PIH Olympia, LLC

REVISED WORK PLAN FOR ADDITIONAL VAPOR INTRUSION/INDOOR AIR INVESTIGATON

Former Phoenix Inn Site

415 Capitol Way North, Olympia, Washington

November 07, 2017

REVISED WORK PLAN FOR ADDITIONAL VAPOR INTRUSION/INDOOR AIR INVESTIGATION

415 Capitol Way North, Olympia, Washington

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ACRONYMS AND ABBREVIATIONS

APN	assessor parcel number
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CUL	cleanup level
EDB	ethylene dibromide
EPA	Environmental Protection Agency
HVAC	heating, ventilation, air conditioning
$\mu g/m^3$	micrograms per cubic meter
MTBE	methyl tertiary butyl ether
mL/min	milliliters per minute
MTCA	Model Toxics Control Act
PVI	petroleum vapor intrusion
RCW	Revised Code of Washington
RSL	Regional Screening Level
SDS	safety data sheet
SIM	Selected Ion Method
SVP	soil vapor probe
SW	southwest
TBA	tert-butyl alcohol
TGI	technical guidance instructions
TMB	trimethylbenzene
VCP	Voluntary Cleanup Program
WAC	Washington Administrative Code
1,2-DCA	1,2-dichloroethane

1 INTRODUCTION

On behalf of PIH Olympia, LLC, Arcadis U.S., Inc. (Arcadis) has prepared this Revised Work Plan for Additional Vapor Intrusion/Indoor Air Investigation at the former Phoenix Inn site located at 415 Capitol Way North, Olympia, Washington (Work Plan). This Work Plan incorporates comments to the Work Plan dated October 20, 2017 from Washington State Department of Ecology (Ecology) in an email correspondence from Ecology dated October 27, 2017.

The 1.38-acre property located at this address (assessor parcel number [APN] 78500100300) is referred to as the “Subject Property”. The Work Plan describes additional indoor air and sub-slab vapor investigative and technical reporting activities requested by Ecology in a letter dated September 26, 2017. A copy of the September 26, 2017 letter is included as **Appendix A.**

The September 26 letter was in response to Ecology being notified by Arcadis on September 21, 2017 of the detection of naphthalene in indoor air at concentrations above the Model Toxics Control Act (MTCA) Method B air cleanup level (CUL) of 0.0735 micrograms per cubic meter ($\mu g/m^3$) inside DoubleTree room numbers 132, 142, and 146. The September 26 letter requested a Work Plan by October 24, 2017 to *“sufficiently evaluate the nature and extent of naphthalene in shallow soil-vapor and indoor air, including the temporal variability of this constituent along with a strategy for appropriately monitoring and mitigating this potential threat.”*

1.1 General Site Information

The Subject Property is located between the East and West Bay of Budd Inlet, north of the mouth of the Deschutes River at 415 Capitol Way North in Olympia, Washington and is bordered to the north by A Avenue, to the east by Capitol Way North, to the south by Thurston Avenue, and to the west by Columbia Street Northwest (Figures 1 and 2). The Site is defined as all areas where hazardous substances originating from the Subject Property have come to be located. Currently available data suggest that petroleum hydrocarbon-affected soil and groundwater do not extend beyond the Subject Property boundary at levels above applicable MTCA CULs. The Subject Property is currently occupied by a DoubleTree Hotel and associated parking. The current three-story building, constructed in 1999 and retrofitted in 2013, occupies the eastern portion of the parcel and an asphalt-paved parking lot occupies the western portion. The hotel includes a swimming pool, spa, fitness center, business center, bar/lounge, meeting rooms, a retail shop, and hotel/guest laundry facilities. Site information includes:

Site Name:	**Former Phoenix Inn**
Facility/Site Identification Number:	1571525
Cleanup Site Identification Number:	5257
Voluntary Cleanup Program (VCP) Number:	SW1582
Property Specifications:	
Address:	415 Capitol Way North, Olympia, Washington

Location:	Northwest corner of the intersection of Thurston Avenue and Capitol Way North
APN:	78500100300
Latitude/Longitude:	47.047931, -122.902364
Public Land Survey System:	NE ¼ NW ¼ Section 47, SE ¼ SW ¼ Section 42 Township 18 North Range 2 West of Willamette Meridian
Acres:	1.38

1.2 Objectives

The activities described in this Work Plan are intended to address Ecology's request for further sub-slab vapor and indoor air investigation as described in the September 26, 2017 letter. The objectives of this work are primarily twofold: (1) to evaluate the nature and extent of naphthalene in shallow soil-vapor and indoor air, including the temporal variability of this constituent and (2) to acquire information to inform a strategy to monitor and mitigate potential risks associated with naphthalene to hotel workers and guests, as appropriate. The Work Plan also considers and addresses the following Ecology-requested elements:

- Effect of the facility's heating, ventilation, and air conditioning (HVAC) system on naphthalene concentrations associated with building pressurization/depressurization and air-exchange cycles.
- Collection of indoor-air samples from additional rooms besides rooms 132, 142, and 146 to evaluate spatial variability in naphthalene indoor air concentrations.
- Evaluation of potential preferential vapor-pathways (if identified) in rooms exhibiting elevated concentrations of naphthalene in indoor air.
- Evaluation of sub-slab concentrations of naphthalene in soil-vapor immediately beneath the facility to assist in identifying potential source area(s) of this constituent.

An additional objective is to establish Site-specific MTCA Method B screening levels (SLs) for air based on an exposure scenario appropriate for hotel workers and guests to inform future risk management decisions. The term SL is used rather than CUL because MTCA does not consider commercial exposure scenarios to establish Method B air CULs.

1.3 Regulatory Context

The activities described in this Work Plan will be performed as an independent action under Ecology's Voluntary Cleanup Program (VCP) in accordance with the substantive requirements of MTCA, Chapter 70.105D Revised Code of Washington (RCW), and its implementing regulations, Chapter 173-340 Washington Administrative Code (WAC). This Work Plan incorporates applicable guidance from Ecology, including:

- Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action (Ecology 2016).

- Ecology Implementation Memorandum No. 18, Draft Petroleum Vapor Intrusion (PVI): Updated Screening Levels, Cleanup Levels, and Sampling Considerations (Ecology 2017).

2 PREVIOUS INDOOR AIR INVESTIGATIONS

Multiple phases of soil and groundwater investigations were performed at the Site beginning in 1993 to evaluate the nature and extent of petroleum impacts from historic activities at the Subject Property and neighboring properties. Previous environmental investigations are summarized in the Arcadis Work Plan for Additional Site Characterization dated April 10, 2017 (Arcadis 2017), and are not repeated herein. Arcadis performed an initial assessment of indoor air at the Subject Property on June 26, 2017, with a follow-up sampling for naphthalene on September 8, 2017. Activities and results of the previous two indoor air sampling events are described below.

2.1 June Sampling Event

The initial June 26, 2017 air sampling event at the Subject Property was performed in accordance with a Work Plan for Additional Site Characterization dated April 10, 2017, and included collection of indoor air samples within three rooms (rooms 132, 142, and 146) and two outdoor air samples. Air samples were collected in 6-liter passivated canisters and were analyzed for naphthalene, benzene, toluene, ethyl benzene, and xylenes (BTEX), and other petroleum-related volatile organic compounds (VOCs), including ethylene dibromide (EDB), 1,2-dichloroethane (1,2-DCA), 1,2,4-trimethylbenzene (1,2,4-TMB), 1,3-butadiene, methyl tert-butyl ether (MTBE), and tert-butyl alcohol (TBA), using Environmental Protection Agency (EPA) Method TO-15. Air samples were also analyzed for methane using American Society of Testing and Materials (ASTM) Method D1946. All samples except the outside ambient air sample collected on the roof were collected over an 8-hour period with a laboratory-supplied flow controller. The ambient air sample on the roof was collected over an approximate 2-hour period because the flow controller was not functional. Samples were analyzed by TestAmerica Laboratories, Inc. (TestAmerica), an Ecology-accredited laboratory, located in Fife, Washington. Additionally, accessible utility vaults at the Subject Property were tested for potential explosive atmospheres using a calibrated lower explosive limit (LEL) meter.

Weather during the June 26, 2017 sampling event was mostly sunny, with a minimum temperature of 53 degrees Fahrenheit (F) and a high temperature of 71 degrees F (National Oceanic and Atmospheric Administration [NOAA] 2017a). Wind was from the southwest (SW) at approximately 8 miles per hour with visibility of approximately 10 miles (Weather Underground 2017).

Results of the June 26, 2017 sampling event for petroleum-related VOCs and LEL are summarized in **Tables 1 and 2**, respectively. Sample locations and results for petroleum-related VOCs and LEL are depicted on Figures **3 and 4**, respectively. Results were as follows:

- Concentrations of BTEX, 1,2-DCA, 1,2,4-TMB, MTBE, TBA, and 1,3-butadiene were either not detected above laboratory reporting limits or did not exceed the standard Method B CULs in samples from the 3 indoor and 2 outdoor sampling locations.

- Naphthalene was detected in the method blank at an estimated concentration of 0.0658 µg/m³, thereby making the naphthalene data suspect and unusable. Resampling for naphthalene using EPA Method TO-17 was recommended by Arcadis and approved by Ecology (see Section 2.2).
- Ethylene dibromide (EDB) was detected above the method detection limit in one sample (room 146), and below the laboratory reporting limit of 0.054 µg/m³. EDB was not detected in any of the other air samples and has not historically been detected in groundwater at the Site. Additionally, EDB was not detected in any of the soil samples collected at the site during the three monitoring well installations in August 2017. No other EDB soil analytical data is available. The laboratory report for the soil samples collected in August 2017 is included in **Appendix B**. Therefore, no future testing for EDB is proposed as part of this investigation.
- Methane concentrations in all indoor air samples were several orders of magnitude below the lower explosive limit (LEL) of 5-percent. The maximum concentration of methane detected in indoor air was 0.00036 percent, which is similar to background concentrations of methane in ambient outside air in the parking lot (0.00035 percent).
- No potentially explosive atmospheres were identified in any of the utility vaults. LEL readings in all utility vaults tested were below 10 percent of the lower explosive limit (e.g., below the LEL criteria for standard MTCA Method B CULS per WAC 173-340-750(C)(iii)).

2.2 September Sampling Event – Naphthalene Only

As discussed with Ecology, due to the detection of naphthalene in the laboratory method blank samples, the naphthalene results from the June 26, 2017 sampling event were deemed unsuitable and re-testing for naphthalene was conducted on September 8, 2017. The re-sampling event was approved by Ecology in an email correspondence dated September 7, 2017. Air sampling was not performed prior to September 8, due to concerns regarding the presence of heavy smoke in the ambient air during the July to early September 2017 timeframe from regional fires.

Weather at the time of sampling included light rain in the morning (prior to approximately 8 AM), followed by partial clouds and sun with temperatures ranging from 58 degrees F in the morning to 74 degrees F in the afternoon. Winds were from the SW at approximately 6 miles per hour with visibility of approximately 10 miles (NOAA 2017b, Weather Underground 2017).

Samples were collected at similar locations as the June 26, 2017 sampling event. Naphthalene was analyzed by Eurofins Air Toxics (Air Toxics), an Ecology-approved laboratory located in Folsom, California, using EPA Method TO-17. EPA Method TO-17 was selected as the preferred method for naphthalene analyses in consultation with Ecology and Air Toxics because of its lower reporting limit (note: TO-15 reporting limits are above the standard naphthalene MTCA B CUL) and because Air Toxics reported that EPA Method TO-17 is less prone to laboratory blank detections of naphthalene compared to EPA Method TO-15 Selected Ion Method (SIM).

Naphthalene was detected in all three indoor air samples at concentrations above the standard MTCA Method B CUL (0.0735 µg/m³), at concentrations of 0.19 µg/m³, 0.18 µg/m³, and 0.32 µg/m³, in rooms 132, 142, and 146, respectively.

3 PROPOSED FURTHER ACTIONS

To evaluate the nature and extent of potential petroleum hydrocarbons in indoor air, and meet the objectives described in Section 1.2, Arcadis will perform the following scope:

- Perform indoor air and sub-slab vapor testing within 21 days of approval by Ecology.
  A second round of sub-slab and indoor air testing will be performed approximately 90 to 120 days after the first event if the data from the first sampling event suggest that the vapor intrusion pathway is potentially complete (see Section 4). Results from the sampling event(s) will be compared to Site-specific MTCA B SLs, and mitigation will be undertaken as appropriate. The indoor air samples will be collected approximately 1 day prior to the sub-slab samples at each co-located sample location.
- Complete a building survey and review safety data sheets (SDS) for chemicals used by hotel for potential naphthalene.
- Review and tabulate available groundwater and soil analytical data for naphthalene (including soil analytical data from the three wells installed in August 2017 and the most recent groundwater sampling event conducted at the end of September 2017) and compare these data to Ecology SLs. Ecology does not currently provide soil screening levels that are protective of the vapor intrusion pathway and current regulatory guidance does not recommend modeling based on soil concentrations due to high variability.
- In consultation with Ecology, establish Site-specific MTCA Method B SLs per MTCA requirements.
- Evaluate and if warranted, adjust HVAC system in consultation with hotel maintenance staff to maximize air exchange.
- Inspect selected areas of the hotel in attempt to identify potential preferential pathways using visual observation and photoionization detector (PID) screening.
- Perform indoor air and sub-slab vapor testing. Two sampling events will be conducted to evaluate temporal variation in sub-slab and indoor air concentrations of naphthalene.
- Evaluate potential mitigation measures including but not limited to modifications of HVAC system, elimination of suspect products, and sub-slab depressurization.

3.1 Building Survey and Chemical Inventory

At least 1 week prior to conducting the indoor air/sub-slab sampling, Arcadis will complete a building survey and chemical inventory in accordance with the Ecology Draft Guidance for Evaluating Vapor Intrusion in Washington State: Investigation and Remedial Action to evaluate potential entry points for soil vapor migration and assess potential chemical background contributions. The building survey will include the use of a calibrated parts-per billion (ppb) range photo-ionization detector (PID) to identify background sources and preferential pathways that may be present and could contribute to indoor air concentrations.

Arcadis will coordinate with DoubleTree staff to perform a non-destructive survey of potential preferential pathways to indoor air from the subsurface. This survey will consist of accessing a limited number of rooms and common worker and guest areas and inspecting for cracks in the slab, if evident, and floor penetrations such as conduits, pipes, or sumps. Arcadis will document the results of the survey using a photo log and site plan marked with the surveyed areas and features identified.

As part of the above-mentioned chemical inventory, Arcadis will locate SDS to compare listed ingredients to those identified in indoor air samples. Naphthalene in products, if found, will be assessed against other lines of evidence as a potential source of concentrations in indoor air. If identified, preferential pathways and chemical background contributions will be removed and/or isolated prior to sampling to the extent practical.

3.2 Tier 1 Groundwater Data Evaluation

Consistent with Ecology's Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action, Arcadis will review the most current groundwater analytical data to identify wells where naphthalene concentrations exceed MTCA Method B CULs and/or groundwater SLs protective of the groundwater to indoor air pathway. These data will be used in conjunction with sub-slab vapor data to assess if the source of naphthalene in indoor air is likely from vapor intrusion or non-vapor intrusion sources (see Section 4).

3.3 Site-Specific Method B Screening Levels

Arcadis will perform a Site-specific risk assessment to establish Site-specific Method B SLs per MTCA requirements. The Site-specific risk assessment will include modification to the Method B air CUL equation 750-2 (carcinogens) default assumptions, including but not limited to the reasonable maximum exposure scenario or default exposure assumptions. The SLs will be based on a commercial exposure scenario appropriate for hotel workers and guests. The risk assessor will discuss exposure assumptions and proposed modifications to the standard Method B air CUL for naphthalene with Ecology and seek concurrence with Ecology for use of a Site-specific Method B SL for making future risk-informed decisions.

3.4 HVAC System Modification and Other Potential Mitigation Measures

Arcadis will coordinate with DoubleTree staff to assess ventilation air intake and exhaust points and obtain other available HVAC information, as appropriate. Using this information Arcadis will evaluate options for modifying hotel air exchange and if practical and warranted, increase the air turnover rate within the hotel to try and diminish naphthalene levels, as appropriate. Additionally, Arcadis will evaluate potential elimination of chemical products used at the Subject property, if chemicals are suspected of containing naphthalene based on further review and, if warranted based on further sub-slab and indoor air test results, evaluate a sub-slab depressurization if the source of naphthalene is determined to be from vapor intrusion and presents an unacceptable risk to hotel workers and guests.

3.6 Indoor Air Sampling

Indoor air sampling will be completed prior to sub-slab probe installation and sampling. Air sampling is proposed at the following 8 locations, 6 of which will be co-located with sub-slab vapor sampling locations within the building footprint:

- Room 132 (Previous Location)
- Room 142 (Previous Location)
- Room 146 (Previous Location)
- Laundry Room (New Location)
- Room 107 (New Location)
- Lobby/Office (New Location)
- Capitol Room
- Fitness Room (New Location)
- Ambient Air 1 – Parking lot (Previous Location)
- Ambient Air 2 – Air Intake on Roof (new location)

Sample locations may be moved based on accessibility, identified potential pathways and building usage. A site plan depicting collocated indoor air and sub-slab probe sampling locations is included as **Figure 5**. Room 148 has been selected for sampling due to the proximity to the laundry room where hotel workers likely spend a significant portion of their work day. The actual laundry is not being sampled at this time due to the moisture exposure concerns on the sampling media and the high potential for interference with non-target compounds related to cleaning activities. Additional sampling locations will be considered in the future based on the evaluation of the data being collected form the currently scoped sampling locations.

The following parameters will be recorded in the field logbook, daily field log, or other appropriate field form before sampling begins:

- Sampling date
- Sampling personnel
- Sampling location
- Initial temperature and barometric pressure as measured from a local weather station
- Sampling method and devices
- Volume of sample
- Weather conditions
- Personal air pump number and flow rate
- Sample start time

The following information will be recorded upon completion of sample collection:

- Sample end time
- Final flow rate and volume of air sampled
- Final temperature and barometric pressure as measured from a local weather station

3.6.1 Sample Collection

Field activities described herein will be performed in a manner consistent with the Standard Operating Procedures (SOPs) presented in **Appendix C**. The hotel staff will be requested to suspend activities that could negatively impact indoor air quality, if possible, such use of sprays, solvents, paints, etc. 24 to 48 hours prior to sampling. To the extent practicable, Arcadis will select sampling locations representative of conditions during routine hotel occupancy. Arcadis will request the hotel staff remove or isolate indoor air sources identified as potential contributors of VOCs prior to sampling, if possible. It is possible that the hotel will contain potential indoor air sources that will be impractical to remove and may be required for ongoing business activities. These sources will be documented, as appropriate.

To the extent practical during normal business operations, the building will be sealed (windows and doors shut) and mechanical fans, if used, will be turned off, at least 24 hours prior to the sampling event to minimize the dilution of potential contaminants, thereby achieving conditions typical of the “worst-case” scenario that is still representative of building occupancy conditions. With the doors and windows shut, mechanical HVAC systems will be left in normal operating conditions during the sampling, thereby producing a temperature and pressure differential between the inside and the outside of the structure creating a stacking effect, which will draw air into the building. This will allow for sampling during the “worst-case” scenario. Arcadis will request hotel staff keep windows and doors shut as much as possible during sampling.

The indoor air sample sorbent tubes will be placed at the designated sample locations. Sample locations may be adjusted from those locations shown on **Figure 5** based on conditions encountered at the time of collection. The indoor air and outdoor ambient air samples will be collected from the breathing zone, approximately 3 to 5 feet above the floor. Indoor air sampling locations adjacent to windows and other potential outdoor air entry points will be avoided.

Samples will be analyzed for naphthalene by EPA Air Method TO-17 using sorbent tubes connected to air sampling pumps set to draw approximately 15 liters of indoor air over an 8-hour period. If 15 liters is not collected within the 8-hour timeframe, the sample duration will be extended up to an additional 2 hours to achieve the target 15-liter volume.

3.7 Sub-Slab Soil Vapor Sampling

3.7.1 Sample Collection

After indoor air sampling has been completed, sub-slab SVPs will be installed and sampled in accordance with the *Standard Operating Procedure, Installation and Extraction of the VaporPin*®, prepared by Cox-Colvin and Associates, Inc., and dated September 9, 2016 (Cox-Colvin 2016; included in **Appendix D**).

Sub-slab soil vapor samples will be collected following the procedures outlined in the SOP: Soil-Gas Sampling and Analysis Using Sorbent Tubes prepared by Arcadis and dated June 17, 2017 (Arcadis 2016; included in **Appendix C**). These methods and procedures are consistent with the Ecology Implementation Memorandum No. 18, Draft Petroleum Vapor Intrusion (VI): Updated Screening Levels, Cleanup Levels, and Sampling Considerations, dated August 7, 2017 (Ecology 2017). Sub-slab soil vapor samples will be collected from VaporPins® (or similar). Prior to sampling, Arcadis will purge the SVPs and leak-test the annular space surrounding the SVP using the water dam leak test method per the Cox-Colvin guidance. Arcadis will collect sub-slab soil vapor samples using sorbent tubes connected to syringes set to draw a known volume of soil vapor through the sorbent tube in accordance with the method-specific instructions for EPA Method TO-17 found in Air Toxics Sorbent and Solution Sampling Guide, included as **Appendix E.**

3.7.2 Sample Analysis

Air samples will be transferred under standard chain-of-custody procedures to an Ecology-accredited laboratory (Air Toxics). Sub-slab soil vapor samples will be analyzed for naphthalene using EPA Method TO-17 using a standard laboratory turnaround time of 10-days. Reporting limits for naphthalene are expected to be below standard MTCA Method B air CULS, if at least 15 liters of sample is collected. Reporting limits may be higher if less than the 15-liter sample volume is collected.

3.8 Quality Assurance/Quality Control

One sorbent tube field blank will be collected to evaluate sampling environment background influence.

4 DATA EVALUATION AND REPORTING

Indoor air samples may contain naphthalene within concentration ranges commonly seen as background values at sites where no subsurface petroleum hydrocarbon contamination is present. There are potentially many sources of background contamination inside buildings. Materials and substances commonly found in commercial and residential settings such as paints, paint thinners, gasoline-powered machinery, building materials, cleaning products, dry-cleaned clothing, and cigarette smoke contain VOCs that may be detected by indoor air testing.

As a result, it is not possible to interpret whether vapor intrusion is occurring by simply comparing indoor air concentration against the most conservative screening values, since these values do not account for background concentrations. Instead, indoor concentrations must be compared to both outdoor air and sub-slab soil vapor concentrations to determine whether external or indoor sources are contributing to indoor air concentrations. Multiple lines of evidence are used to evaluate whether vapor intrusion could be occurring at the Site. A clear indication of an active vapor intrusion pathway would be a combination of indoor and outdoor air samples where indoor air contains significantly greater concentrations of naphthalene than outdoor air, and contains significantly lower concentrations of naphthalene than sub-slab soil vapor. Conversely, low levels of naphthalene in sub-slab vapor samples and low levels of naphthalene in groundwater would suggest non-vapor intrusion sources of naphthalene in indoor air.

An Ecology default attenuation factor of 0.03 will be used for the sub-slab/indoor air (Ecology 2015). Indoor air, outdoor air, and sub-slab vapor concentrations will be evaluated per the above protocols. Criteria indicative of vapor intrusion are listed below:

- Indoor air concentrations significantly higher than outdoor air;
- Indoor air concentrations significantly higher than the range of normal background (based on background measurements taken during the indoor materials and building survey); or

- Sub-slab concentrations significantly higher than indoor air (greater than 10 times).

Other combinations of concentrations and concentration ratios will likely indicate either an indoor or outdoor background source rather than vapor intrusion into the building.

Arcadis will compare sub-slab soil vapor considering the 0.03 attenuation factor and indoor air data to Ecology naphthalene-specific standard and Site-specific Method B SLs for indoor air and SLs for soil vapor to support risk-based decision making for the Site (Ecology 2015). As appropriate and with the consideration of background contributions, the constituent concentrations in sub-slab soil vapor will be used to estimate a Site-specific attenuation factor. If indoor air constituent concentrations exceed the screening criteria (which are calculated using the Ecology-established acceptable target risk of one in one-million for carcinogenicity and the hazard index of 1 for noncarcinogenic health effects), then the need for additional vapor intrusion investigation or mitigation measures at the Site will be considered and included in a future deliverable.

5 PROPOSED SCHEDULE

Arcadis will conduct the proposed scope of work in three mobilizations. The objective of the first Site visit will be to gather additional previously unidentified product and use data, inventory units and evaluate potential adjustments to the DoubleTree Hotel building HVAC system, and evaluate previously unidentified preferential PVI pathways in the building foundation. Arcadis will visit the Site on or by October 31, 2017. The goal of the second Site mobilization will be to collect indoor and outdoor air and sub-slab soil vapor samples. Indoor air samples will be collected one day before the sub-slab samples are collected to avoid interference from potential temporary impacts to indoor air quality during collection of sub-slab samples. Arcadis will perform these activities on or by November 30, 2017. A third mobilization will be to collect the second round of indoor air and sub-slab soil vapor samples, if results of the first round indicate the vapor intrusion pathway is potentially complete. A revised milestone schedule is provided below.

No.	Task/Milestone	Completion Date	Comments/Status
1	Submit Work Plan	October 20, 2017	By October 24, 2017
2	Conduct scoping call with Ecology	October 27, 2017	Optional call with Ecology to discuss work plan.
3	Conduct Site-specific risk assessment and building evaluation	October/November 2017	
4	Conduct indoor air and sub-slab testing (first event)	November 2017	Sub-slab testing will be performed approximately 1 day after indoor air testing at each location
5	Submit data report	December 2017	Assume 10 days to prepare report from receipt of laboratory data

6	Conduct indoor air and sub-slab sample testing (potential second event)	February 2018	Approximately 90 days after first sub-slab/indoor air sampling event if indicated by results of first sampling event
7	Evaluate potential mitigation strategies	October 2017–February 2018	Ongoing
8	Submit report & recommendations	March 2018	Assume 10 days to prepare report from receipt of laboratory data.

6 REFERENCES

Arcadis U.S., Inc. 2016. SOP: Soil-Gas Sampling and Analysis Using Sorbent Tubes. June 17.

Cox-Colvin and Associates, Inc. 2016. Standard Operating Procedure, Installation and Extraction of the VaporPin®. September 9.

National Oceanic and Atmospheric Administration. 2017a. Record of Climatological Observations. Station: Olympia, WA US [June 26, 2017]. National Centers for Environmental Information, Asheville. Generated October 17.

National Oceanic and Atmospheric Administration. 2017b. Record of Climatological Observations. Station: Olympia, WA US [September 8, 2017]. National Centers for Environmental Information, Asheville. Generated October 20.

United States Environmental Protection Agency (EPA). 2017. Regional Screening Levels. Available at: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-may-2016. May.

Washington State Department of Ecology. 2015. Table B-1 Revised Excel Spreadsheet for Vapor Intrusion Screening Levels. April.

Washington State Department of Ecology. Revised 2016. Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action. February.

Washington State Department of Ecology. 2017. Ecology Implementation Memorandum No. 18, Draft Petroleum Vapor Intrusion (VI): Updated Screening Levels, Cleanup Levels, and Sampling Considerations. August 7.

Weather Underground. Weather History for Olympia, WA, 2017. Retrieved from: https://www.wunderground.com/history/airport/KOLM/2017/6/26/DailyHistory.html?req_city=KOLM&req_state=WA&req_statename=Washington&reqdb.zip=98511&reqdb.magic=4&reqdb.wmo=99999

TABLES

Table 1
Indoor Air Sampling - Analytical Results
PIH Olympia LLC
415 Capitol Way North, Olympia, WA

All Concentrations are in micrograms per cubic meter (µg/m^3) unless otherwise indicated

Sample Location	Sample ID	Method	Date Collected	Benzene	1,2-DCA	1,2,4-TMB	Naphthalene	EDB	Ethylbenzene	Toluene	m,p-Xylene	o-Xylene	MTBE	1,3-Butadiene	TBA	Methane (% v/v)
Model Toxics Control Act (MTCA) Method B Screening Levels (CULs) in µg/m^3				**0.321**	**0.0962**	**3.2**	**0.0735**	**0.00417**	**457**	**2,290**	**45.7**	**45.7**	**9.62**	**0.0833**	**N/A**	**N/A**
Room 142	IND-8HR-R142	TO-15	6/26/2017	0.23	0.055 J	0.20	**0.17 B**	***< 0.054***	0.40 J	2.4	1.2 J	0.44J	< 2.9	***< 1.8***	< 6.1	0.00036
Room 132	IND-8HR-R132	TO-15	6/26/2017	0.32	0.063 J	< 0.20	0.063 J B	***< 0.054***	< 1.7	2.2	< 3.5	< 1.7	< 2.9	***< 1.8***	< 6.1	0.00035
Room 146	IND-8HR-R146	TO-15	6/26/2017	0.26	0.058 J	0.27	**0.46 B**	**0.028 J**	0.37 J	2.8	1.2 J	0.47 J	< 2.9	***< 1.8***	< 6.1	0.00036
Parking Lot	OUTD-8HR-PARK	TO-15	6/26/2017	0.19	0.046 J	0.10 J	**0.11 B**	***< 0.054***	< 1.7	0.92 J	0.52 J	< 1.7	< 2.9	***< 1.8***	< 6.1	0.00035
Hotel Roof	OUTD-ROOF	TO-15	6/26/2017	0.25	0.045 J	0.071 J	<0.068	***< 0.054***	<1.7	0.74 J	0.52 J	<1.7	< 2.9	***< 1.8***	<6.1	0.00031
Lab Blank	Lab Blank	TO-15	7/5/2017, 7/14/2017	<0.064	<0.081	<0.20	0.0658 J	***<0.054***	<1.7	<1.5	<3.5	<1.7	<2.9	***<1.8***	<6.1	<0.00002
Room 142	IND-8HR-R142	TO-17	9/8/2017	NS	NS	NS	**0.18**	NS	NS	NS	NS	NS	NS	NS	NS	NS
Room 132	IND-8HR-R132	TO-17	9/8/2017	NS	NS	NS	**0.19**	NS	NS	NS	NS	NS	NS	NS	NS	NS
Room 146	IND-8HR-R146	TO-17	9/8/2017	NS	NS	NS	**0.32**	NS	NS	NS	NS	NS	NS	NS	NS	NS
Parking Lot	OUTD-8HR-PARK	TO-17	9/8/2017	NS	NS	NS	<0.057	NS	NS	NS	NS	NS	NS	NS	NS	NS
Hotel Roof	OUTD-8HR-ROOF	TO-17	9/8/2017	NS	NS	NS	<0.070	NS	NS	NS	NS	NS	NS	NS	NS	NS
Field Blank	Field Blank	TO-17	9/8/2017	NS	NS	NS	<0.068	NS	NS	NS	NS	NS	NS	NS	NS	NS
Lab Blank	Lab Blank	TO-17	9/14/2017	NS	NS	NS	<0.057	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes:

% v/v = Volume concentration as percent

< = analyate was not detected at indicated reporting limit

1,2,4-TMB = 1,2,4-Trimethylbenzene

1,2-DCA = 1,2-Dichloroethane

B = Compound was found in the blank sample

EDB = 1,2-Dibromoethane

J - Result is less than the reporting limit but greater than or equal to the method detection limit and the concentration is an approximate value

MTBE = Methyl tert-butyl ether

N/A = Compound does not have a MTCA Method B cleanup level

ND = Analytical result is less than reporting limit; reporting limits were not available for historical analytical results

NS = Not Sampled

TBA = Tert-butyl alcohol

BOLD ITALIC *= Reporting limit exceeds cleanup level*

BOLD Analyte detected above MTCA Method B Cleanup Level

Benzene, 1,2-dichloroethane, 1,2,4-trimethylbenzene, naphthalene, and 1,2-dibromoethane analyzed using USEPA Method TO-15 SIM

Ethylbenzene, toluene, m,p-xylene, o-xylene, methyl tert-butyl ether, 1,3-butadiene, tert-butyl alcohol analyzed using USEPA Method TO-15

Methane analyzed using ASTM Method D1946

Table 2
Vault Screening Summary
PIH Olympia LLC
415 Capitol Way North, Olympia, WA

Vault ID	Date	LEL (%)	H_2S (ppm)	O_2 (%)	CO_2 (ppm)	VOCs (ppm)
Ambient Air	6/26/2017	0	0	20.9	680	0
Utility Vault 1	6/26/2017	0	0	20.9	550	0
Utility Vault 2	6/26/2017	0	0	20.9	500	0
Utility Vault 3	6/26/2017	0	0	20.9	2,950	0
Utility Vault 4	6/26/2017	0	0	20.1	1,200	0
Utility Vault 5	6/26/2017	0	0	20.4	2,610	0
Utility Vault 6	6/26/2017	0	0	20.6	2,200	0
Utility Vault 7	6/26/2017	0	0	20.5	660	0
Utility Vault 8	6/26/2017	0	0	20.9	680	0
Utility Vault 9	6/26/2017	0	0	20.9	1,260	0
Utility Vault 10	6/26/2017	0	0	20.9	720	0
Utility Vault 11	6/26/2017	0	0	20.9	680	0
Utility Vault 12	6/26/2017	0	0	20.9	1,880	0
Utility Vault 13	6/26/2017	0	0	20.8	710	0
Utility Vault 14	6/26/2017	0	0	20.9	2,830	0
Utility Vault 15	6/26/2017	0	0	20.0	3,010	0

Notes:

% = percent

CO_2 = carbon dioxide

H_2S = hydrogen sulfide

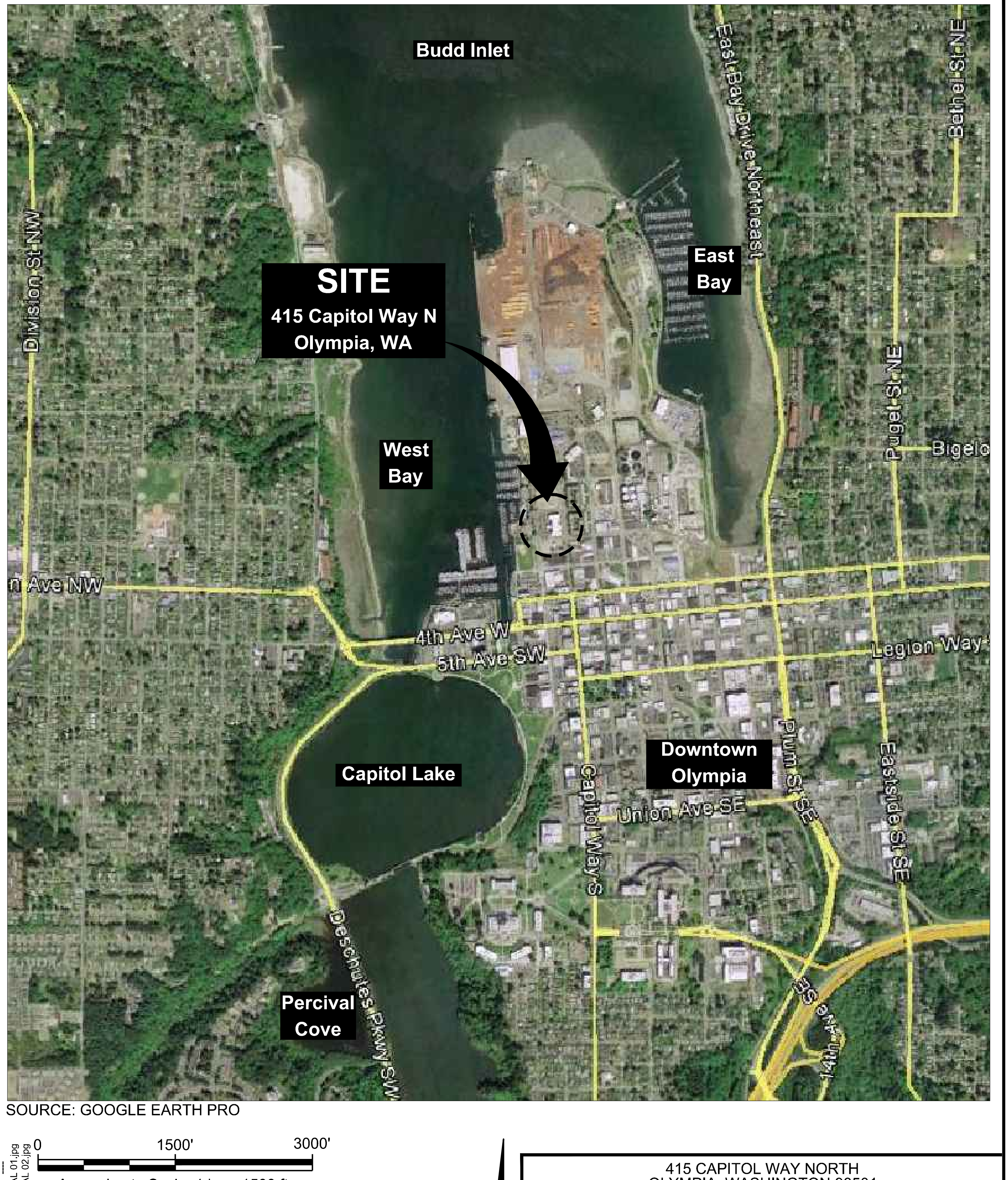
LEL = lower explosive limit

O_2 = oxygen

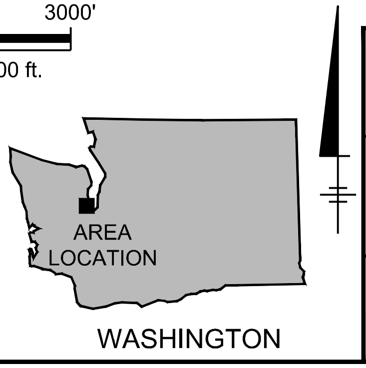
ppm = parts per million

VOCs = volatile organic compounds

FIGURES



SOURCE: GOOGLE EARTH PRO



415 CAPITOL WAY NORTH
OLYMPIA, WASHINGTON 98501

WORK PLAN FOR ADDITIONAL VAPOR/INDOOR AIR INVESTIGATION

SITE LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

CITY:EMERYVILLE, CA DIV/GROUP:ENVCAD DB:A.REYES
G:\ENVCAD\Concord\ACT\SEA41774\0002\00001\WP IA Evaluation\DWG\SEA41774 N01,2.dwg LAYOUT: 1 SAVED: 10/13/2017 12:17 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 10/20/2017 12:52 PM BY: REYES, ALEC
IMAGES: PROJECTNAME: ----
X- SEA41774 GOOGLE-AERIAL 01.jpg
X- SEA41774 GOOGLE-AERIAL 02.jpg

CITY:EMERYVILLE, CA DIV/GROUP:ENVCAD DB:A.REYES
G:\ENVCAD\Concord\ACT\SEA41774\0002\00001\WP IA Evaluation\DWG\SEA41774 N01,2.dwg LAYOUT: 2 SAVED: 10/13/2017 12:17 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 10/20/2017 12:53 PM BY: REYES, ALEC

XREFS: IMAGES: PROJECTNAME: ----
X- SEA41774 GOOGLE-AERIAL 01.jpg
X- SEA41774 GOOGLE-AERIAL 02.jpg

SOURCE: GOOGLE EARTH PRO

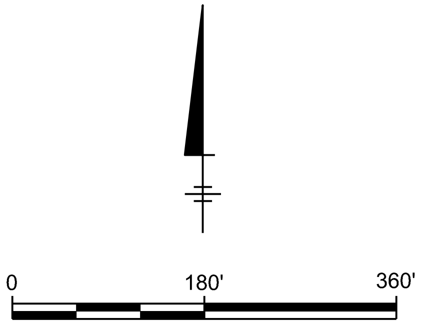
LEGEND

🟥 FORMER YARD BIRDS PROPERTY (INVESTIGATED UNDER ADDRESS 500 CAPITOL WAY NORTH)

🟧 FORMER WASHINGTON NATURAL GAS

🟩 FORMER UNOCAL BULK PLANT (NOW PERCIVAL LANDING PARK)

🟦 FORMER SHELL/ARCO/HULCO BULK PLANT (NOW PERCIVAL LANDING PARK)



Approximate Scale: 1 in. = 180 ft.

415 CAPITOL WAY NORTH
OLYMPIA, WASHINGTON 98501

WORK PLAN FOR ADDITIONAL VAPOR/INDOOR AIR INVESTIGATION

SURROUNDING PROPERTIES MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2

CITY:EMERYVILLE, CA DIV/GROUP:ENVCAD DB:A.REYES
G:\ENVCAD\Concord\ACT\SEA41774\0002\00001\WP IA Evaluation\DWG\SEA41774 SampPlan03.dwg LAYOUT: 3 SAVED: 10/20/2017 12:59 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 10/20/2017 12:59 PM BY: REYES, ALEC
XREFS: IMAGES: PROJECTNAME: ----
X- SEA41774 X01

LEGEND:

PMW-1 ⌖	MONITORING WELL LOCATION
MW-2 ⌖	EXISTING MONITORING WELL ASSOCIATED WITH ADJACENT SITE
MW3 ⊕	APPROXIMATE PREVIOUS MONITORING WELL LOCATION
⬚	FORMER FEATURES (SOURCE: ENVIROS 1994a)
▨	APPROXIMATE SOIL EXCAVATION LOCATION
⌖	VAPOR SAMPLE LOCATION

SAMPLE ID	
Date	Date of Sample
B	Benzene
1,2 DCA	1,2-Dichloroethane
1,2,4 TMB	1,2,4-Trimethylbenzene
NAPH	Naphthalene
EDB	1,2-Dibromoethane
E	Ethylbenzene
T	Toluene
m,p-X	m,p-Xylene
o-X	o-Xylene
MTBE	Methyl-t-Butyl Ether
1,3 B	1,3-Butadiene

NOTES:

BOLD ANALYTE DETECTED ABOVE THE MODEL TOXICS CONTROL ACT METHOD B CLEANUP LEVEL (CUL)

B = COMPOUND WAS FOUND IN THE BLANK SAMPLE

J = RESULT IS LESS THAN THE RL BUT GREATER THAN OR EQUAL TO THE MDL AND THE CONCENTRATION IS AN APPROXIMATE VALUE.

ANALYTICAL RESULTS ARE PRESENTED IN MICROGRAMS PER CUBIC METER (µg/m³).

ALL SAMPLES COLLECTED AT GROUND FLOOR LEVEL, WITH EXCEPTION OF OUTD-ROOF. OUTD-ROOF SAMPLE COLLECTED FROM HOTEL ROOFTOP.

SOURCES:
ENVIROS, INC. - ENVIRONMENTAL SITE ASSESSMENT (JUNE 1994).
STEMEN ENVIRONMENTAL INC. - REMEDIAL INVESTIGATION AND SITE CHARACTERIZATION (2006); EMPI - UPDATE LETTER (FEBRUARY 2000)

OUTD-8HR-PARK		
Date	6/26/2017	9/8/2017
B	0.19	---
1,2 DCA	0.046 J	---
1,2,4 TMB	0.10 J	---
NAPH	**0.11 B**	<0.057
EDB	< 0.054	---
E	< 1.7	---
T	0.92 J	---
m,p-X	0.52 J	---
o-X	< 1.7	---
MTBE	< 2.9	---
1,3 B	< 1.8	---

IND-8HR-R132		
Date	6/26/2017	9/8/2017
B	0.32	---
1,2 DCA	0.063 J	---
1,2,4 TMB	< 0.20	---
NAPH	0.063 J B	**0.19**
EDB	< 0.054	---
E	< 1.7	---
T	2.2	---
m,p-X	< 3.5	---
o-X	< 1.7	---
MTBE	< 2.9	---
1,3 B	< 1.8	---

IND-8HR-R142		
Date	6/26/2017	9/8/2017
B	0.23	---
1,2 DCA	0.055 J	---
1,2,4 TMB	0.2	---
NAPH	**0.17 B**	**0.18**
EDB	< 0.054	---
E	0.40 J	---
T	2.4	---
m,p-X	1.2 J	---
o-X	0.44J	---
MTBE	< 2.9	---
1,3 B	< 1.8	---

IND-8HR-R146		
Date	6/26/2017	9/8/2017
B	0.26	---
1,2 DCA	0.058 J	---
1,2,4 TMB	0.27	---
NAPH	**0.46 B**	**0.32**
EDB	**0.028 J**	---
E	0.37 J	---
T	2.8	---
m,p-X	1.2 J	---
o-X	0.47 J	---
MTBE	< 2.9	---
1,3 B	< 1.8	---

OUTD-ROOF		
Date	6/26/2017	9/8/2017
B	0.25	---
1,2 DCA	0.045 J	---
1,2,4 TMB	0.071 J	---
NAPH	<0.068	<0.070
EDB	<0.054	---
E	<1.7	---
T	0.74 J	---
m,p-X	0.52 J	---
o-X	<1.7	---
MTBE	<2.9	---
1,3 B	1.8	---

0 50' 100'

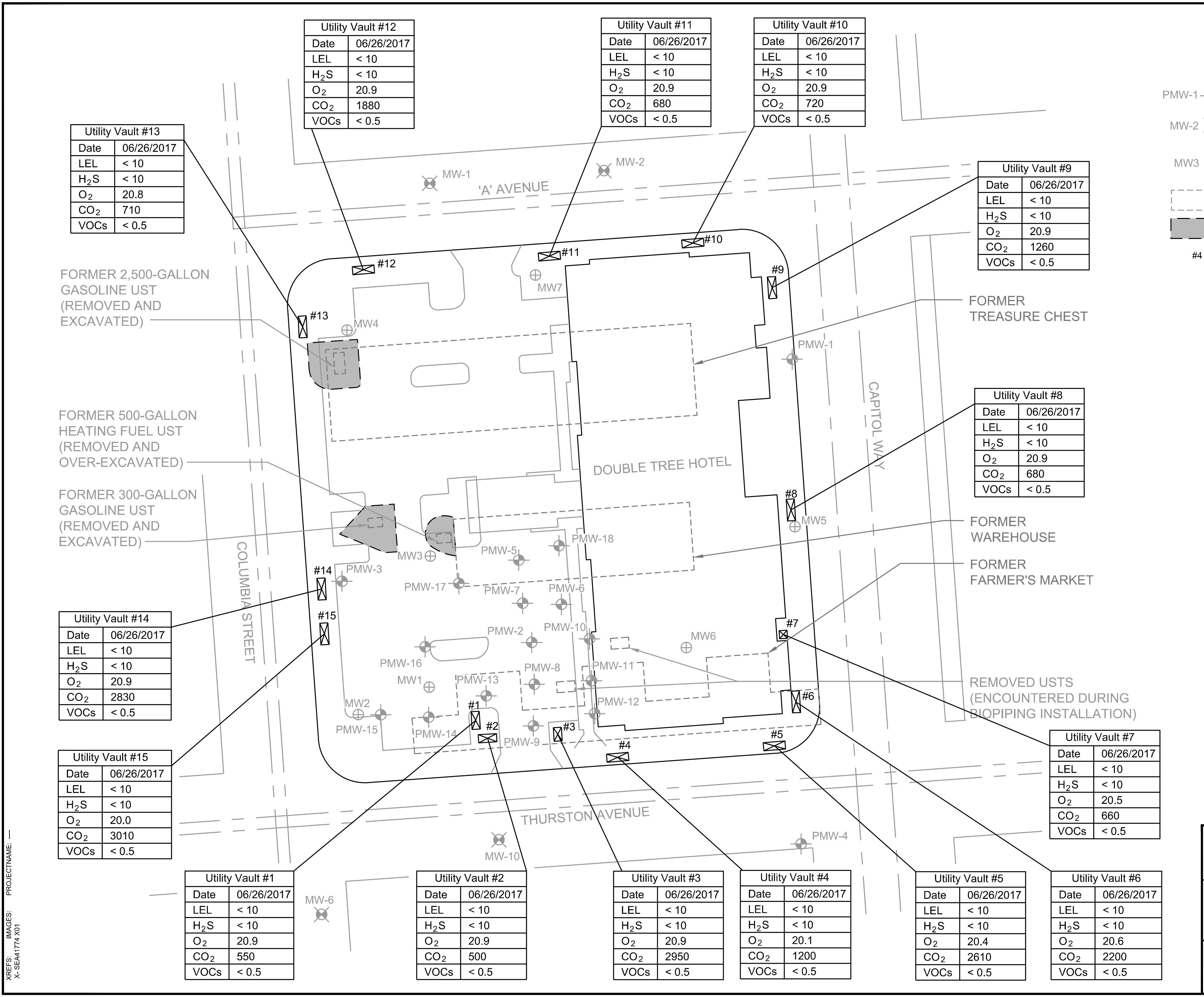
Approximate Scale: 1 in. = 50 ft.

415 CAPITOL WAY NORTH
OLYMPIA, WASHINGTON 98501
WORK PLAN FOR ADDITIONAL VAPOR/INDOOR AIR INVESTIGATION

AIR SAMPLE LOCATIONS AND SELECT ANALYTICAL RESULTS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3



Utility Vault #12	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.9
CO_2	1880
VOCs	< 0.5

Utility Vault #11	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.9
CO_2	680
VOCs	< 0.5

Utility Vault #10	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.9
CO_2	720
VOCs	< 0.5

Utility Vault #13	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.8
CO_2	710
VOCs	< 0.5

Utility Vault #9	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.9
CO_2	1260
VOCs	< 0.5

Utility Vault #8	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.9
CO_2	680
VOCs	< 0.5

Utility Vault #14	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.9
CO_2	2830
VOCs	< 0.5

Utility Vault #15	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.0
CO_2	3010
VOCs	< 0.5

Utility Vault #7	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.5
CO_2	660
VOCs	< 0.5

Utility Vault #1	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.9
CO_2	550
VOCs	< 0.5

Utility Vault #2	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.9
CO_2	500
VOCs	< 0.5

Utility Vault #3	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.9
CO_2	2950
VOCs	< 0.5

Utility Vault #4	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.1
CO_2	1200
VOCs	< 0.5

Utility Vault #5	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.4
CO_2	2610
VOCs	< 0.5

Utility Vault #6	
Date	06/26/2017
LEL	< 10
H_2S	< 10
O_2	20.6
CO_2	2200
VOCs	< 0.5

LEGEND:

PMW-1 ⌖	MONITORING WELL LOCATION
MW-2 ⌖	EXISTING MONITORING WELL ASSOCIATED WITH ADJACENT SITE
MW3 ⊕	APPROXIMATE PREVIOUS MONITORING WELL LOCATION
⬚	FORMER FEATURES (SOURCE: ENVIROS 1994a)
▨	APPROXIMATE SOIL EXCAVATION LOCATION
#4 ☒	APPROXIMATE UTILITY VAULT LOCATION AND INSPECTION VAULT ID KEY

VAULT ID	
Date	Date of Sample
LEL	Lower Explosive Limit (%)
H_2S	Hydrogen Sulfide (ppm)
O_2	Oxygen (%)
CO_2	Carbon Dioxide (ppm)
VOCs	Volatile Organic Compounds (ppm)

SOURCES:
ENVIROS, INC. - ENVIRONMENTAL SITE ASSESSMENT (JUNE 1994).
STEMEN ENVIRONMENTAL INC. - REMEDIAL INVESTIGATION AND SITE CHARACTERIZATION (2006); EMPI - UPDATE LETTER (FEBRUARY 2000)

415 CAPITOL WAY NORTH
OLYMPIA, WASHINGTON 98501
WORK PLAN FOR ADDITIONAL VAPOR/INDOOR AIR INVESTIGATION

UTILITY VAULT LOCATIONS AND SELECT SCREENING RESULTS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4

CITY:EMERYVILLE_CA DIV/GROUP:ENVCAD DB:A.REYES
G:\ENVCAD\Concord\ACT\SEA41774\0002\00001\WP IA Evaluation\DWG\SEA41774 Utility04.dwg LAYOUT: 4 SAVED: 10/20/2017 12:57 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 10/20/2017 12:57 PM BY: REYES, ALEC
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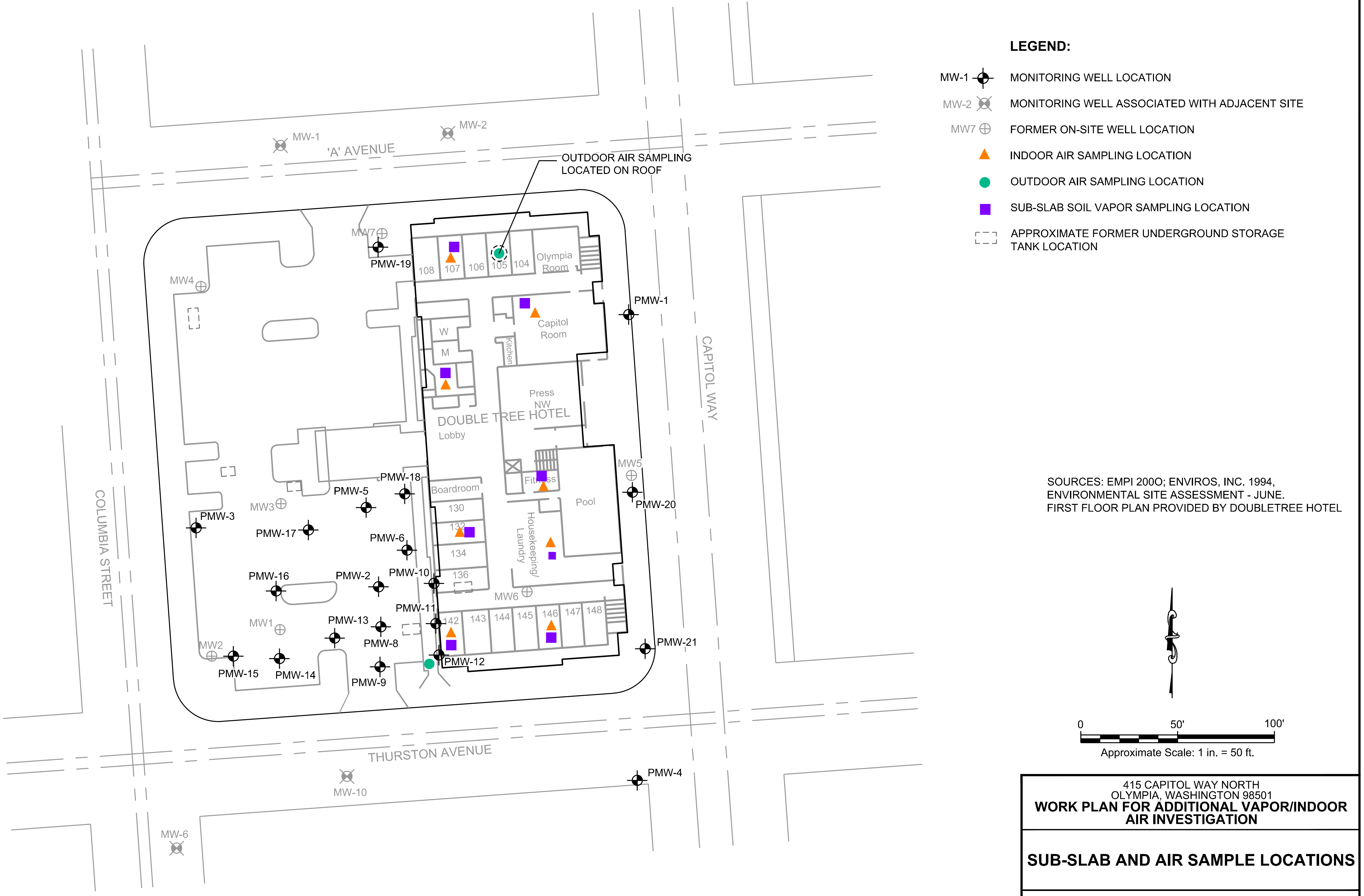

SOURCES: EMPI 200O; ENVIROS, INC. 1994,
ENVIRONMENTAL SITE ASSESSMENT - JUNE.
FIRST FLOOR PLAN PROVIDED BY DOUBLETREE HOTEL

415 CAPITOL WAY NORTH
OLYMPIA, WASHINGTON 98501
WORK PLAN FOR ADDITIONAL VAPOR/INDOOR AIR INVESTIGATION

SUB-SLAB AND AIR SAMPLE LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
5

CITY:EMERYVILLE_CA DIV/GROUP:ENVCAD DB:A.REYES
G:\ENVCAD\Concord\ACT\SEA41774\0002\00001\WP IA Evaluation\DWG\SEA41774 SampPlan05.dwg LAYOUT: 5 SAVED: 10/20/2017 12:54 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 10/20/2017 12:57 PM BY: REYES, ALEC
XREFS: IMAGES: PROJECTNAME: ----
X-SEA41774B01 DoubleTree Site Plan 2.jpg

APPENDIX A

Ecology Letter dated September 26, 2017

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47775 • Olympia, Washington 98504-7775 • (360) 407-6300
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

September 26, 2017

Mr. Michael Stone
Assistant General Counsel
Blackstone Real Estate Advisors, L.P.
501 E. Camino Real
Boca Raton, FL 33432

[redacted]

Re: Results of Confirmation Indoor Air Sampling

- **Site Name:** Phoenix Inn
- **Site Address:** 415 Capitol Way North, Olympia, WA
- **Cleanup Site ID:** 5257
- **Facility Site ID:** 1571525
- **VCP Project Number:** SW1582

Dear Mr. Stone:

The Department of Ecology (Ecology) has received an update from your consultant (Arcadis US, Inc. [Arcadis]) regarding the results of recent confirmation indoor air sampling activities conducted at the DoubleTree Inn (former Phoenix Inn; Facility). Arcadis communicated that the results of those sampling activities confirmed the presence of naphthalene above Method B (Cancer) limits (0.0735 micrograms per cubic meter [μg/m3]) inside DoubleTree Inn Room numbers 132, 142, and 146. To initially address this concern, Arcadis proposed the following activities:

- Performing a chemical inventory at the Facility (noting that the highest results of naphthalene occurred adjacent to the laundering area [0.46 μg/m3 and 0.32 μg/m3 during the initial and confirmation events, respectively, in Room #146]), and
- Adjusting the Facility's heating, ventilation and air-conditioning (HVAC) system to increase turnover of indoor air.

Arcadis also indicated that a routine groundwater monitoring event is planned for the Site and noted that the results of this monitoring, as well as the recent indoor air sampling events, would be provided to Ecology in a forthcoming deliverable.

Given the confirmed presence of naphthalene above Method B (Cancer) limits and potential exposure to long-term guests and staff, Ecology feels that a meaningful and definitive evaluation of the source and potential pathways for this constituent is currently warranted. Such an evaluation should occur in an expedited timeframe given the potential risk present at the Facility.

As such, Ecology is requesting a Work Plan to sufficiently evaluate the nature and extent of naphthalene in shallow soil-vapor and indoor air, including the temporal variability of this constituent along with a strategy for appropriately monitoring and mitigating this potential threat. In addition to the initial, proposed activities described above, the Work Plan should consider and address the following elements:

[redacted]

- Effect of the Facility's HVAC system on naphthalene concentrations associated with building pressurization/depressurization and air-exchange cycles;
- Collection of indoor-air samples from additional rooms to evaluate for vapor "hot spots" and preferential pathways;
- Evaluation of preferential vapor-pathways in rooms exhibiting elevated concentrations of naphthalene in indoor air; and
- Evaluation of sub-slab concentrations of naphthalene in soil-vapor immediately beneath the Facility to assist in the identification of potential source-area(s) of this constituent.

Ecology is requesting receipt of this Work Plan by October 24, 2017.

If you have any questions regarding this letter, please contact me at (360) 407-0276 or Jeremy.Hughes@ecy.wa.gov.

Sincerely,

J Hughes

Jeremy Hughes, LG
VCP Site Manager
Toxics Cleanup Program, Southwest Regional Office
Washington State Department of Ecology

Enclosures [1]: Figure 6 – Air Sample Locations and Select Analytical Results

By certified mail: [91 7199 9991 7037 0277 7613]

cc: Paul McCullough, Arcadis
Nicholas Acklam, Ecology
Matthew Alexander, Ecology
Ecology Site File

APPENDIX B

Soil Laboratory Analytical Report

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

1
2
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4
5
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7
8
9
10
11

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Seattle
5755 8th Street East
Tacoma, WA 98424
Tel: (253)922-2310

TestAmerica Job ID: 580-70655-1
Client Project/Site: PIH Olympia Soils

For:
ARCADIS U.S. Inc
1100 Olive Way
Suite 800
Seattle, Washington 98101

Attn: Ross LaGrandeur

Kristine D. Allen

Authorized for release by:
8/31/2017 5:19:11 PM

Kristine Allen, Manager of Project Management
(253)248-4970
kristine.allen@testamericainc.com

Table of Contents

Case Narrative

Client: ARCADIS U.S. Inc
Project/Site: PIH Olympia Soils

TestAmerica Job ID: 580-70655-1

Job ID: 580-70655-1

Laboratory: TestAmerica Seattle

Narrative

Job Narrative
580-70655-1

Comments
No additional comments.

Receipt
The samples were received on 8/16/2017 10:55 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 5.5º C.

Receipt Exceptions

One or more Stirbar Vials w/DI water for the following samples were broken after putting them in the freezer: PMW-19-5.5-6.5 (580-70655-1), PMW-20-5.5-6.5 (580-70655-2) and PMW-21-6.0-6.5 (580-70655-3).

Sample IDs
PMW-19-5.5-6.5, One vial broke
PMW-20-5.5-6.5, Both vials broke
PMW-21-6.0-6.5, One vial broke

GC/MS VOA
Method(s) NWTPH-Gx: The continuing calibration verification (CCV) associated with batch 580-254422 recovered above the upper control limit for Gasoline. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GC/MS Semi VOA
Method(s) 8270D SIM: The following sample was diluted due to dark extract color: PMW-19-5.5-6.5 (580-70655-1). Elevated reporting limits (RL) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GC Semi VOA
Method(s) NWTPH-Dx: The continuing calibration verification (CCV) associated with batch 580-254821 recovered above the upper control limit for DRO (C10-C24). The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following samples are impacted: PMW-21-6.0-6.5 (580-70655-3) and (CCV 580-254821/49).

Method(s) NWTPH-Dx: The following sample was diluted due to dark extract color: PMW-19-5.5-6.5 (580-70655-1). Elevated reporting limits (RL) are provided.

Method(s) NWTPH-Dx: The following samples contained a hydrocarbon pattern in the diesel range; however, the elution pattern was later than the typical diesel fuel pattern used by the laboratory for quantitative purposes: PMW-20-5.5-6.5 (580-70655-2).
No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Definitions/Glossary

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC/MS Semi VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC Semi VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Client Sample ID: PMW-19-5.5-6.5

Date Collected: 08/14/17 14:00
Date Received: 08/16/17 10:55

Lab Sample ID: 580-70655-1

Matrix: Solid
Percent Solids: 84.6

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2-Dibromoethane (EDB)	ND		2.1	0.42	ug/Kg	☼	08/15/17 14:30	08/21/17 23:03	1
1,2-Dichloroethane	ND		2.1	0.31	ug/Kg	☼	08/15/17 14:30	08/21/17 23:03	1
Benzene	ND		4.2	0.63	ug/Kg	☼	08/15/17 14:30	08/21/17 23:03	1
Ethylbenzene	ND		4.2	0.83	ug/Kg	☼	08/15/17 14:30	08/21/17 23:03	1
Methyl tert-butyl ether	ND		4.2	0.63	ug/Kg	☼	08/15/17 14:30	08/21/17 23:03	1
m-Xylene & p-Xylene	ND		4.2	0.42	ug/Kg	☼	08/15/17 14:30	08/21/17 23:03	1
o-Xylene	ND		4.2	0.54	ug/Kg	☼	08/15/17 14:30	08/21/17 23:03	1
Toluene	ND		4.2	0.63	ug/Kg	☼	08/15/17 14:30	08/21/17 23:03	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*89*		*80 - 121*	*08/15/17 14:30*	*08/21/17 23:03*	*1*
4-Bromofluorobenzene (Surr)	*91*		*47 - 150*	*08/15/17 14:30*	*08/21/17 23:03*	*1*
Dibromofluoromethane (Surr)	*97*		*80 - 118*	*08/15/17 14:30*	*08/21/17 23:03*	*1*
Toluene-d8 (Surr)	*108*		*75 - 120*	*08/15/17 14:30*	*08/21/17 23:03*	*1*
Trifluorotoluene (Surr)	*100*		*60 - 150*	*08/15/17 14:30*	*08/21/17 23:03*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**5.7**	**J**	17	2.2	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3
2-Methylnaphthalene	**6.3**	**J**	17	1.5	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3
Benzo[a]anthracene	**6.5**	**J**	17	2.6	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3
Benzo[a]pyrene	**4.8**	**J**	17	1.4	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3
Benzo[b]fluoranthene	**22**		17	2.0	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3
Benzo[k]fluoranthene	ND		17	2.1	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3
Chrysene	**61**		17	5.2	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3
Dibenz(a,h)anthracene	**4.2**	**J**	17	2.5	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3
Indeno[1,2,3-cd]pyrene	ND		17	2.1	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3
Naphthalene	**3.4**	**J**	17	2.8	ug/Kg	☼	08/18/17 08:36	08/19/17 19:07	3

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Terphenyl-d14	*89*		*68 - 138*	*08/18/17 08:36*	*08/19/17 19:07*	*3*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**2.9**	**J**	4.6	2.4	mg/Kg	☼	08/23/17 10:38	08/23/17 14:37	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*94*		*50 - 150*	*08/23/17 10:38*	*08/23/17 14:37*	*1*
Trifluorotoluene (Surr)				*08/23/17 10:38*	*08/23/17 14:37*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
#2 Diesel (C10-C24)	ND		520	130	mg/Kg	☼	08/18/17 11:59	08/29/17 06:00	10
Motor Oil (>C24-C36)	**460**	**J**	520	94	mg/Kg	☼	08/18/17 11:59	08/29/17 06:00	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*67*		*54 - 118*	*08/18/17 11:59*	*08/29/17 06:00*	*10*

Method: NWTPH-Dx - Semi-Volatile Petroleum Products by NWTPH with Silica Gel Cleanup

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
#2 Diesel (C10-C24)	ND		520	130	mg/Kg	☼	08/18/17 11:59	08/29/17 09:01	10

Client Sample ID: PMW-19-5.5-6.5

Date Collected: 08/14/17 14:00
Date Received: 08/16/17 10:55

Lab Sample ID: 580-70655-1

Matrix: Solid
Percent Solids: 84.6

Method: NWTPH-Dx - Semi-Volatile Petroleum Products by NWTPH with Silica Gel Cleanup (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Motor Oil (>C24-C36)	**470**	**J**	520	94	mg/Kg	☼	08/18/17 11:59	08/29/17 09:01	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*65*		*50 - 150*	*08/18/17 11:59*	*08/29/17 09:01*	*10*

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	**1.5**		0.35	0.034	mg/Kg	☼	08/23/17 11:41	08/23/17 14:32	10

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**84.6**		0.1	0.1	%			08/18/17 16:03	1
Percent Moisture	**15.4**		0.1	0.1	%			08/18/17 16:03	1

Client Sample Results

Client: ARCADIS U.S. Inc
Project/Site: PIH Olympia Soils

TestAmerica Job ID: 580-70655-1

Client Sample ID: PMW-20-5.5-6.5

Date Collected: 08/14/17 11:20
Date Received: 08/16/17 10:55

Lab Sample ID: 580-70655-2
Matrix: Solid
Percent Solids: 82.3

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Methyl tert-butyl ether	ND		50	7.5	ug/Kg	☼	08/23/17 08:35	08/23/17 18:47	1
Benzene	ND		25	11	ug/Kg	☼	08/23/17 08:35	08/23/17 18:47	1
1,2-Dichloroethane	ND		25	6.9	ug/Kg	☼	08/23/17 08:35	08/23/17 18:47	1
Toluene	ND		190	40	ug/Kg	☼	08/23/17 08:35	08/23/17 18:47	1
1,2-Dibromoethane (EDB)	ND		25	4.3	ug/Kg	☼	08/23/17 08:35	08/23/17 18:47	1
Ethylbenzene	ND		50	11	ug/Kg	☼	08/23/17 08:35	08/23/17 18:47	1
m-Xylene & p-Xylene	ND		250	41	ug/Kg	☼	08/23/17 08:35	08/23/17 18:47	1
o-Xylene	ND		50	17	ug/Kg	☼	08/23/17 08:35	08/23/17 18:47	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Trifluorotoluene (Surr)	*104*		*60 - 150*	*08/23/17 08:35*	*08/23/17 18:47*	*1*
Toluene-d8 (Surr)	*103*		*75 - 120*	*08/23/17 08:35*	*08/23/17 18:47*	*1*
1,2-Dichloroethane-d4 (Surr)	*100*		*80 - 121*	*08/23/17 08:35*	*08/23/17 18:47*	*1*
4-Bromofluorobenzene (Surr)	*98*		*47 - 150*	*08/23/17 08:35*	*08/23/17 18:47*	*1*
Dibromofluoromethane (Surr)	*101*		*80 - 118*	*08/23/17 08:35*	*08/23/17 18:47*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**41**		5.7	0.71	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1
2-Methylnaphthalene	**38**		5.7	0.51	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1
Benzo[a]anthracene	**57**		5.7	0.86	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1
Benzo[a]pyrene	**59**		5.7	0.45	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1
Benzo[b]fluoranthene	**56**		5.7	0.67	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1
Benzo[k]fluoranthene	**26**		5.7	0.68	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1
Chrysene	**65**		5.7	1.7	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1
Dibenz(a,h)anthracene	**4.7**	**J**	5.7	0.82	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1
Indeno[1,2,3-cd]pyrene	**33**		5.7	0.68	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1
Naphthalene	**38**		5.7	0.91	ug/Kg	☼	08/18/17 08:36	08/19/17 19:30	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Terphenyl-d14	*72*		*68 - 138*	*08/18/17 08:36*	*08/19/17 19:30*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		5.0	2.6	mg/Kg	☼	08/23/17 10:38	08/23/17 15:08	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*94*		*50 - 150*	*08/23/17 10:38*	*08/23/17 15:08*	*1*
Trifluorotoluene (Surr)				*08/23/17 10:38*	*08/23/17 15:08*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
#2 Diesel (C10-C24)	**37**	**J**	58	14	mg/Kg	☼	08/18/17 11:59	08/29/17 06:23	1
Motor Oil (>C24-C36)	**80**		58	10	mg/Kg	☼	08/18/17 11:59	08/29/17 06:23	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*75*		*54 - 118*	*08/18/17 11:59*	*08/29/17 06:23*	*1*

Method: NWTPH-Dx - Semi-Volatile Petroleum Products by NWTPH with Silica Gel Cleanup

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
#2 Diesel (C10-C24)	**21**	**J**	58	14	mg/Kg	☼	08/18/17 11:59	08/29/17 09:23	1

Client Sample ID: PMW-20-5.5-6.5

Lab Sample ID: 580-70655-2

Date Collected: 08/14/17 11:20

Matrix: Solid

Date Received: 08/16/17 10:55

Percent Solids: 82.3

Method: NWTPH-Dx - Semi-Volatile Petroleum Products by NWTPH with Silica Gel Cleanup (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Motor Oil (>C24-C36)	**44**	**J**	58	10	mg/Kg	☼	08/18/17 11:59	08/29/17 09:23	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*88*		*50 - 150*	*08/18/17 11:59*	*08/29/17 09:23*	*1*

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	**210**		0.52	0.050	mg/Kg	☼	08/23/17 11:41	08/23/17 14:34	10

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**82.3**		0.1	0.1	%			08/18/17 16:03	1
Percent Moisture	**17.7**		0.1	0.1	%			08/18/17 16:03	1

Client Sample ID: PMW-21-6.0-6.5

Lab Sample ID: 580-70655-3

Date Collected: 08/14/17 16:00

Matrix: Solid

Date Received: 08/16/17 10:55

Percent Solids: 73.9

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2-Dibromoethane (EDB)	ND		2.4	0.48	ug/Kg	☼	08/15/17 14:30	08/21/17 23:31	1
1,2-Dichloroethane	ND		2.4	0.36	ug/Kg	☼	08/15/17 14:30	08/21/17 23:31	1
Benzene	**1.4**	**J**	4.8	0.72	ug/Kg	☼	08/15/17 14:30	08/21/17 23:31	1
Ethylbenzene	ND		4.8	0.95	ug/Kg	☼	08/15/17 14:30	08/21/17 23:31	1
Methyl tert-butyl ether	ND		4.8	0.72	ug/Kg	☼	08/15/17 14:30	08/21/17 23:31	1
m-Xylene & p-Xylene	ND		4.8	0.48	ug/Kg	☼	08/15/17 14:30	08/21/17 23:31	1
o-Xylene	ND		4.8	0.62	ug/Kg	☼	08/15/17 14:30	08/21/17 23:31	1
Toluene	ND		4.8	0.72	ug/Kg	☼	08/15/17 14:30	08/21/17 23:31	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*90*		*80 - 121*	*08/15/17 14:30*	*08/21/17 23:31*	*1*
4-Bromofluorobenzene (Surr)	*99*		*47 - 150*	*08/15/17 14:30*	*08/21/17 23:31*	*1*
Dibromofluoromethane (Surr)	*96*		*80 - 118*	*08/15/17 14:30*	*08/21/17 23:31*	*1*
Toluene-d8 (Surr)	*106*		*75 - 120*	*08/15/17 14:30*	*08/21/17 23:31*	*1*
Trifluorotoluene (Surr)	*103*		*60 - 150*	*08/15/17 14:30*	*08/21/17 23:31*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	**64**		6.0	0.75	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1
2-Methylnaphthalene	**80**		6.0	0.54	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1
Benzo[a]anthracene	**240**		6.0	0.91	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1
Benzo[a]pyrene	**210**		6.0	0.48	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1
Benzo[b]fluoranthene	**170**		6.0	0.71	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1
Benzo[k]fluoranthene	**68**		6.0	0.72	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1
Chrysene	**260**		6.0	1.8	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1
Dibenz(a,h)anthracene	**15**		6.0	0.86	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1
Indeno[1,2,3-cd]pyrene	**110**		6.0	0.72	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1
Naphthalene	**140**		6.0	0.96	ug/Kg	☼	08/18/17 08:36	08/19/17 19:52	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Terphenyl-d14	*74*		*68 - 138*	*08/18/17 08:36*	*08/19/17 19:52*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		5.7	3.0	mg/Kg	☼	08/23/17 10:38	08/23/17 15:39	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*93*		*50 - 150*	*08/23/17 10:38*	*08/23/17 15:39*	*1*
Trifluorotoluene (Surr)				*08/23/17 10:38*	*08/23/17 15:39*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
#2 Diesel (C10-C24)	**16**	**J**	66	16	mg/Kg	☼	08/18/17 11:59	08/29/17 06:45	1
Motor Oil (>C24-C36)	**32**	**J**	66	12	mg/Kg	☼	08/18/17 11:59	08/29/17 06:45	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*79*		*54 - 118*	*08/18/17 11:59*	*08/29/17 06:45*	*1*

Method: NWTPH-Dx - Semi-Volatile Petroleum Products by NWTPH with Silica Gel Cleanup

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
#2 Diesel (C10-C24)	ND		66	16	mg/Kg	☼	08/18/17 11:59	08/29/17 10:08	1

Client Sample ID: PMW-21-6.0-6.5
Date Collected: 08/14/17 16:00
Date Received: 08/16/17 10:55

Lab Sample ID: 580-70655-3
Matrix: Solid
Percent Solids: 73.9

Method: NWTPH-Dx - Semi-Volatile Petroleum Products by NWTPH with Silica Gel Cleanup (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Motor Oil (>C24-C36)	**20**	**J**	66	12	mg/Kg	☼	08/18/17 11:59	08/29/17 10:08	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*92*		*50 - 150*	*08/18/17 11:59*	*08/29/17 10:08*	*1*

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	**8.7**		0.65	0.062	mg/Kg	☼	08/23/17 11:41	08/23/17 14:37	10

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**73.9**		0.1	0.1	%			08/18/17 16:03	1
Percent Moisture	**26.1**		0.1	0.1	%			08/18/17 16:03	1

Method: 8260C - Volatile Organic Compounds by GC/MS

Lab Sample ID: MB 580-254258/1-A
Matrix: Solid
Analysis Batch: 254880

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 254258

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		2.0	0.30	ug/Kg		08/21/17 17:02	08/21/17 19:22	1
1,2-Dichloroethane	ND		1.0	0.15	ug/Kg		08/21/17 17:02	08/21/17 19:22	1
Methyl tert-butyl ether	ND		2.0	0.30	ug/Kg		08/21/17 17:02	08/21/17 19:22	1
1,2-Dibromoethane (EDB)	ND		1.0	0.20	ug/Kg		08/21/17 17:02	08/21/17 19:22	1
Ethylbenzene	ND		2.0	0.40	ug/Kg		08/21/17 17:02	08/21/17 19:22	1
m-Xylene & p-Xylene	ND		2.0	0.20	ug/Kg		08/21/17 17:02	08/21/17 19:22	1
Toluene	ND		2.0	0.30	ug/Kg		08/21/17 17:02	08/21/17 19:22	1
o-Xylene	ND		2.0	0.26	ug/Kg		08/21/17 17:02	08/21/17 19:22	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*110*		*80 - 121*	*08/21/17 17:02*	*08/21/17 19:22*	*1*
4-Bromofluorobenzene (Surr)	*109*		*47 - 150*	*08/21/17 17:02*	*08/21/17 19:22*	*1*
Toluene-d8 (Surr)	*96*		*75 - 120*	*08/21/17 17:02*	*08/21/17 19:22*	*1*
Dibromofluoromethane (Surr)	*112*		*80 - 118*	*08/21/17 17:02*	*08/21/17 19:22*	*1*
Trifluorotoluene (Surr)	*106*		*60 - 150*	*08/21/17 17:02*	*08/21/17 19:22*	*1*

Lab Sample ID: LCS 580-254258/2-A
Matrix: Solid
Analysis Batch: 254880

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 254258

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Benzene	20.0	19.7		ug/Kg		99	79 - 135
1,2-Dichloroethane	20.0	21.8		ug/Kg		109	68 - 150
Methyl tert-butyl ether	20.0	20.4		ug/Kg		102	69 - 150
1,2-Dibromoethane (EDB)	20.0	19.9		ug/Kg		100	77 - 123
Ethylbenzene	20.0	19.5		ug/Kg		97	80 - 127
m-Xylene & p-Xylene	20.0	19.5		ug/Kg		98	80 - 128
Toluene	20.0	19.9		ug/Kg		99	80 - 125
o-Xylene	20.0	19.6		ug/Kg		98	80 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*109*		*80 - 121*
4-Bromofluorobenzene (Surr)	*103*		*47 - 150*
Toluene-d8 (Surr)	*100*		*75 - 120*
Dibromofluoromethane (Surr)	*104*		*80 - 118*
Trifluorotoluene (Surr)	*105*		*60 - 150*

Lab Sample ID: LCSD 580-254258/3-A
Matrix: Solid
Analysis Batch: 254880

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 254258

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Benzene	20.0	19.6		ug/Kg		98	79 - 135	1	10
1,2-Dichloroethane	20.0	22.0		ug/Kg		110	68 - 150	1	17
Methyl tert-butyl ether	20.0	21.8		ug/Kg		109	69 - 150	6	30
1,2-Dibromoethane (EDB)	20.0	18.9		ug/Kg		94	77 - 123	5	18
Ethylbenzene	20.0	19.0		ug/Kg		95	80 - 127	2	10

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: LCSD 580-254258/3-A
Matrix: Solid
Analysis Batch: 254880

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 254258

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
m-Xylene & p-Xylene	20.0	19.0		ug/Kg		95	80 - 128	3	13
Toluene	20.0	19.6		ug/Kg		98	80 - 125	2	16
o-Xylene	20.0	19.7		ug/Kg		98	80 - 125	1	14

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*113*		*80 - 121*
4-Bromofluorobenzene (Surr)	*101*		*47 - 150*
Toluene-d8 (Surr)	*98*		*75 - 120*
Dibromofluoromethane (Surr)	*109*		*80 - 118*
Trifluorotoluene (Surr)	*104*		*60 - 150*

Lab Sample ID: MB 580-254384/1-A
Matrix: Solid
Analysis Batch: 254406

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 254384

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		20	8.6	ug/Kg		08/23/17 08:35	08/23/17 10:22	1
1,2-Dichloroethane	ND		20	5.5	ug/Kg		08/23/17 08:35	08/23/17 10:22	1
Methyl tert-butyl ether	ND		40	6.0	ug/Kg		08/23/17 08:35	08/23/17 10:22	1
1,2-Dibromoethane (EDB)	ND		20	3.4	ug/Kg		08/23/17 08:35	08/23/17 10:22	1
Ethylbenzene	ND		40	9.1	ug/Kg		08/23/17 08:35	08/23/17 10:22	1
m-Xylene & p-Xylene	ND		200	33	ug/Kg		08/23/17 08:35	08/23/17 10:22	1
Toluene	ND		150	32	ug/Kg		08/23/17 08:35	08/23/17 10:22	1
o-Xylene	ND		40	13	ug/Kg		08/23/17 08:35	08/23/17 10:22	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*101*		*80 - 121*	*08/23/17 08:35*	*08/23/17 10:22*	*1*
4-Bromofluorobenzene (Surr)	*95*		*47 - 150*	*08/23/17 08:35*	*08/23/17 10:22*	*1*
Toluene-d8 (Surr)	*104*		*75 - 120*	*08/23/17 08:35*	*08/23/17 10:22*	*1*
Dibromofluoromethane (Surr)	*98*		*80 - 118*	*08/23/17 08:35*	*08/23/17 10:22*	*1*
Trifluorotoluene (Surr)	*103*		*60 - 150*	*08/23/17 08:35*	*08/23/17 10:22*	*1*

Lab Sample ID: LCS 580-254384/2-A
Matrix: Solid
Analysis Batch: 254406

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 254384

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Benzene	800	922		ug/Kg		115	79 - 135
1,2-Dichloroethane	800	772		ug/Kg		97	68 - 150
Methyl tert-butyl ether	800	733		ug/Kg		92	69 - 150
1,2-Dibromoethane (EDB)	800	787		ug/Kg		98	77 - 123
Ethylbenzene	800	838		ug/Kg		105	80 - 127
m-Xylene & p-Xylene	800	829		ug/Kg		104	80 - 128
Toluene	800	870		ug/Kg		109	80 - 125
o-Xylene	800	828		ug/Kg		103	80 - 125

QC Sample Results

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: LCS 580-254384/2-A
Matrix: Solid
Analysis Batch: 254406

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 254384

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*97*		*80 - 121*
4-Bromofluorobenzene (Surr)	*97*		*47 - 150*
Toluene-d8 (Surr)	*104*		*75 - 120*
Dibromofluoromethane (Surr)	*101*		*80 - 118*
Trifluorotoluene (Surr)	*101*		*60 - 150*

Lab Sample ID: LCSD 580-254384/3-A
Matrix: Solid
Analysis Batch: 254406

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 254384

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Benzene	800	868		ug/Kg		109	79 - 135	6	10
1,2-Dichloroethane	800	793		ug/Kg		99	68 - 150	3	17
Methyl tert-butyl ether	800	769		ug/Kg		96	69 - 150	5	30
1,2-Dibromoethane (EDB)	800	853		ug/Kg		107	77 - 123	8	18
Ethylbenzene	800	853		ug/Kg		107	80 - 127	2	10
m-Xylene & p-Xylene	800	846		ug/Kg		106	80 - 128	2	13
Toluene	800	879		ug/Kg		110	80 - 125	1	16
o-Xylene	800	812		ug/Kg		101	80 - 125	2	14

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*97*		*80 - 121*
4-Bromofluorobenzene (Surr)	*96*		*47 - 150*
Toluene-d8 (Surr)	*102*		*75 - 120*
Dibromofluoromethane (Surr)	*99*		*80 - 118*
Trifluorotoluene (Surr)	*106*		*60 - 150*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Lab Sample ID: MB 580-254048/1-A
Matrix: Solid
Analysis Batch: 254170

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 254048

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1-Methylnaphthalene	ND		5.0	0.63	ug/Kg		08/18/17 08:36	08/19/17 15:43	1
2-Methylnaphthalene	ND		5.0	0.45	ug/Kg		08/18/17 08:36	08/19/17 15:43	1
Benzo[a]anthracene	ND		5.0	0.76	ug/Kg		08/18/17 08:36	08/19/17 15:43	1
Benzo[a]pyrene	ND		5.0	0.40	ug/Kg		08/18/17 08:36	08/19/17 15:43	1
Benzo[b]fluoranthene	ND		5.0	0.59	ug/Kg		08/18/17 08:36	08/19/17 15:43	1
Benzo[k]fluoranthene	ND		5.0	0.60	ug/Kg		08/18/17 08:36	08/19/17 15:43	1
Chrysene	ND		5.0	1.5	ug/Kg		08/18/17 08:36	08/19/17 15:43	1
Dibenz(a,h)anthracene	ND		5.0	0.72	ug/Kg		08/18/17 08:36	08/19/17 15:43	1
Indeno[1,2,3-cd]pyrene	ND		5.0	0.60	ug/Kg		08/18/17 08:36	08/19/17 15:43	1
Naphthalene	ND		5.0	0.80	ug/Kg		08/18/17 08:36	08/19/17 15:43	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Terphenyl-d14	*79*		*68 - 138*	*08/18/17 08:36*	*08/19/17 15:43*	*1*

QC Sample Results

Lab Sample ID: LCS 580-254048/2-A
Matrix: Solid
Analysis Batch: 254170

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 254048

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1-Methylnaphthalene	1000	889		ug/Kg		89	71 - 120
2-Methylnaphthalene	1000	893		ug/Kg		89	75 - 120
Benzo[a]anthracene	1000	882		ug/Kg		88	66 - 120
Benzo[a]pyrene	1000	994		ug/Kg		99	72 - 124
Benzo[b]fluoranthene	1000	782		ug/Kg		78	63 - 121
Benzo[k]fluoranthene	1000	1020		ug/Kg		102	63 - 129
Chrysene	1000	950		ug/Kg		95	69 - 120
Dibenz(a,h)anthracene	1000	912		ug/Kg		91	70 - 125
Indeno[1,2,3-cd]pyrene	1000	862		ug/Kg		86	65 - 121
Naphthalene	1000	899		ug/Kg		90	70 - 120

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Terphenyl-d14	*72*		*68 - 138*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC)

Lab Sample ID: MB 580-254411/1-A
Matrix: Solid
Analysis Batch: 254422

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 254411

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		4.0	2.1	mg/Kg		08/23/17 10:38	08/23/17 13:04	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*94*		*50 - 150*	*08/23/17 10:38*	*08/23/17 13:04*	*1*
Trifluorotoluene (Surr)	*123*		*50 - 150*	*08/23/17 10:38*	*08/23/17 13:04*	*1*

Lab Sample ID: LCS 580-254411/2-A
Matrix: Solid
Analysis Batch: 254422

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 254411

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Gasoline	40.0	34.8		mg/Kg		87	68 - 120

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
4-Bromofluorobenzene (Surr)	*104*		*50 - 150*
Trifluorotoluene (Surr)	*122*		*50 - 150*

Lab Sample ID: LCSD 580-254411/3-A
Matrix: Solid
Analysis Batch: 254422

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 254411

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Gasoline	40.0	35.7		mg/Kg		89	68 - 120	2	25

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
4-Bromofluorobenzene (Surr)	*102*		*50 - 150*
Trifluorotoluene (Surr)	*124*		*50 - 150*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Lab Sample ID: MB 580-254081/1-A
Matrix: Solid
Analysis Batch: 254821

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 254081

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
#2 Diesel (C10-C24)	ND		50	12	mg/Kg		08/18/17 11:58	08/29/17 04:08	1
Motor Oil (>C24-C36)	ND		50	9.1	mg/Kg		08/18/17 11:58	08/29/17 04:08	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*101*		*54 - 118*	*08/18/17 11:58*	*08/29/17 04:08*	*1*

Lab Sample ID: LCS 580-254081/2-A
Matrix: Solid
Analysis Batch: 254821

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 254081

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
#2 Diesel (C10-C24)	500	387		mg/Kg		77	70 - 125
Motor Oil (>C24-C36)	500	368		mg/Kg		74	70 - 119

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
o-Terphenyl	*75*		*54 - 118*

Lab Sample ID: LCSD 580-254081/3-A
Matrix: Solid
Analysis Batch: 254821

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 254081

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
#2 Diesel (C10-C24)	500	404		mg/Kg		81	70 - 125	4	16
Motor Oil (>C24-C36)	500	382		mg/Kg		76	70 - 119	4	16

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
o-Terphenyl	*78*		*54 - 118*

Method: NWTPH-Dx - Semi-Volatile Petroleum Products by NWTPH with Silica Gel Cleanup

Lab Sample ID: MB 580-254081/1-C
Matrix: Solid
Analysis Batch: 254821

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 254081

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
#2 Diesel (C10-C24)	ND		50	12	mg/Kg		08/18/17 11:58	08/29/17 07:52	1
Motor Oil (>C24-C36)	ND		50	9.1	mg/Kg		08/18/17 11:58	08/29/17 07:52	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*92*		*50 - 150*	*08/18/17 11:58*	*08/29/17 07:52*	*1*

Lab Sample ID: LCS 580-254081/2-C
Matrix: Solid
Analysis Batch: 254821

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 254081

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
#2 Diesel (C10-C24)	500	465		mg/Kg		93	64 - 127

Method: NWTPH-Dx - Semi-Volatile Petroleum Products by NWTPH with Silica Gel Cleanup (Continued)

Lab Sample ID: LCS 580-254081/2-C
Matrix: Solid
Analysis Batch: 254821

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 254081

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Motor Oil (>C24-C36)	500	452		mg/Kg		90	70 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
o-Terphenyl	*82*		*50 - 150*

Lab Sample ID: LCSD 580-254081/3-C
Matrix: Solid
Analysis Batch: 254821

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 254081

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
#2 Diesel (C10-C24)	500	502		mg/Kg		100	64 - 127	8	16
Motor Oil (>C24-C36)	500	500		mg/Kg		100	70 - 125	10	17

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
o-Terphenyl	*87*		*50 - 150*

Method: 6020A - Metals (ICP/MS)

Lab Sample ID: MB 580-254427/19-A
Matrix: Solid
Analysis Batch: 254505

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 254427

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		0.25	0.024	mg/Kg		08/23/17 11:41	08/23/17 13:26	5

Lab Sample ID: LCS 580-254427/20-A
Matrix: Solid
Analysis Batch: 254505

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 254427

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Lead	50.0	50.8		mg/Kg		102	80 - 120

Lab Sample ID: LCSD 580-254427/21-A
Matrix: Solid
Analysis Batch: 254505

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 254427

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Lead	50.0	50.1		mg/Kg		100	80 - 120	1	20

Lab Chronicle

Client Sample ID: PMW-19-5.5-6.5

Lab Sample ID: 580-70655-1

Date Collected: 08/14/17 14:00

Matrix: Solid

Date Received: 08/16/17 10:55

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	254127	08/18/17 16:03	REY	TAL SEA

Client Sample ID: PMW-19-5.5-6.5

Lab Sample ID: 580-70655-1

Date Collected: 08/14/17 14:00

Matrix: Solid

Date Received: 08/16/17 10:55

Percent Solids: 84.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			254258	08/15/17 14:30	IWH	TAL SEA
Total/NA	Analysis	8260C		1	254880	08/21/17 23:03	TL1	TAL SEA
Total/NA	Prep	3546			254048	08/18/17 08:36	APR	TAL SEA
Total/NA	Analysis	8270D SIM		3	254170	08/19/17 19:07	CJ	TAL SEA
Total/NA	Prep	5035			254411	08/23/17 10:38	SHK	TAL SEA
Total/NA	Analysis	NWTPH-Gx		1	254422	08/23/17 14:37	JCV	TAL SEA
Total/NA	Prep	3546			254081	08/18/17 11:59	APR	TAL SEA
Total/NA	Analysis	NWTPH-Dx		10	254821	08/29/17 06:00	CJ	TAL SEA
Total/NA	Prep	3546			254081	08/18/17 11:59	APR	TAL SEA
Total/NA	Cleanup	3630C			254323	08/22/17 14:13	JWL	TAL SEA
Total/NA	Analysis	NWTPH-Dx		10	254821	08/29/17 09:01	CJ	TAL SEA
Total/NA	Prep	3050B			254427	08/23/17 11:41	PAB	TAL SEA
Total/NA	Analysis	6020A		10	254505	08/23/17 14:32	FCW	TAL SEA

Client Sample ID: PMW-20-5.5-6.5

Lab Sample ID: 580-70655-2

Date Collected: 08/14/17 11:20

Matrix: Solid

Date Received: 08/16/17 10:55

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	254127	08/18/17 16:03	REY	TAL SEA

Client Sample ID: PMW-20-5.5-6.5

Lab Sample ID: 580-70655-2

Date Collected: 08/14/17 11:20

Matrix: Solid

Date Received: 08/16/17 10:55

Percent Solids: 82.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			254384	08/23/17 08:35	JSM	TAL SEA
Total/NA	Analysis	8260C		1	254407	08/23/17 18:47	T1W	TAL SEA
Total/NA	Prep	3546			254048	08/18/17 08:36	APR	TAL SEA
Total/NA	Analysis	8270D SIM		1	254170	08/19/17 19:30	CJ	TAL SEA
Total/NA	Prep	5035			254411	08/23/17 10:38	SHK	TAL SEA
Total/NA	Analysis	NWTPH-Gx		1	254422	08/23/17 15:08	JCV	TAL SEA
Total/NA	Prep	3546			254081	08/18/17 11:59	APR	TAL SEA
Total/NA	Analysis	NWTPH-Dx		1	254821	08/29/17 06:23	CJ	TAL SEA
Total/NA	Prep	3546			254081	08/18/17 11:59	APR	TAL SEA
Total/NA	Cleanup	3630C			254323	08/22/17 14:13	JWL	TAL SEA

Lab Chronicle

Client: ARCADIS U.S. Inc
Project/Site: PIH Olympia Soils

TestAmerica Job ID: 580-70655-1

Client Sample ID: PMW-20-5.5-6.5

Lab Sample ID: 580-70655-2

Date Collected: 08/14/17 11:20
Date Received: 08/16/17 10:55

Matrix: Solid
Percent Solids: 82.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	NWTPH-Dx		1	254821	08/29/17 09:23	CJ	TAL SEA
Total/NA	Prep	3050B			254427	08/23/17 11:41	PAB	TAL SEA
Total/NA	Analysis	6020A		10	254505	08/23/17 14:34	FCW	TAL SEA

Client Sample ID: PMW-21-6.0-6.5

Lab Sample ID: 580-70655-3

Date Collected: 08/14/17 16:00
Date Received: 08/16/17 10:55

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	254127	08/18/17 16:03	REY	TAL SEA

Client Sample ID: PMW-21-6.0-6.5

Lab Sample ID: 580-70655-3

Date Collected: 08/14/17 16:00
Date Received: 08/16/17 10:55

Matrix: Solid
Percent Solids: 73.9

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			254258	08/15/17 14:30	IWH	TAL SEA
Total/NA	Analysis	8260C		1	254880	08/21/17 23:31	TL1	TAL SEA
Total/NA	Prep	3546			254048	08/18/17 08:36	APR	TAL SEA
Total/NA	Analysis	8270D SIM		1	254170	08/19/17 19:52	CJ	TAL SEA
Total/NA	Prep	5035			254411	08/23/17 10:38	SHK	TAL SEA
Total/NA	Analysis	NWTPH-Gx		1	254422	08/23/17 15:39	JCV	TAL SEA
Total/NA	Prep	3546			254081	08/18/17 11:59	APR	TAL SEA
Total/NA	Analysis	NWTPH-Dx		1	254821	08/29/17 06:45	CJ	TAL SEA
Total/NA	Prep	3546			254081	08/18/17 11:59	APR	TAL SEA
Total/NA	Cleanup	3630C			254323	08/22/17 14:13	JWL	TAL SEA
Total/NA	Analysis	NWTPH-Dx		1	254821	08/29/17 10:08	CJ	TAL SEA
Total/NA	Prep	3050B			254427	08/23/17 11:41	PAB	TAL SEA
Total/NA	Analysis	6020A		10	254505	08/23/17 14:37	FCW	TAL SEA

Laboratory References:

TAL SEA = TestAmerica Seattle, 5755 8th Street East, Tacoma, WA 98424, TEL (253)922-2310

Accreditation/Certification Summary

Laboratory: TestAmerica Seattle

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	EPA Region	Identification Number	Expiration Date
Alaska (UST)	State Program	10	UST-022	03-02-18
California	State Program	9	2901	01-31-18
L-A-B	DoD ELAP		L2236	01-19-19
L-A-B	ISO/IEC 17025		L2236	01-19-19
Montana (UST)	State Program	8	N/A	04-30-20
Oregon	NELAP	10	WA100007	11-05-17
US Fish & Wildlife	Federal		LE058448-0	10-31-18
USDA	Federal		P330-14-00126	02-10-20
Washington	State Program	10	C553	02-17-18

Sample Summary

Client: ARCADIS U.S. Inc
Project/Site: PIH Olympia Soils

TestAmerica Job ID: 580-70655-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
580-70655-1	PMW-19-5.5-6.5	Solid	08/14/17 14:00	08/16/17 10:55
580-70655-2	PMW-20-5.5-6.5	Solid	08/14/17 11:20	08/16/17 10:55
580-70655-3	PMW-21-6.0-6.5	Solid	08/14/17 16:00	08/16/17 10:55

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Loc: 580
70655

TestAmerica Seattle
5755 8th Street E.
Tacoma, WA 98424
Tel. 253-922-2310
Fax 253-922-5047
www.testamericainc.com

☐ Rush
☐ Short Hold

Chain of Custody Record

Client: Arcadis
Client Contact: Ross La Grandeur
Date: 8/14/17
Chain of Custody Number: 31471
Address: 1100 Olive Way, Suite 800
Telephone Number (Area Code)/Fax Number: 831-229-4548
Lab Number:
Page 1 of 1
City: Seattle
State: WA
Zip Code: 98101
Sampler: Alex Pink
Lab Contact:
Project Name and Location (State): PIH Olympia Soils, WA
Billing Contact: Rory Henneck
Contract/Purchase Order/Quote No.:

Sample I.D. and Location/Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	MeOH	DRO/RRO by NWTPH-Dx with SGC	DRO/RRO by NWTPH-Dx w/o SGC	cPAHs + Naph. by 8270D SIM	Lead by 6020A	GRO by NWTPH-Gx	BTEX/MTBE/EDC/EDB - 8260C						Special Instructions/ Conditions of Receipt
PMW-19-5.5-6.5	8/14/17	1400				X		3						1	X	X	X	X	X	X						Frozen at
PMW-20-5.5-6.5	8/14/17	1120				X		3						1	X	X	X	X	X	X						1430 on 8/15/17
PMW-21-6.0-6.5	8/14/17	1600				X		3						1	X	X	X	X	X	X						
																										Questions or
																										concerns call
																										Alex Pink -
																										906-440-8394

580-70655 Chain of Custody

TB___ **Cooler** IR4 **Cor** 5.5 **Unc** 5.6
Cooler Dsc [illegible] **@Lab** 1335
Wet/Packs **Packing** Bubble
w/o

Cooler
☐ Yes ☐ No Cooler Temp: ____

Possible Hazard Identification
☑ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☑ Disposal By Lab ☐ Archive For ____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required (business days)
☐ 24 Hours ☐ 48 Hours ☐ 5 Days ☐ 10 Days ☐ 15 Days ☐ Other Standard TAT

QC Requirements (Specify)

1. Relinquished By Sign/Print: Paul T. McCullough / Paul T. McCullough	Date: 8/16/17	Time: 1055	1. Received By Sign/Print: / Francisco Luna, J.	Date: 8/16/17	Time: 1055
2. Relinquished By Sign/Print:	Date:	Time:	2. Received By Sign/Print:	Date:	Time:
3. Relinquished By Sign/Print:	Date:	Time:	3. Received By Sign/Print:	Date:	Time:

Comments

DISTRIBUTION: WHITE – Stays with the Samples; CANARY – Returned to Client with Report; PINK – Field Copy

TAL-8274-580 (0210)

Login Sample Receipt Checklist

Client: ARCADIS U.S. Inc

Job Number: 580-70655-1

Login Number: 70655
List Number: 1
Creator: Gall, Brandon A

List Source: TestAmerica Seattle

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	Lab does not accept radioactive samples.
The cooler's custody seal, if present, is intact.	N/A	Not present
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	False	4 DI Stirbar vials broke while in the freezing process.
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

APPENDIX C

SOP: Soil-Gas Sampling and Analysis Using Sorbent Tubes

Design & Consultancy
for natural and
built assets

Soil-Gas Sampling and Analysis Using Sorbent Tubes

Rev. #: 0

Rev Date: June 17, 2016

Approval Signatures

Eric

Prepared by: ______________________________ Date: 6/17/2016

Eric Cathcart

Mitch Wacksman

Approved by: ______________________________ Date: 6/17/2016

Mitch Wacksman

I. Scope and Application

This document describes the procedures to collect subsurface soil-gas samples from sub-slab sampling ports and soil vapor monitoring points for the analysis of volatile organic compounds (VOCs) including volatile polyaromatic hydrocarbons (PAHs) using sorbent tubes. These samples are analyzed by United States Environmental Protection Agency (USEPA) Method TO-17 (TO-17).

The sorbent tube method uses a glass or stainless steel tube packed with a sorbent material. Sorbents of increasing strength and composition are packed within the tube. The specific sorbent material packed within each tube is selected based on the target compounds and desired reporting limits. A measured volume of soil-gas is passed through the tube during sample collection.

Following sample collection the sorbent tube is sent to the laboratory where the sampling media is analyzed for the target compounds.

The following sections list the necessary equipment and provide detailed instructions for the collection of soil-gas samples fusing sorbent tubes.

Soil vapor samples can be collected from sub-slab sample probes or soil-vapor ports. Refer to the appropriate standard operating procedure (SOP) from the Arcadis SOP library for a description of construction methods.

II. Personnel Qualifications

Arcadis field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. Arcadis field sampling personnel will be well versed in the relevant standard operating procedures (SOPs) and possess the required skills and experience necessary to successfully complete the desired field work. Arcadis personnel responsible for leading soil-gas sample collection activities must have previous soil-gas sampling experience.

III. Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. For sub-slab vapor probe installation, drilling with an electric concrete impact drill should be done only by personnel with prior experience using such a piece of equipment and with the appropriate health and safety measures in place as presented in the JSA

IV Equipment List

The equipment required for collect soil-gas samples for analysis using method sorbent tubes is presented below:

- Appropriate personal protective equipment (PPE; as presented in the site specific HASP and the JLA)
- Sorbent tubes pre-packed by the laboratory with the desired sorbent. Specific sorbents will be recommended by the laboratory considering the target compound list and the necessary reporting limits;
- One decontaminated Swagelok or stainless-steel or comparable two-way ball or needle valves (sized to match sample tubing) per sample.
- 1/4-inch outer diameter (OD) tubing (Teflon®, Teflon-lined polyethylene or Nylon [aka Nylaflow]) (referred to throughout as “tubing”);
- Stainless steel or comparable Swagelok® or equivalent compression fittings for 1/4-inch OD tubing;
- One Stainless steel duplicate “T” fittings (if duplicate sample collection is necessary);
- Two 60mL syringe (one needs to be equipped with 3-way valve if employing a tracer gas leak test);
- Integrity testing supplies (depending on site conditions could employ a helium leak test or a water dam test. Arcadis SOPs for both can be found on the Source);
- Appropriate-sized open-end wrench (typically 9/16-inch, 1/2-inch , and 3/4-inch);
- Tubing cutter
- Portable weather meter, if appropriate;
- Chain-of-custody (COC) form;
- Sample collection log;

- Cooler;
- Gel ice (e.g., blue ice); and
- Field notebook.

V. Cautions

The following cautions and field tips should be reviewed and considered prior to collecting soil-gas samples.

- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.
- Care should be taken to ensure that the appropriate sorbent is used in the sorbent tube preparation. Sorbent should be selected in consultation with the analytical laboratory and in consideration of the target compound list, the necessary reporting limits and the expected range of concentrations in field samples. The expected range of concentrations in field samples may be estimated from previous site data, release history and professional judgment informed by the conceptual site model.
- Flow rates for sample collection with sorbent tubes should be determined well in advance of field work in consultation with the laboratory.
- A Shipping Determination must be performed, by DOT-trained personnel, for all environmental samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.
- At the sampling location, keep the tubes in their storage and transportation container to equilibrate with ambient temperature prior to attaching to the sample train.
- Ensure the sample train is set up so that the flow across the sorbent tube is in the proper direction.
- Always use clean gloves when handling sampling tubes.
- Seal clean, blank sorbent tubes and sampled tubes using inert, Swagelok®-type fittings and appropriate, clean ferrules. Wrap capped tubes individually in uncoated aluminum foil. Use clean, sealable glass jars or metal cans containing a small packet of activated charcoal or activated charcoal/silica gel for storage and transportation of multiple tubes. This activated charcoal is not

analyzed, but serves as a protection for the analytical sorbent tube. Store the multi-tube storage container in a clean environment at 4ºC.

- Keep the sample tubes inside the storage container during transportation and only remove them at the monitoring location after the tubes have reached ambient temperature. Store sampled tubes in a refrigerator at 4ºC inside the multi-tube container until ready for analysis.

- Do not overtighten the caps on the sorbent tubes. Use only a quarter turn past finger tight. Tubes cannot be analyzed if caps are overtightened and the fitting becomes crimped.

- The purge flow rate should be consistent with the sample collection rate as determined in consultation with the lab prior to field activities. Record the measured flow rate a during sample collection.

- If possible, have equipment shipped a two or three days before the sampling date so that all materials can be checked. Order replacements if needed.

- Requesting extra sorbent tubes from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.

- Shallow exterior soil-gas sampling should not proceed within 5 days following a significant rain event (1/2-inch of rainfall or more).

VI. Procedure

Soil-Gas Sample Preparation

<u>Selection of Sorbent and Sampling Volume (to be completed prior to sampling event)</u>

1. Identify the necessary final reporting limit for the target compound(s) in accordance with the project quality assurance plan and/or in consultation with the data end user.

2. Identify the necessary method reporting limit(s). The laboratory will be helpful in providing this information as it is typically specific to the sensitivity of the instrumentation.

3. The minimum sampling volume is the volume of soil-gas sample that must be drawn through the sorbent in order to achieve the desired final reporting limit. Calculate the minimum sampling volume using the following equation:

$$Minimum\ Sampling\ Volume\ (L) = \frac{Final\ Reporting\ Limit\ (\mu g)}{Action\ Level\ (\mu g/m^3)} \times \frac{1{,}000\ L}{m^3}$$

Where:

L = liters

µg = microgram

m = meter

4. If a timed sample duration is specified in the work plan, calculate the minimum flow rate. The minimum flow rate is the flow rate necessary to achieve the minimum sampling volume using the following formula:

$$Minimum\ Flow\ Rate\ (L/min) = \frac{Minimum\ Sampling\ Volume\ (L)}{Sample\ Duration\ (min)}$$

Where:

min = minutes

Then compare the minimum flow rate calculated to the requirements for maximum soil gas sampling without excessive danger of short circuiting, normally stated as 0.2 liters/minute, although it can be lower in tight soils. Soil vapor sampling flow rates should not exceed 200 ml/min.

5. Compare the minimum sampling volume to the safe sampling volume (SSV) for the sorbents selected. SSV for specific sorbents can be provide by the manufacture or the laboratory, being used (Table 1 and Appendix 1 in Method TO-17). Ensure that the compound will not breakthrough when sampling the volume calculated above.

Soil-Gas Sample Collection

<u>Assembly of sorbent tube sampling train</u>

1. Record the following information in the field notebook, if appropriate (contact the local airport or other suitable information source [e.g., site-specific measurements, weatherunderground.com] to obtain the information):

   a. wind speed and direction;

   b. ambient temperature;

    c. barometric pressure; and

    d. relative humidity.

2. If samples are being collected from temporary or permanent soil vapor points simply remove the cap or plug and proceed to step 3. When collecting samples from a sub-slab port remove the cap or plug from the sampling port or Vapor Pin^{TM}. Connect a short piece of tubing to the sampling port using a Swagelok or equivalent stainless-steel or comparable compression fitting or silicone tubing for barbed Vapor Pin^{TM} installations.

3. Connect the tubing to a stainless steel two-way valve using a Swagelok or comparable compression fitting (Figure 1).

4. Attach a length of tubing to the other end of the two way valve.

5. Connect the 60mL purge syringe to the tubing using a short piece of silicon tubing. **Figure 1** presents the set up for Shut-in and Integrity Testing.

<u>Purging Sample Train Prior to Sample Collection</u>.

1. Ensure the two-way valve is open. Slowly (<200 mL/min) purge three volumes of air from the vapor probe and sampling line using the 60mL syringe using the same flow rate that will be used to collect the sample.

2. Check the seal established around the soil vapor probe and the sampling train fittings by using a tracer gas (e.g., helium) or other method (e.g., water dam) as appropriate for site conditions. [SOPs for integrity testing methods can be found on the Source]

3. Utilize a Tedlar bag to collect purged air via the 3-way valve on the purge syringe. If utilizing a tracer gas, analyze the contents of the Tedlar bag for the tracer gas following the purge process using and appropriate field screening instrument.

<u>Sorbent Tube Sample Collection</u>

1. Record in the field notebook and COC form the tube number on the sorbent tube.

2. Close two-way valve and remove purge syringe and associated silicon tubing from sample train.

3. Attach sorbent tube to Swagelok valve using laboratory provided fitting or to the terminal end of tubing with proper orientation per figure below:

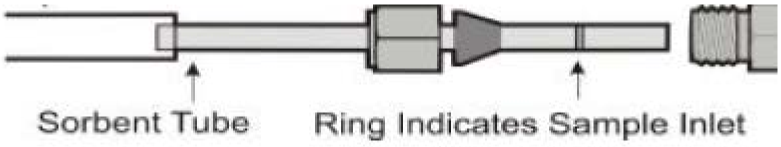


Figure 2 presents the full sample train assembly.

4. Ensure the two-way valve is closed at this time. Attempt to pull a small volume from the sample train system using the purge syringe to conduct shut-in test.

5. If all fittings are air tight the syringe plunger should try to return to its original position. If the vacuum is lost adjust fittings as needed and repeat process. Note: Sample media should be replaced if shut-in test fails.

6. Begin sampling by pulling air through the tubing with the syringe (use a separate syringe than the one used for purging). Use a stopwatch to ensure the flow rate is <200 mL/min. Record in the field notebook and the field sample log the time sampling began and the approximate flow rate from each of the samples.

<u>Termination of Sample Collection</u>

1. Close the two-way valve after the pre-set volume of air has been drawn through the sorbent tube.

2. Record the stop time.

3. Remove sorbent tube from sample train and replace Swagelok caps on both ends of the tube. **<u>Do not overtighten the caps</u>**. Use only a quarter turn past finger tight.

4. Record in the field log book, the sample collection log, and on the COC.

5. Package the tubes according to laboratory protocol on gel ice and ship to the laboratory for analysis.

VII. Waste Management

The waste materials generated during sampling activities should be minimal. PPE, such as gloves and other disposable equipment (e.g., tubing), will be collected by field personnel for proper disposal.

VIII. Data Recording and Management

Measurements will be recorded in the field notebook at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure), tube type and number and sample volume. Field sampling logs and COC records will be transmitted to the Project Manager.

IX. Quality Assurance

Duplicate samples should be collected in the field as a quality assurance step. Generally, duplicates are taken of 10% of samples, but project specific requirements should take precedence. Duplicate soil gas samples should be collected via a split sample train, allowing the primary and duplicate sample to be collected from the soil-gas probe simultaneously.

Field blanks should be collected at a frequency of once per day. Field blank collection consists of removing the Swagelok caps on both ends of a sorbent tube exposing the media to the sampling environment and immediately replacing the caps. Field blanks should be submitted for analysis for quality assurance purposes.

Quality assurance planning for method TO-17 should take careful note of the method requirement for distributed volume pairs. Although in some circumstances this requirement may be waived, this does constitute a deviation from the method as written. It is wise to discuss this decision with clients and/or regulators before sampling.

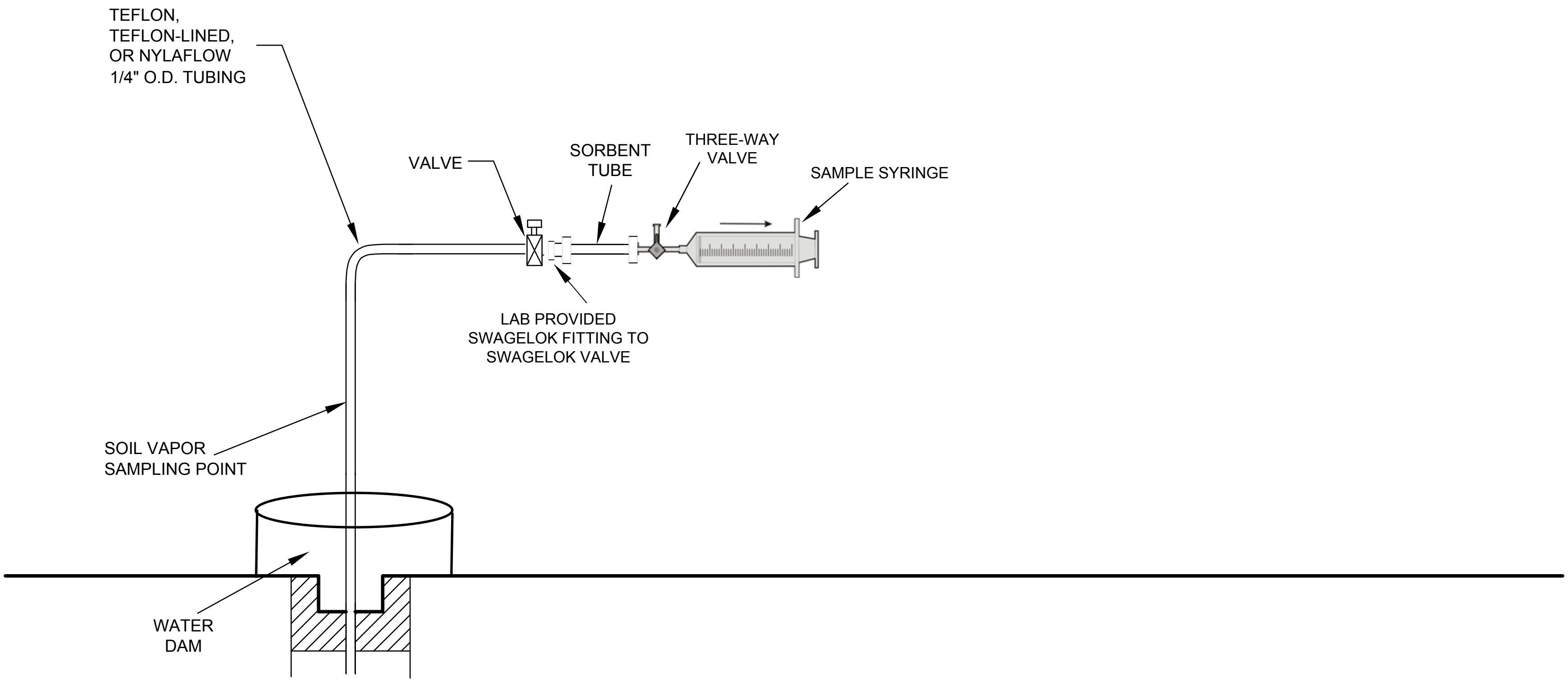
Soil-gas sample analysis will be performed using USEPA TO-17 methodology for a site specific constituent list defined in the work plan. Constituent lists and reporting limits must be discussed with the laboratory prior to mobilizing for sampling. Quality assurance parameters should be confirmed with the laboratory prior to sampling. Field quality assurance parameters should be defined in the site-specific work plan. A trip blank sample should accompany each shipment of soil-gas samples to the laboratory for analysis. Trip blanks assess potential sample contamination resulting from the transportation and storing of samples.

X. References

New York State Department of Health (NYSDOH). 2005. DRAFT “Guidance for Evaluating Soil Vapor Intrusion in the State of New York” February 23, 2005.

AirToxics Ltd. “Sorbent & Solution Sampling Guide.”

CITY: PETALUMA, CA DIV/GROUP: ENV DB: J. HARRIS
C:\U□er□\j□arri□\De□□top\ENVCAD\B0046508\0003\00012\DWG\46508T05.dwg LAYOUT: 1 SAVED: 6/11/2013 6:11 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: SETUP1 PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 6/11/2013 6:30 PM BY: HARRIS, JESSICA
XREFS: IMAGES: PROJECTNAME: ----



ARCADIS SOP: SOIL-GAS SAMPLING AND ANALYSIS USING SORBENT TUBES

SOIL VAPOR POINT SAMPLE TRAIN

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

APPENDIX D

Standard Operating Procedure, Installation and Extraction of the VaporPin®, prepared by Cox-Colvin and Associates, Inc.

Standard Operating Procedure Installation and Extraction of the Vapor Pin®

Updated September 9, 2016

Scope:

This standard operating procedure describes the installation and extraction of the VAPOR PIN® for use in sub-slab soil-gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the VAPOR PIN® for the collection of sub-slab soil-gas samples or pressure readings.

Equipment Needed:

- Assembled VAPOR PIN® [VAPOR PIN® and silicone sleeve(Figure 1)]; Because of sharp edges, gloves are recommended for sleeve installation;
- Hammer drill;
- 5/8-inch (16mm) diameter hammer bit (hole **must** be 5/8-inch (16mm) diameter to ensure seal. It is recommended that you use the drill guide). (Hilti™ TE-YX 5/8" x 22" (400 mm) #00206514 or equivalent);
- 1½-inch (38mm) diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾-inch (19mm) diameter bottle brush;
- Wet/Dry vacuum with HEPA filter (optional);
- VAPOR PIN® installation/extraction tool;
- Dead blow hammer;
- VAPOR PIN® flush mount cover, if desired;
- VAPOR PIN® drilling guide, if desired;
- VAPOR PIN® protective cap; and
- VOC-free hole patching material (hydraulic cement) and putty knife or trowel for repairing the hole following the extraction of the VAPOR PIN®.

Figure 1. Assembled VAPOR PIN®

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½-inch (38mm) diameter hole at least 1¾-inches (45mm) into the slab. Use of a VAPOR PIN® drilling guide is recommended.

4) Drill a 5/8-inch (16mm) diameter hole through the slab and approximately 1-inch (25mm) into the underlying soil to form a void. Hole **must** be 5/8-inch (16mm) in diameter to ensure seal. It is recommended that you use the drill guide.

Nylaflow tubing as close to the VAPOR PIN® as possible to minimize contact between soil gas and Tygon™ tubing.

Figure 5. VAPOR PIN® sample connection

10) Conduct leak tests in accordance with applicable guidance. If the method of leak testing is not specified, an alternative can be the use of a water dam and vacuum pump, as described in SOP Leak Testing the VAPOR PIN® via Mechanical Means (Figure 6). For flush-mount installations, distilled water can be poured directly into the 1 1/2 inch (38mm) hole.

Figure 6. Water dam used for leak detection

11) Collect sub-slab soil gas sample or pressure reading. When finished, replace the protective cap and flush mount cover until the next event. If the sampling is complete, extract the VAPOR PIN®.

Extraction Procedure:

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the VAPOR PIN® (Figure 7). Turn the tool clockwise continuously, don't stop turning, the VAPOR PIN® will feed into the bottom of the installation/extraction tool and will extract from the hole like a wine cork, DO NOT PULL.

2) Fill the void with hydraulic cement and smooth with a trowel or putty knife.

Figure 7. Removing the VAPOR PIN®

- Prior to reuse, remove the silicone sleeve and protective cap and discard. Decontaminate the VAPOR PIN® in a hot water and Alconox® wash, then heat in an oven to a temperature of 265° F (130° C) for 15 to 30 minutes. For both steps, **STAINLESS – ½ hour, BRASS 8 minutes**

3) Replacement parts and supplies are available online.

VAPOR PIN® protected under US Patent # 8,220,347 B2, US 9,291,531 B2 and other patents pending

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of VAPOR PIN® assembly into the drilled hole. Place the small hole located in the handle of the installation/extraction tool over the vapor pin to protect the barb fitting, and tap the vapor pin into place using a dead blow hammer (Figure 2). Make sure the installation/extraction tool is aligned parallel to the vapor pin to avoid damaging the barb fitting.

Figure 2. Installing the VAPOR PIN®

During installation, the silicone sleeve will form a slight bulge between the slab and the VAPOR PIN® shoulder. Place the protective cap on VAPOR PIN® to prevent vapor loss prior to sampling (Figure 3).

Figure 3. Installed VAPOR PIN®

7) For flush mount installations, cover the vapor pin with a flush mount cover, using either the plastic cover or the optional stainless-steel Secure Cover (Figure 4).

Figure 4. Secure Cover Installed

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to re-equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the VAPOR PIN®. This connection can be made using a short piece of Tygon™ tubing to join the VAPOR PIN® with the Nylaflow tubing (Figure 5). Put the

APPENDIX E

Eurofins Sorbent & Solution Sampling Guide

SORBENT & SOLUTION SAMPLING GUIDE

TABLE OF CONTENTS

1.0 Introduction

2.0 Sorbent Sampling

2.2 Method Specific Sampling Instructions

3.0 Solution Sampling

3.1 Method Specific Sampling Instructions

4.0 Filter Sampling

4.1 Method Specific Sampling Instructions

1.0 INTRODUCTION

Air Toxics Ltd. presents this guide as a resource for 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 sampling equipment and media. 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 address the multitude of actual field conditions. Note that this guide is intended for typical projects involving sampling of volatile and semi-volatile organic compounds (VOCs and SVOCs) with sorbent tubes and impingers, and airborne particulates with filters. Air Toxics Ltd. also provides a "Guide to Air Sampling and Analysis – Canisters and Tedlar Bags" for whole air sampling of VOCs.

2.0 INTRODUCTION TO SORBENT SAMPLING

Using a sorbent to collect an air sample normally involves "active" sampling, unlike an evacuated canister that can be filled "passively" by simply opening the valve. The most common method to draw an air sample through a sorbent device is to use a small pump with low flow rates between 10 to 200 milliliters per minute (mL/min) and tubing for connecting the components. For high volume applications, a high volume air sampler can be used with a larger sorbent cartridge.

Determining the Safe Sampling Volume

Determining the appropriate volume of air sample to draw through a sorbent tube is critical to achieving the data quality objectives. The tendency is to increase the sampling volume in order to lower the final reporting limit.

Note that over-sampling may saturate the sorbent tube and allow the target compound to breakthrough. *See method for volume guidelines.*

2.0 Introduction To Sorbent Sampling

It is imperative to know the flow rate through the sorbent tube and the sampling interval. A "set up" sorbent tube is often used to set the pump flow rate. It must be very similar to the actual sorbent tube being used for sample collection. The pressure drop through the sorbent tube determines the flow rate for a given pump setting. The flow rate through the sorbent tube should be monitored continuously (or at least periodically) using a rotometer or electronic flow sensor. If the sampling flow rate is greater than 200 mL/min, simple rotometers and electronic flow sensors cannot be used. It is necessary to use a device capable of measuring high flow rates. Refer to the method for information on the proper method of measuring the flow.

Common Sorbent Sampling Trains

The sampling train generally includes a sorbent tube, pump, and optional components such as a needle valve, particulate filter, and rotometer or electronic flow sensor. The sorbent tube is generally the first component in a sampling train, with the tubing and pump located downstream to minimize contamination of the sample.

The sorbent tube should be upstream of the pump.

For thermal desorption methods, it is critical that the air be drawn through the inlet side of the tube. The inlet side may be marked with a ring or the sampling direction may be indicated with an arrow. Proper orientation is especially important when using the multi-bed sorbent tubes described in EPA Method TO-17. If the low vapor pressure compounds are adsorbed on the high surface area sorbent (i.e., the one designed for gaseous compounds like vinyl chloride), they cannot be removed at the desorption temperatures routinely used.

For thermal desorption methods, the sorbent tube must be sampled in the appropriate direction.

Possible Components of a Sorbent Sampling Train

Tubing and Fittings: The components in the sampling train are connected with tubing and fittings as needed. Because tubing used to connect the sorbent tube to the pump does not come in contact with the air sample, the tubing material can be selected on its ability to seal. Tygon is an excellent material for this purpose, although Nylon and Teflon can be used. The length of tubing connecting the pump to the sorbent tube is not critical. Many sorbent tubes accept 1/4 in. Swagelok fittings and 1/4 in O.D. tubing.

Note that if the tubing is in the sample stream then it is necessary to select the appropriate grade material.

Needle Valve: If a variable speed/adjustable rate air sampling pump is not available, a needle valve can be used to adjust the flow rate. A rotometer (see the following section) with a built-in needle valve can provide an economical solution to adjust and measure sampling flow rate.

Rotometer or Electronic Flow Sensor: Although the flow rate for an air sampling pump can be calibrated before use, it is often desirable to include a flow measuring device in the sampling train. Note that the flow rate produced by a pump can decrease as more components are added to the sampling train. A rotometer is a relatively inexpensive meter that indicates flow with a small weight in a tapered column. As flow increases, air resistance of the weight increases and raises the weight until it is equilibrium with gravity. For best results, the rotometer must be kept vertical and free of particulates or moisture. An electronic flow sensor can provide more precise flow measurement than a rotometer, but is considerably more expensive. Both devices have optimum working ranges of flow rate (e.g., a typical rotometer may provide measurement from 100 to 500 mL/min).

Particulate Filter: If the air sample is known to have high levels of particulate matter, it may be necessary to place a filter at the sorbent tube inlet. In this case, the connecting tubing between the filter and the sorbent tube will be in the sampling stream and it should be new Teflon and as short as possible.

2.1 CONSIDERATIONS FOR SORBENT SAMPLING

Sorbent sampling requires the determination of the optimal sampling parameters: sample volume, flow rate and duration.

Appropriate sample volume should be determined by the media capacity and the required RLs. Matrix constituents such as water vapor and other non-target compounds should also be considered. See method specific sections for media capacity information and use the calculation provided to determine sample volume needed to meet specific RLs.

Determine the Final Reporting Limit for the Target Compound: the concentration may be a risk-based action level or EPA preliminary remediation goal (PRG).

Determine the Method Reporting Limit: the mass value is provided by the laboratory and is based on the analytical method selected and the sensitivity of the instrumentation. The method reporting limit may vary for each target compound.

Calculate the Sampling Volume: use the equation on the next page to determine the volume of air sample that must be drawn through the sorbent in order to achieve the final reporting limit.

Compare the Sampling Volume to the SSV: Refer to tables of safe sampling volume (SSV) for the sorbent being used – (e.g., Table 1 and Appendix 1 in Method TO-17). If the SSV for the compound of interest is not available, use the SSV of a compound in the same class (e.g., toluene for xylene, chloroform for carbon tetrachloride, etc.) and ensure that the compound will not breakthrough when sampling the volume calculated using the equation above. If breakthrough is a possibility, select a sorbent with greater sorbent strength (i.e., surface area).

2.1 Considerations For Sorbent Sampling

1) Calculate Minimum Sample Volume

$$\text{Minimum Volume (L)} = \frac{\text{Reporting Limit (ug)}}{\text{Action Level (ug/m}^3\text{)}} * \frac{1000\ \text{L}}{\text{m}^3}$$

Example: Screening Level = 0.08 ug/m³

$$\text{Minimum Volume (L)} = \frac{0.05\ \text{ug}}{0.08\ \text{ug/m}^3} * \frac{1000\ \text{L}}{\text{m}^3} = 625\ \text{Liters}$$

2) Calculate Minimum Flow Rate if time duration is set.

$$\text{Minimum Flow Rate (L/min)} = \frac{\text{Minimum Volume (L)}}{\text{Duration (min)}}$$

Example: TWA of 24 hours

$$\text{Minimum Flow Rate (L/min)} = \frac{625\ \text{L}}{24\ \text{hour}} * \frac{\text{hour}}{60\ \text{min}} = 0.44\ \text{L/min}$$

3) Calculate if Overloading of tube is possible.

For a source-impacted environment, estimate total concentration to estimate maximum volume. A safe sampling volume is considered to be 75% or less of the cartridge capacity.

Example: the standard TO-11A cartridge supplied by Air Toxics has a capacity of approximately 75 ug total carbonyls.

$$\text{Estimated maximum volume (L)} = \frac{(0.75 * 75\ \text{ug})}{\text{Est. Form. Conc (ug/m}^3\text{)}} * \frac{1000\ \text{L}}{\text{m}^3}$$

Example: Source-impacted site 3 ppmv (3700 ug/m³) Formaldehyde

$$\text{Estimated maximum volume (L)} = \frac{0.75 * 75\ \text{ug}}{3700\ \text{ug/m}^3} * \frac{1000\ \text{L}}{\text{m}^3} = 15\ \text{L}$$

2.1 CONSIDERATIONS FOR SORBENT SAMPLING

Avoid Over Sampling: The adage, "more is better", often finds its way into sorbent sampling practice. In attempting to ensure low reporting limits, you may over sample a sorbent tube – especially if concentrations of target compounds are higher than expected.

Use a Backup Sorbent Tube: The use of a second, or "backup", sorbent tube in series can help prevent compound breakthrough. Even if a safe sampling volume was calculated and not exceeded during sampling, a backup sorbent tube can provide insurance. The backup sorbent tube is only analyzed if a predetermined level of a given compound or total mass is found on the first tube. While the use of a backup sorbent tube will increase media costs, it usually has little effect on sampling costs. It will, however, provide definitive support for data integrity.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method TO-4A

Determination of Pesticides and Polychlorinated Biphenyls (PCBs) in Ambient Air using High Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic / Electron Capture Detector (GC/ECD)

http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-4ar2r.pdf

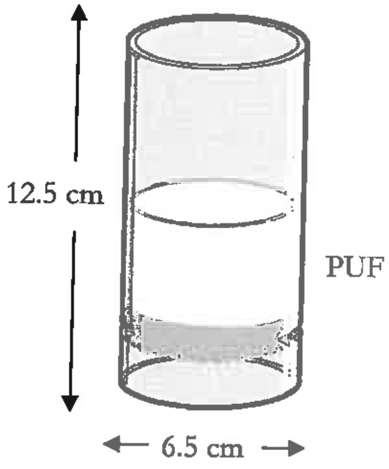
This method is applicable for the sample collection and analysis of pesticides and PCBs in ambient air. See pages 4A-32 and 4A-34 of the method for sampling diagrams.

TO-4A

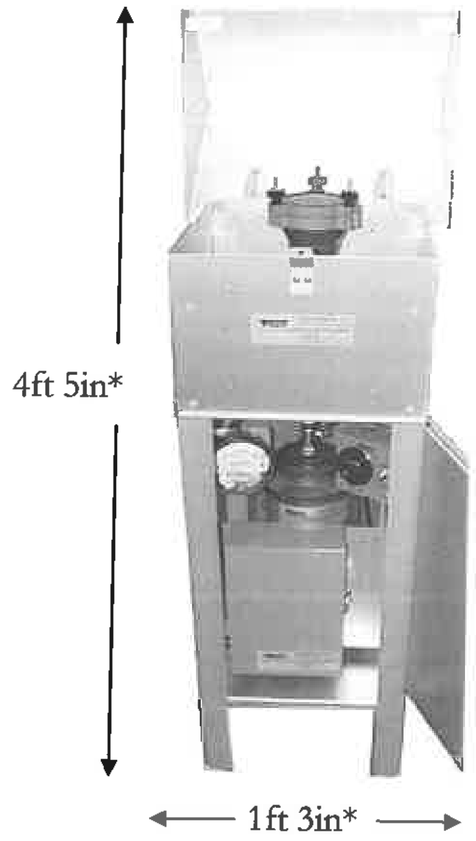
Media	PUF Cartridge (high volume) with Filter (quartz fiber)
Type of Pump	High volume sampler; flow rate capability of (~10cfm)
Sampling Rate and Interval	0.225 m^3/min for up to 24 hours
Sampling Volume	Up to 300 m^3. Determined by user (as needed to achieve project reporting limits)
Sample Handling	Handle with aluminum foil and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Field QC	At least 1 field blank; it is to be treated exactly like a sample except no air is drawn through the cartridge

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

TO-4A Cartridge



PS1 Sampler



Note: This method was developed using the PS-1 semi-volatile sampler provided by General Metal Works, Village of Cleves, OH as a guideline. EPA has experience in use of this equipment during various field monitoring programs over the last several years. Other manufacturers' equipment should work as well. However, modifications to these procedures may be necessary if another commercially available sampler is selected.

* Manufacturers include: Tisch Environmental, Anderson Instruments, and Thermo Environmental Instruments. Equipment specifications may vary by manufacture.

EPA Method TO-10A

Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air using Low Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic / Electron Capture Detector (GC/ECD)

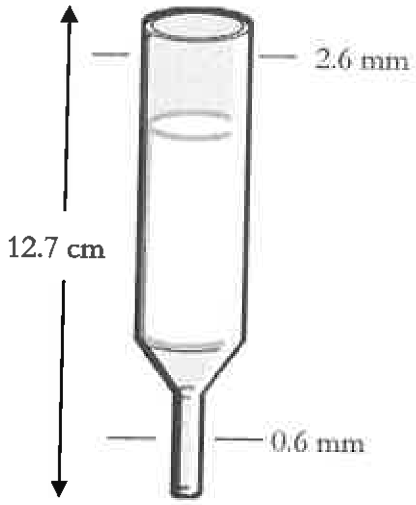
http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-10ar.pdf

This method is applicable for the sample collection and analysis of pesticides and PCBs in ambient air. See pages 10A-26 through 10A-28 of the method for sampling diagrams.

TO-10A

Media	PUF Cartridge (low volume) with or without filter
Type of Pump	Personal/portable continuous flow sampling pump; flow rate capability of 1-5 L/minute
Sampling Rate and Interval	1 to 5 L/min for 4 to 24hrs
Sampling Volume	Determined by user (as needed to achieve project RLs)
Sample Handling	Handle with aluminum foil and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Field QC	At least 1 field blank; it is to be treated exactly like a sample except no air is drawn through the cartridge

TO-10A PUF Cartridge - Low Volume



2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method TO-13A

Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air using Gas Chromatography / Mass Spectrometry (GC/MS)

http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-13arr.pdf

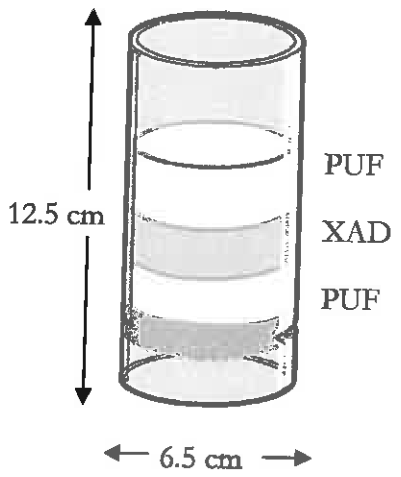
This method is applicable for the analysis of PAHs in ambient air. The high volume PUF/XAD sampling procedure is applicable for a 24-hr sampling period. See pages 13A-55 and 13A-56 of the method for sampling diagrams.

TO-13A

Media	PUF/XAD Cartridge (high volume) with Filter (quartz fiber)
Type of Pump	High volume sampler*; flow rate capability of (~10cfm)
Sampling Rate and Interval	0.225 m^3/min for up to 24 hours
Sampling Volume	Up to 300 m^3. Determined by user (as needed to achieve project reporting limits)
Sample Handling	Handle with aluminum foil and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Field QC	At least 1 field blank; it is to be treated exactly like a sample except no air is drawn through the cartridge

2.2 Method Specific Sampling Instructions

TO-13A PUF/XAD Cartridge



PS1 Sampler

Note: This method was developed using the PS-1 semi-volatile sampler provided by General Metal Works, Village of Cleves, OH as a guideline. EPA has experience in use of this equipment during various field monitoring programs over the last several years. Other manufacturers' equipment should work as well. However, modifications to these procedures may be necessary if another commercially available sampler is selected.

* Manufacturers include: Tisch Environmental, Anderson Instruments, and Thermo Environmental Instruments. Equipment specifications may vary by manufacture.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

Modified EPA Method TO-13A Low Volume

Method TO-13A was intended for sampling SVOCs in ambient air and is generally unsuitable for indoor air applications. Placement of a high volume sampler in a home or office would be considered intrusive and impractical, at best. TO-13A can be modified such that the PUF and XAD-2 sorbent can be packed into a TO-10A cartridge or a XAD tube instead of the usual TO-13A cartridge. The TO-10A cartridge is packed with a combination of XAD-2 and PUF and may be used with or without a particulate filter (see Image 1). The XAD tube is packed with XAD-2 and also may be used with or without a filter (see Image 2). Both of these configurations are illustrated and can be provided by Air Toxics Ltd. on a project-specific basis, upon request.

Because of the pressure drop associated with having a packed bed of XAD-2 resin in the sampling tube, personal sampling pumps (e.g. normally used with small NIOSH sorbent tubes) may prove inadequate, given the large volume of air that must be sampled. These small pumps will have difficulty pulling flows greater than a few mL/min through the tube. A high capacity Kneuberger pump is powered by 12v – using a 12 volt converter or a 12 volt car battery (see Image 3).

Application	Media Type	Considerations
Indoor Air	PUF/XAD Cartridge - Low Volume	Desired volume to meet required reporting limits and desired duration of sampling i.e. 8hrs for an office or 12hrs for a home need to be calculated given the capacity of the car-
Soil Gas	XAD tube	Desired volume to meet required reporting limits considering the amount of vapor that can be collected from soil gas as well as the required flow rate of sampling need to be calculated given the capacity of the tube.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

IMAGE 1

PUF/XAD Cartridge - Low Volume

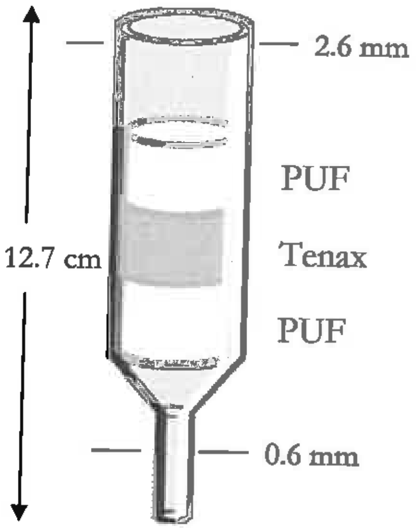


IMAGE 2

XAD Tube

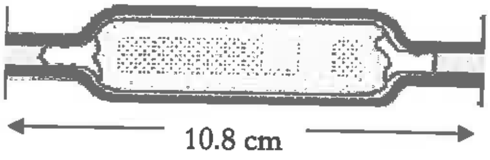
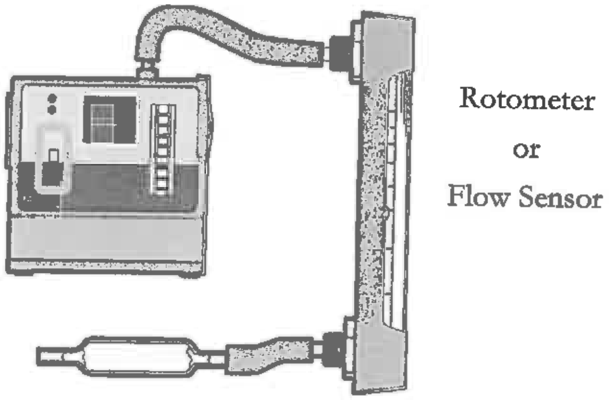


IMAGE 3



2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method 0010/8270C

Modified Method 5 Sampling Train

Determination of Destruction and Removal Efficiency (DRE) of Semivolatile Principal Hazardous Compounds (POHCs) from Incineration Systems and Stationary Sources.

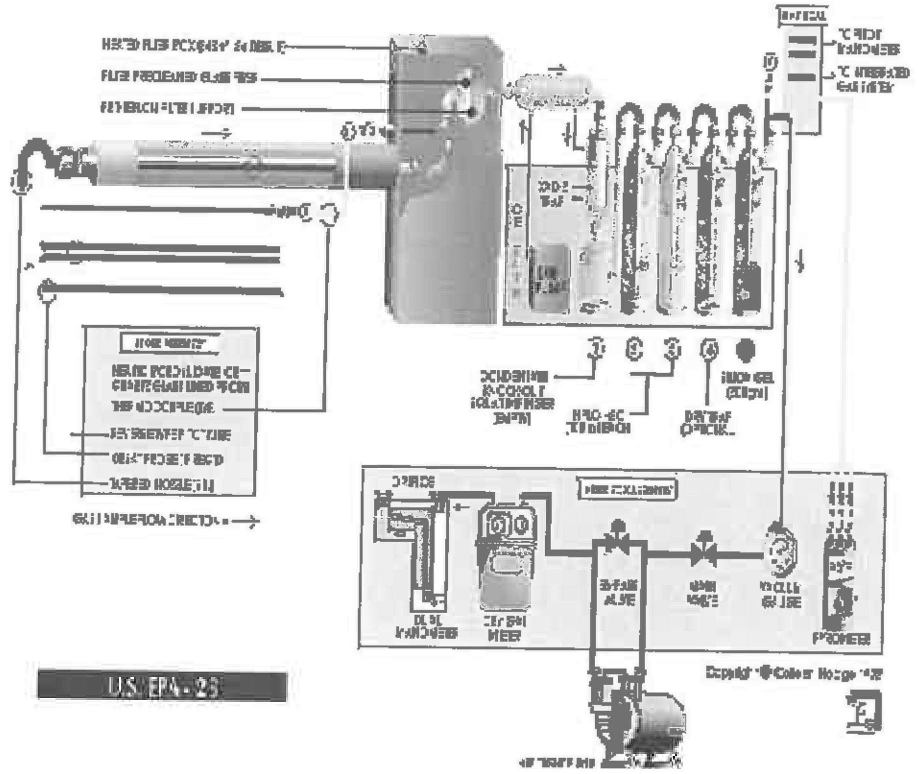
Method 0010 - http://www.epa.gov/epaoswer/hazwaste/test/under.htm

Method 8270C - http://www.epa.gov/epaoswer/hazwaste/test/8_series.htm

0010/8270C Modified Method 5 Sampling Train

Media	Filter (quartz fiber) and sorbent trap (20 g XAD-2)
Type of Pump	Metering system. Pump capable of 4 cfm free flow. see section 4.1.3.9 of method 0010
Sampling Rate and Interval	Determined by user (isokinetic)
Sampling Volume	Determined by user (3 dscm min or as needed to achieve project reporting limits)
Sample Handling	Wrap XAD-2 trap in aluminum foil, and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	14 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Components of the Sample Train	1. Probe 2. Heated Filter 3. XAD-2 Sorbent Trap 4. Impingers 5. Condensates

A typical MM5 sampling train



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SORBENT & SOLUTION SAMPLING GUIDE

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2.0 Sorbent Sampling

3.0 Solution Sampling

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SORBENT & SOLUTION SAMPLING GUIDE

TABLE OF CONTENTS

1.0 INTRODUCTION

Air Toxics Ltd. presents this guide as a resource for 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 sampling equipment and media. 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 address the multitude of actual field conditions. Note that this guide is intended for typical projects involving sampling of volatile and semi-volatile organic compounds (VOCs and SVOCs) with sorbent tubes and impingers, and airborne particulates with filters. Air Toxics Ltd. also provides a "Guide to Air Sampling and Analysis – Canisters and Tedlar Bags" for whole air sampling of VOCs.

2.0 INTRODUCTION TO SORBENT SAMPLING

Using a sorbent to collect an air sample normally involves "active" sampling, unlike an evacuated canister that can be filled "passively" by simply opening the valve. The most common method to draw an air sample through a sorbent device is to use a small pump with low flow rates between 10 to 200 milliliters per minute (mL/min) and tubing for connecting the components. For high volume applications, a high volume air sampler can be used with a larger sorbent cartridge.

Determining the Safe Sampling Volume

Determining the appropriate volume of air sample to draw through a sorbent tube is critical to achieving the data quality objectives. The tendency is to increase the sampling volume in order to lower the final reporting limit.

Note that over-sampling may saturate the sorbent tube and allow the target compound to breakthrough. *See method for volume guidelines.*

2.0 INTRODUCTION TO SORBENT SAMPLING

It is imperative to know the flow rate through the sorbent tube and the sampling interval. A "set up" sorbent tube is often used to set the pump flow rate. It must be very similar to the actual sorbent tube being used for sample collection. The pressure drop through the sorbent tube determines the flow rate for a given pump setting. The flow rate through the sorbent tube should be monitored continuously (or at least periodically) using a rotometer or electronic flow sensor. If the sampling flow rate is greater than 200 mL/min, simple rotometers and electronic flow sensors cannot be used. It is necessary to use a device capable of measuring high flow rates. Refer to the method for information on the proper method of measuring the flow.

Common Sorbent Sampling Trains

The sampling train generally includes a sorbent tube, pump, and optional components such as a needle valve, particulate filter, and rotometer or electronic flow sensor. The sorbent tube is generally the first component in a sampling train, with the tubing and pump located downstream to minimize contamination of the sample.

The sorbent tube should be upstream of the pump.

For thermal desorption methods, it is critical that the air be drawn through the inlet side of the tube. The inlet side may be marked with a ring or the sampling direction may be indicated with an arrow. Proper orientation is especially important when using the multi-bed sorbent tubes described in EPA Method TO-17. If the low vapor pressure compounds are adsorbed on the high surface area sorbent (i.e., the one designed for gaseous compounds like vinyl chloride), they cannot be removed at the desorption temperatures routinely used.

For thermal desorption methods, the sorbent tube must be sampled in the appropriate direction.

2.0 SORBENT SAMPLING

Possible Components of a Sorbent Sampling Train

Tubing and Fittings: The components in the sampling train are connected with tubing and fittings as needed. Because tubing used to connect the sorbent tube to the pump does not come in contact with the air sample, the tubing material can be selected on its ability to seal. Tygon is an excellent material for this purpose, although Nylon and Teflon can be used. The length of tubing connecting the pump to the sorbent tube is not critical. Many sorbent tubes accept 1/4 in. Swagelok fittings and 1/4 in O.D. tubing.

Note that if the tubing is in the sample stream then it is necessary to select the appropriate grade material.

Needle Valve: If a variable speed/adjustable rate air sampling pump is not available, a needle valve can be used to adjust the flow rate. A rotometer (see the following section) with a built-in needle valve can provide an economical solution to adjust and measure sampling flow rate.

Rotometer or Electronic Flow Sensor: Although the flow rate for an air sampling pump can be calibrated before use, it is often desirable to include a flow measuring device in the sampling train. Note that the flow rate produced by a pump can decrease as more components are added to the sampling train. A rotometer is a relatively inexpensive meter that indicates flow with a small weight in a tapered column. As flow increases, air resistance of the weight increases and raises the weight until it is equilibrium with gravity. For best results, the rotometer must be kept vertical and free of particulates or moisture. An electronic flow sensor can provide more precise flow measurement than a rotometer, but is considerably more expensive. Both devices have optimum working ranges of flow rate (e.g., a typical rotometer may provide measurement from 100 to 500 mL/min).

Particulate Filter: If the air sample is known to have high levels of particulate matter, it may be necessary to place a filter at the sorbent tube inlet. In this case, the connecting tubing between the filter and the sorbent tube will be in the sampling stream and it should be new Teflon and as short as possible.

2.1 CONSIDERATIONS FOR SORBENT SAMPLING

Sorbent sampling requires the determination of the optimal sampling parameters: sample volume, flow rate and duration.

Appropriate sample volume should be determined by the media capacity and the required RLs. Matrix constituents such as water vapor and other non-target compounds should also be considered. See method specific sections for media capacity information and use the calculation provided to determine sample volume needed to meet specific RLs.

Determine the Final Reporting Limit for the Target Compound: the concentration may be a risk-based action level or EPA preliminary remediation goal (PRG).

Determine the Method Reporting Limit: the mass value is provided by the laboratory and is based on the analytical method selected and the sensitivity of the instrumentation. The method reporting limit may vary for each target compound.

Calculate the Sampling Volume: use the equation on the next page to determine the volume of air sample that must be drawn through the sorbent in order to achieve the final reporting limit.

Compare the Sampling Volume to the SSV: Refer to tables of safe sampling volume (SSV) for the sorbent being used – (e.g., Table 1 and Appendix 1 in Method TO-17). If the SSV for the compound of interest is not available, use the SSV of a compound in the same class (e.g., toluene for xylene, chloroform for carbon tetrachloride, etc.) and ensure that the compound will not breakthrough when sampling the volume calculated using the equation above. If breakthrough is a possibility, select a sorbent with greater sorbent strength (i.e., surface area).

2.1 Considerations For Sorbent Sampling

1) Calculate Minimum Sample Volume

$$\text{Minimum Volume (L)} = \frac{\text{Reporting Limit (ug)}}{\text{Action Level (ug/m}^3\text{)}} * \frac{1000\ \text{L}}{\text{m}^3}$$

Example: Screening Level = 0.08 ug/m³

$$\text{Minimum Volume (L)} = \frac{0.05\ \text{ug}}{0.08\ \text{ug/m}^3} * \frac{1000\ \text{L}}{\text{m}^3} = 625\ \text{Liters}$$

2) Calculate Minimum Flow Rate if time duration is set.

$$\text{Minimum Flow Rate (L/min)} = \frac{\text{Minimum Volume (L)}}{\text{Duration (min)}}$$

Example: TWA of 24 hours

$$\text{Minimum Flow Rate (L/min)} = \frac{625\ \text{L}}{24\ \text{hour}} * \frac{\text{hour}}{60\ \text{min}} = 0.44\ \text{L/min}$$

3) Calculate if Overloading of tube is possible.

For a source-impacted environment, estimate total concentration to estimate maximum volume. A safe sampling volume is considered to be 75% or less of the cartridge capacity.

Example: the standard TO-11A cartridge supplied by Air Toxics has a capacity of approximately 75 ug total carbonyls.

$$\text{Estimated maximum volume (L)} = \frac{(0.75 * 75\ \text{ug})}{\text{Est. Form. Conc (ug/m}^3\text{)}} * \frac{1000\ \text{L}}{\text{m}^3}$$

Example: Source-impacted site 3 ppmv (3700 ug/m³) Formaldehyde

$$\text{Estimated maximum volume (L)} = \frac{0.75 * 75\ \text{ug}}{3700\ \text{ug/m}^3} * \frac{1000\ \text{L}}{\text{m}^3} = 15\ \text{L}$$

2.1 CONSIDERATIONS FOR SORBENT SAMPLING

Avoid Over Sampling: The adage, "more is better", often finds its way into sorbent sampling practice. In attempting to ensure low reporting limits, you may over sample a sorbent tube – especially if concentrations of target compounds are higher than expected.

Use a Backup Sorbent Tube: The use of a second, or "backup", sorbent tube in series can help prevent compound breakthrough. Even if a safe sampling volume was calculated and not exceeded during sampling, a backup sorbent tube can provide insurance. The backup sorbent tube is only analyzed if a predetermined level of a given compound or total mass is found on the first tube. While the use of a backup sorbent tube will increase media costs, it usually has little effect on sampling costs. It will, however, provide definitive support for data integrity.

EPA Method TO-4A

Determination of Pesticides and Polychlorinated Biphenyls (PCBs) in Ambient Air using High Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic / Electron Capture Detector (GC/ECD)

http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-4ar2r.pdf

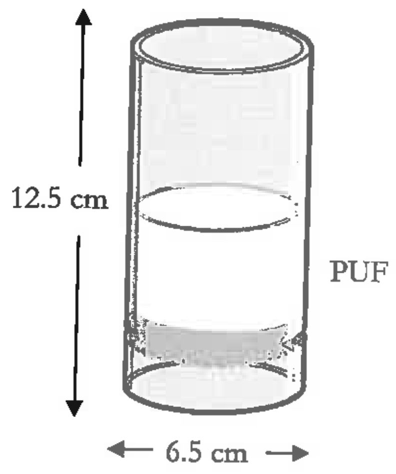
This method is applicable for the sample collection and analysis of pesticides and PCBs in ambient air. See pages 4A-32 and 4A-34 of the method for sampling diagrams.

TO-4A

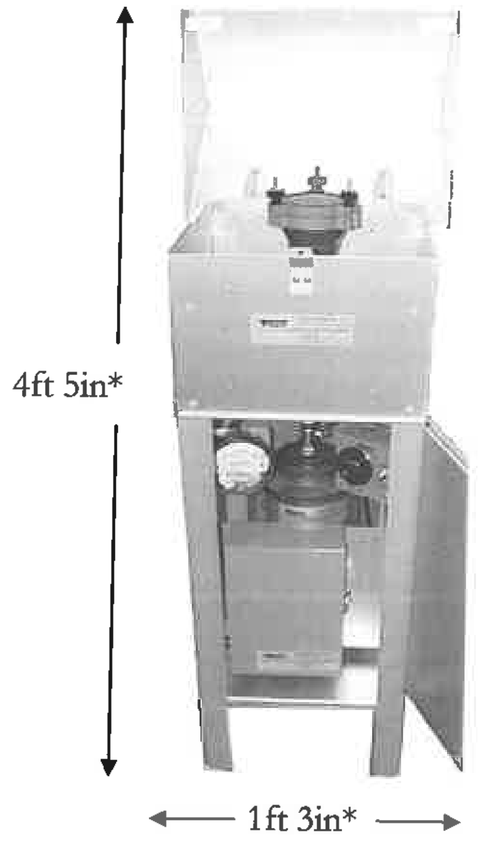
Media	PUF Cartridge (high volume) with Filter (quartz fiber)
Type of Pump	High volume sampler; flow rate capability of (~10cfm)
Sampling Rate and Interval	0.225 m^3/min for up to 24 hours
Sampling Volume	Up to 300 m^3. Determined by user (as needed to achieve project reporting limits)
Sample Handling	Handle with aluminum foil and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Field QC	At least 1 field blank; it is to be treated exactly like a sample except no air is drawn through the cartridge

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

TO-4A Cartridge



PS1 Sampler



Note: This method was developed using the PS-1 semi-volatile sampler provided by General Metal Works, Village of Cleves, OH as a guideline. EPA has experience in use of this equipment during various field monitoring programs over the last several years. Other manufacturers' equipment should work as well. However, modifications to these procedures may be necessary if another commercially available sampler is selected.

* Manufacturers include: Tisch Environmental, Anderson Instruments, and Thermo Environmental Instruments. Equipment specifications may vary by manufacture.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method TO-10A

Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air using Low Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic / Electron Capture Detector (GC/ECD)

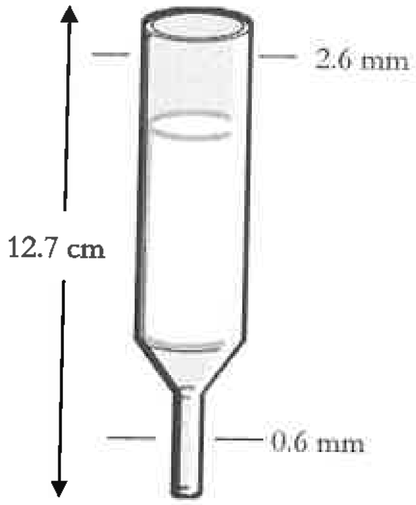
http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-10ar.pdf

This method is applicable for the sample collection and analysis of pesticides and PCBs in ambient air. See pages 10A-26 through 10A-28 of the method for sampling diagrams.

TO-10A

Media	PUF Cartridge (low volume) with or without filter
Type of Pump	Personal/portable continuous flow sampling pump; flow rate capability of 1-5 L/minute
Sampling Rate and Interval	1 to 5 L/min for 4 to 24hrs
Sampling Volume	Determined by user (as needed to achieve project RLs)
Sample Handling	Handle with aluminum foil and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Field QC	At least 1 field blank; it is to be treated exactly like a sample except no air is drawn through the cartridge

TO-10A PUF Cartridge - Low Volume



2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method TO-13A

Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air using Gas Chromatography / Mass Spectrometry (GC/MS)

http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-13arr.pdf

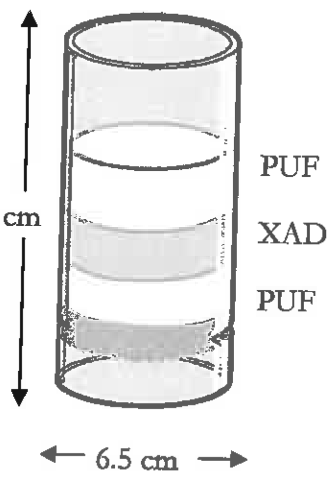
This method is applicable for the analysis of PAHs in ambient air. The high volume PUF/XAD sampling procedure is applicable for a 24-hr sampling period. See pages 13A-55 and 13A-56 of the method for sampling diagrams.

TO-13A

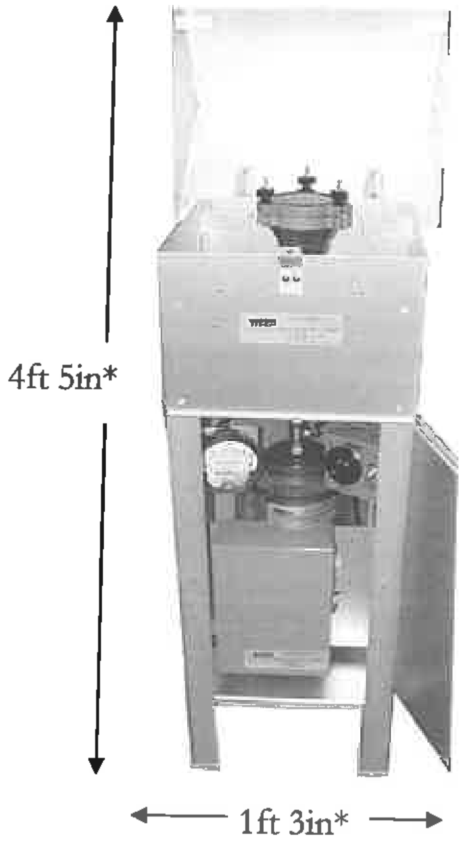
Media	PUF/XAD Cartridge (high volume) with Filter (quartz fiber)
Type of Pump	High volume sampler*; flow rate capability of (~10cfm)
Sampling Rate and Interval	0.225 m^3/min for up to 24 hours
Sampling Volume	Up to 300 m^3. Determined by user (as needed to achieve project reporting limits)
Sample Handling	Handle with aluminum foil and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Field QC	At least 1 field blank; it is to be treated exactly like a sample except no air is drawn through the cartridge

2.2 Method Specific Sampling Instructions

TO-13A PUF/XAD Cartridge



PS1 Sampler



Note: This method was developed using the PS-1 semi-volatile sampler provided by General Metal Works, Village of Cleves, OH as a guideline. EPA has experience in use of this equipment during various field monitoring programs over the last several years. Other manufacturers' equipment should work as well. However, modifications to these procedures may be necessary if another commercially available sampler is selected.

* Manufacturers include: Tisch Environmental, Anderson Instruments, and Thermo Environmental Instruments. Equipment specifications may vary by manufacture.

Modified EPA Method TO-13A Low Volume

Method TO-13A was intended for sampling SVOCs in ambient air and is generally unsuitable for indoor air applications. Placement of a high volume sampler in a home or office would be considered intrusive and impractical, at best. TO-13A can be modified such that the PUF and XAD-2 sorbent can be packed into a TO-10A cartridge or a XAD tube instead of the usual TO-13A cartridge. The TO-10A cartridge is packed with a combination of XAD-2 and PUF and may be used with or without a particulate filter (see Image 1). The XAD tube is packed with XAD-2 and also may be used with or without a filter (see Image 2). Both of these configurations are illustrated and can be provided by Air Toxics Ltd. on a project-specific basis, upon request.

Because of the pressure drop associated with having a packed bed of XAD-2 resin in the sampling tube, personal sampling pumps (e.g. normally used with small NIOSH sorbent tubes) may prove inadequate, given the large volume of air that must be sampled. These small pumps will have difficulty pulling flows greater than a few mL/min through the tube. A high capacity Kneuberger pump is powered by 12v – using a 12 volt converter or a 12 volt car battery (see Image 3).

Application	Media Type	Considerations
Indoor Air	PUF/XAD Cartridge - Low Volume	Desired volume to meet required reporting limits and desired duration of sampling i.e. 8hrs for an office or 12hrs for a home need to be calculated given the capacity of the car-
Soil Gas	XAD tube	Desired volume to meet required reporting limits considering the amount of vapor that can be collected from soil gas as well as the required flow rate of sampling need to be calculated given the capacity of the tube.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

IMAGE 1

PUF/XAD Cartridge - Low Volume

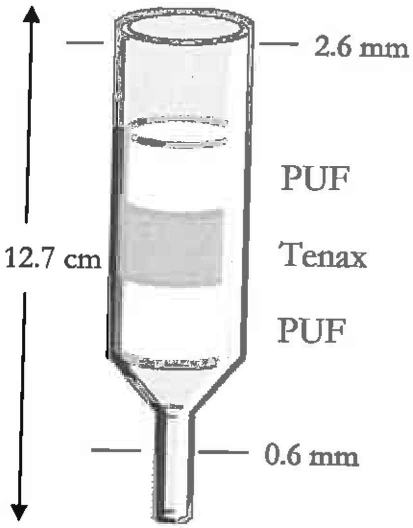


IMAGE 2

XAD Tube

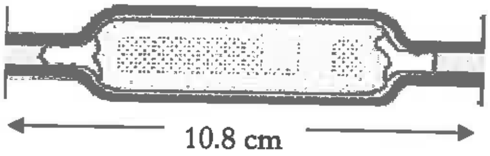
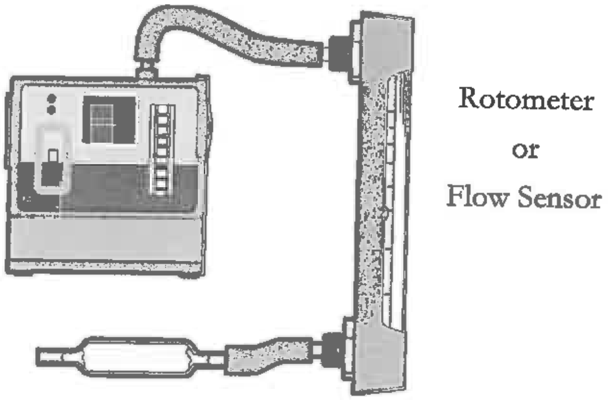


IMAGE 3



EPA Method 0010/8270C

Modified Method 5 Sampling Train

Determination of Destruction and Removal Efficiency (DRE) of Semivolatile Principal Hazardous Compounds (POHCs) from Incineration Systems and Stationary Sources.

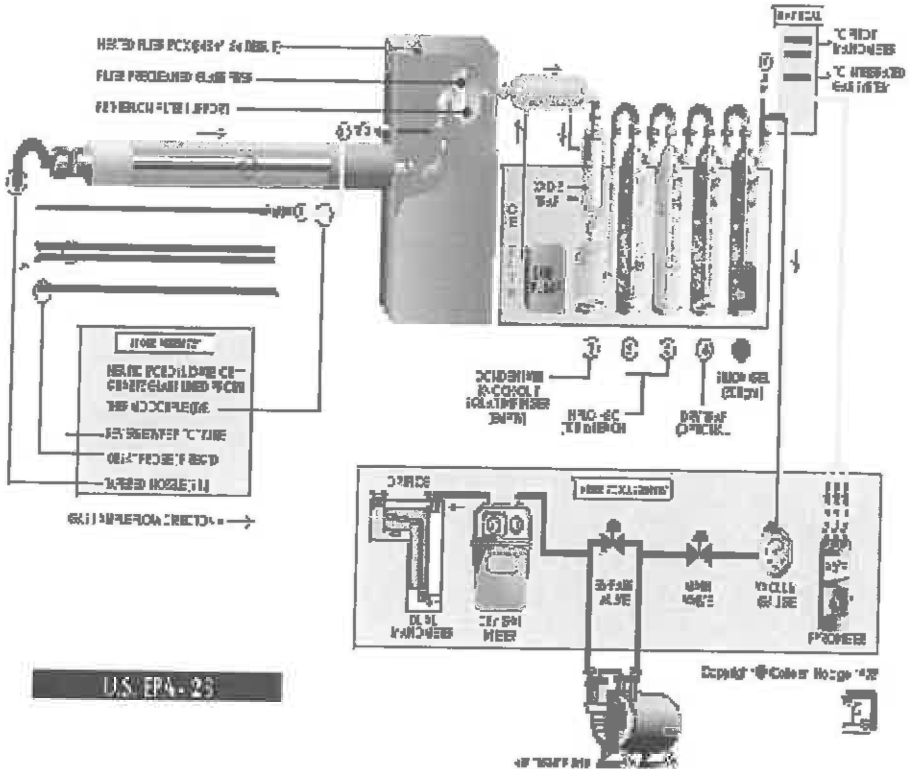
Method 0010 - http://www.epa.gov/epaoswer/hazwaste/test/under.htm

Method 8270C - http://www.epa.gov/epaoswer/hazwaste/test/8_series.htm

0010/8270C Modified Method 5 Sampling Train

Media	Filter (quartz fiber) and sorbent trap (20 g XAD-2)
Type of Pump	Metering system. Pump capable of 4 cfm free flow. see section 4.1.3.9 of method 0010
Sampling Rate and Interval	Determined by user (isokinetic)
Sampling Volume	Determined by user (3 dscm min or as needed to achieve project reporting limits)
Sample Handling	Wrap XAD-2 trap in aluminum foil, and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	14 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Components of the Sample Train	1. Probe 2. Heated Filter 3. XAD-2 Sorbent Trap 4. Impingers 5. Condensates

A typical MM5 sampling train



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1.0 INTRODUCTION

Air Toxics Ltd. presents this guide as a resource for 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 sampling equipment and media. 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 address the multitude of actual field conditions. Note that this guide is intended for typical projects involving sampling of volatile and semi-volatile organic compounds (VOCs and SVOCs) with sorbent tubes and impingers, and airborne particulates with filters. Air Toxics Ltd. also provides a "Guide to Air Sampling and Analysis – Canisters and Tedlar Bags" for whole air sampling of VOCs.

2.0 INTRODUCTION TO SORBENT SAMPLING

Using a sorbent to collect an air sample normally involves "active" sampling, unlike an evacuated canister that can be filled "passively" by simply opening the valve. The most common method to draw an air sample through a sorbent device is to use a small pump with low flow rates between 10 to 200 milliliters per minute (mL/min) and tubing for connecting the components. For high volume applications, a high volume air sampler can be used with a larger sorbent cartridge.

Determining the Safe Sampling Volume

Determining the appropriate volume of air sample to draw through a sorbent tube is critical to achieving the data quality objectives. The tendency is to increase the sampling volume in order to lower the final reporting limit.

Note that over-sampling may saturate the sorbent tube and allow the target compound to breakthrough. *See method for volume guidelines.*

2.0 INTRODUCTION TO SORBENT SAMPLING

It is imperative to know the flow rate through the sorbent tube and the sampling interval. A "set up" sorbent tube is often used to set the pump flow rate. It must be very similar to the actual sorbent tube being used for sample collection. The pressure drop through the sorbent tube determines the flow rate for a given pump setting. The flow rate through the sorbent tube should be monitored continuously (or at least periodically) using a rotometer or electronic flow sensor. If the sampling flow rate is greater than 200 mL/min, simple rotometers and electronic flow sensors cannot be used. It is necessary to use a device capable of measuring high flow rates. Refer to the method for information on the proper method of measuring the flow.

Common Sorbent Sampling Trains

The sampling train generally includes a sorbent tube, pump, and optional components such as a needle valve, particulate filter, and rotometer or electronic flow sensor. The sorbent tube is generally the first component in a sampling train, with the tubing and pump located downstream to minimize contamination of the sample.

The sorbent tube should be upstream of the pump.

For thermal desorption methods, it is critical that the air be drawn through the inlet side of the tube. The inlet side may be marked with a ring or the sampling direction may be indicated with an arrow. Proper orientation is especially important when using the multi-bed sorbent tubes described in EPA Method TO-17. If the low vapor pressure compounds are adsorbed on the high surface area sorbent (i.e., the one designed for gaseous compounds like vinyl chloride), they cannot be removed at the desorption temperatures routinely used.

For thermal desorption methods, the sorbent tube must be sampled in the appropriate direction.

2.0 SORBENT SAMPLING

Possible Components of a Sorbent Sampling Train

Tubing and Fittings: The components in the sampling train are connected with tubing and fittings as needed. Because tubing used to connect the sorbent tube to the pump does not come in contact with the air sample, the tubing material can be selected on its ability to seal. Tygon is an excellent material for this purpose, although Nylon and Teflon can be used. The length of tubing connecting the pump to the sorbent tube is not critical. Many sorbent tubes accept 1/4 in. Swagelok fittings and 1/4 in O.D. tubing.

Note that if the tubing is in the sample stream then it is necessary to select the appropriate grade material.

Needle Valve: If a variable speed/adjustable rate air sampling pump is not available, a needle valve can be used to adjust the flow rate. A rotometer (see the following section) with a built-in needle valve can provide an economical solution to adjust and measure sampling flow rate.

Rotometer or Electronic Flow Sensor: Although the flow rate for an air sampling pump can be calibrated before use, it is often desirable to include a flow measuring device in the sampling train. Note that the flow rate produced by a pump can decrease as more components are added to the sampling train. A rotometer is a relatively inexpensive meter that indicates flow with a small weight in a tapered column. As flow increases, air resistance of the weight increases and raises the weight until it is equilibrium with gravity. For best results, the rotometer must be kept vertical and free of particulates or moisture. An electronic flow sensor can provide more precise flow measurement than a rotometer, but is considerably more expensive. Both devices have optimum working ranges of flow rate (e.g., a typical rotometer may provide measurement from 100 to 500 mL/min).

Particulate Filter: If the air sample is known to have high levels of particulate matter, it may be necessary to place a filter at the sorbent tube inlet. In this case, the connecting tubing between the filter and the sorbent tube will be in the sampling stream and it should be new Teflon and as short as possible.

2.1 CONSIDERATIONS FOR SORBENT SAMPLING

Sorbent sampling requires the determination of the optimal sampling parameters: sample volume, flow rate and duration.

Appropriate sample volume should be determined by the media capacity and the required RLs. Matrix constituents such as water vapor and other non-target compounds should also be considered. See method specific sections for media capacity information and use the calculation provided to determine sample volume needed to meet specific RLs.

Determine the Final Reporting Limit for the Target Compound: the concentration may be a risk-based action level or EPA preliminary remediation goal (PRG).

Determine the Method Reporting Limit: the mass value is provided by the laboratory and is based on the analytical method selected and the sensitivity of the instrumentation. The method reporting limit may vary for each target compound.

Calculate the Sampling Volume: use the equation on the next page to determine the volume of air sample that must be drawn through the sorbent in order to achieve the final reporting limit.

Compare the Sampling Volume to the SSV: Refer to tables of safe sampling volume (SSV) for the sorbent being used – (e.g., Table 1 and Appendix 1 in Method TO-17). If the SSV for the compound of interest is not available, use the SSV of a compound in the same class (e.g., toluene for xylene, chloroform for carbon tetrachloride, etc.) and ensure that the compound will not breakthrough when sampling the volume calculated using the equation above. If breakthrough is a possibility, select a sorbent with greater sorbent strength (i.e., surface area).

2.1 CONSIDERATIONS FOR SORBENT SAMPLING

1) Calculate Minimum Sample Volume

$$\text{Minimum Volume (L)} = \frac{\text{Reporting Limit (ug)}}{\text{Action Level (ug/m}^3\text{)}} * \frac{1000\text{ L}}{\text{m}^3}$$

Example: Screening Level = 0.08 ug/m^3

$$\text{Minimum Volume (L)} = \frac{0.05\text{ ug}}{0.08\text{ ug/m}^3} * \frac{1000\text{ L}}{\text{m}^3} = 625\text{ Liters}$$

2) Calculate Minimum Flow Rate if time duration is set.

$$\text{Minimum Flow Rate (L/min)} = \frac{\text{Minimum Volume (L)}}{\text{Duration (min)}}$$

Example: TWA of 24 hours

$$\text{Minimum Flow Rate (L/min)} = \frac{625\text{ L}}{24\text{ hour}} * \frac{\text{hour}}{60\text{ min}} = 0.44\text{ L/min}$$

3) Calculate if Overloading of tube is possible.

For a source-impacted environment, estimate total concentration to estimate maximum volume. A safe sampling volume is considered to be 75% or less of the cartridge capacity.

Example: the standard TO-11A cartridge supplied by Air Toxics has a capacity of approximately 75 ug total carbonyls.

$$\text{Estimated maximum volume (L)} = \frac{(0.75 * 75\text{ ug})}{\text{Est. Form. Conc (ug/m}^3\text{)}} * \frac{1000\text{ L}}{\text{m}^3}$$

Example: Source-impacted site 3 ppmv (3700 ug/m^3) Formaldehyde

$$\text{Estimated maximum volume (L)} = \frac{0.75 * 75\text{ ug}}{3700\text{ ug/m}^3} * \frac{1000\text{ L}}{\text{m}^3} = 15\text{ L}$$

2.1 CONSIDERATIONS FOR SORBENT SAMPLING

Avoid Over Sampling: The adage, "more is better", often finds its way into sorbent sampling practice. In attempting to ensure low reporting limits, you may over sample a sorbent tube – especially if concentrations of target compounds are higher than expected.

Use a Backup Sorbent Tube: The use of a second, or "backup", sorbent tube in series can help prevent compound breakthrough. Even if a safe sampling volume was calculated and not exceeded during sampling, a backup sorbent tube can provide insurance. The backup sorbent tube is only analyzed if a predetermined level of a given compound or total mass is found on the first tube. While the use of a backup sorbent tube will increase media costs, it usually has little effect on sampling costs. It will, however, provide definitive support for data integrity.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method TO-4A

Determination of Pesticides and Polychlorinated Biphenyls (PCBs) in Ambient Air using High Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic / Electron Capture Detector (GC/ECD)

http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-4ar2r.pdf

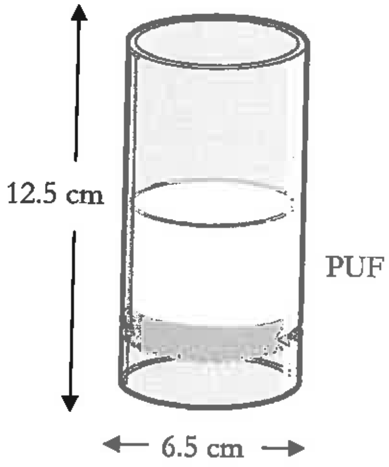
This method is applicable for the sample collection and analysis of pesticides and PCBs in ambient air. See pages 4A-32 and 4A-34 of the method for sampling diagrams.

TO-4A

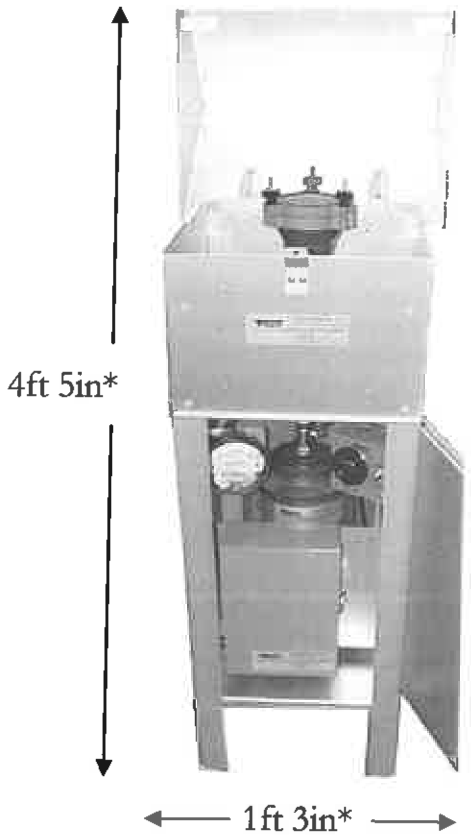
Media	PUF Cartridge (high volume) with Filter (quartz fiber)
Type of Pump	High volume sampler; flow rate capability of (~10cfm)
Sampling Rate and Interval	0.225 m^3/min for up to 24 hours
Sampling Volume	Up to 300 m^3. Determined by user (as needed to achieve project reporting limits)
Sample Handling	Handle with aluminum foil and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Field QC	At least 1 field blank; it is to be treated exactly like a sample except no air is drawn through the cartridge

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

TO-4A Cartridge



PS1 Sampler



Note: This method was developed using the PS-1 semi-volatile sampler provided by General Metal Works, Village of Cleves, OH as a guideline. EPA has experience in use of this equipment during various field monitoring programs over the last several years. Other manufacturers' equipment should work as well. However, modifications to these procedures may be necessary if another commercially available sampler is selected.

* Manufacturers include: Tisch Environmental, Anderson Instruments, and Thermo Environmental Instruments. Equipment specifications may vary by manufacture.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method TO-10A

Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air using Low Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic / Electron Capture Detector (GC/ECD)

http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-10ar.pdf

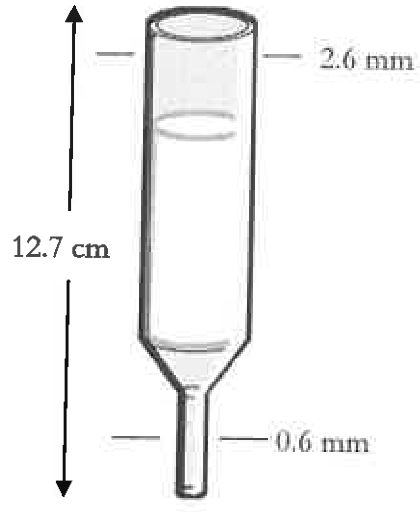
This method is applicable for the sample collection and analysis of pesticides and PCBs in ambient air. See pages 10A-26 through 10A-28 of the method for sampling diagrams.

TO-10A

Media	PUF Cartridge (low volume) with or without filter
Type of Pump	Personal/portable continuous flow sampling pump; flow rate capability of 1-5 L/minute
Sampling Rate and Interval	1 to 5 L/min for 4 to 24hrs
Sampling Volume	Determined by user (as needed to achieve project RLs)
Sample Handling	Handle with aluminum foil and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Field QC	At least 1 field blank; it is to be treated exactly like a sample except no air is drawn through the cartridge

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

TO-10A PUF Cartridge - Low Volume



EPA Method TO-13A

Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air using Gas Chromatography / Mass Spectrometry (GC/MS)

http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-13arr.pdf

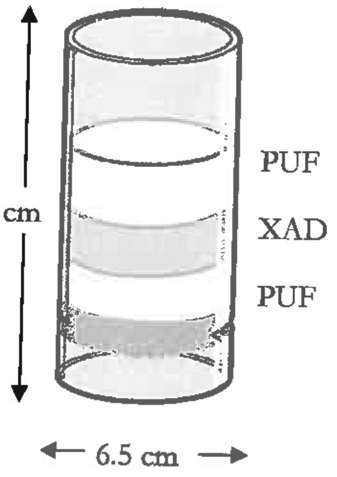
This method is applicable for the analysis of PAHs in ambient air. The high volume PUF/XAD sampling procedure is applicable for a 24-hr sampling period. See pages 13A-55 and 13A-56 of the method for sampling diagrams.

TO-13A

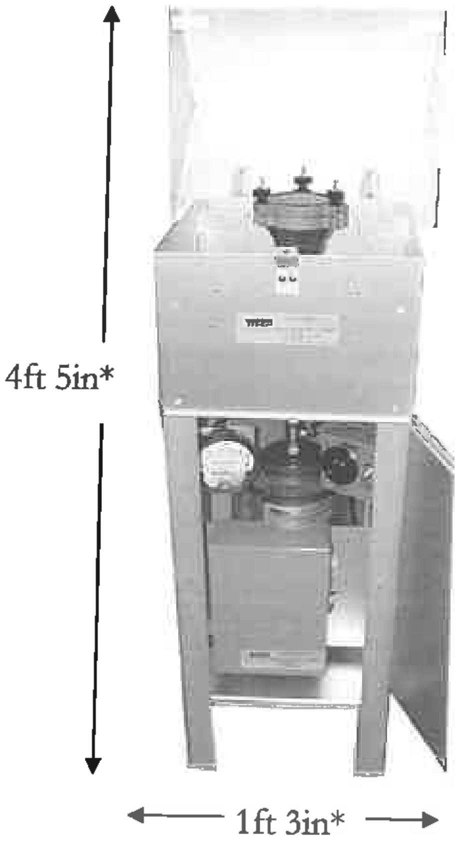
Media	PUF/XAD Cartridge (high volume) with Filter (quartz fiber)
Type of Pump	High volume sampler*; flow rate capability of (~10cfm)
Sampling Rate and Interval	0.225 m^3/min for up to 24 hours
Sampling Volume	Up to 300 m^3. Determined by user (as needed to achieve project reporting limits)
Sample Handling	Handle with aluminum foil and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Field QC	At least 1 field blank; it is to be treated exactly like a sample except no air is drawn through the cartridge

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

TO-13A PUF/XAD Cartridge



PS1 Sampler



Note: This method was developed using the PS-1 semi-volatile sampler provided by General Metal Works, Village of Cleves, OH as a guideline. EPA has experience in use of this equipment during various field monitoring programs over the last several years. Other manufacturers' equipment should work as well. However, modifications to these procedures may be necessary if another commercially available sampler is selected.

* Manufacturers include: Tisch Environmental, Anderson Instruments, and Thermo Environmental Instruments. Equipment specifications may vary by manufacture.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

Modified EPA Method TO-13A Low Volume

Method TO-13A was intended for sampling SVOCs in ambient air and is generally unsuitable for indoor air applications. Placement of a high volume sampler in a home or office would be considered intrusive and impractical, at best. TO-13A can be modified such that the PUF and XAD-2 sorbent can be packed into a TO-10A cartridge or a XAD tube instead of the usual TO-13A cartridge. The TO-10A cartridge is packed with a combination of XAD-2 and PUF and may be used with or without a particulate filter (see Image 1). The XAD tube is packed with XAD-2 and also may be used with or without a filter (see Image 2). Both of these configurations are illustrated and can be provided by Air Toxics Ltd. on a project-specific basis, upon request.

Because of the pressure drop associated with having a packed bed of XAD-2 resin in the sampling tube, personal sampling pumps (e.g. normally used with small NIOSH sorbent tubes) may prove inadequate, given the large volume of air that must be sampled. These small pumps will have difficulty pulling flows greater than a few mL/min through the tube. A high capacity Kneuberger pump is powered by 12v – using a 12 volt converter or a 12 volt car battery (see Image 3).

Application	Media Type	Considerations
Indoor Air	PUF/XAD Cartridge - Low Volume	Desired volume to meet required reporting limits and desired duration of sampling i.e. 8hrs for an office or 12hrs for a home need to be calculated given the capacity of the car-
Soil Gas	XAD tube	Desired volume to meet required reporting limits considering the amount of vapor that can be collected from soil gas as well as the required flow rate of sampling need to be calculated given the capacity of the tube.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

IMAGE 1

PUF/XAD Cartridge - Low Volume

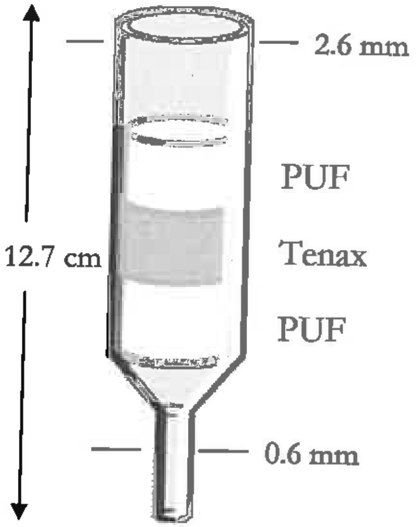


IMAGE 2

XAD Tube

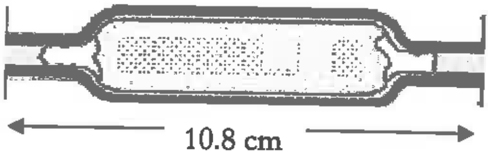
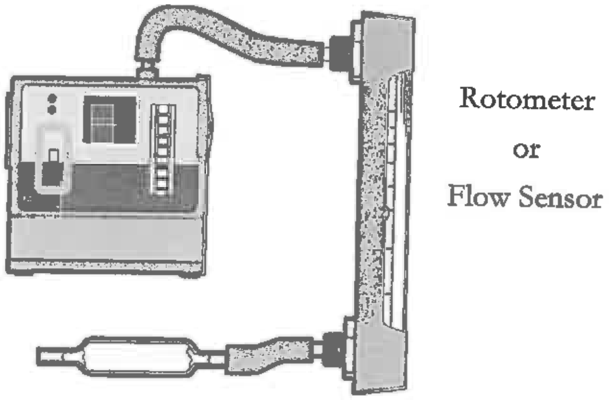


IMAGE 3



2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method 0010/8270C

Modified Method 5 Sampling Train

Determination of Destruction and Removal Efficiency (DRE) of Semivolatile Principal Hazardous Compounds (POHCs) from Incineration Systems and Stationary Sources.

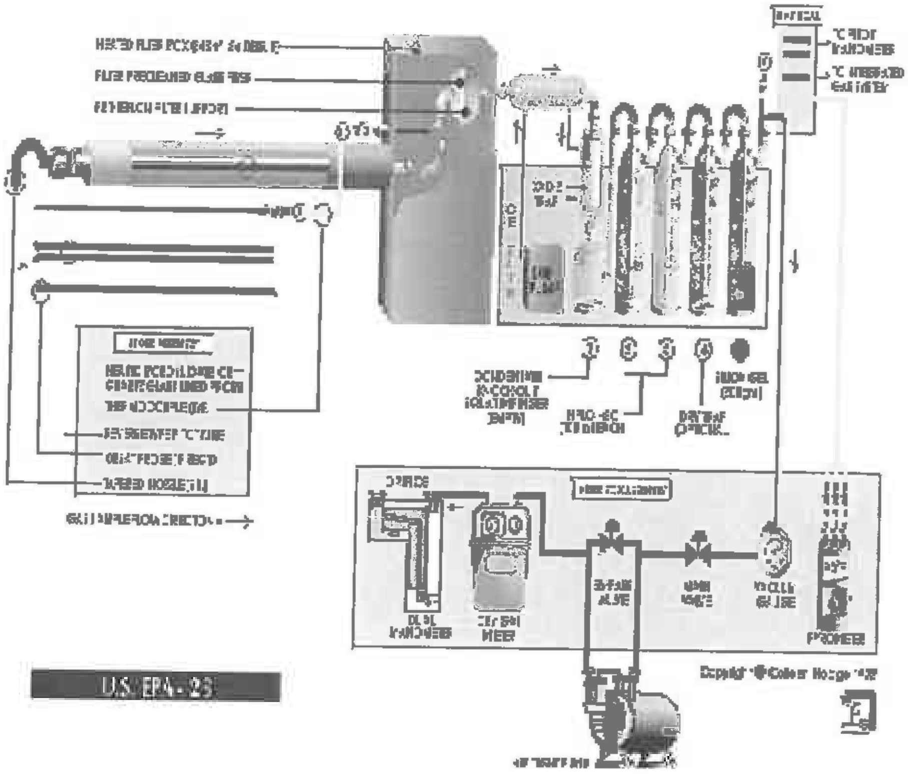
Method 0010 - http://www.epa.gov/epaoswer/hazwaste/test/under.htm

Method 8270C - http://www.epa.gov/epaoswer/hazwaste/test/8_series.htm

0010/8270C Modified Method 5 Sampling Train

Media	Filter (quartz fiber) and sorbent trap (20 g XAD-2)
Type of Pump	Metering system. Pump capable of 4 cfm free flow. see section 4.1.3.9 of method 0010
Sampling Rate and Interval	Determined by user (isokinetic)
Sampling Volume	Determined by user (3 dscm min or as needed to achieve project reporting limits)
Sample Handling	Wrap XAD-2 trap in aluminum foil, and keep chilled at 4°C
Media Hold Time	30 days from date of media certification
Extraction Hold Time	14 days from sampling to extraction at 4°C
Sample Hold Time	40 days from extraction to analysis at 4°C
Components of the Sample Train	1. Probe 2. Heated Filter 3. XAD-2 Sorbent Trap 4. Impingers 5. Condensates

A typical MM5 sampling train



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2.2 Method Specific Sampling Instructions

EPA Method TO-17

Determination of Volatile Organic Compounds in Ambient Air using Active Sampling Onto Sorbent Tubes.

http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-17r.pdf

This method replaces earlier sorbent-based EPA Methods TO-1 and TO-2 and provides an alternative to canister-based EPA Method TO-15. The target compound list is the same as TO-15 (i.e., subsets of the 97 VOCs listed as hazardous air pollutants in the Clean Air Act Amendments of 1990). However, TO-17 can collect VOCs over a wider volatility range than TO-15, by using a tube with multiple sorbents packed in increasing sorbent strength. Both single and multi-bed sorbent tubes are described in TO-17. Tube Style 3 (i.e., Carbotrap 300 by Supelco) can be used for compounds ranging in volatility from n-C_3 to n-C_{16} for air volumes of 2 L at relative humidity below 65% and temperatures below 30°C. Volumes greater than 5 L can be collected, but C_3 compounds are not quantitatively retained. Single bed tubes, such as Tenax TA, can be used to effectively collect Naphthalene and middle distillate fuels in indoor air.

Media	Sorbent tube (e.g., Carbotrap 300) with optional particulate filter and ozone scrubber
Type of Pump	Low flow rate pump (10 to 200 mL/min) or high flow pump with low flow adapter
Sampling Rate and Interval	17 and 67 mL/min for 1 hour (example flow rates)
Sampling Volume	1 and 4 L (example volumes not mandated)
Sample Handling	Cap ends, place in culture tube, keep chilled at 4°C
Media Hold Time	Not specified - recommend 30 days at 4°C
Sample Hold Time	30 days from collection at 4°C
Field QC	Field Blanks - two per sampling event
Distributed Pair	One location sampled at two volumes

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

Although the method suggests sampling volumes of 1 and 4 L, there is considerable mention of calculating a safe sampling volume. The sampling volume you select should include consideration of both the desired final reporting limit and the safe sampling volume of the sorbent being used (see Section 2.1) . The thought process is outlined below.

Determine the Final Reporting Limit for the Target Compound: the concentration may be a risk-based action level or EPA preliminary remediation goal (PRG).

Determine the Method Reporting Limit: the mass value is provided by the laboratory and is based on the analytical method selected and the sensitivity of the instrumentation. The method reporting limit may vary for each target compound.

Calculate the Sampling Volume: use the equation on page 6 of this guide to determine the volume of air sample that must be drawn through the sorbent in order to achieve the final reporting limit.

Compare the Sampling Volume to the SSV: Refer to tables of safe sampling volume (SSV) for the sorbent being used – (e.g., Table 1 and Appendix 1 in Method TO-17). If the SSV for the compound of interest is not available, use the SSV of a compound in the same class (e.g., toluene for xylene, chloroform for carbon tetrachloride, etc.) and ensure that the compound will not breakthrough when sampling the volume calculated using the equation above. If breakthrough is a possibility, select a sorbent with greater sorbent strength (i.e., surface area).

To illustrate the thought process, an example is provided below:

1. Assume Benzene is the target compound and must be reported at a final reporting limit of 0.0005 ug/L.
2. The laboratory provides a method reporting limit of 10 ng (0.010 ug).
3. Using Equation 3, the sampling volume = 0.010/0.0005 = 20 L.
4. TO-17 Appendix 1 shows that for Benzene, a SSV of up to 26 L can be collected using a Type 3 (CarboTrap 300) multi-sorbent tube.

In this example, Benzene can theoretically be reported at a final reporting limit of 0.0005 ug/L with a sampling volume of 20 L.

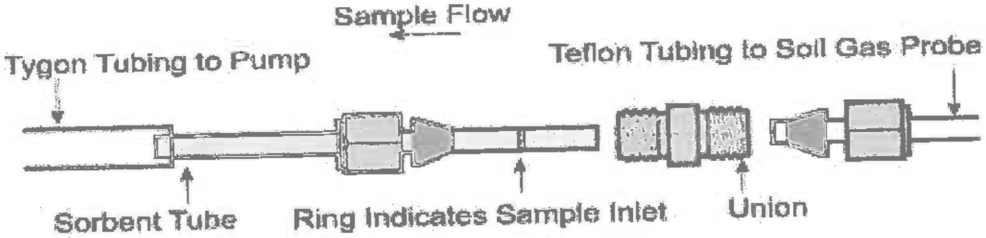
2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

TO-17 Sampling Instructions

Application: Soil Gas

Media: TO-17 tube, 1/4"Teflon tubing, 1/4"Tygon tubing, 1/4" to 1/4"Union, 1/4"fittings with ferrules, a sample pump and a low flow holder maybe required if using a higher flow pump

Typical Sampling Parameters: Sample Flow Rate = 50mL/min **Total Vol.** = 200 mL **Duration** = 4 min. These parameters may change depending on project objectives.



Instructions:

1) In order to calibrate the pump use a "set-up" tube. Using the Tygon tubing connect the sampling pump to the outlet of the sorbent tube, if using a higher flow pump a low flow holder may be necessary to lower the flow rate, then connect the inlet (the ringed side) to the calibrator. Adjust setting to desired flow rate and record.
2) Replace the "set-up" tube with a sample tube. Again using the Tygon tubing connect the sampling pump to the outlet of the sample tube. Attach the inlet to the union fitting using a Swagelok nut. Using a 9/16" wrench on the nut and a 7/16" wrench on the union, tighten the nut. In the same manner, attach the union to the Swagelok nut on the soil gas probe tubing. DO NOT OVERTIGHTEN.
3) Start the sample pump and record the start time. After the desired duration, stop the pump and record the end time.
4) Replace the end plugs on both ends of the sample tube. Record the sample ID, tube ID and the collection date/time on the COC.
5) When completed with a set of samples, re-attach the "set-up" tube to the calibrator and measure the post-sampling flow. Record post-sampling flow rate. This should match within 10% of the pre-sample flow rate.
6) Record sample volume on the COC using the average of the pre- and post- flow rates.
7) Send tubes to the lab in the cooler with ice.

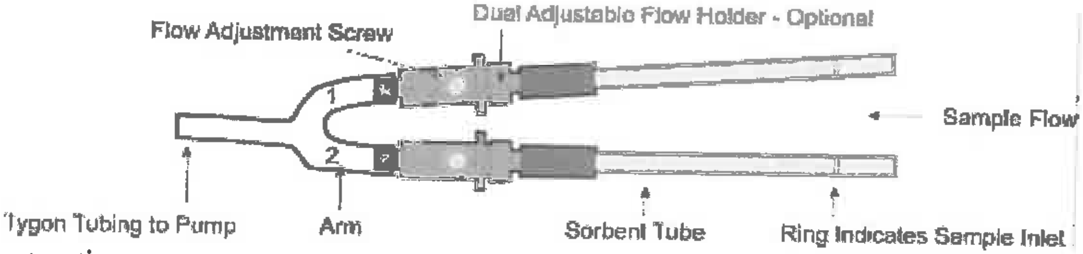
2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

TO-17 Sampling Instructions

Application: Indoor Air

Media: TO-17 tube, 1/4"Tygon tubing, sample pump & optional dual adjustable flow holder

Parameters: Typical flows should be between 10 to 200 ml/min. Consult with the laboratory to insure appropriate volumes are collected to meet desired reporting limits.



Instructions:

1) Connect the sampling pump to the outlet of a "set-up" tube using Tygon tubing, connect the inlet (the ringed side) to the calibrator. Adjust setting to desired flow rate and record. A low flow holder may be required for a higher flow pump.
2) Replace the "set-up" tube with a sample tube. Using the Tygon tubing connect the sampling pump to the outlet of the sample tube.
3) The picture above shows a distributed pair using an adjustable 2-tube flow holder. This allows you to take replicate or distributed samples. The flow is adjusted by tightening the screw on the holder. Two different flows can be used to collect two volumes for a distributed pair. A 2-tube holder is not necessary for single sample collection. If using a dual holder it is important to notate which arm corresponds to each recorded flow measurement.
4) Start the sample pump and record the start time. After the desired duration, stop the pump and record the end time.
5) Replace the end plugs on both ends of the sample tube. Record the sample ID, tube ID and the collection date/time on the COC.
6) When completed with a set of samples, re-attach the "set-up" tube to the calibrator and measure the post-sampling flow. Record post-sampling flow rate. This should match within 10% of the pre-sample flow rate.
7) Record sample volume on the COC using the average of the pre- and post- flow rates.
8) Send tubes to the lab in the cooler with ice.

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method 0030/5041A (VOST)

This method describes the collection of volatile principal organic hazardous constituents (POHCs) from the stack gas effluents of hazardous waste incinerators. For the purpose of definition, volatile POHCs are those POHCs with boiling points less than 100°C. If the boiling point of a POHC of interest is less than 30°C, the POHC may break through the sorbent under the conditions of the sample collection procedure.

ATL has validated a method of "diluting" a VOST sample prior to analysis in the case of high level matrices. The first step is to inject surrogate benzene-d6 onto the sample tube(s). Recovery is monitored as a means of ensuring the integrity of the sample transfers. The VOST tubes are then thermally desorbed into a Tedlar bag. This gaseous sample is screened using GC/FID and an acceptable amount of sample is transferred back onto a clean set of VOST tubes which are subsequently thermally desorbed per the method. High quality data is obtained from every tube.

Method 0031

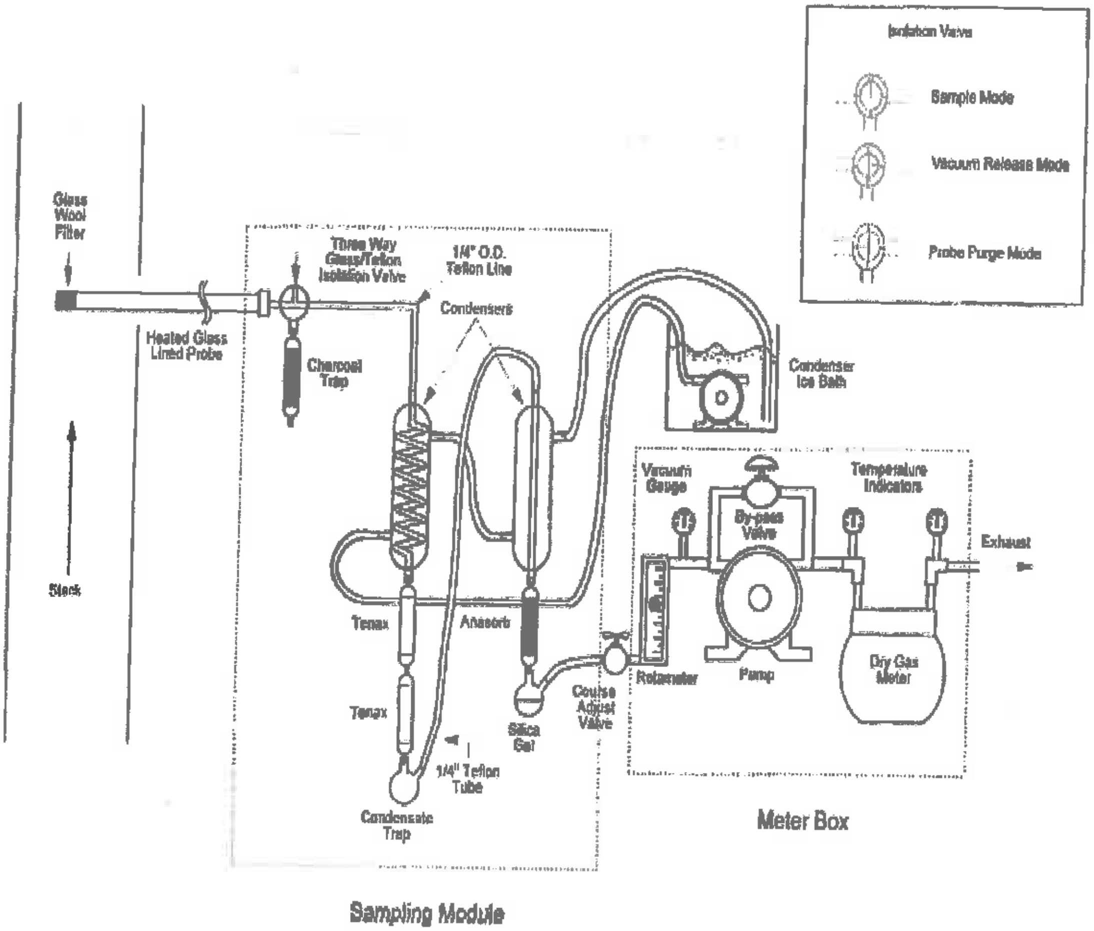
M0031 was written in part to specify which organic compounds are appropriate for collection in contrast to M0030 which provided guidelines based on boiling point alone. Moreover, polar and reactive compounds are identified as poor performers for the M0031 collection strategy. In Method 0031 the VOST consists of three glass tubes containing Tenax, Tenax, and Anasorb, respectively, to trap the organic mass.

0030/5041A VOST

Media	One pair of glass sorbent tubes (1.6 g Tenax; 1.0 g Tenax / 1.0 g petroleum based charcoal)
Media Hold Time	2 weeks at 4°C
Type of Pump	see method for sampling equipment
Sampling Rate/Interval	1 L/min for 20 min (FAST-VOST); 250 mL/min for 20 min and 500 mL/min for 40 min (SLOW-VOST)
Sampling Volume	20 L (FAST-VOST); 5 and 20 L (SLOW-VOST)
Sample Handling	Cap ends, place in culture tube, keep chilled at 4°C
Hold Time to Analysis	14 days at 4°C

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

VOST Sample Train



2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

NIOSH 1500/1501

Media	Coconut Shell Charcoal tube, 100mg/50mg tube
Media Hold Time	Use manufactures expiration date listed on tube
Type of Pump	Personal Sampling Pump
Sampling Rate	0.01 - 0.2 L/min
Sampling Volume	Ranges from a minimum of 1L to a maximum of 30L Dependant on contaminant; see method
Sample Handling	Ship cold after sampling
Sample Hold Time	30 days at 5°C
Field QC	10% field blanks

NIOSH 1550

Media	Coconut Shell Charcoal tube, 100mg/50mg tube
Media Hold Time	Use manufactures expiration date listed on tube
Type of Pump	Personal Sampling Pump
Sampling Rate	0.01 - 0.2 L/min
Sampling Volume	Minimum - 1.3 L; Maximum - 20 L
Sample Handling	Ship cold after sampling
Hold Time to Extraction	7 days at 25°C
Extract Hold Time	2 to 10 field blanks per set

2.2 METHOD SPECIFIC SAMPLING INSTRUCTIONS

NIOSH 5515

Media	5515 filter + Sorbent (37 mm PTFE + 100mg/50mg XAD-2 tube)
Media Hold Time	Use manufactures expiration date listed on tube
Type of Pump	Personal Sampling Pump, capable of operating up to 8hrs at 2 L/min
Sampling Rate	2 L/min
Sampling Volume	Minimum - 200 L; Maximum - 1000 L
Sample Handling	Handle with aluminum foil and keep chilled at 4°C and keep out of sunlight
Sample Hold Time	Unspecified; ATL uses 7 days
Field QC	2 to 10 field blanks; 6 to 10 media blanks

NIOSH 5503

Media	5503 filter + Sorbent (13 mm glass fiber + 100mg/50mg
Media Hold Time	Use manufactures expiration date listed on tube
Type of Pump	Personal Sampling Pump
Sampling Rate and Interval	0.05 - 0.2 L/min
Sampling Volume	Minimum - 1 L; Maximum - 50 L
Sample Handling	Handle with aluminum foil and keep chilled at 4°C and keep out of sunlight
Hold Time	Unspecified for filter; ATL uses 7 days. Method allows 2 months for Florisil tube
Field QC	2 to 10 field blanks per set

3.0 SOLUTION SAMPLING

The gas can be drawn (bubbled) through a solution in an impinger to dissolve the compounds in the gas phase. The sampler records the flow rate and sampling interval for calculating compound concentration by volume. The impinger vial is subsequently capped, chilled (as required), and transported to the laboratory for analysis. Sampling with a solution is similar to sorbent sampling in that compounds are concentrated and the gas matrix is not collected. However, the solution is chosen so that the compounds of interest are either dissolved (and consequently remain in solution) or form a derivative in-situ (and the derivative remains in solution). The compounds/derivatives are analyzed directly or by chemical extraction. The solution (e.g., methanol, DNPH, water) is selected according to the type of air sampling and compounds targeted. An acidic solution of dinitrophenylhydrazine (DNPH) is used to derivatize C1-C3 carbonyl compounds.

3.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method TO-5

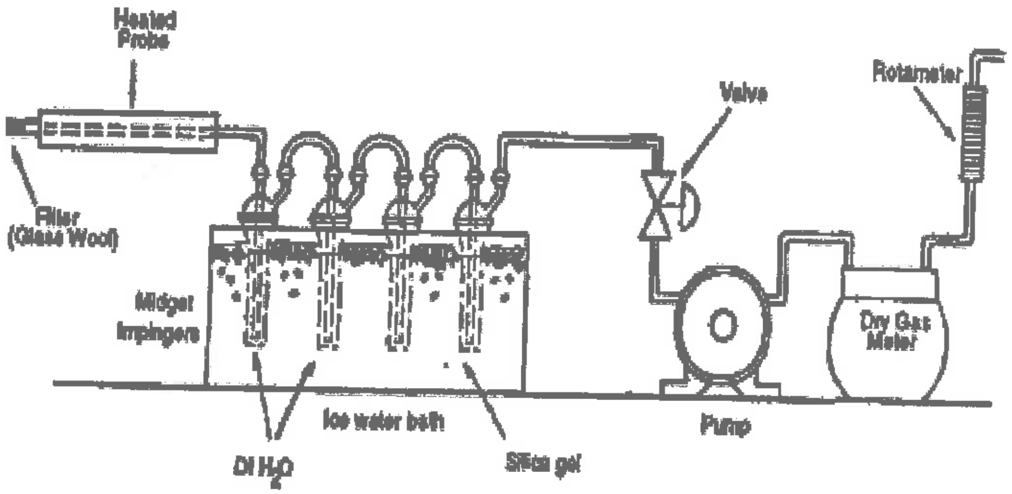
Method for the determination of aldehydes and ketones in ambient air using High Performance Liquid Chromatography (HPLC). http://www.epa.gov/ttn/amtic/airtox.html

TO-5

Media	One pair of 40 mL glass vials with Teflon screw caps and 25 mL midget impingers in ice bath
Impinger Solution	10 mL 2,4-dinitorphenylhydrazine (DNPH) and 10 mL iso-octane
Sampling Volume	Up to 80 L
Sampling Rate	100 to 1,000 mL/min
Sample Handling	Cap vials and keep chilled at 4 ± 2°C
Media Hold Time	48 hrs from date of media preparation at 4°C
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	30 days from extraction to analysis at 4°C

3.1 Method Specific Sampling Instructions

Sampling Train



- Front and Back impingers are to be combined at the laboratory.
- Iso-octane can be used

Field QC:

Field Blank—At least one FB with each group of samples. FB is treated identically to the samples except that no air is drawn through the reagent.

3.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method TO-11A

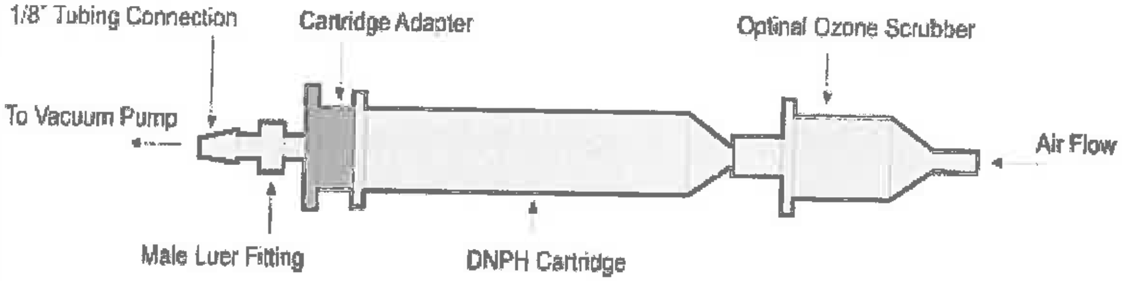
Formaldehyde and other carbonyl compounds (aldehydes and ketones) in air are collected by drawing sample through a DNPH-coated silica gel cartridge using a sampling pump. TO-11A can be applied to indoor air, ambient air, and source-impacted sites. Collection times up to 24 hours are used for low ppbv environments, and short-term sampling (5 to 60 minutes) can be used for higher concentration sites.

http://www.epa.gov/ttn/amtic/airtox.html

TO-11A

Media	Sep-Pak cartridges (DNPH-coated silica gel) an ozone scrubber is strongly recommended
Sampling Rate	Range: 0.1 to 2 L/min. Typical rate for ambient air <1 L/min when using a personal sampling pump.
Cartridge Capacity	S10 Supelco = Approximately 75 ug total carbonyls. Cartridges with higher capacity are available. If breakthrough is a concern, use a back-up tube.
Sample Handling	Cap ends, place in foil-lined envelope included in shipment. Label envelope with sample information. Keep chilled at ~ 4°C and keep out of sunlight.
Media Hold Time	Manufacturer's expiration date listed on cartridge
Sample Hold Time	14 days
Field QC Samples	Field Blank – Treat in the same manner as samples, but do not draw air through cartridge. Field Duplicate – Collect a collocated sample using a second sampling port attached to the sample pump. Back-up tube – If breakthrough is a concern, a back-up tube can be connected to the sample tube.
Sampling QC	QC Measure and record the flow rate before and after sample collection. Flow rates should not vary more than 10% over the sampling duration.

3.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS



Interferences: Atmospheric ozone can result in a loss of formaldehyde and other carbonyl derivatives. An ozone scrubber is recommended to minimize interference. Particulate-laden atmospheres (>50 ug/m3) may result in flow drops during sampling. Additionally, acrolein and crotonaldehyde may partially degrade using DNPH-coated silica gel cartridges.

Special Considerations: Compound breakthrough can occur if too much volume is collected and the sorbent becomes overloaded. If breakthrough is a concern, cartridges may be sampled as a train. The two cartridges are analyzed separately by the laboratory to monitor breakthrough.

3.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS

CARB Method 430

This method applies to the determination of formaldehyde and acetaldehyde emissions from stationary sources. The method is based on the use of high performance liquid chromatography (HPLC).

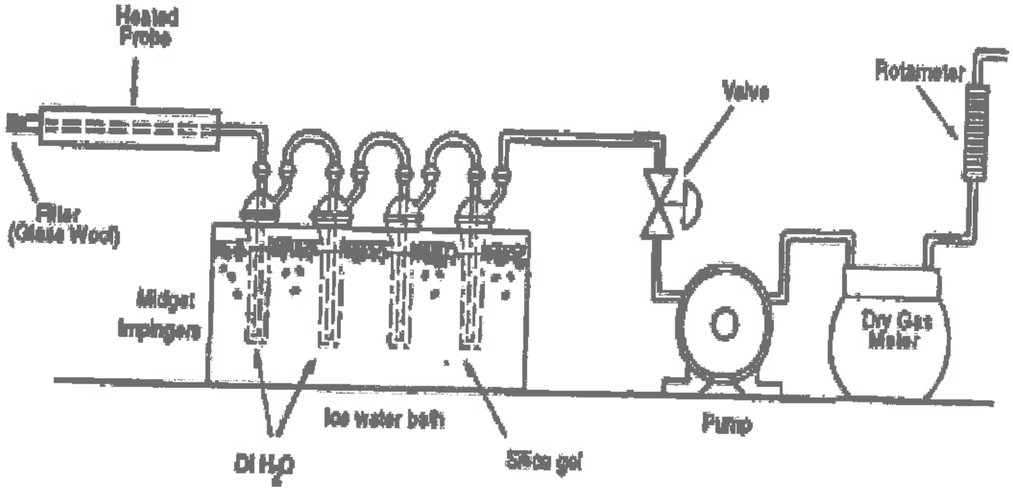
http://www.arb.ca.gov/testmeth/vol3/vol3.htm See sections 8.0 - 8.2 on pages 18 - 23 for sampling procedures.

CARB 430

Media	One pair of 25 mL glass vials with Teflon screw caps and 35 mL midget impingers in ice bath
Impinger Solution	10 mL 2,4-dinitorphenylhydrazine (DNPH)
Sampling Volume	Up to 80 L
Sampling Rate	100 to 1,000 mL/min
Sample Handling	Cap vials and keep chilled at 4 ± 2°C
Media Hold Time	48 hrs from date of media preparation at 4°C
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	30 days from extraction to analysis at 4°C

3.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS

Sampling Train



- Each vial will be treated as an individual sample, do not combine.
- Iso-octane should not be used.

Field QC:

Trip Blank

Field Blank

Field Spike (as requested)

EPA Method 0011 Sampling for selected aldehyde and ketone emissions from stationary sources. http://www.epa.gov/epaoswer/hazwaste/test/under.htm

Method 0011 sampling is comprised of an isokinetic sampling train containing DNPH filled impingers. Formaldehyde and other aldehydes and ketones react with the DNPH to form derivatives. The derivatives are extracted and analyzed by HPLC/UV.

Method 0011

Media	DNPH filled impingers
Sampling Rate	Determined by user (isokinetic)
Sampling Volume	Determined by user
Sample Handling	Cap vials and keep chilled at 4 ± 2°C
Media Hold Time	5 days from date made and 2 days from date opened in the field
Extraction Hold Time	7 days from sampling to extraction at 4°C
Sample Hold Time	30 days from extraction to analysis at 4°C
Quality Control	**Field Spike -** typically ~ 800 ug of formaldehyde. (Place the field spike into an impinger containing 200 mL of DNPH solution, recover, and return for analysis.) **Sample Blank -** add a volume of DNPH reagent and Methylene chloride equal to the total volume of the combined impingers and rinses. **Matrix Spike Sample -** this additional sample may be collected for use as a matrix spike sample as described in Sec. 8.0 of Method 8315. **Field blanks -** may be submitted with the samples collected at each sampling site.

3.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS

EPA Method 316

Sampling and Analysis for Formaldehyde Emissions from Stationary Sources in the Mineral Wool/Wool Fiberglass Industries. http://www.epa.gov/ttn/emc/promgate.html

Method 316 sampling is comprised of an isokinetic sampling train containing reagent grade water filled impingers. Formaldehyde is absorbed in the DI water. The contents of the impinger and DI train rinses are analyzed for by a modified pararosaniline method. Samples are derivatized with pararosaniline and sodium sulfite to create a purple chromophore. The chromophore is analyzed by spectrophotometer set at 570nm.

EPA Method 316

Media	Reagent grade water filled impingers
Sampling Rate	Determined by user (isokinetic)
Sampling Volume	30 cubic ft minimum sample volume
Sample Handling	Cap vials and keep chilled at 2°C
Sample Hold Time	14 days from date of collection at 2°C
Field Blank	1 per set

3.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS

Air Toxics Method @ 71 Siloxanes

Siloxanes are a family of organic compounds containing chains of silicon, oxygen, and methyl groups. These organosilicon compounds, commonly called silicones, differ from naturally occurring inorganic forms of silicon (i.e., silicates). Siloxanes are manufactured in a wide variety of forms including low to high viscosity fluids, gums, elastomers, and resins.

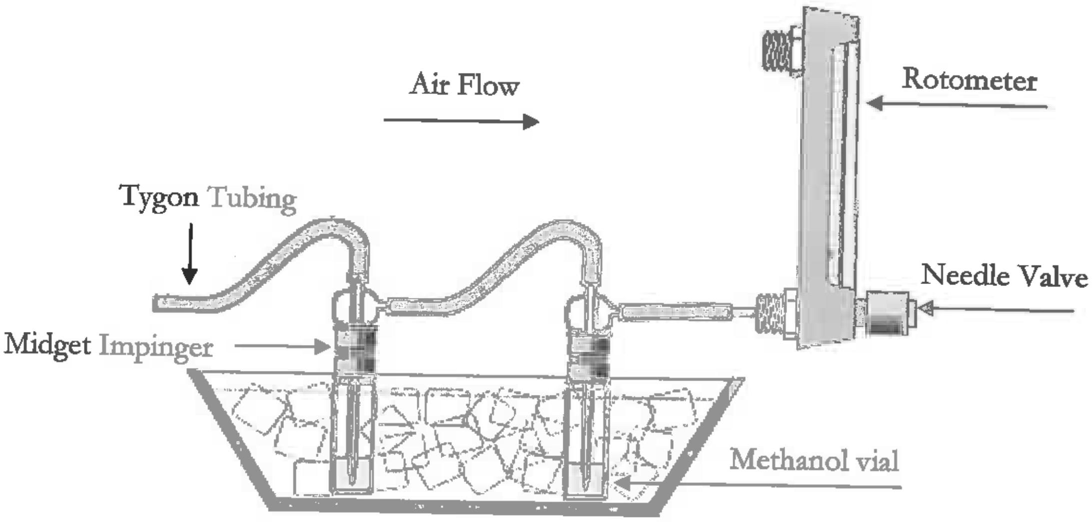
Building on results of the 1997 Dow Corning landfill consortium investigation, the ATL method is based on drawing air-phase samples through a series of two midget impingers containing methanol (see Table 1). Siloxanes present in the air-phase dissolve in the chilled methanol solution and are subsequently capped and kept chilled until analysis. The suggested media hold time is 30 days and the suggested sample hold time until analysis is 21 days.

Air Toxics @ 71 Siloxanes

Media	One pair of 24 mL borosilicate glass vials with Teflon screw
Impinger Solution	Up to 15 mL methanol (6 mL suggested)
Sampling Volume	Determined by user (20 L suggested)
Sampling Rate	Determined by user (112 mL/min for 3 hours suggested)
Sample Handling	Cap vials and keep chilled at 4 ± 2°C
Media Hold Time	30 days from date of certification
Sample Hold Time	21 days from collection

3.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS

Collect the sample by attaching inert, flexible tubing from the source air stream to the inlet of the first impinger (see Figure 4). Additional tubing connects the outlet of the first impinger to the inlet of the second impinger and both impingers are chilled in an ice bath. If the source is not under pressure, a low-volume pump can supply the vacuum required to draw the sample though the impingers.



A needle valve and rotameter can be used to adjust and measure the flow rate of sample through the impingers. The user must determine optimum sampling rate and volume to achieve the data quality objectives of the sampling program. Sampling rates from 100 to 1,000 mL/min are appropriate as long as there is not significant loss of impinger solution. The amount of sample air drawn through the impingers and the amount of methanol in the impinger determine the final reporting limit concentration. The more sample air drawn through the impingers equates to more target constituent concentrated in the solution and thus lower reporting limits. Be careful not to over sample and saturate the solution. Less impinger solution equates to lower reporting limits, but has less capacity to dissolve the target constituents. For applications involving siloxanes removal from methane gas sources, Applied Filter Technology suggests filling each impinger with 6 mL of methanol and sampling at a flow rate of 112 mL/min for 180 minutes [4]. This arrangement results in a sampling volume of approximately 20 L.

4.0 FILTER SAMPLING

Gas may be drawn through a filter to immobilize the compounds suspended in a gas matrix (or adsorbed on particulates suspended in a gas matrix) onto the surface of the filter material. The sampler records the flow rate and sampling interval for calculating compound concentration by volume. The filter is bagged, chilled (as required), and transported to the laboratory for analysis. Sampling with a filter is similar to sorbent and solution sampling in that compounds are concentrated and the gas matrix is not collected. The filter may be weighed before and after sampling to provide a gravimetric analysis of the total particulates and compounds collected. In addition, the filter can undergo solvent extraction or digestion to determine the presence of organic and inorganic compounds. The filter (e.g., quartz fiber, mixed cellulose ester, Teflon) is selected according to the type of air sampling and compounds targeted.

4.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS

PM10

This method provides for the measurement of the mass concentration of particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM10) in ambient air over a 24-hour period for purposes of determining attainment and maintenance of the primary and secondary national ambient air quality standards for particulate matter.

http://www.epa.gov/ttn/emc/promgate.html

TSP

See PM10

The methods for TSP and PM-10 differ slightly in the conditioning requirements for the filters. Air Toxics treats the two methods the same way using the more stringent conditioning requirements.

4.1 METHOD SPECIFIC SAMPLING INSTRUCTIONS

PM10 & TSP

Media	8 X 10 inch glass fiber filter
Media Hold Time	None specified.
Type of Pump	High volume sampler*
Sampling Rate and Interval	0.5 m³/min for 24 hours
Sampling Volume	700 m³
Sample Handling	None Specified. Use protective packaging. Do not allow the filters to get wet or damaged. Do not handle with bare
Hold Time to Analysis	Air Toxics suggests 14-day sample hold time.
Analytical Method	Gravimetric
QC Samples	Duplicates, Lab Blank, Trip Blank

* Manufacturers include: Tisch Environmental, Village of Cleves-Ohio; Anderson Instruments-500 Technology Ct, Smyma, GA; and Thermo Environmental Instruments-8 West Forge Parkway, Franklin, MA.

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