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April 4, 2017

Ms. Joyce L. Munie, PE
Manager, Permit Section
Illinois Environmental Protection Agency
Bureau of Land
1021 North Grand Avenue East
Springfield, Illinois 62794

Routine Updates to Previously Submitted Standard Operating Procedures
Roxana, Illinois
1191150002 - Madison County
ILD080012305

Dear Ms. Munie:

As part of AECOM Technical Services, Inc.'s (AECOM's) routine quality improvement process, we recently performed a review of the Standard Operating Procedures (SOPs) used by field staff performing activities at the investigation Site in Roxana, Illinois. Previously revised versions of SOPs were submitted to the Illinois Environmental Protection Agency (IEPA) in September 27, 2013, July 3, 2014, and March 4, 2015, submittals from URS Corporation and in an August 3, 2015 submittal from AECOM. These procedures were originally submitted, as requested by various IEPA correspondences, within various reports and work plans related to the Investigation Site in Roxana, Illinois. We are submitting this package of updated SOPs for informational purposes.

The SOPs included with this submittal are listed below. All of the SOPs listed received editorial and formatting revisions. A summary of any additional substantive revisions made to the SOPs are included in the table below.

SOP No	SOP Title	Additional Revisions
3	Calibration and Maintenance of Field Instruments	Revised information regarding Water Level/Interface Probe field checks
4	Decontamination	Added section regarding decontamination of Tedlar® bags
8	Field Reporting and Documentation	Revised procedures related to the flow of data gathered during field activities and current Toughbook/Toughpad backup procedures
10	Well Gauging Measurements	Editorial and formatting

SOP No	SOP Title	Additional Revisions
23	Quality Assurance Samples	Editorial and formatting
44R	Soil Vapor Purging and Sampling	Added reference to decontaminated Tedlar® bags
47	Sub-Slab Soil Gas Installation and Sampling with Canisters	Added reference to decontaminated Tedlar® bags
48	Soil Vapor Extraction Well Data Collection and Sampling	Added reference to decontaminated Tedlar® bags
49	Soil Vapor Extraction Effectiveness Monitoring	Added reference to decontaminated Tedlar® bags
52	Soil Vapor Field Laboratory Screening	Added reference to decontaminated Tedlar® bags

If you have any questions, please contact Wendy Pennington at wendy.pennington@aecom.com (314-743-4166) or Bob Billman at bob.billman@aecom.com (314-743-4108).

Yours sincerely,

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encl: Revised SOPs
RCRA Corrective Action Certification Form

cc: Amy Boley (IEPA - Springfield, IL)
Gina Search (IEPA - Collinsville, IL)
Kevin Dyer (SOPUS)
Shannon Haney (Greensfelder Hemker)
Project File
Respositories (Roxana Public Library, website)

Illinois Environmental Protection Agency

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ILLINOIS EPA RCRA CORRECTIVE ACTION CERTIFICATION

This certification must accompany any document submitted to Illinois EPA in accordance with the corrective action requirements set forth in a facility's RCRA permit. The original and two copies of all documents submitted must be provided.

1.0 Facility Identification

Name: Wood River Refinery
Street Address: 900 S. Central Ave
City: Roxana, IL 62084
County: Madison
Site No. (IEPA): 1191150002
Site No. (USEPA): ILD 080 012 305

2.0 Owner Information

Name: Not Applicable
Mail Address:
City:
State: Zip Code:
Contact Name:
Contact Title:
Phone:

3.0 Operator Information

Name: Equilon Enterprises LLC d/b/a SOPUS
Mail Address: 17 Junction Drive, PMB #399
City: Glen Carbon
State: IL Zip Code: 62034
Contact Name: Kevin Dyer
Contact Title: Senior Principal Program Manager
Phone: 618-288-7237

4.0 Type of Submission (check applicable item and provide requested information, as applicable)

- ☐ RFI Phase I Workplan/Report
- ☐ RFI Phase II Workplan/Report
- ☐ CMP Report;
- ☑ Other (describe): Standard Operating Procedures updates

IEPA Permit Log No. B-43R
Date of Last IEPA Letter on Project: Jan 18, 2017
Log No. of Last IEPA Letter on Project: B-43R-CA-59, -60, -69

Does this submittal include groundwater information: ☐ Yes ☑ No

Date of Submittal: April 4, 2017

5.0 Description of Submittal: (briefly describe what is being submitted and its purpose)

Routine updates to previously submitted Standard Operating Procedures (SOPs)

6.0 Documents Submitted (identify all documents in submittal, including cover letter; give dates of all documents)

Cover Letter; SOPs 3, 4, 8, 10, 23, 44R, 47, 48, 49, and 52

7.0 Certification Statement

(This statement is part of the overall certification being provided by the owner/operator, professional and laboratory in Items 7.1, 7.2 and 7.3 below). The activities described in the subject submittals have been carried out in accordance with procedures approved by Illinois EPA. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

7.1 Owner/Operator Certification

(Must be completed for all submittals. Certification and signature requirements are set forth in 35 IAC 702.126.) All submittals pertaining to the corrective action requirements set forth in a RCRA Permit must be signed by the person designated below (or by a duly authorized representative of that person):

1. For a Corporation, by a principal executive officer of at least the level of vice president.
2. For a Partnership or Sole Proprietorship, by a general partner or the proprietor, respectively.
3. For a Governmental Entity, by either a principal executive officer or a ranking elected official.

A person is a duly authorized representative only if:

1. the authorization is made in writing by a person described above; and
2. the written authorization is provided with this submittal (a copy of a previously submitted authorization can be used).

Owner Signature: _____ Date: _____

Title: _____

Operator Signature: Lucie E Alexander Date: 03/29/17

Title: Senior Principal Program Manager

7.2 Professional Certification (if necessary)

Work carried out in this submittal or the regulations may also be subject to other laws governing professional services, such as the Illinois Professional Land Surveyor Act of 1989, the Professional Engineering Practice Act of 1989, the Professional Geologist Licensing Act, and the Structural Engineering Licensing Act of 1989. No one is relieved from compliance with these laws and the regulations adopted pursuant to these laws. All work that falls within the scope and definitions of these laws must be performed in compliance with them. The Illinois EPA may refer any discovered violation of these laws to the appropriate regulating authority.

Any person who knowingly makes a false, fictitious, or fraudulent material statement, orally or in writing, to the Illinois EPA commits a Class 4 felony. A second or subsequent offense after conviction is a Class 3 felony. (415 ILCS 5/44 (h))

Professional's Signature: _____ Date: _____

Professional's Name _____

Address _____ Professional's Seal:

City _____

State _____ Zip Code _____

Phone _____

7.3 Laboratory Certification (if necessary)

The sample collection, handling, preservation, preparation and analysis efforts for which this laboratory was responsible were carried out in accordance with procedures approved by Illinois EPA.

Name of Laboratory _____

_____ Date: _____

Signature of Laboratory Responsible Officer

Mailing Address of Laboratory

Address _____

City _____

State _____ Zip Code _____

_____

Name and Title of Laboratory Responsible Officer

1. Objective

This document defines the standard operating procedure for calibration and maintenance of field instruments frequently used during environmental field activities for the Shell projects in Hartford and Roxana, Illinois. This Standard Operating Procedure (SOP) gives descriptions of the most commonly used of these instruments and field procedures to calibrate and maintain these field instruments. Calibration and maintenance records are maintained with the project file.

2. Equipment

The following equipment is typically required during field instrument calibration and maintenance activities.

- Latex/Nitrile gloves
- Site logbook
- Field data sheets
- Equipment Calibration Record forms
- Distilled or deionized water
- Decontamination equipment
- Health and Safety Equipment
- Field Instrument Operations Manual
- Calibration gases for Air Monitoring Equipment
- Calibration solutions for Water Monitoring Equipment.

3. Types of Field Instruments Commonly used during Environmental Investigations

The following are some of the more commonly used instruments during environmental investigations.

- Photoionization Detector (PID)
- Flame Ionization Detector (FID)
- Multi-gas Meter (usually includes Explosimeter, Hydrogen Sulfide detector, Oxygen sensor, and Carbon Monoxide meter)
- Single-gas Meter (usually Benzene or Hydrogen Sulfide meters)

- Groundwater Level Indicator
- Petroleum/Groundwater Interface Probe
- Groundwater pH, Temperature, Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential and/or Turbidity Meter(s).

4. Maintenance

Each instrument has specific maintenance requirements, which are described in the instrument's manufacturer's manual. These maintenance requirements should be followed. General maintenance such as regular cleaning of the instrument, battery checks and replacement, and ensuring the instrument is handled and stored properly can be performed by AECOM employees. Other maintenance items such as sensor repair, annual calibrations and repair of a malfunctioning piece of equipment should be performed by the instrument manufacturer or licensed dealer and should NOT be performed by AECOM employees, unless specifically directed by the equipment supplier. Contact the manufacturer or licensed dealer to determine where the instrument should be submitted for maintenance tasks, if necessary.

5. Calibration

Due to the wide variety of field instruments available, various parameters potentially monitored, and the wide range of functions potentially performed by each instrument, a description of the calibration of every type of instrument available is not feasible. However, a generalized SOP for general types of field equipment calibration is presented here. Refer to the manufacturer's manual for specific calibration instructions for the instrument being used.

The appropriate calibration field form for the equipment being calibrated should be completed in its entirety, including the equipment model and serial/ID number. If something on the calibration field form does not apply, fill in the space on the form with "NA".

Air Monitoring Instruments (PID, FID, Multi-gas Meters, Single-gas meters, etc.)

1. Turn the instrument on. The on/off switch may be a toggle switch, knob, or button to be depressed depending on the type and brand of instrument being used.
2. Allow the instrument to "warm up" and progress through the startup diagnostic routine.
3. Perform a "fresh air" calibration, if possible, for the air meter. This fresh air calibration should be performed using a zero air filter provided with the air monitor or using a zero air calibration gas.

4. Record the initial reading on the proper equipment calibration field form. Also record the fresh air calibration standard on the field form.
5. Apply the proper calibration gas and proceed with calibration as directed in the manufacturer's manual.
6. Record the final calibrated reading on the field equipment calibration forms.
7. Verify a moisture and dust filter is in place on the air meter intake nozzle, when applicable.
8. If directed in the manufacturer's manual, at periodic intervals throughout the day, the calibration of the instrument should be checked and re-evaluated as directed in the manufacturer's manual.

Groundwater Parameter Instruments (Troll 9500, pH-Con 10, turbidimeters, etc.)

Frequently one instrument will have multiple sensors for measuring various parameters in water. With the exception of temperature, each of these parameters can generally be field calibrated.

1. Turn the instrument on. The on/off switch may be a toggle switch, knob, or button to be depressed depending on the type and brand of instrument being used.
2. Allow the instrument to "warm up" and progress through the startup diagnostic routine.
3. Apply calibration solution(s) as instructed by the instrument prompts and/or the manufacturer's manual. Reseal calibration solution containers for future use.
4. Adjust the reading of the instrument to correlate to the corresponding calibration solution being applied.
5. Record calibration reading(s) on the proper field calibration form(s).
6. Dispose of used calibration solution.

Water Level Indicator and Petroleum/Water Interface Probe

Field calibration of this instrument is not required. Rather a series of field checks to ensure the instrument is in proper working order are described.

1. Turn the instrument on. The on/off switch is usually a knob located on the side of the reel which the measuring tape is rolled onto.

2. Push the "test" button to ensure that the batteries are in working order. If the batteries are working, an audible tone will be heard and a visible light located on the side of the real will illuminate.

3. Immerse the sensor probe in distilled water to ensure the audible tone is heard and visible light illuminates when the probe enters the water and make an observation of where the water level is at on the probe. Repeat this step several times to familiarize yourself with this contact point. If sensor probe does not react when immersed, contact the manufacturer or licensed dealer for troubleshooting or replacement.

4. Immerse the sensor probe (for interface probes only) in pure phase product (such as vegetable oil or baby oil) to ensure the audible tone is heard and visible light illuminates when the probe enters the product. Make an observation of where the product level is at on the probe. Perform decontamination on the probe as outlined in SOP No. 4 Decontamination after this step. If sensor probe does not react when immersed, contact the manufacturer or licensed dealer for troubleshooting or replacement

6. Decontamination

Small instruments and equipment that comes into contact with environmental media shall be cleaned according to SOP No. 4 – Decontamination between each use, and shall be stored in such a way as to prevent contamination.

1. Objective

This document defines the standard procedure for decontamination of field equipment and personnel for Shell projects in Hartford and Roxana, Illinois. This SOP is intended to be used together with several other SOPs.

The overall objective of multimedia sampling programs is to obtain samples that accurately depict the chemical, physical, and/or biological conditions at the sampling site. Extraneous contaminants can be brought onto the sampling location and/or introduced into the medium of interest during the sampling program (e.g. using sampling equipment that is not properly or fully decontaminated). Trace quantities of contaminants can consequently be captured in a sample and lead to false positive analytical results and an incorrect assessment of the contaminant conditions associated with the site. Decontamination of drilling, sampling and other equipment (e.g., all non-disposable equipment that will come in direct contact with samples) is, therefore, required prior to, between, and after uses to ensure that sampling cross-contamination is prevented, and that on-site contaminants are not carried off-site.

2. Equipment

The following is a list of equipment that may be needed to perform decontamination:

- Brushes
- Wash tubs
- Buckets
- Scrapers, flat bladed
- Hot water - high-pressure sprayer
- Sponges or paper towels
- Liquinox detergent (or equivalent)
- Isopropyl alcohol
- Potable tap water
- Deionized or distilled water
- Garden-type water sprayers
- Plastic sheeting or trash bags
- Gast® high-flow pump (or equivalent)

3. Decontamination Procedures

Proper mixing instructions for Liquinox detergent: use 2.5 tablespoons Liquinox detergent per gallon of water. If another detergent is being used, verify the proper mixing instructions prior to use.

Detergent water and rinse water shall be mixed fresh each morning and shall be replaced with new solutions at least at mid-day. More frequent replacement of solutions may be necessary if gross contamination (i.e., free product, sheen, or suspended particles) is observed.

3.1 Personnel

Personnel shall be provided space to wash and rinse gloves, and any other non-disposable personal protective equipment (PPE). A container shall be available to dispose of used disposable items such as gloves, or tyvek (if used).

The decontamination procedure for field personnel shall include:

1. Glove wash in an Liquinox (or similar) solution
2. Glove rinse in distilled water
3. Outer glove removal, if present
4. Coverall removal, if present
5. Inner glove removal

Refer to the project Health and Safety Plan (HASP) for additional information. If conditions change and/or upgrade of PPE is required, refer to the task or project specific HASP for more specific information.

3.2 Groundwater Parameter Equipment (e.g., TroII 9500 or similar)

Equipment used to measure groundwater parameters, which does not come into contact with the sample, may be decontaminated between wells if necessary (i.e., gross contamination observed on the sonde probes, history of elevated benzene results at a particular well[1], etc.) (Steps 1 through 6 below). This equipment will, at a minimum, be decontaminated at the end of each sampling day (Step 7 below). The following steps shall be used when decontaminating groundwater parameter measuring equipment:

[1] Elevated levels of benzene may cause accelerated deterioration of the optical dissolved oxygen lens, which in turn will require more frequent lens replacement.

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the project (HASP).
2. Spray or wash sensors with a soap and water solution (Liquinox or similar and potable or distilled water).
3. Spray or rinse sensors with distilled water.
4. Wash Flow Cell in a wash tub or bucket containing soap and water solution (Liquinox or similar along with potable or distilled water) and scrubbed with a bristle brush or similar utensil.
5. Rinse Flow Cell with distilled water in a second tub or bucket.
6. Detergent water and rinse water shall be mixed fresh each morning and shall be replaced with new solutions at least at mid-day. More frequent replacement of solutions may be necessary if gross contamination (i.e., free product, sheen, or suspended particles) is observed.
7. At the end of each sampling day,
    a. Soak the optical dissolved oxygen (DO) cap in distilled vinegar for 10 to 15 minutes.
    b. Rinse the optical DO cap in distilled water.
    c. Wash the Flow Cell in a wash tub or bucket containing soap and water solution (Liquinox or similar along with potable or distilled water and scrubbed with a bristle brush or similar utensil.
    d. Rinse Flow Cell with distilled water in a second tub or bucket.
    e. If flow through cell is still odorous, soak in a wash tub or bucket containing soap and water solution (Liquinox or similar along with potable or distilled water) for 10 to 15 minutes. Also consider performing decontamination activities more often during the next sampling day/event.

Following decontamination, equipment shall be placed in a clean area (i.e., in the truck, in a dedicated container, etc.) or on clean plastic sheeting in the work zone to prevent contact with contaminated media. If the equipment is not used immediately after decontamination, the equipment shall be stored in a manner which minimizes potential contact with contaminants.

3.3 Groundwater Sampling Pumps

Submersible, non-dedicated, non-disposable groundwater sampling pumps shall be decontaminated between each sampling location. The following steps shall be used to decontaminate groundwater sampling pumps:

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the HASP.
2. Exterior of the sampling pump, including the electrical cord, shall be sprayed and/or wiped off with isopropyl alcohol to remove gross contamination. The outer sampling pump casing may be removed, if necessary, to remove gross contamination on sampling pump motor module.
3. Sampling pump, including electrical cord, shall be placed in a wash tub or bucket containing a soap and water solution (Liquinox or similar along with potable or distilled water). Sampling pump shall be turned on to circulate the soapy water for a minimum of 5 minutes.
    a. Sampling pump may be scrubbed with a bristle brush, sponge or similar utensil.
    b. If the electrical cord will not fit into the wash tub or bucket, it can be wiped down with a paper towel saturated with a detergent water solution.
4. Sampling pump, including electrical cord, shall be placed in a second tub or bucket containing distilled water. Sampling pump shall be turned on to circulate rinse water for a minimum of 5 minutes and until water coming out of the pump no longer contains soapy solution.
    a. If the electrical cord will not fit into the tub or bucket, it can be wiped down with a paper towel saturated with distilled water.
5. Detergent water and rinse water shall be mixed fresh each morning and shall be replaced with new solutions at least at mid-day. More frequent replacement of solutions may be necessary if gross contamination (i.e., free product, sheen, or suspended particles) is observed.

Following decontamination, equipment shall be placed in a clean area (i.e., in the truck, in a dedicated container, etc.) or on clean plastic sheeting in the work zone to prevent potential contact with contaminants. If the equipment is not used immediately after decontamination, the equipment shall be stored in a manner which minimizes potential contact with contaminants.

3.4 Water Level / Interface Probes

The following steps shall be used to decontaminate water level meters and water/product interface probes:

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the HASP.
2. A paper towel or other disposable media shall be saturated with isopropyl alcohol.
3. A portion of a second paper towel or other disposable media shall be saturated with a detergent water solution and the remaining portion of the same paper towel or other disposable media shall be saturated with distilled water.
4. The measuring tape shall be wiped clean as they are removed from the monitoring well by passing through the saturated disposable media. The tape must pass through the isopropyl alcohol first, detergent water solution second, and the distilled water last.
5. Care shall be taken to replace saturated paper towels if gross contamination is observed or to replace paper towels which become dry during the process.
6. Probe tip shall also be sprayed off with Liquinox (or similar) detergent water solution and distilled water after wiping.
    a. Solinst brand probe tips may also be sprayed off with isopropyl alcohol, if necessary.
    b. Heron brand probe tips should NOT be cleaned with isopropyl alcohol.
    c. If another brand interface probe is being used, check the equipment manual to verify proper decontamination procedures and solutions.

Following decontamination, equipment shall be placed in a clean area (i.e., in the truck, in a dedicated container, etc.) or on clean plastic sheeting in the work zone to prevent potential contact with contaminants. If the equipment is not used immediately after decontamination, the equipment shall be stored in a manner which minimizes potential contact with contaminants.

3.5 Other Sampling Equipment

The following steps shall be used to decontaminate other sampling equipment:

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the HASP.

2. Gross contamination on equipment shall be scraped/wiped off at the sampling or construction site.
3. Equipment shall be sprayed and/or wiped off with isopropyl alcohol.
4. Equipment that cannot be damaged by liquid or water shall be placed in a wash tub or bucket containing soap and water solution (Liquinox or similar along with potable or distilled water) and scrubbed with a bristle brush or similar utensil.
5. Equipment that cannot be damaged by liquid or water shall then be rinsed with distilled water in a second tub or bucket.
6. Equipment that may be damaged by liquid/water shall be carefully wiped clean using a sponge/paper towel with isopropyl alcohol, followed by a sponge/paper towel with detergent water and a sponge/paper towel with deionized or distilled water. Care shall be taken to prevent equipment damage.
7. Detergent water and rinse water shall be mixed fresh each morning and shall be replaced with new solutions at least at mid-day. More frequent replacement of solutions may be necessary if gross contamination (i.e., free product, sheen, or suspended particles) is observed.

Following decontamination, equipment shall be placed in a clean area (i.e., in the truck, in a dedicated container, etc.) or on clean plastic sheeting in the work zone to prevent contact with contaminated media. If the equipment is not used immediately after decontamination, the equipment shall be stored in a manner which minimizes potential contact with contaminants.

3.6 Drilling and Heavy Equipment

Drilling rigs shall be decontaminated at a decontamination station located near a central staging area. The decontamination station may consist of a temporary or permanent structure capable of collecting all decontamination fluids. Mobile decontamination trailers may be used to decontaminate heavy equipment at each site. The following steps shall be used to decontaminate drilling and heavy equipment:

1. Review JSA for drilling and heavy equipment decontamination.
2. Personnel shall dress in appropriate PPE to reduce personal exposure as required by the HASP.
3. Equipment showing gross contamination or having caked-on drill cuttings shall be scraped with a flat-bladed scraper at the sampling or construction site.

4. Equipment that cannot be damaged by water, such as drill rigs, augers, drill bits, and shovels, shall be washed with a hot water, high-pressure sprayer then rinsed with potable water. Care shall be taken to adequately clean the insides of the hollow-stem augers, backhoe buckets, etc.

Following decontamination, drilling equipment shall be placed on the clean drill rig and moved to a clean area. If the equipment is not used immediately, it shall be stored in a designated clean area.

3.7 Equipment Leaving the Site

Vehicles used for site activities shall be cleaned on an as-needed basis, as determined by the Site Safety Officer, using soap and water on the outside and vacuuming the inside. On-site cleaning shall be required for dirty vehicles (i.e., muddy tires) leaving the site. Construction equipment, such as hollow stem augers, other drilling equipment, etc., shall be pressure washed before the equipment is removed from the site to limit exposure of off-site personnel to potential contaminants.

3.8 Wastewater

Liquid waste water from decontamination activities shall be containerized and left at the site where it originated, unless otherwise specified. Check the project/task work plan or with the Project Investigative-derived Waste (IDW) Coordinator for additional information/guidance.

3.9 Tedlar® Bags

The following steps shall be used to decontaminate used Tedlar® bags for reuse:

1. Personnel shall dress in appropriate PPE to reduce the potential of personal exposure as required by the HASP.
2. Tedlar® bags shall be pre-sorted into the following purge categories based on previous concentration:

Oxygen (%)	Total Hydrocarbon Concentration (ppm)	Minimum Number of Purges Required
20.9	0.0	none
15 – 20.9	0.1 - 10	1
10 - 15	10 - 100	2
5 - 10	100 – 1,000	3
<5	1,000 – 10,000	4
	10,000 – 100,000	5
N/A	> 100,000	Discard bag

If the oxygen and total hydrocarbon concentration (THC) values in the previous Tedlar® bag concentration do not line up on the table above, the more conservative approach (i.e., the most number of purges) shall be chosen.

3. In a well ventilated area, begin the purge process by introducing ambient air into the Tedlar® bag through a Gast® sampling pump (or equivalent). Fill the Tedlar® bag approximately 80% full and then expel the ambient air from the Tedlar® bag. Repeat until the required number of purges outlined in Step 2 above has been performed.

4. After the final purge is complete, introduce ambient air into the Tedlar® bag through the pump and screen the Tedlar® bag to ensure that Oxygen is 20.9% and THC is 0.0 ppm (ambient conditions). If ambient conditions are not present in the Tedlar® bag after purging is complete, discard the Tedlar® bag.

5. Once ambient conditions are verified and the Tedlar® bag is examined to ensure that it is structurally intact, expel the remaining air and affix a new sampling label. Place the Tedlar® bag in the designated storage location for future use.

4. Documentation

Sampling personnel shall be responsible for documenting the decontamination of sampling and drilling equipment. The documentation shall be recorded with waterproof ink in the sampler's field notebook with consecutively numbered pages. The information entered in the field book concerning decontamination shall include the following:

- Decontamination personnel
- Date and start and end times
- Decontamination observations
- Weather conditions.

Refer to SOP No. 8 Field Reporting and Documentation for further information regarding logbook entries and logbook management.

5. Quality Assurance Requirements

Equipment rinsate samples of the decontaminated sampling equipment may be taken to verify the effectiveness of the decontamination procedures. The rinsate sampling procedure shall include passing distilled water through or over a decontaminated sampling tool (such as a split spoon) and collecting the rinsate water into the appropriate sample bottles. The rinsate sampling procedure, including the sample number, shall be recorded in the field notebook.

1. *Objective*

This document defines the standard procedure for field reporting and documentation for Shell projects in Hartford and Roxana, Illinois. This standard operating procedure (SOP) provides descriptions of equipment and field procedures necessary to properly document field activities.

2. *Equipment*

Equipment used during field reporting and documentation may include, but is not limited to:

- Calculator
- Bound field logbook
- Waterproof pen and/or permanent marker
- Necessary field forms/paperwork (various)
- Panasonic Toughbook/Toughpad rugged tablet PC (Toughbook/Toughpad)
- Camera

3. *Field Reporting and Documentation*

Documentation of observations, activities and data acquired in the field shall provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data shall be recorded using one or more of the following:

- Pens with permanent waterproof ink in a permanently bound weatherproof field logbook;
- On any necessary field forms/paperwork;
- In a Toughbook/Toughpad.

Field investigation situations vary widely. No set of general rules can anticipate all information that must be collected for a particular project. The logbooks, field forms/paperwork and Toughbooks/Toughpads shall be kept in the field team's possession or in a secure place during the investigation.

Since field records (field logbooks, field forms, and Toughbook/Toughpad entries) are the basis for later written reports, and potentially subject to litigation, language should be objective, factual, and free of personal feelings or other terminology which might prove inappropriate. Once completed, these field records become project documents subject to potential legal holds and must be maintained as part of the official project files.

Changes or deletions in the field logbook or on field forms should be lined out with a single strike mark, initialed, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the sampler's memory.

At the end of each day and/or task, a scanned copy of any field sheets used and/or logbook entries made, as appropriate, should be emailed to the task manager and project administrator for review and filing. Obtain further direction regarding documents to be provided and at what frequency from the task/project manager.

4. *Field Logbook*

Each project or task should have a dedicated logbook. The following information should be recorded on the front cover of each logbook:

- Project name/location (i.e., Rand, Roxana, WRR, etc.);
- Date range or year of activities included within; and
- Task the logbook is for (i.e., Quarterly Groundwater; Drilling and Well Installations, System O&M, etc.).

The information in the field logbook should typically include the following as appropriate for the task being performed, even if this information is also recorded on field forms and/or a Toughbook/Toughpad:

- Date;
- Names of field team members performing work;
- Change in field team members throughout the day, if any;
- Any PPE upgrades/downgrades (i.e., Tyvek, respirator, etc.);
- Weather conditions;
- Names and company of subcontractors (if applicable);
- Names and title/organization of any site visitors (i.e., client, property owner, Agency representative, etc.);
- Time for each observation/entry;
- If calibration of field equipment is performed (calibration results are typically recorded on calibration sheets);
- Time of mobilizing to work location;

- Work location (i.e., Property, Process Area, Location ID, etc.);
- Work to be performed at location (i.e., water level gauging, drilling/sampling, etc.);
- Location of Sample (i.e., monitoring well ID, borehole location and depth, etc.);
- Description of samples (matrix sampled – i.e., water, soil vapor, soil, etc.);
- Time of sample collection;
- Sample ID;
- QA/QC samples collected (if applicable);
- Sample analysis planned (i.e., VOC, SVOC, BTEX, etc.);
- Odor observations during field activities, if any (i.e., hydrocarbon- or petroleum-like, etc.);
- Information concerning sampling changes, scheduling modifications, and change orders;
- Time and details of any delay (i.e. operator unavailable, car parked over location, drill rig delays, equipment malfunction, etc.);
- Field observations and/or summary of daily tasks;
- Sketch (i.e. well construction details, utility locate markings, etc.);
- Signature/Initials and date by personnel responsible for observations at the end of the entry/day;
- If decontamination is performed and on what equipment.

It is recommended that each page in the logbook shall be numbered and dated. The entries should be legible and contain accurate and inclusive documentation of the project/task activities. Lines and pages should not be skipped within a logbook. If a page is inadvertently skipped, a diagonal line should be drawn across the page and "Page inadvertently skipped" should be written. The bottom of each page in the field books shall be signed or initialed by the person making the entry at the end of the day.

5. *Field Forms/Paperwork*

Data may also be recorded on various field forms for different tasks performed. If filling out a field form, verify that every line contains an entry with the appropriate information. If something on the field form does not apply, that should be indicated using "NA".

6. *Toughbooks/Toughpads*

The AECOM employees working on the Shell project may also use a field laptop and/or Panasonic Toughbook/Toughpad rugged tablet PC (Toughbook/Toughpad) to collect field data. The Toughbooks/Toughpads have a Microsoft Windows 7 operating system and Microsoft Office software. For data management purposes, they are referred to using sequential numbering (Toughpad 1, Toughbook 1, Toughbook 2, Toughbook 3, etc.). Multiple electronic data entry programs have been developed. The programs were created using Microsoft Access, a relational database software program. When completing an entry in a Toughbook/Toughpad, verify that every line/box contains an entry with the appropriate information. If something in the Toughbook/Toughpad entry does not apply, that should be indicated using "NA".

Dedicated Toughbooks/Toughpads are typically used for dedicated locations and routine activities; however this may change over time or as tasks warrant.

The various Toughbooks/Toughpads are not automatically synchronized with one another or with a central database. Therefore, the database files are sent, typically via email, to the AECOM-St. Louis office at least once per week to mitigate the risk of data loss. The database files backed up in this manner also provide a means for aggregation of data into a central project database located in the AECOM-St. Louis office.

7. *Document Control*

Document control refers to the maintenance of inspection and investigation project files. All information below shall be kept in project files. Investigators may keep copies of reports in their personal files, however, all official and original documents relating to inspections and investigations shall be placed in the official project files. Information recorded in electronic format shall be saved in the project directory on the office network. The following documents shall be placed in the project file, if applicable:

- Chain-of-Custody Records and bound field logbooks
- Records obtained during the investigation
- Complete copy of the analytical data and memorandas transmitting analytical data
- Official correspondence received or transmitted, including records of telephone calls
- Photographs and/or digital files associated with the project
- One copy of the final report and transmittal memorandum

- Relevant documents related to the original investigation/inspection or follow-up activities related to the investigation/inspection.

Inappropriate personal observations and irrelevant information should not be placed in the official project files. Throughout the performance of field work as well as at the conclusion of the task/project, the Task Manager should review the file to ensure that it is complete or follow up with the field team member(s), if necessary.

1. Objective

This document defines the standard procedure for measuring water and non-aqueous phase liquid (NAPL) levels in monitoring wells for Shell projects in Hartford and Roxana, Illinois. This SOP serves as a supplement to information which might be in a project Work Plan or scope of work and is intended to be used together with other SOPs.

2. Equipment

The following equipment is typically needed:

- Water Level or Product/Water Interface probe with 0.01-foot increments;
- Well keys;
- Photoionization Detector (PID) (e.g., RAE Instruments MiniRAE 3000 or equivalent);Latex/Nitrile gloves;
- Site logbook;
- Field data sheets;
- Toughbook/Toughpad;
- Appropriate decontamination equipment;
- Appropriate personal protective equipment (PPE); and
- Permanent ink pen.

3. Fluid Level Measurement Procedures

Observations made during the fluid (water and/or NAPL) level measurement shall be recorded in the field logbook, on appropriate field forms, and/or in the appropriate program in the Toughbook/Toughpad in accordance with the procedures defined in SOP No. 8 Field Reporting and Documentation.

Appropriate PPE, as described in the Health and Safety Plan (HASP) shall be worn during well opening, fluid level measurement, and decontamination. The following procedures shall be completed when measuring fluid levels:

1. The water level probe shall be decontaminated prior to use in each monitoring well according to SOP No. 4 Decontamination.
2. Observations regarding the condition of the well, including the well pad, surface completion or protective casing, working padlock, etc. shall be documented in the field logbook, on appropriate field forms and/or in the Toughbook/Toughpad.

3. Put on a new, unused pair of disposable latex or nitrile gloves.
4. The well will be approached from upwind, the well cap unlocked and removed, and the air quality monitored at the top of the casing and in the breathing zone with a PID. Air quality measurements shall be recorded on appropriate field forms and/or in the Toughbook/Toughpad.
5. An electric water level or NAPL/water interface probe shall be used to measure the depth to water from the top-of-casing reference point (either PVC or steel monitoring well casing) and/or check for NAPLs in the water column, where applicable.
    a. If no reference point is marked on the well casing, measurements shall be made from the north side of the well casing.
    b. If a special well wizard dedicated pump cap is present, the cap shall be removed and depth to water measured from the top of well casing reference point. If the well wizard dedicated pump cap is unable to be removed, gauge the fluid level through the opening in the cap.
    c. If a special well wizard dedicated pump is present, fluid level measurements shall be taken with the pump in place within the well.
6. Record the depth of water and/or NAPL, as applicable. Measurements will be made to the nearest 0.01 feet. Regauge and recheck recorded measurements before the probe is removed from the well.
7. If NAPL is detected within a well, the presence of NAPL should be confirmed by visual observations on the interface probe, a clear plastic bailer (disposable or dedicated), or similar. The confirmation method shall be documented along with the measurements on the field data sheet, and/or in the Toughbook/Toughpad.
8. This procedure can also be used to measure the total depth of the well, if required. A measuring tape, with a weight attached to the end if necessary, can be used in place of the water level or interface probe to measure the total well depth. Measurements will be made to the nearest 0.01 feet.
    a. If a special well wizard dedicated pump is present, the pump shall be removed prior to measuring the total well depth.
9. The static water level, the total depth of the well, and the depth of NAPL (if applicable), shall be measured with the probe, recorded on the water level data sheet and/or in the Toughbook/Toughpad, and then immediately rechecked before the probe is removed from the well.

10. All columns/entries of field data sheets and/or Toughbook/Toughpad shall be completed, including date and time of measurements. An example water level data sheet is attached to this SOP. Verify that every line/box contains an entry with the appropriate information. If something on the field form or in the Toughbook/Toughpad does not apply, that should be indicated using "NA".
11. Care shall be taken to verify the readings during each water level measurement period. Any significant changes in water level will be noted by comparing the most recent measurement with past measurements. This comparison is easily performed on the Toughbook/Toughpad when entering the data.
12. After any measurement is taken, the water level probe shall be decontaminated as described in SOP No. 4 Decontamination.
13. Place disposable equipment into a plastic garbage bag for disposal.

4. Documentation

The appropriate information will be entered into the Toughbook/Toughpad and/or on the water level data sheet in the field during gauging activities. A field logbook will also be kept during water level measurement activities describing decontamination procedures, calibration procedures, monitoring procedures, and other activities/observations during water level measurement. Refer to SOP No. 8 Field Reporting and Documentation for additional documentation information.

Water Level Record

Job No.: _____ Project/Event: _____

Client: _____ Date: _____

Location: _____ Personnel: _____

Well No.	Time	Depth to Water (ft btoc)	Depth to Product (ft btoc)	Depth to Bottom (ft btoc)	All Bolts Present	Lock Present	Working Cap Present	Pad Condition	Comments

G = Pad in good condition
BR = Cracked and Broken
NP = No visible pad present

1. Objective

This document defines the standard Quality Assurance/Quality Control (QA/QC) samples for Shell projects in Hartford and Roxana, Illinois. QA/QC samples are typically collected during field studies for various purposes which include the isolation of site effects (control samples), define background conditions (background sample), and evaluate field/laboratory variability (e.g., matrix spikes/matrix spike duplicates (MS/MSDs), equipment blanks, trip blanks, duplicates, split samples). This SOP is intended to be used together with several other SOPs.

2. Equipment

The following equipment is typically used:

- Insulated coolers (hard plastic or metal)
- Nitrile gloves, or similar
- Field forms such as Chain of Custody (COC) or sample collection sheet
- Logbook
- Ice
- Protective packing material
- Sealed storage bags
- Sample containers and labels
- Waterproof pen/marker
- Trash bags

3. QA/QC Samples

Refer to the scope of work for a description of relevant QA/QC samples.

- Background Sample – a sample (usually a grab sample) collected from an area, water body, or site similar to the one being studied, but located in an area known or thought to be free from pollutants of concern.
- Split Sample – Two or more representative subsamples taken from one environmental sample in the field. Prior to splitting, the environmental sample is homogenized to correct for sample heterogeneity that would adversely impact data comparability. Field split samples are usually analyzed by different laboratories (interlaboratory comparison) or by the same laboratory (intralaboratory comparison). Field splits are

typically used to assess sample handling procedures from field to laboratory and laboratory's comparability.

- Field Duplicate – Field duplicates should be samples collected side by side or by collecting one sample and immediately collecting the second sample. Field duplicates represent the precision of the whole method, site heterogeneity, field sampling and the laboratory analysis. When results for both duplicate and sample values are greater than 5 times the practical quantitation limit (PQL), satisfactory precision is indicated by a relative percent difference (RPD) less than or equal to 25% for aqueous samples, and 50% for non-aqueous samples. Where one or both of the results of a field duplicate pair are reported at less than 5 times the PQL, satisfactory precision is indicated if the field duplicate results agree within 2 times the quantitation limit for aqueous samples and within 5 times the quantitation limit for soil samples. Field duplicate results that do not meet these criteria may indicate unsatisfactory precision of the results.

- Trip Blanks – A sample which is prepared by the laboratory using analyte free water prior to the sampling event in a laboratory provided container and is stored with the investigative sample bottles and samples throughout the sampling event. They are then packaged for shipment with the other samples and submitted for analysis. At no time after their preparation are trip blanks to be opened before they reach the laboratory. Trip blanks are used to assess volatile organic compound (VOC) cross contamination of samples during storage and/or transportation back to the laboratory (a measure of sample handling variability resulting in positive bias in contaminant concentration). If VOC samples are to be shipped, trip blanks are to be provided with each cooler containing VOC samples.

- Equipment Blanks – A sample collected using distilled or deionized water which has been collected using decontaminated investigative sample collection equipment in the same manner that investigative samples are collected (e.g. run over/through equipment). In the case of groundwater collection pumps, a new/clean section of tubing shall be attached to the pump and used to collect the equipment blank sample. The equipment blank sample identifies contamination resulting from the field equipment, sampling procedure, or sample container, preservative. Equipment blanks are often associated with collecting rinse blanks of equipment that has been field cleaned. Equipment blanks should be labelled with the ID of the next sample to be collected.

- Temperature Blanks – A container of water shipped with each cooler of samples requiring preservation by cooling to 4°C ± 2°C (ice). The temperatures of the blanks are measured at the time of sample receipt by the laboratory. No temperature blank is necessary for samples designated as "waste".
- Field Blanks – A sample that is prepared in the field to evaluate the potential for contamination of a sample by site contaminants from a source not associated with the sample collected (for example air-borne dust or organic vapors which could contaminate a soil sample). Analyte-free water is taken to the field in sealed containers or generated on-site. The water is poured into the appropriate sample containers at pre-designated locations at the site. Field blanks should be collected in dusty environments and/or from areas where volatile organic contamination is present in the atmosphere and originating from a source other than the source being sampled.
- Material Blanks – Samples of sampling materials (e.g., material used to collect/wipe samples, etc.), construction materials (e.g., well construction materials), or reagents (e.g., organic/analyte free water generated in the field, water from local water supplies used to mix well grout, etc.) collected to measure any positive bias from sample handling variability. Commonly collected material blanks are listed below:
    - Wipe Sample Blanks – A sample of the material used for collecting wipe samples. The material is handled, packaged, and transported in the same manner as all other wipe samples with the exception that it is not exposed to actual contact with the sample medium.
    - Grout Blanks – a sample of the material used to make seals around the annular space in monitoring wells.
    - Filter Pack Blanks – a sample of the material used to create an interface around the screened interval of a monitoring well.
    - Construction Water Blanks – a sample of the water used to mix or hydrate construction materials such as monitoring well grout.
    - Organic/Analyte Free Water Blanks – a sample collected from a field organic/analyte free water generating system. The sample is normally collected at the end of sampling activities since the organic/analyte free water system is recharged prior to use on a study. On large studies, samples can be collected at intervals at the discretion of the project leader. The purpose of the organic/analyte free water blank is to measure positive bias from sample

handling variability due to possible localized contamination of the organic/analyte free water generating system or contamination introduced to the sample containers during storage at the site. Organic/analyte free water blanks differ from field blanks in that the sample should be collected in as clean an area as possible (a usual location for the organic/analyte free water system) so that only the water generating system/containers are measured.

- Matrix Spike – A sample collected in the same manner as the investigative sample, with known concentrations of analytes added by the laboratory prior to laboratory analysis, which is introduced into a second aliquot. The spiked sample is processed through the entire analytical procedure. Analysis of the matrix spike is used to assess the accuracy and precision of the analytical process on an analytical sample in a particular matrix, and can be indicative of matrix effects/analyte recoveries. A group of up to 20 field samples of the same matrix (e.g., water, soil, sediment, waste) being analyzed for the same constituents may be associated with a single matrix spike (MS) sample of a matrix spike/matrix spike duplicate (MS/MSD) pair.
- Matrix Spike Duplicate – A sample collected in the same manner as the investigative sample, with known concentrations of analytes added by the laboratory prior to laboratory analysis (same concentrations of analytes as the matrix spike), which is introduced into a third sample aliquot. The spiked sample is processed through the entire analytical procedure. Analysis of the matrix spike duplicate is an additional measure of accuracy and precision.

4. Sample Containers

Certified commercially clean sample containers shall be obtained from the contract analytical laboratory. The lab shall indicate the type of sample to be collected in each bottle type, and the preservative (if applicable) of each bottle. A work plan or other project documentation may list the appropriate sample containers for the specific analyses require for each project/task.

5. Sample Preservation

Samples shall be preserved prior to, or at the time of the sample collection. Chemical preservatives, if necessary, are typically added to the sample containers by the laboratory prior to shipment to the field, but may be added in the field by sampling personnel.

After QA/QC sample collection, the QA/QC sample shall be recorded on the chain of custody (COC). Each container shall be labeled (see SOP No. 24 Sample Classification, Packaging and Shipping for additional information) and stored on ice at 4°C ± 2°C in an insulated cooler until

packed for shipment to the laboratory. The ice or the sample bottles shall be bagged in sealed storage bags, or as otherwise recommended by the laboratory. Freezing samples shall not be permitted. Any breakable sample bottles need to be wrapped in protective packing material (bubble wrap) to prevent breakage during shipping. Refer to SOP No. 24 Sample Classification, Packaging and Shipping for additional information regarding packaging of samples.

6. QA/QC Sample Collection Frequency

The table below outlines common frequencies for QA/QC sample collection. Refer to the project work plan or scope of work for a description of relevant QA/QC samples.

QA/QC Sample	Frequency
Background Sample	Optional/Project or Task Specific
Split Sample	Optional/Project or Task Specific
Field Duplicate Sample	One per 10 samples collected per matrix Project or Task Specific
Trip Blank	One per cooler containing VOC samples Project or Task Specific
Equipment Blanks	One per 10 samples collected Project or Task Specific
Temperature Blanks	Laboratory specific One per cooler Project or Task Specific
Field Blanks	Optional/Project or Task Specific One per 20 samples collected per matrix
Material Blanks	Optional/Project or Task Specific One per matrix
Matrix Spike	One per 20 samples collected per matrix Project or Task Specific
Matrix Spike Duplicate	One per 20 samples collected per matrix Project or Task Specific

1. Objective

This document defines the standard operating procedure (SOP) and necessary equipment for collection of soil vapor samples from vapor monitoring points / sampling ports using stainless steel canisters for Shell projects in Hartford and Roxana, Illinois.

2. Equipment

The following equipment is typically needed:

- Field book
- Disposable nitrile gloves
- Cut resistant gloves
- Ultra-fine permanent marker
- Paper towels
- Decontamination equipment
- Soil vapor sampling logs
- Small brush or broom
- Charcoal filter
- 15 mL hand pump
- 60 mL syringe or equivalent
- Peristaltic pump
- Rotometer or equivalent
- Photoionization Detector (PID) (e.g., RAE Instruments MiniRAE 3000 or equivalent)
- Flame Ionization Detector (FID) (e.g., Thermo Scientific TVA-1000 or equivalent)
- Lower Explosive Limit (LEL) meter (e.g., RAE Instruments QRAE II or equivalent)
- Landfill gas detector (e.g., LANDTEC GEM-2000 or equivalent)
- Stainless steel canisters with flow controllers (supplied by the laboratory)
- 1-Liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination) – 2 per sample

- Sample train assembly (configuration and parts shown on **Figure 1**)
- Vacuum gauge (0 – 30 inches Hg)
- Teflon® tubing (laboratory-grade) – 1/8" ID – ¼" OD
- Tygon® tubing (laboratory-grade) – 3/16" ID – 3/8" OD
- Tracer gas (e.g., Grade 5 helium)
- Tracer gas shroud (e.g., plastic tote)
- Tracer gas meter (e.g., Dielectric Technologies MGD-2002 or equivalent)
- Watch or timer
- Standard field tools (e.g., ratchet set, safety cutting tools, pry bar, etc.)
- Shipping supplies (e.g., UN boxes, shipping labels, hazard labels, packing tape)

3. Vapor Port Development Purging

If the port has been newly installed, the port must be developed by purging 3 volumes of the sampling assembly including 3 volumes of the sand pack. If development is not required, proceed to **Section 4** or **Section 5** below for the appropriate sampling procedures

1. Open vapor point vault to check integrity of individual soil vapor monitoring port(s) (VMP). Each port should have a hose barb connected to a 4-way polycarbonate stopcock (4-way) using silicone tubing. The 4-way should be in the "off" position.
2. Connect peristaltic pump and Tygon tubing connected to the 4-way.
3. Connect charcoal filter exhaust to the discharge end of the tubing assembly.
4. Calculate Purge volume:
    - Vapor Port tubing (1/8-in diameter): 2.41 mL/foot (single volume)
    - Sample train assembly / Tygon® tubing (1/4-in diameter): 9.65 mL/foot (single volume)
    - Sand Pack: 18,765 mL (4.95 gallons – single volume – assuming 18 inch thick sand pack)
5. Open 4-way and begin purging port at a rate no greater than 2 L/min. Document time started.
6. Once 3 volumes are reached, stop pump and close 4-way. Document time stopped.
7. Move to next depth or replace vault cover and clean up at location.

4. Vapor Port Sampling – With No Tracer Gas

To perform vapor port sampling with tracer gas shroud, proceed to **Section 5** below.

1. Open vapor point vault to check integrity of individual soil VMP(s). Each port should have a hose barb connected to a 4-way valve using silicone tubing. The 4-way should be in the "off" position.
2. Perform stainless steel canister vacuum check, per the steps listed in **Section 6** of this SOP.
3. Setup the sample assembly using the configuration shown in **Figure 2**. The flow controller (one for each stainless steel canister provided by the laboratory) shall be connected to the stainless steel canister inlet. Do not re-use flow controllers between samples. Flow controllers can be set to different rates as specified by the project work plan, depending on size of container to be filled. For a 1-Liter stainless steel canister, approximately 5 minutes is a standard collection time (~167 ml/min).
4. Perform sample train leak check, per the steps listed in **Section 6** of this SOP.
5. Remove the 4-way and connect the sample train to the VMP using Swagelok® fittings.
6. Open Port Valve.
7. Calculate Purge volume:
    - Vapor Port tubing (1/8-in diameter): 2.41 mL/foot (single volume)
    - Sample train assembly (1/4-in diameter): 9.65 mL/foot (single volume)
8. Open Valve #2.
9. Purge the three volumes from the vapor monitoring port purge using the 60 mL syringe. If pullback is observed on the 60 mL syringe and the purge cannot be completed, the VMP screen may be saturated with water and will not yield a representative sample. If this happens, do not sample the VMP. Similarly, if water is observed in the syringe during the purge, do not sample the VMP. Record purge results in Toughbook or on sample sheets.
10. Close Valve #2.
11. Open stainless steel canister valve completely and record the time in the Toughbook or on sample sheets.
12. Allow the canister to fill until the vacuum gauge reads between -5 and -10 inches of mercury; however, an ideal sample shall be have approximately -5 inches of mercury remaining after sampling is complete. For a 1-Liter canister, filling shall take

approximately 5 minutes but may require more or less time depending on formation materials.[1] If the vacuum gauge reading drops below -5 inches Hg before approximately 5 minutes, close the stainless steel canister valve completely. Record the time in the Toughbook or on sample sheets.

13. Connect peristaltic pump to tubing connected to Valve #2 and open Valve #2 to collect a sample in a sample bag. The sample bag should be filled at a rate no greater than 200 ml/min.
14. Disconnect the sample train from the VMP and reconnect the 4-way.
15. Disconnect flow controller, stainless steel canister, and used tubing from sample assembly.
16. From the soil vapor in the sample bag obtain readings for total volatile organics with a PID and for CO2, CH_4, LEL, and oxygen (O2) with a combustible gas detector. Record readings in Toughbook or on sample sheets. If FID or PID is not on-site, label and retain bag for reading at field trailer.
17. Perform stainless steel canister vacuum check, per the steps listed in **Section 6** of this SOP.
18. Setup on the next depth or replace vault cover and clean up at location.
19. Decontaminate any non-designated equipment (e.g., sample assembly) following procedures listed in **Section 7**.

5. Vapor Port Sampling – With Tracer Gas Shroud

To perform vapor port sampling with no tracer gas shroud, proceed to **Section 4** above.

1. Open vapor point vault to check integrity of individual VMP(s). Each port should have a hose barb connected to a 4-way valve using silicone tubing. The 4-way should be in the "off" position.
2. Perform stainless steel canister vacuum check, per the steps listed in **Section 6** of this SOP.
3. Setup the sample assembly using the configuration shown in **Figure 3**. The flow controller (one for each stainless steel canister provided by the laboratory) shall be connected to the stainless steel canister inlet. Do not re-use flow controllers between samples. Flow controllers can be set to different rates as specified by the project work plan, depending on size of container to be filled. For a 1-Liter stainless steel canister, approximately 5 minutes is a standard collection time (~167 ml/min).

[1] Other sized canisters will take different amounts of time to sufficiently fill.

4. Perform sample train leak check, per the steps listed in **Section 6** of this SOP.
5. Remove the 4-way and connect the sample train to the VMP using Swagelok® fittings.
6. Open Port Valve.
7. Place an enclosure shroud over the VMP and assembled sample train as shown in **Figure 3**. The shroud should have openings for:
    - Introduction of tracer gas;
    - Pressure relief to the atmosphere and access of a tracer gas monitoring device;
    - Tygon tubing to connect to the peristaltic pump for Valve #1 (out) and Valve #2 (in and out).

    The shroud should have sufficient glove access to open or close all valves within. As shown in **Figure 3**, the shroud must also be sealed to the ground with hydrated bentonite or equivalent.
8. Introduce tracer gas into the shroud at a known rate until the atmosphere within the shroud contains a sufficient quantity (typically 20% to 50%) of tracer gas.
9. Calculate Purge volume:
    - Vapor Port tubing (1/8-in diameter): 2.41 mL/foot (single volume)
    - Sample train assembly (1/4-in diameter): 9.65 mL/foot (single volume)
10. Open Valve #1.
11. Purge the three volumes from the vapor monitoring port purge using the 60 mL syringe. If pullback is observed on the 60 mL syringe and the purge cannot be completed, the VMP screen may be saturated with water and will not yield a representative sample. If this happens, do not sample the VMP. Similarly, if water is observed in the syringe during the purge, do not sample the VMP. Record purge results in Toughbook or on sample sheets.
12. Connect peristaltic pump to the purge tubing to collect a sample of the tracer gas from the shroud in sample bag #1. The sample bag should be filled at a rate no greater than 200 ml/min.
13. Close Valve #1.
14. From the soil vapor in sample bag #1, obtain readings for tracer gas with tracer gas detector. If tracer gas readings are elevated, analyze sample bag #1 using a landfill gas detector to obtain a direct methane reading. See **Section 6** for acceptance criteria.

15. Open stainless steel canister valve completely and record the time in Toughbook or on sample sheets.
16. Allow the canister to fill until the vacuum gauge reads between -5 and -10 inches of mercury; however, an ideal sample shall be have approximately -5 inches of mercury remaining after sampling is complete. For a 1-Liter canister, filling shall take approximately 5 minutes but may require more or less time depending on formation materials.[2] If the vacuum gauge reading drops below 5 inches Hg before approximately 5 minutes, close the stainless steel canister valve completely. Record the time in the Toughbook or on sample sheets. Record the concentration of tracer gas within the shroud after closing the canister valve.
17. Connect peristaltic pump to tubing connected to Valve #2 and open Valve #2 to collect a sample in sample bag #2. The sample bag should be filled at a rate no greater than 200 ml/min.
18. Break seal on the shroud and disconnect flow controller, stainless steel canister, and used tubing from sample assembly.
19. From the soil vapor in sample bag #2 obtain readings for total volatile organics with a PID, for CO_2, CH_4, LEL, and oxygen (O_2) with a landfill gas meter, and for tracer gas concentration with the tracer gas detector. See **Section 6** for acceptance criteria. Record readings in Toughbook or on field sheets. If FID or PID is not on-site, label and retain sample bag #2 for reading at field trailer.
20. Perform stainless steel canister vacuum check, per the steps listed in **Section 6** of this SOP.
21. Disconnect the sample train from the VMP and reconnect the 4-way.
22. Move to next depth or replace vault cover and clean up at location.
23. Decontaminate any non-designated equipment (e.g., sample assembly) following procedures listed in **Section 7**.

6. Quality Control

Quality control procedures have been developed to verify equipment integrity, sample quality, and sample repeatability.

In addition to the procedures listed below, the following items are also of concern:

- Care should be taken to keep all sampling equipment, especially the stainless steel canisters, safe from damage.

[2] Other sized canisters will take different amounts of time to sufficiently fill.

- No samples are to be collected in an area where vehicle or other equipment exhaust is being discharged.

Field Duplicates

A field duplicate shall be collected for 10% of the samples collected.

Field duplicates are collected by using a sample assembly with an additional 3-way union. A stainless steel canister with a flow controller is attached to each of the 3-way unions on the assembly. For sampling, both stainless steel canister valves should be opened and closed simultaneously. Use the appropriate procedure described above to collect samples.

Stainless Steel Canister Vacuum Check

The stainless steel canister vacuum check shall be performed for 100% of the stainless steel canisters.

Prior to Sampling

1. Remove brass cap from stainless steel canister.
2. Attach the pressure gauge provided by the laboratory to the stainless steel canister inlet.
3. Open valve completely.
4. Record reading on the canister tag. The canister should show a vacuum of approximately -28 inches of mercury (Hg). If the canister does not show a vacuum or shows a vacuum of less than -26 inches of Hg, then:
    - Label the canister tag with "Insufficient vacuum – No Sample";
    - Set canister aside for return to the laboratory; and
    - Contact task manager and lab coordinator if canister failures affect field work.
5. Close valve completely.
6. Remove the pressure gauge.
7. If not immediately using the stainless steel canister for sample, place and tighten brass cap on stainless steel canister.

After Sampling

1. Attach the pressure gauge provided by the laboratory to the stainless steel canister inlet.
2. Open valve completely.

3. Record reading. There should still be a vacuum in the stainless steel canister. The final vacuum on the canister should be between -10 inches of Hg to -2 inches of Hg. If the final vacuum does not fall within this range, contact the project manager immediately to determine the value of using another stainless steel canister to recollect the sample.
4. Close valve completely.
5. Remove the pressure gauge.
6. Place and tighten brass cap on stainless steel canister.

Sample Train Vacuum Leak Check

The sample train leak check shall be performed for 100% of the samples collected.

1. Assemble the sampling apparatus as shown in **Figure 1**.
2. Keep the stainless steel canister and Valve #1 in the "off" or "closed" position. Valve #2 should be in the "open" position.
3. Attach the 15 mL hand pump to sample train at Valve #2.
4. Withdraw air from the sampling apparatus until a vacuum between 15 and 20 inches Hg is achieved. Observe the induced vacuum for at least five minutes.
5. If the change in vacuum over five minutes is equal to or less than 0.5 inch Hg, the system leak rate is acceptable.
6. If the change in vacuum over five minutes is greater than 0.5 inch Hg, check, tighten or replace the fittings and connections and repeat the leak check.

Tracer Gas Check

An appropriate number of samples shall be collected using a tracer gas, as per the project work plan or activity plan.

1. Tracer gas should be introduced near the VMP to test the integrity of the probe seal and the above ground connections.
2. Collect the soil vapor sample per procedures in **Section 5**.
3. If the concentration of the tracer gas in a sample is $\leq$10% of the concentration of the tracer gas in the shroud:
    - Prior to stainless steel canister sampling: continue with sample collection.
    - Following stainless steel canister sampling: the sample is acceptable.
4. If the concentration of the tracer gas in the sample is >10% of the concentration of the tracer gas in the shroud:

- Prior to stainless steel canister sampling: check methane levels.
    - If methane reading ≥2%, continue with sample collection.
    - If methane reading ≤2%, stop sample collection. Check fittings and valves before restarting sample collection.
- Following stainless steel canister sampling: check methane levels.
    - If methane reading ≥2%, the results may be biased high by methane.
    - If methane reading <2%, sample likely compromised. Call task manager to inform of need for re-sample.
- If a sample is found to be compromised, 2 additional attempts (3 attempts total) should be made to collect a sample.
    - With each additional attempt, visually check stainless steel tubing and fittings for holes and loose connections, and place an additional layer of bentonite seal in the interior of the well vault.
    - After 3 attempts, if a successful sample has not been collected, the VMP shall not be sampled for that quarter.

7. Decontamination

- Non-designated stainless steel assemblies shall be thoroughly decontaminated by purging with at least half a liter of air (e.g., with hand pump or peristaltic pump).
- Should a stainless steel assembly come into contact with groundwater, it shall be decontaminated using a Liquinox® detergent wash followed by a distilled water rinse.
- Multiple stainless steel assemblies shall be available to sample crews to allow for equipment to be cleaned and dried sufficiently before being reused.
- Tedlar® bags may be decontaminated if it meets the criteria listed in Section 3.9 of SOP No. 4 Decontamination.

8. Shipping

- Sample information shall be recorded on a chain of custody for the laboratory following procedures outlined in SOP No. 26 Sample Control and Custody Procedures.
- Samples shall be shipped to the laboratory following DOT regulations. If there is the possibility that samples may be classified as hazardous, samples must be shipped as such. For procedures, see SOP No. 51 Vapor Sampling

Classification, Packaging and Shipping, and check with one of the office hazardous shipping personnel.

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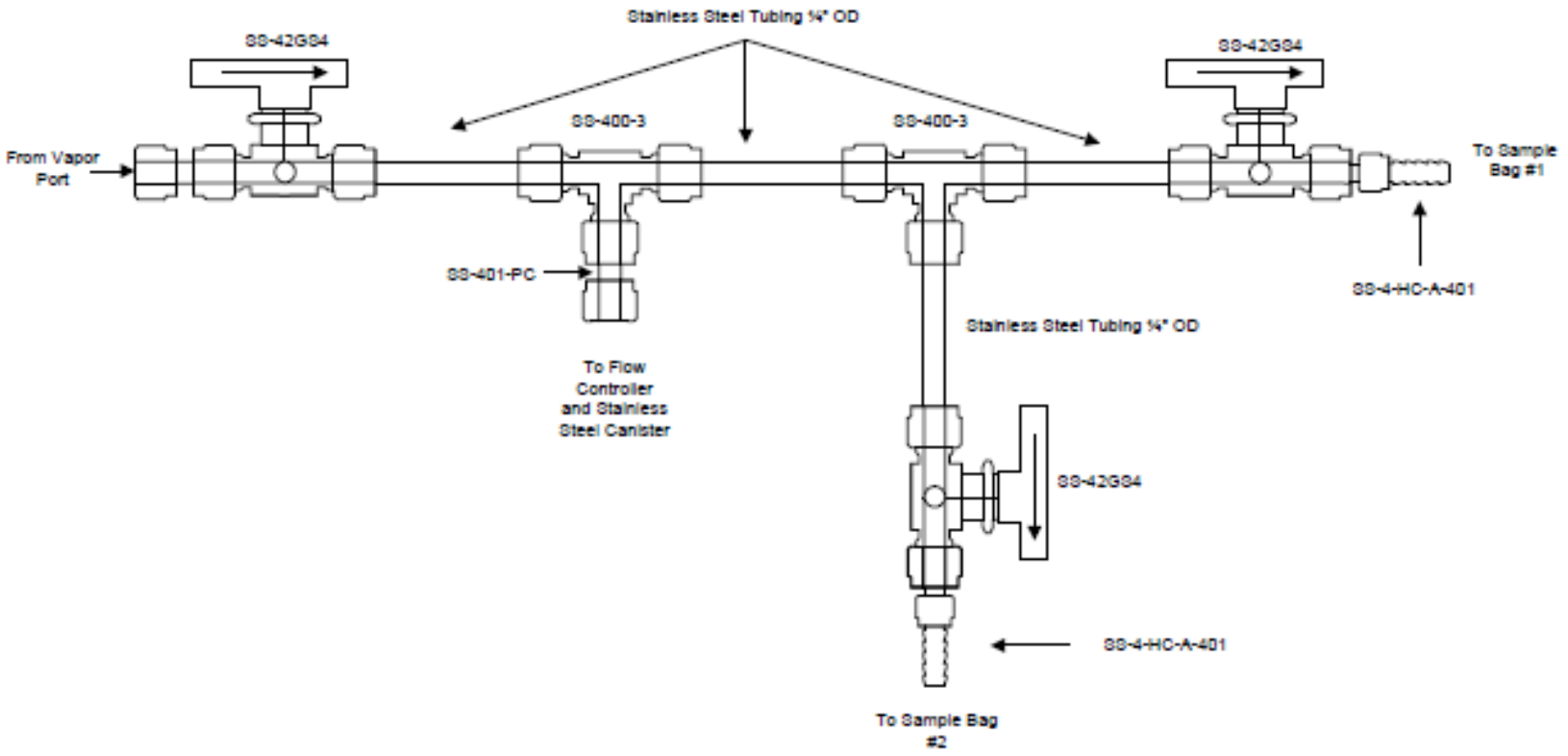
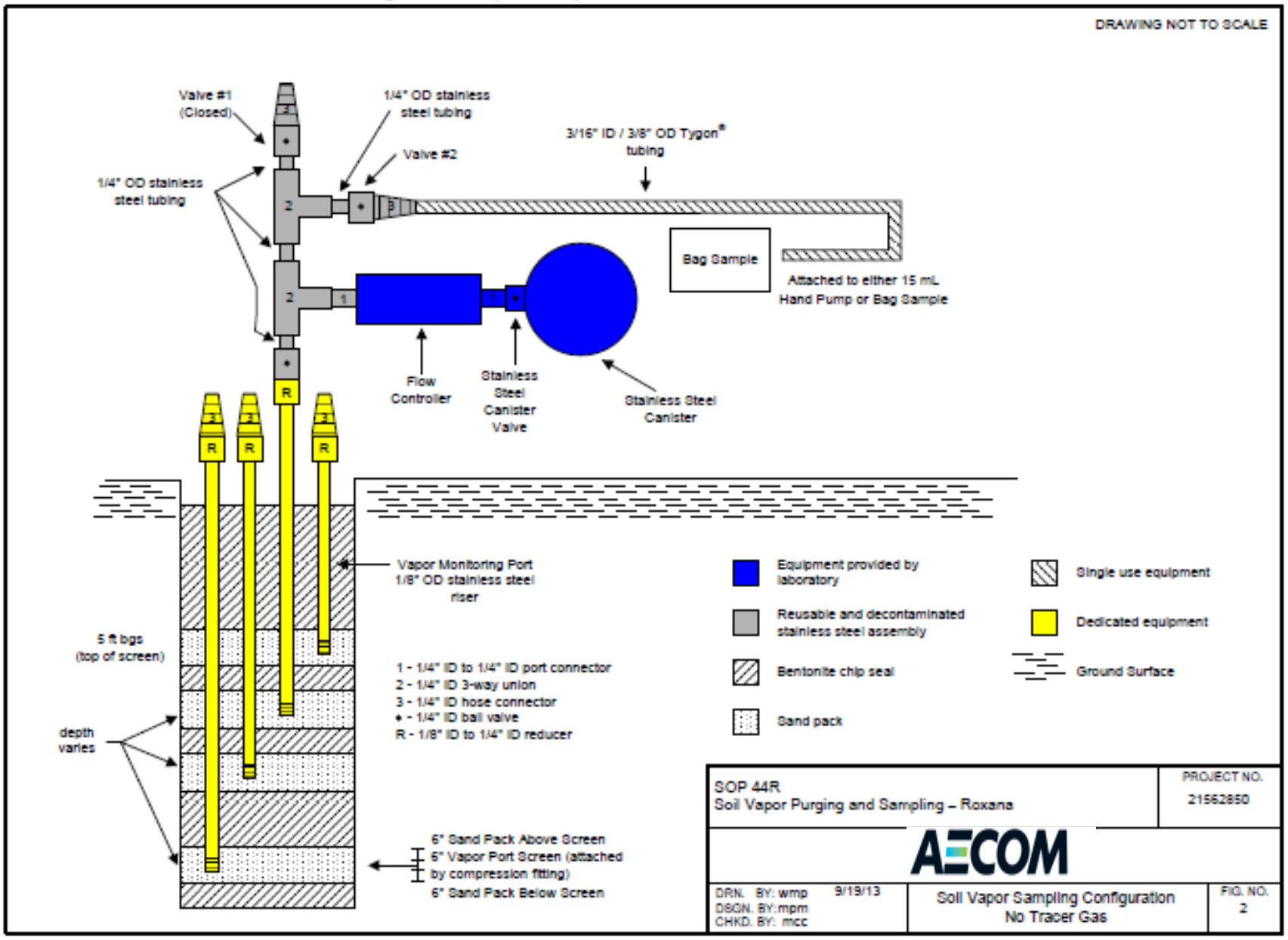


Notes:
1) All components listed with Swagelok part numbers.
2) Assembly shown for standard sample.
3) Duplicate assembly includes an additional 3-way union between the two shown.
4) All fittings shown are compression fittings with SS-400-Set ferules and SS-402-1 nuts.

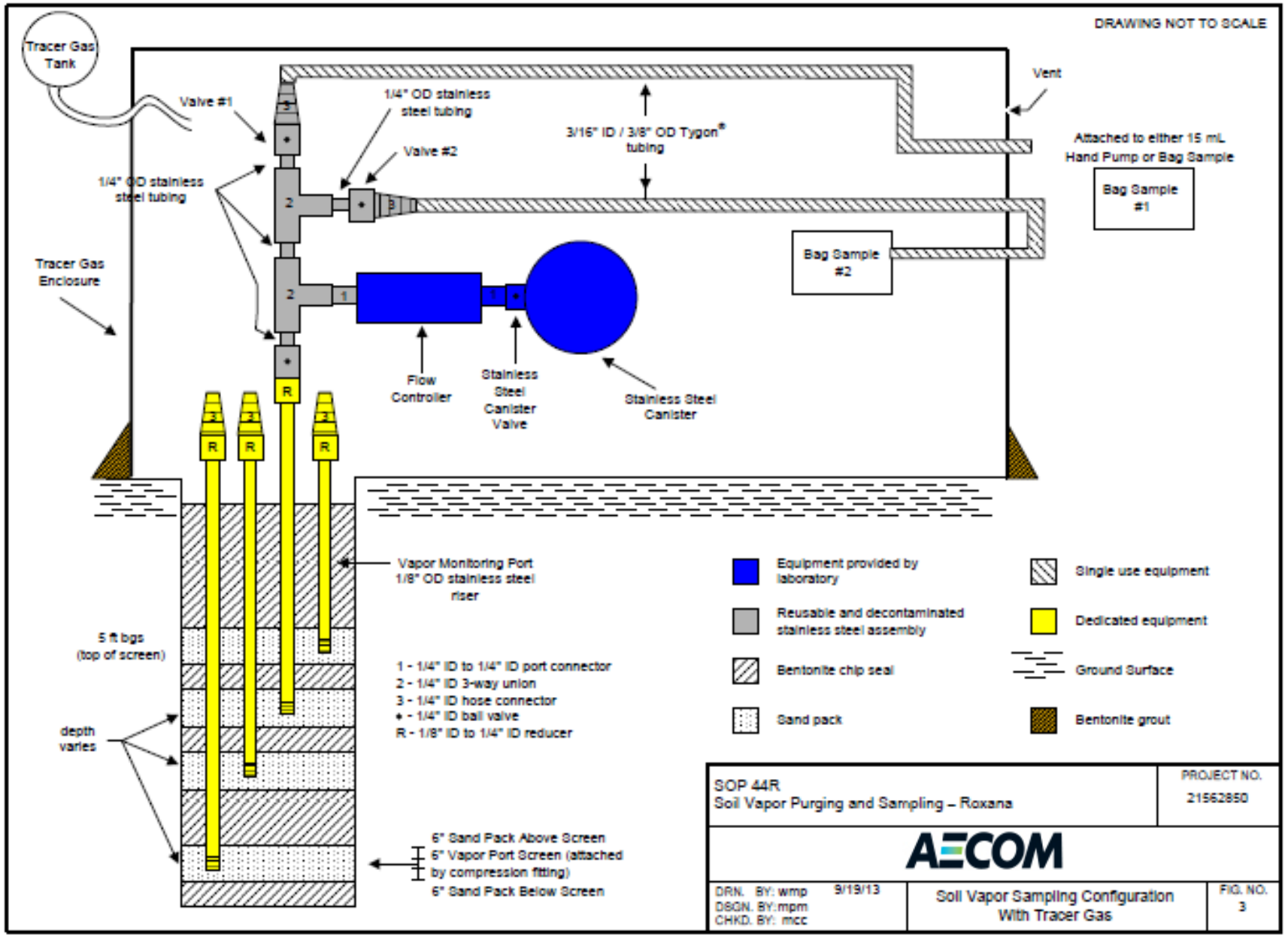
Source: http://swagelok.com/products.aspx; Accessed April 2, 2012.

SOP 44R Soil Vapor Purging and Sampling – Roxana	PROJECT NO. 21562850
AECOM	
DRN. BY: wmp 9/19/13 DSGN. BY: mpm CHKD. BY: mcc	Soil Vapor Sampling Assembly — FIG. NO. 1

P:\Environmental\Shell Oil Product US\I-SHELL CONTRACT PROGRAM FILES\I_SOPs\SOP No 44R Figure 2 - SV Configuration no Shroud.vsd 9/19/2013 1:22 PM



P:\Environmental\Shell Oil Product US\I-SHELL CONTRACT PROGRAM FILES_SOPs\SOP No 44R Figure 3 - SV Configuation with Shroud.vsd 9/19/2013 1:22 PM



SOP 44R Soil Vapor Purging and Sampling – Roxana	PROJECT NO. 21562850
AECOM	
DRN. BY: wmp 9/19/13 DSGN. BY: mpm CHKD. BY: mcc	Soil Vapor Sampling Configuration With Tracer Gas — FIG. NO. 3

1. Objective

This document defines the standard operating procedure (SOP) and typical equipment for sub-slab soil-gas sampling with canisters for the Shell project in Roxana, Illinois.

Work involving location access must be conducted by a team of at least two personnel. One member of the team shall be designated as the field lead. The field lead shall be responsible for interaction with site occupants.

2. Equipment

The following equipment is typically used for this procedure:

- Field book
- Leather gloves
- Permanent marker
- Paper towels or Kimwipes
- Calculator
- Decontamination equipment
- Sample logs
- Small brush or broom
- 15-mL hand pump or 60-mL syringe
- Vacuum gauge (-30 to 0 inches mercury)
- Peristaltic pump
- Bios Dry Cal flow meter or equivalent device
- Portable analyzer with Flame Ionization Detector (FID) (e.g., Thermo Scientific TVA-1000 or equivalent)
- Portable analyzer with Photo-ionization detector (PID) (e.g., RAE Instruments MiniRAE 3000 or equivalent)
- LEL meter (e.g., RAE Instruments QRAE II or equivalent)
- Landfill gas detector (e.g., LANDTEC GEM-2000 or equivalent)
- Tracer gas meter (e.g., Dielectric MGD-2002 or equivalent)
- Tracer gas shroud (e.g., plastic tote)
- Tracer gas (e.g. Grade 5.0 helium or equivalent) with regulator

- Canisters with flow controllers (project specific appropriate size, supplied by the laboratory) or equivalent
- Swagelok® T-Connector (2 per sample train assembly) – ¼" ID
- Swagelok® Port Connector (3 per sample train assembly) – ¼" ID to ¼" ID
- Swagelok® Ball Valves (2 per sample train assembly) – ¼" ID
- Swagelok® Barb Connector (2 per sample train assembly) – ¼" ID
- Swagelok® Bulkhead Reducing Union (1 per sample train assembly) – ¼" ID
- Swagelok® Ferrules (6 per sample) – ¼" ID
- Swagelok® Nuts (6 per sample) – ¼" ID
- Teflon® hard tubing (food or laboratory grade) – 1/8" ID – ¼" OD (connects 1-Liter Tedlar® bags to Tygon® tubing)
- Tygon® soft tubing (food or laboratory grade) – 3/16" ID – 3/8" OD
- Small diameter continuous SS-316 stainless tubing – 1/8" OD
- 1-Liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination, 2 per sample)
- Hydrogen gas
- Calibration gas
- Watch or timer
- Lighting (e.g., head lamps)
- Rotary hammer drill
- 7/8-inch concrete drill bit
- 5/16-inch concrete drill bit
- Extension cord with GFI adapter
- Measuring tape
- Duct tape
- Quikrete® concrete crack sealer (14lb bottle)
- Concrete trowel
- Modeling clay

- Shop vacuum
- Spray bottle with water
- Safety equipment (e.g. first aid kit, eye wash, 20lb fire extinguisher, etc.)
- Standard field tools (e.g., ratchet set, safety cutting tools, wrenches, etc.)
- Shipping supplies (e.g., UN boxes, shipping labels, hazard labels, packing tape)

3. Preliminary Procedures

Prior to mobilizing to install Sub-slab monitoring probes (SSMPs), ensure the following:

1. Verify access has been granted for the building in question for the period necessary for installation and sampling.
2. A utility locate will not be conducted as utilities cannot be located beneath a building. A review of surrounding features (e.g. drains, meters, etc.) shall be performed to determine where utilities are entering the building. The owner of the building should also be consulted for their knowledge of any additional known utilities.
3. Perform daily safety meeting, reviewing weather, procedures, and location concerns (access, animals, etc.).
4. Verify that the occupant is present and is at least 18 years old. If no occupant is at least 18 years of age, installation shall be rescheduled.

Mobilize equipment into the location, minimizing re-entries, and perform the following:

1. Verify that screening instruments are operating properly. Instruments indicating negative concentrations shall be re-zeroed.
2. Assess indoor air quality, using a four gas meter, methane detector, FID and PID, in the room where a SSMP is to be installed. If necessary locate any sources for potential elevated readings.
3. If VOCs or LEL readings are above the levels stated in the site Health and Safety Plan (HASP) work shall cease until ambient air conditions have resumed safe levels.
4. If oxygen levels drop below 19.6% vacate the residence.

4. Installation Procedures

1. Collect sub-slab soil-gas samples at up to three locations per building of interest (or as otherwise defined in project planning documents).
2. Mentally divide the slab into three rectangles of roughly equal size and select sample locations near the center of each rectangle. Adjust the locations as needed to account for logistical factors. Select an area where visible damage to the floor shall be minimized. Avoid areas with tile or wood floors.

3. Construct a sampling probe using a reducer connected to a short length of 1/8" stainless steel tubing. Select a length of stainless steel tubing so that the bottom of the probe is close to the bottom of the sub-slab (typically a 4" probe for a 6" sub-slab). Attach the reducer via a port connector, as shown in the sample train configuration in **Figure 1**.
4. If possible, pre-cut the 1/8" stainless steel tubing before deploying to the field and bring a variety of lengths (e.g. 4", 6", and 12").
5. Drill down into the slab approximately 1 to 2 inches using a rotary hammer drill with a 7/8" diameter concrete bit. Clean out the dust using a shop vacuum (do not use a shop vacuum to clean out the dust from drilling if the hole extends all the way through the sub-slab).
6. Continue drilling down using a 5/16" diameter concrete bit to below the slab. Use the drill bit to measure the thickness of the slab and record the value.
7. Use modeling clay to seal the hole until the sampling train configuration is set (Step 4 under Sampling Procedures below).
8. Label the SSMP with indelible marker or paint pen on removable duct tape.
9. Record all measurements in the project logbook, including:
    - Slab thickness;
    - Borehole diameter; and
    - Time when clay seal was installed

5. Sampling Procedures

1. Perform canister vacuum check, per the steps listed in **Section 7** of this SOP.
2. Setup the sample train configuration as shown in **Figure 1**. The flow controller (one for each canister provided by the laboratory) shall be connected to the canister inlet. Do not reuse flow controllers between locations. Each flow controller is pre-set by the laboratory to collect the sample over a two-hour period. Flow controllers can be set to a different rate if desired by project, depending on size of container to be filled. For a 1-Liter canister set at -28 inches mercury (Hg) over a two hour period the flow rate is set at 6.7 ml/min.
3. Perform sample train leak check, per the steps listed in **Section 7** of this SOP.
4. Remove the temporary modeling clay and install the probe in the hole, with the sampling train configuration already attached. Use the tubing in the sampling train configuration to hold the union at the correct height in the hole (just below the top). Use modeling clay to seal around the probe to set it in place.

5. Open Valve #1 located at the end of the sampling train.
6. Place a shroud over the SSMP and assembled sample train as shown in **Figure 1**. The shroud should have openings for:
   - The introduction of tracer gas;
   - Pressure relief to the atmosphere and access of a tracer gas monitoring device;
   - Tygon tubing to connect to the peristaltic pump for Valve #2 (out).
7. The shroud should have sufficient glove access to open or close all valves within as shown in **Figure 1**. Open Valve #1. Attach a hand pump with 15 mL stroke volume and built-in vacuum gauge to the purge tubing connected to Valve #1. Two or three strokes should purge out the system. There should be no vacuum build up on the gauge during purging if the sub-slab material is dry and porous. If no vacuum is observed during purge, close Valve #1.
   a. If the sampling point will hold a -15 inches of Hg vacuum for 1 minute, the sampling probe may be plugged or the location may not be suitable for canister sampling. Unplug the probe by inserting a wire the length of the probe or by forcing air into the probe. If this does not work, install a sampling probe at another location.
8. Introduce tracer gas into the shroud at a known rate until the atmosphere within the shroud has a concentration of approximately 50% tracer gas. The tracer gas check shall be performed within the first 30 minutes of sample collection.
9. Open Valve #1.
10. Connect a peristaltic pump to the purge tubing connected to Valve #2 to collect a sample in a 1-Liter Tedlar® bag. The 1-Liter Tedlar® bag should be filled at a rate no faster than 200 ml/min.
11. Close Valve #1.
12. From the soil vapors in the 1-Liter Tedlar® bag obtain readings for tracer gas with the tracer gas detector. If tracer gas readings are elevated, analyze the Tedlar® bag using a landfill gas detector to obtain a direct methane reading. Following procedures listed in Section 7 for elevated tracer gas readings in Tedlar® bags.
13. Open canister valve completely and record the time.
14. After approximately 2 hours, or if the vacuum gauge reading drops below -5 inches of Hg before 2 hours, close the canister valve completely. Record the time. The vacuum gauge

should reach less than -10 inches of Hg, but should not be allowed to drop below -2 inches of Hg.

15. Open Valve #2.
16. Connect peristaltic pump to tubing connected to Valve #2 to collect a sample in a 1-Liter Tedlar® bag. The 1-Liter Tedlar® bag should be filled at a rate no faster than 200 ml/min.
17. From the soil vapor in the 1-Liter Tedlar® bag obtain readings for total volatile organics with a photoionization detector (PID), with a Flame Ionization Detector (FID), and for CO2, CH4, LEL, and oxygen (O2) with a landfill gas meter. Record readings from each instrument.
18. Break down sampling train configuration.
19. Remove flow controller from canister, obtain final canister pressure readings, and replace brass cap on the canister, per the steps listed in Section 4 of this SOP.
20. Decontaminate any non-designated equipment (e.g., Swagelok® connectors and valves) following procedures listed in Section 8.

6. Remove and Seal the Sampling Probe

1. Remove the probe from the floor and decontaminate.
2. Temporarily plug the hole with modeling clay.
3. Remove all modeling clay that was used for the seal and fill the hole with Quikrete® Gray Concrete Crack Sealer or equivalent until it is flush with the remainder of the sub-slab. Use a concrete trowel to smooth out excess concrete, if necessary.

7. Quality Control

Quality control procedures have been developed to verify equipment integrity, sample quality, and sample repeatability.

In addition to the procedures listed below, care should be taken to keep all sampling equipment, especially the canisters, safe from damage.

Field Duplicates

A field duplicate shall be collected for 10% of the samples collected.

Field duplicates are collected by attaching a T-fitting to the end of the tubing prior to the flow controller. A canister with a flow controller is attached to each end of the T-fitting. For sampling, both canister valves are opened and closed simultaneously. Use the procedure described above to collect samples.

Canister Vacuum Check

The canister vacuum check shall be performed for 100% of the canisters.

Prior to Sampling

- Attach the pressure gauge provided by the laboratory to the canister inlet.
- Open valve completely.
- Record reading. The canister should show a vacuum of approximately -28 inches of Hg. If the canister has a vacuum of equal to or less than -25.5 inches of Hg (after adjustment for any elevation effects), then:
  - Label the canister with "Insufficient vacuum – No Sample";
  - Set canister aside for return to the laboratory; and
  - Contact project manager and lab coordinator if canister failures affect field work.
- Close valve completely.
- Remove the pressure gauge.

After Sampling

- Attach the pressure gauge provided by the laboratory to the canister inlet.
- Open valve completely.
- Record reading. There should still be a slight vacuum in the canister. If the canister does not show a significant net loss in vacuum after sampling, evaluate and document the problem. If necessary, contact the project manager immediately to determine the value of using another canister to recollect the sample.
- Close valve completely.
- Remove the pressure gauge.

Sample Train Vacuum Leak Check

The sample train leak check shall be performed for 100% of the samples collected.

- Assemble the sampling apparatus as shown in **Figure 1**.
- Keep the canister, Ball Valve #1, and Ball Valve #3 in the "off" or "closed" position. Ball Valve #2 should be in the "open" position.
- Attach the 15 mL hand pump to sample train attached where indicated.

- Withdraw air from the sampling apparatus until a vacuum of at least -10 inches of Hg is achieved on the flow controller. Close Ball Valve #2. Observe the induced vacuum for at least five minutes.
- If the change in vacuum over five minutes is equal to or less than -0.5 inches of Hg, the system leak rate is acceptable.
- If the change in vacuum over five minutes is greater than -0.5 inches of Hg, check, tighten or replace the fittings and connections and repeat the leak check.

Tracer Compound Check

All samples shall be collected using a tracer compound.

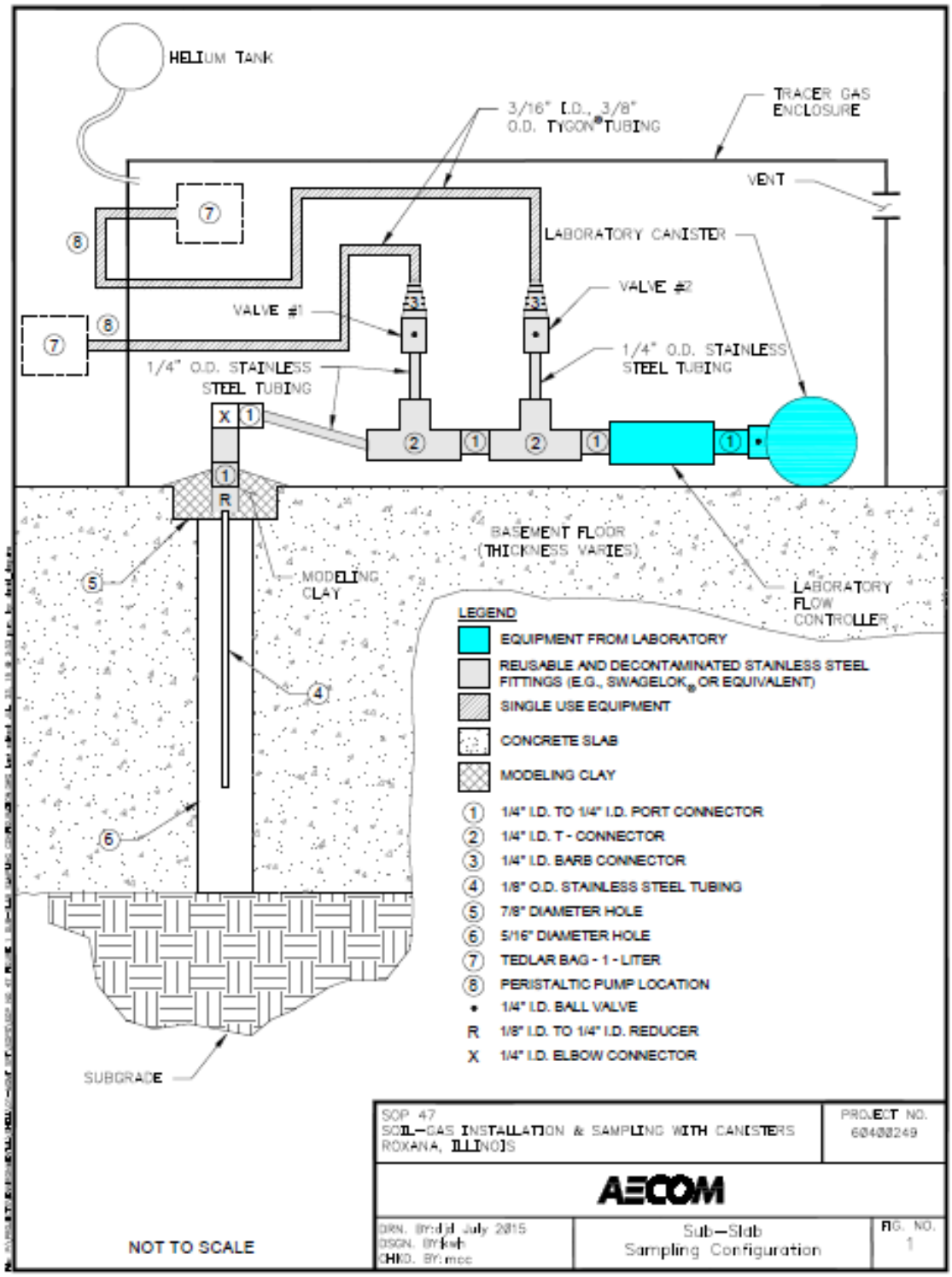
- Tracer gas should be introduced near the SSMP to test the integrity of the probe seal and the above ground connections.
- Collect the 1-Liter Tedlar® sub-slab bag per procedures in Section 5.
- If the concentration of the tracer gas in a sample is <10% of the concentration of the tracer gas in the shroud, the sample is acceptable.
- If the concentration of the tracer gas in the sample is >10% of the concentration of the tracer gas in the shroud, analyze the 1-Liter Tedlar® bag using a landfill gas detector to obtain a direct methane reading. If methane levels are not elevated, tighten or replace the fittings and connections and repeat the leak check.

8. Decontamination

- Designated stainless steel Swagelok® connectors or equivalent shall be thoroughly decontaminated using a Liquinox® wash followed by a distilled water rinse.
- Multiple sets of stainless steel Swagelok® connectors or equivalent shall be available to sample crews to allow for equipment to be cleaned and dried sufficiently before being reused.
- Do not reuse Tygon® and Teflon® tubing. Tubing shall be disposed of after sampling each SSMP. Do not reuse ferrules from compression fittings.

9. Shipping

- Sample information shall be recorded on a chain of custody for the laboratory following procedures outlined in SOP No. 26 Sample Control and Custody Procedures.
- Samples shall be shipped to the laboratory following DOT regulations, as outlined in SOP No. 51 Vapor Sampling Classification, Packaging and Shipping.



SOP 47 SOIL-GAS INSTALLATION & SAMPLING WITH CANISTERS ROXANA, ILLINOIS		PROJECT NO. 60400249
AECOM		
DRN. BY: dil July 2015 DSGN. BY: kwh CHKD. BY: mcc	Sub-Slab Sampling Configuration	FIG. NO. 1

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to provide a consistent methodology for data and soil vapor sample collection related to the Shell Roxana soil vapor extraction (SVE) remediation system. This SOP is applicable to:

- Collecting data from and sampling Roxana Soil Vapor Extraction (SVE) wells
- Collecting data from and sampling the West Fenceline and Public Works header lines and/or the RTO exhaust stack.

2. Equipment

The following equipment is typically used for SVE well data collection and sampling:

- Crow bars (2) (if needed)
- Extension cord (if needed)
- SVE Data Collection sheets and Toughbook with SVE Monitoring software
- Impact driver (or socket set) with 3/4 and 9/16 sockets (if needed)
- Oil/Water Interface probe
- Isopropyl alcohol
- Dwyer Series 475 Mark III Digital manometer (measuring appropriate range(s)), or equivalent
- Nut driver – 5/16 (if needed)
- Paper towels
- PPE
    - ANSI Class II safety vest
    - Hardhat
    - Nitrile gloves
    - Leather gloves
    - Safety glasses
    - Safety goggles (when working within Wood River Refinery (WRR))
    - Steel-toe boots
    - FRC Clothing (when working within WRR)

- Power inverter (if needed)
- Sump pump (if needed)
- Geotech® peristaltic pump (or equivalent)
- 1- Liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination)
- Traffic barricades (orange cones)
- Tygon® tubing – 3/16" ID x 3/8" OD
- Teflon® tubing – 3/16" ID x 1/4" OD
- Black collection bag (trash bag)

The following equipment is typically used for the West Fenceline and Public Works header line and RTO exhaust stack data collection and sampling:

- Combination wrench 1/2 and 9/16 inch
- Extension cord
- Gast high flow vacuum pump
- Geotech® peristaltic pump
- Dwyer Series 475 Mark III Digital manometer (measuring appropriate range(s)), or equivalent
-
- PPE
  - ANSI Class II safety vest
  - Hardhat
  - Nitrile gloves
  - Safety glasses
  - Safety goggles
  - Steel-toe boots
  - FRC Clothing
- Summa canister

- Pressure gauge
- Regulators (flow controllers)
- Calibrated rotometer (or equivalent)
- Sample train
- 1- Liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination)
- Tygon® tubing – 3/16" ID x 3/8" OD
- Teflon® tubing – 1/8" ID x 1/4" OD
- Black collection bag (trash bag)

3. Procedures for SVE Wells

This section provides step-by-step procedures for data collection and soil vapor sampling of SVE wells. The field data sheet or the appropriate fields in the SVE Monitoring software should be filled out completely with the appropriate observations and data collected during sampling. All applicable components of the Health and Safety Plan, including completion of Job Safety Analysis (JSA) forms, shall be followed while performing the activities described in this SOP.

Upon Arrival at Well

1. Position truck between the well to be sampled (work zone) and on-coming traffic, turn on hazard lights.
2. Place traffic cones in front of and behind the truck.
3. Unlock the well vault, remove well vault bolts, use crow bars (if needed) to release vault latch, and pry open vault lid for underground wells or open above ground well vault to access well. Engage safety latch or chain (if present) to secure vault lid in open position. Record position of main SVE valve.
4. If sufficient rain water is present in vault to impede work, use a sump pump to drain the vault.
    - If water in vault has no evidence of sheen water can be pumped to ground surface.
    - If water in vault has evidence of sheen water must be pumped into 5–gallon containers and transferred to polyethylene tank located in rear of work vehicle. Containerized water from wells located within the refinery is

transported to Site 9 in WRR for proper management. Containerized water from wells located outside the refinery is transported to Tannery property for proper management.

Sample Collection

1. Connect manometer to sample port and record the vacuum on the SVE well by connecting the appropriate digital manometer (SOP No. 53 Dwyer Digital Manometer) to the sample port of the well and turning the sample port lever to the open position. If the vacuum reading fluctuates, record the highest, lowest, and the most consistent reading.
2. Write the well ID, date, sample time, vacuum, and sampler's initials on the Tedlar® bag.
3. Connect a clean piece of disposable Tygon® tubing to the sample port of the SVE well.
4. Insert Tygon® tubing into the peristaltic pump head.
5. Connect power cord to peristaltic pump and plug into battery, vehicle cigarette lighter, or other available power source (car battery adapter).
6. Inset hard plastic (e.g. Teflon) reducer on end of Tedlar® bag which shall later connect to Tygon® tubing.
7. Turn on the peristaltic pump with sample port open to purge Tygon® tubing for approximately 10 seconds.
8. Connect Tedlar® bag to Tygon® tubing.
9. Once the Tedlar® bag is full, close valve on Tedlar® bag, turn peristaltic pump off, close sample port, remove Tygon® tubing from Tedlar® bag and sample port and dispose of tubing.
10. Place Tedlar® bag sample in black collection bag to protect from sunlight while other samples are being collected and transported to on-site screening lab.

Fluid Level Measurement

1. Turn the main SVE valve to its fully closed position, if necessary.
2. Remove the sample plug from the well cap.
3. Turn the interface probe on and lower probe into the SVE well. Record fluid levels and total depth as described in SOP No. 10 Well Gauging Measurements.

Additionally, record if the bottom surface of the well is hard or soft. Decontaminate the probe and tape as described in SOP No. 4 Decontamination.

4. Record the condition of the probe and tape upon removal (e.g. clean, visual or olfactory evidence of petroleum hydrocarbon, sludge, foam, silt) and any well defects or maintenance issues.
5. Replace the sample plug into the well cap.
6. Return the main SVE valve to its original position, if closed in Step 1 above.
7. Disengage safety latch and lower vault lid. Replace well vault bolts (if needed) and lock the well vault.
8. Load traffic cones and other equipment and move to next well location.

4. Procedures for the Header Lines and Exhaust Stack

This section provides step-by-step procedures for data collection and soil vapor sampling of the Public Works and West Fenceline Headers located immediately upstream of the VLS units and the RTO Exhaust stack.

4.1. Data/Sample Collection at the Regenerative Thermal Oxidizer (RTO) Unit – PW and WFL Header Lines

1. Connect appropriate manometer to sample port on the header line and record the vacuum (SOP No. 53 Dwyer Digital Manometer). Write the sample ID, date, sample time, vacuum, and sampler's initials on the Tedlar® bag.
2. Connect one end of a clean piece of disposable Tygon® tubing to the header sample port and the other end to the inlet port of the Gast® high flow sample pump.
3. Connect clean section of Tygon® tubing to the outlet port of the Gast® high flow sample pump.
4. Connect power cord to Gast® high flow pump and plug into ac power source, (extension cord with GFI plugged into wall outlet)
5. Inset hard plastic reducer on end of Tedlar® bag which shall later connect to Tygon® tubing.
6. Turn on the Gast® high flow pump with sample port open and allow pump to run for approximately 10 seconds to purge the tubing.
7. Connect Tedlar® bag to Tygon® tubing on the outlet port of the Gast® high flow sample pump.

8. Once the Tedlar® bag is full, close valve on Tedlar® bag.
9. Turn Gast® high flow pump off, close sample port, and remove/dispose of Tygon® tubing from Tedlar® bag and sample port.
10. Place Tedlar® bag with sample in black collection bag to protect from sunlight while other samples are being collected and transported to on-site screening lab.

4.2. Summa Canister Sample Collections - PW and WFL Header Lines

Prior to Sampling - PW and WFL Header Lines

1. Remove brass cap from stainless steel canister.
2. Attach the pressure gauge provided by the laboratory to the stainless steel canister inlet.
3. Open valve completely.
4. Record the vacuum reading on the canister tag. The canister should show a vacuum of approximately -28 inches of mercury (Hg). If the canister does not show a vacuum or shows a vacuum of less than -26 inches of Hg, then:
    - Label the canister tag with "Insufficient vacuum – No Sample";
    - Set canister aside for return to the laboratory; and
    - Contact task manager and lab coordinator if canister failures affect field work.
5. Close valve completely.
6. Remove the pressure gauge.
7. If not immediately using the stainless steel canister for sample, place and tighten brass cap on stainless steel canister.

Sampling - PW and WFL Header Lines

1. Collect a Tedlar® bag sample using steps 1 through 9 from Section 4.1 above.
2. Remove brass cap, attach particulate filter and sample train to the canister using wrenches.
3. Using a clean piece of disposable silicone tubing, connect the hose barb attached to the sample train to the exhaust port on the Gast® pump.
4. Open the sample canister. Allow sample to enter the canister until the vacuum reads approximately between -5 and -10 inches of Hg. **The vacuum gauge should reach less than -10 inches Hg, but should not be allowed to drop below -2 inches of Hg.**
5. Turn off Gast® pump and close valve to the sample port.

6. Close the sample canister valve completely and remove the sample train using wrenches. Replace brass cap onto canister while leaving the particulate filter in place.
7. Close the sample port on the exhaust/header line and properly dispose of any used silicone tubing.

After Sampling - PW and WFL Header Lines

1. Attach the pressure gauge provided by the laboratory to the stainless steel canister inlet.
2. Open valve completely.
3. Record reading. There should still be a vacuum in the stainless steel canister. If the canister does not show a net loss in vacuum after sampling of at least -10 inches Hg, evaluate and document the problem. If necessary, contact the project manager immediately to determine the value of using another stainless steel canister to recollect the sample.
4. Close valve completely.
5. Remove the pressure gauge.
6. Place and tighten brass cap on stainless steel canister.

4.3. Data/Sample Collection at the Regenerative Oxidizer Unit – Exhaust Stack

1. Connect appropriate manometer to sample port on the exhaust stack and record the vacuum (SOP No. 53 Dwyer Digital Manometer). Write the sample ID, date, sample time, vacuum, differential pressure, and sampler's initials on the Tedlar® bag.
2. Connect a clean piece of disposable Tygon® tubing to the sample port of the exhaust stack and insert into peristaltic pump.
3. Inset hard plastic reducer on end of Tedlar® bag which shall later connect to Tygon® tubing.
4. Turn on the Geotech® peristaltic pump with sample port open. Allow pump to run for at least 60 seconds to purge the sample line.
5. Use a calibrated rotometer or equivalent to set the speed of the peristaltic pump at approximately 125mL/min.
6. At the beginning of poppet valve switch, connect Tedlar® bag to Tygon® tubing.
7. After 2 cycles of poppet valve switching, close valve on Tedlar® bag,

8. Turn peristaltic pump off, close sample port, and remove/dispose of Tygon® tubing from Tedlar® bag and sample port.
9. Place Tedlar® bag with sample in black collection bag to protect from sunlight while other samples are being collected and transported to on-site screening lab.

4.4. Summa Canister Sample Collection – Exhaust Stack

Prior to Sampling - Exhaust Stack

1. Remove brass cap from stainless steel canister.
2. Attach the pressure gauge provided by the laboratory to the stainless steel canister inlet.
3. Open valve completely.
4. Record reading on the canister tag. The canister should show a vacuum of approximately -28 inches of mercury (Hg). If the canister does not show a vacuum or shows a vacuum of less than -26 inches of Hg, then:
    - Label the canister tag with "Insufficient vacuum – No Sample";
    - Set canister aside for return to the laboratory; and
    - Contact task manager and lab coordinator if canister failures affect field work.
5. Close valve completely.
6. Remove the pressure gauge.
7. If not immediately using the stainless steel canister for sample, place and tighten brass cap on stainless steel canister.

Sampling - Exhaust Stack

1. Collect a Tedlar® bag sample using steps 1 through 7 from **Section 4.3** above.
2. Remove brass cap, attach particulate filter and sample train to the canister using wrenches.
3. Using a clean piece of disposable silicone tubing, connect the hose barb attached to the sample train to the sample tubing on the peristaltic pump.
4. At the beginning of the poppet valve switch, open the sample canister. Allow sample to enter the canister though 2 cycles of poppet valve switching and the vacuum reads approximately between -5 and -10 inches of Hg. **The vacuum gauge should reach less than -10 inches Hg, but should not be allowed to drop below -2 inches of Hg.**

5. Close the sample canister valve completely and remove the sample train using wrenches.
6. Close the sample port on the exhaust line and properly dispose of any used silicone tubing.

After Sampling - Exhaust Stack

1. Attach the pressure gauge provided by the laboratory to the stainless steel canister inlet.
2. Open valve completely.
3. Record reading. There should still be a vacuum in the stainless steel canister. If the canister does not show a net loss in vacuum after sampling of at least -10 inches Hg, evaluate and document the problem. If necessary, contact the project manager immediately to determine the value of using another stainless steel canister to recollect the sample.
4. Close valve completely.
5. Remove the pressure gauge.
6. Place and tighten brass cap on stainless steel canister.

5. *Sample Screening, Classification, Packaging and Shipping*

Refer to SOP No. 51 Vapor Sample Classification, Packaging and Shipping for information related to packing and shipping samples to the laboratory for analysis, if necessary. Refer to SOP No. 52 Soil Vapor Field Laboratory Screening for information related to on-site field laboratory screening of samples collected.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to provide a consistent methodology for the collection of soil vapor samples from vapor monitoring points related to the Shell Roxana Soil Vapor Extraction (SVE) system. This SOP details the necessary procedures to follow so that representative samples are collected. These procedures are applicable to any soil vapor sample collected at vapor monitoring points (VMPs). Important uses of these data include:

- SVE system performance evaluation
- Hydrocarbon plume definition

2. Equipment

The following equipment is typically used for sample collection.

- Dwyer Series 475 Mark III Digital manometer (or equivalent)
- 1-Liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination)
- Tygon® or silicone tubing (or equivalent) - 3/16" ID x 3/8" OD
- Polyethylene tubing – 3/16" ID x 1/4" OD
- Peristaltic pump – 60-350 RPM
- BIOS DC-LITE flow calibrator or calibrated rotometer (0-500 mL/min)
- 60-mL syringe
- Crescent wrench (or equivalent hand tools)
- Black collection bag (trash bag)
- New or dedicated 3-way micro valves for purging and sampling
- SVE System Effectiveness Monitoring Forms or Toughbook® with SVE Monitoring software

3. Procedures

Initial Vacuum/Pressure Measurement

Using a Dwyer Series 475 Mark III digital manometer, the initial vacuum/pressure is measured. Basic manometer operation instructions can be found in SOP No. 53 Dwyer Digital Manometer.

At VMP monitoring locations the positive fitting of the manometer shall be connected to the VMP. The negative fitting on the manometer shall remain open to the atmosphere. The pressure

and time, are immediately read and recorded to the nearest hundredth of an inch (or tenth of an inch if using 0-200 manometer) of water column on the SVE System Effectiveness Monitoring Form or Toughbook/Toughpad with SVE Monitoring software. Immediately following the recording of the vacuum/pressure measurement, the VMP shall be closed to the atmosphere.

VMP Purging

After obtaining the initial vacuum/pressure measurements and prior to soil vapor sample collection, each monitoring location shall be purged a predetermined amount based on the volume of the VMP riser and screen. The purge volume shall be equivalent to a minimum of three VMP volumes. The actual purge volume removed shall be recorded on the appropriate field form. If the VMP will not yield the purge volume or if water and/or product are encountered during purging, this observation shall be documented in the appropriate field form. The VMP screen is presumed to be submerged when this condition is encountered. No sample is to be collected and no stabilized reading is required.

To purge VMP monitoring locations, a 60-mL plastic syringe is attached to the VMP to allow the removal of the required purge volume. The syringe plunger shall be drawn back to evacuate a purge volume.

VMP Sampling

Upon completion of VMP purging, soil vapor sample collection using Tedlar® bags may commence. If water and/or product are encountered during sample collection, this observation shall be documented on the appropriate field form. Note that samples which indicate the presence of water and/or product shall not be analyzed.

Tedlar® Bag Samples

Air samples for on-site screening shall be collected using a Tedlar® bag and a peristaltic pump. For VMP monitoring locations, the inlet of the peristaltic pump tubing is attached to the VMP and the positive pressure (output) side of the peristaltic pump shall be attached to the inlet side of the flow calibrator (or rotometer) using designated tubing. Prior to flow-rate adjustment and sample collection, the sample identification, date, time of initial vacuum reading, and initial vacuum/pressure reading (if applicable) shall be clearly marked on the Tedlar® bag.

Flow Rate Adjustment

The rotometer[1] shall be used to adjust the flow rate of the peristaltic pump to allow a flow rate of 200 mL/minute. For VMPs, this adjustment shall be performed by observing the flow rate

[1] Rotometers are checked and calibrated on an annual basis.

indicated by the ball height and adjusting the peristaltic pump to allow a flow rate of 200 mL/minute. *Notes: The initial settings on the pump should be set to allow for the minimum flow possible. It is important to set the flow rate as quickly as possible in order to minimize the amount of additional sample purge.* After setting the sample flow, sample collection shall be immediately initiated. Care shall be taken at this time to avoid unintentionally adjusting (by bumping or handling) the pump speed control.

Sample Collection

After setting the sample flow, the rotometer shall be removed from the sample train and a new or decontaminated, pre-labeled one-liter Tedlar® bag shall be connected to the tubing exiting from the output side of the peristaltic pump. A wire tie shall be used, if necessary, to make the connection between the bag and the pump a leak-proof fitting. Immediately open the valve on the Tedlar® bag approximately one turn. *Please note: The sample time is the same time as the acquisition of the initial vacuum/pressure reading. If a vacuum/pressure reading was not collected, the sample start time shall be documented on the appropriate field form* Based on the flow rate to collect a 1-liter vapor sample, the peristaltic pump shall be allowed approximately five (5) minutes to collect the sample. Total sample collection time, which may exceed five (5) minutes, is dependent on the soil characteristics of the stratum from which the sample is being collected. Upon retrieval of the one-liter sample volume, close the valve on the Tedlar® bag, turn off the peristaltic pump, and close the VMP to the atmosphere. Place the sample bag in a black trash bag or container that will minimize exposure to sunlight. These samples are taken to the field laboratory for screening throughout the day (refer to SOP No. 52 Soil Vapor Field Laboratory Screening).

Duplicate samples shall be collected by repeating the procedure detailed above. The duplicate sample shall be collected immediately after the first sample (original sample) has been collected. Due to the nature of the coarse-adjustment valves that are typically installed on Tedlar® bags, the use of a sample splitter is not recommended and will often result in the collection of unequal sample volumes. Duplicate samples shall be obtained at a frequency of one per every twenty original samples collected.

Post-Sample Collection

Dismantle the sample train, dispose of all non-dedicated lines used for sample collection. New sample lines at each sample location shall be used, except for dedicated equipment. Non-dedicated, reusable equipment shall be decontaminated according to SOP No 4 Decontamination.

Venting

Following sample collection, VMPs are vented (opened to atmosphere) for a minimum of 15 minutes. This allows for VMP stabilization to occur.

Final (Stabilized) Vacuum/Pressure Measurement

After venting, a final, stabilized vacuum/pressure measurement shall be recorded. A pressure is considered to be stabilized when it does not fluctuate more than 5% in one minute. The manometer shall be allowed a maximum of thirty (30) minutes to stabilize before the vacuum/pressure is recorded. If the manometer does not stabilize within the 30-minute period, the range in which the vacuum/pressure fluctuates over an additional one (1) minute period shall be documented on the appropriate field form. The highest reading observed within the observed range shall also be recorded on the appropriate field form. (*Please note: If the manometer reading fluctuates between two vacuums, the lowest vacuum observed shall be recorded on the field form. If the manometer reading fluctuates between a vacuum and a pressure, the highest pressure observed shall be recorded on the field form. If the manometer reading fluctuates between two pressures, the highest/strongest pressure observed shall be recorded on the field form. In all cases, the range in the manometer readings over the additional one-minute period shall be recorded on the field form.)*

At VMP monitoring locations, the manometer should be turned on, zeroed, and connected to the well as it was for the initial pressure. Once the pressure is stabilized the reading should be taken. The manometer can then be removed and the VMP can be closed to the atmosphere.

Note: Any monitoring location where water/product is encountered during purge or Tedlar® bag collection, where the requisite volume cannot be purged, or where the VMP screen is submerged will not have a stabilized pressure collected.

URS
Shell Oil Products US
SVE Effectiveness Monitoring

SVE:_____ Date:_____

Technician(s):_____ Time Arrived:_____

SVE System Running at_____ in wc

Gauge Reading_____ in Hg Gauge type/brand_____

Valve Position Upon Arrival: Open / Closed Position/Notch # :_____
Valve Position Upon Departure: Open / Closed Position/Notch # :_____

Vacuum Reading:_____ in wc Time:_____ Surface Temp of Flow Meter

If Surging:_____ in wc to_____ in wc _____ °F

Flow Differential (pitot / venturi):_____ in wc Time:_____

If Surging:_____ in wc to_____ in wc
Water in Pitot Tube: Yes / No

Tedlar Bag Sample: Yes / No If Yes: Time Sample Taken:_____

Well/Vault Integrity
Quantity of Water in Vault:_____ Short Circuiting: Yes / No

Drain Plug: In / Out / Pulled - Time:_____ Hear Well Surge Yes / No

Condition of Well/Vault/Valves:

SILT and WATER INVESTIGATION

Time:_____ DTW:_____ Bottom: Hard / Soft

TD:_____

Condition of Tape After Removal:
Circle One: Dilution Valve / Stinger / Bubbler Tube / None in Well

Date Well Last Cleaned:_____ Header Line Last Cleaned:_____

AIR ANALYSIS

FID TVA 1000 4-Gas Meter

PID ppm FID ppm $\%O_2$ $\%CO_2$ %LEL

Dilution Probe Used: Yes / No If Yes, Dilution Ratio:_____

1. Introduction

The purpose of this Standard Operating Procedure (SOP) is to provide a consistent methodology for the screening of soil vapor samples from the Shell projects in Hartford and Roxana, Illinois. Whenever possible, the soil vapor samples collected for the various work tasks shall be screened on the same day of collection. If same-day screening is not possible due to time constraints, instrument problems, etc., the samples shall be screened within 24-hours of sample collection. This SOP details the necessary procedures to follow in order to ensure that valid total vapor phase hydrocarbons, oxygen, methane and carbon dioxide concentration data is collected and adequately documented. These procedures are applicable to any vapor sample collected at the Roxana site, but are particularly useful for samples collected from vapor monitoring ports (VMPs), soil vapor extraction (SVE) wells, and sub-slab (SS) ports that are located throughout the Village. Important uses of these data include:

- Evaluation of indoor air or sub-slab methane concentrations
- Screening of indoor air or sub-slab petroleum hydrocarbon concentrations
- Evaluation of the performance of the Roxana Soil Vapor Extraction System.
- Evaluation of the performance of the Rand Avenue Remediation System
- Ambient air samples can either be collected and analyzed on-location using real-time instrumentation, or collected in Tedlar® bags and analyzed at a dedicated sample screening station.

2. Equipment

The following materials are typically used to perform sample screening, either on-site or at a dedicated sample screening station:

- Thermo Scientific TVA-1000 (TVA-1000), RAE Instruments PPbRAE-3000 (PPbRAE), and LANDTEC GEM-2000 (GEM-2000) real-time monitors (or similar);
- Calibration gas cylinders, including;
  - Methane in air at concentrations of 50; 500; 5,000, and 32,500 ppmv
  - Isobutylene in air at concentrations of 10, 50 and 1,000 ppmv
  - Hydrocarbon-free air
  - 35 percent by volume concentration CO2
- Regulators for calibration gas cylinders

- SKC sorbent tubes (part # 226-09) used for methane determination
- ¼-inch O.D. Teflon™ or Tygon™ tubing cut to length
- 10-to-1 dilution probe (Thermo Environmental Instruments Part #CR010MR)
- Disposable 3-way plastic valves used to switch the sample between methane and total hydrocarbon analyses.
- 1-liter Tedlar® bags (new or decontaminated as outlined in SOP No. 4 Decontamination)

3. Procedure

The following instruments shall be used to screen soil vapor samples:

- TVA-1000 or performance equivalent for volatile organic compounds (VOCs) and methane by flame ionization detector (FID) and for VOCs by photoionization detector (PID)
- PPbRAE or performance equivalent for VOCs by PID for low-concentration samples
- LANDTEC GEM-2000 or performance equivalent for methane, lower explosive limit (LEL), oxygen and carbon dioxide.

Immediately prior to use, each instrument shall undergo a calibration check. In the event that instrument accuracy is not within 15-percent of the designated calibration check standard concentration, the instrument shall be recalibrated. Field personnel shall follow applicable instrument operation SOP's and/or manufacturer's recommended procedures for the calibration and operation of the instruments. Calibration data shall be documented on the appropriate calibration forms for each instrument.

Calibration Procedures Applicable to All Field Screening Analyses

Instruments shall be calibrated in accordance with applicable SOPs and/or manufacturers recommended procedures immediately prior to sample screening. If the screening instruments are to be used throughout the work day, a mid-day and end-day calibration check shall be performed. Further, the TVA-1000 instrument detectors and associated dilution probe shall be bump checked (1-point accuracy check) approximately every two hours in order to document instrument stability. In the event that a bump check indicates a deviation greater than ± 15percent from the designated bump-gas concentration, a full instrument calibration shall be performed. Due to negligible (<5-percent) instrument drift throughout the day, the GEM-2000 and PPbRAE shall not undergo bi-hourly bump checks. Instead, if the GEM-2000 is used throughout the work day, calibration accuracy checks shall be conducted at approximately midday, and again at the

conclusion of the sample event.

As stated above, calibration of the GEM-2000, TVA-1000, and PPbRAE shall be performed in accordance with applicable SOPs and/or manufacturer recommended procedures. However, the wide range of petroleum hydrocarbons and methane concentrations present at the site (i.e., greater than four orders-of magnitude) may be outside of the linear range of the TVA-1000 FID. To meet a primary data quality objective of the project (i.e., to quickly and accurately determine whether a potentially explosive condition is present at a sampling location), the FID calibration shall be based on a calibration standard that is approximately 10% of the LEL for methane (5,000 ppmv). However, additional QC procedures shall be implemented to ensure quality data for both hydrocarbon and methane concentrations.

The linearity of instrument response shall be verified by using 50 ppmv, 500-ppmv methane standards. If significant non-linear response (i.e., greater than 15% relative root mean square error) is observed, a nonlinear calibration curve shall be developed. The relative response factor for isobutylene (which is used here as a surrogate for petroleum vapors) shall be determined by using a 1,000 ppmv (nominal) isobutylene calibration standard. (1,000 ppmv is approximately 10% of the LEL for gasoline.)

Calibration shall be considered adequate when check standards are within +/- 15%. If the calibration check standards are outside that range, a second check standard shall be run and if the check standard fails again, the instrument shall be recalibrated and data obtained since the last check standard was successfully run shall be flagged as estimated values.

Screening of Concentrated Samples Utilizing a Dilution Probe

Because samples will need to be analyzed which are above the measurement range of the FID or which may not have sufficient oxygen content to analyze reliably, dilution of some samples shall be required prior to screening. The 10:1 dilution probe shall be calibrated using the 32,500 ppmv methane standard. Calibration of the dilution probe is considered complete when the FID response to this standard is within ± 15-percent of 3,250 ppmv.

The critical orifice in the dilution probe is density-dependent. As it will be calibrated using a 3.25% methane standard that has a density of 98.6% that of air, samples that have a density significantly different from that shall be subject to some level of deterministic error. Samples that have extremely high hydrocarbon or methane concentrations have the potential to have significantly varying densities, which can introduce significant error when the screening relies on the dilution probe. For example, error in excess of 10% will be present at concentrations of methane above 40% (if significant concentrations of petroleum hydrocarbons are not present).

Because the average density of petroleum hydrocarbon vapors is variable, the error is not as

readily quantified for elevated concentrations petroleum hydrocarbons. Assuming an average density of 2.5 times that of air (i.e., density equivalent to isopentane), error in excess of 10% will be present at concentrations of petroleum hydrocarbon above 17% (if significant concentrations of methane are not present).

The density error associated with methane and heavier hydrocarbons have the potential to offset each other. Because the average density of measured hydrocarbon will not be known, data associated with an estimated error greater than 10% due to the presence of hydrocarbon or methane shall be flagged as estimated, rather than corrected for an assumed density. As the concentrations at which significant error is introduced are well above project action levels, estimated concentrations at these ranges are considered adequate to meet project data quality objectives.

Screening of Samples Utilizing a Charcoal Scrubber Tube to Filter Heavy Hydrocarbons

Use of the sorbent tube to screen out hydrocarbons other than methane affects the function of the FID instrument by lessening the flow of air through the detector. Preliminary testing indicates that a 25% to 30% reduction in instrument response occurs over the linear calibration range of the instrument. To calibrate the instrument for use of the sorbent tube, the 50, 500 and 5,000-ppmv methane standards shall be run with the sorbent tube to determine the relative response of the instrument to methane passed through the sorbent tube. The relative response factor (RRF) for each calibration standard shall be calculated as:

$$RRF = \frac{FID_{sorb}}{FID_{raw}}$$

Where;

RRF = relative response factor;

FID_{sorb} = Instrument response with sorbent tube; and

FID_{raw} = Instrument response to calibration standard without sorbent tube

The average RRF shall be used as a correction factor for samples analyzed using the sorbent tube. It is not necessary to correct instrument response (other than multiplying the displayed value by 10) when using the 10:1 dilution probe in conjunction with the sorbent tube. When using the dilution probe, the majority (approximately 90-percent) of the sample that is analyzed is actually dilution air that does not pass through the sorbent tube.

4. Sample Screening

Most soil vapor samples collected in Tedlar® bags shall be screened at a fixed location using the instrumentation noted above. The fixed location facilitates the use of the instrumentation,

allows for a more stable environment in which to screen the samples, and provides adequate space in which to perform the screening and complete the associated documentation. However, to allow rapid screening of indoor air and sub-slab soil vapor, such samples can be analyzed on site, using the same field instrumentation. The calibration of these instruments, as outlined in **Section 3.0**, shall be performed in such a way that instrument response is most accurate in the concentration range that corresponds to project action levels.

The TVA-1000 has been configured with a switching device (disposable 3-way valve) to allow sample to be passed through an SKC carbon sorbent tube to remove petroleum hydrocarbons (i.e., site data indicate that the remainder will be primarily methane).

Procedures for Sample Screening On Site

- Screen air sample with GEM-2000 landfill gas analyzer. Quickly document methane, LEL, oxygen and carbon dioxide concentrations on the appropriate sample screening data sheet;
- Screen sample with the TVA-1000 PID or PPbRAE PID instrument and quickly document the concentration on the appropriate data sheet; and
- Set the TVA-1000 to sample through the SKC sorbent tube used in conjunction with the FID.

  Calculate the methane concentration as;

$$C_{meth} = \frac{FID}{RRF};$$

  Where

  C_{meth} = methane concentration (ppmv); and

  FID = FID reading (ppmv)

- Switch the TVA-1000 to sample without the sorbent tube. Screen the sample with the TVA-1000 and quickly record the vapor concentration by FID on the appropriate data sheet; and

- The hydrocarbon concentration portion of the FID response should be calculated as;

$$PHC = C_{raw} - C_{meth};$$

Where

PHC = petroleum hydrocarbon concentration (ppmv); and

C_{raw} = FID reading without sorbent tube (ppmv)

Procedures for Sample Screening at a Dedicated Sample Screening Station

The sampling instrumentation for the dedicated sample screening station has been configured such that the TVA-1000 can be operated with a 10:1 dilution valve, if concentrations are outside the operational range of the FID (i.e., if there is insufficient oxygen to support the FID flame or if the sample is above the linear range of the instrument).

- Open the valve on the Tedlar® bag sample approximately one turn and attach to the inlet of the GEM-2000 landfill gas analyzer. Quickly document oxygen and carbon dioxide concentrations on the appropriate sample screening data sheet;
- Immediately connect the sample bag to the PPbRAE PID instrument and quickly document the concentration on the appropriate data sheet. If the instrument registers over range, the VOC concentration by PID shall be completed using the TVA-1000 PID;
- If the oxygen concentration in the sample is less than approximately 16-percent, configure the TVA-1000 for use with a 10-to-1 dilution probe. The dilution probe will allow for the sample to be screened by FID without flameout associated with low oxygen concentration samples. If the oxygen concentration is below 16 percent in a sample but a flameout does not occur on the TVA-1000, it should be screened without the 10-to-1 dilution probe. The dilution probe must be separately calibrated and should be used for sample screening by FID only;
- Set the TVA-1000 to sample through the SKC sorbent tube. Record the reading as the methane concentration. If the 10-to-1 dilution probe is used, the displayed concentration (FID) must be multiplied by 10;
- Switch the TVA-1000 to sample without the sorbent tube. Immediately connect the sample bag to the TVA-1000 probe inlet and quickly record the vapor concentration by FID on the appropriate data sheet. If the 10-to-1 dilution probe is used, the displayed concentration (FID) must be multiplied by 10; and
- The hydrocarbon (HC) concentration portion of the FID response should be calculated as:

$$HC = C_{raw} - C_{meth}.$$

- After screening of the Tedlar® bag sample is complete, set aside the Tedlar® bag for cleaning if it meets the decontamination criteria listed in Section 3.9 of SOP No. 04 Decontamination.

Procedures Applicable to All Sample Screening

Because concentrations of hydrocarbons in some samples are elevated, the carbon in the sorbent tube can be saturated with hydrocarbon relatively quickly. If possible, use historical data to screen samples from low hydrocarbon concentration to high hydrocarbon concentration to avoid sorbent tube saturation. Therefore, the following protocols are in place to assure quality data:

- The sorbent tube shall be replaced at least every 10 samples;
- The sorbent tube shall also be replaced, if breakthrough is observed (readily apparent) or if concentrations do not go to zero after sample is removed from analyzer inlet; and
  Associated sample lines (Teflon™ or Tygon™ tubing), valves, etc. shall be replaced if concentrations do not return to zero after sample is removed from analyzer inlet.

5. Conclusion

The screening of soil gas samples must be conducted in an organized and precise manner. The resultant data will be valid only if proper procedure and associated QA/QC is followed. It is imperative that personnel conducting the sample screening strictly adhere to the protocol detailed above. Because the samples are collected in 1-liter bags, the samples must be removed from the instrument inlets as soon as a stable reading can be documented. Failure to do so will result in an inadequate amount of sample volume to complete all the screening parameters. Larger bags cannot be used due to time constraints during sample collection.