Sampling and Analysis Work Plan

Ken's Auto Wash

1013 East University Way
Ellensburg, Washington

Prepared for
Secret Assets University Way
Property LLC

September 27, 2018
7168-10

HARTCROWSER

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Sampling and Analysis Work Plan

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1.0 INTRODUCTION

This work plan presents our approach for installing additional soil borings and temporary soil vapor probes at the Ken's Auto Wash site (Site) at 1013 East University Way in Ellensburg, Washington. The proposed work is intended to address the Washington State Department of Ecology's (Ecology's) comments in pursuit of a No Further Action (NFA) determination.

The goal of this investigation is to assess whether residual soil petroleum contamination present at the Site is below Model Toxics Control Act (MTCA) Method B direct contact cleanup levels and to determine if the vapor intrusion pathway is of potential concern for occupants of future or current buildings located on the Ken's Auto Wash property.

2.0 SITE DESCRIPTION AND BACKGROUND

The Site, which is defined as the area impacted by petroleum release(s) originating from the Ken's Auto Wash property, is affected by a petroleum hydrocarbon release discovered during tightness testing for a gasoline underground storage tank (UST) in 1996. Corrective actions were taken at that time, and the gasoline UST was subsequently removed with all other site USTs in April 2005 (June 7, 2005, Gasoline UST Closure Report by Hart Crowser). Prior to UST removal, Hart Crowser removed a hotspot of accessible petroleum-impacted soil in October and November 2000. During the hotspot removal, oxygen-release compound (ORC) was added to the excavation backfill below the seasonal high water table elevation to promote biodegradation of remaining petroleum hydrocarbons. ORC was also injected in the area of affected groundwater immediately downgradient of the UST area in February 2005 (April 6, 2005, Supplemental Strataprobe Exploration Report by Hart Crowser).

Additional project and regulatory background information is presented in Hart Crowser's November 14, 2006, Remedial Investigation and Feasibility Study Report (RI/FS). The RI/FS identified monitored natural attenuation with free product removal as the preferred remedial action. No free product has been identified at the Site since 2004.

In 2011, Hart Crowser implemented a bioremediation program to accelerate natural biological attenuation of petroleum at the Site. The enhanced bioremediation program introduced remediation amendments (hydrocarbon-degrading microbes, surfactants, and nutrients) into existing monitoring wells (MW) to accelerate natural attenuation already occurring at the Site over a series of three injection events, which occurred on January 31, May 3, and November 30, 2011. Based on groundwater monitoring data collected through February 2012, substantial petroleum destruction occurred within the treatment zone (May 16, 2012, Bioremediation Data Report by Hart Crowser). However, the data also showed that the biological oxidants had been consumed and groundwater sampled from monitoring well (MW-14) continued to exhibit petroleum concentrations above Washington State's Model Toxics Control Act (MTCA) Method A cleanup levels.

In February 2015, a bioremediation lance injection program was initiated. Unlike the remedial program conducted in 2011, this approach was designed to directly deliver amendments to areas of residual contamination, rather than injecting amendments into monitoring wells and relying on passive transport via groundwater. Our subcontractor, Bioremediation Specialists, LLC, (BIOS) of Beaverton, Oregon, used lance injection technology to apply a mixture of chemical and biological oxidants, a surfactant, and microbial amendment. Eight lance injections were completed in an east-west alignment approximately 2-feet south of MW-4. Two weeks later, 14 additional lance injections were completed. The 2-week interval between injections allowed time for the chemical oxidants to establish an environment conducive to microbial growth.

Groundwater monitoring has been conducted at the Site through December 2016, in compliance with an Agreed Order (dated December 23, 2013) with Ecology under MTCA (RCW 70.105D.040[5]).

Cleanup activities conducted at the Ken's Auto Site have effectively reduced the concentrations and mobility of petroleum hydrocarbon contaminants. There are no locations that exceed MTCA groundwater cleanup levels for petroleum constituents of concern over the last four quarterly monitoring events. Total petroleum hydrocarbons as gasoline (TPH-G) remain in the soil that was left in place near the utility line along University Way during the hotspot excavation in 2000. However, the 2015 lance injections appear to have enhanced biological degradation in this area and reduced the leachable petroleum hydrocarbon concentrations in well MW-14.

TPH-G and benzene groundwater concentrations in the vicinity and downgradient of the former UST and hotspot soil excavations have been below MTCA cleanup levels for at least four quarters of monitoring. Benzene and TPH-G concentrations in the Site wells that were inaccessible during 2016 have been non-detect at the specified reporting limit since 2011.

Based on these results, Ecology has determined that the historic petroleum releases at the Site are no longer significantly impacting the groundwater pathway. However, current soil quality data is needed to evaluate if residual petroleum contamination still exceeds Method B direct contact cleanup levels. Additional data is also needed to evaluate if the vapor intrusion pathway is of potential concern to future or current buildings located on the Site.

3.0 SCOPE OF WORK

For this project, we will:

- Advance up to 10 soil borings to approximately 15 feet below ground surface (bgs) adjacent to the former underground storage tank (UST) area. Up to 20 soil samples will be collected for chemical analyses.

- Complete five of the borings as temporary soil vapor probes. Soil vapor samples will be collected above the groundwater table for chemical analyses.
- Submit the soil and soil vapor samples to Washington-state accredited laboratories for chemical analyses.
- Review and validate the analytical results for quality assurance.
- Compile laboratory results and compare them with MTCA Method A soil cleanup levels for unrestricted land uses and current Ecology vapor intrusion screening levels (per Implementation Memo #18).

Sampling locations, procedures, analytical methods, and evaluation of results are discussed in subsequent sections of this work plan.

4.0 FIELD SAMPLING PROCEDURES

4.1 Exploration Locations

4.1.1 Subsurface Investigation

Proposed soil and vapor boring locations are shown on Figure 2. These locations may be modified after work begins, based on utility locations and our field observations. The area to be investigated will be located and marked in the field by a Hart Crowser field representative. Locations will be documented on field sampling forms or in a field notebook. Before exploration begins, we will contract with a private company to search for utilities at the proposed probe locations. If previously unidentified utilities or other obstructions are encountered during field activities, the investigation locations may be modified to avoid utilities or obstructions. Locations will be documented by measurements from distinct reference points on the Site. There may be other underground obstacles such as concrete slabs that cannot be detected by a utility locator; therefore, multiple soil boring attempts near each target location may be necessary.

Up to 10 soil and vapor borings will be advanced to a depth of approximately 15 feet bgs using a hollow-stem auger drill rig. Five of these borings will be completed as temporary soil vapor probes by installing a tubing system in each probe location. A driller subcontracted by Hart Crowser will conduct the work, and a Hart Crowser field representative will supervise drilling and sample collection. Approximately 20 soil samples and five soil vapor samples will be collected and submitted for chemical analysis.

Soil samples will be collected continuously in approximately 2.5-foot intervals. Samples will be classified in general accordance with ASTM D2488 (ASTM 2009), and pertinent characteristics of the subsurface conditions will be recorded on the boring logs.

We will evaluate samples in the field using visual observations, headspace vapor screening, and water sheen testing for potential soil contamination. One soil sample will be collected from each 2.5-foot sampling interval. Up to two soil samples from each boring will be selected for potential chemical analysis according to the following protocol:

- If we observe no evidence of soil contamination, we will select one or two soil samples for chemical analysis from these locations: (1) the soil sample collected from the vadose zone, (2) the soil sample collected from at or just below the groundwater table, and/or (3) the soil sample from the bottom of the boring.
- If we observe evidence of soil contamination, we will select up to three samples for chemical analysis including at least one sample from the zone with the most significant evidence of contamination, one sample from at or just below the groundwater table, and/or one sample from the bottom of the boring.

Soil samples will be collected in pre-cleaned sample containers provided by the analytical laboratory, packed in an ice-chilled cooler, and submitted to the laboratory using chain of custody protocols. Soil sampling analytical methods, containers, and holding times are listed in Table 1. Soil reporting limits and cleanup levels are listed in Table 2.

Soil vapor samples will be collected from approximately 4 feet bgs to evaluate the vadose zone above the anticipated groundwater table. A temporary probe casing and vapor collection screen will be advanced into the bore hole and sealed with bentonite clay. The sampling assembly will then be shrouded with helium gas as a helium detector is used to draw representative soil vapor from the sample point and confirm that the sampling assembly is airtight. After sample collection is completed (see Section 4.2), we will remove the temporary casing and sampling assembly and continue drilling to the desired depth of 15 feet bgs.

After the soil and soil vapor samples are collected, these investigation locations will be abandoned in accordance with State of Washington Administrative Code (WAC) Chapter 173-160, Minimum Standards for Construction and Maintenance of Wells.

4.1.2 Soil Screening and Sample Selection

Soil samples will be field-screened for contamination by visual examination, water sheen tests, and headspace vapor using a photoionization detector (PID). The results of field screening will be used to help select sampling intervals. The effectiveness of field screening methods varies with site characteristics, temperature, moisture content, organic content, soil type, and age of contaminant. It is important to note that although it is useful to know whether a sheen or headspace vapor is present, field screening tests do not confirm the presence or absence of contamination. Soil screening tests may not be completed if limited soil volume is recovered.

Visual examination includes inspecting the soil for stains that may indicate contamination; high concentrations of heavy petroleum hydrocarbons such as motor or hydraulic oil are the contaminants most easily detected by visual examination.

Water sheen testing involves placing a small volume of soil in a pan of water and observing the water surface for signs of sheen. Sheens are classified as described in the following table.

Sheen Classification

Classification	Description
No sheen (NS)	No visible sheen on water surface.
Slight sheen (SS)	Light colorless film, spotty to globular; spread is irregular, not rapid, areas of no sheen remain, film dissipates rapidly.
Moderate sheen (MS)	Light to heavy film, may have some color or iridescence, globular to stringy, spread is irregular to flowing; few remaining areas of no sheen on water surface.
Heavy sheen (HS)	Heavy colorful film with iridescence; stringy, spread is rapid; sheen flows off the sample; most of the water surface may be covered with sheen.

Headspace vapor screening is used to detect volatile organic vapors. The procedure involves placing a soil sample in a plastic bag and shaking the bag to expose the soil to the air trapped in the bag. The PID probe is then inserted in the bag so the instrument can measure the concentration of organic vapors in the headspace. The highest vapor reading is recorded for each sample. The PID measures concentrations in parts per million (ppm) and is calibrated to isobutylene. The PID can typically quantify organic vapor concentrations in the range of 0 to 1,000 ppm.

Soil vapor samples will also be field screened for methane, carbon dioxide, and oxygen (percent by volume) using a LMS-40 gas analyzer or similar. Results will be recorded in the field by HC field staff.

4.1.3 Soil Sample Collection

Field staff will collect samples in a consistent manner at all boring locations. Subsurface samples will be collected in 2.5-foot intervals by boring to the desired sample depth using split spoons. The sample location and site conditions will be recorded in field books and on field sampling forms.

- Field staff will put on clean nitrile gloves (or equivalent) for each sampling interval.
- Samples to be analyzed for VOCs will be collected first. Soil samples for VOC analyses will be collected as independent, discrete samples. The samples will be collected using the soil sampling syringes for use with EPA 5035A methodology into 40mL VOA vials. Samples will be sealed and placed in a resealable bag in an iced cooler.
- Place soil into a clean 4-ounce container provided by the laboratory for percent moisture analysis.
- Once container is full, wipe the rim with a clean paper towel or Kimwipe, and tighten the lid.
- Label the sample jar with the date, time, and sample identification and place in a resealable bag. Mark the sample identification on the jar lid and the bag.
- Place the labeled sample containers into an iced cooler.

Repeat the procedure for each discrete sample. Sample containers, preservation, and holding times are listed in Table 1.

4.2 Soil Vapor Sample Collection

At five boring locations (shown on Figure 2), a soil vapor implant will be used to collect soil vapor (as described in section 4.1.1), and then the soil vapor implant (6-inch stainless steel screen and ¼-inch Teflon tubing) will be inserted into the boring. The soil vapor sample will be drawn into the sample tubing. The tubing will be purged to remove ambient air, and approximately one liter of soil vapor will be withdrawn through the tubing into a Summa canister, using a flow controller set at its lowest rate. To prevent cross-contamination, disposable polyethylene tubing will be used for each soil vapor sample.

Sampling procedures for the use of the Summa canisters are provided in Appendix A. Sample containers and holding times for soil vapor are in Table 3.

4.3 Equipment Decontamination Procedures

Pre-cleaned equipment will be used for all sampling. All reusable or non-dedicated field equipment (e.g., sampling spoons and mixing bowls) will be decontaminated before reuse. Clean sample equipment will be used for each depth interval for the profile samples. Nitrile gloves (or equivalent) will be worn during decontamination. A trash bag will be provided for waste paper towels, used nitrile gloves, and so forth.

Equipment will be cleaned as follows:

- Remove excess soil by using paper towels or by dry brushing.
- Rinse with potable water.
- Wash with a spray bottle containing Liquinox™ (or equivalent non-phosphate detergent) and water; clean with a stiff-bristle brush until all evidence of soil or other material has been removed.
- Rinse with tap water, removing all soap from the previous step.
- Rinse three times with deionized or distilled water.
- Place the equipment on a piece of plastic to air dry.

4.4 Disposal of Investigation-Derived Waste

Incidental trash generated during this investigation (including discarded nitrile gloves, aluminum foil, paper towels, and disposable equipment) will be placed in plastic trash bags and disposed of as solid waste. Excess soil will be placed in 55-gallon steel drums. The drums will be stored on site pending analytical results.

Development and purge water will be drummed and stored on site pending analytical results. Wash water and rinse water will also be drummed. Soil and water investigation derived waste will be stored in separate drums and the contents and quantities will be recorded daily during the investigation.

4.5 Sample Containers and Labels

Sample container requirements vary according to analyte. Pre-cleaned sample containers will be obtained from the analytical laboratory. Sample containers will be cleaned following the requirements described in Specifications and Guidance for Contaminant-Free Sample Containers (EPA 1992).

Soil samples will be identified by the boring location and depth interval. Groundwater and soil vapor samples will be identified from the boring location or vapor well identifier.

4.6 Field Documentation

Field notes will be maintained during sampling and processing, and will include:

- Date and time of entry;
- Names of the field samplers collecting and logging the samples;
- Date, time, and identification of each sample, including number of jars and tests requested;
- Observations on soil characteristics;
- Documentation of photographs;
- Details of sample collection (actual sampling point locations will be recorded on a sketch map);
- Any deviation from the approved work plan; and
- General observations.

5.0 SAMPLE HANDLING AND LABORATORY ANALYSIS

5.1 Sample Preservation and Holding Times

Samples will be preserved according to the requirements of the specific analytical methods to be employed, and all samples will be extracted and analyzed within method-specified holding times. Required sample containers, preservatives, and holding times for soil and soil vapor testing are summarized in Tables 1 and 3, respectively.

5.2 Chain of Custody and Shipping Procedures

5.2.1 Chain of Custody Procedures

Chain of custody forms will be used to document the collection, custody, and transfer of samples from their initial collection location to the laboratory, and their ultimate use and disposal. Each sample will be entered on the custody form immediately after it is collected.

Sample custody procedures will be followed to provide a record that can accompany a sample as it passes from collection through analysis. A sample is considered to be in custody if it meets at least one of the following conditions:

- It is in someone's physical possession or view;
- It is secured to prevent tampering (i.e., custody seals); and/or
- It is locked or secured in an area restricted to authorized personnel.

A chain of custody form will be completed in the field as samples are packaged. At a minimum, the information on the custody form will include the sample number, date and time of sample collection, sampler, analysis, and number of containers. A copy of the custody form will be placed in the cooler with its respective samples before the container is sealed for delivery to the laboratory. Another copy will be retained and placed in the project files after review by the project manager. Custody seals will be placed on each cooler or package containing samples so the package cannot be opened without breaking the seals.

5.2.2 Sample Shipping Procedures

After sample containers have been filled, they will be packed on ice in coolers. The coolers will be transferred to Analytical Resources, Inc. (ARI) for chemical analysis. The Summa canisters will be transferred to Fremont Analytical. Chain of custody procedures will commence in the field and will track delivery of the samples to the analytical laboratory. Specific procedures are:

- Individual sample containers will be packed to prevent breakage;
- The coolers will be clearly labeled with sufficient information to enable positive identification; labels will list name of project, time and date container was sealed, person sealing the cooler, and the Hart Crowser office name and address;
- The custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler;
- Signed and dated custody seals will be placed on all coolers before shipping;
- Samples will be hand-delivered to Analytical Resources, Inc (ARI) by Hart Crowser personnel or courier;
- Summa canisters will be hand-delivered to Fremont Analytical by Hart Crowser personnel or courier;
- When sample possession is transferred to the testing laboratories, the custody form will be signed by the persons transferring custody of the coolers; and
- Upon receipt of samples at the laboratory, the shipping container custody seal will be broken and the sample-receiving custodian will compare samples with information on the chain of custody form and record the condition of the samples received.

5.3 Laboratory Analysis

Selected soil samples will be analyzed for one or more of the following:

- Gasoline-range petroleum hydrocarbons (TPH-G) by Ecology method NWTPH-Gx;
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX) by EPA Method 8021; and
- Total solids (percent moisture) by Standard Method 2540B or equivalent.

Three soil samples that appear to contain elevated concentrations of petroleum hydrocarbons based on field screening will also be analyzed for volatile petroleum hydrocarbons (VPH) by 1997 WDOE-VPH (1997). Based on previous sampling events, it appears that the composition of petroleum present in site soils is relatively similar. However, if significant variation in petroleum composition is encountered, additional VPH analyses may be performed.

Soil screening levels, method detection limits, and reporting limits are given in Table 2.

Soil vapor samples will be analyzed for the following:

- Petroleum fractionation air-phase petroleum hydrocarbons (APH) EC5-8 (aliphatics), EC9-12 (aliphatics), and EC9-10 (aromatics) by Method TO-15;
- BTEX and naphthalene by Method TO-15 with selected ion monitoring (SIM); and
- Helium by Method GC-TCD.

Screening levels and reporting limits are presented in Table 4.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

The quality of analytical data generated is assessed by the frequency and type of internal QC checks specific to the analytical test type. Hart Crowser will assess the quality of measurements by reviewing results for method blanks, matrix spikes, laboratory control samples, surrogate compound recoveries, and other data as specified for the analytical methods to be used.

The following general procedures will be followed for all laboratory analyses:

- Laboratory blank measurements at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix;
- Laboratory control sample (LCS) analysis to assess accuracy at a minimum frequency of one per batch for each matrix;

- Matrix spike (MS) analysis to assess accuracy at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix; and
- Matrix spike duplicate or laboratory duplicate to assess precision at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix.

Laboratory quality control procedures, criteria, and corrective actions for the various analyses are summarized in Tables 5 through 7.

6.1 Data Quality Indicators

All sample collection, field measurements, and laboratory analytical tests are designed to produce data of known and appropriate quality. Environmental laboratories use internal quality control checks to ensure the data they produce is of adequate quality. To ensure the data reported by the laboratory meets agreed-upon standards, Hart Crowser will assign an independent data quality reviewer to evaluate the internal quality control checks (including method blanks, matrix spikes, laboratory control samples, calibrations, performance evaluation samples, interference checks, etc.), for each data package.

Hart Crowser follows the procedures and quality control checks described in this section to verify that known and acceptable levels of accuracy and precision are maintained for each data package.

6.1.1 Precision

Precision is the degree of reproducibility or agreement between independent or repeated measurements. Analytical variability will be expressed as the relative percent difference (RPD) between laboratory replicates and between the matrix spike and matrix spike duplicate. The RPD will be calculated by:

$$\mathrm{RPD} = \frac{(D_1 - D_2)}{(D_1 + D_2)/2} \times 100$$

Where,

D_1 = Sample value
D_2 = Duplicate sample value

Precision will be assessed by analysis of laboratory duplicates. Field variability will be assessed by analyzing numerous field samples rather than by comparing select samples to field duplicates.

6.1.2 Accuracy

Accuracy is the agreement between a measured value and its true or accepted value. It is not possible to determine absolute accuracy for environmental samples, so we use known standards and spiked samples to assess accuracy.

Laboratory accuracy will be assessed as the percent recovery of matrix spikes, matrix spike duplicates, surrogate spiked compounds (for organic analyses), and laboratory control samples. Accuracy will be defined as the percentage recoverable from the true value and is calculated by:

$$\%\text{Recovery} = \frac{(\text{SSR-SR})}{\text{SA}} \times 100$$

Where,

SSR = spiked sample result
SR = sample results (not applicable for surrogate recovery)
SA = amount of spike added

6.1.3 Representativeness

Representativeness expresses the degree to which the sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. The sampling program will be designed to ensure that: (a) sample locations are selected properly; (b) sufficient samples are collected to accurately reflect conditions at the site; and (c) samples are representative of sampling locations. A sufficient volume of sample will be collected at each sampling point to minimize bias or errors associated with sample particle size and heterogeneity.

6.1.4 Completeness

Completeness is the percentage of measurements that are judged to be valid. Completeness will be calculated separately for each analytical group (e.g., TPH-G). The analytical results must contain all quality control checks required to verify precision and accuracy to be considered complete. Data qualified as "estimated" during the validation process will be considered complete, but results that are rejected during the validation review and samples for which no analytical results were obtained will be considered nonvalid. Completeness will be calculated for each analytical group using the following equation:

$$\text{Completeness} = \frac{\text{valid data points obtained}}{\text{total data points planned}} \times 100$$

The target goal for completeness is a minimum of 95 percent. Completeness will be monitored on an ongoing basis so that archived sample extracts can be reanalyzed, if required, without remobilization.

6.1.5 Comparability

Comparability is the degree to which data from separate data sets may be compared.

Samples will be collected according to the same protocol at all sampling locations to ensure all data collected as part of this study are comparable to each other. Comparability is attained by careful adherence to standardized sampling and analytical procedures; rigorous documentation of sample locations (including depth, time, and date) is required. The use of standardized methods to collect and analyze samples, along with instruments calibrated against the National Institute for Standards and

Technology (NIST) and US EPA traceable standards will also ensure comparability, particularly for comparison of data collected from this study (within-study comparability).

7.0 SITE INVESTIGATION REPORT

Hart Crowser will prepare a report summarizing sampling procedures and laboratory testing results. The report will include a map with sampling locations, tabulated analytical testing data compared with MTCA cleanup levels, sample depth, chemical data quality review, and laboratory analytical reports. The report will include statements on any limitations on the data use that are the result of adverse QC exceedances, as identified in Section 6.1, Data Quality Assurance Review.

We will compare soil quality data to the site-specific petroleum Method B cleanup level to evaluate if the direct contact pathway is adequately protected. We will also utilize Ecology guidance provided in Implementation Memos #14 and #18 to evaluate if the vapor intrusion pathway is of potential concern to future and current Site buildings.

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Table 1 – Sample Containers, Preservation, and Holding Times for Soil

Analysis	Preservation	Holding Time[a]	Container
Gasoline-range petroleum hydrocarbons (TPH-G) and benzene, toluene, ethylbenzene, and total xylenes (BTEX) by NWTPH-Gx/8260	Methanol, Cool to 4 °C	14 days	2 40 mL VOA vials
Volatile petroleum hydrocarbons by EPA 1997 WDOE-VPH	Methanol, Cool to 4 °C	14 days	1 40 mL amber VOA vial
Total solids	Cool to 4 °C	7 days	4 oz. wide mouth jar

Notes:
a. Holding times are from date of sample collection.

Table 2 - Cleanup Levels, Method Detection Limits, and Practical Quantitation Limits for Soil

Analyte	MTCA Method A Cleanup Level Unrestricted Land Uses	MDL	RL
TPH (mg/kg)			
NWTPH-gasoline	100[a]/30[b]	2.5	5.0
BTEX by EPA Method 8260C (mg/kg)			
Benzene	0.03	0.01	50.0
Toluene	7	0.01	50.0
Ethylbenzene	6	0.01	50.0
m,p-Xylene	9	0.03	100
o-Xylene	9	0.01	50.0
VPH by WA VPH (mg/kg)			
C5-C6 Aliphatics		4.50	9000
C6-C8 Aliphatics		4.50	9000
C8-C10 Aliphatics		4.50	9000
C10-C12 Aliphatics		4.50	9000
C8-C10 Aromatics		4.50	9000
C10-C12 Aromatics		4.50	9000
C12-C13 Aromatics		4.50	9000
Methyl tert-butyl Ether	0.1	0.45	900
Benzene	0.03	0.45	900
Toluene	7	0.45	900
Ethylbenzene	6	0.45	900
m,p-Xylene	9	0.90	1800
o-Xylene	9	0.45	900
1,2,3-Trimethylbenzene		0.45	900
Naphthalene	5	0.45	900
1-Methylnaphthalene		0.45	900
n-Pentane		0.45	900
n-Hexane		0.45	900
n-Octane		0.45	900
n-Decane		0.45	900
n-Dodecane		0.45	900

a. No benzene detected in any samples and BTEX < 1% of total TPH-Gx.
b. Benzene detected or BTEX > 1% of total TPH-Gx.

Table 3 – Sample Containers, Preservation, and Holding Times for Soil Vapor

Analysis	Preservation	Holding Time[a]	Container
Volatile organic compounds by TO-15	None	30 days	1L Summa canister
Volatile organic compounds by TO-15 SIM	None	30 days	1L Summa canister
Helium by Method GC-TCD	None	3 days	1L Summa canister

Note:
a. Holding time is from date of sample collection.

Table 4 - Screening Levels and Reporting Limits for Soil Vapor

	Screening Levels VI Method B		TO-15 Reporting Limits		TO-15 SIM Reporting Limits	
Compound	2015 Deep Soil Gas Noncancer µg/m^3	2015 Deep Soil Gas Cancer µg/m^3	Base Reporting Limit ppbv	Base Reporting Limit µg/m^3	Base Reporting Limit ppbv	Base Reporting Limit µg/m^3
1,2,3-Trimethylbenzene			0.403	1.98		
1,3,5-Trimethylbenzene			0.432	2.13		
1,3-Butadiene	9.14E+01	8.33E+00	0.508	1.12		
1-methyl-3-ethylbenzene			0.221	1.09		
2,3-Dimethylheptane			0.427	2.24		
2,3-Dimethylpentane			0.715	2.93		
p-isopropyltoluene			0.447	2.45		
Aliphatic Hydrocarbon (EC5-8)	(a)		7.5	2.93		
Aliphatic Hydrocarbon (EC9-12)	(a)		7.5	2.45		
Aromatic Hydrocarbon (EC9-10)	(a)		6.25	28.5		
Benzene	1.37E+03	3.21E+01	0.391	44.2	0.04	0.128
Cyclohexane			0.303	31.4		
Decane			0.416	1.25		
Ethylbenzene	4.57E+04		0.338	1.04	0.05	0.217
Heptane			0.58	2.42		
Isopentane			0.711	1.47		
Isopropylbenzene			0.349	2.33		
m,p-Xylene	4.57E+03		0.901	2.1	0.06	0.261
Naphthalene	1.37E+02	7.35E+00	0.0128	1.72	0.3	1.57
Butylcyclohexane			0.544	3.91		
Dodecane			1.1	0.0669		
n-Hexane	3.20E+04		0.318	3.12		
Nonane			0.487	7.65		
Undecane			0.724	1.12		
Octane			0.503	2.55		
o-Xylene	4.57E+03		0.332	5.04	0.04	0.174
Methyl tert-butyl ether (MTBE)	1.37E+05	9.62E+02	0.364	2.35		
Toluene	2.29E+05		0.373	1.44	0.05	0.188

	GC-TCD Reporting Limits
	PQL ppt
Helium	100

a. Method B generic indoor air TPH cleanup level of 140 µg/m^3 will be used based on Ecology's Petroleum Vapor Intrusion (PVI) Implementation Memo No. 18, dated January 1, 2018.

Table 5 – Laboratory Quality Control Procedures, Criteria, and Corrective Actions for Gasoline Analysis

Laboratory Quality Control: NWTPH-Gx (GC/FID or GC/MS)			
Quality Control Check	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Method blank	1 per batch of every 20 or fewer samples	All analytes < reporting limit	Re-extract and re-analyze associated samples unless concentrations are > 5 x blank level
Initial calibration	5-point external calibration before sample analysis	< 15% difference from true value, correlation coefficient ≥ 0.99	Recalibrate instrument
Continuing calibration	Beginning and end of instrument run	NWTPH-Gx ≤ 20% difference from initial calibration.	Recalibrate instrument and re-analyze affected samples
Surrogates	Every lab and field sample	Laboratory control chart limits	Evaluate data for usability
Laboratory duplicate	1 per 20 or fewer samples	< 30% RPD	Evaluate data for usability

Note:

RPD = relative percent difference

Table 6 – Laboratory Quality Control Procedures, Criteria, and Corrective Actions for Volatile Organic Compound Analysis

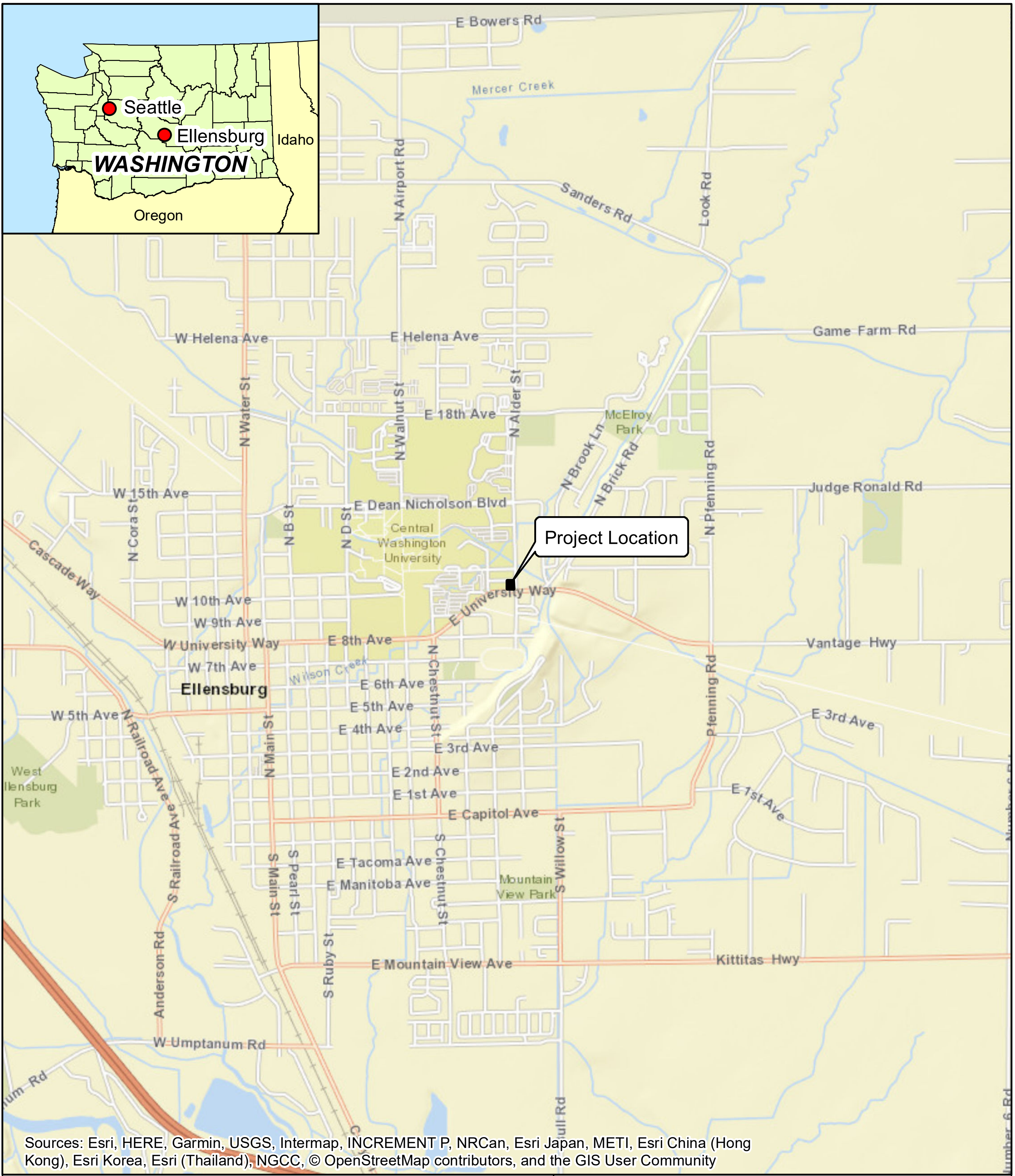
Laboratory Quality Control: VOCs – EPA 8260			
Quality Control Check	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Instrument tuning	Before initial calibration and every 12 hours	See EPA Method 8260	Retune and recalibrate instrument
Initial calibration	See EPA Method 8260	< 20% relative percent difference	Laboratory to recalibrate and re-analyze affected samples
Continuing calibration verification	Every 12 hours	See EPA Method 8260 < 20% percent difference	Laboratory to recalibrate if correlation coefficient or response factor does not meet method requirements
Method blank	1 per batch of 20 or fewer samples	All analytes < reporting limit	Laboratory to eliminate or greatly reduce laboratory contamination due to glassware or reagents or analytical system; re-analyze affected samples
Laboratory control samples	One per analytical batch or every 20 samples, whichever is more frequent	Laboratory control chart limits	Laboratory to correct problem to verify the analysis can be performed in a clean matrix with acceptable precision and recovery; then re-analyze affected samples
Surrogates	Added to every organics sample as specified in analytical protocol	Laboratory control chart limits	Follow corrective actions specified in EPA Method 8260
Matrix spikes	One per sample batch or every 20 samples, whichever is more frequent; spiked with the same analytes at the same concentration as the laboratory control sample	Laboratory control chart limits	Matrix interferences should be assessed and explained in case narrative accompanying the data package.
Laboratory control sample duplicate or Matrix spike duplicates	One duplicate analysis with every sample batch or every 20 samples	Compound- and matrix-specific RPD ≤ 35%, applied when the analyte concentration is > PQL	Laboratory to re-analyze samples if analytical problems suspected, or to qualify the data if sample homogeneity problems are suspected and the project manager is consulted

Note:
RPD = relative percent difference

Table 7 – Laboratory Quality Control Procedures, Criteria, and Corrective Actions for Volatile Petroleum Hydrocarbons Analysis

Laboratory Quality Control: VPH - WDOE VPH (GC/FID/PID)			
Quality Control Check	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Initial calibration	See WDOE VPH Method	< 20% relative percent difference	Laboratory to recalibrate and re-analyze affected samples
Continuing calibration verification	See WDOE VPH Method	See WDOE VPH Method	Laboratory to recalibrate if correlation coefficient or response factor does not meet method requirements
Method blank	1 per batch of 20 or fewer samples	All analytes < reporting limit	Laboratory to eliminate or greatly reduce laboratory contamination due to glassware or reagents or analytical system; re-analyze affected samples
Laboratory control samples	One per analytical batch or every 20 samples, whichever is more frequent	70 - 130 %	Laboratory to correct problem to verify the analysis can be performed in a clean matrix with acceptable precision and recovery; then re-analyze affected samples
Surrogates	Added to every organics sample as specified in analytical protocol	60 - 140 %	Follow corrective actions specified in WDOE VPH Method
Matrix spikes	One per sample batch or every 20 samples, whichever is more frequent; spiked with the same analytes at the same concentration as the laboratory control sample	70 - 130 %	Matrix interferences should be assessed and explained in case narrative accompanying the data package.
Laboratory control sample duplicate or Matrix spike duplicates	One duplicate analysis with every sample batch or every 20 samples	RPD ≤ 30%, applied when the analyte concentration is > PQL	Laboratory to re-analyze samples if analytical problems suspected, or to qualify the data if sample homogeneity problems are suspected and the project manager is consulted

Note:
RPD = relative percent difference



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Feet

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Ken's Auto Wash
Ellensburg, Washington

Vicinity Map

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6/18

HARTCROWSER

Figure
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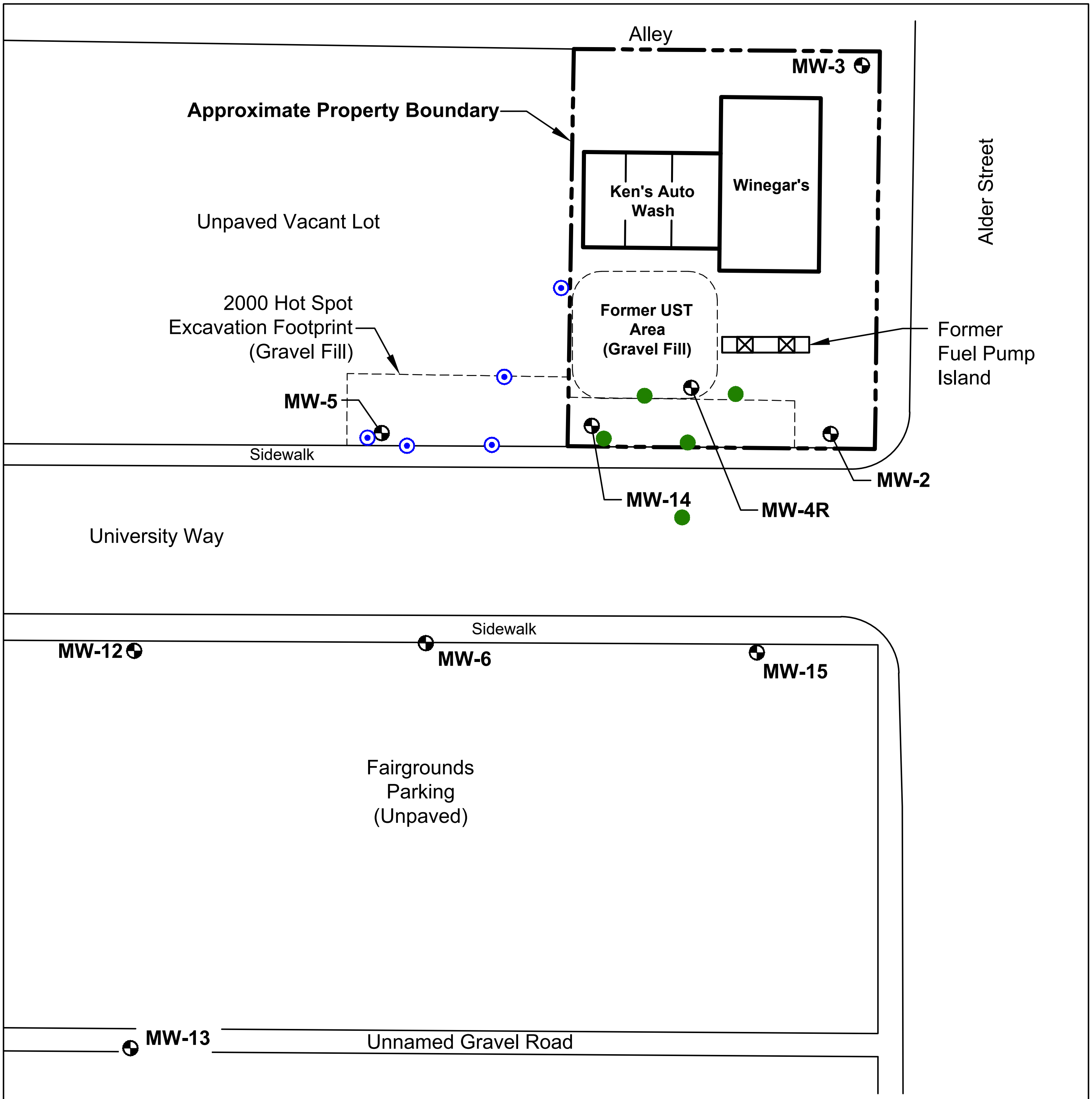

Note: Base map prepared from drawing provided by Sage Earth Sciences titled "Proposed Addtional Monitoring Well and ORC Injections Locations," dated January 1998.

0 50 100

Scale in Feet

● Proposed Soil Boring

⦿ Proposed Temporary Soil Vapor Well

MW-6 ⊕ Hart Crowser Monitoring Well

N

Ken's Auto Wash
Ellensburg, Washington

Proposed Soil and Vapor Boring Locations

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Figure
2

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APPENDIX A
Eurofins Air Toxics – Guide to Air Sampling

- Soil Gas
- Vapor Intrusion
- Property Redevelopment
- Ambient Air Monitoring
- Indoor Air Quality
- Waste-to-Energy

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Guide to Air Sampling

Canisters and Bags

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Always Air. Always Accurate.

Eurofins Air Toxics, Inc.
Guide to Whole Air Sampling – Canisters and Bags

Revision 6/27/14

Contents

Section 1.0 Introduction

Eurofins Air Toxics Inc. presents this guide as a resource for individuals engaged in air sampling. Air sampling can be more involved than water or soil sampling due to the reactivity of chemical compounds in the gas matrix and sample interaction with the equipment and media used. Ensuring that air samples are collected properly is an important step in acquiring meaningful analytical results. This guide is not a substitute for experience and cannot sufficiently address the multitude of field conditions. Note that this guide is intended for projects involving whole air sampling of volatile organic compounds (VOCs) in canisters and Tedlar® bags. Eurofins Air Toxics provides the "Guide to Sorbent-Based Sampling - Volatiles and Semi-Volatiles" for other types of sampling.

1.1 Whole Air Sampling of VOCs

There are three general ways to collect compounds in a gas phase sample. A sampler may collect the gas sample in a container, actively pump the vapor through a sorbent tube, solution or filter, or rely on passive sample collection onto a sorbent bed. This guide focuses on collecting a sample in the most common air sampling containers, Summa canisters and bags. The sample may be collected in the container either passively, relying on an evacuated canister to drive the sample collection, or actively using a pump to fill the container. The container is subsequently sealed and transported to the laboratory for analysis. The sample is referred to as a "whole air sample" and the compounds remain in the gas matrix inside the container.

As a general rule, whole air sampling is appropriate when target compounds are chemically stable and have vapor pressures greater than 0.1 torr at 25°C and 760mm Hg (EPA standard ambient conditions). Performance of a given compound in a whole air sample is dependent upon its chemical properties, the matrix of the sample, and the degree of inertness of the sample container.

1.2 Choosing Between Canisters and Bags

Table 1.2 compares the features and performance of Summa canisters and bags. Summa canisters or similarly treated canisters are rugged containers designed to provide superior inertness and extended sample storage times. Evacuated canisters also do not require a sampling pump for sample collection. By contrast, bags require a sample pump, but can be purchased inexpensively in bulk, require little preparation or cleaning, and take up little space prior to use. Unlike canisters, bags are typically not appropriate for ppbv-level VOC measurements due to their background artifacts and short hold-times. Over time, low molecular weight gases can diffuse through the bag material while chemicals with lower vapor pressures can condense on the bag surface thereby compromising analyte recoveries. Call your Project Manager at 800-985-5955 if you have questions regarding the appropriate sampling media.

Table 1.2 Comparison of Canisters to Bags

	Canisters	Bags
Type of Sampling	Passive (vacuum)	Active (pump required)
Media Hold Time	Up to 30 days recommended	Indefinite
Hold Time to Analysis	Up to 30 days	Up to 3 days
Surface Inertness	Excellent	Fair
Cleanliness	Batch or 100% certified to ppbv/pptv levels	Some VOCs present in the ppbv range
Sampling Application	Ambient air, soil/landfill gas	Soil/landfill gas, stationary sources, SVE systems
Rule of Thumb	"ppbv device"	"ppmv device"
Advantages	Inertness, hold time, ruggedness, no pump	Purchase/shipping cost, availability, convenience

Section 2.0 Canisters and Associated Media

This section provides a description of air sampling canisters, practical considerations for sampling, and step-by-step instructions for collecting grab and integrated samples. Photographs illustrate the correct way to assemble the various sampling components. Tables provide detailed information on many operational factors that ultimately influence the quality of the data obtained from a canister sample.

2.1 Introduction to Canisters

An air sampling canister is a container for collecting a whole air sample. A canister may be spherical or cylindrical and is constructed of specially treated stainless steel. The canister is prepared for sampling by evacuating the contents to a vacuum of approximately 29.9 inches of Mercury (in Hg). Opening the stainless steel bellows valve allows the air sample to enter the canister. Flow controllers can be utilized to restrict the flow and allow for collection at a desired flow rate or over a desired range. When the sample has been collected, the valve is closed and the canister is returned to the laboratory. Canisters range in volume from less than 1 liter (L) to 6 L. In general, 6 L canisters are used to collect ambient air samples and samples requiring time integration greater than 2 hours. One liter canisters are typically used for taking high concentration (i.e., greater than 5 ppbv) samples not requiring time integration such as soil vapor.

2.1.1 Summa Canister

A Summa canister is a stainless steel container that has had the internal surfaces specially passivated using a “Summa” process. This process combines an electropolishing step with a chemical deactivation step to produce a surface that is nearly chemically inert. A Summa surface has the appearance of a mirror: bright, shiny and smooth. The degree of chemical inertness of a whole air sample container is crucial to minimizing reactions with the sample and maximizing recovery of target compounds from the container. Eurofins Air Toxics maintains a large inventory of Summa canisters in 1 and 6 L volumes.

2.1.2 Canister Certification

Eurofins Air Toxics provides two types of canister cleaning certification, batch and 100%, depending upon the requirements of the project. The batch certification process is most appropriate for routine ambient air applications and high concentration applications such as soil vapor and landfill gas monitoring. The batch certification process begins by cleaning a set of canisters using a combination of dilution, heat and high vacuum. The cleaning batch is certified by analyzing a percentage of canisters for approximately 60 VOCs using GC/MS. The batch meets cleaning requirements if the target compound concentrations are below 0.2 ppbv. Alternatively, the 100% certification (i.e., individual certification) process is typically required for ambient and indoor air applications driven by risk assessment or litigation requiring pptv (parts per trillion by volume) sensitivity. If 100% certification is required, canisters are individually certified for a client-specific list of target compounds using GC/MS. When the 100% certified canisters are shipped, the analytical documentation demonstrating that they are free of the target compounds down to the project reporting limits is emailed to the client. When sampling with certified media, it is important to note that all media is certified as a train and must be sampled as such (i.e., a particular flow controller goes with a particular canister and is labeled as such).

Specify whether your project requires batch or 100% canister certification.

2.1.3 Canister Hold Time

Media Hold Time: Unlike water and soil environmental samples, which are collected in single-use, disposable vials and jars, air samples are collected in reusable summa canisters. Eurofins Air Toxics requires that canisters be returned within 15 days of receipt to effectively manage our inventory and to insure canisters meet performance requirements in the field. Evacuated canisters have a finite timeframe before the canisters naturally lose vacuum during storage. Using canisters beyond 15 days increases the risk of having unacceptable initial vacuum at the start of sampling.

Sample Hold Time: EPA Method TO-15 cites a sample hold time of up to 30 days for most VOCs. Several non-routine compounds, such as bis(chloromethyl)ether, degrade quickly and demonstrate low recovery even after 7 days. Reactive sulfur compounds such as hydrogen disulfide and methyl, ethyl, and butyl mercaptan are not amenable to storage in stainless steel summa canister, and either fused silica lined (FSL) canisters or Tedlar bags are required for sample collection.

2.2 Associated Canister Hardware

Associated hardware used with the canister includes the valve, brass cap, particulate filter and vacuum gauge. (Flow controllers are covered in detail in section 3.2.)

2.2.1 Valve

An industry standard 1/4" stainless steel bellows valve is mounted at the top of the canister. The valve maintains the vacuum in the canister prior to sampling and seals the canister once the sample has been collected. No more than a half turn by hand is required to open the valve. Do not over-tighten the valve after sampling or it may become damaged. A damaged valve can leak, possibly compromising the sample. Some canisters have a metal cage near the top to protect the valve.

To protect the valve and provide secure connections in the field, a replaceable fitting is attached to all canisters. As threads wear and require replacement, new fittings can be installed at the laboratory prior to shipping to the field. You will need a 1/2" wrench to secure the fitting while connecting or removing the required equipment to the canister.

2.2.2 Brass Cap

Each canister comes with a brass cap (i.e., Swagelok 1/4" plug) secured to the inlet of the valve assembly. The cap serves two purposes. First, it ensures that there is no loss of vacuum due to a leaky valve or a valve that is accidentally opened during handling. Second, it prevents dust and other particulate matter from damaging the valve. The cap is removed prior to sampling and replaced following sample collection.

Always replace the brass cap following canister sampling.

2.2.3 Particulate Filter

Particulate filters should always be used when sampling with a canister. Separate filters are provided to clients taking a grab sample, and filters are built into the flow controllers for clients taking integrated samples. The 2 micron filter is a fritted stainless steel disk that has been pressed into a conventional Swagelok adapter. This device has a relatively high pressure drop across the fritted disk and restricts the flow into the canister even when sampling without a flow controller. Table 2.2.3 lists the typical fill time for a grab sample using a 2 micron particulate filter.

Table 2.2.3 Grab Sample Fill Times for Canisters

CANISTER VOLUME	2 micron filter
6 L	<5 minutes
1 L	<1 minute

2.2.4 Fittings

All fittings on the sampling hardware are 1/4” Swagelok, and a 9/16” wrench is used to assemble the hardware. A 1/2” wrench is also required to tighten fittings onto a union connector. Compression fittings should be used for all connections. Never use tube-in-tube connections. It is critical to avoid leaks in the sampling train. Leaks of ambient air through fittings between pieces of the sampling train will dilute the sample and cause the canister to fill at a faster rate than desired. Eurofins Air Toxics can provide the necessary fittings and ferrules if requested.

2.2.5 Vacuum Gauge

A vacuum gauge is used to measure the initial vacuum of the canister before sampling, and the final vacuum upon completion. A gauge can also be used to monitor the fill rate of the canister when collecting an integrated sample. Eurofins Air Toxics provides 2 types of gauges. For grab sampling, a test gauge checks initial and final vacuums only and is not to be sampled through. For integrated sampling a gauge is built into the flow controller and may be used for monitoring initial and final vacuums, as well as monitoring the fill rate of the canister. Both gauges are considered to be rough gauges, intended to obtain a relative measure of vacuum change. Accuracy of these field gauges are generally on the order of +/-5 in Hg. Individuals with work plans that outline specific gauge reading requirements are strongly encouraged to purchase and maintain their own gauges in the field. In special cases, a laboratory-grade, NIST-traceable vacuum gauge can be provided upon request.

The vacuum gauges that are routinely provided are intended as a rough gauge measurement device (+/-5 in Hg accuracy).

Section 3.0 Sampling with Canisters

There are two basic modes of canister sampling: grab and integrated. A grab sample is taken over a short interval (i.e., 1-5 minutes) to provide a point-in-time sample concentration, while an integrated sample is taken over a specified duration or utilizing a specified flow rate. In both modes the canister vacuum is used to draw the sample into the canister. This is commonly referred to as passive canister sampling. Sections 3.1 and 3.2 detail procedures for grab and integrated sampling, and section 3.3 provides procedures specific to soil vapor collection.

Regardless of the type of canister samples collected, the following rules apply:

- DO NOT use canister to collect explosive substances, radiological or biological agents, corrosives, extremely toxic substances or other hazardous materials. It is illegal to ship such substances and you will be liable for damages.
- ALWAYS use a filter when sampling. NEVER allow liquids (including water) or corrosive vapors to enter canister.
- DO NOT attach labels to the surface of the canister or write on the canister; you will be liable for cleaning charges.
- DO NOT over tighten the valve, and remember to replace the brass cap.
- IF the canister is returned in unsatisfactory condition, you will be liable for damages.
- DO NOT make modifications to the equipment connections and/or use Teflon tape unless approved by the laboratory.
- AND, if you have any questions or need any support, our experienced project management team is just a phone call away at 800-985-5955.

Use a 9/16” and 1/2” wrench to tighten Swagelok connections on the canister sampling train.

3.1 Grab Sampling Using Canisters

The most common hardware configuration used to take a grab sample is to simply attach a particulate filter to the canister inlet. A particulate filter is shown in section 2.2.3 and is used to prevent particulate matter from fouling the valve and entering the canister.

3.1.1 Step-By-Step Procedures for Canister Grab Sampling

These procedures are for a typical ambient air sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and gauge – if requested).
2. Make sure you include a 9/16” and 1/2” wrench in your field tool kit.
3. Verify the gauge is working properly.
4. Verify the initial vacuum of canister as described in the following section:

- **Verify Initial Vacuum of the Canister**: Prior to shipment, each canister is checked for mechanical integrity. However, it is still important to check the vacuum of the canister prior to use. Eurofins Air Toxics recommends doing this before going to the field if possible. The initial vacuum of the canister should be greater than 25 in Hg. If the canister vacuum is less than 25 in Hg, ambient air may have leaked into the canister during storage or transport and the sample may be compromised. Contact your Project Manager if you have any questions on whether to proceed with sample collection. If sampling at altitude, there are special considerations for gauge readings and sampling (see Section 5.2). The procedure to verify the initial vacuum of a canister is simple but unforgiving.

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove the brass cap.
3. Attach gauge.
4. Attach brass cap to side of gauge tee fitting to ensure a closed train.
5. Open and close valve quickly (a few seconds).
6. Read vacuum on the gauge.
7. Record gauge reading on “Initial Vacuum” column of chain-of-custody.
8. Verify that canister valve is closed and remove gauge.
9. Replace the brass cap.

When ready to sample:

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove brass cap.
3. Attach particulate filter to canister.
4. Open valve 1/2 turn (6 L canister normally takes less than 5 minutes to fill).
5. Close valve by hand tightening knob clockwise.
6. Verify and record final vacuum of canister (repeat steps used to verify initial vacuum). For grab samples, the ending vacuum is typically close to ambient pressure (0 in Hg).
7. Replace brass cap.
8. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).
9. Return canister in box provided.
10. Return sample media in packaging provided.
11. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).
12. Place chain-of-custody in box and retain pink copy.
13. Tape box shut and affix custody seal (if applicable) across flap.
14. Ship accordingly to meet method holding times.

Return all equipment used or unused to the laboratory. Unreturned canisters and associated hardware will result in additional charges as outlined in the media agreement.

3.2 Integrated Sampling with Canisters and Flow Controllers

As an alternative to an “instantaneous” grab sample, an air sample collected at a controlled rate is referred to as an integrated sample. Flow controllers or flow restrictors are devices which provide sample collection at a desired flow rate and/or sampling interval. By using a flow controller at a specified flow rate, air samples can provide information on average compound concentrations over a defined period. For example, an 8- or 10-hour integrated sample can be used to determine indoor air quality in the workplace. Similarly, a 24-hour integrated sample may be collected to determine residential exposure to indoor or outdoor air sources. In addition to using a flow controller for time-integrated sample collection, a flow controller may be required for soil gas collection to restrict the vacuum applied to the soil and pore water and to collect a representative sample with minimal intrusion of ambient air.

Eurofins Air Toxics provides two general types of flow controllers: mass flow controllers and critical orifice devices. Both devices are driven by differential pressure between ambient conditions and vacuum in the canister.

3.2.1 Mass Flow Controller

A mass flow controller employs a diaphragm that actively compensates to maintain a constant mass flow rate over the desired time period. As the differential pressure decreases, the flow rate decreases and the diaphragm responds by opening up to allow more air to pass through to maintain a stable flow rate. Mass flow controllers are calibrated in the laboratory to provide flow rates suitable for durations up to 24 hours. Durations greater than 24 hours are possible, however, performance of the flow controller is less reliable due to the low flow rates required.

3.2.2 Critical Orifice Devices

Eurofins Air Toxics has two types of critical orifice controllers – “capillary column” and “frit pressed”. Both types restrict the flow rate and the canister fill rate decreases as the canister fills to ambient pressure. These controllers are suitable for applications not requiring constant flow rate over the sampling period such as soil vapor collection or at sites in which temporal variability of VOCs is not expected. Critical orifice devices can cover intervals from 0.5 to 12 hours and flow rate from 10 to 250 ml/min. The “capillary column” device (also known as the Blue Body Flow Controller) restricts air flow by forcing the sample to enter a capillary column of minute radius. The flow rate is a function of the length of inert capillary column. The frit pressed device has a critical orifice machined to meet a set flow rate.

3.2.3 Sampling Interval and Flow Controller Setting

When you request canisters and flow controllers from Eurofins Air Toxics, you will be asked for the flow rate (soil vapor) or sampling interval (ambient air), and the flow controllers will be pre-set prior to shipment. The flow rate is set at standard atmospheric conditions (approximately sea level and 25°C). If samples will be collected at elevation or at ambient temperatures significantly different than 25°C, the canister will fill faster or slower depending on sample conditions. If you specify unusual sample conditions at the time of project set-up, we can set the flow controller accordingly. (See Section 5.2 for a discussion of collecting a sample at elevation.) Mass flow controllers should not be utilized for source or process samples in which the collection point is under vacuum or pressure. Please discuss these specific non-standard field conditions with your Project Manager at the time of project set-up.

Table 3.2.3 Flow Rates for Selected Sampling Intervals (mL/min)

Sampling Interval (hrs)	**4 min.**	**0.5**	**1**	**2**	**4**	**8**	**12**	**24**
6 L Canister	NA	167	83.3	41.7	20.8	11.5	7.6	3.8
1 L Canister	167	26.6	13.3	6.7	-	-	-	-

Note: Target fill volumes for 6 L and 1 L canisters are 5,000 mL and 800 mL, respectively.

3.2.4 Final Canister Vacuum and Flow Controller Performance

For time-integrated sample collection using a mass flow controller, the final vacuum of a canister should ideally be approximately 5 in Hg or greater. The flow rate will remain constant as the canister fills and will start to decrease as the canister vacuum approaches

5 in Hg. At this point, the differential pressure between the canister and ambient air is not sufficient to maintain the set flow rate. Because of normal fluctuations in the flow rate due to changes in field temperature and pressure, the final vacuum typically ranges between 3 and 10 in Hg.

- **If the residual canister vacuum is greater than 10 in Hg** (i.e., more vacuum), the actual flow rate is lower than the set point and less sample volume is collected. When the canister is pressurized prior to analysis, the pressurization dilution will be greater than normal. This will result in elevated reporting limits.
- **If the residual canister vacuum is near ambient pressure** for a time-integrated sample, the canister filled faster than calibrated. Once the vacuum decreases below 5 in Hg, the flow rate begins to decrease from its set point. This scenario indicates that the sample is weighted toward the first portion of the sampling interval. The sampler cannot be certain the desired sampling interval was achieved before the canister arrived at ambient conditions. Although the actual sampling interval is uncertain, the canister still contains a sample from the site.

Table 3.2.4 Relationship between Final Canister Vacuum, Volume Sampled, and Dilution Factor (6 L Canister)

Final Vacuum (in Hg)	**0**	**2.5**	**5**	**7.5**	**10**	**12.5**	**15**	**17.5**	**20**
Volume Sampled (L)	6	5.5	5.4	5	4	3.5	3	2.5	2
Dilution Factor*	1.34	1.46	1.61	1.79	2.01	2.30	2.68	3.22	4.02

*Canister pressurized to 5 psig for analysis

$$\textbf{Final Reporting Limit} = \text{Method Reporting Limit} \times \text{Dilution Factor (Canister Pressurization)} \times \text{Dilution Factor (Sample Analysis)}$$

$$\textbf{Dilution Factor (Canister Pressurization)} = \frac{\text{Final Pressure}}{\text{Receipt Pressure}} = \frac{14.7\text{ psig} + \text{Final Pressure (psig)}}{14.7\text{ psig}\left[\dfrac{1\text{-Receipt Vacuum (in Hg)}}{29.9\text{ in Hg}}\right]}$$

3.2.5 Considerations for Integrated Sampling with Canisters

Collecting an integrated air sample is more involved than collecting a grab sample. Sampling considerations include verifying that the sampling train is properly configured, monitoring the integrated sampling progress, and avoiding contamination.

- **Avoid Leaks in the Sampling Train**: A leak in any one of these connections means that some air will be pulled in through the leak and not through the flow controller. (Follow the leak check step #4 in 3.2.6).
- **Verify Initial Vacuum of Canister:** See Section 3.1.1 for instructions on verifying initial canister vacuum. A separate gauge is not necessary as both the mass flow controllers and critical orifice flow controllers have built-in rough gauges.
- **Monitor Integrated Sampling Progress**: When feasible, it is a good practice to monitor the progress of the integrated sampling during the sampling interval. The volume of air sampled is a linear function of the canister vacuum. For example, when using a 24-hour mass flow controller, at a quarter of the way (6 hours) into a 24-hour sampling interval, the canister should be a quarter filled (1.25 L) and the gauge should read approximately 6 in Hg lower than

the starting vacuum (~22 in Hg). More vacuum indicates that the canister is filling too slowly; less vacuum means the canister is filling too quickly. If the canister is filling too slowly, a valid sample can still be collected (see Section 3.2.4). If the canister is filling too quickly because of a leak or incorrect flow controller setting, corrective action can be taken. Ensuring all connections are tight may eliminate a leak. It is possible to take an intermittent sample; the time interval need not be continuous.

- **Avoid Contamination**: Flow controllers should be cleaned between uses. This is done by returning them to the laboratory.
- **Caution When Sampling in Extreme Temperatures**: Field temperatures can affect the performance of the mass flow controllers. Laboratory studies have shown that flow rates can increase slightly with decreasing temperatures. A flow rate increase of approximately 10% is expected when sampling at field temperatures of 5 to 10°C.

3.2.6 Step-by-Step Procedures for Integrated Sampling

These procedures are for a typical ambient air sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, and flow controller)
2. Make sure you include a 9/16” and 1/2” wrench in your field tool kit.
3. Verify the gauge is working properly
4. Verify the initial vacuum of canister (section 3.1.1)

When ready to sample:

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove brass cap from canister.
3. Attach flow controller to canister. The flow controller is securely attached if the flow controller body does not rotate.
4. Place the brass cap at the end of the flow controller creating an air tight train, and quickly open and close the canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady.
5. Once the sample train is airtight remove the brass cap from the flow controller and open the canister valve a ½ turn.
6. Monitor integrated sampling progress periodically.
7. Verify and record final vacuum of canister (simply read built-in gauge).
8. When sampling is complete, close valve by hand tightening knob clockwise.
9. Detach flow controller and replace brass cap on canister.
10. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).
11. Return canisters and associated media in boxes provided. **Failure to return all of the provided equipment will result in a replacement charge as outlined in the media agreement.**
12. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).
13. Place chain-of-custody in box and retain pink copy.
14. Tape box shut and affix custody seal at each opening (if applicable).
15. Ship accordingly to meet method holding times.

3.3 Soil Gas Sample Collection

Canisters can be used for the collection of soil vapor by attaching the sampling train to the soil gas probe. Typically, a critical orifice flow controller is used to minimize the applied vacuum in order to minimize partitioning of VOCs from the soil or pore water to the soil vapor. Additionally, lower flow rates help to minimize the intrusion of ambient air into the soil vapor probe. In general, time-integration is not required for soil gas samples; however, there may be exceptions to this rule of thumb. For example, some regulatory guidance documents recommend concurrent indoor air and sub-slab soil vapor collection over a

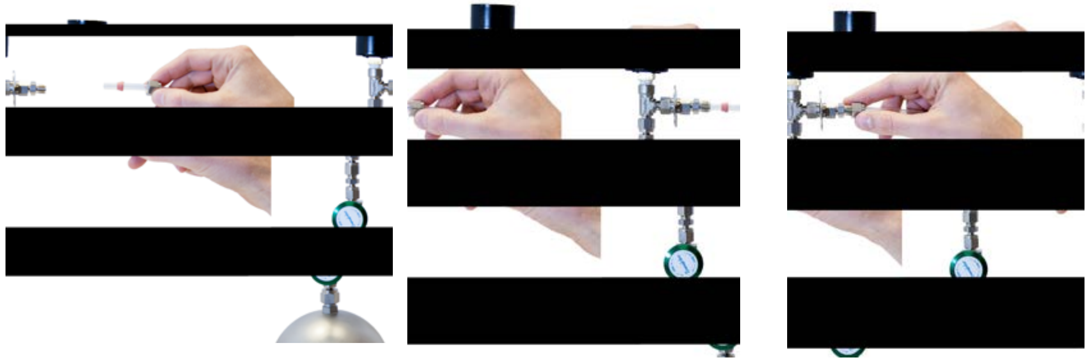
24-hour period. This means that a mass flow controller calibrated for a 24-hour sample would be required for the sub-slab as well as the indoor air sample.

3.3.1 Canister to probe connection – Tubing

Collection of a soil gas sample requires the use of tubing to connect the soil gas probe to the sample train. Teflon FEP tubing is recommended based on its low background and its inertness. Alternative tubing can be used if shown to meet data quality objectives. Please note that Low Density Polyethylene or flexible Tygon tubing is not recommended due to VOC adsorption during sample collection. Teflon tubing is provided by the laboratory upon request at the time of order. A charge based on the length will be assessed. It is important to store the tubing away from VOC sources during storage and transport to the site to minimize contamination.

3.3.2 Canister to probe connection –Fittings

To connect the tubing to the canister sampling train, a Swagelok fitting and a pink ferrule are used. The position of the ferrule is key to ensure the fitting is securely connected to the canister. See the figure below for the correct positioning and connection. The pink ferrule is flexible and cannot be over-tightened.



3.3.3 Leak Check Compounds Considerations

To determine whether ambient air is introduced into soil gas sample, a leak check may be used. Leak check compounds may be liquid or gaseous tracers. Liquid compounds are challenging to use effectively in the field and can be introduced into the sample due to improper handling in the field, erroneously indicating a leak in the sampling train. Liquid tracers such as isopropanol should never be directly applied to connections in the sampling train. Rather, the liquid is carefully applied to a cloth and placed near the connection or on the ground next to the probe. Great care must be used in the field to insure the liquid tracer is not handled during sampling train assembly or disassembly. Even a trace amount of a liquid tracer on a glove used to replace a canister brass cap can contaminate the sample. Liquid leak check compounds can interfere with the analytical runs, and even small leaks may result in analytical dilution and raised reporting limits when measuring ppbv target compound levels.

Gaseous tracers such as helium are typically used with shroud placed over the sampling equipment and/or borehole. To quantify the leak, the concentration of the tracer gas in the shroud should be measured.

Specify the leak check compound planned for your soil gas sampling event and record on the COC.

3.3.4 Step-by-Step Procedures for Soil Vapor Sampling

These procedures are for a typical soil vapor sampling application; actual field conditions and procedures may vary. Please consult your specific regulatory guidance for details.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, tubing, fittings, and flow controller).
2. Make sure you include a 9/16" and 1/2" wrench in your field tool kit.
3. Verify the gauge is working properly.
4. Verify the initial vacuum of canister.

Prior to vapor collection:

- **Purge tubing adequately**. A long length of tubing has significant volume of "dead air" inside. Without purging, this air will enter the canister and dilute the sample. Consider using a handheld PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing. A standard rule of thumb is to utilize 3 purge volumes prior to sample collection. However, under certain circumstances, purge volumes of 1 to 10 may be appropriate. Please review your regulatory guidance and your site specific conditions in determining the appropriate purge volumes.
- **Don't sample water**. If moisture is visible in the sample tubing, the soil gas sample may be compromised. Soil gas probes should be at an appropriate depth to avoid reaching the water table. Additionally, subsurface vapor should not be collected immediately after measurable precipitation.

When ready to sample:

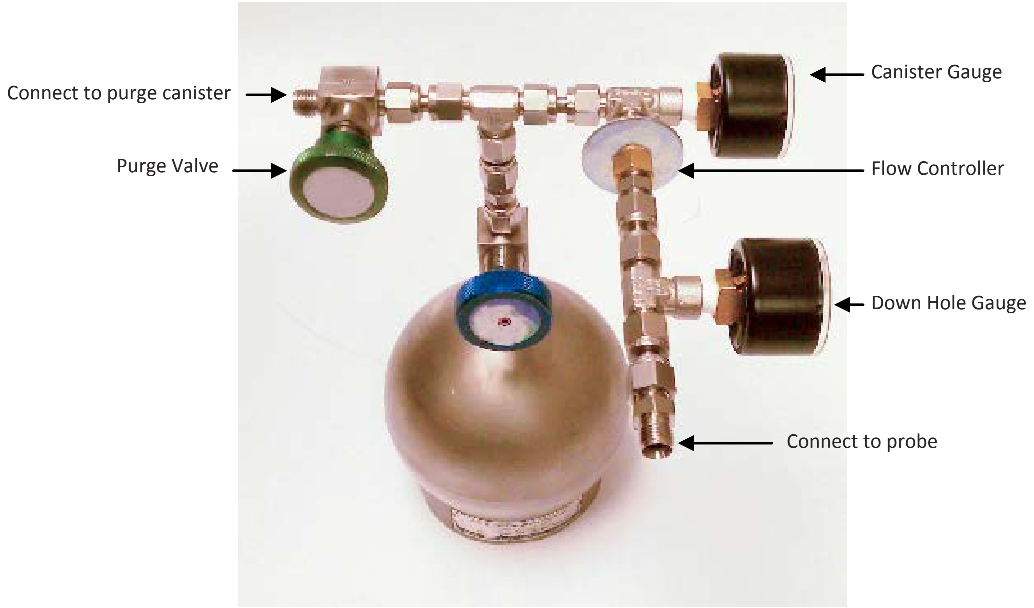
1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove brass cap from canister.
3. Attach flow controller to canister if needed. The flow controller is securely attached if the flow controller body does not rotate. (Note: The frit-press flow controller and 1 L canister may be pre-assembled by the laboratory.)
4. Place the brass cap at the end of the flow controller creating an air tight train, and quickly open and close the canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady.
5. Once the sample train is airtight remove the brass cap from the flow controller and attach the probe tubing to the flow controller using the pink ferrule and Swagelok nut. (See 3.3.2 for proper positioning of the ferrule.)
6. Once the probe line has been purged and appropriate leak check measures have been implemented, open the canister valve a ½ turn.
7. Verify and record final vacuum of canister (simply read built-in gauge).
8. When canister fills to the desired end vacuum, close valve by hand tightening knob clockwise.

   Please note: Some projects require residual vacuum of approximately 5 in Hg at the end of sample collection even if time-integrated samples are not required. The residual vacuum serves to provide a check of the integrity of the canister during transport to the laboratory to insure no leaks occurred during shipment. A field vacuum reading similar to the lab receipt vacuum reading demonstrated that no leak occurred.

9. Detach tubing and flow controller and replace brass cap on the canister.
10. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).
11. Return canisters and associated media in boxes provided. **Failure to return all of the provided equipment will result in a replacement charge as outlined in the media agreement.**
12. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).
13. Place chain-of-custody in box and retain pink copy
14. Tape box shut and affix custody seal at each opening (if applicable)
15. Ship accordingly to meet method holding times

3.4.4 Collecting Soil Gas Samples with Sampling Manifolds

If required, Eurofins Air Toxics can provide a sampling manifold to assist with leak checking the sampling train, purging the sampling line, and monitoring the vacuum applied to the soil gas bore hole during sample collection. The manifold is shown below:



The 'Down Hole Gauge', located prior to the flow restrictor, is a vacuum gauge that monitors the vacuum applied to the soil gas probe. Because this is not a flow meter but a measure of pressure/vacuum, the gauge should read at zero if there is sufficient flow from the soil. If the gauge begins to read a vacuum, then the flow is being restricted. Low flow, high vacuum conditions can be encountered when sampling in low permeability soil. The 'Canister Gauge', in line after the flow controller and prior to the purge canister, is a vacuum gauge that indicates to the sampler whether or not the canister is filling properly at the expected rate. This setup enables the sampler to evaluate the lithologic conditions at the site and determine if a valid soil gas sample is being taken. Finally, when duplicate samples are required, the manifold can be used as a duplicate sampling "T" by simply replacing the purge canister with another sample canister.

There are several options to use as a purge vacuum source to attach to the purge valve connection – a Summa canister, sampling pump or sampling syringe. The below instructions assume a Summa canister will be used as a purge volume source since other sources are generally provided by the client.

When ready to sample:

Leak Check Test

1. Confirm that canister valves are closed (knob should already be tightened clockwise).
2. Remove brass caps from both the sample canister and the purge canister. (Unless using certified media, there is no difference between the two).
3. Attach manifold center fitting to sample canister.
4. Attach purge canister to the Purge Valve end of the manifold by attaching provided Teflon tubing and compression fittings.
5. Confirm that there is a brass cap secured at the inlet of the manifold creating an air tight train, make sure the manifold valve above the purge canister is open, and quickly open and close the purge canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady.

Purging

6. Once the sample train is airtight remove the brass cap from the manifold inlet, connect the tubing from the sample port using a compression fitting and open the purge canister valve, 1/2 turn.
7. Monitor integrated sampling progress periodically. *Please note, because the purge canister is inline after the flow restrictor the line will not purge faster than at a rate of 167 ml/min.

8. Once the desired purge volume is met close both the manifold valve and the purge canister valve by hand tightening the knobs clockwise.

9. If sampling at multiple locations, the purge canister can be disconnected from the manifold and used to begin purging the next sample location without compromising the sample train.

Sampling

10. The line is now ready to be sampled. Open the sample canister valve and monitor sampling progress periodically.

11. When the sampling is complete close the valve and replace the brass cap on the canister; record final vacuum of canister (simply read built-in gauge).

12. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).

13. Return canisters in boxes provided and all parts of the soil gas manifold. **Unreturned media will result in a replacement charged assessed as described in the media agreement**.

14. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).

15. Place chain-of-custody in box and retain pink copy.

16. Ship accordingly to meet method holding times.

Section 4.0 Sampling with Bags

This section provides a description of the types of air sampling bags, selecting the right bag for your application, practical considerations for sampling, and step-by-step instructions for collecting a grab sample. Photographs illustrate the correct way to assemble the various sampling components.

4.1 Introduction to Bags

Air sampling bags are containers used to collect whole air samples for landfill gas, soil gas and stationary source applications. Bags can be constructed from various materials which can differ in terms of stability characteristics and cleanliness. In general, air sampling bags are best suited for projects involving analysis of compounds in the ppmv range. They can be used to collect sulfur compounds, but only if the fittings are non-metallic (e.g., polypropylene, Teflon®, or Nylon).

Air sampling bags are equipped with a valve that allows for filling. Sample collection requires a pressurized sampling port, a low flow rate pump or a lung sampler. The bag expands as the vapor sample is pulled in. When the target volume of the sample is collected, the valve is closed and the bag is returned to the laboratory. Bag materials should be selected based on the specific application. Common air sampling bags include Tedlar film and FlexFoil. Eurofins Air Toxics maintains a limited inventory of air sampling bags in 1 L, 3 L and 5 L volumes.

4.1.1 Tedlar® Film

Tedlar® is a trade name for a polyvinyl fluoride film developed by DuPont Corporation in the 1960's. This patented fluoropolymer has been used in a wide variety of applications including protective surfacing for signs, exterior wall panels and aircraft interiors. Tedlar® film is tough yet flexible and retains its impressive mechanical properties over a wide range of temperatures (from well below freezing to over 200°F). Tedlar® exhibits low permeability to gases, good chemical inertness, good weathering resistance and low off-gassing.

Tedlar® bags may be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, sulfur compounds, atmospheric and biogenic gases and many other classes of compounds. Compounds with low vapor pressures such as Naphthalene are not appropriate for Tedlar bags as recovery is very low even under short sample storage times. Low molecular compounds such as Helium and Hydrogen can diffuse through the Tedlar bag material resulting in poor storage stability.

4.1.2 Tedlar® Bag Suppliers and Re-use

Compounds commonly detected from analyzing new Tedlar® bags include methylene chloride, toluene, acetone, ethanol, 2-propanol, phenol, and dimethylacetamide. While levels of these common artifacts are typically in the ppbv range, the cleanliness of bags can vary significantly between vendors, and purchasing bags directly from an unknown vendor should be avoided. Once the Tedlar® bag is used for sample collection, the surface has been exposed to moisture and possible VOCs. It may irreversibly adsorb many VOCs at the low ppbv level. A series of purges with certified gas may not remove the VOCs from the surface. Consider your data quality objectives to determine whether re-using Tedlar® bags is appropriate.

4.1.3 Hold Time for a Tedlar® Bag

The media hold time for a Tedlar® bag is indefinite if stored out of sunlight in a cool, dry location.

The sample hold time to analysis varies by method and compound. See Table 4.1.3 for recommended sample storage times for commonly requested parameters.

Table 4.1.3 Recommended Maximum Sample Storage Times for Tedlar® Bags

Analytical Method	Chemical Class	Storage Time
ASTM D5504	Suite of sulfur compounds including Reactive Sulfur compounds (Hydrogen sulfide, Methyl mercaptan)	24 hours
ASTM D1946 ASTM D1945	Atmospheric and natural gases: CO, CO2, CH4, C2-C5 hydrocarbons (He and H_2 not recommended)	Up to 3 days
Modified TO-14A, TO-15, TO-3, TO-12	Volatile Organic Compounds (VOCs)	Up to 3 days

4.1.4 FlexFoil Bags

FlexFoil bags are made from an opaque and flexible material with 4-ply construction resulting in high physical strength to minimize rupture and leakage and low permeability to provide good stability for low molecular weight compounds. FlexFoil bags are ideal for target compounds such as Hydrogen and Helium and can be used for the suite of atmospheric and natural gas components. While the reactive sulfur compounds, Hydrogen Sulfide and Methyl Mercaptan, show good stability over 24 hours in FlexFoil bags, other sulfur compounds demonstrate low recovery. Table 4.1.4 summarizes the compounds and the hold times amenable to FlexFoil bags.

Table 4.1.4 Recommended Maximum Sample Storage Times for FlexFoil Bags

Analytical Method	Chemical Class	Storage Time
ASTM D5504	Hydrogen sulfide, Methyl mercaptan only Not recommended for full sulfur list.	24 hours
ASTM D1946 ASTM D1945	Atmospheric and natural gases Full List	Up to 3 days

4.2 Air Bag Sampling

Using a bag to collect an air sample normally involves "active" sampling, unlike an evacuated canister that can be filled "passively" by simply opening the valve. There are two methods commonly used to fill a bag: a pump or a lung sampler.

- **Sampling with a Pump**: The most common method for filling a bag is to use a small pump with low flow rates (50-200 mL/min) and tubing to fill the bag. Eurofins Air Toxics, Inc. does not provide pumps but pumps may be rented from equipment providers or purchased from manufacturers such as SKC or Gilian.
- **Sampling with a Lung Sampler**: A "lung sampler" may be used to fill a bag. Although a little more complicated than simply using a pump, the main advantage to using a lung sampler to fill a bag is that it avoids potential pump contamination.

A bag with attached tubing is placed in a small airtight chamber (even a 5-gallon bucket can work) with the tubing protruding from the chamber. The sealed chamber is then evacuated via a pump, causing the bag to expand and draw the sample into the bag through the protruding tube. The sample air never touches the wetted surfaces of the pump. Eurofins Air Toxics does not provide lung samplers, but they can be rented from equipment suppliers or purchased by manufacturers such as SKC Inc.

4.2.1 Considerations for Bag Sampling

Some considerations for collecting a bag sample:

- **Fill the bag no more than 2/3 full**: Allow for possible expansion due to an increase in temperature or decrease in atmospheric pressure (e.g., the cargo hold of a plane)
- **Keep the Tedlar® bag out of sunlight**: Tedlar® film is transparent to ultraviolet light (although opaque versions are available) and the sample should be kept out of sunlight to avoid any photochemical reactions
- **Protect the bag**: Store and ship the bag samples in a protective box at room temperature. An ice chest may be used, but DO NOT CHILL
- **Fill out the bag label**: It is much easier to write the sample information on the label before the bag is inflated. Make sure to use a ball-point pen, never a Sharpee or other marker which can emit VOCs.
- **Provide a "back-up" bag**: Consider filling two bags per location in the rare occasion that a defective bag deflates before analysis. The "hold" sample does not need to be documented on the Chain-of-Custody and should have an identical sample ID to the original sample indicating that it is the "hold" sample
- **Avoid Contamination**: Care should be taken to avoid contamination introduced by the pump or tubing. Begin sampling at locations with the lowest compound concentrations (e.g., sample the SVE effluent before the influent). Decontaminate the pump between uses by purging with certified air for an extended period; better yet, use a lung sampler. Use the shortest length possible of Teflon® tubing or other inert tubing. DO NOT REUSE TUBING. If long lengths of tubing are used, consider purging the tubing with several volumes worth before sampling. If you are concerned about sampling for trace compounds, you shouldn't be using a Tedlar® bag (see Section 1.2)
- **Don't Sample Dangerous Compounds in a Bag**: Do not ship any explosive substances, radiological or biological agents, corrosives or extremely hazardous materials to Eurofins Air Toxics. Bag rupture during transit to the laboratory is possible and the sampler assumes full liability.

4.2.2 Step-by-Step Procedures for Bag Sampling (Pump)

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

Before you get to the field:

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

When ready to sample:

3. Purge sample port.
4. Attach new Teflon® tubing from sample port or probe to low flow rate pump.
5. Purge tubing.
6. Fill out bag sample tag.
7. Attach additional new Teflon® tubing from the pump outlet to the bag valve.
8. Open bag valve.
9. Collect sample (FILL NO MORE THAN 2/3 FULL).
10. Close bag valve by hand tightening valve clockwise.
11. Return filled bags in a rigid shipping container (DO NOT CHILL).
12. Fill out chain-of-custody and relinquish samples properly.
13. Place chain-of-custody in box and retain pink copy.

14. Tape box shut and affix custody seal (if applicable) across flap.
15. Ship first overnight or priority overnight to meet method holding times.

> Expedite delivery of air sampling bags to the laboratory for analysis.

Section 5.0 Special Sampling Considerations

This section provides recommendations for the collection of field QC samples such as field duplicates. Considerations for sampling at altitude, sampling SVE ports and using sample cylinders are presented.

5.1 Field QC

To measure accuracy and precision of the field activities, project plans often include field duplicates, field blanks, ambient blanks, trip blanks and/or equipment blanks.

5.1.1 Field Duplicate

A field duplicate is a second sample collected in the field simultaneously with the primary sample at one sampling location. The results of the duplicate sample may be compared (e.g., calculate relative percent difference) with the primary sample to provide information on consistency and reproducibility of field sampling procedures. Due to the nature of the gas phase, duplicate samples should be collected from a common inlet. The configuration for collecting a field duplicate includes stainless steel or Teflon® tubing connected to a Swagelok "T". If integrated samples are being collected and the sample duration is to be maintained, the sample train should be assembled as follows: each canister should have a flow controller attached, then the duplicate sampling T should be attached to the flow controllers. If the collection flow rate from the sample port is to be maintained then the duplicate sampling T should be connected to the canisters; then the flow controller is connected to the inlet of the sampling T.

Alternatively, if the project objective is to assess spatial or temporal variability, then field duplicates may be deployed in close proximity (ambient air sampling) or samples may be collected in succession (soil vapor).

5.1.2 Field Blank

A field blank is a sample collected in the field from a certified air source. Analysis of the field blank can provide information on the decontamination procedures used in the field. Clean stainless steel or Teflon® tubing and a certified regulator should be used. It is imperative that individually certified canisters (the sample canister and the source canister/cylinder, if applicable) be used to collect a field blank.

5.1.3 Ambient Blank

An ambient blank is an ambient air sample collected in the field. It is usually used in conjunction with soil gas or stationary source (e.g., SVE system) sampling. Analysis of the ambient blank can provide information on the ambient levels of site contaminants. It is recommended that an individually certified canister be used to collect an ambient blank.

5.1.4 Trip Blank

When sampling for contaminants in water, the laboratory prepares a trip blank by filling a VOA vial with clean, de-ionized water. The trip blank is sent to the field in a cooler with new sample vials. After sampling, the filled sample vials are placed back in the cooler next to the trip blank and returned to the laboratory. Analysis of the trip blank provides information on decontamination and sample handling procedures in the field as well as the cleanliness of the cooler and packaging.

When sampling for compounds in air, a trip blank provides little, if any, of the information above. A trip blank canister can be individually certified, evacuated, and sent to the field in a box with the sample canisters. Since the valve is closed and the brass cap tightened, it is questionable if the trip blank canister contents are ever "exposed" to sampling conditions. The trip blank VOC concentrations essentially provide information regarding the cleanliness and performance of the trip blank canister. Results cannot necessarily be applied to the associated field sample canisters accompanying the trip blank. **Eurofins Air Toxics does not recommend collecting a trip blank for air sampling.**

5.2 Considerations for Sampling at Altitude

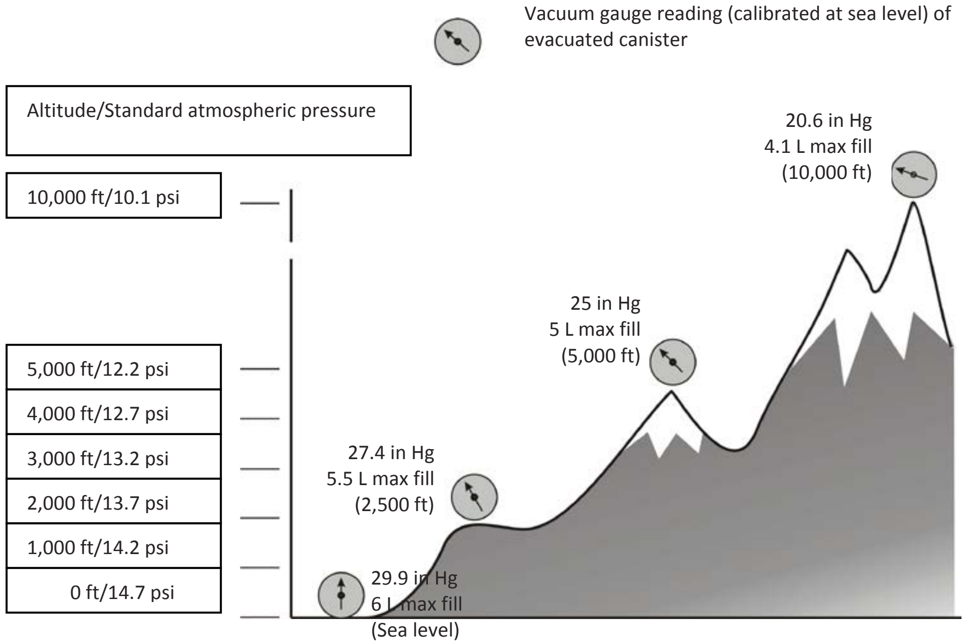
Sampling at altitudes significantly above sea level is similar to sampling a stationary source under vacuum in that target fill volumes may be difficult to achieve. The figure to the right illustrates the relationship between increasing altitude and decreasing atmospheric pressure. Ambient conditions in Denver at 5,000 ft altitude are quite different from ambient conditions at sea level. Canister sampling is driven by the differential pressure between ambient conditions and the vacuum in the canister.

There is less atmospheric pressure in Denver and 5 L is the maximum fill volume of standard air assuming the canister is allowed to reach ambient conditions (i.e., final gauge reading of 0 in Hg). Theoretically, if you sample high enough (e.g., in space), no sample would enter the canister because there is no pressure difference between the evacuated canister and ambient conditions. To fill a canister to 6 L in Denver, you would need to use an air pump.

Sampling at altitude also affects gauge readings. The gauges supplied by Eurofins Air Toxics, Inc. (see Section 2.2.4) measure canister vacuum relative to atmospheric pressure and are calibrated at approximately sea level. Before sampling at altitude, the gauges should be equilibrated (see Section 3.1). But even after equilibrating the gauge, verifying the initial vacuum of a canister at altitude is misleading. In Denver at 5,000 ft, expect the gauge to read 25, not 29.9 in Hg. You do not have a bad canister (i.e., leaking or not evacuated properly). The canister is ready for sampling and the gauge is working properly.

Rule of Thumb: For every 1,000 ft of elevation, the gauge will be off by 1 in Hg and the fill volume will be reduced by 1/5 L.

If you have questions about sampling at altitude, please call your Project Manager at 800-985-5955.



5.3 Considerations for SVE/LFG Collection System Sampling

There are some additional sampling considerations for collecting grab samples (canister or bag) from a Soil Vapor Extraction (SVE) system or landfill gas (LFG) collection system. The general challenge with these samples arises from the need to employ a length of tubing to direct the landfill gas or process air to the canister or bag. Tubing introduces the potential for contamination and diluting the sample.

- **Use inert tubing**. Teflon® tubing is recommended. Tubing with an outer diameter of ¼" works best with the fittings on the particulate filter. (See Section 3.3.1).
- **Do not reuse tubing**.
- **Purge tubing adequately**. A long length of tubing has significant volume of "dead air" inside. Without purging, this air will enter the canister and dilute the sample. Consider using a handheld PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing.
- **Avoid leaks in the sampling train**. Leaks of ambient air through fittings between pieces of the sampling train (e.g., tubing to particulate filter) will dilute the sample.
- Always use compression fittings for all connections; never use tube in tube connections.
- **Purge the sample port**. A sample port on an SVE system or LFG collection system can accumulate solids or liquids depending upon the location of the port in the process and the orientation of the port. An influent sample port located upstream of a filter or moisture knock-out can be laden with particulates or saturated with water vapor. Heavy particulate matter can clog the particulate filter and foul the canister valve. It is important to prevent liquids from entering the canister. A sample port oriented downward may have liquid standing in the valve. Purge the sample port adequately before connecting the sampling train.
- **Consider the effects of sampling a process under vacuum or pressure**. When collecting a grab sample from a stationary source such as an SVE system or LFG collection system, some sample ports may be under vacuum or pressure relative to ambient conditions. When the sample port is under vacuum, such as the header pipe from the extraction well network, it may be difficult to fill the canister with the desired volume of sample. A vacuum pump may be used to collect a canister grab sample from a sample port under considerable vacuum. See the related discussion on sampling at altitude in Section 5.2. When the sample port is under pressure, such as the effluent stack downstream of the blower and treatment system, you may inadvertently pressurize the canister. Only a DOT-approved sample cylinder should be used to transport pressurized air samples (see Section 5.4). Under no circumstances should a Summa canister be pressurized more than 15 psig. Bleed off excess pressure by opening the valve temporarily while monitoring the canister with a pressure gauge.

5.4 Considerations for Sample Cylinder Sampling

Sample cylinders, also known as "sample bombs", are DOT-approved, high pressure, thick-walled, stainless steel cylinders with a valve at each end. They were intended for collecting a pressurized sample for petroleum gas applications. Sample cylinders differ from sample canisters in that they do not have a Summa-passivated interior surface and are not evacuated prior to shipment. Sample cylinders are not suitable for analysis of hydrocarbons at ppbv levels. Sample cylinders can be used for analysis of natural gas by ASTM D-1945 and calculation of BTU by ASTM D-3588. Eurofins Air Toxics assumes that clients requesting a sample cylinder have a pressurized process and sample port with a built-in gauge and 1/4" Swagelok fitting to attach to the sample cylinder. Eurofins Air Toxics has a limited inventory of 500 mL sample cylinders that are particularly suited for landfill gas collection systems (i.e., LFG to energy applications). This section provides step-by-step procedures for sampling with a sample cylinder.

> Inform the lab during project set up if hazardous samples (e.g. high Hydrogen Sulfide concentrations) will be collected to verify the lab can safely handle the samples.

Step-by-Step Procedures for Sample Cylinder Sampling

These procedures are for a typical stationary source sampling application and actual field conditions; procedures may vary. Follow all precautions in the site Health and Safety Plan when dealing with a pressurized sample port and sample cylinder. Follow required DOT guidelines for packaging and shipping.

1. Verify contents of the shipped package (e.g., chain-of-custody, sample cylinder, particulate filter).
2. Verify that gauge on sample port is working properly.
3. Purge sample port.

4. Remove brass caps on either end of cylinder.
5. Attach particulate filter to upstream valve.
6. Attach filter/cylinder assembly directly to the sample port.
7. Open both valves 1/2 turn.
8. Allow sample air to flow through sample cylinder (approximately 10 L for a 500 mL cylinder).
9. Close downstream valve of sample cylinder by hand tightening knob clockwise.
10. Allow sample cylinder to pressurize to process pressure (max 100 psig).
11. Close upstream valve of sample cylinder and sample port.
12. Detach filter/cylinder assembly from sample port and remove particulate filter.
13. Replace brass caps.
14. Fill out sample cylinder sample tag.
15. Fill out chain-of-custody and relinquish samples properly.
16. Include the chain-of-custody with the samples and retain pink copy.
17. Pack, label, and ship according to DOT regulations.

Follow DOT regulations for packaging and shipping hazardous samples.

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