Soil Gas Assessment Addendum Report

Oregon DEQ ECSI Site No. 2424
3720 NW Yeon Avenue
Portland, Oregon 97210

Prepared for:

Conax Properties, Inc.
c/o Matthew LeMaster
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1201 3rd Avenue
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September 2024
PBS Project 20125.011

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Supporting Data

1 INTRODUCTION

PBS Engineering and Environmental LLC (PBS) completed a soil gas sampling assessment at Environmental Cleanup Site Inventory (ECSI) site number 2424 (Site; Figure 1). The assessment was completed following remedial injections and groundwater monitoring. This report presents the results and conclusions of the recent investigation.

2 PROJECT BACKGROUND

Soil gas sampling was historically completed by PBS at the site in 2014; however, the chemical composition of the contaminant mass has undergone significant alteration resulting from the remedial injections. Given these chemical changes and the amount of time elapsed since the 2014 assessment, a new soil gas assessment is warranted.

The following section presents an abbreviated background for the site. More detailed information can be found in PBS' *Site Closure Report*[1] and from Oregon Department of Environmental Quality's (DEQ) ECSI database.

2.1 Site Description and Ownership

The site is located within Multnomah County in the NE ¼ of the NW ¼ of Section 29 of Township 1 North, Range 1 East of the Willamette Meridian. A site vicinity map is included as Figure 1. A 57,750-square-foot warehouse building is currently situated on the site, occupied by Convoy Supply Ltd., a roofing, siding, and fencing distributor. Conax Properties USA Inc. has owned the property since 2010.

2.2 Site Hydrogeology

The subject property is in the Guilds Lake area. This area was an intermittent lake and marsh until extensive filling and grading occurred in preparation for the 1905 Lewis and Clark Exposition, which was constructed on the lake and grounds south and southeast of the lake. Additional filling and grading occurred through the 1940s to create land for industrial use. Fill materials included incinerator ash in some locations. Underlying the site is an undetermined amount of fill with possible subordinate amounts of gravel.

Underlying fill at a depth of 20 to 30 feet are fine-grained to sand-sized periglacial deposits from the glacial outburst floods of Glacial Lake Missoula. Beneath the flood deposits are poorly consolidated sands and gravelly sands of the Troutdale Formation. Underlying the Troutdale Formation are approximately 200 feet of siltstone, sandstone, and mudstone of the Sandy River Mudstone. Basalt lava flows of the Columbia River Basalt Group are at depth.

The shallowest occurrence of groundwater is expected to be at approximately 5 to 10 feet below the ground surface (bgs). The shallow groundwater flow direction varies, extending to the south at a relatively flat hydraulic gradient. Topography suggests relatively flat gradients across this large level area of historical fill at the base of Willamette Heights, so shallow groundwater flow direction varies based on location. Deeper groundwater would be expected to flow to the north/northeast toward the Willamette River.

2.3 Post In Situ Findings

In May 2022, PBS completed 53 gridded injections into the subsurface of the site. The injections were composed of three remedial compounds designed to dechlorinate and degrade halogenated volatile organic compounds (VOCs). Post-treatment performance groundwater monitoring results indicated that significant

[1] PBS (PBS Engineering and Environmental Inc.). (2023). *Site Closure Report, Oregon DEQ ECSI Site No. 2424, 3720 NW Yeon Avenue, Portland, Oregon 97210.* Prepared for Conax Properties, Inc. PBS Project 20125.011.

dechlorination of the primary halogenated solvents tetrachloroethene (PCE) and trichloroethene (TCE) has occurred. Cumulative PCE and TCE concentrations across the monitoring well network decreased 37.6% and 68.2%, respectively, based on a comparison of sampling data from the May 2022 pre-injection groundwater monitoring event and the final post-treatment (Quarter 4) monitoring event. Excluding monitoring well MW-8, PCE and TCE concentrations reduced 98.4% and 91.9%, respectively. Reduction of halogenated solvents in MW-8 is expected to be slower due to the lower mobility of the remedial chemicals and MW-8's location outside of the gridded treatment area.

An increase of several compounds associated with the degradation of TCE and PCE occurred following the injections. Breakdown compounds commonly associated with TCE and PCE were detected, including cis-1,2 dichloroethene (cis-1,2-DCE) and vinyl chloride with secondary breakdown compounds of 1,2-trans dichloroethene (trans-1,2-DCE) and 1,1 dichloroethene (1,1-DCE). Monitoring wells MW-3, MW-5, MW-6, MW-7, and MW-9 indicated concentrations of one or more breakdown compounds that exceeded DEQ risk screening criteria during the final monitoring event. The detections are indicative that dechlorination is occurring. Over time, the remedial compounds are anticipated to further degrade and reduce the concentrations of breakdown compounds into harmless byproducts, resulting in a complete dechlorination process.

During the most recent groundwater monitoring event (May 2023), breakdown compounds in monitoring wells MW-3 and MW-5 through MW-9 exceeded the Vapor Intrusion into Buildings Risk-Based Concentration (RBC) protective of occupational receptors. Monitoring well MW-6 detected the highest concentrations of both vinyl chloride and cis-1,2-DCE.

3 SOIL GAS ASSESSMENT SCOPE OF WORK

The scope of work was proposed to evaluate concentrations of PCE, TCE, and their breakdown products in soil gas within and adjacent to the area of dissolved contaminants present following remedial injections. The assessment included the collection of soil gas samples using a push-probe drilling rig, as well as the collection of sub-slab soil gas samples.

The exterior soil gas sampling was described in a work plan submitted to DEQ on February 1, 2024.[2] The work plan was approved by DEQ on February 14, 2024, with the following modifications:

- DEQ requested depth-to-water measurements be collected before and after the vapor sampling.
- DEQ requested the weather conditions (including temperature, precipitation, and barometric pressure, noting if the pressure is rising or falling during the sampling period) should be noted in the field.

The proposed sub-slab sampling approach was outlined to DEQ in a memorandum submitted on May 13, 2024.[3] It was approved by DEQ without modification on May 20, 2024. Copies of both work plans are included in Appendix A.

[2] PBS. (2024, February). *Soil Gas Assessment Work Plan.*
[3] PBS. (2024, May). *Proposed Sub-Slab Sample Locations Memo*.

4 FIELD ACTIVITIES

4.1 Push Probe Soil Gas Assessment

DEQ has published a vapor intrusion guidance document (VI Guidance) that establishes protocols for collecting soil gas samples.[4] PBS collected six soil gas samples from the Site. Soil gas samples were collected from the following locations:

- Near monitoring wells MW-6 and MW-9 (SV-1 and SV-2, respectively)
- Near the west-adjacent building and property boundary (SV-3)
- Near the southern end of the subject warehouse (SV-4 and SV-5). These vapor samples were additionally located adjacent to a sewer line to evaluate the utility as a potential preferential pathway for vapor migration.
- Adjacent to the southern property boundary (SV-6).

The sample locations are illustrated in Figure 3. The samples were collected following Sections 3.2.1 and 3.2.2 of the VI Guidance with modifications, as needed, for leak detection. The sample collection process is described in PBS' Standard Operating Procedure titled Sub-Slab Vapor and Soil Gas Sampling, a copy of which is in Appendix B.

PBS collected the samples on March 19, 2024, using a post-run tubing (PRT) sampling system provided and operated by Holt Drilling of Vancouver, Washington. The PRT borings were advanced with a track-mounted drill rig to depths ranging from 4.5 feet to 5.5 feet bgs, depending on depth to groundwater as measured at the proximity monitoring wells, which prior to sampling ranged in depth from 4.29 to 7.39 feet below top of casing (btoc). Groundwater depths were measured again following completion of the sampling and found to be consistent with initial measurements. Groundwater depths are included in Table 4. PBS performed leak detection monitoring using helium as a tracer gas. The samples were collected into Summa canisters obtained from the laboratory with flow regulators set to a rate of no more than 200 milliliters per minute (mL/min).

Following collection, the Summa canisters were sealed, labeled, and shipped to Friedman and Bruya (F&B) in Seattle, Washington, under chain-of-custody documentation. The soil gas samples were analyzed for chlorinated solvent-related VOCs that included PCE and its breakdown compounds (including TCE, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride) by Environmental Protection Agency (EPA) Method TO-15. The samples were additionally analyzed for helium by ASTM D-1946 for leak detection purposes. A copy of the laboratory report is included in Appendix C.

PBS utilized regional weather station data from Portland International Airport to determine barometric pressure, which was noted to be consistently decreasing during the sampling event ranging from 30.05 inches of mercury at 8:00 AM at the beginning of the sampling event to 29.98 inches of mercury upon completion of the sampling event at 3:00 PM. Air temperature during this time period trended upward, starting at 46 degrees Fahrenheit (°F) and increasing to 68°F at the completion of the sampling event. No precipitation was noted during the sampling event. Weather data recorded during the sampling is included in Appendix D.

4.2 Sub-Slab Vapor Sampling

Additional evaluation of the vapor intrusion pathway included the collection of sub-slab vapor samples from inside the warehouse. PBS staff completed a site visit on May 9, 2024, to evaluate interior conditions of the

[4] Oregon Department of Environmental Quality. (March 2010). *Guidance for Assessing and Remediating Vapor Intrusion in Buildings*.

warehouse and identify suitable sub-slab sampling locations. The site warehouse is constructed on an elevated slab to compensate for site grade, starting at close to site grade at the northern end of the warehouse and approximately 5 feet above grade at the southern end of the building. The slab was estimated to be approximately 8 inches thick and is presumed to be installed on top of compacted soil or similar material (detail was not provided in historic plans or permits). No sub-slab trenches were identified in the southern portion of the warehouse. In the northern extent of the warehouse (northwest of MW-1), a concrete ventilation trench was observed that was situated in an east-to-west configuration beneath the warehouse. Because the trench is in the northern extent of the warehouse and approximately 200 feet north of the area of interest, it was not considered for the evaluation of sample locations. PBS selected two locations near the southernmost extent of the warehouse:

- Sub-slab sample location SSV-1 was placed directly north of SV-5, and approximately 20 feet from the southern end of the warehouse.
- Sub-slab sample location SSV-2 was placed directly north of SV-4, and also approximately 20 feet from the southern end of the warehouse.

Sub-slab sample locations are shown in Figure 3.

DEQ recently released a draft vapor intrusion guidance document that concluded that longer duration samples, such as those obtained from passive samplers deployed for 14 or more days, more reliably detect vapor intrusion risk and should be used when feasible. A passive sampling approach is recommended to better understand vapor intrusion risk over a period of time (time-weighted average) and account for fluctuations in vapor transport that could be impacted by the heating, ventilation, or atmospheric pressure changes.

On May 30, 2024, PBS supervised Accurate Concrete Cutting of Vancouver, Washington, as they drilled holes in the concrete floor slab to facilitate sample collection. Installation consisted of drilling a 1.5-inch hole to a depth of 1.75 inches and then drilling a 0.625-inch hole through the remainder of the concrete slab. PBS used Waterloo Membrane Samplers obtained from Eurofins TestAmerica as the passive vapor sampling media. PBS deployed three passive sub-slab samples (two primary samples and one duplicate) using a reusable vapor pin sampling system with an attached capsule to contain the Waterloo Membrane Samplers. The duplicate sub-slab sample was collected adjacent to SSV-2 and labeled SSV-DUP. Once the holes were drilled, the samplers were installed and secured with a flush-mounted stainless-steel cap. The passive samplers remained in place for 14 days.

The samplers were collected on June 13, 2024. PBS observed the samplers to be in good condition without damage or evidence of tampering. The concrete holes were patched with concrete the same day following collection of the samplers.

Following sample collection, the samplers were sealed, labeled, and shipped to Eurofins TestAmerica, an Oregon-accredited laboratory, under chain-of-custody documentation. The sub-slab vapor samples were analyzed for PCE and its breakdown compounds (including TCE, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride) by EPA Method TO-17 under a standard turnaround time.

5 FINDINGS

5.1 Soil Gas Analytical Results

Analytical results from the soil gas assessment are provided in Table 1. Contaminant concentrations were generally significantly higher in sample SV-2, which was collected near monitoring well MW-9 (centrally situated within the primary area of interest). PCE was detected in all samples at concentrations ranging from 280 micrograms per cubic meter (µg/m^3) to 15,000 µg/m^3. TCE was also detected in each soil gas sample at concentrations ranging from 1.3 µg/m^3 to 1,900 µg/m^3. 1,1-Dichloroethene, chloroethane, cis-1,2-Dichloroethene and vinyl chloride were only detected above applicable reporting limits in sample SV-2. Several compounds including the PCE detections in samples SV-2, SV-5 and SV-6 were flagged with a qualifier by the laboratory because the analyte response exceeded the upper calibration point. PBS requested clarification from F&B and further evaluation of the raw data to ensure accuracy of the qualified compounds. F&B noted that review of the data showed that all peaks associated with qualified compounds were resolved to a distinct maximum and therefore additional dilution was not performed during the analysis.

The field sampling protocol for soil vapor collection requires the use of helium for leak detection. The VI Guidance allows up to 5% helium to be present in the sample, which is deemed to represent an insignificant contribution from ambient air. Helium was not detected above applicable reporting limits in any of the samples, as shown in Table 2, which indicates the contribution from ambient air is negligible and the results are within acceptable limits.

5.2 Sub-Slab Analytical Results

Analytical results from the sub-slab assessment are provided in Table 1. PCE was detected in all three samples at concentrations ranging from 550 µg/m^3 to 880 µg/m^3. TCE concentrations in the three sub-slab samples ranged from 20 µg/m^3 to 89 µg/m^3. No other contaminants of concern were detected above applicable reporting limits.

PBS noted that laboratory method reporting limit for the compound vinyl chloride of 99 µg/m^3 slightly exceeded the applicable vapor intrusion RBC for chronic commercial receptors of 93 µg/m^3. The higher reporting limit and subsequent screening level exceedance is related to the passive sampler sorbent tubes, which are currently unable to achieve a laboratory reporting limit lower than the RBC. The elevated reporting limit was communicated to DEQ prior to completing the sampling on May 20, 2024, and it was agreed that the sampling should proceed as outlined in the *Proposed Sub-Slab Sample Locations Memo*.

A duplicate sub-slab sample was collected as previously described. The relative percent difference (RPD) of detections was calculated as the difference between the values divided by the average of the values. For samples with results greater than five times the practical quantitation limit (PQL), an RPD of less than 20% is considered good duplication. Samples with results less than five times the PQL, the difference between the sample and its duplicate must be less than the PQL to meet the quality assurance acceptance criteria. The RPD calculations for this sampling event are included in Table 3.

TCE had an RPD of 26%. The results are more than five times the PQL of 3.0 µg/m^3 and the difference between the two results (6.0 µg/m^3) is slightly greater than the PQL; therefore, the results for TCE for these samples are considered estimates.

6 UPDATED VAPOR INTRUSION RISK ASSESSMENT

Sample results were compared to the most recent DEQ RBCs for commercial receptors for the vapor intrusion into buildings pathway.[5] Two soil gas samples (SV-2 and SV-5) detected contaminant concentrations that exceeded applicable RBCs, indicating a potentially complete vapor intrusion pathway for on-site receptors. However, results of the two passive sub-slab samples indicated that while present, compounds of concern were well below the applicable DEQ RBCs.

[5] DEQ. (2024, March). *Tables of Vapor Intrusion RBCs Based on EPA VISL Calculations*.

Soil gas samples collected near the western property boundary (SV-1 and SV-3) and southern property boundary (SV-6) met DEQ RBCs and indicate there is not an off-site vapor intrusion risk as adjacent property use is industrial.

7 CONCLUSIONS AND RECOMMENDATIONS

PBS has completed an evaluation of potential vapor intrusion risk at the site. Vapor samples collected along the western and southern boundaries indicate that there is not a vapor intrusion risk to adjacent properties. Two soil gas samples (SV-2 and SV-5) detected contaminant concentrations that exceed DEQ risk screening levels. SV-2 was placed within the highest area of residual contamination and is located away from buildings and structures where a vapor intrusion risk could occur.

The PCE detection in SV-5, near the southeastern corner of the site warehouse, indicated a potential vapor intrusion risk; however, sub-slab soil gas samples collected at the southern end of the building met DEQ RBCs. The sub-slab sample locations were conservatively placed in the southernmost extent of the building to evaluate sub-slab soil gas concentrations at the closest proximity to the Locality of Facility. Given the large size of the 57,750-square-foot warehouse and lack of detections exceeding DEQ screening levels, vapor intrusion risk does not appear to be present, and the Site should be issued a Conditional No Further Action Letter.

A recommended component of the regulatory closure will be a restriction recorded on the deed that requires mitigation (e.g., a DEQ-approved vapor barrier) for any structures built in the area of bounded by SV-1, SV-3, SV-4, and SV-6.

8 LIMITATIONS

PBS has prepared this report for use by Conax Properties, Inc. This report is for the exclusive use of the client and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced in total or in part without the express written consent of the client and PBS.

This study was limited to the tests, locations, and depths as indicated to determine the absence or presence of certain contaminants. The site as a whole may have other contamination that was not characterized by this study. The findings and conclusions of this report are not scientific certainties but probabilities based on professional judgment concerning the significance of the data gathered during the course of this investigation. PBS is not able to represent that the Site or adjoining land contain no hazardous waste, oil, or other latent conditions beyond that detected or observed by PBS. Groundwater data collected from temporary borings is considered preliminary; detections may need confirmation by installation of permanent wells.

PBS Engineering and Environmental LLC

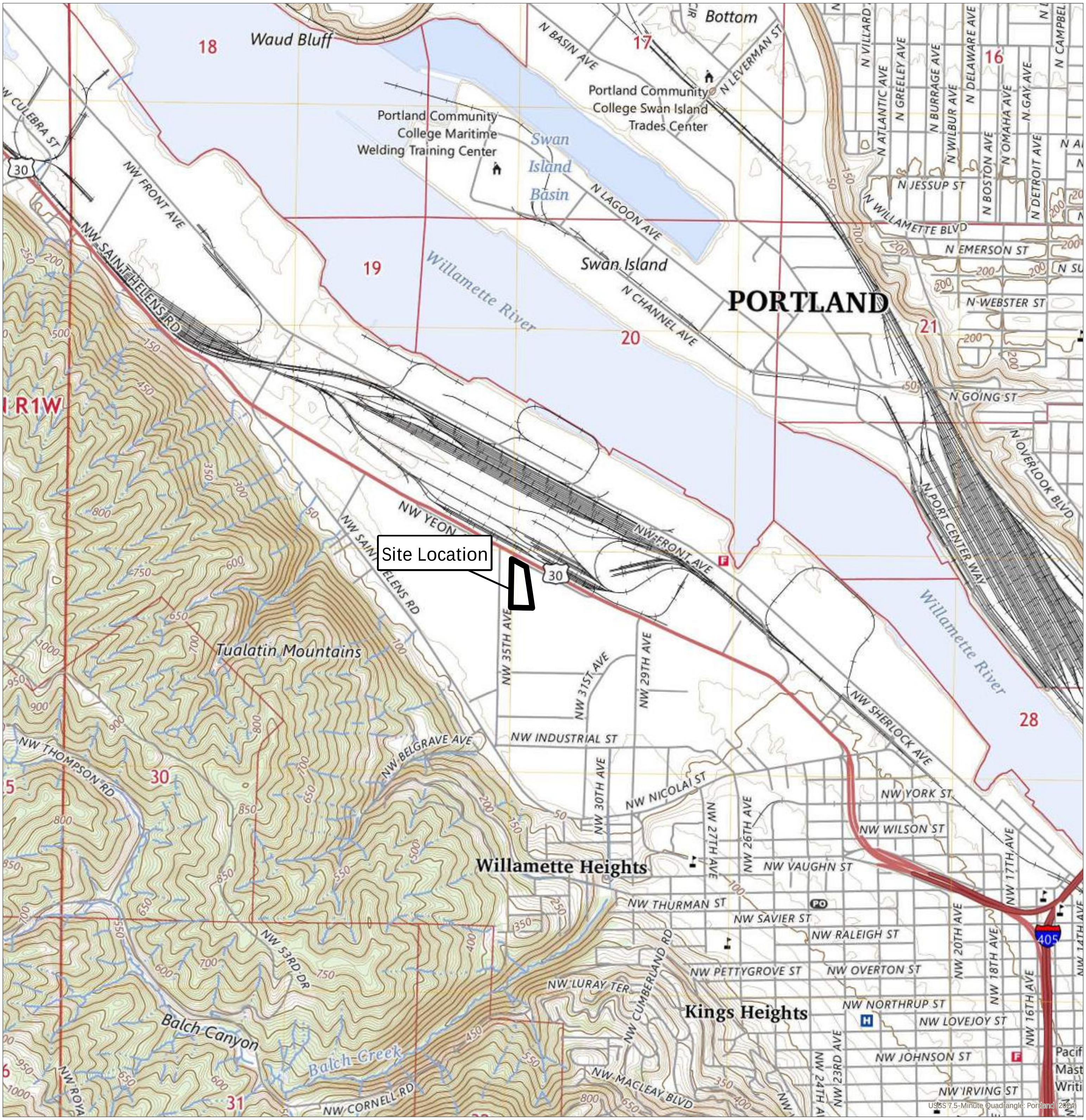
Digitally signed by Nick Thornton
Date: 2024.09.16 12:45:40 -07'00'

Nick Thornton — Date
Senior Project Manager

Digitally signed by Dennis Terzian
Date: 2024.09.16 14:32:41 -07'00'

Dennis Terzian, RG — Date
Senior Geologist

Figures



Site Vicinity

3720 NW Yeon Avenue, Portland, Oregon

Date: September 2024 | Project: 20125.011

Figure: 1

Site Boundary

N

1 INCH = 2,000 FEET

0 Feet 2,000

This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

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Site Plan

3720 NW Yeon Avenue, Portland, Oregon

Date: September 2024 | Project: 20125.011

Figure: 2

Site Boundary

N

1 INCH = 100 FEET

0 100 Feet

PBS

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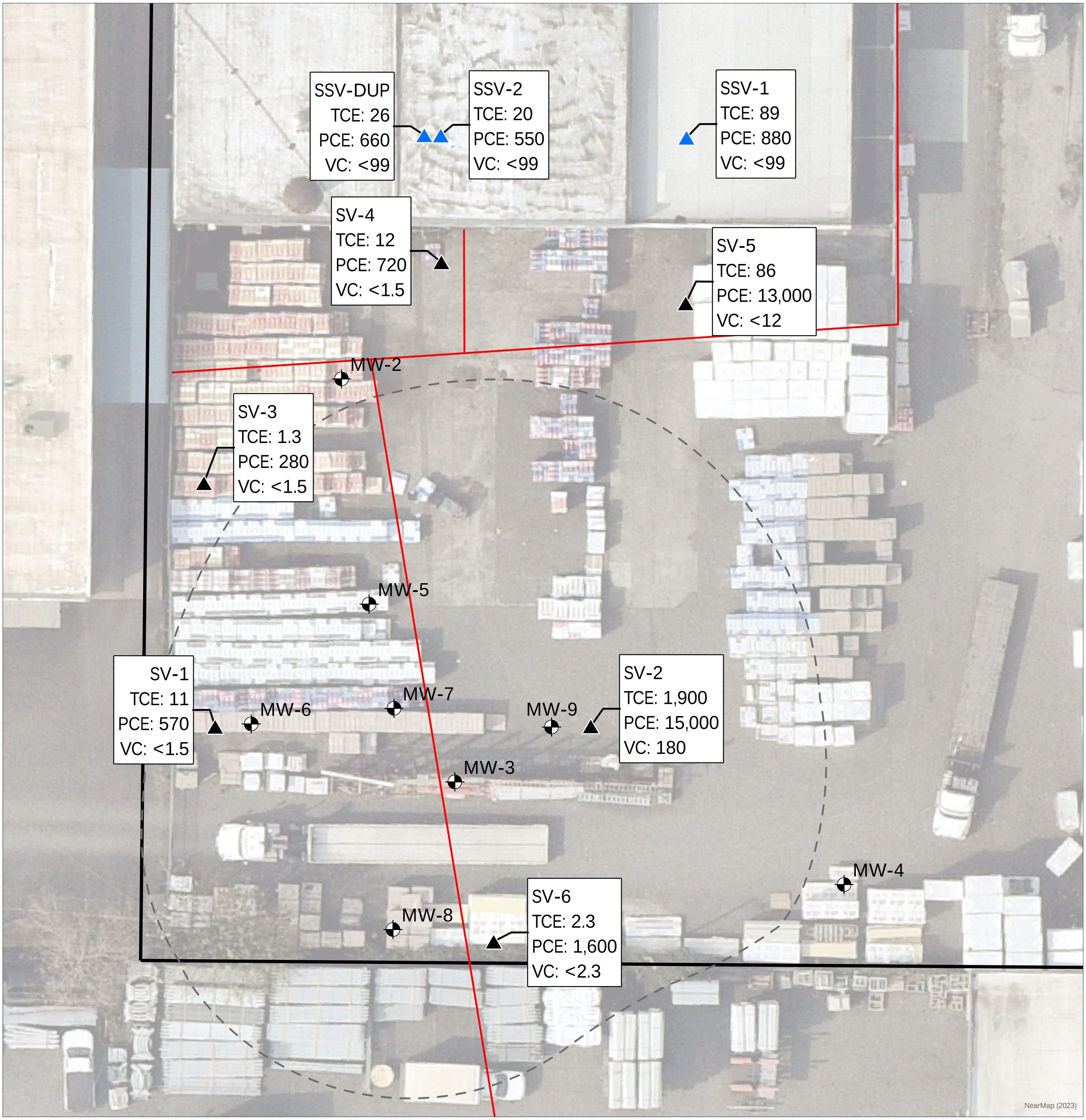

Detail Plan

3720 NW Yeon Avenue, Portland, Oregon

Date: September 2024 | Project: 20125.011

Figure: 3

Sub Slab Vapor Sample
Soil Gas Sample
Storm Sewer Utility (approximate)
Monitoring Well
Locality of Facility (LOF)
Site Boundary

1 INCH = 30 FEET

N

0 30 Feet

PBS

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Tables

Table 1. Summary of Soil Gas Analytical Results

3720 NW Yeon Avenue

Portland, Oregon

ECSI Site No. 2424

Sample ID	Sampling Date	Chloroethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Tetrachloroethene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride
		Chlorinated Volatile Organic Compounds ($\mu g/m^3$)										
Soil Gas Assessment												
SV-1	3/19/2024	<16	<2.4	<0.24	<2.4	<2.4	<2.4	570	<3.3	<0.33	11	<1.5
SV-2	3/19/2024	9,500 ve	<18	<1.8	110	5,500 ve	26	**15,000 ve**	<25	<2.5	**1,900**	**180**
SV-3	3/19/2024	<16	<2.4	<0.24	<2.3	<2.3	<2.3	280	4.2	<0.32	1.3	<1.5
SV-4	3/19/2024	<15	<2.3	<0.23	<2.3	<2.3	<2.3	720	<3.2	<0.32	12	<1.5
SV-5	3/19/2024	<120	<18	<1.8	<18	<18	<18	**13,000 ve**	<25	<2.5	86	<12
SV-6	3/19/2024	<23	<3.6	<0.36	<3.5	<3.5	<3.5	1,600 ve	<4.9	<0.49	2.3	<2.3
Sub-Slab Assessment												
SSV-1	5/30/24 through 6/13/24	--	<50	--	<50	<5.5	<18	880	--	--	89	<99
SSV-2	5/30/24 through 6/13/24	--	<50	--	<50	<5.5	<18	550	--	--	20	<99
SSV-DUP	5/30/24 through 6/13/24	--	<50	--	<50	<5.5	<18	660	--	--	26	<99
Oregon RBC - Vapor Intrusion into Buildings[1]	Chronic Commercial	580,000	260	16	29,000	5,800	5,800	**1,600**	730,000	26	**100**	**93**
	Acute Commercial	4,000,000	NS	NS	20,000	NS	80,000	**4,000**	1,100,000	NS	**210**	130,000

Notes:

See laboratory report for full list of analytes and quality-control data.

Bold text, if present, indicates an exceedance of one or more of the cleanup levels.

<: Not detected above the laboratory reporting limit

$\mu g/m^3$: micrograms per cubic meter

NS: Not set for this analyte

ve: the analyte response exceeded the upper calibration point. Review of the data showed that all peaks associated with the VE qualified compounds were resolved to a distinct maximum and additional dilution was not performed

--: Not Analyzed

[1]Oregon Risk-Based Decision-Making for the Remediation of Petroleum-Contaminated Sites, Oregon DEQ, Table 1. Chronic and Acute Vapor Intrusion Risk-Based Concentrations, March 2024.

Table 2. Helium Leak Detection Results

3720 NW Yeon Avenue
Portland, Oregon
ECSI Site No. 2424

Sample ID	Sample Date	[1]Helium Concentration (shroud)	Helium Concentration (sample)	Percentage of Helium in Sample	Leak Test Results
		ppmv	ppmv	%	pass/not pass
SV-1	3/19/2024	799,000	< 6,000	0.75	pass
SV-2	3/19/2024	740,667	< 6,000	0.81	pass
SV-3	3/19/2024	812,000	< 6,000	0.74	pass
SV-4	3/19/2024	826,333	< 6,000	0.72	pass
SV-5	3/19/2024	809,000	< 6,000	0.74	pass
SV-6	3/19/2024	781,000	< 6,000	0.76	pass

Notes:

[1]Readings taken using a Dielectric MGD-2002 Helium Meter (average of pre-sample, mid-sampling, post-sample readings).

pass: percent of helium in sample is less than 5%

ppmv: parts per million volume

<: Less than the reported detection limit (RDL)

Table 3. Field Duplicate Sample Evaluation

3720 NW Yeon Avenue
Portland, Oregon
ECSI Site No. 2424

This table provides an assessment of the relative percent difference (RPD) between a sample and its field duplicate.

Analyte	SSV-2			
	Original	Dup	RPD	Pass
1,1-Dichloroethane	<50	<50	Acceptable	✓
1,1-Dichloroethene	<50	<50	Acceptable	✓
cis-1,2-Dichloroethene	<5.5	<5.5	Acceptable	✓
trans-1,2-Dichloroethene	<18	<18	Acceptable	✓
Tetrachloroethene	550	660	18%	✓
Trichloroethene	20	26	26%	*
Vinyl Chloride	<99	<99	Acceptable	✓

Notes:

Results in micrograms per cubic meter ($\mu g/m^3$)

#: For samples with results less than five times the MRL: If the difference between the sample and its duplicate is less than the MRL, then the duplicate sample meets the quality assurance acceptance criteria.

*: The results are outside of acceptable RPD limits and should be considered estimates.

Acceptable: no detection in original or duplicate, or meets quality assurance acceptance criteria

Field Duplicate: Precision indicated by analysis of the field duplicate will be expressed as the relative percent difference (RPD) between a sample and its field duplicate. RPD is calculated as follows:

RPD (%) = Absolute Value of

$$\left| \frac{X_1 - X_2}{(X_1 + X_2)/2} \right| \bullet 100\%$$

where: X_1 = measured concentration in the first sample
X_2 = measured concentration in the second sample

An RPD of 20% or less is considered acceptable.

Table 4. Groundwater Level Data

3720 NW Yeon Avenue
Portland, Oregon
ECSI Site No. 2424

Well ID	Date	Pre-Sampling Depth to Water (feet)[b]	Post-Sampling Depth to Water (feet)[b]
MW-1	3/19/24	4.29	4.27
MW-2		4.49	4.47
MW-3		5.72	5.68
MW-4		7.39	7.36
MW-5		4.95	4.92
MW-6		5.10	5.21
MW-7		5.34	5.35
MW-8		5.88	5.87
MW-9		6.25	6.15

[b]Depth to groundwater measured in feet from the
surveyed location at the top of each well casing to the

Appendix A
PBS Work Plans

February 1, 2024

Kevin Dana
Oregon Department of Environmental Quality – Northwest Region
700 NE Multnomah Street
Portland, Oregon 97232

Via email: Kevin.DANA@deq.oregon.gov

Regarding: Soil Gas Assessment Work Plan
Oregon DEQ ECSI Site No. 2424
3720 NW Yeon Avenue
Portland, Oregon
PBS Project 20125.011

Dear Mr. Dana:

PBS Engineering and Environmental Inc. (PBS) is submitting this work plan to perform a soil gas assessment at Environmental Cleanup Site Inventory (ECSI) site number 2424. The assessment is designed to evaluate vapor intrusion risk from residual dissolved halogenated solvents in shallow groundwater following in-situ remedial injection treatments. Results from the assessment will be used to evaluate potential exposure from both the Vapor Intrusion into Buildings and Volatilization to Outdoor Air Pathways.

BACKGROUND

Soil gas sampling was historically completed by PBS at the site in 2014; however, the chemical composition of the contaminant mass has undergone significant alteration resulting from the remedial injections. Given these chemical changes and the amount of time elapsed since the 2014 assessment, a new soil gas assessment is warranted.

The following section presents an abbreviated background for the site. More detailed information can be found in PBS' August 2023 Site Closure Report[1] and from DEQ's ECSI database.

Site Description and Ownership

The site is located within Multnomah County in the NE ¼ of the NW ¼ of Section 29 of Township 1 North, Range 1 East of the Willamette Meridian. A site vicinity map is included as Figure 1. A 57,750-square-foot (sf) warehouse building is currently situated on the site, occupied by Convoy Supply Ltd., a roofing, siding, and fencing distributor. The property has been owned by Conax Properties USA Inc. since 2010.

Site Hydrogeology

The subject property is in the Guilds Lake area. This area was an intermittent lake and marsh until extensive filling and grading occurred in preparation for the 1905 Lewis and Clark Exposition, which was constructed on the lake and grounds south and southeast of the lake. Additional filling and grading occurred through the 1940s to create

[1] PBS Engineering and Environmental Inc. (2023). *Site Closure Report, Oregon DEQ ECSI Site No. 2424, 3720 NW Yeon Avenue, Portland, Oregon 97210*. Prepared for Conax Properties, Inc. PBS Project 20125.011.

land for industrial use. Fill materials included incinerator ash in some locations. Underlying the site is an undetermined amount of fill with possible subordinate amounts of gravel.

Underlying fill at a depth of 20 to 30 feet are fine-grained to sand-sized periglacial deposits from the glacial outburst floods of Glacial Lake Missoula. Beneath the flood deposits are poorly consolidated sands and gravelly sands of the Troutdale Formation. Underlying the Troutdale Formation are approximately 200 feet of siltstone, sandstone, and mudstone of the Sandy River Mudstone. Basalt lava flows of the Columbia River Basalt Group are at depth.

The shallowest occurrence of groundwater is expected to be at approximately 5 to 10 feet below the ground surface (bgs). The shallow groundwater flow direction varies, extending to the south at a relatively flat hydraulic gradient. Topography suggests relatively flat gradients across this large level area of historical fill at the base of Willamette Heights, so shallow groundwater flow direction varies based on location. Deeper groundwater would be expected to flow to the north/northeast toward the Willamette River.

Post In-Situ Remediation Findings

In May 2022, PBS completed 53 gridded injections into the subsurface of the site. The injections were comprised of three remedial compounds designed to dechlorinate and degrade halogenated volatile organic compounds (VOCs). Post-treatment performance groundwater monitoring results indicated that significant dechlorination of the primary halogenated solvents tetrachloroethene (PCE) and trichloroethene (TCE) has occurred. Cumulative PCE and TCE concentrations across the monitoring well network decreased 37.6% and 68.2%, respectively, based on a comparison of sampling data from the May 2022 pre-injection groundwater monitoring event and the final post-treatment (Q4) monitoring event. Excluding monitoring well MW-8, PCE and TCE concentrations reduced 98.4% and 91.9%, respectively. Reduction of halogenated solvents in MW-8 is expected to be slower due to the lower mobility of the remedial chemicals and MW-8's location outside of the gridded treatment area.

An increase of several compounds associated with the degradation of TCE and PCE occurred following the injections. Breakdown compounds commonly associated with TCE and PCE were detected including cis-1,2 dichloroethene (cis-1,2-DCE) and vinyl chloride with secondary breakdown compounds of 1,2-trans dichloroethene (trans-1,2-DCE) and 1,1 dichloroethene (1,1-DCE). Monitoring wells MW-3, MW-5, MW-6, MW-7, and MW-9 indicated concentrations of one or more breakdown compounds that exceeded DEQ risk screening criteria during the final monitoring event. The detections are indicative that dechlorination is occurring. Over time, the remedial compounds are anticipated to further degrade and reduce the concentrations of breakdown compounds into harmless byproducts, resulting in a complete dechlorination process.

During the most recent monitoring event completed in May 2023, breakdown compounds in monitoring wells MW-3 and MW-5 through MW-9 exceeded the Vapor Intrusion into Buildings Risk Based Concentration (RBC) protective of occupational receptors. Monitoring well MW-6 detected the highest concentrations of both vinyl chloride and cis-1,2-DCE.

SOIL GAS ASSESSMENT SCOPE OF WORK

The following scope of work is proposed to evaluate concentrations of PCE, TCE and their breakdown products in soil gas within and adjacent to the area of dissolved contaminants present following remedial injections.

Preparatory Activities

A site-specific health and safety plan (HASP) was previously prepared for the site—the HASP will be updated to reflect new activities and personnel slated for this project. The HASP will include a map to the hospital, will be reviewed with field personnel on a daily basis, and will be maintained on site throughout the duration of field activities. Work will be conducted by experienced PBS personnel and supervised by an Oregon registered geologist (RG).

Field Activities

PBS is proposing to collect six soil gas samples from the locations indicated on the attached figure (Figure 2). Soil gas samples will be collected using a Post Run Tubing (PRT) sampler advanced to at least 5 feet below ground surface (bgs). Deeper advancement of the PRT system is not recommended due to the proximity of shallow groundwater. The PRT system will be advanced using a direct-push track mounted drilling rig operated by a licensed driller. Helium will be used as a tracer gas for leak detection at each sampling location. Soil gas sampling will occur at least 2 days or more following a significant (greater than 0.1 inches) rainfall event.

Soil gas samples will be collected from the following locations:

- SV-1 and SV-2 will be collected near monitoring wells MW-6 and MW-9, respectively, to evaluate source-area soil gas concentrations.
- SV-3 through SV-5 will be collected near the northwestern and northern extent of the LOF, respectively, in proximity to the site warehouse and west-adjacent warehouse (SV-3). Each location will be situated near the storm sewer utility to account for soil gas migration through utility backfill. SV-4 and SV-5 are also located in the vicinity of buried storm sewer lines to address this potential preferential pathway.
- SV-6 will be collected near the southern property boundary to assess potential offsite migration as well as soil gas concentrations in proximity to MW-8. SV-6 will also be situated near the storm sewer utility in order to address this potential preferential migration pathway.

The samples will be collected in accordance with PBS' Standard Operating Procedure (SOP) for sub slab and soil gas sampling, which is attached. PBS will use laboratory-certified Summa canisters connected to flow regulators set to a rate of no more than 200 milliliters per minute. Each sample will be analyzed for the following analyses:

- Halogenated volatile organic compounds (VOCs) by EPA Method TO-15 including PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE and vinyl chloride.
- Helium by ASTM D-1946

Reporting

PBS will prepare an addendum to the Closure Report that summarizes the results of the sampling and our findings. If sampling confirms the absence of vapor intrusion risk, PBS will request conditional regulatory closure be issued from DEQ following the implementation of site controls.

Please feel free to contact me at 503.417.7610 or nick.thornton@pbsusa.com with any questions or comments.

Sincerely,

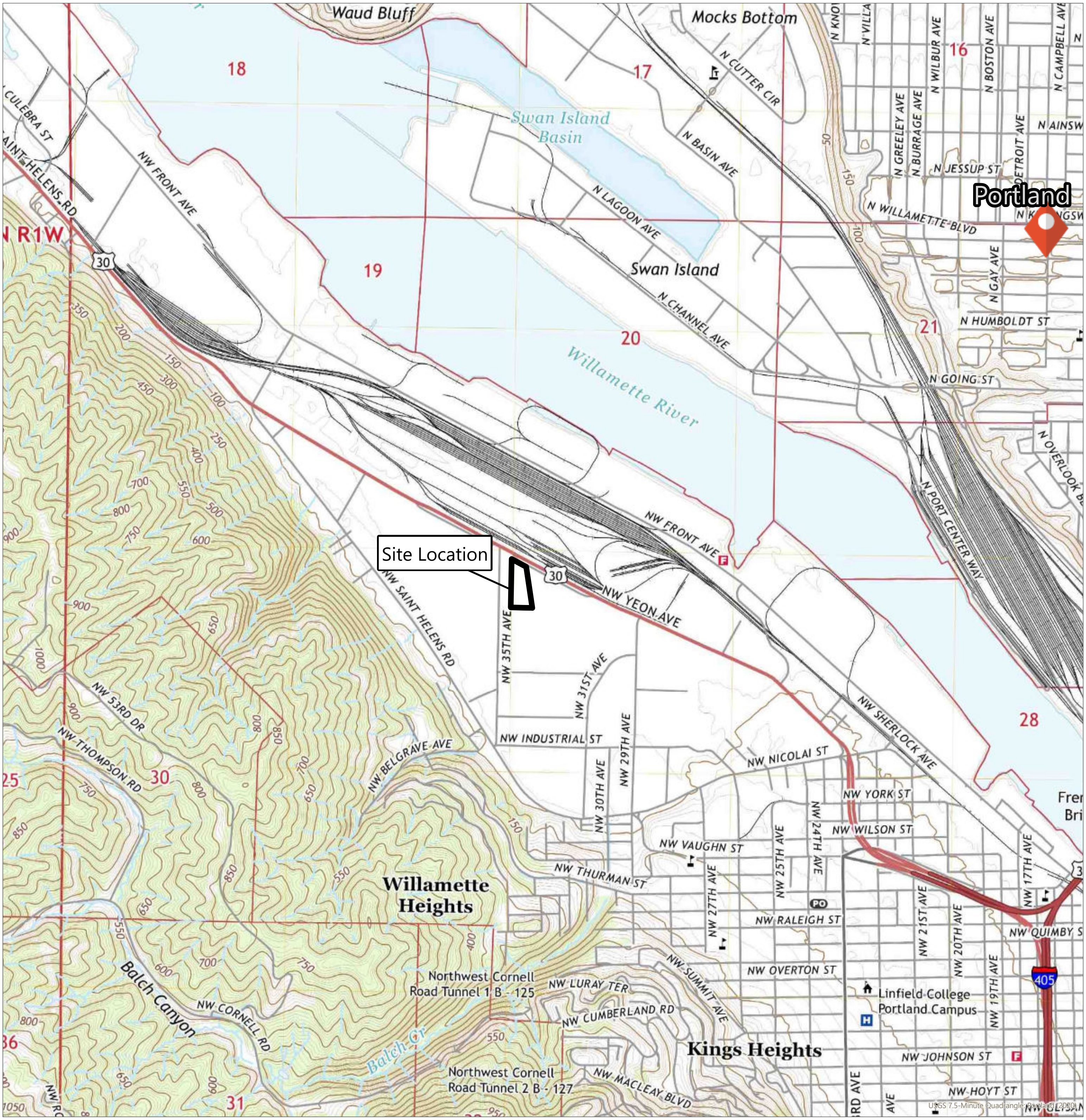
Nick Thornton
Project Manager
PBS Engineering and Environmental Inc.

Dennis Terzian, RG
Senior Geologist
PBS Engineering and Environmental Inc.

Attachment(s): Figure 1. Site Vicinity
Figure 2. Proposed Soil Gas Sampling Locations
Standard Operating Procedure – Sub Slab and Soil Gas Sampling

cc: Conax Properties, Inc.
Davis Wright Tremaine LLP

NT: DT



Site Vicinity

3720 NW Yeon Avenue, Portland, Oregon

Date: February 2024 | Project: 20125.011

Figure: 1

Site Boundary

1 INCH = 2,000 FEET

0 2,000 Feet

N

PBS

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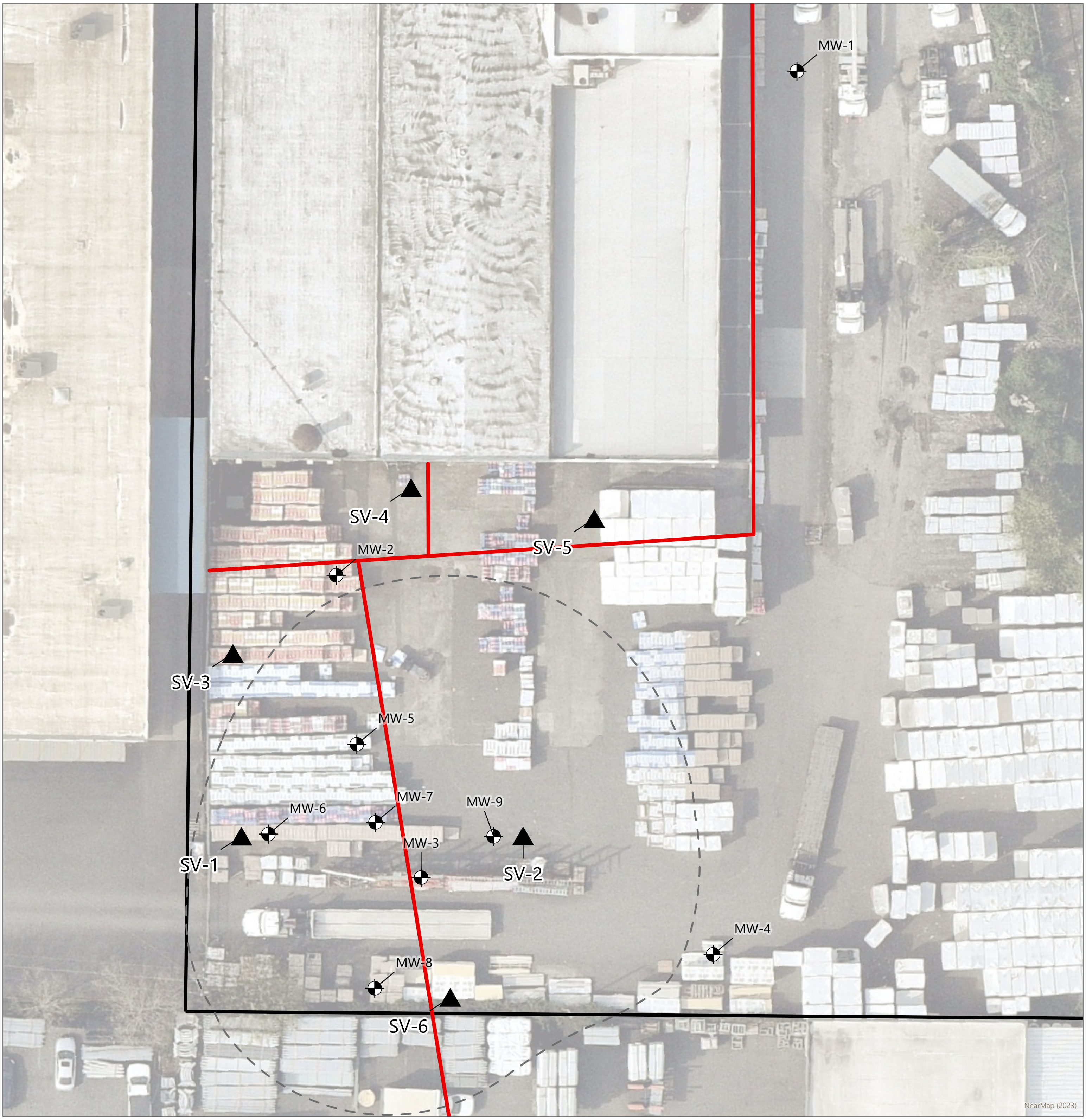

Proposed Soil Gas Sampling Locations

3720 NW Yeon Avenue, Portland, Oregon

Date: February 2024 | Project: 20125.011

Figure: 2

- Proposed Soil Gas Sampling Location
- Monitoring Well
- Storm Sewer Utility (approximate)
- Locality of Facility (LOF)
- Site Boundary

N

1 INCH = 40 FEET

0 40 Feet

PBS

This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

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STANDARD OPERATING PROCEDURE
Sub-Slab Vapor and Soil Gas Sampling

PURPOSE

Vapor intrusion of volatile organic compounds (VOCs) into occupied structures is considered a critical migration pathway requiring assessment at contaminated sites. Specifically, regulators may require property owners to sample soil gas, sub-slab vapor, or indoor air to assess risk to building occupants.

This standard operating procedure (SOP) is intended to guide soil gas or sub-slab vapor sampling efforts when creating temporary sampling points when Method TO-15 or other analytical methods utilizing a Summa canister as the sampling media are required. The sampling points can be modified to produce a permanent sampling location. The sampling protocols for analysis of soil gas or sub-slab vapor by Method TO-17, which utilizes a sorbent tube as the sampling media (instead of a Summa canister), as well as the sampling of indoor air are presented as separate SOPs.

Soil gas and sub-slab vapor sampling is typically conducted based on prior results from other environmental studies, such as soil or groundwater sampling, or if historical uses indicate a human health risk could be present. A variety of issues can significantly affect the results of soil gas and sub-slab vapor sampling. Adherence to this SOP will help ensure that sampling results are valid and reliable. This SOP assumes that samples will be collected in Summa canisters. If other sampling media is used (such as tedlar bags), some of the steps in this SOP may not apply or may need to be modified.

Use one of the following two methods to conduct the sub-slab vapor or soil gas sampling

METHOD 1 – VAPOR PIN

1 EQUIPMENT LIST

The following table lists standard equipment and tools needed for soil gas and sub-slab vapor sampling. When renting a helium meter, ask the vendor for one that is intended for use in leak detection testing (e.g., MGD-2002 multi-gas leak locator). It should have the ability to purge the line quickly (the equipment company may provide a special filter for this), and preferably, a meter with an active pump (as opposed to passive venting). It does not need to be intrinsically safe UNLESS site conditions require this feature.

Equipment to get from lab	• 1 or 6 liter (L) Summa canister. • One extra Summa canister in the event that a canister fails in the field. • Flow regulator (also known as critical orifice) preset by lab for pre-determined sampling time, not to exceed a flow rate of 200 mL/min. • Vacuum gauge (for verifying vacuum prior to sampling, flow regulator may act in this role). • Tubing (new for each sample location). Must be Teflon, Nylaflow, Peek, or stainless tubing. Do NOT use polyethylene tubing. • Chain of custody and identification tags. • T-fitting (need one for each sampling location, including ferrules and hex nuts for each leg of T).

Other equipment	• Purging syringe (calibrated, typically for 50 to 60 milliliters [mL]). • Granular bentonite. • Disposable or washable containers (~16 ounces) for mixing bentonite and/or cement. • Water for mixing bentonite and cement. • Sand. • Silicone tubing. • Helium gas tank with regulator. • Helium meter (make sure that it measures in ppm by volume). • On-off valve (two per sampling location). • Vapor Pin with a silicon sleeve (or similar equipment). • Vapor Pin tool and hammer for installation and removal (or similar equipment). • Vapor Pin drill guide (for permanent installations). • Field notebook and/or field forms. • Helium shroud. • Weight for shroud, if needed. • Nuts and ferrules (if you did not receive from lab). • Cap for "shroud air tubing." • Water dam (e.g., 1.5-inch PVC coupler).
Tools	• Scissors. • Rotohammer/drill for drilling through concrete. • Drill bits (0.625-inch, 1.5-inch). • Crescent wrench (1/2 and 9/16 inch). • Whisk broom/dust pan. • Wet-dry vacuum. • Extra-thin knife/screwdriver. • Extension cord for rotohammer. • Wrench for helium regulator. • Generator (if power is not available)
Supplemental supplies	• Teflon tape (if seal leaks are sustained). • Purging pump with tubing (if purging syringe not used) and charging cord. • Fast setting concrete to patch floor. • Adhesive to repair carpet or tile.

2 LABORATORY

The lab will supply the Summa canisters, flow regulators, gauges, and tubing, and can also provide the purging syringe, if needed. Have the equipment arrive TWO business days prior to sampling, if possible. This allows the lab time to express-mail any additional, broken, or forgotten equipment.

As soon as the shipment is received, ensure that all equipment was provided and verify the vacuum of all Summa canisters. Order an extra gauge, if needed, to check the canisters for pressure prior to leaving the office. Knowing that the canister has sufficient initial vacuum allows for better trouble shooting in the field.

The following information must be provided to the lab to ensure shipment of the correct equipment:

- Size of canister (400 mL, 1 L, 6 L). A 1 L Summa will require a minimum of two times dilution of reporting limits. If this will cause your sample reporting limits to exceed screening criteria, use a larger Summa canister. You MUST know your reporting limits to determine the canister size.
- Type of canister certification (batch vs. individual). Batch certification is usually sufficient for sub-slab vapor and soil gas sampling projects.
- Method reporting limits.
- Tracer gas to be used (the lab must certify container for this prior to shipping). PBS uses Helium as a tracer gas.
- Sample time/flow rate.

Samples should be collected at a rate between 100 and 175 mL per minute (most guidance documents recommend that samples not be collected faster than 200 mL per minute). A flow rate greater than 200 mL/min runs the risk of introducing ambient air dilution to the sample. The sample time for grab samples is calculated by determining an acceptable sample flow rate (perhaps 150 mL/min) and multiplying that by the sample container size. For a 150 mL/min rate, a 1 L Summa canister would require approximately seven minutes. A 6 L Summa canister would require 40 minutes.

3 SUB-SLAB VAPOR INITIAL PROCEDURES

Order equipment as previously identified, and do the following prior to field activities:

- Determine the proposed locations for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Confirm with the property owner/occupant that subsurface utilities will not be impacted when drilling through the slab in these locations.
- Conduct a private utility locates for your locations to check for subslab or subgrade obstructions.
- If possible, determine the slab thickness to confirm that a hand-operated drill can drill through it.
- Determine if carpeting or other flooring will need to be removed prior to drilling, or will require patching.
- Have the helium meter arrive the day before sampling.

Once at the site, sampling should occur as described below.

Drill Hole and Seal Tubing

These instructions assume that all samples will be collected using a Vapor Pin or similar equipment.

- Confirm concrete thickness, if possible, so you'll know when to expect the drill bit to break through bottom of slab.
- If the Vapor Pin will be installed for on-going monitoring (i.e., permanent installation), begin by drilling a hole 2 inches into the concrete using the 1.5-inch drill bit. This larger hole will be used to install a flush-

mount cover. Then insert the Vapor Pin drill guide into this hole so that the smaller diameter drill hole will be centered. Continue with the directions below.

- Drill a hole through the slab using the 0.625-inch drill bit. Drill 1 to 3 inches into backfill or native material beneath the concrete slab.
- Use a 0.625-inch tube brush to clean concrete dust from the hole.
- Use the whisk broom or vacuum to remove concrete dust or loose material from around the drill hole.
- Install a Vapor Pin with a silicon sleeve (the silicon sleeve provides the seal) into the 0.625-inch drilled hole utilizing a dead weight hammer and the Vapor Pin installation/extraction tool (or similar equipment).
- If not drilling the 1.5-inch hole, place a small amount of hydrated bentonite on the concrete surface around the Vapor Pin and insert a water dam into the bentonite.
- Place a silicon mat with a circular cut-out for the Vapor Pin on the concrete surface around the sample point and water dam.
- Add a small piece of silicone tubing to the top of the Vapor Pin for attaching tubing later.
- Add a small amount of water to the inside of the water dam to ensure a good seal is in place.
- Place the shroud over the sample point and thread 0.25-inch tubing through a stopper in the shroud.
- Place a weight on the shroud to prevent it from being moved and compromising the seal integrity, if needed.

For temporary holes, allow 20 to 30 minutes for the hole to equilibrate. If collecting sub-slab gas samples at multiple locations, consider performing these initial activities at each location prior to continuing with the sampling.

4 SOIL GAS INITIAL PROCEDURES

Order equipment as previously identified. Prior to field activities, the following should occur:

- Determine the locations and depths for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Determine if equipment, vehicles, or other stored items will need to be moved prior to the field event.
- Call in a public utility notification.
- Conduct a private utility locates for your locations to check for subgrade utilities/obstructions.
- Arrange for a driller to deploy a Post Run Tubing (PRT) sample system, or equivalent, or arrange with the driller to install a sample point using a hand auger.

Once at the site, sampling should occur as described below.

Drill Hole and Seal Tubing

- Drill a borehole hole using a PRT system, or equivalent. The bottom of the hole should be at least 5.5 feet below ground surface (bgs), as long as this is above the water table.
- Lift up on the drilling rod approximately 6 inches to create a void in the subsurface.
- Insert the PRT fitting to the 0.25-inch tubing and place down the hole. Once it reaches the bottom, screw the fitting onto the PRT sample point (note: the fitting uses left-hand threads).

- Determine the length of 0.25-inch tubing needed to conduct sampling at this location and cut it to that length. Do not forget that there must be enough tubing to go through the helium shroud, connect to the purging T-valve and connect to the Summa canister. Be sure to cut the ends straight with no burrs or jagged edges.
- Mix bentonite with water for sealing.
- Place bentonite around the rod protruding from the ground.
- Insert bentonite evenly around tubing exiting the drill rod, making sure it penetrates fully into the rod. Thread the other tubing end through the helium shroud/stopper. Cover the loose tubing end with a plastic bag or cap to ensure it remains clean until it is connected to the Summa canister.
- Place the shroud over the drill rod and place more bentonite around the base to seal the shroud to the ground.

Sample Train Assembly

- Place the shroud over the sample point, and thread tubing through the shroud and shroud stopper.
- Place a weight on the shroud to prevent it from being moved and compromising the seal integrity, if needed.
- Attach an on-off valve to the end of the tubing, then place additional tubing on the other side of the valve. Turn the valve off.
- Install a T-fitting and a second on-off valve in-line with the sample tubing to allow for purging. Add tubing from the third leg of the T-fitting to the Summa canister.
- Connect the gauge and flow regulator to the Summa canister and tubing. Do not over tighten the fittings.
- Record the canister and flow regulator serial numbers on the field form.
- Ensure that all connections are tight and all valves are closed.

For temporary holes, wait 20 to 30 minutes to allow the hole to equilibrate. If a hand auger was used to install the sample point you must wait 48 hours.

5 LEAK DETECTION TESTING

Shut-in test and field/laboratory test for helium are two testing methods performed for leak detection.

Shut-in Test

Evaluate the integrity of the sample train by performing a vacuum shut-in test. Remove a sufficient volume of air from the sample train using the purging syringe to provide a vacuum of at least -15 inches of mercury (Hg). Observe the gauge for at least two minutes to detect any decrease in measured vacuum. The vacuum must be maintained for at least two minutes. If the vacuum is not maintained, check the fittings and retest.

Helium Test

At this point, you should have the shroud in place with the tubing from the Vapor Pin or soil gas sample point extending from the shroud, and the inlet hose from the helium tank extending into the shroud. Perform these actions:

- Fill the shroud with helium for several seconds and turn off the tank.

- Using the helium meter (meter), measure and record the helium concentration in the shroud in percent (%) or parts-per-million-volume (ppmv) (1% is equivalent to 10,000 ppmv). The target helium concentration is 70 to 90%. Remove the meter from the shroud air tubing and cap the tubing. *Allow meter to clear back to zero*.

Sample Train Purging

- Open the on-off valve to the Vapor Pin or PRT sampling point tubing. The Summa canister remains closed.
- Determine the amount of air that requires purging within the sampling tubing.
    - Determine how much tubing you need to purge (round up to whole feet).
    - Multiply the number of feet by the volume of air within one unit foot of tubing (see multipliers below for various tubing sizes).
    - Determine how much you need to purge from the hole drilled through the concrete slab or PRT sampler (usually 6 inch length).
    - Add the tubing and hole purge volumes together.
    - You want to remove a minimum of two purge volumes, so multiply volume calculated by two.

Size of tubing (inches)	Air volume in mL per one unit foot
1/4	9.7
3/8	21.7
1/2	38.6
5/8	60.3
3/4	86.9
1	154.4

- Connect the purging syringe and turn the on-off valve to ON.
- Purge the calculated volume of air. Draw the air slowly through the syringe, approximating the sample collection flow rate, to minimize the effect of creating a vacuum that could compromise the connections or seals. If your sample collection rate is 150 mL/min, and you need to purge 50 mL, then take approximately 20 seconds to purge the 50 mL or as slowly as possible.
- If you need to purge more than one syringe volume, complete the first purge, turn the valve on the syringe to OFF, depress the syringe to purge the air out of the syringe, turn syringe valve to ON and repeat the purging process.
- When done purging, turn the on-off valve to OFF.
- Connect the meter to the sample point tubing (Vapor Pin or PRT) and allow the meter to run for approximately one minute. Measure the helium concentration.
- If elevated readings on the helium meter (greater than 5,000 ppmv [0.5%]) are detected, make adjustments to seals.
- Once all necessary adjustments have been made, record the helium measurement in the shroud on field sheet following adjustment to seals.

Once the leak detection testing has confirmed the Vapor Pin or PRT seal is sufficient, proceed to sample collection.

6 SAMPLE COLLECTION

- Confirm that all connections remain tight and all valves are closed.
- Close the on-off valve connected to the purging syringe.
- Open the Summa canister by turning its valve approximately one-half turn.
- Immediately record the vacuum on the gauge (it should stabilize very quickly) and the time. The gauge should measure approximately -30 inches Hg (please note that some gauges may read greater than -30 inches Hg). If the vacuum is less than -27 inches Hg, the canister may not have sufficient vacuum for sampling. In this case, select another canister. If another canister is not available, call the project manager and ask how they would like you to proceed.
- Allow the Summa canister to fill, keeping in mind the amount of time determined for sample collection (i.e., what you told the lab to set for a flow regulator time)
- At the mid-point of the sample collection, record the helium concentration in the shroud. Add additional helium if shroud concentration is below 50%, and record the new reading.
- The vacuum gauge should never drop below -5 inches Hg. If the vacuum readings are not matching up with the expected sampling time (the gauge is dropping faster or slower than expected), you will need to use your best judgment as to when to stop the sample collection (or call the lab or project manager to discuss).
- Once the sample has been collected, close the canister valve, be sure it is tightly closed (but do not over tighten), and record the vacuum reading and time.
- Record the helium concentration in the shroud.
- Remove the gauge and flow regulator and replace the canister fitting.
- Fill out the chain of custody and return the containers to the lab with the original chain of custody. Retain a copy of the chain of custody for the project files.

When collecting 6 L Summa canister samples, it is recommended that you monitor the vacuum gauge during the entire sample duration, which can take up to 50 minutes. If the gauge should drop below -5 inches Hg, the sample may be considered void; this can be prevented by watching the gauge. If the gauge drops to 0 inches Hg the sample will need to be re-taken using a new canister.

Drill Hole Abandonment
Once soil gas sampling is completed, the boring will be abandoned by the licensed drilling subcontractor who completed the borehole following applicable state requirements.

Once sub-slab vapor sampling is completed, the following should occur:

- Remove the water from the water dam.
- Clean out the remaining bentonite, cleaning as much as possible from the floor.
- If the sampling location is for one-time use, deploy the Vapor Pin extraction tool to remove the pin.

- Add a small amount of sand to fill the drill hole approximately 1 to 2 inches below the concrete surface (approximately 1 to 2 inches below the bottom of the "seat"). Do NOT overfill with sand as this may compromise your patch.
- Use the whisk broom to remove any loose material at the surface.
- Fill the upper 1 to 2 inches with a quick setting cement grout. Smooth or feather the surface to help create a bond between the slab and the grout.

If the Vapor Pin or similar equipment is for a permanent installation, the following should occur:

- Place a white cap over the tip of the Vapor Pin.
- Install a permanent cover over the capped Vapor Pin (plastic or metal).

7 POST FIELD ACTIVITIES

- Retain all paperwork provided by the lab, including the packing list and certifications. This information must be retained in the permanent project file.
- Decontaminate reusable fittings owned by PBS following the *Standard Operating Procedure for Vapor Pin Decontamination for Vapor Intrusion Assessments*. This includes the Vapor Pin drill guide and any brushes or other tools used for cleaning.
- Return all rental equipment.

Confirming Helium Detections Meet Regulatory Requirements

- Calculate average helium concentration in shroud by taking two or more readings before, during, and after sampling (be sure that meter is reading in ppm by volume).
- When lab results are received, if helium is detected, use this formula to confirm level of leakage:

  Level of leakage = lab-detected concentration / shroud concentration
- Be sure you are using the same units (ppm may not always equal ppmv – check your units).
- Some regulatory guidance documents allow up to 5 to 10% helium within a sample. Be sure to check your state's guidance for allowable levels. Oregon and Washington both allow up to 5% helium for a valid sample.

METHOD 2 – SEALED TUBING

1 EQUIPMENT LIST

The following table lists standard equipment and tools needed for soil or sub-slab gas sampling. When renting a helium meter, ask the vendor for one that is intended for use in leak detection testing. It should have the ability to purge line quickly (the equipment company may provide a special filter for this) and preferably, a meter with an active pump (as opposed to passive venting). It does not need to be intrinsically safe UNLESS site conditions require this feature.

Equipment to get from lab	• 1 or 6 liter (L) Summa canister. • One extra Summa canister in the event that a canister fails in the field. • Flow regulator (also known as critical orifice) preset by lab for pre-determined

	sampling time. • Vacuum gauge (for verifying vacuum prior to sampling). • Tubing (new for each sample location). Must be Teflon, Nylaflow, Peek, or stainless tubing. Do NOT use polyethylene, silicone, or any other type. • Chain of custody and identification tags. • T-valve (need one for each sampling location, including ferrels and hex nuts for each end of T).
Other equipment	• Purging syringe (calibrated, typically for 50 to 60 milliliters [mL]). • Granular bentonite. • Disposable or washable containers (~16 ounces) for mixing bentonite and/or cement. • Water for mixing bentonite and cement. • Sand. • Silicone tubing. • Weight for shroud. • Helium gas with regulator. • Helium meter (make sure that it measures in ppm by volume). • On-off valve (two per sampling location). • Vapor Pin with a silicon sleeve (or similar equipment). • Vapor Pin tool and hammer for installation and removal (or similar equipment). • Field notebook or field forms. • Helium shroud. • Nuts and ferrels (if you did not receive from lab). • Cap for "shroud air tubing." • Water dam (1.5-inch PVC coupler).
Tools	• Scissors. • Rotohammer/drill for drilling through concrete. • Drill bits (0.625-inch, 1.5-inch). • Crescent wrench (9/16 inch). • Whisk broom/dust pan. • Wet-dry vacuum. • Extra-thin knife/screwdriver. • Extension cord for rotohammer. • Plumber's wrench for helium regulator.
Supplemental	• Teflon tape (if seal leaks are sustained).

supplies	• Purging pump with tubing (if purging syringe not used) and charging cord.

2 LABORATORY

The lab will supply the Summa canisters, flow regulators, gauges, and tubing, and can also provide the purging syringe, if needed. Have the equipment arrive TWO business days prior to sampling, if possible. This allows the lab time to express-ship any additional or forgotten equipment.

As soon as the shipment is received, ensure that all equipment was provided and verify the vacuum of all Summa canisters. Order an extra gauge, if needed, to check the canisters for pressure prior to leaving the office. Knowing that the canister has sufficient initial vacuum allows for better trouble shooting in the field.

The following information must be provided to the lab to ensure shipment of the correct equipment.

- Size of canister (400 mL, 1 L, 6 L). A 1 L Summa will require a minimum of two times dilution of reporting limits. If this will cause your sample reporting limits to exceed screening criteria, use a larger Summa canister. You MUST know your reporting limits to determine the canister size.
- Type of canister certification (batch vs individual). Batch certification is usually sufficient for sub-slab or soil gas sampling projects.
- Method reporting limits.
- Tracer gas to be used (the lab must certify container for this prior to shipping).
- Sample time.

Samples should be collected at a rate between 100 and 175 milliliters (mL) per minute (most guidance documents recommend that samples not be collected faster than 200 mL per minute). A flow rate greater than 200 mL/min runs the risk of introducing ambient air dilution to the sample. The sample time for grab samples is calculated by determining an acceptable sample flow rate (perhaps 150 mL per minute) and multiplying that by the sample container size. For a 150 mL per minute rate, a 1 L Summa canister would require approximately seven minutes. A 6 L Summa canister would require 40 minutes.

3 SUB-SLAB GAS INITIAL PROCEDURES

Order equipment as previously identified, and do the following prior to field activities:

- Determine the proposed locations for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Confirm with the property owner/occupant that subsurface utilities will not be impacted when drilling through the slab in these locations.
- Conduct a private utility locates for your locations to check for sub-slab or sub-grade obstructions.
- If possible, determine the slab thickness to confirm that a hand-operated drill can drill through it.
- Determine if carpeting or other flooring will need to be removed prior to drilling, or will require patching.
- Get the lab equipment delivered two days prior to sampling and ensure that all equipment was provided.

Once at the site, sampling should occur as described below.

Drill Hole and Seal Tubing

- Confirm concrete thickness, if possible, so you'll know when to expect the drill bit to break through the bottom of slab.
- Drill a hole using the 0.25-inch or 0.5-inch drill bit. Drill approximately two inches into slab backfill or native material beneath the concrete slab.
- Using a 0.5-inch or 0.75-inch drill bit, overdrill the hole by approximately one inch to create a "seat" for sealing the tubing. The drill bit used for overdrilling should be one size larger than the original hole (0.5-inch for a 0.25-inch initial hole, etc.).
- Use the whisk broom to remove concrete dust or loose material from around the drill hole.
- Test the 0.25-inch tubing to ensure it can be pushed completely down the hole. Once it reaches the bottom, keep track of that tubing length as you pull it back out. Ensure there is no material stuck in the bottom of the tubing (if there is, cut the tubing end off and repeat this step). Re-insert the tubing so that the bottom rests approximately one inch from the drilled bottom, making sure it is below the bottom of the slab. If the tubing rests at the bottom of the hole that is okay.
- Determine the length of 0.25-inch tubing needed to conduct sampling at this location and cut it to that length. Do not forget that there must be enough tubing to go through helium shroud, connect to the purging T-valve and connect to the Summa canister. Be sure to cut the ends straight with no burrs or jagged edges.
- Thread the other tubing end through the helium shroud/stopper, leaving enough tubing within the shroud to allow you to install the sealing material. Cover the loose tubing end with a plastic bag to ensure it remains clean until it is connected to the Summa canister.
- Mix bentonite to an appropriate consistency for sealing.
- Insert bentonite evenly around tubing, making sure it penetrates fully into the larger drill hole. Push down with fingers or appropriate tool to ensure a good seal. Take care not to scrape or puncture the tubing.
- At the surface, mound the bentonite against the tubing and smooth away from it to create a tight seal. It is appropriate to moisten the top of the bentonite mound to aid in creating a good seal.

For temporary holes, allow approximately 20 to 30 minutes for the bentonite to seal and the hole to equilibrate. If collecting sub-slab gas samples at multiple locations, consider performing these initial activities at each location prior to continuing with the sampling.

4 SOIL GAS INITIAL PROCEDURES

Order equipment as previously identified. Prior to field activities, the following should occur:

- Determine the locations and depths for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Determine if equipment, vehicles, or other stored items will need to be moved prior to the field event.
- Arrange for a utility locate.
- Arrange for a driller to deploy a Post Run Tubing (PRT) sample system, or equivalent.

Once at the site, sampling should occur as described below.

Drill Hole and Seal Tubing

- Drill a hole using a PRT system, or equivalent. The bottom of the hole should be at least 5.5 feet below ground surface (bgs).
- Lift up on the drilling rod approximately 6 inches to create a void in the subsurface.
- Insert the screw on end to the 0.25-inch tubing and place down the hole. Once it reaches the bottom, screw the fitting onto the PRT sample point (note: the fitting uses left-hand threads).
- Determine the length of 0.25-inch tubing needed to conduct sampling at this location and cut it to that length. Do not forget that there must be enough tubing to go through the helium shroud, connect to the purging T-valve, and connect to the Summa canister. Be sure to cut the ends straight with no burrs or jagged edges.
- Mix bentonite to appropriate thickness for sealing.
- Insert bentonite evenly around tubing exiting the drill rod, making sure it penetrates fully into the rod. Thread the other tubing end through the helium shroud/stopper. Cover the loose tubing end with a plastic bag to ensure it remains clean until it is connected to the Summa canister.
- Place the shroud over the drill rod and place more bentonite around the base to seal the shroud to the ground.

For temporary holes, allow approximately 20 to 30 minutes for the bentonite to seal and the hole to equilibrate.

5 LEAK DETECTION TESTING

In order to perform the leak detection testing, have the shroud in place with the following setup and procedure:

- Tubing from drill hole.
- Tubing for measuring air within shroud (attach tubing onto appropriate fitting if not attached previously).
- Inlet hose from helium tank.
- If needed, place a brick or other weight on the shroud to prevent it from being moved and compromising the seal integrity.
- Fill the shroud with helium for several seconds and turn off the tank.
- Using the helium meter (meter), measure and record the helium concentration through the shroud air tubing in parts-per-million-volume (ppmv) (or know how to readily convert the reading to ppmv). The target helium concentration is 70 to 90 percent. Remove the meter from the shroud air tubing and cap the tubing. Allow meter to clear back to zero.
- Remove the helium tubing from the shroud and put a cap on the brass air fitting immediately.
- Connect the meter to the drill hole tubing and allow the meter to run for approximately a minute. Measure the helium concentration.
- Spray helium around fittings (T, on-off valve and flow regulator connections to Summa canister) and use the helium meter to monitor if any leaks are associated with these fittings.
- If indicated by elevated readings on the helium meter, make adjustments to seals.

- Once all necessary adjustments have been made, record the helium measurement in the shroud on field sheet following adjustment to seals.

Once the leak detection testing has confirmed the drill-hole seal is sufficient, proceed to sample collection.

6 SAMPLE COLLECTION

Sample Train Assembly and Purging

- Install the T-valve and on-off switch in-line with the sample tubing to allow for purging.
- Connect the gauge and flow regulator to the Summa canister and tubing. Do not overtighten the fittings.
- Record the can and flow regulator serial numbers on the field form.
- Ensure that all connections are tight and all valves are closed.
- Determine the amount of air that requires purging within the sampling tubing.
    - Determine how much tubing you need to purge (round up to whole feet).
    - Multiply the number of feet by the volume of air within one unit foot of tubing (see multipliers below for various tubing sizes).
    - You want to remove a minimum of two purge volumes, so multiply volume calculated by two.

Size of tubing (inches)	Air volume in mL per one unit foot
1/4	9.7
3/8	21.7
1/2	38.6
5/8	60.3
3/4	86.9
1	154.4

- Connect the purging syringe and turn the on-off switch to ON.
- Purge the calculated volume of air. Draw the air slowly through the syringe to minimize the effect of creating a vacuum that could compromise the connections or seals. If your sample collection rate is 150 mL per minute, and you need to purge 50 mL, then take approximately 20 seconds to purge the 50 mL or as slowly as possible.
- If you need to purge more than one syringe volume, complete the first purge, turn the switch on the syringe to OFF, depress the syringe to purge the air out of the syringe, turn syringe valve to ON and repeat the purging process.
- When done purging, turn the on-off switch to OFF.

Sample Collection

- Confirm that all connections remain tight and all valves are closed.
- Open the Summa canister by turning its valve approximately one-half turn.

- Immediately record the vacuum on the gauge (it should stabilize very quickly) and the time. The gauge should measure approximately -30 inches mercury (Hg). If the reading is not close to this value, the canister may not have sufficient vacuum for sampling. In this case, call the lab or select another canister.
- Allow the Summa canister to fill, keeping in mind the amount of time determined for sample collection (i.e., what you told the lab to set for a flow regulator time).
- The vacuum gauge should not drop below 3 inches Hg. If the vacuum readings are not keeping pace with the expected sampling time (either the gauge is dropping faster or slower than expected), you will need to use your best judgment as to when to stop the sample collection (or call the lab or project manager to discuss).
- Once the sample has been collected, record the vacuum reading and time.
- Close the canister valve. Be sure it is tightly closed (do not overtighten).
- Remove the gauge and flow regulator and replace the canister fitting.
- Fill out the chain of custody and return the containers to the lab with the original chain of custody. Retain a copy of the chain of custody for the project files.

When collecting 6L Summa canister samples, it is recommended that you watch the vacuum gauge the entire time (which can be up to 50 minutes). If the gauge should drop below 3 inches Hg, the sample may be considered void; this can be prevented by watching the gauge during sampling. If the gauge drops to 0 inches Hg the sample will need to be re-taken using a new canister.

Drill Hole Abandonment
Once sampling is completed at a sub-slab gas location, the following should occur:

- Clean out the remaining bentonite, scraping as much as possible from the drill hole "seat" and sidewalls (do not push down hole but instead place in bag for disposal).
- Add a small amount of sand to fill the drill hole to approximately two inches below the concrete surface (approximately two inches below the bottom of the "seat"). Do NOT overfill with sand as it may compromise your seal.
- Use the whisk broom to remove any loose material at the surface.
- Fill the upper three inches with a quick setting cement grout. Smooth or feather the surface to help create a bond between the slab and the grout.

For soil gas sampling locations, the drill rig operator should abandon the sample point as required by state regulations (Oregon Administrative Rule 690-240 or Washington Administrative Code 173-160).

POST FIELD ACTIVITIES

Retain all paperwork provided by the lab, including the packing list and certifications. This information must be retained in the permanent project file.

Reusable fittings owned by PBS must be decontaminated following PBS' *Standard Operating Procedure for On-Off Valve Decontamination for Vapor Intrusion Assessments*.

ASSESSING LEAK DETECTION RESULTS

Regulatory guidance in Oregon and Washington allow up to 5 percent helium within a sample. To confirm that helium detections meet this regulatory requirement, the following will occur:

- Calculate average helium concentration in shroud ("shroud concentration") by taking two or more readings before and after sampling (the measurements should have been recorded in ppmv).
- When we receive lab results, if helium is detected, use this formula to confirm level of leakage.
  Level of leakage = lab-detected concentration / shroud concentration
- Be sure you are using the same units (ppm may not always equal ppmv: check your units).

Memorandum

DATE: May 13, 2024

TO: Kevin Dana
Oregon Department of Environmental Quality – Northwest Region
700 NE Multnomah Street
Portland, Oregon 97232

FROM: Nick Thornton

PROJECT: Oregon DEQ ECSI Site 2424

REGARDING: Proposed Sub-Slab Sample Locations

This memo is to provide you with an update on the soil gas assessment results for ECSI Site 2424, as well as provide a summary of our proposed next steps for evaluation of the vapor intrusion pathway. Attached is a table of the soil gas results (including their respective screening levels), as well as a copy of our sample location figure for reference. The assessment successfully delineated soil gas to the western, northwestern and southern directions, which suggests that there is not unacceptable risk to adjacent property occupants.

Two of the soil vapor samples (SV-2 and SV-5) had detections that exceeded DEQ risk screening levels. SV-2 was placed within the highest areas of residual contamination and is located away from buildings and structures where a vapor intrusion risk could occur. A component to be included in the regulatory closure will be future restrictions recorded on the deed that require mitigation (e.g. DEQ-approved vapor barrier) should future development occur at this location.

The other sample that exceeded screening levels was SV-5, located near the southeastern end of the warehouse. The sample had a PCE detection of 13,000 $\mu g/m^3$, which exceeds the chronic exposure risk screening concentration of 1,600 $\mu g/m^3$. No other contaminants were detected in the sample above risk screening levels. Because of the exceedance and the sample's location near the warehouse, PBS plans to proceed with the collection of sub-slab samples to evaluate vapor intrusion risk for onsite receptors.

PBS completed a site walk on May 9, 2024, to evaluate interior conditions and identify suitable sub-slab sampling locations. The warehouse is constructed on an elevated slab to compensate for site grade, starting at close to site grade at the northern end of the site and approximately 5 feet above grade at the southern end of the building. The slab is estimated to be approximately 8 inches thick, presumably installed on top of compacted soil or similar material (detail was not provided in historic plans or permits). No sub-slab trenches were identified in the southern portion of the warehouse. In the northern extent of the warehouse (northwest of MW-1) a trench was observed that is situated in an east to west configuration beneath the warehouse. Because the trench is in the northern extent of the warehouse and approximately 200 feet north of the area of interest, it was not considered for the evaluation of sample locations.

Several floor drains were observed within the southern extent of the warehouse. It is not clear where they drain to. As well, two areas of reinforced concrete related to historic heavy machinery were noted in this area that were bordered by fibrous expansion joint material. Given the likely age of these reinforced areas, they could represent minor compromised areas in the slab for sub-slab vapor to exit. The slab in the southern portion of the warehouse was observed to have several areas with minor cracks present but significant cracks or splits in the concrete slab were not observed. No interior sources of solvents were observed and material stored in the warehouse was limited to package roofing products and hard foam insulation products.

Given the above considerations PBS has identified two suitable sub-slab sample locations. Both samples will be installed approximately 20 feet from the southern end of the warehouse and south of the reinforced slabs and any floor drains. The placement of the samples biased toward the southern end of the warehouse is considered a conservative approach for assessing possible vapor intrusion, given the proximity to the residual contamination. SSV-1 will be installed directly north of SV-5 and SSV-2 will be installed directly north of SV-4. Neither sample location is adjacent to floor cracks. The attached figure indicates sample locations.

DEQ recently released a draft vapor intrusion guidance document (VI Guidance) that establishes protocols for collecting sub-slab vapor and soil gas samples.[1] As noted in that document, DEQ concluded that longer duration samples, such as those obtained from passive samplers deployed for 14 to 28 days, more reliably detect VI risk and should be used when feasible. A passive sampling approach is recommended to better understand vapor intrusion risk over a period of time (time-weighted average) and account for fluctuations in vapor transport that could be impacted by the heating, ventilation, and air conditioning, and atmospheric pressure changes. This approach is preferred compared to the limited duration Summa Canister method, which could be prone to short-term variations that could influence sample results.

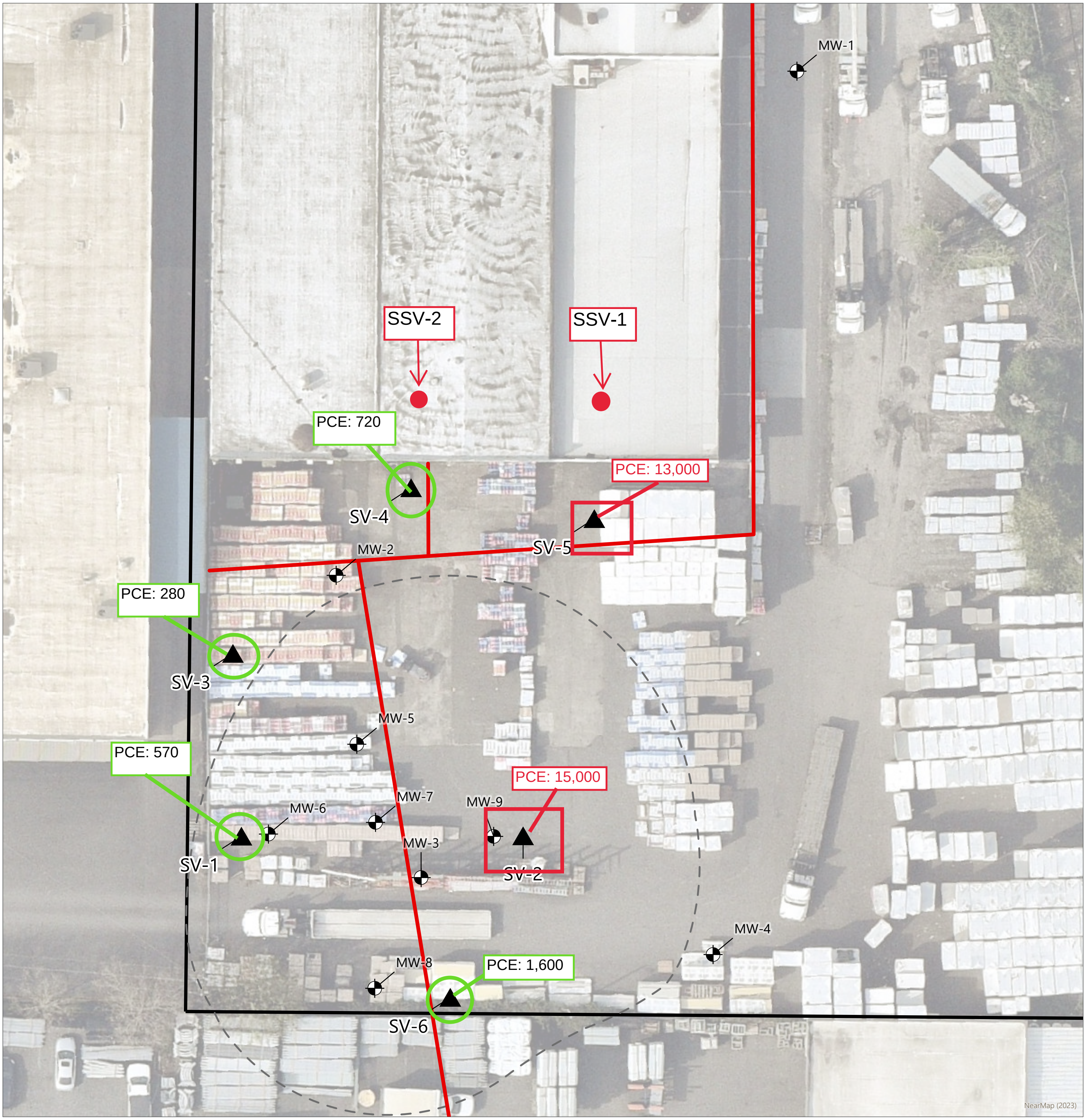
PBS will collect the two passive sub-slab samples using a reusable vapor pin sampling system with an attached capsule to contain a Waterloo Membrane Sampler. Temporary sampling points will be installed by drilling a 0.625-inch hole through 1.5-inch pre-cored holes and secured with a flush mounted stainless-steel cap. The passive samplers will remain in place for 14 days. Quality control samples will include one duplicate sample and two trip blanks.

Upon completion of testing, PBS will retrieve and label the samplers and ship them to the laboratory for analysis of tetrachloroethylene (PCE) and its six breakdown compounds (including TCE) by EPA Method TO-17.

Assuming results do not exceed applicable RBCs, we will prepare the assessment report addendum to request closure.

NT: DT

[1] DRAFT *Guidance for Assessing and Remediating Vapor Intrusion into Buildings*, Oregon Department of Environmental Quality. (March 2024).



Proposed Soil Gas Sampling Locations

3720 NW Yeon Avenue, Portland, Oregon

Date: February 2024 | Project: 20125.011

Figure: 2

Proposed Soil Gas Sampling Location
Monitoring Well
Storm Sewer Utility (approximate)
Locality of Facility (LOF)
Site Boundary

N

1 INCH = 40 FEET

0 40 Feet

PBS

This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl | L:\Projects\20000\20100-20199\20125 NWYeon\20125.011 Remedial Injection and Monitoring\GIS\June 2023\20125.011_NW_Yeon\20125.011_NW_Yeon.aprx | 1/18/2024 1:41 PM

Table 1. Summary of Soil Gas Analytical Results

3720 NW Yeon Avenue

Portland, Oregon

Sample ID	Sampling Date	Chloroethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Tetrachloroethene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	Trichloroethene	Vinyl Chloride
		Chlorinated VOCs										
		µg/m³										
SV-1	3/19/2024	<16	<2.4	<0.24	<2.4	<2.4	<2.4	570	<3.3	<0.33	11	<1.5
SV-2	3/19/2024	9,500	<18	<1.8	110	5,500	26	**15,000**	<25	<2.5	**1,900**	**180**
SV-3	3/19/2024	<16	<2.4	<0.24	<2.3	<2.3	<2.3	280	4.2	<0.32	1.3	<1.5
SV-4	3/19/2024	<15	<2.3	<0.23	<2.3	<2.3	<2.3	720	<3.2	<0.32	12	<1.5
SV-5	3/19/2024	<120	<18	<1.8	<18	<18	<18	**13,000**	<25	<2.5	86	<12
SV-6	3/19/2024	<23	<3.6	<0.36	<3.5	<3.5	<3.5	1,600	<4.9	<0.49	2.3	<2.3
Oregon RBC - Vapor Intrusion into Buildings[1]	Chronic	580,000	260	16	29,000	5,800	5,800	**1,600**	730,000	26	**100**	**93**
	Acute	4,000,000	NS	NS	20,000	NS	80,000	**4,000**	1,100,000	NS	**210**	130,000

Notes:

See laboratory report for full list of analytes and quality-control data.

Bold text, if present, indicates an exceedance of one or more of the cleanup levels.

<: Not detected above the laboratory reporting limit

µg/m³: micrograms per cubic meter

NS: Not set for this analyte

VOCs: Volatile organic compounds

[1]Oregon Risk-Based Decision-Making for the Remediation of Petroleum-Contaminated Sites, Oregon DEQ, Table 1. Chronic and Acute Vapor Intrusion Risk-Based Concentrations, March 2024.

Appendix B

Standard Operating Procedure Sub-Slab and Soil Gas Sampling

STANDARD OPERATING PROCEDURE
Sub-Slab Vapor and Soil Gas Sampling

PURPOSE

Vapor intrusion of volatile organic compounds (VOCs) into occupied structures is considered a critical migration pathway requiring assessment at contaminated sites. Specifically, regulators may require property owners to sample soil gas, sub-slab vapor, or indoor air to assess risk to building occupants.

This standard operating procedure (SOP) is intended to guide soil gas or sub-slab vapor sampling efforts when creating temporary sampling points when Method TO-15 or other analytical methods utilizing a Summa canister as the sampling media are required. The sampling points can be modified to produce a permanent sampling location. The sampling protocols for analysis of soil gas or sub-slab vapor by Method TO-17, which utilizes a sorbent tube as the sampling media (instead of a Summa canister), as well as the sampling of indoor air are presented as separate SOPs.

Soil gas and sub-slab vapor sampling is typically conducted based on prior results from other environmental studies, such as soil or groundwater sampling, or if historical uses indicate a human health risk could be present. A variety of issues can significantly affect the results of soil gas and sub-slab vapor sampling. Adherence to this SOP will help ensure that sampling results are valid and reliable. This SOP assumes that samples will be collected in Summa canisters. If other sampling media is used (such as tedlar bags), some of the steps in this SOP may not apply or may need to be modified.

Use one of the following two methods to conduct the sub-slab vapor or soil gas sampling

METHOD 1 – VAPOR PIN

1 EQUIPMENT LIST

The following table lists standard equipment and tools needed for soil gas and sub-slab vapor sampling. When renting a helium meter, ask the vendor for one that is intended for use in leak detection testing (e.g., MGD-2002 multi-gas leak locator). It should have the ability to purge the line quickly (the equipment company may provide a special filter for this), and preferably, a meter with an active pump (as opposed to passive venting). It does not need to be intrinsically safe UNLESS site conditions require this feature.

Equipment to get from lab	• 1 or 6 liter (L) Summa canister. • One extra Summa canister in the event that a canister fails in the field. • Flow regulator (also known as critical orifice) preset by lab for pre-determined sampling time, not to exceed a flow rate of 200 mL/min. • Vacuum gauge (for verifying vacuum prior to sampling, flow regulator may act in this role). • Tubing (new for each sample location). Must be Teflon, Nylaflow, Peek, or stainless tubing. Do NOT use polyethylene tubing. • Chain of custody and identification tags. • T-fitting (need one for each sampling location, including ferrules and hex nuts for each leg of T).

Other equipment	• Purging syringe (calibrated, typically for 50 to 60 milliliters [mL]). • Granular bentonite. • Disposable or washable containers (~16 ounces) for mixing bentonite and/or cement. • Water for mixing bentonite and cement. • Sand. • Silicone tubing. • Helium gas tank with regulator. • Helium meter (make sure that it measures in ppm by volume). • On-off valve (two per sampling location). • Vapor Pin with a silicon sleeve (or similar equipment). • Vapor Pin tool and hammer for installation and removal (or similar equipment). • Vapor Pin drill guide (for permanent installations). • Field notebook and/or field forms. • Helium shroud. • Weight for shroud, if needed. • Nuts and ferrules (if you did not receive from lab). • Cap for "shroud air tubing." • Water dam (e.g., 1.5-inch PVC coupler).
Tools	• Scissors. • Rotohammer/drill for drilling through concrete. • Drill bits (0.625-inch, 1.5-inch). • Crescent wrench (1/2 and 9/16 inch). • Whisk broom/dust pan. • Wet-dry vacuum. • Extra-thin knife/screwdriver. • Extension cord for rotohammer. • Wrench for helium regulator. • Generator (if power is not available)
Supplemental supplies	• Teflon tape (if seal leaks are sustained). • Purging pump with tubing (if purging syringe not used) and charging cord. • Fast setting concrete to patch floor. • Adhesive to repair carpet or tile.

2 LABORATORY

The lab will supply the Summa canisters, flow regulators, gauges, and tubing, and can also provide the purging syringe, if needed. Have the equipment arrive TWO business days prior to sampling, if possible. This allows the lab time to express-mail any additional, broken, or forgotten equipment.

As soon as the shipment is received, ensure that all equipment was provided and verify the vacuum of all Summa canisters. Order an extra gauge, if needed, to check the canisters for pressure prior to leaving the office. Knowing that the canister has sufficient initial vacuum allows for better trouble shooting in the field.

The following information must be provided to the lab to ensure shipment of the correct equipment:

- Size of canister (400 mL, 1 L, 6 L). A 1 L Summa will require a minimum of two times dilution of reporting limits. If this will cause your sample reporting limits to exceed screening criteria, use a larger Summa canister. You MUST know your reporting limits to determine the canister size.
- Type of canister certification (batch vs. individual). Batch certification is usually sufficient for sub-slab vapor and soil gas sampling projects.
- Method reporting limits.
- Tracer gas to be used (the lab must certify container for this prior to shipping). PBS uses Helium as a tracer gas.
- Sample time/flow rate.

Samples should be collected at a rate between 100 and 175 mL per minute (most guidance documents recommend that samples not be collected faster than 200 mL per minute). A flow rate greater than 200 mL/min runs the risk of introducing ambient air dilution to the sample. The sample time for grab samples is calculated by determining an acceptable sample flow rate (perhaps 150 mL/min) and multiplying that by the sample container size. For a 150 mL/min rate, a 1 L Summa canister would require approximately seven minutes. A 6 L Summa canister would require 40 minutes.

3 SUB-SLAB VAPOR INITIAL PROCEDURES

Order equipment as previously identified, and do the following prior to field activities:

- Determine the proposed locations for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Confirm with the property owner/occupant that subsurface utilities will not be impacted when drilling through the slab in these locations.
- Conduct a private utility locates for your locations to check for subslab or subgrade obstructions.
- If possible, determine the slab thickness to confirm that a hand-operated drill can drill through it.
- Determine if carpeting or other flooring will need to be removed prior to drilling, or will require patching.
- Have the helium meter arrive the day before sampling.

Once at the site, sampling should occur as described below.

Drill Hole and Seal Tubing

These instructions assume that all samples will be collected using a Vapor Pin or similar equipment.

- Confirm concrete thickness, if possible, so you'll know when to expect the drill bit to break through bottom of slab.
- If the Vapor Pin will be installed for on-going monitoring (i.e., permanent installation), begin by drilling a hole 2 inches into the concrete using the 1.5-inch drill bit. This larger hole will be used to install a flush-

mount cover. Then insert the Vapor Pin drill guide into this hole so that the smaller diameter drill hole will be centered. Continue with the directions below.

- Drill a hole through the slab using the 0.625-inch drill bit. Drill 1 to 3 inches into backfill or native material beneath the concrete slab.
- Use a 0.625-inch tube brush to clean concrete dust from the hole.
- Use the whisk broom or vacuum to remove concrete dust or loose material from around the drill hole.
- Install a Vapor Pin with a silicon sleeve (the silicon sleeve provides the seal) into the 0.625-inch drilled hole utilizing a dead weight hammer and the Vapor Pin installation/extraction tool (or similar equipment).
- If not drilling the 1.5-inch hole, place a small amount of hydrated bentonite on the concrete surface around the Vapor Pin and insert a water dam into the bentonite.
- Place a silicon mat with a circular cut-out for the Vapor Pin on the concrete surface around the sample point and water dam.
- Add a small piece of silicone tubing to the top of the Vapor Pin for attaching tubing later.
- Add a small amount of water to the inside of the water dam to ensure a good seal is in place.
- Place the shroud over the sample point and thread 0.25-inch tubing through a stopper in the shroud.
- Place a weight on the shroud to prevent it from being moved and compromising the seal integrity, if needed.

For temporary holes, allow 20 to 30 minutes for the hole to equilibrate. If collecting sub-slab gas samples at multiple locations, consider performing these initial activities at each location prior to continuing with the sampling.

4 SOIL GAS INITIAL PROCEDURES

Order equipment as previously identified. Prior to field activities, the following should occur:

- Determine the locations and depths for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Determine if equipment, vehicles, or other stored items will need to be moved prior to the field event.
- Call in a public utility notification.
- Conduct a private utility locates for your locations to check for subgrade utilities/obstructions.
- Arrange for a driller to deploy a Post Run Tubing (PRT) sample system, or equivalent, or arrange with the driller to install a sample point using a hand auger.

Once at the site, sampling should occur as described below.

Drill Hole and Seal Tubing

- Drill a borehole hole using a PRT system, or equivalent. The bottom of the hole should be at least 5.5 feet below ground surface (bgs), as long as this is above the water table.
- Lift up on the drilling rod approximately 6 inches to create a void in the subsurface.
- Insert the PRT fitting to the 0.25-inch tubing and place down the hole. Once it reaches the bottom, screw the fitting onto the PRT sample point (note: the fitting uses left-hand threads).

- Determine the length of 0.25-inch tubing needed to conduct sampling at this location and cut it to that length. Do not forget that there must be enough tubing to go through the helium shroud, connect to the purging T-valve and connect to the Summa canister. Be sure to cut the ends straight with no burrs or jagged edges.
- Mix bentonite with water for sealing.
- Place bentonite around the rod protruding from the ground.
- Insert bentonite evenly around tubing exiting the drill rod, making sure it penetrates fully into the rod. Thread the other tubing end through the helium shroud/stopper. Cover the loose tubing end with a plastic bag or cap to ensure it remains clean until it is connected to the Summa canister.
- Place the shroud over the drill rod and place more bentonite around the base to seal the shroud to the ground.

Sample Train Assembly

- Place the shroud over the sample point, and thread tubing through the shroud and shroud stopper.
- Place a weight on the shroud to prevent it from being moved and compromising the seal integrity, if needed.
- Attach an on-off valve to the end of the tubing, then place additional tubing on the other side of the valve. Turn the valve off.
- Install a T-fitting and a second on-off valve in-line with the sample tubing to allow for purging. Add tubing from the third leg of the T-fitting to the Summa canister.
- Connect the gauge and flow regulator to the Summa canister and tubing. Do not over tighten the fittings.
- Record the canister and flow regulator serial numbers on the field form.
- Ensure that all connections are tight and all valves are closed.

For temporary holes, wait 20 to 30 minutes to allow the hole to equilibrate. If a hand auger was used to install the sample point you must wait 48 hours.

5 LEAK DETECTION TESTING

Shut-in test and field/laboratory test for helium are two testing methods performed for leak detection.

Shut-in Test

Evaluate the integrity of the sample train by performing a vacuum shut-in test. Remove a sufficient volume of air from the sample train using the purging syringe to provide a vacuum of at least -15 inches of mercury (Hg). Observe the gauge for at least two minutes to detect any decrease in measured vacuum. The vacuum must be maintained for at least two minutes. If the vacuum is not maintained, check the fittings and retest.

Helium Test

At this point, you should have the shroud in place with the tubing from the Vapor Pin or soil gas sample point extending from the shroud, and the inlet hose from the helium tank extending into the shroud. Perform these actions:

- Fill the shroud with helium for several seconds and turn off the tank.

- Using the helium meter (meter), measure and record the helium concentration in the shroud in percent (%) or parts-per-million-volume (ppmv) (1% is equivalent to 10,000 ppmv). The target helium concentration is 70 to 90%. Remove the meter from the shroud air tubing and cap the tubing. *Allow meter to clear back to zero*.

Sample Train Purging

- Open the on-off valve to the Vapor Pin or PRT sampling point tubing. The Summa canister remains closed.
- Determine the amount of air that requires purging within the sampling tubing.
    - Determine how much tubing you need to purge (round up to whole feet).
    - Multiply the number of feet by the volume of air within one unit foot of tubing (see multipliers below for various tubing sizes).
    - Determine how much you need to purge from the hole drilled through the concrete slab or PRT sampler (usually 6 inch length).
    - Add the tubing and hole purge volumes together.
    - You want to remove a minimum of two purge volumes, so multiply volume calculated by two.

Size of tubing (inches)	Air volume in mL per one unit foot
1/4	9.7
3/8	21.7
1/2	38.6
5/8	60.3
3/4	86.9
1	154.4

- Connect the purging syringe and turn the on-off valve to ON.
- Purge the calculated volume of air. Draw the air slowly through the syringe, approximating the sample collection flow rate, to minimize the effect of creating a vacuum that could compromise the connections or seals. If your sample collection rate is 150 mL/min, and you need to purge 50 mL, then take approximately 20 seconds to purge the 50 mL or as slowly as possible.
- If you need to purge more than one syringe volume, complete the first purge, turn the valve on the syringe to OFF, depress the syringe to purge the air out of the syringe, turn syringe valve to ON and repeat the purging process.
- When done purging, turn the on-off valve to OFF.
- Connect the meter to the sample point tubing (Vapor Pin or PRT) and allow the meter to run for approximately one minute. Measure the helium concentration.
- If elevated readings on the helium meter (greater than 5,000 ppmv [0.5%]) are detected, make adjustments to seals.
- Once all necessary adjustments have been made, record the helium measurement in the shroud on field sheet following adjustment to seals.

Once the leak detection testing has confirmed the Vapor Pin or PRT seal is sufficient, proceed to sample collection.

6 SAMPLE COLLECTION

- Confirm that all connections remain tight and all valves are closed.
- Close the on-off valve connected to the purging syringe.
- Open the Summa canister by turning its valve approximately one-half turn.
- Immediately record the vacuum on the gauge (it should stabilize very quickly) and the time. The gauge should measure approximately -30 inches Hg (please note that some gauges may read greater than -30 inches Hg). If the vacuum is less than -27 inches Hg, the canister may not have sufficient vacuum for sampling. In this case, select another canister. If another canister is not available, call the project manager and ask how they would like you to proceed.
- Allow the Summa canister to fill, keeping in mind the amount of time determined for sample collection (i.e., what you told the lab to set for a flow regulator time)
- At the mid-point of the sample collection, record the helium concentration in the shroud. Add additional helium if shroud concentration is below 50%, and record the new reading.
- The vacuum gauge should never drop below -5 inches Hg. If the vacuum readings are not matching up with the expected sampling time (the gauge is dropping faster or slower than expected), you will need to use your best judgment as to when to stop the sample collection (or call the lab or project manager to discuss).
- Once the sample has been collected, close the canister valve, be sure it is tightly closed (but do not over tighten), and record the vacuum reading and time.
- Record the helium concentration in the shroud.
- Remove the gauge and flow regulator and replace the canister fitting.
- Fill out the chain of custody and return the containers to the lab with the original chain of custody. Retain a copy of the chain of custody for the project files.

When collecting 6 L Summa canister samples, it is recommended that you monitor the vacuum gauge during the entire sample duration, which can take up to 50 minutes. If the gauge should drop below -5 inches Hg, the sample may be considered void; this can be prevented by watching the gauge. If the gauge drops to 0 inches Hg the sample will need to be re-taken using a new canister.

Drill Hole Abandonment
Once soil gas sampling is completed, the boring will be abandoned by the licensed drilling subcontractor who completed the borehole following applicable state requirements.

Once sub-slab vapor sampling is completed, the following should occur:

- Remove the water from the water dam.
- Clean out the remaining bentonite, cleaning as much as possible from the floor.
- If the sampling location is for one-time use, deploy the Vapor Pin extraction tool to remove the pin.

- Add a small amount of sand to fill the drill hole approximately 1 to 2 inches below the concrete surface (approximately 1 to 2 inches below the bottom of the "seat"). Do NOT overfill with sand as this may compromise your patch.
- Use the whisk broom to remove any loose material at the surface.
- Fill the upper 1 to 2 inches with a quick setting cement grout. Smooth or feather the surface to help create a bond between the slab and the grout.

If the Vapor Pin or similar equipment is for a permanent installation, the following should occur:

- Place a white cap over the tip of the Vapor Pin.
- Install a permanent cover over the capped Vapor Pin (plastic or metal).

7 POST FIELD ACTIVITIES

- Retain all paperwork provided by the lab, including the packing list and certifications. This information must be retained in the permanent project file.
- Decontaminate reusable fittings owned by PBS following the *Standard Operating Procedure for Vapor Pin Decontamination for Vapor Intrusion Assessments*. This includes the Vapor Pin drill guide and any brushes or other tools used for cleaning.
- Return all rental equipment.

Confirming Helium Detections Meet Regulatory Requirements

- Calculate average helium concentration in shroud by taking two or more readings before, during, and after sampling (be sure that meter is reading in ppm by volume).
- When lab results are received, if helium is detected, use this formula to confirm level of leakage:

  Level of leakage = lab-detected concentration / shroud concentration
- Be sure you are using the same units (ppm may not always equal ppmv – check your units).
- Some regulatory guidance documents allow up to 5 to 10% helium within a sample. Be sure to check your state's guidance for allowable levels. Oregon and Washington both allow up to 5% helium for a valid sample.

METHOD 2 – SEALED TUBING

1 EQUIPMENT LIST

The following table lists standard equipment and tools needed for soil or sub-slab gas sampling. When renting a helium meter, ask the vendor for one that is intended for use in leak detection testing. It should have the ability to purge line quickly (the equipment company may provide a special filter for this) and preferably, a meter with an active pump (as opposed to passive venting). It does not need to be intrinsically safe UNLESS site conditions require this feature.

Equipment to get from lab	• 1 or 6 liter (L) Summa canister. • One extra Summa canister in the event that a canister fails in the field. • Flow regulator (also known as critical orifice) preset by lab for pre-determined

	sampling time. • Vacuum gauge (for verifying vacuum prior to sampling). • Tubing (new for each sample location). Must be Teflon, Nylaflow, Peek, or stainless tubing. Do NOT use polyethylene, silicone, or any other type. • Chain of custody and identification tags. • T-valve (need one for each sampling location, including ferrels and hex nuts for each end of T).
Other equipment	• Purging syringe (calibrated, typically for 50 to 60 milliliters [mL]). • Granular bentonite. • Disposable or washable containers (~16 ounces) for mixing bentonite and/or cement. • Water for mixing bentonite and cement. • Sand. • Silicone tubing. • Weight for shroud. • Helium gas with regulator. • Helium meter (make sure that it measures in ppm by volume). • On-off valve (two per sampling location). • Vapor Pin with a silicon sleeve (or similar equipment). • Vapor Pin tool and hammer for installation and removal (or similar equipment). • Field notebook or field forms. • Helium shroud. • Nuts and ferrels (if you did not receive from lab). • Cap for "shroud air tubing." • Water dam (1.5-inch PVC coupler).
Tools	• Scissors. • Rotohammer/drill for drilling through concrete. • Drill bits (0.625-inch, 1.5-inch). • Crescent wrench (9/16 inch). • Whisk broom/dust pan. • Wet-dry vacuum. • Extra-thin knife/screwdriver. • Extension cord for rotohammer. • Plumber's wrench for helium regulator.
Supplemental	• Teflon tape (if seal leaks are sustained).

supplies	• Purging pump with tubing (if purging syringe not used) and charging cord.

2 LABORATORY

The lab will supply the Summa canisters, flow regulators, gauges, and tubing, and can also provide the purging syringe, if needed. Have the equipment arrive TWO business days prior to sampling, if possible. This allows the lab time to express-ship any additional or forgotten equipment.

As soon as the shipment is received, ensure that all equipment was provided and verify the vacuum of all Summa canisters. Order an extra gauge, if needed, to check the canisters for pressure prior to leaving the office. Knowing that the canister has sufficient initial vacuum allows for better trouble shooting in the field.

The following information must be provided to the lab to ensure shipment of the correct equipment.

- Size of canister (400 mL, 1 L, 6 L). A 1 L Summa will require a minimum of two times dilution of reporting limits. If this will cause your sample reporting limits to exceed screening criteria, use a larger Summa canister. You MUST know your reporting limits to determine the canister size.
- Type of canister certification (batch vs individual). Batch certification is usually sufficient for sub-slab or soil gas sampling projects.
- Method reporting limits.
- Tracer gas to be used (the lab must certify container for this prior to shipping).
- Sample time.

Samples should be collected at a rate between 100 and 175 milliliters (mL) per minute (most guidance documents recommend that samples not be collected faster than 200 mL per minute). A flow rate greater than 200 mL/min runs the risk of introducing ambient air dilution to the sample. The sample time for grab samples is calculated by determining an acceptable sample flow rate (perhaps 150 mL per minute) and multiplying that by the sample container size. For a 150 mL per minute rate, a 1 L Summa canister would require approximately seven minutes. A 6 L Summa canister would require 40 minutes.

3 SUB-SLAB GAS INITIAL PROCEDURES

Order equipment as previously identified, and do the following prior to field activities:

- Determine the proposed locations for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Confirm with the property owner/occupant that subsurface utilities will not be impacted when drilling through the slab in these locations.
- Conduct a private utility locates for your locations to check for sub-slab or sub-grade obstructions.
- If possible, determine the slab thickness to confirm that a hand-operated drill can drill through it.
- Determine if carpeting or other flooring will need to be removed prior to drilling, or will require patching.
- Get the lab equipment delivered two days prior to sampling and ensure that all equipment was provided.

Once at the site, sampling should occur as described below.

Drill Hole and Seal Tubing

- Confirm concrete thickness, if possible, so you'll know when to expect the drill bit to break through the bottom of slab.
- Drill a hole using the 0.25-inch or 0.5-inch drill bit. Drill approximately two inches into slab backfill or native material beneath the concrete slab.
- Using a 0.5-inch or 0.75-inch drill bit, overdrill the hole by approximately one inch to create a "seat" for sealing the tubing. The drill bit used for overdrilling should be one size larger than the original hole (0.5-inch for a 0.25-inch initial hole, etc.).
- Use the whisk broom to remove concrete dust or loose material from around the drill hole.
- Test the 0.25-inch tubing to ensure it can be pushed completely down the hole. Once it reaches the bottom, keep track of that tubing length as you pull it back out. Ensure there is no material stuck in the bottom of the tubing (if there is, cut the tubing end off and repeat this step). Re-insert the tubing so that the bottom rests approximately one inch from the drilled bottom, making sure it is below the bottom of the slab. If the tubing rests at the bottom of the hole that is okay.
- Determine the length of 0.25-inch tubing needed to conduct sampling at this location and cut it to that length. Do not forget that there must be enough tubing to go through helium shroud, connect to the purging T-valve and connect to the Summa canister. Be sure to cut the ends straight with no burrs or jagged edges.
- Thread the other tubing end through the helium shroud/stopper, leaving enough tubing within the shroud to allow you to install the sealing material. Cover the loose tubing end with a plastic bag to ensure it remains clean until it is connected to the Summa canister.
- Mix bentonite to an appropriate consistency for sealing.
- Insert bentonite evenly around tubing, making sure it penetrates fully into the larger drill hole. Push down with fingers or appropriate tool to ensure a good seal. Take care not to scrape or puncture the tubing.
- At the surface, mound the bentonite against the tubing and smooth away from it to create a tight seal. It is appropriate to moisten the top of the bentonite mound to aid in creating a good seal.

For temporary holes, allow approximately 20 to 30 minutes for the bentonite to seal and the hole to equilibrate. If collecting sub-slab gas samples at multiple locations, consider performing these initial activities at each location prior to continuing with the sampling.

4 SOIL GAS INITIAL PROCEDURES

Order equipment as previously identified. Prior to field activities, the following should occur:

- Determine the locations and depths for each sample. Locations should be located at a minimum of 3 feet inside foundation edges or exterior walls to obtain the most representative results.
- Determine if equipment, vehicles, or other stored items will need to be moved prior to the field event.
- Arrange for a utility locate.
- Arrange for a driller to deploy a Post Run Tubing (PRT) sample system, or equivalent.

Once at the site, sampling should occur as described below.

Drill Hole and Seal Tubing

- Drill a hole using a PRT system, or equivalent. The bottom of the hole should be at least 5.5 feet below ground surface (bgs).
- Lift up on the drilling rod approximately 6 inches to create a void in the subsurface.
- Insert the screw on end to the 0.25-inch tubing and place down the hole. Once it reaches the bottom, screw the fitting onto the PRT sample point (note: the fitting uses left-hand threads).
- Determine the length of 0.25-inch tubing needed to conduct sampling at this location and cut it to that length. Do not forget that there must be enough tubing to go through the helium shroud, connect to the purging T-valve, and connect to the Summa canister. Be sure to cut the ends straight with no burrs or jagged edges.
- Mix bentonite to appropriate thickness for sealing.
- Insert bentonite evenly around tubing exiting the drill rod, making sure it penetrates fully into the rod. Thread the other tubing end through the helium shroud/stopper. Cover the loose tubing end with a plastic bag to ensure it remains clean until it is connected to the Summa canister.
- Place the shroud over the drill rod and place more bentonite around the base to seal the shroud to the ground.

For temporary holes, allow approximately 20 to 30 minutes for the bentonite to seal and the hole to equilibrate.

5 LEAK DETECTION TESTING

In order to perform the leak detection testing, have the shroud in place with the following setup and procedure:

- Tubing from drill hole.
- Tubing for measuring air within shroud (attach tubing onto appropriate fitting if not attached previously).
- Inlet hose from helium tank.
- If needed, place a brick or other weight on the shroud to prevent it from being moved and compromising the seal integrity.
- Fill the shroud with helium for several seconds and turn off the tank.
- Using the helium meter (meter), measure and record the helium concentration through the shroud air tubing in parts-per-million-volume (ppmv) (or know how to readily convert the reading to ppmv). The target helium concentration is 70 to 90 percent. Remove the meter from the shroud air tubing and cap the tubing. Allow meter to clear back to zero.
- Remove the helium tubing from the shroud and put a cap on the brass air fitting immediately.
- Connect the meter to the drill hole tubing and allow the meter to run for approximately a minute. Measure the helium concentration.
- Spray helium around fittings (T, on-off valve and flow regulator connections to Summa canister) and use the helium meter to monitor if any leaks are associated with these fittings.
- If indicated by elevated readings on the helium meter, make adjustments to seals.

- Once all necessary adjustments have been made, record the helium measurement in the shroud on field sheet following adjustment to seals.

Once the leak detection testing has confirmed the drill-hole seal is sufficient, proceed to sample collection.

6 SAMPLE COLLECTION

Sample Train Assembly and Purging

- Install the T-valve and on-off switch in-line with the sample tubing to allow for purging.
- Connect the gauge and flow regulator to the Summa canister and tubing. Do not overtighten the fittings.
- Record the can and flow regulator serial numbers on the field form.
- Ensure that all connections are tight and all valves are closed.
- Determine the amount of air that requires purging within the sampling tubing.
    - Determine how much tubing you need to purge (round up to whole feet).
    - Multiply the number of feet by the volume of air within one unit foot of tubing (see multipliers below for various tubing sizes).
    - You want to remove a minimum of two purge volumes, so multiply volume calculated by two.

Size of tubing (inches)	Air volume in mL per one unit foot
1/4	9.7
3/8	21.7
1/2	38.6
5/8	60.3
3/4	86.9
1	154.4

- Connect the purging syringe and turn the on-off switch to ON.
- Purge the calculated volume of air. Draw the air slowly through the syringe to minimize the effect of creating a vacuum that could compromise the connections or seals. If your sample collection rate is 150 mL per minute, and you need to purge 50 mL, then take approximately 20 seconds to purge the 50 mL or as slowly as possible.
- If you need to purge more than one syringe volume, complete the first purge, turn the switch on the syringe to OFF, depress the syringe to purge the air out of the syringe, turn syringe valve to ON and repeat the purging process.
- When done purging, turn the on-off switch to OFF.

Sample Collection

- Confirm that all connections remain tight and all valves are closed.
- Open the Summa canister by turning its valve approximately one-half turn.

- Immediately record the vacuum on the gauge (it should stabilize very quickly) and the time. The gauge should measure approximately -30 inches mercury (Hg). If the reading is not close to this value, the canister may not have sufficient vacuum for sampling. In this case, call the lab or select another canister.
- Allow the Summa canister to fill, keeping in mind the amount of time determined for sample collection (i.e., what you told the lab to set for a flow regulator time).
- The vacuum gauge should not drop below 3 inches Hg. If the vacuum readings are not keeping pace with the expected sampling time (either the gauge is dropping faster or slower than expected), you will need to use your best judgment as to when to stop the sample collection (or call the lab or project manager to discuss).
- Once the sample has been collected, record the vacuum reading and time.
- Close the canister valve. Be sure it is tightly closed (do not overtighten).
- Remove the gauge and flow regulator and replace the canister fitting.
- Fill out the chain of custody and return the containers to the lab with the original chain of custody. Retain a copy of the chain of custody for the project files.

When collecting 6L Summa canister samples, it is recommended that you watch the vacuum gauge the entire time (which can be up to 50 minutes). If the gauge should drop below 3 inches Hg, the sample may be considered void; this can be prevented by watching the gauge during sampling. If the gauge drops to 0 inches Hg the sample will need to be re-taken using a new canister.

Drill Hole Abandonment

Once sampling is completed at a sub-slab gas location, the following should occur:

- Clean out the remaining bentonite, scraping as much as possible from the drill hole "seat" and sidewalls (do not push down hole but instead place in bag for disposal).
- Add a small amount of sand to fill the drill hole to approximately two inches below the concrete surface (approximately two inches below the bottom of the "seat"). Do NOT overfill with sand as it may compromise your seal.
- Use the whisk broom to remove any loose material at the surface.
- Fill the upper three inches with a quick setting cement grout. Smooth or feather the surface to help create a bond between the slab and the grout.

For soil gas sampling locations, the drill rig operator should abandon the sample point as required by state regulations (Oregon Administrative Rule 690-240 or Washington Administrative Code 173-160).

POST FIELD ACTIVITIES

Retain all paperwork provided by the lab, including the packing list and certifications. This information must be retained in the permanent project file.

Reusable fittings owned by PBS must be decontaminated following PBS' *Standard Operating Procedure for On-Off Valve Decontamination for Vapor Intrusion Assessments*.

ASSESSING LEAK DETECTION RESULTS

Regulatory guidance in Oregon and Washington allow up to 5 percent helium within a sample. To confirm that helium detections meet this regulatory requirement, the following will occur:

- Calculate average helium concentration in shroud (“shroud concentration”) by taking two or more readings before and after sampling (the measurements should have been recorded in ppmv).
- When we receive lab results, if helium is detected, use this formula to confirm level of leakage.
  Level of leakage = lab-detected concentration / shroud concentration
- Be sure you are using the same units (ppm may not always equal ppmv: check your units).

Appendix C
Laboratory Reports

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

James E. Bruya, Ph.D.
Yelena Aravkina, M.S.
Michael Erdahl, B.S.
Vineta Mills, M.S.
Eric Young, B.S.

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April 4, 2024

Nick Thornton, Project Manager
PBS Engineering and Environmental, Inc.
4412 SW Corbett Ave
Portland, OR 97239

Dear Mr Thornton:

Included are the results from the testing of material submitted on March 21, 2024 from the NW Yeon 20125.011, F&BI 403319 project. There are 12 pages included in this report.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.

Michael Erdahl
Project Manager

Enclosures
PBP0404R.DOC

CASE NARRATIVE

This case narrative encompasses samples received on March 21, 2024 by Friedman & Bruya, Inc. from the PBS Engineering and Environmental NW Yeon 20125.011, F&BI 403319 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	PBS Engineering and Environmental
403319 -01	SV-1
403319 -02	SV-2
403319 -03	SV-3
403319 -04	SV-4
403319 -05	SV-5
403319 -06	SV-6

The concentration of chloroethane, cis-1,2-dichloroethene, and tetrachloroethene in sample SV-2, and tetrachloroethene in samples SV-4, SV-5, and SV-6 exceeded the calibration range of the instrument. The data were flagged accordingly.

All other quality control requirements were acceptable.

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	SV-1	Client:	PBS Engineering and Environmental
Date Received:	03/21/24	Project:	NW Yeon 20125.011
Date Collected:	03/19/24	Lab ID:	403319-01 1/6.0
Date Analyzed:	03/25/24	Data File:	032513.D
Matrix:	Air	Instrument:	GCMS8
Units:	ug/m3	Operator:	bat

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	97	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<1.5	<0.6
Chloroethane	<16	<6
1,1-Dichloroethene	<2.4	<0.6
trans-1,2-Dichloroethene	<2.4	<0.6
1,1-Dichloroethane	<2.4	<0.6
cis-1,2-Dichloroethene	<2.4	<0.6
1,2-Dichloroethane (EDC)	<0.24	<0.06
1,1,1-Trichloroethane	<3.3	<0.6
Trichloroethene	11	2.1
1,1,2-Trichloroethane	<0.33	<0.06
Tetrachloroethene	570	84

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	SV-2	Client:	PBS Engineering and Environmental
Date Received:	03/21/24	Project:	NW Yeon 20125.011
Date Collected:	03/19/24	Lab ID:	403319-02 1/45
Date Analyzed:	03/25/24	Data File:	032518.D
Matrix:	Air	Instrument:	GCMS8
Units:	ug/m3	Operator:	bat

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	99	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	180	72
Chloroethane	9,500 ve	3,600 ve
1,1-Dichloroethene	110	28
trans-1,2-Dichloroethene	26	6.5
1,1-Dichloroethane	<18	<4.5
cis-1,2-Dichloroethene	5,500 ve	1,400 ve
1,2-Dichloroethane (EDC)	<1.8	<0.45
1,1,1-Trichloroethane	<25	<4.5
Trichloroethene	1,900	360
1,1,2-Trichloroethane	<2.5	<0.45
Tetrachloroethene	15,000 ve	2,200 ve

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	SV-3	Client:	PBS Engineering and Environmental
Date Received:	03/21/24	Project:	NW Yeon 20125.011
Date Collected:	03/19/24	Lab ID:	403319-03 1/5.9
Date Analyzed:	03/25/24	Data File:	032514.D
Matrix:	Air	Instrument:	GCMS8
Units:	ug/m3	Operator:	bat

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	91	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<1.5	<0.59
Chloroethane	<16	<5.9
1,1-Dichloroethene	<2.3	<0.59
trans-1,2-Dichloroethene	<2.3	<0.59
1,1-Dichloroethane	<2.4	<0.59
cis-1,2-Dichloroethene	<2.3	<0.59
1,2-Dichloroethane (EDC)	<0.24	<0.059
1,1,1-Trichloroethane	4.2	0.78
Trichloroethene	1.3	0.24
1,1,2-Trichloroethane	<0.32	<0.059
Tetrachloroethene	280	41

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	SV-4	Client:	PBS Engineering and Environmental
Date Received:	03/21/24	Project:	NW Yeon 20125.011
Date Collected:	03/19/24	Lab ID:	403319-04 1/5.8
Date Analyzed:	03/25/24	Data File:	032515.D
Matrix:	Air	Instrument:	GCMS8
Units:	ug/m3	Operator:	bat

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	92	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<1.5	<0.58
Chloroethane	<15	<5.8
1,1-Dichloroethene	<2.3	<0.58
trans-1,2-Dichloroethene	<2.3	<0.58
1,1-Dichloroethane	<2.3	<0.58
cis-1,2-Dichloroethene	<2.3	<0.58
1,2-Dichloroethane (EDC)	<0.23	<0.058
1,1,1-Trichloroethane	<3.2	<0.58
Trichloroethene	12	2.2
1,1,2-Trichloroethane	<0.32	<0.058
Tetrachloroethene	720 ve	110 ve

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	SV-5	Client:	PBS Engineering and Environmental
Date Received:	03/21/24	Project:	NW Yeon 20125.011
Date Collected:	03/19/24	Lab ID:	403319-05 1/45
Date Analyzed:	03/25/24	Data File:	032517.D
Matrix:	Air	Instrument:	GCMS8
Units:	ug/m3	Operator:	bat

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	93	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<12	<4.5
Chloroethane	<120	<45
1,1-Dichloroethene	<18	<4.5
trans-1,2-Dichloroethene	<18	<4.5
1,1-Dichloroethane	<18	<4.5
cis-1,2-Dichloroethene	<18	<4.5
1,2-Dichloroethane (EDC)	<1.8	<0.45
1,1,1-Trichloroethane	<25	<4.5
Trichloroethene	86	16
1,1,2-Trichloroethane	<2.5	<0.45
Tetrachloroethene	13,000 ve	2,000 ve

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	SV-6	Client:	PBS Engineering and Environmental
Date Received:	03/21/24	Project:	NW Yeon 20125.011
Date Collected:	03/19/24	Lab ID:	403319-06 1/8.9
Date Analyzed:	03/25/24	Data File:	032516.D
Matrix:	Air	Instrument:	GCMS8
Units:	ug/m3	Operator:	bat

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	95	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<2.3	<0.89
Chloroethane	<23	<8.9
1,1-Dichloroethene	<3.5	<0.89
trans-1,2-Dichloroethene	<3.5	<0.89
1,1-Dichloroethane	<3.6	<0.89
cis-1,2-Dichloroethene	<3.5	<0.89
1,2-Dichloroethane (EDC)	<0.36	<0.089
1,1,1-Trichloroethane	<4.9	<0.89
Trichloroethene	2.3	0.44
1,1,2-Trichloroethane	<0.49	<0.089
Tetrachloroethene	1,600 ve	230 ve

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	Method Blank	Client:	PBS Engineering and Environmental
Date Received:	Not Applicable	Project:	NW Yeon 20125.011
Date Collected:	Not Applicable	Lab ID:	04-0674 mb
Date Analyzed:	03/25/24	Data File:	032512.D
Matrix:	Air	Instrument:	GCMS8
Units:	ug/m3	Operator:	bat

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	95	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.26	<0.1
Chloroethane	<2.6	<1
1,1-Dichloroethene	<0.4	<0.1
trans-1,2-Dichloroethene	<0.4	<0.1
1,1-Dichloroethane	<0.4	<0.1
cis-1,2-Dichloroethene	<0.4	<0.1
1,2-Dichloroethane (EDC)	<0.04	<0.01
1,1,1-Trichloroethane	<0.55	<0.1
Trichloroethene	<0.11	<0.02
1,1,2-Trichloroethane	<0.055	<0.01
Tetrachloroethene	<6.8	<1

Date of Report: 04/04/24
Date Received: 03/21/24
Project: NW Yeon 20125.011, F&BI 403319
Date Extracted: 04/01/24
Date Analyzed: 04/01/24

RESULTS FROM THE ANALYSIS OF AIR SAMPLES FOR HELIUM USING METHOD ASTM D1946

Results Reported as % Helium

Sample ID Laboratory ID	Helium
SV-1 403319-01	<0.6
SV-2 403319-02	<0.6
SV-3 403319-03	<0.6
SV-4 403319-04	<0.6
SV-5 403319-05	<0.6
SV-6 403319-06	<0.6
Method Blank 04-0694 MB	<0.6

Date of Report: 04/04/24
Date Received: 03/21/24
Project: NW Yeon 20125.011, F&BI 403319

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF AIR SAMPLES FOR VOLATILES BY METHOD TO-15

Laboratory Code: 403361-01 1/5.1 (Duplicate)

Analyte	Reporting Units	Sample Result	Duplicate Result	RPD (Limit 30)
Vinyl chloride	ug/m3	<1.3	<1.3	nm
Chloroethane	ug/m3	<13	<13	nm
1,1-Dichloroethene	ug/m3	<2	<2	nm
trans-1,2-Dichloroethene	ug/m3	<2	<2	nm
1,1-Dichloroethane	ug/m3	<2.1	<2.1	nm
cis-1,2-Dichloroethene	ug/m3	<2	<2	nm
1,2-Dichloroethane (EDC)	ug/m3	<0.21	<0.21	nm
1,1,1-Trichloroethane	ug/m3	<2.8	<2.8	nm
Trichloroethene	ug/m3	<0.55	<0.55	nm
1,1,2-Trichloroethane	ug/m3	<0.28	<0.28	nm
Tetrachloroethene	ug/m3	<35	<35	nm

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Vinyl chloride	ug/m3	35	107	70-130
Chloroethane	ug/m3	36	109	70-130
1,1-Dichloroethene	ug/m3	54	113	70-130
trans-1,2-Dichloroethene	ug/m3	54	112	70-130
1,1-Dichloroethane	ug/m3	55	117	70-130
cis-1,2-Dichloroethene	ug/m3	54	108	70-130
1,2-Dichloroethane (EDC)	ug/m3	55	118	70-130
1,1,1-Trichloroethane	ug/m3	74	116	70-130
Trichloroethene	ug/m3	73	118	70-130
1,1,2-Trichloroethane	ug/m3	74	125	70-130
Tetrachloroethene	ug/m3	92	113	70-130

Date of Report: 04/04/24
Date Received: 03/21/24
Project: NW Yeon 20125.011, F&BI 403319

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF AIR SAMPLES FOR HELIUM USING METHOD ASTM D1946

Laboratory Code: 403379-01 (Duplicate)

Analyte	Sample Result (%)	Duplicate Result (%)	Relative Percent Difference	Acceptance Criteria
Helium	<0.6	<0.6	nm	0-20

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for the analyte were outside of acceptance criteria, biased low; or, the calibration results for the analyte were outside of acceptance criteria, biased high, with a detection for the analyte in the sample. The value reported is an estimate.

c - The presence of the analyte may be due to carryover from previous sample injections.

cf - The sample was centrifuged prior to analysis.

d - The sample was diluted. Detection limits were raised and surrogate recoveries may not be meaningful.

dv - Insufficient sample volume was available to achieve normal reporting limits.

f - The sample was laboratory filtered prior to analysis.

fb - The analyte was detected in the method blank.

fc - The analyte is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. Variability is attributed to sample inhomogeneity.

hs - Headspace was present in the container used for analysis.

ht – The analysis was performed outside the method or client-specified holding time requirement.

ip - Recovery fell outside of control limits due to sample matrix effects.

j - The analyte concentration is reported below the standard reporting limit. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The laboratory control sample(s) percent recovery and/or RPD were out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

k – The calibration results for the analyte were outside of acceptance criteria, biased high, and the analyte was not detected in the sample.

lc - The presence of the analyte is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc - The sample was received with incorrect preservation or in a container not approved by the method. The value reported should be considered an estimate.

ve - The analyte response exceeded the valid instrument calibration range. The value reported is an estimate.

vo - The value reported fell outside the control limits established for this analyte.

x - The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

403319 [redacted]

SAMPLE CHAIN OF CUSTODY

03/21/24 [redacted]

Page # 1 of 1

Report To [redacted] Nick Thoroton

Company PBS

Address 4412 S Corbett Ave

City, State, ZIP Portland, OR 97239

Phone 503-417-7610 Email Nick.thornton@pbsusa.com

SAMPLERS (*signature*) [illegible]	
PROJECT NAME & ADDRESS	PO #
NW Yeon	20125.011
NOTES:	INVOICE TO

TURNAROUND TIME
Standard
RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
Default: Clean following final report delivery
Hold (Fee may apply):

SAMPLE INFORMATION / ANALYSIS REQUESTED

Sample Name	Lab ID	Canister ID	Flow Cont. ID	Reporting Level: IA=Indoor Air SG=Soil Gas (Circle One)	Date Sampled	Initial Vac. ("Hg)	Field Initial Time	Final Vac. ("Hg)	Field Final Time	TO15 Full Scan	TO15 BTEXN	TO15 cVOCs	APH	Helium		Notes
SV-1	01	3255	63	IA / SG	3/19/24	-30	1131	-7	1135			X		X		
SV-2	02	3483	280	IA / SG			1443		1447			X		X		
SV-3	03	3252	51	IA / SG			1031		1035			X		X		
SV-4	04	3259	258	IA / SG			944		948			X		X		
SV-5	05	3311	255	IA / SG			1330		1335			X		X		
SV-6	06	2300	52	IA / SG			1406		1411			X		X		
				IA / SG												
				IA / SG												

Friedman & Bruya, Inc.
5500 4th Avenue South
Seattle, WA 98108
Ph. (206) 285-8282
Fax (206) 283-5044

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by: [illegible]	David Rukki	PBS	3/20/24	1105
Received by: [illegible]	Phan Phan	F&BI	3/21/24	1420
Relinquished by:				
Received by:		**Samples received at 20 °C**		

FORMS\COC\COCTO-15.DOC

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6/27/2024
Mr. David Rukki
PBS Engineering & Environmental
4412 S Corbett

Portland OR 97239

Project Name: NW Yeon
Project #: 20125.011
Workorder #: 2406379

Dear Mr. David Rukki

The following report includes the data for the above referenced project for sample(s) received on 6/14/2024 at Eurofins Air Toxics LLC.

The data and associated QC analyzed by Passive S.E. WMS are compliant with the project requirements or laboratory criteria with the exception of the deviations noted in the attached case narrative.

Thank you for choosing Eurofins Air Toxics LLC. for your air analysis needs. Eurofins Air Toxics Inc. is committed to providing accurate data of the highest quality. Please feel free to contact the Project Manager: Monica Tran at 916-985-1000 if you have any questions regarding the data in this report.

Regards,

Monica Tran

Monica Tran
Project Manager

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WORK ORDER #: 2406379

Work Order Summary

CLIENT:	Mr. David Rukki PBS Engineering & Environmental 4412 S Corbett Portland, OR 97239	**BILL TO:**	Accounts Payable PBS Engineering & Environmental 4412 S Corbett Portland, OR 97239
PHONE:	503-248-1939	**P.O. #**	
FAX:	503-248-0223	**PROJECT #**	20125.011 NW Yeon
DATE RECEIVED:	06/14/2024	**CONTACT:**	Monica Tran
DATE COMPLETED:	06/27/2024		

FRACTION #	NAME	TEST
01A	SSV-1	Passive S.E. WMS
02A	SSV-2	Passive S.E. WMS
03A	SSV-DUP	Passive S.E. WMS
04A	TB-053024-1	Passive S.E. WMS
05A	TB-053024-2	Passive S.E. WMS
06A	Lab Blank	Passive S.E. WMS
07A	CCV	Passive S.E. WMS
08A	LCS	Passive S.E. WMS
08AA	LCSD	Passive S.E. WMS

CERTIFIED BY: Heidi Hayes DATE: 06/27/24

Technical Director

Certification numbers: AZ Licensure AZ0775, FL NELAP – E87680, LA NELAP – 02089, NH NELAP – 209222, NJ NELAP - CA016, NY NELAP - 11291, TX NELAP – T104704434-22-18, UT NELAP – CA009332022-14, VA NELAP - 12240, WA ELAP - C935
Name of Accreditation Body: NELAP/ORELAP (Oregon Environmental Laboratory Accreditation Program) CA300005-017
Eurofins Environment Testing Northern California, LLC certifies that the test results contained in this report meet all requirements of the 2016 TNI Standard.

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 95630
(916) 985-1000

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LABORATORY NARRATIVE
WMS Passive SE by Mod EPA TO-17
PBS Engineering & Environmental
Workorder# 2406379

Five WMS-VP samples were received on June 14, 2024. The laboratory analyzed the charcoal sorbent bed of the passive sampler following modified method EPA TO-17. The VOCs were chemically extracted using carbon disulfide and an aliquot of the extract was injected into a GC/MS for identification and quantification of volatile organic compounds (VOCs).

The mass of each target compound adsorbed by the sampler was converted to units of concentration using the sample deployment time and the sampling rate for each VOC. If sampling rates were calculated by the lab or the manufacturer, the concentration result has been flagged as an estimated value. Results are not corrected for desorption efficiency.

Please note that 1,1,2,2-Tetrachloroethane (1,1,2,2-PCA) can degrade into Trichloroethene (TCE) during storage on the charcoal-based sorbent used in the WMS device. Samples containing 1,1,2,2-PCA may yield reduced concentrations of 1,1,2,2-PCA and elevated concentrations of TCE.

The reference method used for this procedure is EPA TO-17, which describes the collection of VOCs in ambient air using sorbents and analysis by GC/MS. Because TO-17 describes active sample collection using a pump and thermal desorption as the preparation step, several modifications are required. Modifications to TO-17 are listed in the table below:

Requirement	***TO-17***	***ATL Modifications***
Sample Collection	Pump pulls measured air volume through sorbent tube	VOCs in air adsorbed onto sorbent bed passively through diffusion
Sample Preparation	Thermal extraction	Solvent extraction
Sorbent tube conditioning	Condition newly packed tubes prior to use	Charcoal-based sorbent is a single use media and conditioning is conducted by vendor.
Instrumentation	Thermal desorption introduction system	Liquid injection introduction system
Internal Standard	Gas-phase internal standard introduced on the tube or focusing trap during analysis	Liquid-phase internal standard introduced on the tube at the time of extraction
Media and sample storage	<4 deg C, 30 days	Media shelf life is determined by vendor; sample hold-time is 6 months for the RAD130 and WMS. Sample preservation requirements are storage in a cool, solvent-free refrigerator and optional use of ice during shipping.
Internal Standard Recovery	+/-40% of daily CCV area	-50% to +100% of daily CCV area

Receiving Notes

There were no receiving discrepancies.

Analytical Notes

To calculate ug/m3 concentrations in the Lab Blank and Trip Blanks, a sampling duration of 20114 minutes was applied.

All Quality Control Limit exceedances and affected sample results are noted by flags. Each flag is defined at the bottom of this Case Narrative and on each Sample Result Summary page.

Definition of Data Qualifying Flags

Ten qualifiers may have been used on the data analysis sheets and indicate as follows:

B - Compound present in laboratory blank greater than reporting limit (background subtraction not performed).

J - Estimated value.

E - Exceeds instrument calibration range.

S - Saturated peak.

Q - Exceeds quality control limits.

U - Compound analyzed for but not detected above the reporting limit.

UJ- Non-detected compound associated with low bias in the CCV

N - The identification is based on presumptive evidence.

C - Estimated concentration due to calculated sampling rate

CN - See case narrative explanation.

File extensions may have been used on the data analysis sheets and indicates as follows:

a-File was requantified

b-File was quantified by a second column and detector

r1-File was requantified for the purpose of reissue

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Summary of Detected Compounds
VOC BY PASSIVE SAMPLER - GC/MS

Client Sample ID: SSV-1

Lab ID#: 2406379-01A

Compound	Rpt. Limit (ug)	Rpt. Limit (ug/m3)	Amount (ug)	Amount (ug/m3)
Trichloroethene	0.050	3.0	1.5	89
Tetrachloroethene	0.050	1.9	23	880

Client Sample ID: SSV-2

Lab ID#: 2406379-02A

Compound	Rpt. Limit (ug)	Rpt. Limit (ug/m3)	Amount (ug)	Amount (ug/m3)
Trichloroethene	0.050	3.0	0.34	20
Tetrachloroethene	0.050	1.9	14	550

Client Sample ID: SSV-DUP

Lab ID#: 2406379-03A

Compound	Rpt. Limit (ug)	Rpt. Limit (ug/m3)	Amount (ug)	Amount (ug/m3)
Trichloroethene	0.050	3.0	0.44	26
Tetrachloroethene	0.050	1.9	17	660

Client Sample ID: TB-053024-1

Lab ID#: 2406379-04A

No Detections Were Found.

Client Sample ID: TB-053024-2

Lab ID#: 2406379-05A

No Detections Were Found.

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Client Sample ID: SSV-1

Lab ID#: 2406379-01A

VOC BY PASSIVE SAMPLER - GC/MS

File Name:	**18062007sim**	**Date of Collection: 6/13/24 9:25:00 AM**
Dil. Factor:	**1.00**	**Date of Analysis: 6/20/24 10:40 AM**
		Date of Extraction: 6/20/24

Compound	Rpt. Limit (ug)	Rpt. Limit (ug/m3)	Amount (ug)	Amount (ug/m3)
Vinyl Chloride	0.20	99	Not Detected	Not Detected
1,1-Dichloroethene	0.20	50	Not Detected	Not Detected
trans-1,2-Dichloroethene	0.10	18	Not Detected	Not Detected
cis-1,2-Dichloroethene	0.050	5.5	Not Detected	Not Detected
Trichloroethene	0.050	3.0	1.5	89
Tetrachloroethene	0.050	1.9	23	880

Temperature = 63.7F , duration time = 20107 minutes.

Container Type: WMS-VP

Surrogates	%Recovery	Method Limits
Toluene-d8	98	70-130

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Client Sample ID: SSV-2

Lab ID#: 2406379-02A

VOC BY PASSIVE SAMPLER - GC/MS

File Name:	**18062008sim**	**Date of Collection: 6/13/24 9:14:00 AM**
Dil. Factor:	**1.00**	**Date of Analysis: 6/20/24 11:06 AM**
		Date of Extraction: 6/20/24

Compound	Rpt. Limit (ug)	Rpt. Limit (ug/m3)	Amount (ug)	Amount (ug/m3)
Vinyl Chloride	0.20	99	Not Detected	Not Detected
1,1-Dichloroethene	0.20	50	Not Detected	Not Detected
trans-1,2-Dichloroethene	0.10	18	Not Detected	Not Detected
cis-1,2-Dichloroethene	0.050	5.5	Not Detected	Not Detected
Trichloroethene	0.050	3.0	0.34	20
Tetrachloroethene	0.050	1.9	14	550

Temperature = 63.3F , duration time = 20114 minutes.

Container Type: WMS-VP

Surrogates	%Recovery	Method Limits
Toluene-d8	98	70-130

Air Toxics

Client Sample ID: SSV-DUP

Lab ID#: 2406379-03A

VOC BY PASSIVE SAMPLER - GC/MS

File Name:	**18062009sim**	**Date of Collection: 6/13/24 9:15:00 AM**
Dil. Factor:	**1.00**	**Date of Analysis: 6/20/24 11:33 AM**
		Date of Extraction: 6/20/24

Compound	Rpt. Limit (ug)	Rpt. Limit (ug/m3)	Amount (ug)	Amount (ug/m3)
Vinyl Chloride	0.20	99	Not Detected	Not Detected
1,1-Dichloroethene	0.20	50	Not Detected	Not Detected
trans-1,2-Dichloroethene	0.10	18	Not Detected	Not Detected
cis-1,2-Dichloroethene	0.050	5.5	Not Detected	Not Detected
Trichloroethene	0.050	3.0	0.44	26
Tetrachloroethene	0.050	1.9	17	660

Temperature = 62.8F , duration time = 20109 minutes.

Container Type: WMS-VP

Surrogates	%Recovery	Method Limits
Toluene-d8	97	70-130

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Client Sample ID: TB-053024-1

Lab ID#: 2406379-04A

VOC BY PASSIVE SAMPLER - GC/MS

File Name:	**18062010sim**	**Date of Collection: 6/13/24**
Dil. Factor:	**1.00**	**Date of Analysis: 6/20/24 11:59 AM**
		Date of Extraction: 6/20/24

Compound	Rpt. Limit (ug)	Rpt. Limit (ug/m3)	Amount (ug)	Amount (ug/m3)
Vinyl Chloride	0.20	99	Not Detected	Not Detected
1,1-Dichloroethene	0.20	50	Not Detected	Not Detected
trans-1,2-Dichloroethene	0.10	18	Not Detected	Not Detected
cis-1,2-Dichloroethene	0.050	5.5	Not Detected	Not Detected
Trichloroethene	0.050	3.0	Not Detected	Not Detected
Tetrachloroethene	0.050	1.9	Not Detected	Not Detected

Temperature = 63.7F , duration time = 20114 minutes.

Container Type: WMS-VP

Surrogates	%Recovery	Method Limits
Toluene-d8	97	70-130

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Client Sample ID: TB-053024-2

Lab ID#: 2406379-05A

VOC BY PASSIVE SAMPLER - GC/MS

File Name:	**18062011sim**	**Date of Collection:**	**6/13/24**
Dil. Factor:	**1.00**	**Date of Analysis:**	**6/20/24 12:26 PM**
		Date of Extraction:	**6/20/24**

Compound	Rpt. Limit (ug)	Rpt. Limit (ug/m3)	Amount (ug)	Amount (ug/m3)
Vinyl Chloride	0.20	99	Not Detected	Not Detected
1,1-Dichloroethene	0.20	50	Not Detected	Not Detected
trans-1,2-Dichloroethene	0.10	18	Not Detected	Not Detected
cis-1,2-Dichloroethene	0.050	5.5	Not Detected	Not Detected
Trichloroethene	0.050	3.0	Not Detected	Not Detected
Tetrachloroethene	0.050	1.9	Not Detected	Not Detected

Temperature = 63.7F , duration time = 20114 minutes.

Container Type: WMS-VP

Surrogates	%Recovery	Method Limits
Toluene-d8	97	70-130

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Client Sample ID: Lab Blank

Lab ID#: 2406379-06A

VOC BY PASSIVE SAMPLER - GC/MS

File Name:	**18062006sim**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 6/20/24 10:13 AM**
		Date of Extraction: 6/20/24

Compound	Rpt. Limit (ug)	Rpt. Limit (ug/m3)	Amount (ug)	Amount (ug/m3)
Vinyl Chloride	0.20	99	Not Detected	Not Detected
1,1-Dichloroethene	0.20	50	Not Detected	Not Detected
trans-1,2-Dichloroethene	0.10	18	Not Detected	Not Detected
cis-1,2-Dichloroethene	0.050	5.5	Not Detected	Not Detected
Trichloroethene	0.050	3.0	Not Detected	Not Detected
Tetrachloroethene	0.050	1.9	Not Detected	Not Detected

Temperature = 63.7F , duration time = 20114 minutes.
Container Type: WMS-VP

Surrogates	%Recovery	Method Limits
Toluene-d8	98	70-130

Client Sample ID: CCV

Lab ID#: 2406379-07A

VOC BY PASSIVE SAMPLER - GC/MS

File Name:	**18062002sim**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 6/20/24 08:18 AM**
		Date of Extraction: NA

Compound	%Recovery
Vinyl Chloride	98
1,1-Dichloroethene	108
trans-1,2-Dichloroethene	103
cis-1,2-Dichloroethene	104
Trichloroethene	99
Tetrachloroethene	95

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	104	70-130

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Client Sample ID: LCS

Lab ID#: 2406379-08A

VOC BY PASSIVE SAMPLER - GC/MS

File Name:	**18062003sim**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 6/20/24 08:45 AM**
		Date of Extraction: 6/20/24

Compound	%Recovery	Method Limits
Vinyl Chloride	111	50-140
1,1-Dichloroethene	128	70-130
trans-1,2-Dichloroethene	123	70-130
cis-1,2-Dichloroethene	120	70-130
Trichloroethene	112	70-130
Tetrachloroethene	103	70-130

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	99	70-130

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Client Sample ID: LCSD

Lab ID#: 2406379-08AA

VOC BY PASSIVE SAMPLER - GC/MS

File Name:	**18062004sim**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 6/20/24 09:12 AM**
		Date of Extraction: 6/20/24

Compound	%Recovery	Method Limits
Vinyl Chloride	118	50-140
1,1-Dichloroethene	136 Q	70-130
trans-1,2-Dichloroethene	128	70-130
cis-1,2-Dichloroethene	125	70-130
Trichloroethene	113	70-130
Tetrachloroethene	102	70-130

Q = Exceeds Quality Control limits.

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
Toluene-d8	99	70-130

Air Toxics

Method : Passive SE GC/MS WMS (Sh)-1,1-DCE, c/t-1,2-DCE, PCE, TCE & VC

CAS Number	Compound	Rpt. Limit (ug)
75-01-4	Vinyl Chloride	0.20
75-35-4	1,1-Dichloroethene	0.20
156-60-5	trans-1,2-Dichloroethene	0.10
156-59-2	cis-1,2-Dichloroethene	0.050
79-01-6	Trichloroethene	0.050
127-18-4	Tetrachloroethene	0.050

	Surrogate	Method Limits
2037-26-5	Toluene-d8	70-130

Appendix D
Weather Data

STATION: KPDX
STATION NAME: Portland International Airport
LATITUDE: 45.59578
LONGITUDE: -122.60917
ELEVATION [ft]: 20.0
STATE: OR

Station_ID	Date	Time	Air Temperature (Fahrenheit)
KPDX	3/19/2024	7:00	46.40
KPDX	3/19/2024	7:05	46.40
KPDX	3/19/2024	7:10	46.40
KPDX	3/19/2024	7:15	46.40
KPDX	3/19/2024	7:20	46.40
KPDX	3/19/2024	7:25	46.40
KPDX	3/19/2024	7:30	46.40
KPDX	3/19/2024	7:35	48.20
KPDX	3/19/2024	7:40	48.20
KPDX	3/19/2024	7:45	48.20
KPDX	3/19/2024	7:50	46.40
KPDX	3/19/2024	7:53	46.94
KPDX	3/19/2024	7:55	46.40
KPDX	3/19/2024	8:00	46.40
KPDX	3/19/2024	8:05	46.40
KPDX	3/19/2024	8:10	48.20
KPDX	3/19/2024	8:15	48.20
KPDX	3/19/2024	8:20	48.20
KPDX	3/19/2024	8:25	50.00
KPDX	3/19/2024	8:30	50.00
KPDX	3/19/2024	8:35	50.00
KPDX	3/19/2024	8:40	50.00
KPDX	3/19/2024	8:45	50.00
KPDX	3/19/2024	8:50	50.00
KPDX	3/19/2024	8:53	50.00
KPDX	3/19/2024	8:55	50.00
KPDX	3/19/2024	9:00	51.80
KPDX	3/19/2024	9:05	51.80
KPDX	3/19/2024	9:10	51.80
KPDX	3/19/2024	9:15	51.80
KPDX	3/19/2024	9:30	53.60
KPDX	3/19/2024	9:35	53.60
KPDX	3/19/2024	9:40	53.60
KPDX	3/19/2024	9:50	53.60
KPDX	3/19/2024	9:53	53.96
KPDX	3/19/2024	9:55	53.60
KPDX	3/19/2024	10:00	53.60
KPDX	3/19/2024	10:05	55.40
KPDX	3/19/2024	10:10	55.40
KPDX	3/19/2024	10:15	55.40
KPDX	3/19/2024	10:20	55.40
KPDX	3/19/2024	10:25	55.40
KPDX	3/19/2024	10:30	55.40
KPDX	3/19/2024	10:40	55.40
KPDX	3/19/2024	10:45	55.40
KPDX	3/19/2024	10:50	55.40
KPDX	3/19/2024	10:53	57.02
KPDX	3/19/2024	11:35	59.00
KPDX	3/19/2024	11:40	60.80
KPDX	3/19/2024	11:45	59.00
KPDX	3/19/2024	11:50	60.80
KPDX	3/19/2024	11:53	60.98
KPDX	3/19/2024	11:55	60.80
KPDX	3/19/2024	12:00	60.80
KPDX	3/19/2024	12:05	60.80
KPDX	3/19/2024	12:10	60.80
KPDX	3/19/2024	12:15	62.60
KPDX	3/19/2024	12:20	60.80
KPDX	3/19/2024	12:25	60.80
KPDX	3/19/2024	12:30	60.80
KPDX	3/19/2024	12:35	60.80
KPDX	3/19/2024	12:40	62.60
KPDX	3/19/2024	12:45	62.60
KPDX	3/19/2024	12:50	62.60
KPDX	3/19/2024	12:53	62.96

KPDX	3/19/2024	12:55	62.60
KPDX	3/19/2024	13:00	64.40
KPDX	3/19/2024	13:05	64.40
KPDX	3/19/2024	13:10	64.40
KPDX	3/19/2024	13:15	64.40
KPDX	3/19/2024	13:20	64.40
KPDX	3/19/2024	13:25	64.40
KPDX	3/19/2024	13:30	66.20
KPDX	3/19/2024	13:35	66.20
KPDX	3/19/2024	13:40	66.20
KPDX	3/19/2024	13:45	66.20
KPDX	3/19/2024	13:50	66.20
KPDX	3/19/2024	13:53	66.02
KPDX	3/19/2024	13:55	66.20
KPDX	3/19/2024	14:00	66.20
KPDX	3/19/2024	14:05	66.20
KPDX	3/19/2024	14:10	66.20
KPDX	3/19/2024	14:15	66.20
KPDX	3/19/2024	14:20	66.20
KPDX	3/19/2024	14:53	68.00
KPDX	3/19/2024	15:53	69.80
KPDX	3/19/2024	16:25	69.80
KPDX	3/19/2024	16:30	69.80
KPDX	3/19/2024	16:35	69.80
KPDX	3/19/2024	16:40	69.80
KPDX	3/19/2024	16:45	69.80
KPDX	3/19/2024	16:53	69.98
KPDX	3/19/2024	16:55	69.80
KPDX	3/19/2024	17:00	71.60

STATION: KPDX
STATION NAME: Portland International Airport
LATITUDE: 45.59578
LONGITUDE: -122.60917
ELEVATION [ft]: 20.0
STATE: OR

Station_ID	Date	Time	Atmospheric Pressure (IN HG)
KPDX	3/19/2024	7:00	30.04
KPDX	3/19/2024	7:05	30.04
KPDX	3/19/2024	7:10	30.04
KPDX	3/19/2024	7:15	30.04
KPDX	3/19/2024	7:20	30.04
KPDX	3/19/2024	7:25	30.04
KPDX	3/19/2024	7:30	30.04
KPDX	3/19/2024	7:35	30.04
KPDX	3/19/2024	7:40	30.04
KPDX	3/19/2024	7:45	30.05
KPDX	3/19/2024	7:50	30.05
KPDX	3/19/2024	7:53	30.05
KPDX	3/19/2024	7:55	30.05
KPDX	3/19/2024	8:00	30.05
KPDX	3/19/2024	8:05	30.05
KPDX	3/19/2024	8:10	30.05
KPDX	3/19/2024	8:15	30.05
KPDX	3/19/2024	8:20	30.05
KPDX	3/19/2024	8:25	30.05
KPDX	3/19/2024	8:30	30.05
KPDX	3/19/2024	8:35	30.05
KPDX	3/19/2024	8:40	30.05
KPDX	3/19/2024	8:45	30.05
KPDX	3/19/2024	8:50	30.05
KPDX	3/19/2024	8:53	30.05
KPDX	3/19/2024	8:55	30.05
KPDX	3/19/2024	9:00	30.05
KPDX	3/19/2024	9:05	30.05
KPDX	3/19/2024	9:10	30.05
KPDX	3/19/2024	9:15	30.05
KPDX	3/19/2024	9:30	30.05
KPDX	3/19/2024	9:35	30.05
KPDX	3/19/2024	9:40	30.05
KPDX	3/19/2024	9:50	30.05
KPDX	3/19/2024	9:53	30.05
KPDX	3/19/2024	9:55	30.05
KPDX	3/19/2024	10:00	30.05
KPDX	3/19/2024	10:05	30.05
KPDX	3/19/2024	10:10	30.05
KPDX	3/19/2024	10:15	30.05
KPDX	3/19/2024	10:20	30.05
KPDX	3/19/2024	10:25	30.05
KPDX	3/19/2024	10:30	30.05
KPDX	3/19/2024	10:40	30.05
KPDX	3/19/2024	10:45	30.05
KPDX	3/19/2024	10:50	30.05
KPDX	3/19/2024	10:53	30.05
KPDX	3/19/2024	11:35	30.04
KPDX	3/19/2024	11:40	30.04
KPDX	3/19/2024	11:45	30.04
KPDX	3/19/2024	11:50	30.04
KPDX	3/19/2024	11:53	30.04
KPDX	3/19/2024	11:55	30.04
KPDX	3/19/2024	12:00	30.04
KPDX	3/19/2024	12:05	30.03
KPDX	3/19/2024	12:10	30.03
KPDX	3/19/2024	12:15	30.03
KPDX	3/19/2024	12:20	30.03
KPDX	3/19/2024	12:25	30.03
KPDX	3/19/2024	12:30	30.03
KPDX	3/19/2024	12:35	30.03
KPDX	3/19/2024	12:40	30.02
KPDX	3/19/2024	12:45	30.02
KPDX	3/19/2024	12:50	30.02
KPDX	3/19/2024	12:53	30.02

KPDX	3/19/2024	12:55	30.02
KPDX	3/19/2024	13:00	30.02
KPDX	3/19/2024	13:05	30.02
KPDX	3/19/2024	13:10	30.02
KPDX	3/19/2024	13:15	30.02
KPDX	3/19/2024	13:20	30.02
KPDX	3/19/2024	13:25	30.01
KPDX	3/19/2024	13:30	30.01
KPDX	3/19/2024	13:35	30.01
KPDX	3/19/2024	13:40	30.01
KPDX	3/19/2024	13:45	30.01
KPDX	3/19/2024	13:50	30.00
KPDX	3/19/2024	13:53	30.00
KPDX	3/19/2024	13:55	30.00
KPDX	3/19/2024	14:00	30.00
KPDX	3/19/2024	14:05	30.00
KPDX	3/19/2024	14:10	29.99
KPDX	3/19/2024	14:15	29.99
KPDX	3/19/2024	14:20	29.99
KPDX	3/19/2024	14:53	29.98
KPDX	3/19/2024	15:53	29.97
KPDX	3/19/2024	16:25	29.96
KPDX	3/19/2024	16:30	29.96
KPDX	3/19/2024	16:35	29.96
KPDX	3/19/2024	16:40	29.96
KPDX	3/19/2024	16:45	29.96
KPDX	3/19/2024	16:53	29.96
KPDX	3/19/2024	16:55	29.96
KPDX	3/19/2024	17:00	29.96

Appendix E
Site Photos

Photo 1. Collecting soil gas sample SV-3 adjacent to the western property boundary with a post-run tubing (PRT) sampling system.

Photo 2. Collecting soil gas sample SV-2 near monitoring well MW-9.

Photo 3. Collecting soil gas sample SV-6 near the southern property boundary and monitoring well MW-8.

Photo 4. Sub-slab sample location SSV-2 marked out in paint near the southern end of the warehouse.

Photo 5. Waterloo membrane samplers installed for the collection of sub-slab samples SSV-2 and SSV-DUP.

Photo 6. The passive samplers were collected after 14 days and the holes in the concrete slab were patched and sealed with hydraulic cement.