe in order to derive maximum extended use of the tooling.

#### Section 1.4: Deployment, Sampling and Retrieval of the Mini Probe With Hollow Stem Auger (and other cased hole drilling methods)

##### *Deployment*

Once the SimulProbe has been assembled, the next step is down-hole deployment (Figure 9). The Mini Probe is attached to the soil gas line which is typically polyethylene (LDPE or HDPE), Teflon, or Teflon lined polyethylene tubing. The typical diameter that is used is ¼" OD x 3/16" ID. Depending on regulatory guidelines, some projects require that the tubing is changed out after each sample, some after each borehole. The most frequent requirement according to our experience is to change out the tubing after each sample. Whenever the tubing



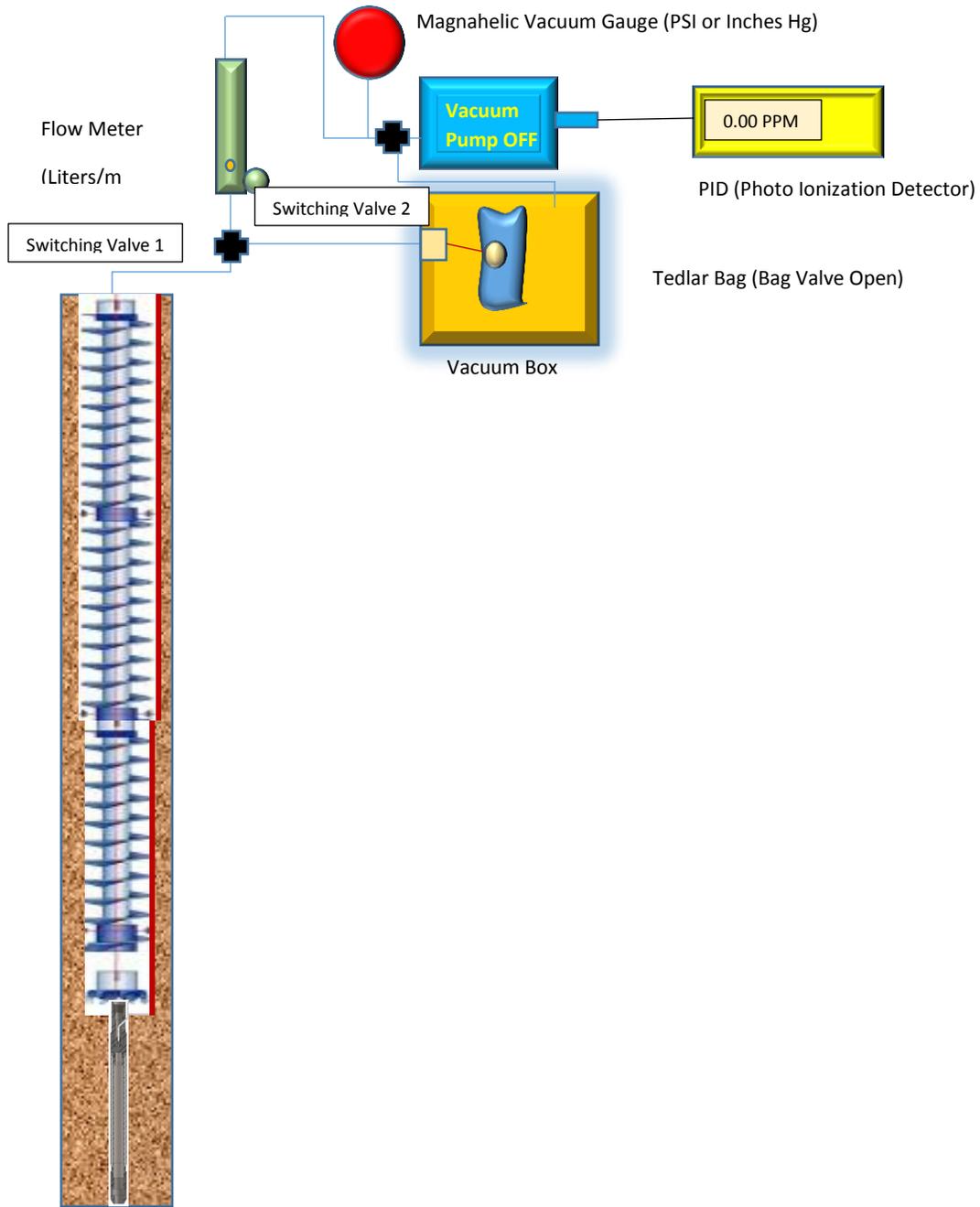
**Figure 9: Ready Mini Probe for down-hole transit through auger (upper left). Lowering through hollow stem auger drill stem with soil gas tubing (upper right photo). Using Mini Probe core sleeve to mark drive distance on drive hammer rod (lower left); (total drive distance = 18 inches for core barrel and 3 inches for drive shoe = total drive distance of 21 inches). Using PID to detect TVOC PID concentration from vacuum pump exhaust (NOTE: the end of the PID sniffer tube is inserted into the exhaust port when monitoring begins).**

is replaced, the ferrule set that secures the tubing connection must also be replaced at each required location (connection to Mini Probe Soil Gas Washer) and connection to Vacuum Pump (Figure 8 – lower right photo). The Mini Probe is then driven ahead 20 to 21 inches using the drill rig's drive hammer.

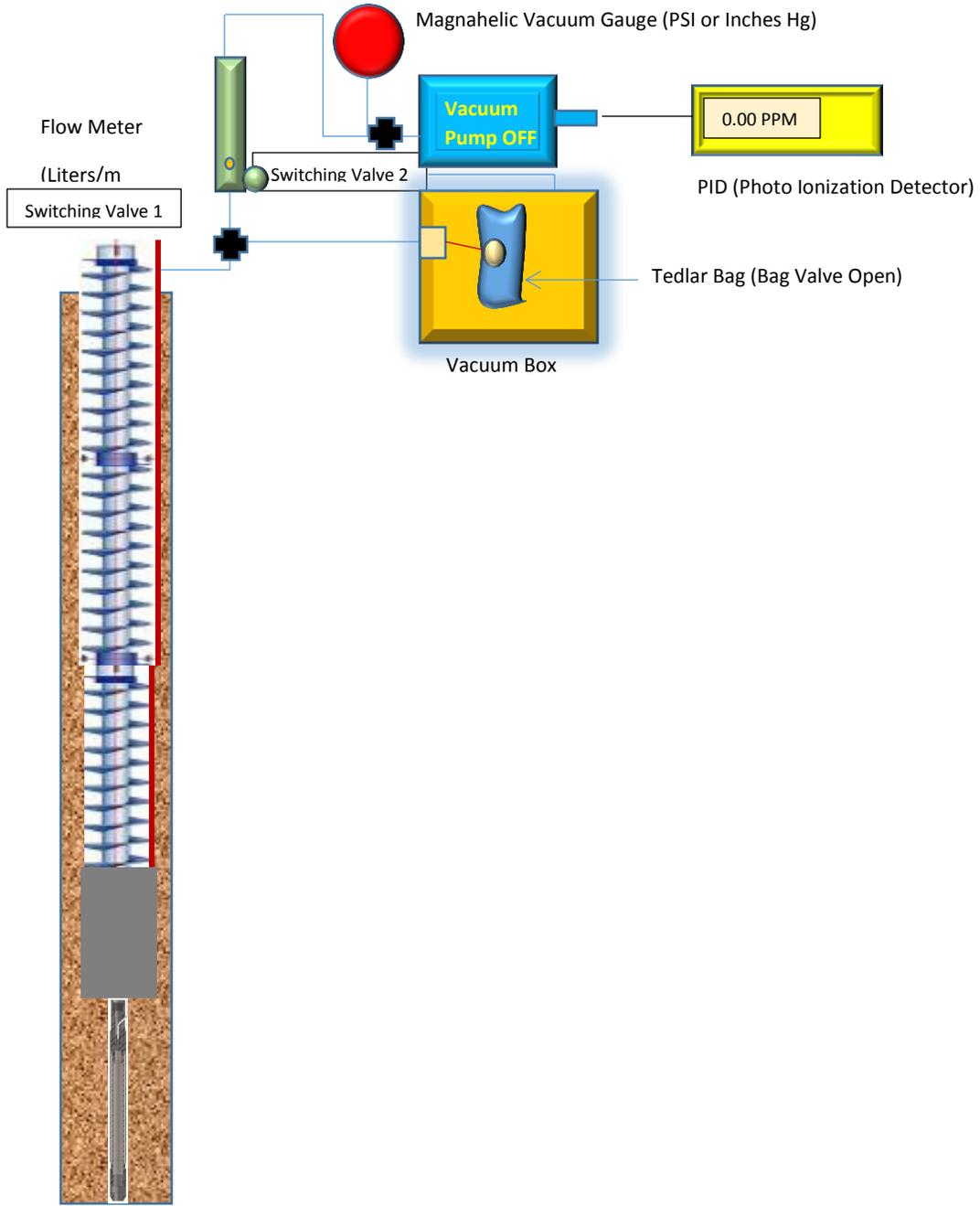
Upon completing the drive distance, the auger flight is then retracted by the driller 1 to 2 feet. Either a thick solution of hydrogel or dry bentonite crumble is poured down the auger flight in sufficient quantity to fill the open borehole space created by the retracted auger. If crumble is used, about 1-liter of distilled water is poured down the auger flight following the emplacement of the crumble. The crumble hydrates almost immediately, but the operator should wait 5 to 10 minutes for complete hydration.

*Sampling*

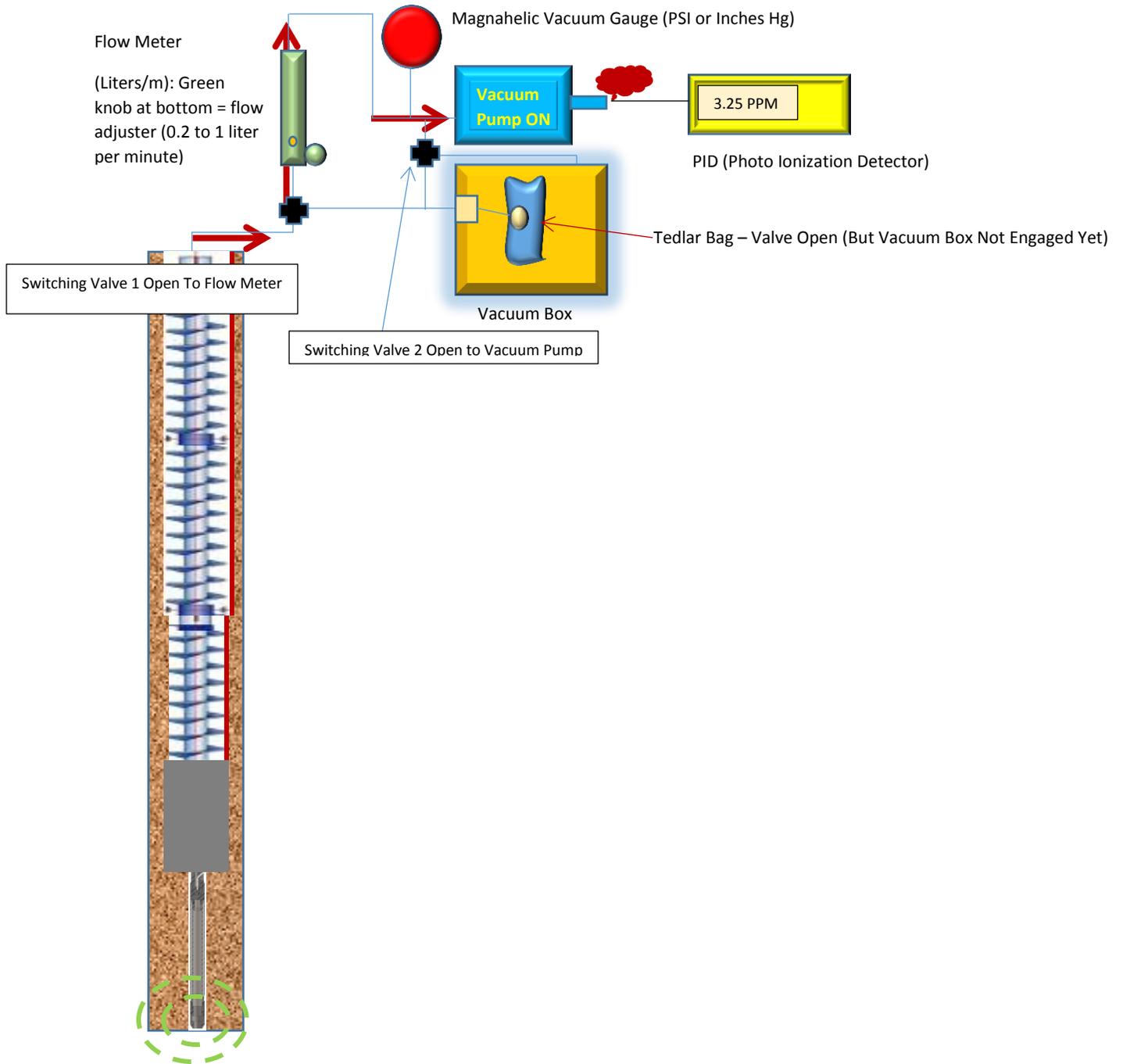
Figures 10 through 13 show the sequence of events in terms of how a Tedlar bag sample is collected.



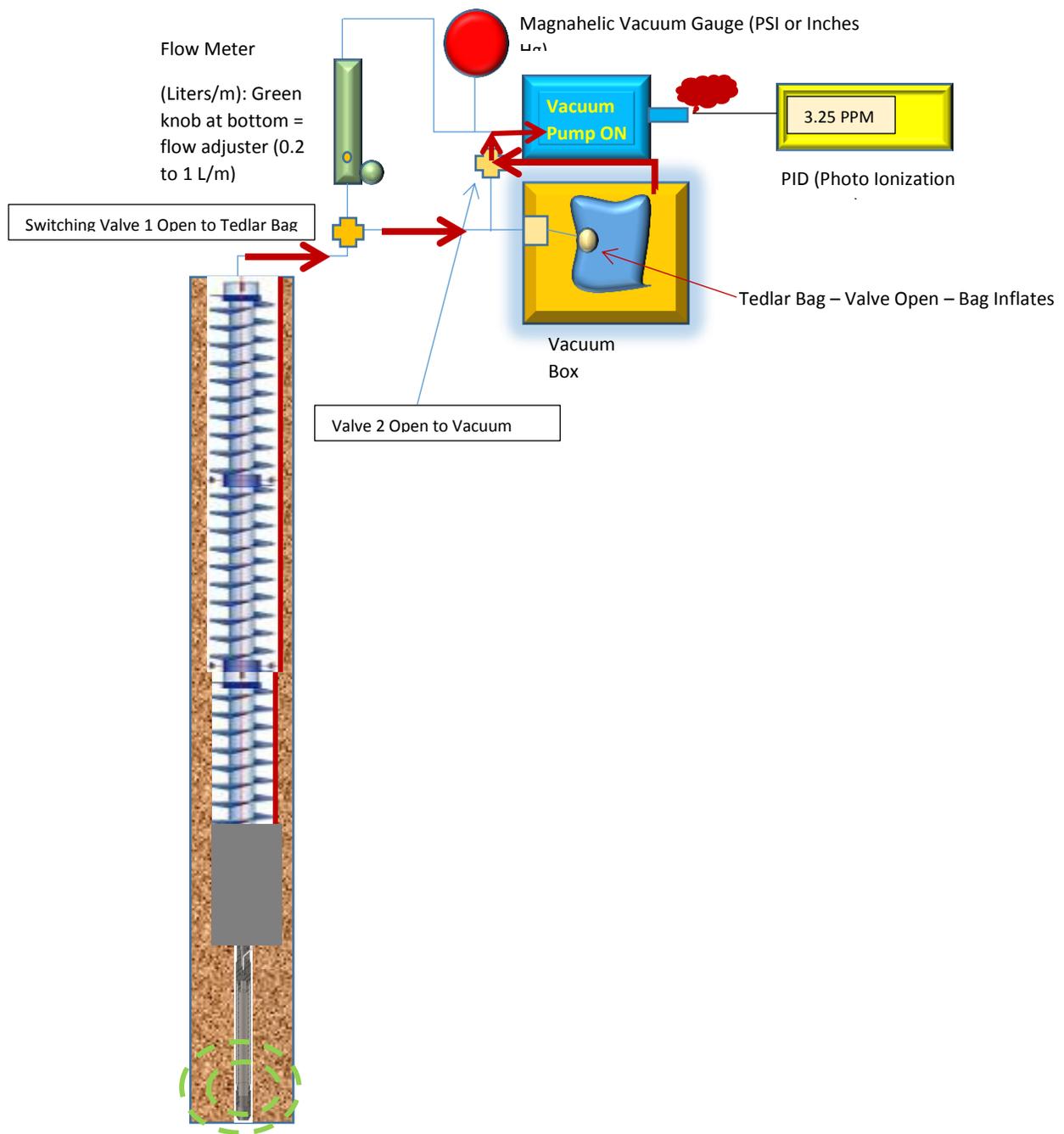
**Figure 10: General Overview of Vacuum Pump / Vacuum Box assembly for Down-Hole Soil Gas Sampling. Hydrated bentonite “Hydrogel” or Bentonite Crumble seal not installed yet.**



**Figure 11: Bentonite Seal Installed (Auger flights retracted 1 to 2 feet prior to seal installation)**



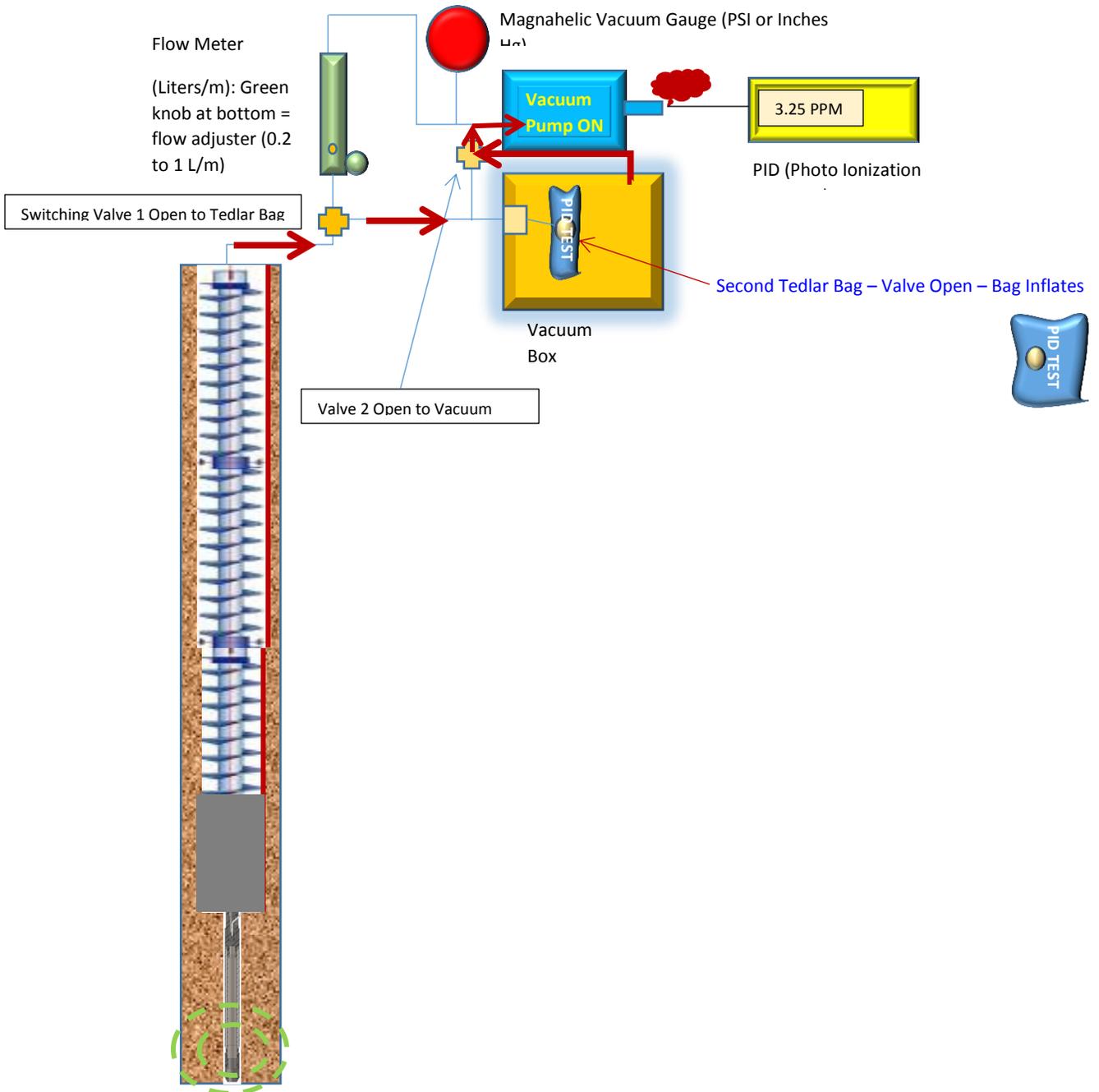
**Figure 12: Purge 3 x Tubing Volume + 3 x Mini Probe Volume (20 ml): Sniff vacuum pump exhaust with PID. Monitor PID concentrations. Wait for peak and then sample when PID readings are stable and 3 X purge volumes reached. DO NOT OVER PURGE SINCE OVER PURGING COULD LEAD TO THE NEGATIVE PRESSURE WAVE GROWING BEYOND THE UPPER BOUNDARY OF THE BENTONITE SEAL AND SHORT CIRCUIT WITH THE BOREHOLE ATMOSPHERE.**



**Figure 13: Inflation of Tedlar Bag. Inflate to approximately 2/3 full.**

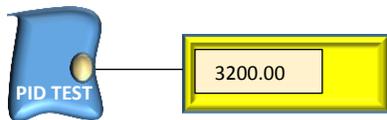
### Section 1.6: SimulProbe In-situ Head Space Test

The SimulProbe In-Situ Head Space Test is shown in Figure 13. The purpose of the test is to obtain a more representative PID measurement prior to the core sample being brought to the ground surface. For this test, a second Tedlar bag is placed inside the vacuum box and the box is closed and once again. Steps shown in Figures 9 through 12 are repeated once more with the final step (Figure 12) being repeated as before and shown in Figure 13 below (but with a Tedlar bag labeled (PID TEST)).



**Figure 14: SimulProbe In-Situ Head Space Test. The soil core is screened in-situ prior to removal of Mini Probe from subsurface drive hole.**

The Tedlar bag is then removed from the vacuum box and connected to the sniffer tube of the PID. The valve on the bag is then opened and the reading recorded from the PID analyzer on the boring log report data sheet.



**Figure 15: PID analysis of Tedlar test bag**

### *Retrieval*

The Mini Probe is then removed from the borehole and the core samples retrieved from the core barrel section. If desired, a sub-core of the soil sample can be collected for both an ex-situ head space test in a plastic baggy or glass jar as well as a lab analysis. The MiniProbe is then decontaminated in a typical three step wash, dried and reloaded with the consumable parts.

### **Section 1.7 General practice for Tedlar Bag sampling**

Using a bag to collect an air sample normally involves “active” sampling, unlike an evacuated canister that can be filled “passively” by simply opening the valve. There are two methods commonly used to fill a bag: a pump or a lung sampler. Sampling with a Pump: The most common method for filling a bag is to use a small pump with low flow rates (50-200 mL/min) and tubing to fill the bag. Eurofins Air Toxics, Inc. does not provide pumps but pumps may be rented from equipment providers or purchased from manufacturers such as SKC or Gilian. Sampling with a Lung Sampler: A “lung sampler” may be used to fill a bag. Although a little more complicated than simply using a pump, the main advantage to using a lung sampler to fill a bag is that it avoids potential pump contamination. bag with attached tubing is placed in a small airtight chamber (even a 5-gallon bucket can work) with the tubing protruding from the chamber. The sealed chamber is then evacuated via a pump, causing the bag to expand and draw the sample into the bag through the protruding tube. The sample air never touches the wetted surfaces of the pump. Eurofins Air Toxics does not provide lung samplers, but they can be rented from equipment suppliers or purchased by manufacturers such as SKC Inc.

#### **1.7.1 Considerations for Bag Sampling Some considerations for collecting a bag sample:**

- Fill the bag no more than 2/3 full: Allow for possible expansion due to an increase in temperature or decrease in atmospheric pressure (e.g., the cargo hold of a plane) Keep the Tedlar® bag out of sunlight:
- Tedlar® film is transparent to ultraviolet light (although opaque versions are available) and the sample should be kept out of sunlight to avoid any photochemical reactions Protect the bag:
- Store and ship the bag samples in a protective box at room temperature. An ice chest may be used, but DO NOT CHILL Fill out the bag label: It is much easier to write the sample information on the label before the bag is inflated. Make sure to use a ball-point pen, never a Sharpie or other marker which can emit VOCs. Provide a “back-up” bag:
- Consider filling two bags per location in the rare occasion that a defective bag deflates before analysis. The “hold” sample does not need to be documented on the Chain-of-Custody and should have an identical sample ID to the original sample indicating that it is the “hold” sample
- Avoid Contamination: Care should be taken to avoid contamination introduced by the pump or tubing. Begin sampling at locations with the lowest compound concentrations (e.g., sample the SVE effluent before the influent). Decontaminate the pump between uses by purging with certified air for an extended period; better yet, use a lung sampler.
- Use the shortest length possible of Teflon® tubing or other inert tubing. DO NOT REUSE TUBING. If long lengths of tubing are used, consider purging the tubing with several volumes worth before sampling. If

you are concerned about sampling for trace compounds, you shouldn't be using a Tedlar® bag (see Section 1.2)

- Don't Sample Dangerous Compounds in a Bag: Do not ship any explosive substances, radiological or biological agents, corrosives or extremely hazardous materials to Eurofins Air Toxics. Bag rupture during transit to the laboratory is possible and the sampler assumes full liability.

### 1.7.2 Step-by-Step Procedures for Bag Sampling (Pump)

Note: These procedures are for a typical stationary source (e.g., SVE system) sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, bag, and tubing/fittings – if requested).
2. Verify pump cleanliness and operation (Eurofins Air Toxics does not provide pumps).

When ready to sample:

3. Purge sample port.
4. Attach new Teflon® tubing from sample port or probe to low flow rate pump.
5. Purge tubing.
6. Fill out bag sample tag.
7. Attach additional new Teflon® tubing from the pump outlet to the bag valve.
8. Open bag valve.
9. Collect sample (FILL NOMORE THAN 2/3 FULL).
10. Close bag valve by hand tightening valve clockwise.
11. Return filled bags in a rigid shipping container (DO NOT CHILL).
12. Fill out chain-of-custody and relinquish samples properly.
13. Place chain-of-custody in box and retain pink copy.

### Section 1.8: Key Application of the Mini-Probe! Relating Soil Vapor Concentration to Total Soil Concentration

Calculation of total soil concentrations using the method outlined below will vary depending on the input choice of chemical and physical values, such as soil adsorption coefficients (Koc) and soil organic carbon fractions (foc). In this section, ADEQ provides a list of default values and methods to derive alternative values to be utilized in the three-phase partitioning equation outlined in Section 6.1. The listed default values are appropriate for use throughout much of Arizona and are conservative values so as to be protective of public health and the environment.

#### 1.8.1 Three-phase Partitioning Equation

The following three-phase partitioning equation is accepted by ADEQ for the calculation of total soil concentrations which may occur in situ for a chemical. The equation is based on a standard soil partitioning equilibrium model which assumes that a fourth phase, non-aqueous phase liquid (NAPL) is not present. Therefore,

at soil concentrations exceeding the 3-phase saturation limit, measured soil vapor concentrations are inapplicable for calculating total soil concentrations using this equation. The equations used that govern the equilibrium partitioning between phases are the linear sorption partitioning equation normalized with respect to organic carbon (Karichoff et al., 1979) and Henry's Law:

$$C_t = \frac{C_g [K_{oc} f_{oc} \rho_b / H_o + \theta_w / H_o + (\theta_t - \theta_w)]}{\rho_b}$$

where,

$C_t$  – Total concentration in soil ( $\mu\text{g}/\text{kg}$ )

$C_g$  – Concentration in soil vapor ( $\mu\text{g}/\text{L}$ )

$f_{oc}$  – Mass fraction of natural soil organic carbon content (g-organic carbon/g-soil)

$K_{oc}$  – Soil organic carbon-water partitioning coefficient (ml/g)

$\rho_b$  – Dry Bulk Density (kg/L)

$H_o$  – Henry's Law Constant (dimensionless)

$\theta_t$  – Total soil porosity (volume of voids/volume total)

$\theta_w$  – Volumetric Water Content (volume of water/volume of soil)

#### List of Default Values for the Soil Matrix

- **Fraction of Organic Carbon in Soil ( $f_{oc}$ ).** A default input for fraction of organic carbon in soil of 0.006 (0.6%) is selected for use in the equation.
- **Soil Dry Bulk Density ( $\rho_b$ ).** A default input for dry bulk soil density of 1.5 kg/L is selected for use in the equation. Dry bulk-densities for basin-fill deposits typically range from 1.3 to 1.8 kg/L. The 1.5 kg/L value is within this range.
- **Total Soil Porosity ( $\theta_t$ ).** A total soil porosity of 0.43 (43%) is selected is selected for use in the equation and was based on a default soil particle density ( $\rho_s$ ) of 2.65 kg/L [ $\theta_t = 1 - \rho_b/\rho_s = 0.43$ ].
- **Soil Volumetric Water Content ( $\theta_w$ ).** A default volumetric water content of 15% (0.15) is selected for use in the equation. Volumetric water content in basin-fill deposits typically range from 5 to 25 percent. The 15% value is within this range.

List of Chemical Default Values ( $K_{oc}$  and  $H_o$ ) for Selected VOCs Soil organic carbon-water partitioning coefficients ( $K_{oc}$ ) and dimensionless Henry's Law constants ( $H_o$ ) are provided for the following VOCs (see table below).

These values, taken from Soil Screening Guidance (US EPA, 1996), are generally accepted for use in the three-phase partitioning equation. The chemicals shown are not a complete list of all potential VOCs encountered in contaminant releases, but represent those commonly encountered, those with greater potential to exist in the vapor phase, or those with greater toxicity relative to other VOCs. Alternative  $K_{oc}$  and  $H_o$  values can be substituted for the values listed in the table on the next page if those alternative values more accurately represent conditions encountered at a site. Sources for these values may be obtained from the Superfund Chemical Data Matrix (US EPA, most current editions) and the most recent version of Estimation Programs Interface Suite™ (US EPA, 2007) available at <http://www.epa.gov/opptintr/exposure/pubs/episuite.htm>.

Compound	K <sub>oc</sub> (L/kg) <sup>1</sup>	H <sub>o</sub> (dimensionless) <sup>2</sup>
Benzene	5.89E+01	2.28E-01
Bromodichloromethane	5.50E+01	6.56E-02
Bromoform	8.71E+01	2.19E-02
Carbon disulfide	4.57E+01	1.24E+00
Carbon tetrachloride	1.74E+02	1.25E+00
Chlorobenzene	2.19E+02	1.52E-01
Chloroform	3.98E+01	1.50E-01
1,2-Dibromoethane (EDB)	2.81E+01	2.90E-02
1,1-Dichloroethane	3.16E+01	2.30E-01
1,2-Dichloroethane (DCA)	1.74E+01	4.01E-02
1,1-Dichloroethene	5.89E+01	1.07E+00
cis-1,2Dichloroethene	3.55E+01	1.67E-01
Trans-1,2=Dichloroethene	5.25E+01	3.85E-01
1,2-Dichloropropane	4.37E+01	1.15E-01
1,3-Dichloropropene	4.57E+01	7.26E-01
Ethyl benzene	3.63E+02	3.23E-01
Methyl bromide	1.05E+01	2.56E-01
Methylene chloride	1.17E+01	8.98E-02
Styrene	7.76E+02	1.13E-01
1,1,1,2-Tetrachloroethane	9.33E+01	1.41E-02
Tetrachloroethene (PCE)	1.55E+02	7.54E-01
Toluene	1.82E+02	2.72E-01
1,1,1-Trichloroethane	1.10E+02	7.05E-01
1,1,2-Trichloroethane	5.01E+01	3.74E-02
Trichloroethene (TCE)	1.66E+02	4.22E-01
1,2,4-Trimethylbenzene	3.72E+03	2.30E-01
1,3,5-Trimethylbenzene	8.19E+02	3.20E-01
Vinyl acetate	5.25E+00	2.10E-02
Vinyl chloride	1.86E+01	1.11E+00
Xylenes (total) <sup>3</sup>	3.86E+02	2.76E-01

Ref. U.S. EPA Soil Screening Guidance: User's Guide, 2<sup>nd</sup> Edition (July 1996)  
<sup>1</sup> - K<sub>oc</sub> = organic carbon partition coefficient  
<sup>2</sup> - H<sub>o</sub> = Dimensionless Henry's Law Constant (HLC[atm-m]\*41(25°C))  
<sup>3</sup> - K<sub>oc</sub> and F<sub>oc</sub> values for total Xylenes represent average of values for *ortho*-, *meta*-, and *para*-Xylenes.

Table 1: Henry's Law Constants for common VOCs

Soil Vapor Unit Conversion Factors*		
Unit	To Convert To:	Multiply by:
µg/L	mg/m <sup>3</sup>	1
µg/m <sup>3</sup>	mg/m <sup>3</sup>	0.001
ppbv	µg/m <sup>3</sup>	MW/24
µg/m <sup>3</sup>	ppbv	24/MW
ppmv	mg/m <sup>3</sup>	MW/24
ppbv	mg/m <sup>3</sup>	MW/24,000
µg/L	µg/m <sup>3</sup>	1000
µg/m <sup>3</sup>	µg/L	0.001
µg/L	ppbv	24,000/MW
µg/L	ppmv	24/MW
ppbv	ppmv	0.001
ppmv	ppbv	1000

\*At standard temperature and pressure.

Table 2: Soil Vapor Unit Conversion Factors