URS

September 27, 2013

Mr. Steven F. Nightingale, P.E.
Manager, Permit Section
Illinois Environmental Protection Agency
Bureau of Land
1021 North Grand Avenue East
Springfield, Illinois 62794

Subject: Routine Updates to Previously Submitted Standard Operating Procedures
Roxana, Illinois
119115002 – Madison County

Dear Mr. Nightingale:

As part of URS Corporation'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. Prior versions of these SOPs were submitted to the Illinois Environmental Protection Agency (IEPA) within various reports and work plans identified in the table below. We are therefore submitting this package of updated SOPs for informational purposes. The SOPs included with this submittal, along with a summary of the revisions made, are listed below.

SOP No.	SOP Title	Revision
Dissolved Phase Groundwater Investigation & P-60 Free Phase Product Delineation Workplan & Report[1]		
3	Calibration and Maintenance of Field Instruments	Editorial/formatting
4	Decontamination	Add isopropyl alcohol as a decontamination step
5	Utility Clearance Procedures	Add discussion of private locating activities
8	Field Reporting and Documentation	Add discussion about electronic data entry using Panasonic Toughbooks®

[1] The *Dissolved Phase Groundwater Investigation and P-60 Free Phase Product Delineation Work Plan* for Roxana, Illinois was prepared for Shell Oil Products US by URS Corporation and dated January 21, 2009. This work plan included a copy of the SOPs listed under this section above. The *Dissolved Phase Groundwater Investigation and P-60 Free Phase Product Delineation Report* for Roxana, Illinois was prepared for Shell Oil Products US by URS Corporation and dated February 2010. This report included SOP 44R.

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SOP No.	SOP Title	Revision
Dissolved Phase Groundwater Investigation & P-60 Free Phase Product Delineation Workplan & Report (cont'd)		
10	Well Gauging Measurements	Editorial/formatting
12	Grouting Procedures	Editorial/formatting
14	Headspace Soil Screening	Editorial/formatting
16	IDW Handling	Editorial/formatting
18	Low Flow Groundwater Purging and Sampling	Editorial/formatting
20	Well Development	Add steps for what to do if NAPL is present
21	Monitoring Well Installation	Editorial/formatting
23	Quality Assurance Samples	Editorial/formatting
24	Sample Classification, Packaging and Shipping	Editorial/formatting
25	Sample Containers, Preservative and Holding Times	Editorial/formatting
26	Sample Control and Custody Procedures	Editorial/formatting
28	Soil Sampling	Editorial/formatting
29	Soil Probe Operation	Editorial/formatting
33	Water Quality Monitoring	Editorial/formatting
42	Groundwater Profiling	Editorial/formatting
44R	Soil Vapor Purging and Sampling	Change in valves and tubing used for some connections
Vapor Intrusion Investigation Work Plan[2]		
47	Sub-Slab Soil Gas Installation and Sampling with Canisters	Change in tubing used for some connections
51	Vapor Sample Classification, Packaging and Shipping	Editorial/formatting

[2] The *Vapor Intrusion Investigation Work Plan* for Roxana, Illinois was prepared for Shell Oil Products US by URS Corporation and dated March 2011 (revised).

SOP No.	SOP Title	Revision
***SVE Operating and Maintenance Plan*[3]**		
48	Soil Vapor Extraction Well Data Collection and Sampling	Editorial/formatting
49	Soil Vapor Extraction Effectiveness Monitoring	Editorial/formatting
52	Soil Vapor Field Laboratory Screening	Editorial/formatting
53	Dwyer Digital Manometer	Editorial/formatting

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

Sincerely,

Wendy Pennington, P.E.
Staff Environmental Engineer

Robert B. Billman
Senior Project Manager

Enclosures Revised SOPs

Cc: Gina Search, IEPA (Collinsville, IL)
Kevin Dyer, SOPUS
Marty Reynolds, Village of Roxana
Shannon Haney, Greensfelder Hemker
Amy Boley, IEPA (Springfield, IL)
Project File
Repository (Village of Roxana, Website)

[3] The *SVE Operating and Maintenance Plan* was prepared for Shell Oil Products US by URS Corporation and dated May 2011. This O&M Plan was included as Appendix E of the *Conceptual/Final Design Report* for Roxana, Illinois, which was prepared for Shell Oil Products US by URS Corporation and dated June 2011.

1. Objective

This document defines the standard operating procedure for calibration and maintenance of field instruments frequently used during environmental field activities. This Standard Operating Procedure (SOP) gives descriptions of the most common used of these instruments and field procedures necessary to calibrate and maintain these field instruments. Calibration and maintenance records for all equipment are maintained with the project file.

2. Equipment

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

- Latex/Nitrile gloves
- Site logbook
- Field data sheets
- Equipment Calibration Record forms
- Distilled/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

Maintenance should be performed on all field instruments on a regular basis to ensure instruments are in proper working order at all times and to prolong the instrument life. General maintenance such as regular cleaning of the instrument, battery checks and replacement, and ensuring the instrument is handled and stored properly can easily be performed by URS 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 URS employees. Contact the manufacturer to determine where the instrument should be submitted for these maintenance tasks. The vast range of instruments available for use by the environmental professional have an equally vast maintenance regime and therefore maintenance guidelines specified in the manual for each piece of equipment should be referred to and followed at all times.

5. Calibration

Due to the vast number 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 and should be followed while performing calibrations of field instruments.

<u>Air Monitoring Instruments</u> (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.
4. Record the initial reading on the proper equipment calibration field form and in the site logbook. Also record the fresh air calibration standard on the field form and in the logbook.

5. Apply the proper calibration gas and proceed with calibration as directed in the operator's manual.
6. Record the final calibrated reading on the field equipment calibration forms and in the field logbook.
7. At periodic intervals throughout the day the calibration of the instrument should be check and re-evaluated.

Groundwater Parameter Instruments (pH, Temperature, Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity, 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 operator's manual.
4. Adjust the reading of the instrument to correlate to the corresponding calibration solution being applied.
5. Record calibration reading(s) in the field logbook and on proper field calibration forms.
6. Dispose of used calibration solution and reseal calibration solution containers for future use.

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 will be described.

1. Turn the instrument on. The on/off switch is usually a knob located on the side of the reel in 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 potable water to ensure the audible tone is heard and visible light illuminates when the electrical circuit is completed when the probe enters the water. Make an observation of where the water level is at on the probe when the circuit is completed. Repeat this step several times to familiarize yourself with this contact point. By performing this step, the chance of submersing the probe to a greater depth than necessary is reduced. Over submersion of the probe will result in a greater amount of the probe and measuring tape to be cleaned and decontaminated prior to collection of another groundwater measurement.

6. Decontamination

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

1. Objective

This document defines the standard procedure for decontamination. This SOP serves as a supplement to the project Work/O&M/Field Sampling Plans and 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, ultimately, to an incorrect assessment of the contaminant conditions associated with the site. Decontamination of sampling equipment (e.g., all non-disposable equipment that will come in direct contact with samples) and field support equipment (e.g., drill rigs, vehicles) 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
- Alconox/Liquinox detergent (or equivalent)
- Isopropyl alcohol
- Potable tap water
- Deionized or distilled water
- Garden-type water sprayers.
- Plastic sheeting or trash bags

3. Decontamination Procedures

3.1 Personnel

A temporary personnel decontamination line will be set up around each exclusion zone. If contamination is not encountered, a dry decontamination station may be established which consists of discarding of disposable personal protective equipment (PPE).

If real-time monitoring instruments indicate that contamination has been encountered (i.e. action levels are exceeded requiring an upgrade from initial PPE levels), a complete personnel decontamination station will be established.

The temporary decontamination line should provide space to wash and rinse boots, gloves, and all sampling or measuring equipment prior to placing the equipment into a vehicle. A container should be available to dispose of used disposable items such as gloves, tape, or tyvek (if used).

The decontamination procedure for field personnel will include:

1. Glove and boot wash in an Liquinox (or similar) solution
2. Glove and boot rinse
3. Duct tape removal
4. Outer glove removal
5. Coverall removal
6. Respirator removal (if used)
7. Inner glove removal

3.2 Sampling Equipment

The following steps will be used to decontaminate sampling equipment:

1. Personnel will dress in suitable safety PPE to reduce personal exposure as required by the HASP.
2. Gross contamination on equipment will be scraped off at the sampling or construction site.
3. Equipment will be sprayed and/or wiped off with isopropyl alcohol.
4. Equipment that cannot be damaged by liquid or water will be placed in a wash tub or bucket containing Liquinox or similar along with potable or distilled water and

scrubbed with a bristle brush or similar utensil (pumps will be turned on in order to circulate water through).

5. Equipment that cannot be damaged by liquid or water will then be rinsed with distilled water in a second wash tub or bucket.
6. Equipment that may be damaged by liquid/water will 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 will be taken to prevent equipment damage.
7. Rinse water and detergent water will be replaced with new solutions periodically throughout the day, at least at mid-day.

Following decontamination, equipment will be placed in a clean area or on clean plastic sheeting to prevent contact with contaminated media. If the equipment is not used immediately after decontamination, the equipment will be stored in such a way as to minimize potential contact with contaminants.

3.3 Water Level / Interface Probes

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

1. Personnel will dress in suitable safety PPE to reduce personal exposure as required by the HASP.
2. Paper towel or other disposable media will be saturated with isopropyl alcohol.
3. Measuring tape and probe will be wiped clean as removed from the monitoring well where gauging activities are being performed by passing through the disposable media saturated with isopropyl alcohol.
4. Care will be taken to replace saturated paper towel if gross contamination is observed or it becomes dry during the process.
5. Probe tip will also be sprayed off with isopropyl alcohol, Liquinox (or similar) soapy water solution, and distilled water after wiping.

Following decontamination, equipment will be placed in a clean area or on clean plastic sheeting to prevent potential contact with contaminants.

3.4 Drilling and Heavy Equipment

Drilling rigs will 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 will be used to decontaminate drilling and heavy equipment:

1. Review JSA for drilling and heavy equipment decontamination.
2. Personnel will dress in suitable PPE to reduce personal exposure as required by the HASP.
3. Equipment showing gross contamination or having caked-on drill cuttings will 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, will be washed with a hot water, high-pressure sprayer then rinsed with potable water. Care will be taken to adequately clean the insides of the hollow-stem augers, backhoe buckets, etc.

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

3.5 Equipment Leaving the Site

Vehicles used for activities in non-contaminated areas 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 will be required for very dirty vehicles leaving the area. Construction equipment such as trucks, drilling rigs, backhoes, trailers, etc., will be pressure washed before the equipment is removed from the site to limit exposure of off-site personnel to potential contaminants.

3.6 Wastewater

Liquid waste water from decontamination activities will be containerized and left at the site where it originated, unless otherwise specified. Check the project/task work plan or with the Shell IDW Coordinator for additional information/guidance.

4. Documentation

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

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

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 will include rinsing deionized 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, will be recorded in the field notebook.

1. Objective

This document defines the standard procedure for subsurface utility clearance. This procedure provides descriptions of equipment and procedures necessary to properly clear utilities prior to beginning subsurface field activities.

This document also defines the procedure for contacting the applicable "one-call" service for locating underground utilities. One-call is a public service provided by individual states as a single point of contact for requesting a utility locate from a majority of underground utilities. This service is primarily for locating utilities on public properties and right-of ways.

2. Equipment

Equipment used during utility clearance procedures:

- Project map
- Known utility map
- Marking paint
- Stakes or flags
- Permanent marker
- Measuring tape and/or wheel
- Other related field paperwork, as needed.

3. Location Marking

Prior to utility clearance, locations to be drilled or excavated should be marked by field personnel scheduled to complete the work. Per one-call guidelines excavation areas should be marked either a) with stakes or flags with the necessary radius to be cleared marked on the stake or flag or b) with white marking paint (black paint may be substituted when necessary). When using paint, the extent of the area to be cleared should be marked.

When marking locations, initial adjustments to locations should be made based on visible utilities such as overhead power lines, sewers and other utility corridors. As a general rule drill rig masts and excavating equipment must stay at least 12 feet away from overhead utilities. Depending on the voltage of the overhead lines or site/client requirements, a greater distance may be necessary.

4. One-Call

The purpose of the one-call system is to alert member utility companies to a planned drilling or excavating project. The one-call system will inform the person making the utility call which member companies will be notified. Additional contacts may be necessary if suspected utility providers in the area of the proposed work are not members of the public one-call system. Individual states have their own one-call number or the national one-call number, 811, may be used. (e.g., Missouri: 1-800-DIG-RITE (344-7483), Illinois: 1-800-892-0123) Some states require the subcontractor actually performing the drilling or excavating to make the initial call (e.g., Illinois).

Once a one-call notification has been placed the utility companies have 48-hours to respond. The time does not include weekends or observed holidays. Once a one-call has been placed work should be ready to start within 10 working days. Once work has begun, renewal of utility locates is determined by an individual state's regulations.

A joint meet may also be requested if the area of the proposed work is large and/or complicated. Member utilities must be given 48-hours prior to the joint meet to schedule a representative to attend. Following the joint meet, an additional 48 hours must be allowed for the utility companies to mark their utilities.

The following information should be provided when making a one-call:

- Identification of who is conducting the work as well as any subcontractor such as a drilling or excavating firm. The contact information for the person responsible along with a phone number where they can be easily reached is a minimum.
- Type of work being conducted (e.g. drilling or excavating).
- Location of work being conducted described as best as possible. Addresses in conjunction with relation to buildings when possible should be used. Other forms of locating include distances and directions from intersections.
- Whether or not a joint meet is required.
- The time frame expected for work to begin.

The following information should be recorded and kept available after the one-call has been made:

- Ticket serial number
- Utilities one-call will notify
- Time and location of joint meet (if applicable)
- Time and date by which utilities are to be cleared
- Log of utilities which have been cleared, either from markings on ground at the location or locator calling to confirm.

Industrial facilities often are responsible for utility locates on their own property and will not be covered by a one-call. Field personnel should coordinate with their contact at such a facility in order to check for known utilities under control or the facility and for any additional clearance efforts which may be required.

When possible, identify the size of underground utilities being marked. The general rule is that the accuracy of marking, from the center of the utility, is the width of the utility plus 1.5-feet. Certain utility companies may require a greater distance from their lines.

The following are the colors from the uniform color code and marking guidelines:

- White (or Black) – Proposed excavations
- Pink – Temporary survey markings
- Red – Electric power lines, cables, conduit and lighting cables
- Yellow – Gas, oil, steam, petroleum or gaseous materials
- Orange – Communication, alarm or signal lines, cables or conduit
- Blue – Potable water
- Purple – Reclaimed water, irrigation and slurry lines
- Green – Sewers and drain lines

These colors shall be used by both the company requesting the utility locate and the member companies marking underground utilities.

5. Private Utility Clearance

Private utility clearance involves using ground penetrating radar (GPR) and/or electromagnetic (EM) technologies to check for utilities prior to beginning secondary utility clearance and excavation or drilling activities. Some clients/sites require private utility clearance as an additional precaution to minimize risk of encountering either active or abandoned buried utilities. GPR and EM should be performed by a trained and qualified subcontractor.

6. Secondary Utility Clearance

Secondary utility clearance involves using an air knife, a hand auger, a post-hole digger and/or a shovel to check for utilities prior to beginning the excavation or boring. Some clients/sites require secondary utility clearance as an additional precaution to minimize risk of encountering either active or abandoned buried utilities.

Air Knife

Air Knife operations involve air/water jetting combined with a high suction vacuum to create a boring or trench of specified dimensions. Single point borings need to have the hole cleared to below the depth of known utilities in the area and to a diameter 3-inches greater than the diameter of the tools penetrating the ground surface. As an alterative, a “V-trench” or a triangle configuration of air-knife holes can also be used to clear a location. If the air-knife is to be completed in a triangle formation, the air knife holes should be completed in sets of three in as tight a triangle as the boring size will allow, with the center of the boring to be completed at the center of the triangle. Whichever method is selected, the air knife boring(s) must be located so that the absence of underground utilities can be confirmed. Once the location is confirmed as being clear, the air knife hole(s) or trench should be backfilled with an inert material, such as silica sand or flowable fill.

Hand Auger

Due to access, availability or cost, air knifing may not be an option. If this is the case, hand augers may be used to clear a location. Due to the size of the hand auger bucket, multiple hand auger holes may be necessary to clear a location for a single boring. If multiple hand augers are necessary, the best option is to complete hand auger holes in sets of three in as tight a triangle as the boring size will allow, with the center of the boring to be completed at the center of the triangle. The same depth requirement for clearance applies to hand auger holes as it does for air knifing. Once the location is confirmed as being clear, the hand auger hole(s) should be backfilled with an inert material, such as silica sand or flowable fill.

Post-hole digger / Hand Shovel

As a last choice, conventional means such as a post-hole digger or hand shovel may be used to clear a location. This option is generally best only when any known utilities are very shallow or the surface material is extremely coarse (large gravels and rocks). Hand shovels and post-hole diggers have a higher chance of damaging weaker utilities, so caution should be taken when used. If deeper clearance than a foot or two is necessary, either an air knife or hand auger should be used for utility clearance. Other procedures/protocols mentioned above still apply.

7. Documentation

Once private utility locating personnel and one-call personnel have marked any utility lines in the vicinity of the work to be performed, document the markings for the project file. Documentation can included, but is not limited to, photographs showing the markings and surrounding area, or field sketch of the vicinity including work locations and utility lines marked. Documentation should be kept with the project file for future reference.

1. Objective

This document defines the standard procedure for field reporting and documentation. This procedure 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 rugged tablet PC (Toughbook)

3. Field Reporting and Documentation

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent waterproof ink in a permanently bound weatherproof field logbook. Some data will also be recorded using Toughbooks.

Field investigation situations vary widely. No set of general rules can anticipate all information that must be collected for a particular site. A site-specific logging procedure will be developed to include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel. The logbooks will be kept in the field team member's possession or in a secure place during the investigation.

Each project or task should have a dedicated logbook. The project leader's name, the sample team leader's name (if appropriate), the project name and location, and the project number should be entered on the inside of the front cover of the logbook. 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 an individual's project activities. At the end of the all entries for each day, or at the end of a particular event, if appropriate, the investigator shall draw a diagonal line and initial and date indicating the conclusion of the entry. Since field records are the basis for later written reports, language should be objective, factual, and free of personal feelings or other terminology which might prove inappropriate. Once completed, these field logbooks become accountable documents and must be maintained as part of the official project files. All aspects of sample collection and handling, as well as visual observations, shall be documented in the logbooks.

The information in the field logbook will include the following as a minimum:

- Personnel present
- Level of PPE used during sampling
- Weather conditions
- Names and responsibilities of field crew members
- Names and title of any site visitors
- Field analytical equipment, and equipment utilized to make physical measurements shall be identified
- Sample collection equipment (where appropriate)
- Calibration results of field equipment
- Location of Sample
- Description of samples (matrix sampled)
- Results of any field measurements, such as depth to water, pH, temperature, and conductivity
- Sample depth (if applicable)
- Date and time of sample collection
- Sample identification code including QC and QA identification
- Number and volume of samples
- Sampling methods or reference to the appropriate SOP
- Sample handling, including filtration and preservation, as appropriate for separate sample aliquots
- Analytes of interest
- Information concerning sampling changes, scheduling modifications, and change orders
- Field observations

- Summary of daily tasks
- Signature and date by personnel responsible for observations
- Problems identified with equipment or aspects of the project.

Each page in the field books will be signed by the person making the entry at the end of the day, as well as on the bottom of each page. Anyone making entries in another person's field book will sign and date those entries.

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

Changes or deletions in the field logbook or 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.

4. 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. 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 memorandums transmitting analytical data
- Official correspondence received or transmitted, including records of telephone calls
- Photographs and negatives 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. At the conclusion of the project, the project leader shall review the file to ensure that it is complete.

5. Toughbooks (Shell Projects)

Background

The URS employees working on the Shell project use a field laptop and Panasonic Toughbook rugged tablet PCs to collect field data. The Panasonic Toughbooks have a Microsoft Windows 7 operating system and Microsoft Office software. For data management purposes, they are referred to using sequential numbering (Toughbook 1, Toughbook 2, Toughbook 3, etc.). A single field laptop is currently used to enter data generated from the analysis of tedlar bag soil vapor samples in the URS office trailer. Multiple electronic data entry programs have been developed. The programs were created using Microsoft Access, a relational database software program. The names and locations of the database files on the Toughbooks are listed in the table below. Note that the number of Toughbook units and applications may change over time.

Field PC	Monitoring Use	Path and Name of Database File(s)
Toughbook 1	Roxana Soil Vapor and Groundwater Monitoring	C:\URS Shell Monitoring Program\Shell_Backend_Data.mdb C:\URS Shell Monitoring Program\Shell_Backend_Lookups.mdb
Toughbook 2	Roxana Soil Vapor and Groundwater Monitoring	C:\URS Shell Monitoring Program\Shell_Backend_Data.mdb C:\URS Shell Monitoring Program\Shell_Backend_Lookups.mdb
Toughbook 3	Roxana Soil Vapor and Groundwater Monitoring	C:\URS Shell Monitoring Program\Shell_Backend_Data.mdb C:\URS Shell Monitoring Program\Shell_Backend_Lookups.mdb
Toughbook 4	Roxana Soil Vapor and Groundwater Monitoring	C:\URS Shell Monitoring Program\Shell_Backend_Data.mdb C:\URS Shell Monitoring Program\Shell_Backend_Lookups.mdb
Toughbook 5	Roxana Soil Vapor Extraction (SVE) System	C:\URS Shell SVE System\Shell_SVE_System_Backend_Data.mdb C:\URS Shell Monitoring Program\Shell_Backend_Data.mdb C:\URS Shell Monitoring Program\Shell_Backend_Lookups.mdb
Toughbook 6	Rand Avenue Remediation System	C:\URS - Rand Remediation System\RandRemSys_O-M_Data.accdb

Field PC	Monitoring Use	Path and Name of Database File(s)
Laptop PC	Tedlar Bag Sample Analysis	C:\URS Shell Monitoring Program\Shell_Backend_Data.mdb C:\URS Shell Monitoring Program\Shell_Backend_Lookups.mdb C:\URS - Rand Remediation System\RandRemSys_O-M_TedlarBag Program.accdb

The various Toughbooks and the field laptop are not automatically synchronized with one another or with a central database. Therefore, the database files must be backed up nightly to a file server in the URS-St. Louis office 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 URS-St. Louis office.

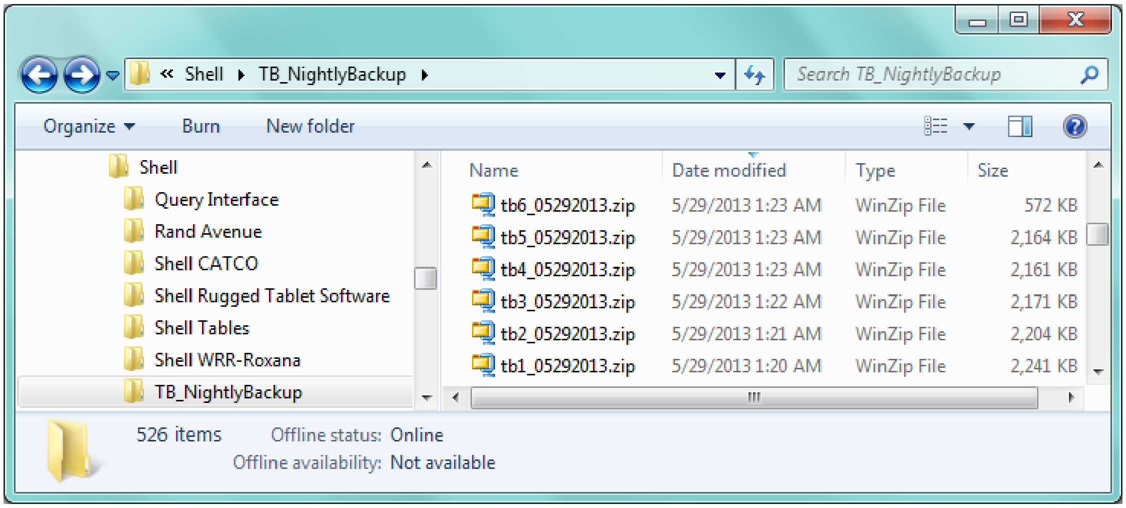
Backup Procedure

The nightly backup of database files is accomplished by automated file transfer (FTP) from the URS office trailer at the Shell job site to the URS-St. Louis office. The steps are as follows:

1. At the end of each work day, each Toughbook PC must be placed in its desktop cradle (docking station) in the URS office trailer. The field laptop and Toughbooks must be left powered on and configured so they don't automatically hibernate/sleep overnight.
2. A batch file on a workstation computer in the office trailer automatically executes each night at around 1:15 AM. The batch file script saves a copy of the database file(s) from the field laptop and each of the Toughbooks. A separate zip file is created for each computer. The names of the zip files are assigned automatically and include the computer ID (tb1, tb2, etc.) and the date in "mm/dd/yyyy" format. The zip files are transferred via FTP to the following network directory on a file server in the URS-St. Louis office:

P:\Systems\Environmental Database Projects\Shell\TB_NightlyBackup

The screenshot below shows an example of zip files resulting from the successful nightly backup of the database files.


« Shell ▸ TB_NightlyBackup ▸
Search TB_NightlyBackup
Organize
Burn
New folder
Shell
Query Interface
Rand Avenue
Shell CATCO
Shell Rugged Tablet Software
Shell Tables
Shell WRR-Roxana
TB_NightlyBackup
Name
Date modified
Type
Size
tb6_05292013.zip 5/29/2013 1:23 AM WinZip File 572 KB
tb5_05292013.zip 5/29/2013 1:23 AM WinZip File 2,164 KB
tb4_05292013.zip 5/29/2013 1:23 AM WinZip File 2,161 KB
tb3_05292013.zip 5/29/2013 1:22 AM WinZip File 2,171 KB
tb2_05292013.zip 5/29/2013 1:21 AM WinZip File 2,204 KB
tb1_05292013.zip 5/29/2013 1:20 AM WinZip File 2,241 KB
526 items
Offline status: Online
Offline availability: Not available

1. Objective

This document defines the standard procedure for measuring water levels in wells. This SOP serves as a supplement to the project Work Plan and is intended to be used together with other SOPs.

2. Equipment

The following equipment is required:

- Water Level or Product/Water Interface probe with 0.01-foot increments;
- Well keys;
- Organic vapor monitor;
- Latex/Nitrile gloves;
- Site logbook;
- Field data sheets;
- Toughbook;
- Appropriate decontamination equipment;
- Appropriate health and safety equipment; and
- Permanent ink pen.

3. Groundwater Level Measurement Procedures

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

Appropriate health and safety equipment, as described in the HASP should be worn during well opening, water level measurement, and decontamination. The following procedures will be completed when measuring water levels:

1. The water level probe shall be decontaminated prior to use in each monitoring well according to SOP No. 4 Decontamination.
2. The well will be approached from upwind, the well cap unlocked and removed, and the air quality monitored in the casing and breathing zone with an FID or PID. Air quality measurements will be recorded in the field logbook, on appropriate field forms and/or in the Toughbook.

3. Observations regarding the condition of the well, including the well pad, surface completion or protective casing, working padlock, etc. will be documented in the field logbook, on appropriate field forms and/or in the Toughbook.
4. Put on a new, unused pair of disposable latex or nitrile gloves.
5. An electric water level or NAPL/water interface probe will 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. Record the depth of water and/or NAPLs, as applicable. Measurements will be made to the nearest 0.01 feet.
6. 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 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.
7. 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 in the Toughbook, and then immediately rechecked before the probe is removed from the well.
8. All columns of field data sheets shall be completed, including time of measurement. An example water level data sheet is attached to this SOP. If measurements are taken over a several-day period, the date of each measurement should be clearly indicated on the form.
9. 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 when entering the data.
10. 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 in the field logbook, on the field data sheet, and/or in the Toughbooks.
11. After any measurement is taken, the water level probe shall be decontaminated as described in SOP No. 4 Decontamination.
12. Place disposable equipment into a plastic garbage bag for disposal.

4. Documentation

The water level data sheet (a sample is attached to this SOP) shall be completed during each measuring event. Field data sheets will include field personnel, date, time, well number, total well depth, water level, static water elevation, and comments. The appropriate information will also be entered into the Toughbook 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 observations during water level measurement. Both the data sheets and notebook shall be filled out using legible handwriting, and shall be signed and dated by the person completing the page.

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

The purpose of this Standard Operating Procedure (SOP) is to define the procedures and necessary equipment for the grouting of borings following their completion. If a monitoring well or piezometer is to be installed in the boring refer to the procedure outlined in SOP No. 21 Monitoring Well Installation.

2. Equipment

The following is the equipment typical for grouting a borehole:

- Portland Type I or II Cement
- Powdered bentonite
- Potable water
- Appropriate health and safety equipment as specified in the Health and Safety Plan (HASP)
- Log book and/or boring log sheets
- Drums or other suitable container for mixing of grout

3. Procedures

A standard mixture of cement-bentonite grout will consist of the following ratio:

- 1 (94 lb) sack of Portland cement,
- Powdered bentonite (as permitted by state regulations), and
- 7 to 15 gallons of potable water.

A standard mixture of high-solids bentonite grout will consist of the following:

- Powdered bentonite (as permitted by state regulations), and
- 7 to 15 gallons of potable water.

The grouting procedures for either type of grout consist of the following:

1. Mix the bentonite and water first to a creamy consistency.
2. Slowly add the Portland Cement (if used). The amount of bentonite or water can be varied to control the consistency and pumpability of the mix.

3. Pump the mixture through tremie pipe or drill rods placed to the bottom of the boring to displace any water or drilling fluids.
4. Withdraw rods or piping when grout has reached surface.
5. Repeat steps 1 – 4 as augers/drill pipe are removed.
6. Grout the remaining open boring to the surface after the augers are removed. The grout will be tremied into the borehole until it is completely filled.
7. After the grout sets for 24 hours it will be checked for settlement. If necessary, additional grout will be added to top off. Hydrated bentonite chips, or similar, may also be used to top off.
8. Add surface seal (asphalt or concrete) as necessary.

4. Documentation

Additional documentation will be written in the field book according to SOP No. 8 Field Reporting and Documentation and will include the following:

- Date
- Time
- Personnel
- Weather
- Subcontractors
- Health and Safety monitoring equipment and readings
- Portland and bentonite bag counts
- The quantity and composition of the grout
- Start and completion dates and times
- Discussion of all procedures and any problems encountered during drilling/grouting.

1. Objective

Volatile Organic Compound (VOC) field headspace screenings will be performed on selected soil samples to obtain preliminary estimates of VOC concentrations. This qualitative data will be used as criteria in selecting soil samples from locations where collection depths have not been predetermined.

2. Equipment

The following equipment is required.

- Quart-sized Zip-Loc bag or equivalent
- Photoionization detector (PID)
- Permanent Marker
- Watch.

3. Procedure

The following general procedure is followed:

1. Obtain approximately 1/2 qt of soil and place in clean 1 qt Zip-Loc bag. Immediately seal the Zip-Loc bag. Record the boring location and sample depth on the bag.
2. Break soil into about 1 in. sized particles by squeezing the bag, taking care not to compromise the seal.
3. Place sample in a shaded location where it can be left undisturbed for a minimum of 5 minutes. If the temperature is less than 35o F, place the sample bag in a heated vehicle or other location for a minimum of 5 minutes.
4. Measure ambient air background VOC concentrations.
5. After at least 5 minutes has elapsed, obtain PID reading from bag headspace by opening a space in the bag seal just large enough to allow the PID probe to enter unobstructed. Continue monitoring until PID readings drop to background concentrations.
6. Record highest PID reading measured on the field boring log and/or in the field logbook.
7. Archive or dispose of soil per site field sampling plan.

1. Objective

This document defines general standard operating procedure for IDW handling. A variety of IDW related activities may require unearthing, moving, lifting, over packing, or sampling drums. Such activities are inherently hazardous and will always require special health and safety precautions. Drum handling presents numerous serious physical hazards including back injury, crushing, bruising, laceration, and severe trauma from mishandling. Drum contents may represent a fire or explosion hazard or may consist of shock-sensitive or pyrophoric materials. Drum contents may be pressurized or be acutely toxic. Contents may be corrosive or irritating or have other toxic effects. Drum handling may, therefore, represent both physical and chemical hazards.

2. Equipment

Equipment used during field reporting and documentation:

- Bound field logbook;
- Waterproof pen and permanent marker;
- Paint pen (appropriate color to be seen on 55-gallon drum);
- Labels for IDW Container;
- Other related field paperwork, as needed;
- Disposable latex or nitrile gloves;
- Assorted tools (knife, screwdriver, crescent wrench, (15/16") socket and drive, non-sparking bung wrench, etc.)

3. IDW Handling

A. Prior to work commencing, identify staging area for IDW containers.

B. If using 55-gallon drums at individual locations, be sure to stage drums neatly, out of normal traffic patterns, and in such a manor as they can be easily moved for transport to a central staging area or for removal from site.

C. Containers of IDW must be clearly marked with the following information on an appropriate label (hazardous, non-hazardous, waste material, etc.):

  - Date(s) of Accumulation;
  - Project / Client identification;
  - Location (area of site, boring, well, SWMU, etc.)

- Type of materiel contained within (soil, water, PPE, etc.)
- Specific potential contamination streams (PCBs, Dioxins, etc.) – if applicable

D. Avoid filling IDW drums more than three-fourths full in order to facilitate transport to the designated staging area or removal from the site.

E. IDW containers must be properly closed and labeled as stated above prior to leaving a location. Record in a field logbook the number of IDW containers left at a location.

F. For characterization of soil from IDW containers refer to SOP No. 28 Soil Sampling and SOP No. 38 Methanol Preservation Sampling (Terracore). For characterization of water from IDW containers refer to SOP No. 11 Groundwater Sampling. Following collection, place all samples on ice inside a cooler immediately. Each sample should be identified with the Sample ID, location, analysis number, preservatives, date and time of sampling event, and sampler. The sample time and constituents to be analyzed for should be recorded in the logbook and on the groundwater sampling form. Chain-of-custody procedures should be started. Sample equipment should be decontaminated.

G. Spills or leaks may occur during drum movement and handling. Absorbent materials (clay, oil-dry, etc.) should be readily available in sufficient quantity to absorb spilled or leaked material. Where large spills could occur, a containment berm should be constructed around the area. A special pad for drum handling (concrete, HDPE, etc.) with containment berms may be required for certain types of work. Spill control should be performed by appropriately trained personnel wearing adequate personal protective equipment (PPE). A Spill Plan should be part of the Site Health and Safety Plan (HSP).

Refer to the site specific IDW management plan, if one exists, and federal/state regulations for additional information and requirements.

1. Objective

This document defines the standard operating procedure (SOP) and necessary equipment for collection of groundwater samples in monitoring wells, extraction wells, or piezometers using low-flow techniques. The term "Low Flow" refers to the velocity that the groundwater is removed from the soil formation immediately adjacent to the well screen.

In this technique, in order to withdraw water from within the well screen and to lessen drawdown, a pump that minimizes disturbance to the groundwater is operated at a low flow rate. The well is only purged within the screened interval until specific parameters have stabilized and as according to the site-specific work plan. Therefore, the groundwater samples collected are representative of the water bearing formation and hydraulically isolated from the water in the casing. The need to purge three well volumes, as required in traditional techniques, is not necessary with low flow purging and sampling. The low flow procedure described in this SOP is not necessarily applicable for every site or for wells screened in materials with very low permeability.

2. Equipment

Equipment potentially used during well purging and sampling:

- Well installation information for well being sampled
- Well keys
- Disposable latex or nitrile gloves
- Assorted tools (knife, screwdriver, etc.)
- New synthetic rope
- Pump and required accessories (described in more detail in following section)
- Electronic water level indicator or water/product interface probe with 0.01-foot increments
- Graduated cylinder, measuring cup, or similar
- Water quality instrument with appropriate sensors
- Flow-through cell
- Calibration fluids
- Paper towels or Kimwipes

- Calculator
- Panasonic Toughbook®
- Bound field logbook (logbook)
- Waterproof pen and permanent marker
- Plastic buckets
- 55-gallon drums or truck-mounted tank
- Plastic sheeting or similar for purgewater collection secondary containment, if necessary
- Appropriate decontamination equipment (see SOP No. 4)
- Cooler with ice
- Sample containers and labels
- Groundwater sampling form
- Chain-of-Custody form
- Appropriate health and safety equipment (e.g., photoionization detector (PID)).

3. *Sampling Procedure*

A. This section provides the step-by-step procedure for collecting groundwater samples in the field. Observations made during groundwater purging and sampling should be recorded in a logbook and Toughbook® in accordance with procedures described in SOP No. 8 Field Reporting and Documentation.

B. Any reusable equipment used in the sampling procedure that could contact groundwater should be properly decontaminated before each use (see SOP No.4 Decontamination).

C. Equipment should be calibrated based on the manufacturers' instructions. The frequency of calibration should be specified in the site-specific Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP) or work plan. Refer to SOP No. 3 Calibration and Maintenance of Field Instruments for additional information.

D. Before well purging begins, the following steps should be performed at each well:

- Inspect the well and surrounding site for security, damage, and evidence of tampering. If damage or tampering is evident, contact the project manager for guidance.

- Place clean plastic sheeting or similar around the well, as necessary, to keep equipment clean and catch potential splash of purgewater.
- Measure ambient volatile organic compounds (VOCs) background levels in the immediate vicinity of the well (i.e., using a PID or a flame ionization detector (FID) per the Health and Safety Plan (HASP).
- Remove the well cap and immediately measure VOCs at the rim of the well and record the readings in the logbook, in the Toughbook®, and on the groundwater sampling form. Give the water in the well adequate time to reach equilibrium.

E. After the well has reached equilibrium, the groundwater elevation should be measured to the nearest 1/100-foot. The total well depth and screened interval should be obtained from the well construction information. Measuring the total depth prior to sampling should be avoided to prevent resuspension of settled solids in the well casings and to minimize the necessary purge time for turbidity equilibration. The total depth of the well should be confirmed after sampling has been completed, if necessary. A detailed description of monitoring well gauging activities is provided in SOP No. 10 Well Gauging Measurements.

F. Following measurement of the static groundwater elevation, the appropriate equipment will be slowly and carefully placed in the well. If the wells have light or dense non-aqueous-phase liquids (LNAPLs or DNAPLs) and are still to be sampled, care should be taken to place sampling equipment below or above the NAPL.

G. Selection of the proper pump is important for low-flow sampling activities. USEPA guidance (1996) notes that dedicated sampling devices capable of purging and sampling are preferred over any other type of device. In addition, the pump must be capable of flow rates between 0.1 and 1.0 liter per minute. A variety of portable sampling devices are available, such as bladder pumps, peristaltic pumps, electrical submersible pumps, gas-driven pumps, inertial lift foot-valve samplers (e.g. check-ball systems), and bailers (a list of pump manufacturers and suppliers is included on pg. 8). However, some of this sampling equipment has drawbacks or has been specifically rejected for low-flow sampling. The peristaltic pump can only be used for shallow applications and it can cause degassing of groundwater. Degassing results in the alteration of pH and alkalinity values as well as some loss of volatiles. Also, USEPA guidance asserts that inertial lift foot-valve type samplers and bailers cause too much groundwater disturbance and may invite unacceptable operator variability. Therefore, these sampling devices should be avoided for low-flow sampling activities.

H. Some submersible pumps are hooked up to a vehicle battery with the vehicle running for an adequate power supply. If this is the case, the following will be performed:

   1. The vehicle will be positioned such that it is not over a significant amount of vegetation.

   2. The parking brake will be applied.

   3. A fire extinguisher will be staged nearby for easy access, if necessary.

   4. Personnel will remain in attendance of the vehicle while running so the vehicle may be promptly shut off in case of fire, etc.

I. When placing the equipment in the well, the pump intake should be set near the middle or slightly above the middle of the screened interval or water column, whichever is deeper. In situations in which contaminants of interest are know to concentrate near the top or the bottom of the screened zone it may be desirable to position the pump intake to target this zone instead.

J. Tubing should be connected from the pump to a flow-through cell. Then, calculate the volume of water to fill the flow-through cell. According to American Society for Testing and Materials (ASTM) Standard D 6771 (2002), the frequency of measurements should be equal to the time required to completely evacuate one volume of the cell (minimum). This ensures that independent measurements are made.

K. The pump should be started at a low flow rate, approximately 100 mL/min or the lowest flow rate possible. The pumping rate can be increased up to 500 mL/min as long as significant drawdown does not occur (200 to 300 mL/min is the optimum flow rate for sampling VOCs).

L. Water level measurements should continue every two minutes until the measurements indicate that significant drawdown is not occurring. According to ASTM standards (2002), allowable drawdown should never exceed the distance between the top of the well screen and the pump intake. Including a safety factor, also provided by ASTM, drawdown should actually not exceed 25% of this distance. This ensures that water stored in the casing is not purged or sampled. For example, for a 4-foot screen, the pump should be placed at the midpoint of the screen (two feet from the top of the screen to the pump intake). With a safety factor of 25%, this would require drawdown not to exceed six inches.

If drawdown surpasses 25% of the distance from the pump intake to the top of the screen even while pumping is occurring at the lowest flow rate possible, samplers should refer to the project specific criteria as found in the appropriate FSP or work plan.

M. Parameters should be documented on the groundwater sampling form, in the logbook and in the Toughbook®. Refer to SOP No. 33 Water Quality Monitoring for information. The time between parameter measurements is calculated as follows:

$$T = \frac{V}{Q}$$, where

T = time between measurements (minutes)

V = volume of the flow-through cell (liters)

Q = purge flow rate (liters per minute)

N. Sampling should be as stated in the FSP or work plan. However, in most cases, purging will continue until specific parameters have stabilized over three consecutive flow-through cell volumes or until a specific time requirement is met, whichever happens first. Table 1 provides guidelines that may be used for parameter stabilization as specified by USEPA, ASTM, and in the Nielsen and Nielsen Technical Guidance on Low-Flow Purging and Sampling and Minimum-Purge Sampling (Nielsen and Nielsen, 2002). These guidelines are to be used in combination with professional judgment.

Table 1. Stabilization Guidelines for Low-Flow Sampling

Parameter	**Stabilization Guidelines**		
	EPA	**ASTM**	**Nielsen & Nielsen**
DO	+/- 10%	+/- 10% or +/-0.2 mg/L, whichever is greatest	+/- 10% or +/-0.2 mg/L, whichever is greatest
ORP	+/- 10 mV	+/- 20 mV	+/- 20 mV
PH	+/- 0.1 units	+/- 0.2 units	+/- 0.2 units
Conductivity	+/- 3%	+/- 3%	+/- 3%
Temperature	Not Specified	Not Specified	+/- 0.2 ºC
Turbidity	+/- 10%	Not Specified	Not Specified

O. After the relevant parameters have stabilized, the flow-through cell should be disconnected or bypassed for sampling. If, after a considerable number of readings have been taken, parameters have not stabilized, samplers should refer to the work plan or possibly use alternative sampling methods.

P. A new pair of disposable latex or nitrile gloves should be put on immediately before sampling.

Q. The constituents should be sampled for in the order given below:

- VOCs – Vials should be filled completely so that the water forms a convex meniscus then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles. If air bubbles are observed in the sample vial, remove the lid and attempt to fill the vial two more times, (being careful not to dump out any groundwater currently in the vial). If air bubbles are present twice more, discard the sample vial and repeat the procedure with a new vial. If, after three attempts, air bubbles are still in the vial, make a note of this and place the vial in the cooler.
- Gas sensitive parameters (e.g., ferrous iron, methane, alkalinity)
- Semivolatile organic compounds, pesticides, polychlorinated biphenyls, and herbicides
- Petroleum hydrocarbons
- Metals (unfiltered)
- Explosives
- Any filtered analytes (use in-line filters if possible)

R. Place all samples on ice inside a cooler immediately.

S. Each sample should be identified with the Sample ID, location, analysis number, preservatives, date and time of sampling event, and sampler.

T. The sample time and constituents to be analyzed for should be recorded in the logbook, in the Toughbook®, and on the groundwater sampling form.

U. Chain-of-custody procedures should be started (SOP No. 26 Sample Control and Custody Procedures).

V. Sample equipment should be decontaminated (SOP No. 4 Decontamination).

W. The well sampling order should be dependent on expected levels of contamination in each well, if known, and should be determined prior to sampling. Sampling should progress approximately from the least contaminated to the most contaminated well. Quality assurance/quality control (QA/QC) samples should be collected during groundwater sampling as required in the work plan and/or QAPP (SOP No. 23 Quality Assurance Samples).

4. List Of Potential Suppliers Who Provide Pumps Suitable for Low-Flow Sampling:

- Field Environmental. 1-800-3930-4009. www.fieldenvironmental.com. Pumps: peristaltic, QED bladder pumps, Fultz rotor pump, control boxes, compressors, etc.
- QED. 1-800-624-2026. www.micropurge.com. Pumps: bladder pumps, flow cell, compressors, etc.
- Fultz Pumps. 1-717-248-2300. www fultzpumps.com.

5. References

ASTM 2002, Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations, ASTM D6771-02, American Society for Testing and Materials. West Conshohocken, PA.

Nielsen, David and Nielsen, Gillian. Technical Guidance on Low-Flow Purging and Sampling and Minimum-Purge Sampling. Second Edition. NEFS-TG001-02. April 2002.

USEPA. 1996. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. EPA/540/S-95/504. OSWER, April 1996.

1. Objective

The objective of groundwater monitoring well development is to clear the well of accumulated sediments, when a well is installed or when 10% or more of the well screen has been occluded by sediment, so that representative groundwater samples may be collected. The accumulated sediments need to be re-suspended in the water column in order to be removed. A variety of techniques can be used to re-suspend the sediments. Some of the common methods that can be used to re-suspend sediments include using a surge block, injection of air into the water column of the well, or using a submersible pump or bailer. Once the sediment is re-suspended, the water and sediment can then be removed from the well using a submersible pump, an air bladder pump, or a bailer.

2. Equipment

Equipment potentially used during well development:

- Well installation information
- Well keys
- Disposable latex or nitrile gloves
- Assorted tools (knife, screwdriver, etc.)
- Pump and required accessories
- Electronic water level indicator or water/product interface probe with 0.01-foot increments
- Graduated cylinder, measuring cup or similar
- Paper towels or Kimwipes
- Calculator
- Bound field logbook
- Waterproof pen or permanent marker
- Plastic Buckets
- Truck-mounted poly tank
- 55-gallon drums
- *NuWell 220* dispersant polymer

- Groundwater Development Sheet
- Appropriate health and safety equipment (e.g. photoionization detector (PID))

3. Procedure

The preferred method for development will be surging and removing water with a submersible pump. The following procedures will be used when developing a new or existing well.

1. Place a clean, plastic drop cloth on the ground around the well to be developed, if necessary.
2. Unlock the protective well cover and remove the well cap.
3. Check the well for NAPL using an interface probe. Measure the depth to groundwater and/or NAPL to the nearest hundredth of a foot. (SOP No. 10 Well Gauging Measurements). Calculate the amount of water to be removed (5 well volumes).

   installed depth – depth to water = height of water column

   height of water column * gallons/foot conversion = 1 well volume

Well Diameter	Gal/ft Conversion
0.75 inch	0.0229
1 inch	0.0408
1.5 inches	0.0918
2 inches	0.163
4 inches	0.652
6 inches	1.468

   Measure the total depth of the well to the nearest hundredth of a foot. Note whether the bottom of the well feels hard or soft.

   If LNAPL is present, go to Step 4. If NAPL is not present, go to Step 5.

4. If LNAPL is observed within the monitoring well, add *NuWell 220* dispersant polymer into the well in accordance with the dosage guide below or the manufacturer’s dosage recommendations

   - 2” monitoring well – add 0.12 ounces per foot of water within the well

     (Example: 20-foot deep 2” monitoring well, DTW = 7 feet;

     13 feet of water * 0.12 ounces per foot = 1.56 ounces of *NuWell 220*)

   - 4” monitoring well – add 0.46 ounces per foot of water within the well

5. If using a separate surge block, attach the decontaminated surge block to the appropriate lengths of pole section and push the surge block to the bottom of the well. Pull and push the surge block up and down vigorously to agitate the water and suspend the sediments in the well. Once sufficient re-suspension has occurred, pull the surge block/bailer out of the well. A submersible pump or bailer may also be used to surge the well (go to Step 6).
6. Attach an appropriate length of polyethylene tubing to a submersible pump, and lower the pump to the bottom of the well. (If using a bailer, attach an appropriate length of string to the bailer and lower the bailer to the bottom of the well.
7. Place the discharge end of the tubing such that purged water will be collected in a bucket, poly-tank, 55-gallon drum, or other.
8. Turn on the pump and adjust the flow rate, if possible, to pump at a sufficiently high rate to allow the sediments to be removed without causing the pump to clog.
9. Vigorously surge the well during purging in order to continuously agitate and suspend the sediment within the bottom of the well.
10. Continue surging and pumping until the volume of any water added during installation near the screened zone has been removed (for newly installed wells), any water added to the well for any reason has been removed, 5 well volumes of water have been removed, and relatively visually sediment-free water is observed during purging.
11. Remove the pump and allow the well to recover. Re-measure the total well depth. If the measured depth indicates 10% or more occlusion, repeat steps 7 through 10. If the measured depth indicates less than 10% well screen occlusion, disconnect the tubing from the pump and place into the appropriate waste container. Dismantle the surge block and pole connectors, if used, for decontamination. Pick up and appropriately dispose of any plastic sheeting and other disposables into the appropriate waste container. Close and properly label the 55-gallon drum(s).

$$\frac{\text{installed total well depth} - \text{measured total well depth}}{\text{screen length}}\ (100\%) = \%\ \text{occlusion}$$

12. Decontaminate the pump, wiring, and any other reusable equipment (SOP No. 4 Decontamination).

Note in the field log book and on any field data sheets the approximate number of gallons of water removed during development of each well, well screen depth interval, depth to bottom prior to well development, and depth to bottom after well development.

1. Summary

The purpose of this Standard Operating Procedure (SOP) is to define the procedures and necessary equipment for installation of groundwater monitoring wells and piezometers. A piezometer is simply a small diameter monitoring well. Therefore, the equipment and procedures for building a piezometer are the same as those used to install a monitoring well. The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly install any size monitoring well.

2. Equipment

This section details the required equipment for the drilling and installation of groundwater monitoring wells.

The following is an equipment list typical for well drilling and installation:

- Drill rig capable of installing wells to the desired depth in the expected formation materials and conditions
- Well casing and well screen
- Bentonite pellets or chips
- Filter pack sand
- Portland Type I or II Cement and powdered bentonite for grouting
- Protective well casing with locking cap
- Appropriate decontamination supplies as specified in SOP No. 4 - Decontamination
- Location map
- Plastic bags (Ziploc)
- Self-adhesive labels
- Weighted tape measure
- Water level probe
- Deionized or distilled water
- Appropriate health and safety equipment as specified in the Health and Safety Plan (HASP)
- Log book

- Boring log sheets
- Well construction form
- Plastic sheeting, if necessary
- Roll-off box and/or drums for containment of cuttings and Decontamination and/or development water (if necessary).

3. Procedures

Decontamination

Before drilling or well installation begins, all drilling and well installation material will be decontaminated according to the protocols listed in SOP No. 4 - Decontamination. Drilling equipment will be decontaminated between well locations.

Instrument Calibration

Before going into the field, the sampler shall verify that field instruments are operating properly. Refer to SOP No. 3 – Calibration and Maintenance of Field Instruments, as well the manufacturer's instructions for more information.

Drilling and Well Installation Procedures

Drilling Technique

If soil sampling is required, all soil samples will be taken following the protocol outlined in SOPs No. 28 - Soil Sampling and No. 38 – Methanol Preservation Sampling (Terracore). The hole will be logged following the methods specified in SOP No. 17 – Logging.

Boreholes will be advanced using drilling methods specified in the Work Plan and a drill rig capable of completing the monitor well(s) to the depth(s) specified in the Scope of Work. Before drilling, well locations will be numbered and staked. The necessary permits and utility clearances (SOP No. 5 – Utility Clearance Procedures) will be obtained prior to commencement of drilling activities. Appropriate health and safety measures will be followed during drilling and well installation activities as specified in the Health and Safety Plan (HASP).

During the drilling operation, the cuttings from the boring will be containerized or placed directly onto the ground as specified in the Work Plan. Disposal of cuttings will be in accordance with the Work Plan.

Monitor Well Drilling Operations

The procedures for drilling are as follows:

- Set up drilling rig at staked and cleared borehole location.
- Record location, date, time and other pertinent information in the field book and on the boring log.
- Drill hole of appropriate size using hollow-stem augers or similar. Refer to SOP No. 29 – Soil Probe Operation if a geoprobe-style drilling rig is being used.
- Collect samples at the predetermined intervals, if appropriate, for sample description and/or chemical analysis as specified in the Work Plan. See SOPs No. 17 – Logging, No. 28 – Soil Sampling, No. 38 Methanol Preservation Sampling (Terracore) for further instructions.
- Complete the borehole to the depth specified in the Work Plan.

Well Design Specifications

The following general specifications will be:

Boring Diameter: The boring will be of sufficient diameter to allow for the accurate placement and proper installation of the screen, riser, filter pack, seal, and grout.

Well Casing: Well riser will consist of new threaded, flush joint, PVC or stainless steel. Well diameter and thickness will be specified in the Work Plan. Risers will extend approximately two to three feet above the ground surface, except in the case of flush-mount surface casings (see Work Plan for appropriate construction). The tops of all well casings will be fitted with expandable locking caps or PVC slip caps.

Well Screens: Screen length for each well will be specified in the Work Plan. Well screens will consist of new threaded pipe with factory-machine slots/ wrapped screen with an inside diameter equal to or greater than that of the well casing. The slot size will be indicated in the Work Plan and designed to be compatible with aquifer and sand pack material. The schedule thickness of PVC screen will be the same as that of the well casing. All screen bottoms will be fitted with a cap or plug of the same composition as the screen and should be within 0.5 foot from the open part of the screen. Traps or sumps may be used.

Well Installation Procedure

The following procedures will be initiated within 12 consecutive hours of boring completion for uncased holes or partially cased holes and within 48 consecutive hours for fully cased holes. Once installation has begun, no breaks in the installation procedure will be made if no unusual conditions are encountered until the well has been grouted and the drill casing has been removed.

The procedure for monitoring well installation is as follows:

1. Decontaminate all well materials according to SOP No. 4 - Decontamination. Following decontamination, all personnel that handle the casing will don a clean pair of rubber or surgical gloves.
2. Measure each section of casing, and screen, to nearest 0.10 foot.
3. Assemble screen and casing as it is lowered into the borehole.
4. Lower screen and casing to about 6 inches above the bottom of the boring.
5. Record the level of top of casing and calculate the screened interval. Adjust screen interval by raising assembly to desired interval if necessary and add sand to raise the bottom of the boring.
6. Calculate and record the volume of the filter pack, bentonite seal, and grout required for existing boring conditions.
7. Begin adding filter pack sand around the annulus of the casing a few feet at a time. Repeated depth soundings shall be taken to monitor the level of the sand.
8. Allow sufficient time for the filter sand to settle through the water column outside the casing before measuring the sand level.
9. Extend the filter pack sand to about 2 feet above the top of the well screen, unless otherwise specified in the Work Plan.
10. Following sand filter pack placement in the shallow wells, install a minimum 2 foot-thick seal of bentonite pellets or chips by slowly adding the pellets to avoid bridging. The thickness of the completed bentonite seal shall be measured before the pellets are allowed to swell. The completed bentonite seal shall be allowed to hydrate for a minimum of 20 minutes before proceeding with the grouting operations.
11. Grout the remaining annulus from the top of the bentonite seal to about 3 feet below the surface as measured after the augers are removed. The grout will be tremied into the

borehole until the annulus is completely filled. The base of the tremie pipe should be placed approximately 5 feet above the bentonite seal.

12. After the grout sets for 24 hours it will be checked for settlement. If necessary, additional grout will be added to top off the annulus.
13. The proper protector, concrete pad and bollards, if required, will be installed according to specifications in this SOP. Stick-up protective casing and posts will be painted a high visibility color.
14. URS personnel will clearly mark the well number at each location in some way.

Well Installation Specifications:

Filter Pack: The annular space around the well screen will be backfilled with a clean, washed, silica sand sized to perform as a filter between the formation material and the well screen. The filter pack will extend about two feet above the screen and may be tremied into place. The final depth to the top of the filter pack will be measured directly using a weighted tape measure or rod and not by using volumetric calculation methods. The grain size of the filter pack will be shown on the well construction log.

Bentonite Seal and Grout: A minimum two-foot thick bentonite pellet/chip seal will be placed in the annulus above the filter pack. The thickness of the seal may vary slightly based on site conditions. The thickness of the seal will be measured immediately after placement, without allowance for swelling. Bentonite slurry seals should have a thick batter-like consistency. Slurry seals will have a maximum placement thickness of 8 feet. High-solids bentonite or cement-bentonite grout will then be placed from the top of the bentonite seal to the ground surface. The cement grout will consist of a mixture of Portland cement (ASTM C150) and clean water in the proportion of not more than seven gallons of clean water per bag of cement (one cubic foot or 94 pounds). Additionally, three percent by weight of bentonite powder will be added if permitted by state regulations. The grout will be prepared in an above-ground rigid container by first thoroughly mixing the cement with water and then mixing in the bentonite powder. The grout will be placed by pumping through a tremie pipe. The lower end of the tremie pipe will be kept within five feet of the top of the bentonite seal. Grout will be pumped through the tremie pipe until undiluted grout flows from the annular space at the ground surface. The tremie pipe will then be removed and more grout added to compensate for settling. After 24 hours, the drilling contractor will check the site for grout settlement and add more grout to fill any depression. This will be repeated until firm grout remains at the surface.

Protection of Well: URS personnel will at all times during the progress of the work, take precautions to prevent tampering with the wells or entrance of foreign material into them. Upon completion of a well, a suitable cap will be installed to prevent foreign material from entering the well. The wells will be enclosed in a steel protective casing. Steel casings will be, at a minimum, 4 inches in diameter and will be provided with locking caps and locks. All locks will be keyed alike. If the well is to be a stickup, as specified in the Work Plan, a 1/4-inch drainage hole will be drilled in the protective steel casing centered approximately 1/8-inch above the internal mortar collar for drainage. The well designation will be painted or otherwise marked on the protective casing. Marking will be done prior to well development. If specified in the Work Plan, a minimum 2-foot by 2-foot, 4 to 8-inch-thick concrete pad, sloped away from the well, will be constructed around the protective casing at the final ground level elevation. Three or four 2-inch-diameter or larger steel posts will be equally spaced around the well, for stick-up surface completions, and embedded in separate concrete filled holes just outside of the concrete pad. The protective steel posts will extend approximately 1 foot above the well riser. Any well that is to be temporarily removed from service or left incomplete due to delay in construction, will be capped with a water tight cap and equipped with a "vandal-proof" cover satisfying applicable state or local regulations or recommendations.

Once the well is installed and surface completion is finished, the new monitoring well will be developed and surveyed within 30 days. Refer to SOP No. 20 – Well Development for additional information regarding development of a well.

4. Documentation

Observations and data acquired in the field during drilling and installation of wells will be recorded to provide a permanent record. A boring log will be completed for each boring according to the procedures outlined in SOP No. 17 – Logging.

Additional documentation for well construction will be written recorded in the field book according to SOP No. 8 – Field Reporting and Documentation and will include the following:

- Date
- Time
- Personnel

- Weather
- Subcontractors
- Health and Safety monitoring equipment and readings
- Grout, sand, and bentonite volume calculations prior to well installation
- The quantity and composition of the grout, seals, and filter pack actually used during construction
- Screen slot size (in inches), slot configuration, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer
- Coupling/joint design and composition
- Protective casing composition and nominal inside diameter
- Start and completion dates
- Discussion of all procedures and any problems encountered during drilling and well construction.

In addition, the well installation details will be shown in a diagram which will be drawn in the field book. Each well diagram will consist of the following (denoted in order of decreasing depth from ground surface):

- Reference elevation for all depth measurements
- Project and site names
- Well number
- Date(s) of installation
- The depth at which the hole diameter changes (if appropriate)
- The depth of the static water level and date of measurement(s)
- Total depth of completed well
- Depth of any grouting or sealing
- Nominal hole diameter(s)
- Amount of cement used for grouting or sealing
- Depth and type of well casing

- Description (to include length, internal, diameter, slot size, and material of well screen(s)
- Any sealing off of water-bearing strata
- Static water level upon completion of the well and after development
- Drilling date(s)
- Other construction details of monitoring well including grain size of well filter pack material and location of all seals and casing joints.

1. Objective

This document defines the standard Quality Assurance/Quality Control (QA/QC) samples. QA/QC samples are 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 (spikes and blanks, trip blanks, duplicate, split samples). This SOP is intended to be used together with several other SOPs.

2. Equipment

The following equipment typically is required for this SOP:

- Waterproof coolers (hard plastic or metal)
- Nitrile gloves, or similar
- Custody Seals
- Field forms such as COC or sample collection sheet
- Field Notebook
- Ice
- Bubble Wrap
- Clear Tape
- Duct Tape
- Zip Loc Bags
- Sample Containers
- Waterproof Pen
- Permanent Marker.

3. 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 – A sample which has been portioned into two or more containers from a single sample container or sample mixing container. The primary purpose of a split

sample is to measure sample handling variability. A split sample will also measure inter-or intra-laboratory precision.

- Duplicate Sample – Two or more samples collected from, and representative of, a given population. The purpose of a duplicate sample is to estimate the variability of a given characteristic or contaminant associated with a population.
- Field duplicate results are used to evaluate precision of the entire data collection activity, including sampling, analysis and site heterogeneity. 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. 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 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.
- Spikes (also known as proficiency test (pt) samples) – A sample with known concentrations of contaminants. Spike samples are often packaged for shipment with other samples and sent for analysis. At no time after their preparation are the sample containers to be opened before they reach the laboratory. Spiked samples are normally sent with each shipment to contract laboratories only. Spiked samples are used to measure bias due to sample handling or analytical procedures.
- Equipment Field Blanks – a sample collected using organic-free water which has been collected using investigative sample collection equipment in the same manner that

investigative samples are collected (e.g. run over/through equipment). These samples are used to assess the effectiveness of equipment decontamination procedures. Equipment field blanks are often associated with collecting rinse blanks of equipment that has been field cleaned.

- Temperature Blanks – A container of water shipped with each cooler of samples requiring preservation by cooling to 4oC ± 2oC (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".
- Preservative Blanks – A sample that is prepared in the field and used to determine if the preservative used during field operations was contaminated, thereby causing a positive bias in the contaminant concentration. On studies of short duration, usually only a post-preservative blank is prepared at the end of all sampling activities. On studies extending beyond one week, a pre-preservative blank should also be prepared prior to beginning sampling activities. At the discretion of the project leader, additional preservative blanks can be prepared at intervals throughout the field investigation. These blanks are prepared by putting organic/analyte-free water in the container and then preserving the sample with the appropriate chemical.
- 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). Organic-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 contamination added by the laboratory upon 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.
- Matrix Spike Duplicate – A sample collected in the same manner as the investigative sample, with known concentration of contaminants added by the laboratory upon laboratory analysis (same as the matrix spike) of a target analyte(s) 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 used as an indicator of sample matrix effect on the recovery of target analyte(s) as well as method precision.

4. Sample Containers

Certified commercially clean sample containers will be obtained from the contract analytical laboratory. The lab will indicate the type of sample to be collected in each bottle type. The work plan may list the appropriate sample containers for the specific analyses require for each project.

5. Sample Preservation

Samples will be preserved at the time of the sample collection. Chemical preservatives, if necessary, will be added to the sample containers either by the laboratory prior to shipment to the field, or in the field by sampling personnel.

After sample collection, each container will be labeled (see SOP No. 24) and stored on ice at 4°C ± 2°C in an insulated cooler until packed for shipment to the laboratory. The ice will be bagged in storage bags per laboratory specific requirements. Freezing samples will not be permitted. Any breakable sample bottles need to be wrapped in protective packing material (bubble wrap) to prevent breakage during shipping.

6. QA/QC Sample Collection Frequency

QA/QC Sample	Frequency
Background Sample	Project Specific
Split Sample	Project Specific
Duplicate Sample	One per 10 samples collected per matrix
Trip Blank	One per cooler containing VOC samples
Spikes	Project Specific One per 20 samples collected per matrix
Equipment Field Blanks	One per 10 samples collected
Temperature Blanks	Laboratory/project specific One per cooler
Preservative Blanks	Project Specific One post sampling – for projects less than one week. Two samples (one pre- and one post sampling) – for projects longer than one week.
Field Blanks	Project Specific One per 20 samples collected per matrix
Material Blanks	Project Specific One per matrix
Matrix Spike	One per 20 samples collected per matrix
Matrix Spike Duplicate	One per 20 samples collected per matrix

1. Objective

This document defines the standard protocols for sample handling, identification, labeling, documentation, and tracking. This SOP serves as a supplement to the Work Plan Addendum and Sampling and Analysis Plan Addendum and is intended to be used together with several other SOPs.

2. Equipment

The following equipment will be needed for sample classification, packaging and shipping:

- Chain-of custody form
- Sample bottles (laboratory provided)
- Sample labels
- Water proof pen or similar
- Trash bag or similar for lining cooler
- Bubble wrap
- Ice
- Zipper storage bags
- Custody seal
- Packing tape
- Shipping label, if necessary
- Sample cooler

3. Procedures

Sample Identification

Samples collected during site activities shall have discrete and site specific sample identification numbers. These sample IDs are necessary to identify and track each of the many samples collected for analysis during the life of project. In addition, the sample IDs can be used in a database to identify and retrieve the analytical results received from the laboratory.

Each sample is identified by a unique code which indicates the specific project, site identification, sample location number, sample matrix identifier, sample depth, and/or date. The sample locations will be numbered sequentially.

If used, sample matrix identifiers may include the following:

SF - Direct-Push Soil Sample (Field Analysis)

SL - Direct-Push Soil Sample (Laboratory Analysis)

WF - Direct-Push Groundwater Sample (Field Analysis)

SS - Soil Sample

GW - Groundwater

MW - Monitoring Well

SW - Surface Water Sample

SD - Sediment Sample

SL - Sludge or Sewer Sediment Sample

TB - Trip Blank

RN - Rinsate (Deionized Water)

An example of the sample identification number codes for a groundwater monitoring well sample collected for field analysis will be: MW13-PROJECT-070713-EB.

Where MW indicates Monitoring Well, 13 indicates the well location, PROJ indicates the abbreviated project name, 070713 indicates the date, and EB indicates an equipment blank.

The project abbreviation, sample sequence, sampling locations, and sample type will be established prior to field activities for each sample to be collected. On-site personnel will obtain assistance from the Task or Project Manager in defining any special sampling requirements.

Sample Labeling

Sample labels will be filled out as completely as possible by a designated member of the sampling team prior to beginning field sampling activities each day. The date, time, sampler initials/signature should not be completed until the time of sample collection. All sample labels shall be filled out using waterproof ink. At a minimum, each label shall contain the following information:

- Sampler's company affiliation
- Project/Site location
- Sample identification code

- Date and time of sample collection
- Analyses required
- Method of preservation (if any) used
- Sample matrix (i.e., soil, groundwater, surface water)
- Sampler's signature or initials.

Labels will be affixed to the sample bottle and clear tape applied in order to keep the label attached to the sample and to keep the label legible. If a sample bottle displays a tared weight from the laboratory, clear tape will NOT be used.

Sample Handling and Shipping

After sample collection, each container will be labeled as described above, and then stored on ice at 4°C (+/- 2°C) in an insulated cooler until packed for shipment to the laboratory. Coolers will be lined with a trash bag or similar and the ice will be bagged per laboratory specific requirements.

To the extent possible, the sample containers will be placed in resealable storage bags and wrapped in protective packing material (bubble wrap). Samples will then be placed right side up in a lined cooler with ice (bagged using laboratory specific requirements) and a completed chain-of-custody (COC) form (placed in a separate zip-locked bag. The cooler will be taped with a custody seal for delivery to the laboratory. Samples will be hand delivered or shipped by overnight express carrier for delivery to the analytical laboratory. All samples must be shipped for laboratory receipt and analyses within specific holding times. This may require daily shipment of samples with short holding times. The temperature of all coolers will be measured upon receipt at the laboratory. A temperature blank will be included in each cooler for temperature measurement purposes, per laboratory specific requirements.

Sample Documentation and Tracking

Field Notes

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent waterproof ink in a permanently bound weatherproof field log book containing consecutively numbered pages.

The information in the field book will include the following as a minimum. Additional information is included in the specific SOPs regarding the field books.

- Project name
- Location of sample
- Sampler's printed name and signature
- Date and time of sample collection
- Sample identification code including QC and QA identification
- Description of samples (matrix sampled)
- Sample depth (if applicable)
- Number and volume of samples
- Sampling methods or reference to the appropriate SOP
- Sample handling, including filtration and preservation, as appropriate for separate sample aliquots
- Analytes of interest
- Field observations
- Results of any field measurements, such as depth to water, pH, temperature, and conductivity
- Personnel present
- Level of PPE used during sampling.

Changes or deletions in the field book 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.

Each page in the field books will be signed by the person making the entry at the end of the day, as well as on the bottom of each page. Anyone making entries in another person's field book will sign and date those entries.

Sample Chain-of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Initial information concerning collection of the samples will be recorded in the field log book as described above. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form. The COC should contain project specific information. Sample labels should be checked against the COC to ensure everything intended for analysis is listed on the COC. Split samples should be on separate COCs and kept together in their own cooler(s).

The sampler will be responsible for initiating and filling out the COC form as samples are collected. The COC will be signed by the sampler when the sampler relinquishes the samples to anyone else. One COC form will be completed for each sampling team or project collected daily. The COC will contain the following information:

- Sampler's signature and company affiliation
- Project number
- Date and time of collection
- Sample identification number
- Sample type
- Analyses requested
- Preservative (where applicable), using number of containers to be analyzed
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Method of shipment
- Shipping air bill number (if appropriate)
- Turnaround time (TAT) requested
- Appropriate project-specific Incident and SAP numbers (for Shell projects)

The person responsible for delivery of the samples to the laboratory will sign the COC form, retain a copy of the COC form, document the method of shipment, and send the original COC form with the samples. Upon receipt at the laboratory, the person receiving the samples will sign the COC form. Copies of the COC forms documenting custody changes and all custody documentation will be received and kept in the central files. The original COC forms will remain with the samples until final disposition of the samples by the laboratory. The analytical laboratory will dispose of the samples in an appropriate manner 60 to 90 days after data reporting. After sample disposal, a copy of the original COC will be sent to the Project Manager by the analytical laboratory to be incorporated into the central files.

1. Objective

This document defines the standard protocols for sample containers, preservation and hold times. This SOP is intended to be used together with several other SOPs.

2. Equipment

The following equipment will be required for this SOP:

- Waterproof coolers (hard plastic or metal)
- Custody Seals
- Field forms such as COC or sample collection sheet
- Field Notebook
- Ice
- Bubble Wrap
- Clear Tape
- Duct Tape
- Zip Loc Bags
- Sample Containers
- Waterproof Pen
- Permanent Marker
- Nitrile gloves, or similar

3. Sample Containers

Certified commercially clean sample containers will be obtained from the contract analytical laboratory. The lab will indicate the type of sample to be collected in each bottle type. The work plan may list the appropriate sample containers for the specific analyses required for each project.

4. Sample Preservation

Samples will be preserved 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. In some cases, preservatives may be added to the sample containers in the field by sampling personnel.

After sample collection, each container will be labeled and stored on ice at 4°C (+/- 2°C) in an insulated cooler until packed for shipment to the laboratory. The ice will be bagged per laboratory specific requirements. Freezing samples will not be permitted. Any breakable sample bottles need to be wrapped in protective packing material (i.e., bubble wrap) to prevent breakage during shipping. (Refer to SOP No. 24 Sample Classification, Packaging and Shipping for additional information)

5. Sample Hold Times

Samples will be hand delivered or shipped via overnight express carrier for delivery to the analytical laboratory. All samples must be shipped for laboratory receipt and analyses as soon as possible and within specific holding times. This may require daily shipment of samples with short holding times. The hold time varies for each type of analysis, and therefore, it will be necessary to check with the lab to verify the hold times to determine how frequently samples need to be sent to the lab. Typical hold times are provided in Table 1.

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent waterproof ink in a permanently bound weatherproof field log book containing consecutively numbered pages. Documentation for the sample containers, preservation, and hold times is outlined in SOP No. 8 Field Reporting and Documentation.

Table 1
SOP No. 25 Sample Containers, Preservatives, and Holding Times

Analysis	Holding Time	Preservation
% Lipids	NA	Freeze
Alkalinity	14 days	Cool to 4°C
Ammonia NH3	28 days	Cool to 4°C - H2SO4 to pH<2
Asbestos	1 year	None
BOD 5	48 hours	Cool to 4°C
BOD 5 Inhibited	48 hours	Cool to 4°C
BTEX	14 days	Cool to 4°C; HCl
Chloride	28 days	Cool to 4°C
Chlorophyll	24 hrs to filtration - 28 days after filtration	Freeze filters in 90% acetone
Chromium VI (Hexavalent) in water	24 hours	Cool to 4°C
COD	28 days	Cool to 4°C - H2SO4 to pH<2

Table 1
SOP No. 25 Sample Containers, Preservatives, and Holding Times

Analysis	Holding Time	Preservation
Coliform (fecal and total)	6 hours	Cool to 4°C; 0.008% Sodium Thiosulfate
Conductivity	28 days	Cool to 4°C
Cyanide in Soil	14 days	Cool to 4°C
Cyanide in Water	14 days	Cool to 4°C NaOH to pH>12; 0.6 g ascorbic acid
Enterococci	6 hours	Cool to 4°C; 0.008% Sodium Thiosulfate
Fecal Streptococcus	6 hours	Cool to 4°C; 0.008% Sodium Thiosulfate
Fluoride in Soil	28 days	Cool to 4°C
Fluoride in Water	28 days	Cool to 4°C
Grain Size Sediment	6 months	None required
Guaiacols/Catechols/Phenols	30 days	Cool to 4°C; H2SO4 to pH<2
Halogenated Hydrocarbons HH	7 days water/14 days soil	Cool to 4°C
Hardness	6 months	HNO3 to pH<2
Herbicides	7 days water/14 days soil	Cool to 4°C
Hydrocarbon chlorinated	7 days water/14 days soil	Cool to 4°C Ascorbic acid
Ignitability	None	Cool to 4°C
Iron and sulfur bacteria	6 hours	Cool to 4°C; 0.008% Sodium Thiosulfate
Klebsiella	6 hours	Cool to 4°C; 0.008% Sodium Thiosulfate
Mercury in Water	28 days	Cool to 4°C; HNO3 to pH<2
Metals -- Except Cr(6) and Hg	180 days	HNO3 to pH <2
Metals dissolved	6 months	Filter - then add HNO3 to pH<2
Nitrate NO3-	48 hours	Cool to 4°C
Nitrate-Nitrite	28 days	Cool to 4°C; H2SO4 to pH<2
Nitrite NO2-	48 hours	Cool to 4°C
Nitrogen Pesticides	7 days water/14 days soil	Cool to 4°C

Table 1
SOP No. 25 Sample Containers, Preservatives, and Holding Times

Analysis	Holding Time	Preservation
NWTPH-Dx and NWTPH-HCID	7 days water/14 days soil	Cool to 4°C HCl to pH<2
NWTPH-Gx	14/14 days	Cool to 4°C HCl to pH<2
Oil & Grease in Water	28 days	Cool to 4°C; HCl to pH<2
Oil and Grease in Soil	28 days	Cool to 4°C
Organic Screen (PAH Phenolics Creosote etc.)	7 days water/14 days soil	Cool to 4°C
Organophosphorus pesticides	7 days water/14 days soil	Cool to 4°C
Ortho Phosphate PO43-	48 hours	Filter; Cool to 4°C
PAH Hazardous Waste Designation w/o HPLC	7 days water/14 days soil	Cool to 4°C
PAH Polynuclear Aromatic Hydrocarbons	7 days water/14 days soil	Cool to 4°C
PCBs only	7 days water/14 days soil	Cool to 4°C
Percent Solids Soil/Tissue	7 days	Cool to 4°C
Personal Monitors	None	None
Pesticides/PCBs	7 days water/14 days soil	Cool to 4°C
pH	24 hours	Cool to 4°C
Phenolics in Soil (4AAP)	28 days	Cool to 4°C
Phenolics in Water (4AAP)	28 days	Cool to 4°C; H3PO4; FeSO4 and CuSO4
PM10	1 year	Cool to 4°C
PM2.5	30 days	Cool to 4°C
Resin/Fatty acids	30 days	Cool to 4°C NaOH to pH>10
Semivolatiles BNA	7 days water/14 days soil	Cool to 4°C
Settleable Solids(SS)	48 hours	Cool to 4°C
Specific conductance	28 days	Cool to 4°C
Sulfate	28 days	Cool to 4°C

Table 1
SOP No. 25 Sample Containers, Preservatives, and Holding Times

Analysis	Holding Time	Preservation
Sulfide	7 days	Zinc acetate; NaOH to pH>9
TOC in Soil	28 days5	Cool to 4°C
TOC in Water	28 days	Cool to 4°C; H2SO4 to pH<2
Total Dissolved Solids(TDS)	7 days	Cool to 4°C
Total Kjeldahl Nitrogen (TKN)	28 days	Cool to 4°C; H2SO4 to pH<2
Total Non-Volatile Solids(TNVS)	7 days	Cool to 4°C
Total Non-Volatile Suspended Solids(TNVSS)	7 days	Cool to 4°C
Total Persulfate Nitrogen (TPN)	28 days	Cool to 4°C; H2SO4 to pH<2
Total Phosphorus (TP)	28 days	Cool to 4°C; H2SO4 to pH<2
Total Solids(TS)	7 days	Cool to 4°C
Total Suspended (TSS)	7 days	Cool to 4°C
Total Volatile Solids(TVS)	7 days	Cool to 4°C
Tributyl tin	7 days water/14 days soil	Cool to 4°C
Turbidity	48 hours	Cool to 4°C
VOA Air Toxics	none	Room temperature
Volatile Organics/VOA	7 days water/14 days soil	Cool to 4°C HCl -- ascorbic acid

1. Objective

This document defines the standard procedure for the control and custody of environmental samples. This SOP is intended to be used together with several other SOPs.

2. Equipment

The following equipment will be needed for sample control and custody procedures:

- Waterproof coolers (hard plastic or metal)
- Custody Seals
- Field forms such as a Chain of Custody (COC) or sample collection sheet
- Field Notebook
- Ice
- Sample Log-in Book
- Clear Tape
- Duct Tape
- Zip-Loc Bags
- Waterproof pens
- Permanent Markers
- Nitrile gloves, or similar

3. Sample Control and Custody

Once the samples are collected, they must remain in the custody of the sampler or another worker from the site. The samples can also remain unattended in a locked vehicle or jobsite trailer so tampering with the samples will not be possible. Right before shipment, a custody seal should be placed over the opening of the cooler and then the cooler should be taped all the way around with clear packing tape to prevent tampering with the samples. Samples will be hand delivered or shipped via overnight express carrier for delivery to the analytical laboratory (see SOP No. 24 Sample Classification, Packaging and Shipping). All samples must be shipped for laboratory receipt and analyses within specific holding times. This may require daily shipment of samples with short holding times. Each cooler will contain a chain of custody (COC) form.

During field sampling activities, traceability of the samples must be maintained from the time the samples are collected until the laboratory data is issued. Initial information concerning the collection of the samples will be recorded in the field log book as outlined in SOP No. 8 Field Reporting and Documentation. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form. If the COC is not three-part (minimum) carbon-copy form, then photocopy the COC after signatures have been obtained, before the samples and original copy leave the site. An example COC form is attached to this procedure.

The sampler will be responsible for initiating and filling out the COC form during sample collection. The COC will be signed by the sampler or the field person responsible for sample handling when the sampler relinquishes the samples to anyone else. One COC form will be completed for each cooler of samples collected daily and if samples are not hand delivered, the COC will be placed in a Zip-Loc bag and shipped inside the cooler. COC forms will be used to document the transport and receipt of samples from the field to the lab. Information required on a COC includes the following:

- Samplers signature and company affiliation
- Project Number
- Date and time of collection
- Sample identification number
- Sample Type
- Analyses requested.
- The total number of containers being sent to the lab for each sample and analysis requested
- The appropriate preservative used, designating the number of containers to be analyzed with that preservative
- If any samples are to be placed on hold at the laboratory, this should be clearly indicated on the COC in the comments section
- Turnaround time (TAT) requested
- Signature of person(s) relinquishing custody, dates, and times
- Signature of person(s) accepting custody, dates, and times
- Method of shipment
- Shipping air bill number (if appropriate)

- Appropriate project-specific Incident and SAP numbers (for Shell projects)

The person responsible for delivery of the samples to the laboratory will sign the COC form, retain a copy of the COC form, document the method of shipment, and send the original COC form with the samples. Upon receipt at the laboratory, the person receiving the samples will sign the COC form. The original COC will remain with the samples until final disposition of the samples by the laboratory. The laboratory will dispose of the samples in an appropriate manner typically 60 to 90 days after data reporting.

CHAIN OF CUSTODY RECORD

SHEET___of___

URS CORPORATION
1001 HIGHLAND PLAZA DRIVE WEST, SUITE 300
ST. LOUIS, MISSOURI 63110
314-429-0100

PROJECT NO:	PROJECT NAME:		NO. OF CONTAINERS	CONTAINER DESCRIPTION / ANALYSES REQUESTED						REMARKS
SAMPLER'S: (Signature)										
DATE	TIME	SAMPLE I.D. NUMBER								

RELINQUISHED BY: (Signature)	DATE / TIME	RECEIVED BY: (Signature)	DATE / TIME
RELINQUISHED BY: (Signature)	DATE / TIME	RECEIVED AT LAB BY: (Signature)	DATE / TIME
METHOD OF SHIPMENT:		AIRBILL NO:	

1. Objective

This document defines the standard procedure for collection of soil samples for environmental characterization purposes. This procedure provides descriptions of equipment and field procedures necessary to collect soil samples.

2. Equipment

The following equipment is typically used to collect soil samples:

- Hand Auger (if required to collect sample)
- Latex/Nitrile gloves
- Organic Vapor meter (e.g. PID)
- Surveyor's stakes, pin flags, spray paint or similar
- Portable field table
- Stainless steel knife, if needed
- Stainless steel spoon or scoop, if needed
- Stainless steel bowl, if needed
- Sample containers
- Decontamination equipment
- Plastic Sheeting, if necessary
- Field data sheets/bound field logbook
- Health & Safety equipment
- Cooler with ice.

3. Soil Sample Collection Procedures

This section provides step-by-step procedures for collecting soil samples in the field. Observations made during soil sample collection should be recorded on applicable field sheets and in a bound field logbook in accordance with the procedures defined in SOP No. 8 Field Reporting and Documentation:

A. Remove appropriate sample containers from the transport container, and prepare the sample containers for receiving samples.

B. Fill out a self-adhesive label with the appropriate information and affix it to the appropriate sample container, or fill out the sample label attached by the laboratory. Place clear polyethylene tape over the completed label to protect it from dirt and water (unless a tare weight has been recorded by the lab on the container). Sample labels can be prepared prior to sample collection except for time and date. Labels can be filled in with the date and time of sample collection just prior to collecting the sample. Sample containers will be kept cool with their caps on until they are ready to receive samples.

C. Place labeled sample containers near the sampling location.

D. Place clean plastic sheeting on the ground surface or the field table at the sampling area as needed.

E. Put on a pair of new nitrile or latex gloves.

F. Decontaminate the reusable sampling equipment as described in detail in SOP No. 4 Decontamination prior to beginning sampling activities.

G. Advance the sampler (direct push sampler, hand auger, split-spoon, etc.) to the desired sample depth and retrieve the sample.

H. VOC samples cannot be composited without losing volatiles. Therefore, collect a discrete VOC sample prior to compositing the remaining soil (if doing so). Collect the VOC sample with a Terra Core sampler (SOP No. 38 Methanol Preservation Sampling (Terracore)), or by placing it directly into an appropriate sample container. If the sample is transferred to a jar, the entire jar must be filled without any voids and the top surface of the soil should be smeared to prevent VOCs from escaping when opening the jar. After collecting the sample at the desired location within the sample interval, place the remainder of the sample into a stainless steel bowl/Ziploc bag, break up large chunks and mix the soil, if a composite sample is to be collected. Fill the remaining sample containers from the steel bowl.

I. Place the sample containers on ice in a cooler to maintain the samples at approximately 4oC as described in SOP No. 25 Sample Container, Preservation and Holding Times.

J. Begin chain-of-custody procedures. A sample chain-of-custody form is included in SOP No. 26 Sample Control and Custody Procedures. Ship the cooler to the laboratory for analysis within 24-48 hours of sample collection in accordance with the procedures described in SOP No. 24 Sample Classification, Packaging and Shipping.

K. Decontaminate the sample equipment as described in SOP No. 4 Decontamination.

L. Field notes shall be kept on applicable field sheets and in a bound field logbook.

4. Possible Soil Sample Collection Methods

- Geoprobe (micro or macro samplers)
- Split Spoon sampler using a conventional drill rig
- Hand Auger
- Surface Sampling with a stainless steel spoon or scoop.

1. Objective

This document defines the standard operating procedure (SOP) and necessary equipment for sampling with the use a hydraulically advanced direct push GeoProbe® (or similar) to obtain representative subsurface soil samples for geologic logging and physical and chemical laboratory testing.

2. Equipment

The following equipment is typically required:

- Hydraulic percussion hammer Geoprobe® or similar rig
- Probe/sample rods (macro core or dual-tube)
- Acetate liners
- Disposable sample retainers
- Photoionization detector (PID)
- Surveyor's stakes, pin flags, spray paint or similar
- Stainless steel knife and resealable plastic bags (Ziplock)
- Sample containers
- Decontamination equipment
- Health and safety equipment
- Field data sheets
- Field logbook
- Water proof or permanent ink pen

3. Procedure

The general procedure for using the Geoprobe® equipment for sampling is as follows. The specific soil probe operation procedures may vary slightly based on individual drilling contractors' SOPs for soil probe operation:

A. Locate boring using facility drawings to check utilities. Refer to SOP No. 5 Utility Clearance Procedures.

B. Log boring location on site base map.

C. Hydraulically push or drive probe rods with acetate sample liner, or dual tube system with acetate liner to the first sample depth

D. Remove probe/inner rods and retrieve acetate liner. Visually log and classify the soil (SOP No. 17 Logging), select specimen for physical and/or chemical testing (SOP No. 28 Soil Sampling). Record information on field data sheets and/or in field logbook.

E. Replace sampler acetate liner.

F. Monitoring breathing zone according to requirements in the project Health and Safety Plan (HASP).

G. Insert acetate sample liner and attached rods in exiting probe hole and push or drive sampler to the next sample depth, repeat sampling procedure.

H. Repeat Geoprobe® sampling until the target depth is reached.

I. Record total depth.

J. Retrieve probe rods.

K. Backfill probe hole with bentonite grout or similar as required by the work plan unless a monitoring well, piezometer, soil vapor port or similar installation is to be completed.

L. Place survey stake or similar at boring location.

M. Record data collected on boring log and in log book.

N. Decontaminate equipment (SOP No. 4 Decontamination).

4. Decontamination

Refer to the HSP for personnel decontamination procedures; refer to SOP No. 4 Decontamination for equipment decontamination procedures.

1. Purpose and Scope

This Standard Operating Procedure (SOP) describes the standard protocols for operating, calibrating, and maintaining equipment commonly used during water quality monitoring. This SOP also defines the documentation necessary when using this equipment.

2. Equipment List

Equipment used for monitoring water quality parameters is as follows:

- Water Quality Parameter Instrument – measures pH, temperature, conductivity, turbidity, dissolved oxygen (DO) and/or oxidation-reduction potential (ORP)
- Other water quality monitoring devices (if necessary)
- Distilled water
- Dry, clean paper towels
- Latex gloves
- Field log book
- Manufacturer's guide for each meter used
- Calibration fluids
- Calibration forms

3. Calibration & Maintenance

Calibration of the Water Quality Parameter Instrument should be performed per the manufacturer's specific instructions. In general, calibration is done by adjusting the meter with standard buffer solution(s). Refer to SOP No. 3 Calibration and Maintenance of Field Instruments for more information.

4. Operating Procedures

Operation of the Water Quality Parameter Instrument will be done in accordance with the manufacturer's specific instructions. Generally, operating procedures are as follows:

1. Turn on instrument, clear instrument.
2. If using a flow-through cell, allow the water to flow through the cell and record readings as indicated in the work plan and go to Step 9. If not using a flow-through cell, go to Step 3.

3. Rinse the sample cup with distilled water and fill with sample water.
4. Rinse the probes with distilled water. Blot excess.
5. Immerse the probes in the sample and swirl gently, keeping the probes in the sample until the display stops flashing or readings have generally stabilized.
6. Record the water quality parameters of the sample after stabilization. Note any problems such as meter drift.
7. Rinse the probes with distilled water. Blot excess.
8. Repeat steps 3-7 for additional samples.
9. When finished, rinse the probes and sample cup/flow-through cell with distilled water and turn off instrument.

****
Note: degrees C = (degrees F - 32) (5/9)
degrees F = ((9/5)C degrees) + 32
****

5. Documentation

The following information should be recorded:

- Calibration of equipment will be recorded in the field logbook and on daily calibration forms to document that appropriate procedures have been followed. Information regarding the calibration of any field equipment will contain, but are not necessarily limited to, the following information:
  1. Date and time of calibration
  2. Name of person doing calibration
  3. Type of equipment being serviced, and identification number (such as serial number)
  4. Reference standard used for calibration (such as pH of buffer solutions)
  5. Calibration and/or maintenance procedure used
  6. Any problems or other pertinent information.

- Each reading taken for a particular sample/location will be recorded on a field form and in the Toughbook®, if applicable. Entries will include, but are not limited to the following:

  1. Date and time of reading
  2. Type of reading
  3. Value of reading with units
  4. Any problems or other pertinent information.

1. Objective

This document defines the standard operating procedure (SOP) and necessary equipment for collection of groundwater profiling samples within hydraulically advanced GeoProbe® (or similar) hollow drill rods and well screens using a peristaltic pump or ball and check valve.

During groundwater profiling activities, groundwater samples are collected at predetermined intervals from the top of the uppermost aquifer to the base of the lower aquifer. Sampling intervals are specified in the Scope of Work for a specific site. Groundwater samples are collected by using a GeoProbe® to hydraulically advance a 4- or 5-foot stainless steel slotted sampler with a screen slot size of 0.002 inches to pre-determined intervals below ground surface. In this technique, in order to lessen drawdown within the hollow drill rods, a pump that minimizes disturbance to the groundwater is operated at the lowest possible flow rate. Purging is performed until specific parameters have stabilized as specified in the Work Plan over three consecutive flow-through cell volumes or until one hour of purge time has elapsed, whichever occurs first. Therefore, the groundwater samples collected are representative of the water bearing formation and hydraulically isolated from the water in the casing.

2. Equipment

Equipment used during well purging and sampling:

- Polyethylene tubing
- Ball and check valve
- Disposable latex or nitrile gloves
- Assorted tools (knife, screwdriver, etc.)
- Pump and required accessories (described in more detail in following section)
- Electronic water level indicator or water/product interface probe with 0.01-foot increments
- Graduated cylinder, measuring cup or similar
- Water quality parameter instrument with necessary sensors
- Flow-through cell
- Calibration fluids
- Paper towels or Kimwipes

- Calculator
- Bound field logbook (logbook)
- Waterproof pen and permanent marker
- Plastic buckets with lids
- 55-gallon drums or truck-mounted tank
- Plastic sheeting, if necessary
- Appropriate decontamination equipment (see SOP No. 4)
- Cooler with ice
- Sample containers and labels
- Groundwater sampling form
- Chain-of-Custody form
- Appropriate health and safety equipment (e.g., photoionization detector (PID)).

3. Sampling Procedure

This section provides the step-by-step procedure for collecting groundwater profile samples in the field. Observations made during groundwater purging and sampling should be recorded in a logbook in accordance with procedures described in SOP No. 8 Field Reporting and Documentation.

A. Any equipment used in the profile sampling procedure that could contact groundwater should be properly decontaminated before each use (see SOP No.4 Decontamination).

B. Equipment should be calibrated based on the manufacturers' instructions. The frequency of calibration should be specified in the site-specific Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP) or work plan. Refer to SOP No. 3 Calibration and Maintenance of Field Instruments for more information.

C. Underground utilities at the location of each soil probe will be cleared prior to commencement of probing activities (SOP No. 5 Utility Clearance Procedures). Following utility clearance the sampler will be advanced to the predetermined depth and opened. A groundwater measurement of the water within the screen and rods will be collected to the nearest 1/100th of a foot (SOP No. 10 Well Gauging Measurements).

Measurements will be recorded in the logbook and any pertinent field forms. The volume of water within the screen and rods will then be calculated.

D. Following measurement of the static groundwater elevation, the appropriate equipment will be slowly and carefully placed in the rods. If the rods have light or dense non-aqueous-phase liquids (LNAPLs or DNAPLs) care should be taken to place sampling equipment below or above the NAPL.

When placing the equipment in the well, the pump intake should be set near the middle or slightly above the middle of the screened interval. If the screen length allows, the pump intake should be at least two feet from the bottom of the screen. Placing the pump intake near the top of the water column can cause stagnant water from the casing to be purged, but placing the pump intake near to the bottom of the well can cause mobilization and entrainment of settled solids from the bottom of the well.

E. Tubing should be connected from the pump to a flow-through cell. New tubing should be used for each profiling interval.

F. The pump should be started at a low flow rate, approximately 100 mL/min or the lowest flow rate possible. Refer to SOP No. 18 Low Flow Groundwater Purging and Sampling for additional low flow procedure information.

G. In most cases, purging will continue until specific parameters have stabilized over three consecutive flow-through cell volumes. Table 1 provides guidelines that may be used for parameter stabilization as specified by USEPA, ASTM, and in the Nielsen and Nielsen Technical Guidance on Low-Flow Purging and Sampling and Minimum-Purge Sampling (Nielsen and Nielsen, 2002). These guidelines are to be used in combination with professional judgment.

Table 1. Stabilization Guidelines for Low-Flow Sampling

Parameter	**Stabilization Guidelines**		
	EPA	**ASTM**	**Nielsen & Nielsen**
DO	+/- 10%	+/- 10% or +/-0.2 mg/L, whichever is greatest	+/- 10% or +/-0.2 mg/L, whichever is greatest
ORP	+/- 10 mV	+/- 20 mV	+/- 20 mV
PH	+/- 0.1 units	+/- 0.2 units	+/- 0.2 units
Conductivity	+/- 3%	+/- 3%	+/- 3%
Temperature	Not Specified	Not Specified	+/- 0.2 ºC
Turbidity	+/- 10%	Not Specified	Not Specified

H. After the relevant parameters have stabilized or the required purging time has elapsed, the flow-through cell should be disconnected or bypassed for sampling. Samples will be collected by allowing the groundwater to flow from the tubing directly into the laboratory supplied containers.

I. A new pair of disposable latex or nitrile gloves should be put on immediately before sampling.

J. The constituents should be sampled for in the order given below:

- VOCs – Vials should be filled completely so that the water forms a convex meniscus then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles. If air bubbles are observed in the sample vial, remove the lid and attempt to fill the vial two more times, (being careful not to dump out any groundwater currently in the vial). If air bubbles are present twice more, discard the sample vial and repeat the procedure with a new vial. If, after three attempts, air bubbles are still in the vial, make a note of this and place the vial in the cooler.
- Gas sensitive parameters (e.g., ferrous iron, methane, alkalinity)
- Semivolatile organic compounds, pesticides, polychlorinated biphenyls, and herbicides
- Petroleum hydrocarbons
- Metals (unfiltered)
- Explosives
- Any filtered analytes (use in-line filters if possible).

K. Place all samples on ice inside a cooler immediately.

L. Each sample should be identified with the Sample ID, location, analysis number, preservatives, date and time of sampling event, and sampler.

M. The sample time and constituents to be analyzed for should be recorded in the logbook and on the groundwater sampling form.

N. Chain-of-custody procedures should be started.

O. Sample equipment should be decontaminated or replaced as applicable.

P. The GeoProbe® rods/screen should then be advanced to the next predetermined profiling depth and the process of purging and sampling repeated.

Q. Upon completion of each alluvial aquifer boring, each GeoProbe® hole will be sealed with bentonite grout from the bottom up using the GeoProbe® rods as a tremie pipe and the surface will be returned to the original condition. Purge water will be placed in 55-gallon drums (or similar) that are labeled, sealed, and staged at a pre-determined location on-site. The GeoProbe® unit and rods will be cleaned between profiling holes using a steam pressure washer (SOP No. 4 Decontamination). Decontamination water will be containerized in 55-gallon drums (or similar) and labeled.

4. List of Potential Suppliers Who Provide Pumps Suitable for Groundwater Profile Sampling

Field Environmental. 1-800-3930-4009. www.fieldenvironmental.com. Pumps: peristaltic, QED bladder pumps, Fultz rotor pump, control boxes, compressors, etc.

QED. 1-800-624-2026. www.micropurge.com. Pumps: bladder pumps, flow cell, compressors, etc.

Fultz Pumps. 1-717-248-2300. www.fultzpumps.com.

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.

2. Equipment

Personnel implementing this guideline must ensure that the following are in place:

- Field book
- Disposable nitrile gloves
- Cut resistant gloves
- Ultra-fine permanent marker
- Paper towels
- Decontamination equipment
- Soil vapor sampling logs
- Small brush or broom
- 15 mL hand pump with gauge (inches Hg)
- Peristaltic pump
- Rotometer or equivalent
- PID, combustible gas detector (e.g., Mini-RAE, Landtec GEM 500)
- Stainless steel canisters with flow controllers (supplied by the laboratory)
- Sample bags (2 - 1 liter and 1 - 3 liter per sample) (e.g., Tedlar, Kynar, Solef)
- 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. 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 sand pack)

4. Open 4-way and begin purging port at a rate no greater than 2 L/min. Document time started.
5. Once 3 volumes are reached, stop pump and close 4-way. Document time stopped.
6. 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 vapor monitoring port(s) (VMP). 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) will 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, 30-minutes is a standard collection time (~28 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 15 mL hand pump. If the pump gauge holds a vacuum, 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 pulled out 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 Toughbook or on sample sheets.
12. After 30 minutes or other appropriate sampling duration, or if the vacuum gauge reading drops below 5 inches Hg before 30 minutes, close the stainless steel canister valve completely. Record the time in Toughbook or on sample sheets. **The vacuum gauge should reach less than 10 inches Hg, but should not be allowed to drop below 2 inches of Hg.**
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 second sample bag obtain readings for total volatile organics with a photoionization detector (PID) and for CO2, CH4, LEL, and oxygen (O2) with a landfill gas meter. Record readings in Toughbook or on sample sheets. If FID 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 soil vapor monitoring port(s) (VMP). 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) will 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, a 30-minute duration is a standard collection time (~28 ml/min). Other sample durations may be appropriate if using different size canisters.
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 of $\geq$40L volume over the VMP and assembled sample train as shown in **Figure 3**. The enclosure 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 #1 (out) and Valve #2 (in and out).

The enclosure should have sufficient glove access to open or close all valves within. As shown in **Figure 3**, the enclosure must also be sealed to the ground with hydrated bentonite or equivalent.

8. Introduce tracer gas into the enclosure at a known rate until the atmosphere within the enclosure has a concentration of approximately 50% 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 15 mL hand pump. If the pump gauge holds a vacuum, 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 pulled out 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 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 helium with helium gas detector. If helium 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. After the designated sample duration, or if the vacuum gauge reading drops below 5 inches Hg, close the stainless steel canister valve completely. Record the time in Toughbook or on sample sheets. **The vacuum gauge should reach less than 10 inches Hg, but should not be allowed to drop below 2 inches of Hg.** Record the concentration of tracer gas within the enclosure 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, CH4, 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 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.
- No samples are to be collected in an area where vehicle or other equipment exhaust is being discharged.

Field Duplicates

A field duplicate will 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 will 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. 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.

Sample Train Vacuum Leak Check

The sample train leak check will 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

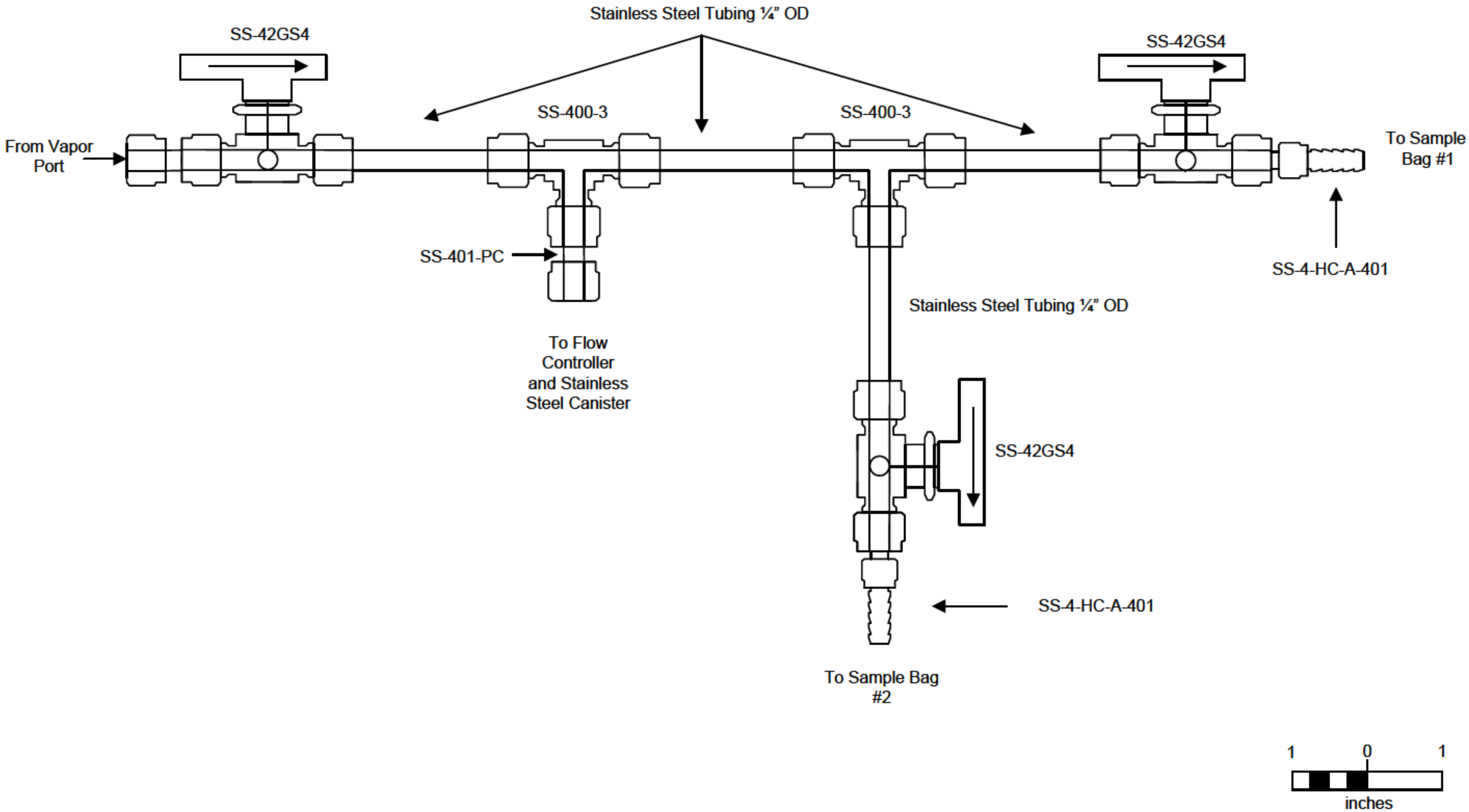
An appropriate number of samples will be collected using a tracer gas, as per the project work plan or activity plan.

1. Helium 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 enclosure:
   - 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 enclosure:
   - Prior to stainless steel canister sampling: check methane levels.
     - If methane reading $\geq$2%, continue with sample collection.
     - If methane reading $\leq$2%, stop sample collection. Check fittings and valves before restarting sample collection.
   - Following stainless steel canister sampling: check methane levels.
     - If methane reading $\geq$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.

7. Decontamination

- Non-designated stainless steel assemblies will be thoroughly decontaminated by purging with at least half a liter of air.
- Should a stainless steel assembly come into contact with groundwater, it will be decontaminated using an Alconox® wash followed by a distilled water rinse.
- Multiple stainless steel assemblies will be available to sample crews to allow for equipment to be cleaned and dried sufficiently before being reused.
- 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 will 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.



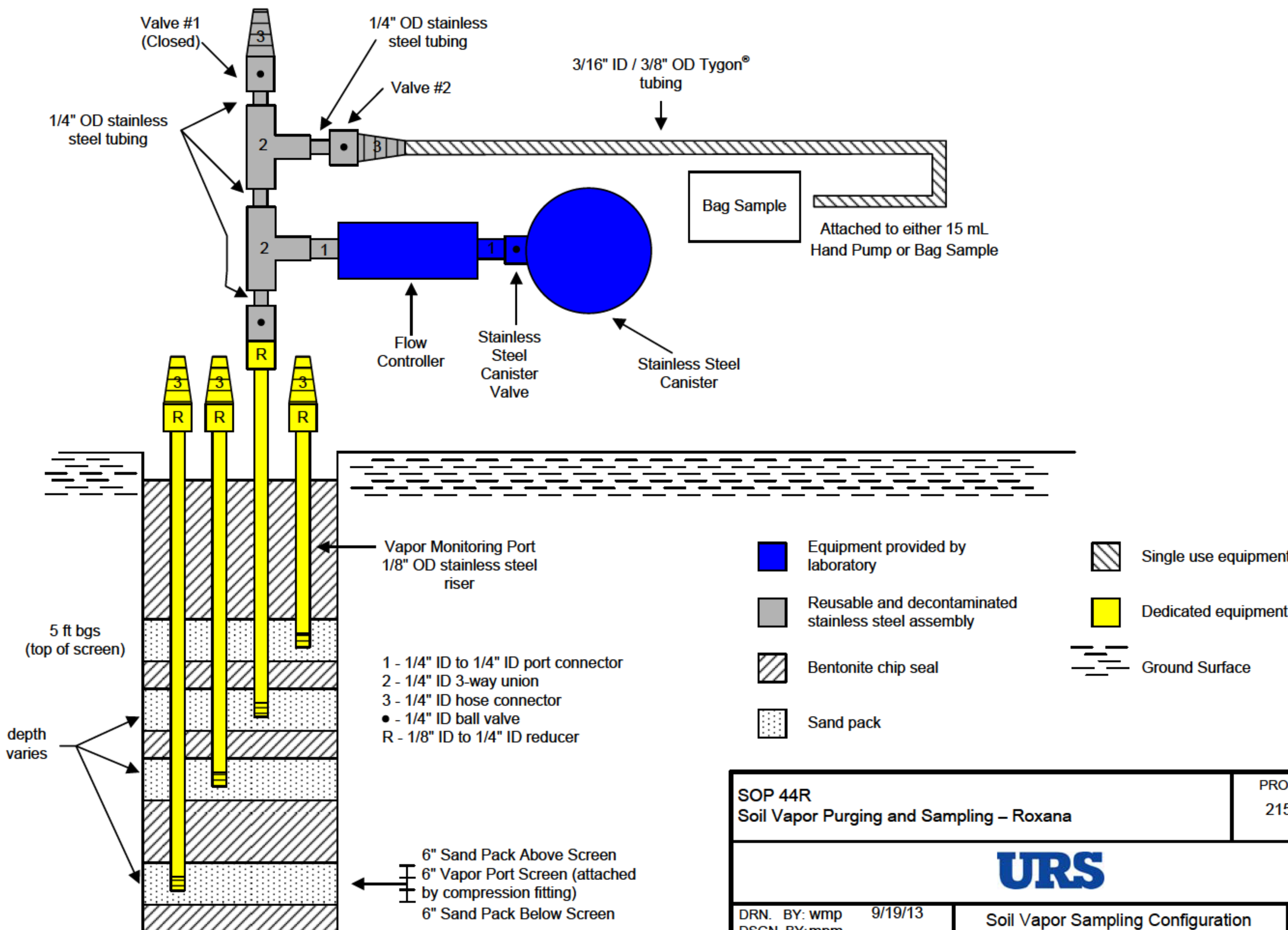
Notes:
1) All components listed with Swagelok part numbers.
2) Assembly shown for standard sample.
3) Duplicate assembly includes an additional 3-way union between the two shown.
4) All fittings shown are compression fittings with SS-400-Set ferules and SS-402-1 nuts.

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

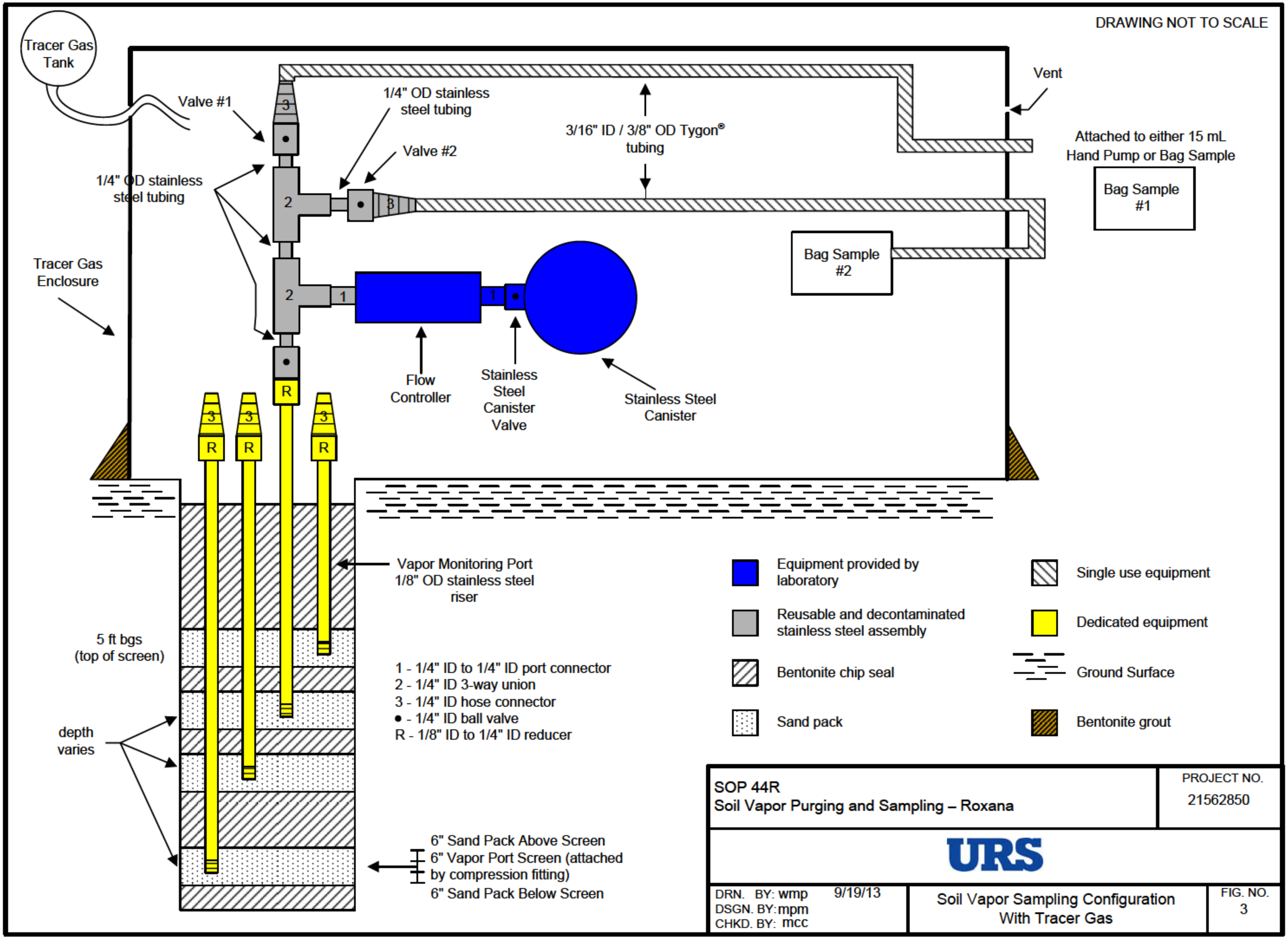
SOP 44R Soil Vapor Purging and Sampling – Roxana	PROJECT NO. 21562850
URS	
DRN. BY: wmp 9/19/13 DSGN. BY: mpm CHKD. BY: mcc	Soil Vapor Sampling Assembly — FIG. NO. 1

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

DRAWING NOT TO SCALE



SOP 44R Soil Vapor Purging and Sampling – Roxana	PROJECT NO. 21562850
URS	
DRN. BY: wmp 9/19/13 DSGN. BY: mpm CHKD. BY: mcc	Soil Vapor Sampling Configuration No Tracer Gas — FIG. NO. 2


DRAWING NOT TO SCALE
Tracer Gas Tank
Valve #1
1/4" OD stainless steel tubing
Valve #2
3/16" ID / 3/8" OD Tygon® tubing
Vent
Attached to either 15 mL Hand Pump or Bag Sample
Bag Sample #1
Bag Sample #2
1/4" OD stainless steel tubing
Tracer Gas Enclosure
Flow Controller
Stainless Steel Canister Valve
Stainless Steel Canister
Vapor Monitoring Port 1/8" OD stainless steel riser
5 ft bgs (top of screen)
depth varies
1 - 1/4" ID to 1/4" ID port connector
2 - 1/4" ID 3-way union
3 - 1/4" ID hose connector
• - 1/4" ID ball valve
R - 1/8" ID to 1/4" ID reducer
6" Sand Pack Above Screen
6" Vapor Port Screen (attached by compression fitting)
6" Sand Pack Below Screen
Equipment provided by laboratory
Reusable and decontaminated stainless steel assembly
Bentonite chip seal
Sand pack
Single use equipment
Dedicated equipment
Ground Surface
Bentonite grout
SOP 44R
Soil Vapor Purging and Sampling – Roxana
PROJECT NO. 21562850
URS
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 necessary equipment for sub-slab soil-gas sampling with canisters.

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

2. Equipment

Personnel implementing this guideline must ensure that the following are in place:

- Field book
- Leather gloves
- Ultra-fine permanent marker
- Paper towels or Kimwipes
- Calculator
- Decontamination equipment
- Sample logs
- Small brush or broom
- 15 mL hand pump with gauge
- Vacuum pressure 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 Environmental TVA 1000, Photovac MicroFID)
- Portable analyzer with Photo-ionization detector (PID)(e.g., Mini-RAE)
- LEL meter (e.g., 4-gas meter)
- Landfill gas detector (e.g., Landtec GEM 500)
- 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) 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 (2 per sample)
- Hydrogen gas
- Calibration gas
- Watch or timer
- Lighting (e.g., head lamps)
- Rotary hammer drill
- 7/8 concrete drill bit
- 5/16 concrete drill bit
- Extension cord with GFI adapter
- Measuring 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:

A. Verify access has been granted for the building in question for the period necessary for installation;

B. 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.) will 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.

C. Perform daily safety meeting, reviewing weather, procedures, and location concerns (access, animals, etc.)

D. Verify that the occupant is present and is at least 18 years old. If no occupant is at least 18 years of age, installation will be rescheduled.

E. Mobilize equipment into the location, minimizing re-entries.

F. Verify that screening instruments are operating properly. Instruments indicating negative concentrations shall be re-zeroed.

G. 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.

H. If VOCs or LEL readings are above the levels stated in the site Health and Safety Plan (HASP) work will cease until ambient air conditions have resumed safe levels.

I. If oxygen levels drop below 19.6% vacate the residence.

4. Installation Procedures

A. Collect sub-slab soil-gas samples at up to three locations per building of interest.

B. 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 will be minimized. Avoid areas with tile or wood floors.

C. Construct a sampling probe using a reducer connected to a short length of 1/4” 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 with Valve #1 via a port connector, as shown in the sample train configuration in Figure 1.

D. If possible, pre-cut the 1/4” stainless steel tubing before deploying to the field and bring a variety of lengths (e.g. 4”, 6”, and 12”)

E. 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).

F. 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.

G. Use modeling clay to seal the hole until the sampling train configuration is set.

H. Label the SSMP with indelible marker or paint pen.

I. Record all measurements in the project logbook, including:

- Slab thickness;
- Borehole diameter; and
- Time when clay seal was installed

5. Sampling Procedures

A. Perform canister vacuum check, per the steps listed in Section 7 of this SOP.

B. Setup the sample train configuration as shown in Figure 1. The flow controller (one for each canister provided by the laboratory) will 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.

C. Perform sample train leak check, per the steps listed in Section 7 of this SOP.

D. 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.

E. Open Valve #1 located at the end of the sampling train.

F. Place an enclosure of >40L volume over the SSMP and assembled sample train as shown in Figure 1. The enclosure 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).

G. The enclosure should have sufficient glove access to open or close all valves within as shown in Figure 1. Open Valve #2. Attach a hand pump with 15 mL stroke volume and built-in vacuum gauge to the purge tubing connected to Valve #2. Two or three strokes should purge out the system. There should not be much 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 #2.

If the sampling point will hold a -15 inches of Hg vacuum for 1 minute, the sampling location is not 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.

H. Introduce helium gas into the enclosure at a known rate until the atmosphere within the enclosure has a concentration of approximately 50% tracer gas. The helium check will be performed within the first 30 minutes of sample collection.

I. Open Valve #2.

J. 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.

K. Close Valve #2.

L. From the soil vapors in the 1-Liter Tedlar bag obtain readings for helium with the helium gas detector. If helium 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 helium readings in Tedlar bags.

M. Open canister valve completely and record the time.

N. 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.

O. Open Valve #3.

P. Connect peristaltic pump to tubing connected to Valve #3 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.

Q. 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.

R. Break down sampling train configuration.

S. 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.

T. Decontaminate any non-designated equipment (e.g., Swagelok® connectors and valves) following procedures listed in Section 8.

6. Remove and Seal the Sampling Probe

A. Pull the probe form the floor and decon.

B. Temporarily plug the hole with modeling clay.

C. 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, the following items are also of concern:

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

Field Duplicates

A field duplicate will 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 will 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 will 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 will be collected using a tracer compound.

- Helium 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 enclosure, 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 enclosure, analyze the 1-Liter Tedlar bag using a landfill gas detector to obtain a direct methane reading. If methane levels are not elevated then tighten or replace the fittings and connections and repeat the leak check.

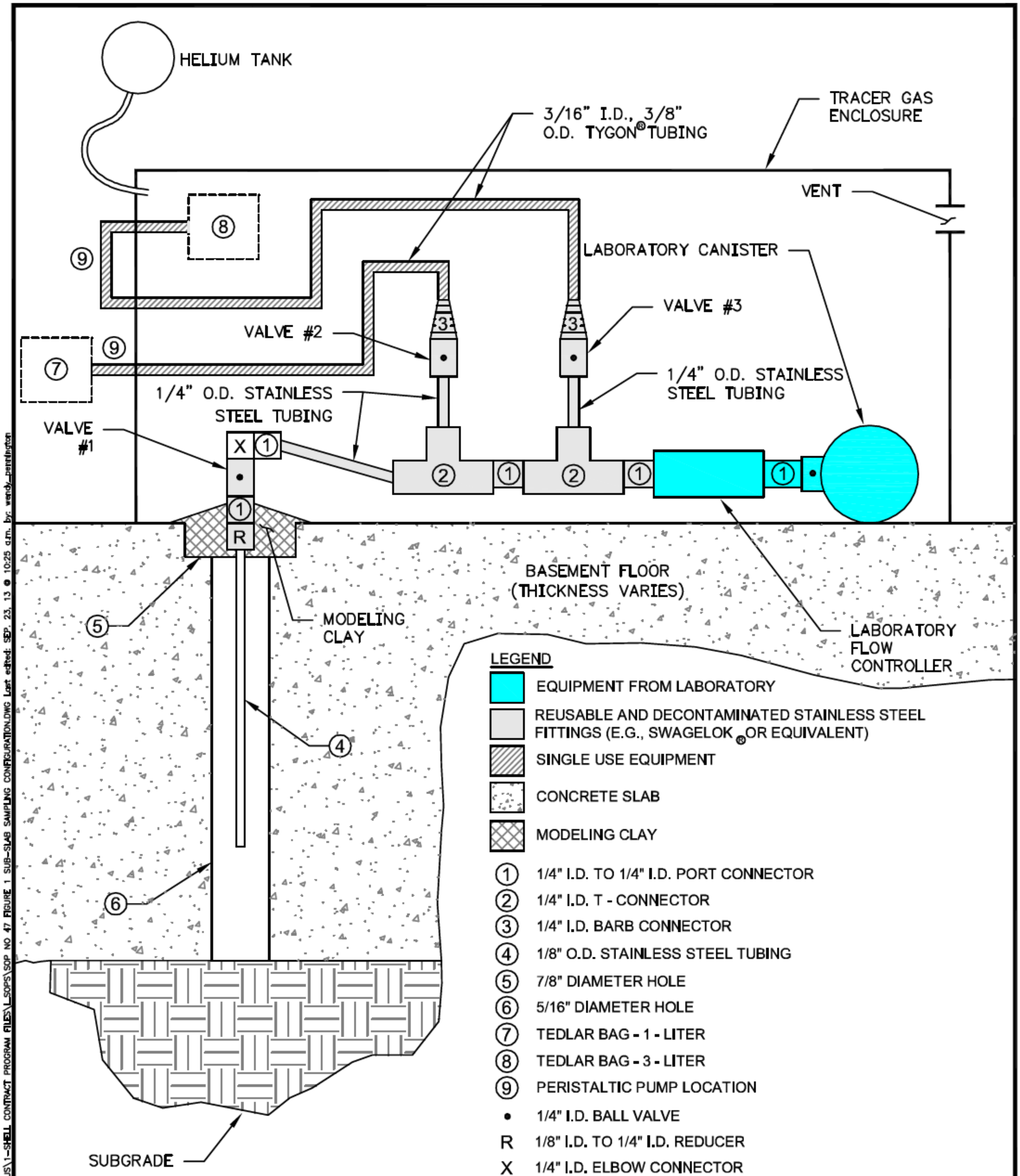
8. Decontamination

- Designated stainless steel Swagelok® connectors or equivalent will be thoroughly decontaminated using an Alconox® wash followed by a distilled water rinse.
- Multiple sets of stainless steel Swagelok® connectors or equivalent will 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 will 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 will be shipped to the laboratory following DOT regulations, as outlined in SOP No. 51 Vapor Sampling Classification, Packaging and Shipping.



NOT TO SCALE

SOP 47
SUB–SLAB PURGING AND SAMPLING
ROXANA, ILLINOIS

PROJECT NO. 21562850

URS

DRN. BY:djd/wmp Sept 2013
DSGN. BY:kwh
CHKD. BY:mcc

Sub–Slab Sampling Configuration

FIG. NO. 1

File: P:\ENVIRONMENTAL\SHELL OIL PRODUCT US\1-SHELL CONTRACT PROGRAM FILES\1_SOPS\SOP NO 47 FIGURE 1 SUB-SLAB SAMPLING CONFIGURATION.DWG Last edited: SEP. 23, 13 @ 10:25 a.m. by: wendy_pennington

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 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 Main Header Line

2. Equipment

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

- Crow bars (2)
- Extension cord
- SVE Data Collection sheets or Toughbook with SVE Monitoring software
- Impact driver (or socket set) with 3/4" socket
- Infrared thermometer, if available and/or necessary
- Oil/Water Interface probe
- Isopropyl alcohol
- Manometer(s) (measuring appropriate range(s))
- 12 V Marine battery
- Nut driver – 5/16"
- Paper towels
- Pitot tube
- PPE
  - ANSI Class II safety vest
  - Hardhat
  - Nitrile gloves
  - Leather gloves
  - Safety glasses

    - Steel-toe boots
    - FRC Clothing
    - Hearing protection
- Polyethylene tubing – 3/16” ID x 1/4” OD
- Power inverter
- Quick-connects (2) – 3/16” Barb
- Silicone tubing - 3/16” ID x 3/8” OD
- Sump pump
- Tedlar bags
- Traffic barricades
- Vacuum chamber
- Vacuum pump

The following equipment is required for Main Header Line data collection and sampling:

- Crescent wrench
- Extension cord
- Main Header Line Data Collection sheets
- Manometer(s) (measuring appropriate range(s))
- PPE
    - ANSI Class II safety vest
    - Hardhat
    - Nitrile gloves
    - Safety glasses
    - Steel-toe boots
- Silicone tubing - 3/16” ID x 3/8” OD
- Polyethylene tubing – 3/16” ID x 1/4” OD
- Summa canister

- Tedlar bags
- Vacuum chamber
- Vacuum pump
- High vacuum pump for headers and stack

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, will be followed while performing the activities described in this SOP.

Upon Arrival at Well

1. Position truck in front of the well to be sampled, turn on hazard lights.
2. Place traffic cones in front of and behind the truck.
3. Remove well vault bolts and use crow bars to release vault latch and pry open. Engage safety latch 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.

Sample Collection

1. Write the well ID, date, and sample time on a Tedlar bag and place in vacuum chamber.
2. Using a clean piece of disposable silicone tubing, connect the Tedlar bag to the interior barb of the vacuum chamber sample inlet port. Open the valve on the Tedlar bag by turning it counterclockwise ½ to 1 full turn.
3. Connect the vacuum pump to the vacuum port on the exterior of the vacuum chamber.
4. Connect the exterior barb of the vacuum chamber sample inlet port to the sample port of the well. Turn the lever on the sample port of the well and also of the vacuum chamber inlet port to the open position.

5. Turn on the vacuum pump to fill the Tedlar bag.
6. Once the Tedlar bag is full, turn the lever on the vacuum chamber sample inlet port to the off position and disconnect the vacuum line from the vacuum chamber. (*Note: This is not the final sample. Steps 6 through 10 were performed to purge ambient air from the tubing)*
7. Open the vacuum chamber, disconnect the Tedlar bag, and connect the vacuum line to Tedlar bag to remove purged ambient air. Reconnect Tedlar bag to sample inlet of vacuum chamber and reconnect vacuum line to vacuum chamber.
8. Open the sample inlet port on the vacuum chamber to refill the Tedlar bag.
9. Once the Tedlar bag is full, turn the lever on the vacuum chamber sample inlet port to the off position, disconnect the vacuum line from the vacuum chamber, turn off the vacuum pump, and turn the lever of the sample port on the well to the closed position.
10. Close the valve on the Tedlar bag, remove it from the vacuum chamber, and check for leaks by holding the bag close to ear. If no leaks are detected, thread bag onto a string for later analysis (SOP No. 52 Soil Vapor Field Laboratory Screening).

Temperature, Vacuum, and Flow Data Collection

1. 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. Record the flow measurement by first connecting the appropriate digital manometer (SOP No. 53 Dwyer Digital Manometer) to the pitot tube (the top port of the pitot tube connects to the high pressure port of the manometer and the side port of the pitot tube connects to the low pressure port of the manometer). Unscrew the sample port or plug located on the SVE well and insert the pitot tube. If the flow reading fluctuates, record the highest, lowest, and the most consistent reading.
3. Upon removal from the well, check the pitot tube for moisture by placing the tip of the pitot tub next to the vacuum of the well. Record any moisture that is observed exiting the pitot tube.
4. Replace the sample port or plug.

Fluid Level Measurement

1. Turn the main SVE valve to its fully closed position.
2. Remove 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, product, sludge, foam, silt) and any well defects or maintenance issues.
5. Replace the well cap.
6. Return the main SVE valve to its original position.
7. Disengage safety latch and lower vault lid. Replace well vault bolts.
8. Load traffic cones and other equipment and move to next well location.

4. Procedures for the Main Header Line

This section provides step-by-step procedures for data collection and soil vapor sampling of the Main Header Line, located immediately upstream of the VLS units. 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.

Data Collection at the Regenerative Oxidizer Unit

1. Record Ashcroft gauge reading. If the reading fluctuates, record the highest, lowest, and the most consistent reading.
2. Record the temperature of the inflowing soil vapor from the temperature gauge.
3. Record the differential pressure reading from the Barton gauge. If the reading fluctuates, record the highest, lowest, and the most consistent reading.
4. Record the vacuum reading by connecting the appropriate digital manometer (SOP No. 53 Dwyer Digital Manometer) to the sample port located on main header line and turning the valve to the open position. If the vacuum reading fluctuates, record the highest, lowest, and the most consistent reading.
5. Record the status of the SVE system, on or off.

6. From the computer located in the control building, record the main header vacuum and flow readings.

Tedlar Bag Sample Collection

1. Write the sample ID, date, and sample time on a Tedlar bag and place in the vacuum chamber. Record this data on the field data sheet.
2. Using a clean piece of disposable silicone tubing, connect the Tedlar bag to the interior barb of the vacuum chamber sample inlet port. Open the valve on the Tedlar bag by turning it counterclockwise ½ to 1 full turn.
3. Connect the high vacuum pump to the vacuum port on the exterior of the vacuum chamber.
4. Connect exterior barb of the vacuum chamber sample inlet port to the sample port on the main header line. Turn the lever on the sample port of the main header line and also of the vacuum chamber inlet port to the open position.
5. Turn on the vacuum pump to fill the Tedlar bag.
6. Once the Tedlar bag is full, turn the lever on the vacuum chamber sample inlet port and the main header line lever to the closed position and disconnect the vacuum pump line from the vacuum chamber. (*Note: This is not the final sample. Steps 10 through 14 were performed to purge ambient air from the tubing)*
7. Open the vacuum chamber, disconnect the Tedlar bag, and manually push all the air out of the Tedlar bag to remove purged ambient air. Reconnect Tedlar bag to sample inlet of vacuum chamber.
8. Reconnect the vacuum pump line and open the sample inlet port on the vacuum chamber to refill the Tedlar bag.
9. Once the Tedlar bag is full, turn the lever on the vacuum chamber sample inlet port and the main header sample port to the closed position, disconnect the vacuum pump line from the vacuum chamber, and repeat steps 16 and 17 for a second Tedlar bag.
10. Close the valve on the Tedlar bag, remove it from the vacuum chamber, and check for leaks by holding the bag close to ear. If no leaks are detected, bag is ready for analysis (SOP No. 52 Soil Vapor Field Laboratory Screening).

Summa Canister Sample Collection

1. Use a crescent wrench to attach the vacuum gauge to the top of a new summa canister.
2. Using a clean piece of disposable silicone tubing, connect the sample nipple coming off the vacuum gauge to the main header sample port. Do not open sample port. Open valve on summa canister and record the initial vacuum reading of the summa canister.
3. Turn the main header sample port lever to the open position and wait until the vacuum reading on the summa canister vacuum gauge stabilizes.
4. Close the inlet valve on the summa canister and turn the main header sample port lever to the closed position.
5. Record the final vacuum reading of the summa canister and then disconnect the silicone tubing.
6. Fill out chain of custody form, including sample ID, date and time of collection, initial and final vacuum, summa canister number, and analyses requested.

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to provide a consistent methodology for the collection of soil vapor samples related to the 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 the site, with the exception of those collected directly from SVE wells. Important uses of these data include:

- SVE system performance evaluation
- Evaluation of sub-slab VOC concentrations
- Hydrocarbon plume definition

2. Equipment

The following equipment is required for sample collection.

- Dwyer Series 475 Mark III Digital manometer
- 1-liter Tedlar bags
- Silicone tubing - 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)
- New or dedicated 4-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 well. 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 with SVE Monitoring software. Immediately following the recording of the vacuum/pressure measurement, the well shall be closed to the atmosphere.

Well 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 well riser and screen. The purge volume shall be equivalent to a minimum of three well volumes. The actual purge volume removed shall be recorded on the appropriate field form. If the well 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 well 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 well to allow the removal of the required purge volume. The syringe plunger shall be drawn back to evacuate a purge volume.

Well Sampling

Upon completion of well purging, soil vapor sample collection using Tedlar sample media 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 well and the positive pressure (output) side of the peristaltic pump shall be attached to the inlet side of the flow calibrator (or rotometer) using a combination of Tygon® and polyethylene (or equivalent) 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 shall be used to adjust the flow rate of the peristaltic pump to allow a flow rate of 200 mL/minute. For VMP wells, this adjustment shall be performed by observing the flow rate 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, clean, 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 well to the atmosphere. Place the sample bag in a black trash bag or container that will minimize exposure to sunlight.

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, VMP wells are vented (opened to atmosphere) for 15 minutes. This allows for well 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 will be documented on the appropriate field form. The highest reading observed within the observed range will also be recorded on the appropriate field form. (*Please note: If the manometer reading fluctuates between two vacuums, the lowest/weakest vacuum observed will be recorded on the field form. If the manometer reading fluctuates between a vacuum and a pressure, the highest pressure observed will be recorded on the field form. If the manometer reading fluctuates between two pressures, the highest/strongest pressure observed will be recorded on the field form. In all cases, the range in the manometer readings over the additional one-minute period will 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 well can be closed to the atmosphere.

Note: Any monitoring location where water/product is encountered during purge or Tedlar collection, where the requisite volume cannot be purged, or where the well 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.Purpose and Scope

This document defines the standard protocols for sample classification, packaging and shipping. This SOP is intended to be used together with several other SOPs.

2. Equipment

The following equipment will be needed for sample classification, packaging and shipping:

- Chain of Custody (COC)
- Sample canisters
- Sample labels
- Waterproof pen
- UN-approved shipping box
- Shipping labels
- Packing materials
- Packing tape

3. Procedures

Sample Identification

Samples collected during site activities shall have discrete and site specific sample identification numbers. These sample IDs are necessary to identify and track each of the many samples collected for analysis during the life of project. In addition, the sample IDs can be used in a database to identify and retrieve the analytical results received from the laboratory.

Each sample is identified by a unique code which indicates the sample location type, sample location number, sample depth, and/or date collected. The sample locations will be numbered sequentially.

An example of the sample identification number codes for a vapor monitoring port collected for field analysis will be: VMP-1-5-090110.

Where VMP indicates a Vapor Monitoring Port sample, 1 indicates the site location number, 5 indicates the top of the sample depth interval, 090110 indicates the date the sample was collected.

The sampling locations and sample sequence identifiers will be established prior to field activities for each sample to be collected. On-site personnel will obtain assistance from the Task or Project Manager in defining any special sampling requirements. Other sample identification may be specified by the Task or Project Manager on an individual project basis.

Sample Labeling

Sample labels will be filled out as completely as possible by a designated member of the sampling team prior to beginning field sampling activities each day. The date, time, sampler initials/signature, and the last field of the sample identification number should not be completed until the time of sample collection. All sample labels shall be filled out using waterproof ink. At a minimum, each label shall contain the following information:

- Sampler's company affiliation
- Project/Site location
- Sample identification code
- Date and time of sample collection
- Analyses required
- Canister ID
- Initial and final vacuum readings
- Sampler's signature or initials.

Sample Handling and Shipping

After sample collection, each container will be labeled as described above, and then stored in a fashion which will protect the stems of the stainless steel canisters. A determination will be made prior to sample collection if the samples will be handled as hazardous materials for shipping and transportation purposes. If the samples are to be handled as hazardous material, a designated hazardous material shipper will be required to pack and ship samples.

The sample containers will be placed right side up in a UN approved shipping box. No more than the specified number of samples will be placed in an individual box for shipment (check regulations prior to packing). The box will be taped with a custody seal for delivery to the laboratory. Samples will be hand delivered or shipped by overnight express carrier for delivery to the analytical laboratory. All samples must be shipped for laboratory receipt and analyses within specific holding times. This may require daily shipment of samples with short holding times. A chain-of-custody (COC) form will accompany each box.

Sample Documentation and Tracking

Field Notes

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent waterproof ink in a permanently bound weatherproof field log book containing consecutively numbered pages.

The information in the field book will include the following as a minimum. Additional information is included in the specific SOPs regarding the field books.

- Project name
- Location of sample
- Sampler's printed name and signature
- Date and time of sample collection
- Sample identification code including QC and QA identification
- Sample depth (if applicable)
- Number and volume of samples
- Sampling methods or reference to the appropriate SOP
- Sample handling
- Analytes of interest
- Field observations
- Results of any field measurements
- Personnel present
- Level of PPE used during sampling.

Changes or deletions in the field book 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.

Each page in the field books will be signed by the person making the entry at the end of the day, as well as on the bottom of each page. Anyone making entries in another person's field book will sign and date those entries.

Sample Chain-of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Initial information concerning collection of the samples will be recorded in the field log book as described above. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form. The COC should contain project specific information. Sample labels should be checked against the COC to ensure everything intended for analysis is listed on the COC.

The sampler/shipper will be responsible for initiating and filling out the COC form. The COC will be signed by the sampler/shipper when the samples are relinquished to anyone else. The COC will contain the following information:

- Sampler's signature and company affiliation
- Project number
- Date and time of collection
- Sample identification number
- Canister ID
- Initial and final vacuum readings
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Shipping air bill number (if appropriate)
- Turnaround time (TAT) requested
- Appropriate project-specific Incident and SAP numbers (for Shell projects).

The person responsible for delivery of the samples to the laboratory will sign the COC form, retain a copy of the COC form, document the method of shipment, and send the original COC form with the samples. Upon receipt at the laboratory, the person receiving the samples will sign the COC form. Copies of the COC forms documenting custody changes and all custody documentation will be received and kept in the central files. The original COC forms will remain with the samples until final disposition of the samples by the laboratory.

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 Rand Avenue and Roxana Sites. Whenever possible, the soil vapor samples collected for the various work tasks will be screened on the same day of collection. If same-day screening is not possible due to time constraints, instrument problems, etc., the samples will 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), 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 (TVA 1000, GEM 2000, etc), or collected in Tedlar™ sample media and analyzed at a dedicated sample analysis station.

2. Equipment

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

- TVA-1000, PPbRAE, and LANDTEC 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 4-way plastic valves used to switch the sample between methane and total hydrocarbon analyses.

3. *Procedure*

The following instruments will 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 oxygen and carbon dioxide.

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

Calibration Procedures Applicable to All Field Screening Analyses

Instruments will be calibrated in accordance with applicable SOPs and/or manufacturers recommended procedures at the beginning of the day. If the screening instruments are to be used throughout the work day, a mid-day and end-day calibration check will be performed. Further, the TVA 1000 instrument detectors and associated dilution probe will 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 will be performed. Due to negligible (<5-percent) instrument drift throughout the day, the LANDTEC GEM-2000 and PPbRAE will not undergo bi-hourly bump checks. Instead, calibration accuracy checks will be conducted at approximately midday, and again at the conclusion of the sample event.

As stated above, calibration of the Landtec GEM-2000, TVA-1000, and PPbRAE will 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 will be based on a calibration standard that is approximately 10% of the lower explosive limit (LEL) for methane (5,000 ppmv). However, additional QC procedures will be implemented to ensure quality data for both hydrocarbon and methane concentrations.

The linearity of instrument response will 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 will be developed. The relative response factor for isobutylene (which is used here as a surrogate for petroleum vapors) will 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 will be run and if the check standard fails again, the instrument will be recalibrated and data obtained since the last check standard was successfully run will be flagged as estimated values.

Analysis 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 will be required prior to analysis. The 10:1 dilution probe will 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 will 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 analysis 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 will 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.

Analysis 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 will 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 will 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 will 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 4.0, will 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 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 LANDTEC Model GEM-2000 landfill gas analyzer. Quickly document 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;

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

Where

HC = hydrocarbon concentration (ppmv); and

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

Procedures for Sample Screening at a Dedicated Sample Analysis Station

The sampling instrumentation for the dedicated sample analysis 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 LANDTEC Model GEM-2000 landfill gas analyzer. Quickly document oxygen and carbon dioxide concentrations on the appropriate sample screening data sheet (attached);
- 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 will be completed using the TVA-1000 PID;
- If the oxygen concentration in the sample is less than 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. The dilution probe must be separately calibrated and should be used for sample analysis 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:

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

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. Therefore, the following protocols are in place to assure quality data:

- The sorbent tube will be replaced at least every 10 samples;
- The sorbent tube will 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. will 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.

1. Introduction to the Dwyer Digital Manometer

The Dwyer Series 475 Mark III Digital Manometer is used by personnel in the field to measure vacuum/pressure at wells throughout the Village of Roxana and at the Rand Avenue Remediation Site. Personnel responsible for using a manometer are required to read the manufacturer's instruction manual and be trained in the operation of the instrument.

2. Zeroing the Manometer

The manometer is zeroed before each measurement. This is done by either depressing the "zero" button located on the front of the manometer, or adjusting the knob ("zero adjust knob") on the top of the manometer (depending on which model is being used) while both positive and negative connections are open to the atmosphere. The "zero" button will automatically zero the instrument. The knob must be turned either clockwise (more positive) or counterclockwise (more negative) depending upon whether the manometer is reading positive or negative.

3. Vacuum / Pressure Measurement

The manometer shall be set on the "inches of water column" unit setting which can be done by depressing the "E/M" button and scrolling until "in/H2O" is found.

The positive fitting of the manometer shall be connected to the appropriate vacuum measurement fitting located on the well. The negative fitting on the manometer shall remain open to the atmosphere. The vacuum/pressure is immediately read and recorded to the nearest hundredth of an inch (or tenth of an inch if using 0-200 manometer) of water. The manometer can then be removed from the vacuum measurement fitting.

4. Maintenance and Calibration

If the "low bat" indicator is lit on the manometer display, the battery needs to be replaced. A weak battery can cause improper operation or inaccurate measurements. The battery is changed by unscrewing the flathead screws located on the bottom of the manometer and removing the battery plate. The 9 volt alkaline battery will slide out and can then be unclipped from the wiring. Install a fresh battery and secure the battery plate. When replacing the cover, be sure the rubber sealing gasket is properly seated in the gasket channel of the endcap. Note the endcap will only fit one way.

In the event that the manometer comes in contact with water or other conditions which cause the display to either not power on, or to read incorrectly, the manometer should be sent back to the manufacturer for calibration.

Exceeding the range of the manometer will not damage it or affect calibration if the maximum pressure is not exceeded. Exceeding the maximum pressure will cause permanent damage to the sensor and may rupture the housing and/or cause injury. The maximum pressure is shown on the rear label of the manometer.

Manometers should be sent back to the manufacturer or certified calibration agency every six (6) months for calibration following the “Manometer Calibration Schedule.” Calibration and maintenance records as well as calibration certificates are maintained on site.