Tier II Vapor Intrusion Assessment Report

Port of Tacoma's Administration Building

Project Number: 013PT-002

Prepared for:
The Port of Tacoma

January 24, 2018

Prepared by:

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Prepared for:
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Prepared by:

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January 24, 2018

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Executive Summary

On December 30, 2017, CRETE Consulting Inc. (CRETE) completed a Tier II vapor intrusion (VI) site assessment at the Port of Tacoma's (Port) administrative building located at 1 Sitcum Way, Tacoma, WA. The Tier II VI site assessment was completed in accordance with Ecology's Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State revised February 2016. The VI site assessment was completed due to the presence of a chlorinated solvent groundwater plume located in close proximity to the building; the plume is associated with the 1940 E. 11th Street site. The VI site assessment included the collection of ambient air, indoor air, and sub-slab (beneath the building foundation) air samples. Samples were analyzed for chlorinated volatile organic compounds (VOC).

All ambient and indoor air sample results collected from the administrative building were less than Washington State Department of Ecology (Ecology) cleanup standards for indoor air (Model Toxic Control Act [MTCA] Method B) and the sub-slab sample results were less than the Ecology screening levels for sub-slab soil gas (MTCA Method B, no cleanup levels are established for sub-slab soil gas).

The only VOC detected in any samples was tetrachloroethene (PCE) which was detected in indoor air samples, at a maximum concentration of 0.34 microgram per cubic meter (ug/m^3), and ambient samples, at a maximum concentration of 1.3 ug/m^3. All indoor and ambient air detections are below the Ecology cleanup level of 9.62 ug/m^3 (MTCA Method B). PCE was also detected in one sub-slab sample at a concentration of 11 ug/m^3, below the Ecology screening level of 320.51 ug/m^3.

PCE has not been detected in groundwater in the vicinity of the Port administrative building. Vinyl chloride and cis-1,2 dichloroethene are the primary chlorinated VOCs detected in groundwater suggesting that the source of low level PCE concentrations is not the groundwater. The presence of PCE in the upwind ambient air sample suggests that the primary source of PCE in the indoor air samples was likely ambient air.

1 Introduction and Background

This document presents the results of the Tier II vapor intrusion (VI) site assessment at the Port of Tacoma's (Port) administrative building located at 1 Sitcum Way, Tacoma, WA.

The VI site assessment was completed due to a chlorinated solvent groundwater plume located in close proximity to the building; the plume is associated with the 1940 E. 11th Street site. The known chlorinated solvent groundwater plume extends from the 1940 E. 11th Street Site downgradient to MW-15 and MW-17 located 50 and 25 feet, respectively, to the north east of the Port's administrative building.

The VI site assessment included the collection of ambient air, indoor air, and sub-slab (beneath the building foundation) air samples. Samples were analyzed for chlorinated volatile organic compounds (VOC). This analysis approach for assessment of VI at the building is based on the tiered approach presented in Ecology's draft vapor intrusion guidance document ('Ecology's VI Guidance', Ecology 2016). The assessment process consists of two stages:

1. Tier I assessment – Focuses on determining whether there is a potential vapor intrusion risk based on groundwater and soil gas concentrations and which buildings may potentially be at risk for vapor intrusion. A Tier I assessment does not evaluate individual buildings.

2. Tier II assessment – If a potential vapor intrusion risk is identified in an area with overlying structures, a Tier II assessment focuses on evaluating individual structures using additional building-specific sampling such as indoor air, ambient air, and sub-slab soil gas.

A Tier I assessment evaluates VOC concentrations in shallow groundwater or soil gas to determine whether VOCs could pose a vapor intrusion threat to indoor air quality in nearby buildings. Where possible, wells screened near the water table are used for Tier 1 groundwater evaluation because VOCs at the water table have the greatest potential to volatilize into soil gas. A Tier II assessment evaluates specific buildings to determine if VOCs of potential concern are present in indoor air above Model Toxic Control Act (MTCA) cleanup levels (CULs) and if the VOCs are related to vapor intrusion or background sources (Ecology 2016).

For the Tier I assessment, existing groundwater data from the MW-15 and MW-17 were evaluated against screening levels. Vinyl chloride has been detected above the MTCA groundwater screening level for protection of indoor air (0.35 micrograms per liter [µg/l]) in groundwater samples from both of these wells. Measured vinyl chloride concentrations in groundwater ranged between 130 and 180 µg/l in MW-17 (2012 and 2014) and between 51 and 290 µg/l in MW-15 (2010, 2012, and 2014).

Based on the results of the Tier I assessment, a Tier II assessment was recommended. Ecology's VI Guidance recommends that when the building of concern is an existing structure, a Tier II assessment can be used to determine what impact vapor intrusion is actually having on indoor air. This requires that samples of indoor air be collected and analyzed. At the same time as indoor air samples are collected, Ecology's VI Guidance recommends sampling sub-slab soil gas as well as building specific ambient (outdoor) air. The results can then be evaluated together to better estimate how much of the measured indoor air contamination is likely to be due to vapor intrusion.

2 Tier II Vapor Intrusion Assessment

Samples were collected following Ecology's VI guidance documents as summarized in Section 2.2. CRETE standard operating procedures, a photographic log, and copies of field reports are included in Appendix A. Sample locations are shown on Figure 1.

The generic MTCA Method B indoor air cleanup and screening levels were used to evaluate results from the Port's administration building VI assessment. Cleanup levels were developed per WAC 173-340-750 and are summarized below. These represent default MTCA cleanup levels, no modifications or adjustments were applied to the MTCA cleanup and screening levels.

Table 1 Cleanup and Screening Levels

Constitute	Indoor Air Cleanup Level Method B (µg/m³)	Sub-Slab Soil Gas SL Method B (µg/m³)
Vinyl chloride	0.28	9.33
Chloroethane	No Value Established	No Value Established
1,1-Dichloroethene	91.43	3047.62
trans-1,2-Dichloroethene	No Value Established	No Value Established
1,1-Dichloroethane	1.56	52.08
cis-1,2-Dichloroethene	No Value Established	No Value Established
1,2-Dichloroethane	0.10	3.21
1,1,1-Trichloroethane	2285.71	76190.48
Trichloroethene	0.37	12.33
1,1,2-Trichloroethane	0.09	3.05
Tetrachloroethene	9.62	320.51

Notes:
Cleanup and screening levels (SL) are From CLARC, January 19 2018.
ug/m^3 = microgram per cubic meter

2.1 Sub-Slab Probe Installation

The sub-slab soil vapor sampling was completed by coring a hole through the building's concrete floor slab, inserting a sample collection device ('probe'), and sealing the hole around the sample collection device so that ambient air cannot enter the subsurface.

Sample probes were installed as permeant sample locations so that future samples could be collected. The AMS Sampler sub-slab gas vapor probe sample kit included stainless steel sample probe, plugs, covers, and ports. Prior to installing the probes, the sample areas were screened for utility conflicts. Once the location was cleared of utility conflicts, the probe was installed by advancing a 1-inch diameter core directly through the building floor slab. To create sufficient space for the probe to be installed below the concrete slab, a handheld rotary hammer style drill was used to drill into the sub-slab backfill. Immediately following coring and drilling, the sample probe was installed. The sample probe was installed with a stopper (Teflon and clay) to ensure that the porous sampling tip extended at least 1 to 2 inches below the slab. The void space above the stopper and around the sampling probe was backfilled with quick setting anchoring cement. Sub slab sampler installation was conducted following Ecology VI guidance.

Four sub-slab sample probes were installed on December 28, 2017. Installation was scheduled after normal working hours to ensure that the locations were undisturbed as the concrete set.

2.2 Sampling Procedures

2.2.1 Sub-Slab Soil Gas

The sub-slab sample points were left undisturbed for more than 24 hours to allow the cement to fully set and also to allow for the soil vapor to equilibrate (guidance suggests a minimum of 2 hours for equilibration, EPA 2012). Prior to sampling, the lids were removed and replaced with the stainless steel sample port.

Each sub-slab sample was collected in a 1-liter (L) Summa (vacuum) canister fitted with a flow controller. The flow controller was calibrated by the laboratory to a flow rate not to exceed 200 milliliters per minute. The summa canister was connected to the sample port in a sample train; a typical sample train is shown on Figure 2. The tubing and fittings for the sample train were provided by the laboratory and were dedicated for each location. Leak test procedures were implemented as part of the sub-slab soil gas sampling to check for potential ambient air leaks that could compromise soil-gas sample results. Leak testing included a shut-in test to ensure that pressure was maintained in the sample train. Prior to sampling, purging was completed to remove approximately three volumes of air from the soil-gas sampling port and sampling line using a flow rate of 200 mL/min. Once purging was completed, sampling was conducted.

Figure 2 Typical Sub-Slab Sample Train

2.2.2 Indoor and Ambient Air Samples

Indoor and ambient air samples were collected over 8 hours so that a time weighted average sample could be collected. Samples were collected using an integrated passive air sampler consisting of a 6-L laboratory-certified evacuated Summa canister. Each Summa canister was equipped with a pressure gauge and a calibrated critical orifice air flow controller, all supplied by the laboratory. Indoor air samples were collected near the location of the four sub-slab sample probes plus two additional locations (Figure 1). Canister inlet valve heights for indoor air samples were set to be approximately at the breathing zone of an office worker. Ambient samples were set at the two main entrances to the building, on the north and south sides, as shown on Figure 1.

2.2.3 Sample Analysis

Sub-slab soil gas samples were collected with 1-liter (L) Summa (vacuum) canisters fitted with flow controllers calibrated by the laboratory to a flow rate not to exceed 200 milliliters per minute. Time-weighted average indoor air and ambient air samples were collected with 6-L Summa canisters fitted with 8-hour flow controllers. The samples were submitted to Friedman and Bruya analytical laboratory (Seattle, WA) to measure the concentrations of chlorinated VOCs using EPA Method TO-15 (sub-slab soil gas samples) and EPA Method TO-15 low-level (indoor air and ambient air samples).

2.3 Sample Results

Sample locations are shown on Figure 1 and sample results are summarized on Tables 2 through 4 below. Copies of laboratory data reports are included in Appendix B.

(PCE) was the only constituent detected in indoor, ambient air, or soil gas samples collected from the building. PCE concentrations were below Ecology cleanup levels (indoor air MTCA Method B) and screening levels (soil gas draft screening levels).

Two ambient samples were placed on the northeast and southwest sides of the building, opposite the main entrance and exit doors for the building (Figure 1). Figure 3 shows the wind rose generated from the metrological data for December 30, 2017 during the sampling period (NOAA station TCMW1-9446482). The wind was primarily blowing from the southwest during the sampling period. Ambient 01 represents the upwind sample and Ambient 02 represents the downwind sample. PCE was detected in the upwind sample (Ambient-01, Table 3) at a concentration higher than what was measured in the indoor air samples (Table 2).

One field duplicate was collected from indoor air sample location 04, shown on Table 5. No field or laboratory data quality concerns were identified with the data set.

Table 2 Sub-Slab Sample Results

Constitute	Subslab-01	Subslab-02	Subslab-03	Subslab-04	Sub-Slab Soil Gas SL Method B (µg/m³)
	12/30/17	12/30/17	12/30/17	12/30/17	
	µg/m³	µg/m³	µg/m³	µg/m³	
Vinyl chloride	2.6 U	2.6 U	2.6 U	2.6 U	9.33
Chloroethane	2.6 U	2.6 U	2.6 U	2.6 U	No Value
1,1-Dichloroethene	4 U	4 U	4 U	4 U	3047.62
trans-1,2-Dichloroethene	4 U	4 U	4 U	4 U	No Value
1,1-Dichloroethane	4 U	4 U	4 U	4 U	52.08
cis-1,2-Dichloroethene	4 U	4 U	4 U	4 U	No Value
1,2-Dichloroethane	4 U	4 U	4 U	4 U	3.21
1,1,1-Trichloroethane	5.5 U	5.5 U	5.5 U	5.5 U	76190.48
Trichloroethene	5.4 U	5.4 U	5.4 U	5.4 U	12.33
1,1,2-Trichloroethane	5.5 U	5.5 U	5.5 U	5.5 U	3.05
Tetrachloroethene	6.8 U	6.8 U	6.8 U	**11**	320.51

Notes:
Bold = detection
U = not detected above the lab reporting limit
ug/m^3 = microgram per cubic meter
SL = MTCA draft screening level

Table 3 Indoor Air Sample Results

Constitute	Indoor-01	Indoor-02	Indoor-03	Indoor-04	Indoor-05	Indoor-06	Indoor Air CUL (µg/m³)
	12/30/17	12/30/17	12/30/17	12/30/17	12/30/17	12/30/17	
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	
Vinyl chloride	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.28
Chloroethane	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	No Value
1,1-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	91.43
trans-1,2-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	No Value
1,1-Dichloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	1.56
cis-1,2-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	No Value
1,2-Dichloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.10
1,1,1-Trichloroethane	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	2285.71
Trichloroethene	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.37
1,1,2-Trichloroethane	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.09
Tetrachloroethene	0.34 U	**0.34**	**0.34**	**0.34**	0.34 U	0.34 U	9.62

Notes:
Bold = detection
U = not detected above the lab reporting limit
ug/m^3 = microgram per cubic meter
CUL = Indoor Air Cleanup Level – MTCA Method B
Indoor Air sample results presented in this table have not been adjusted or modified by the VOCs detected in Ambient air samples.

Table 4 Ambient Air Sample Results

Constitute	Ambient-01	Ambient-02	Indoor Air CUL (µg/m³)
	12/30/17	12/30/17	
	µg/m³	µg/m³	
Vinyl chloride	0.13 U	0.13 U	0.28
Chloroethane	0.13 U	0.13 U	No Value
1,1-Dichloroethene	0.2 U	0.2 U	91.43
trans-1,2-Dichloroethene	0.2 U	0.2 U	No Value
1,1-Dichloroethane	0.2 U	0.2 U	1.56
cis-1,2-Dichloroethene	0.2 U	0.2 U	No Value
1,2-Dichloroethane	0.2 U	0.2 U	0.10
1,1,1-Trichloroethane	0.27 U	0.27 U	2285.71
Trichloroethene	0.27 U	0.27 U	0.37
1,1,2-Trichloroethane	0.27 U	0.27 U	0.09
Tetrachloroethene	**1.3**	0.34 U	9.62

Notes:
Bold = detection
U = not detected above the lab reporting limit
ug/m^3 = microgram per cubic meter
CUL = Indoor Air Cleanup Level – MTCA Method B

Table 5 Quality Control Sample Results

	Indoor-04	Duplicate (Parent Sample Indoor-04)
	12/30/17	12/30/17
	µg/m³	µg/m³
Vinyl chloride	0.13 U	0.13 U
Chloroethane	0.13 U	0.13 U
1,1-Dichloroethene	0.2 U	0.2 U
trans-1,2-Dichloroethene	0.2 U	0.2 U
1,1-Dichloroethane	0.2 U	0.2 U
cis-1,2-Dichloroethene	0.2 U	0.2 U
1,2-Dichloroethane	0.2 U	0.2 U
1,1,1-Trichloroethane	0.27 U	0.27 U
Trichloroethene	0.27 U	0.27 U
1,1,2-Trichloroethane	0.27 U	0.27 U
Tetrachloroethene	**0.34**	0.34 U

Notes:
Bold = detection
U = not detected above the lab reporting limit
ug/m^3 = microgram per cubic meter

3 Conclusions

A Tier I site assessment using existing groundwater data (from the MW-15 and MW-17) indicated that vinyl chloride had been detected above the MTCA groundwater screening level for protection of indoor air (0.35 micrograms per liter [µg/l]) in groundwater samples. Measured vinyl chloride concentrations in groundwater ranged between 130 and 180 µg/l in MW-17 (2012 and 2014) and between 51 and 290 µg/l in MW-15 (2010, 2012, and 2014). The Tier II vapor intrusion assessments included the collection of sub-slab, ambient, and indoor air samples. Vinyl chloride was not detected above laboratory reporting limits in any samples. PCE was detected in 1 sub-slab sample and in indoor and ambient air samples. The PCE results do not exceed the indoor air cleanup levels for Method B residential use or the sub-slab vapor screening levels.

Two ambient samples were collected upwind and downwind of the building. PCE was detected in the upwind sample (Ambient-01, Table 3) at a concentration higher than what was measured in the indoor air samples. Ecology's VI guidance suggests that, when this is the case, it should be assumed that "vapor intrusion is unlikely to be significantly impacting indoor air quality. In this situation, the ambient contribution to the indoor air concentration is probably close to 100%" (Ecology 2016). The PCE detected in indoor air samples is likely from the ambient (outside) air and not from other sources.

Based on the results summarized in this report, no vapor mitigation is necessary to reduce worker exposure and no additional indoor air sampling is recommended.

4 References

EPA 2012. Advisory – Active Soil Gas Investigations. Department of Toxic Substances Control, Los Angeles Regional Water Quality Control Board, San Francisco Regional Water Quality Control Board. California Environmental Protection Agency. April 2012.

Ecology 2016. Ecology's Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State, revised February 2016.

Figures

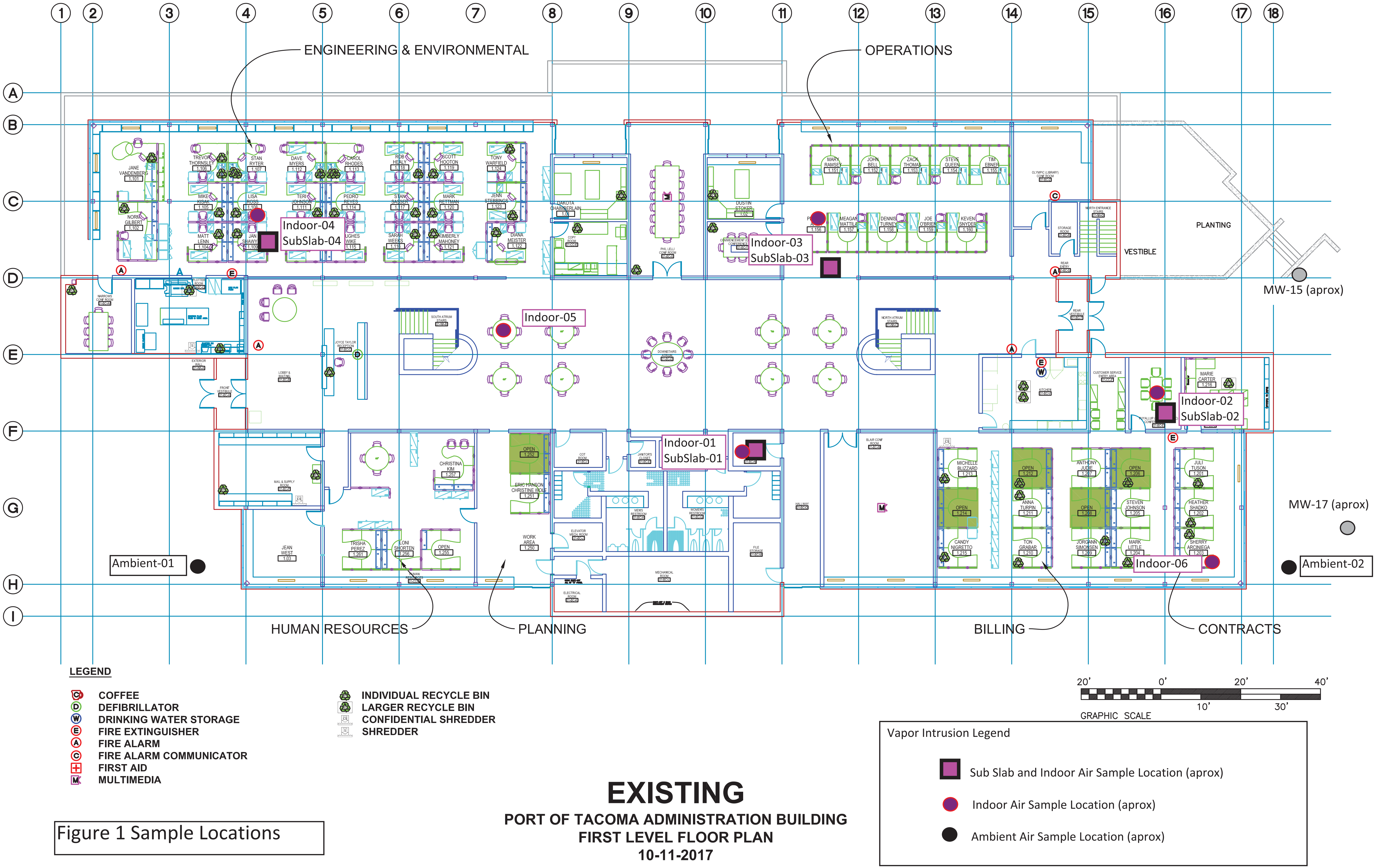


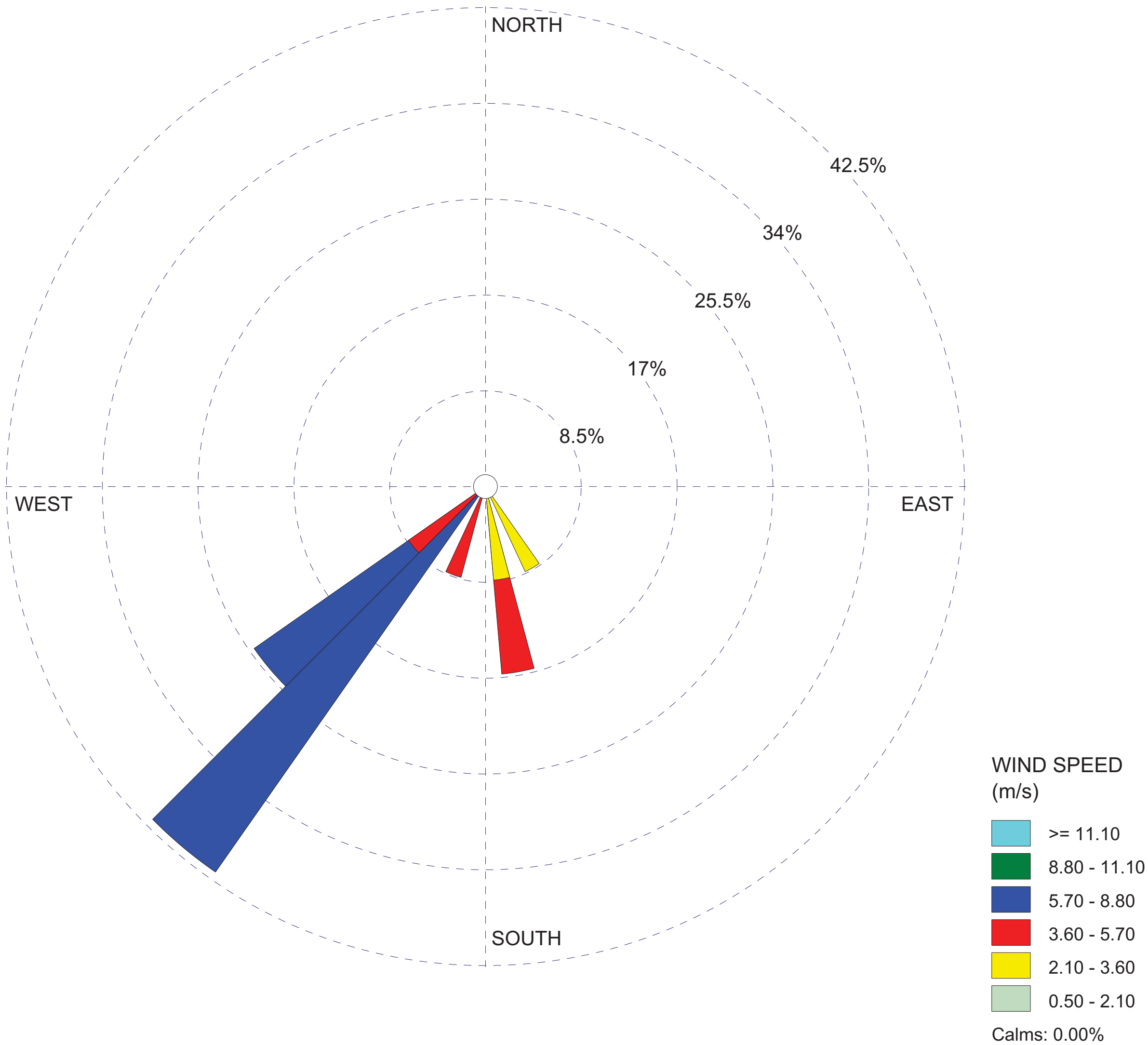
Figure 1 Sample Locations

WIND ROSE PLOT:

Station #94464
NOAA TCMW1 (47.276N 122.418W)

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 12/30/2017 - 06:00 **End Date: 12/30/2017 - 17:00**	CRETE Consulting	
		MODELER: J.Stevens	
	CALM WINDS: **0.00%**	TOTAL COUNT: **12 hrs.**	
	AVG. WIND SPEED: **5.70 m/s**	DATE: **1/23/2018**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

Figure 3 Tacoma WA Wind Direction and Speed December 30 2017

Appendix A

Field Forms, Photographic Log and Standard Operating Procedures

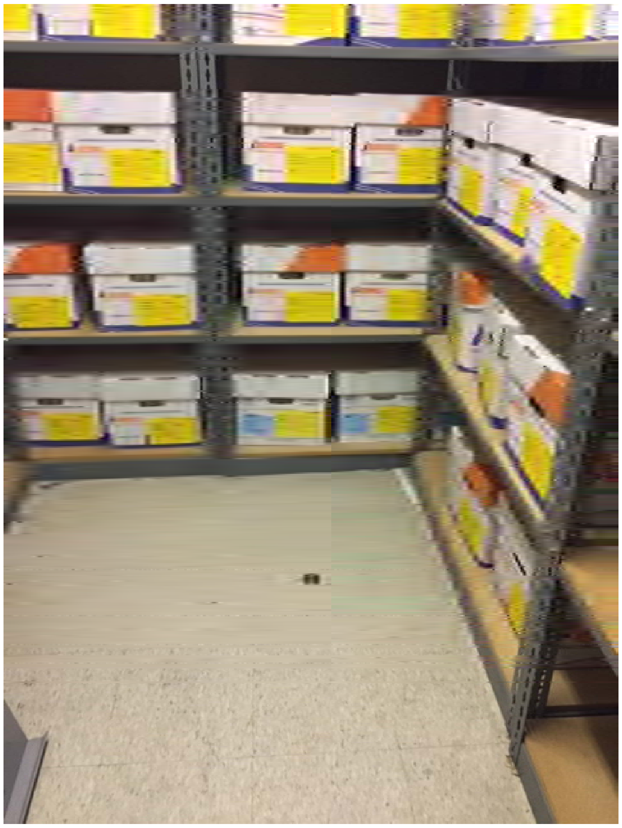


Photo 1 - Sub Slab -1

Photos 2 and 3: Sub Slab-2, yellow flag denotes carpet tile above location.

Photos 4 and 5: Sub Slab-3, yellow flag denotes carpet tile above location.

Photos 6 and 7: Sub Slab-4, yellow flag denotes carpet tile above location.

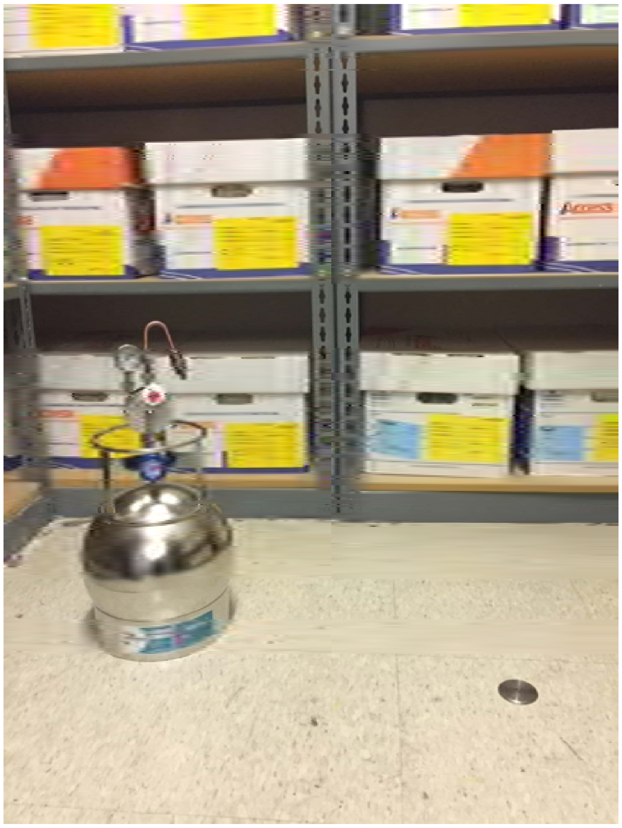


Photo 8: Indoor Air -1

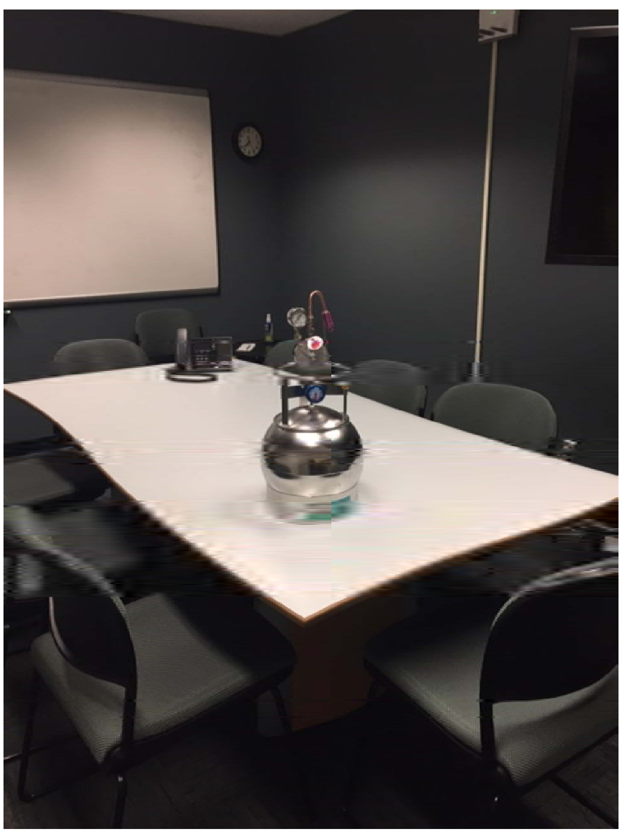


Photo 9: Indoor Air -2

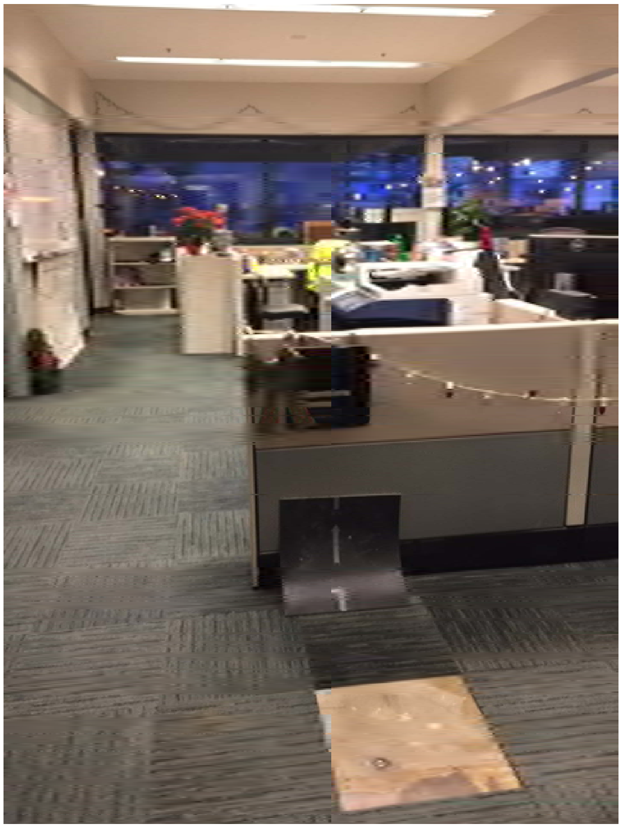


Photo 10: Indoor Air -3 (on table by copier machine)

Photo 11: Indoor Air -4 and Duplicate

Photo 12: Indoor Air -5

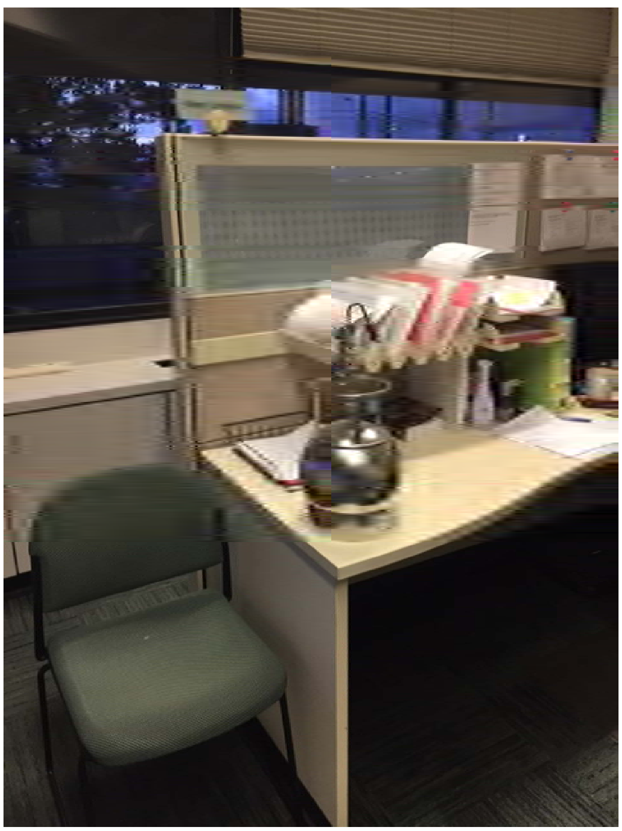


Photo 13: Indoor Air -6


Photo 15: Ambient 1 (south side of building, in the planter)


Photo 16: Ambient 1 (north-east side of the buliding, eastern most planter near the exit gate)

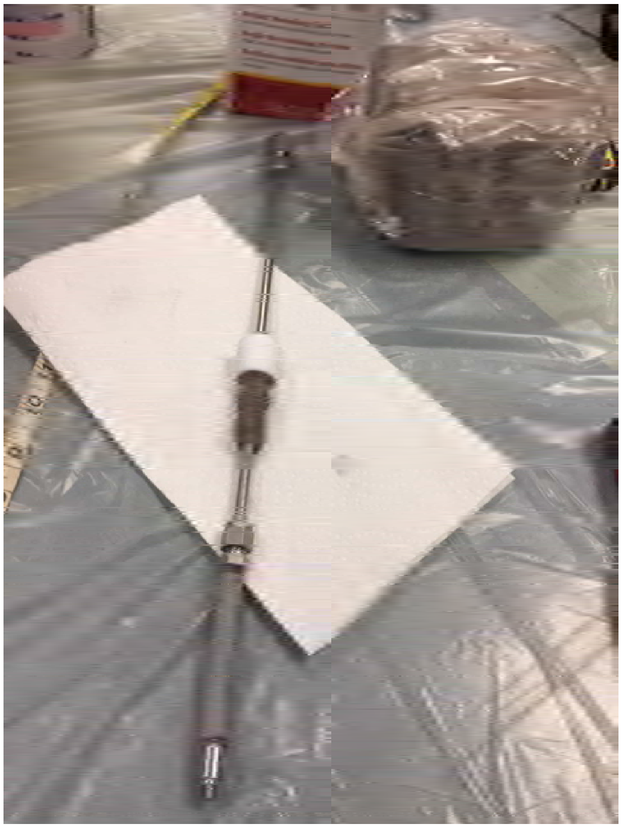


Photo 18: Tpyical sample probe with plug.


Photo 19: Typical sub-slab soil gas sample set up

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Ambient/Indoor Air Sampling - Field Form			
Project	Port of Tacoma VI Assessment, Administration Building		
Sampler	Jamie Stevens		
Date and Start Time	12/30/17		
Date and End Time	12/30/17		
Weather	Clear, mid 40's		

Canister/ Location ID		Start Time		Start Pressure (in Hg)	
Canister/ Location ID	Ambient-01 #20545 main entrance, south side	Start Time	7:05	Start Pressure (in Hg)	28.5
Canister/ Location ID	Ambient-02 # 18570	Start Time	7:09	Start Pressure (in Hg)	30+
Canister/ Location ID	Indoor-01 # ~~23229~~ 20547 sub-slab 1 colocation	Start Time	7:35	Start Pressure (in Hg)	29
Canister/ Location ID	Indoor-02 ~~18576~~ 21453 sub-slab2 colocation	Start Time	7:37	Start Pressure (in Hg)	30
Canister/ Location ID	Indoor-03 #21440 sub-slab3 colocation	Start Time	7:33	Start Pressure (in Hg)	+30
Canister/ Location ID	Indoor-04 #18576 Duplicate #23229 sub-slab 4 colocation	Start Time	7:30 7:30	Start Pressure (in Hg)	+30 +30
Canister/ Location ID	Indoor-05 # 23227 common area	Start Time	7:25	Start Pressure (in Hg)	+30
Canister/ Location ID	Indoor-06 # 20555 office cubical	Start Time	7:39	Start Pressure (in Hg)	+30

Time	Ambient 01	Ambient ~~01~~ 02	Indoor-01	Indoor -02	Indoor -03	Indoor - 04	Indoor -05	Indoor -06	Duplicate
8:15	26	28	26.5	28	28	28	28.5	28	28
9:45	21	24	22	24	22	23	24	24	24
11:26	16.5	17	17	18.5	16	17.5	19	19	18
12:39	12.5	14	12.5	14.5	11	14	15	15	14
14:05	8	10	9	11	7	10	11	11	10
Final Time	15:08	15:10	15:04	15:11	14:41	15:15	15:17	15:13	15:15
Final pressure	6 in Hg	7	6	8	5	7	8	8	7

Notes

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Soil Vapor Sampling - Field Form	
Project	Port of Tacoma VI Assessment, Administration Building
Sampler	Jamie Stevens
Date and Start Time	12/30/17 0821
Date and End Time	12/30/17 ~~0821~~ 0920
Weather (attach copies of detailed weather reports)	Clear, mid 40's

Location ID	Sub-slab 01 can id # 07						
Surface Conditions	closet, vinyl tile						
Start Sample Time	9:18	Start Pressure (" Hg)	29	End Sample Time	9:20	End Pressure (" Hg)	5
Analysis	TO-15 Full VOC						

Purging Volumes and Purge Time

Purge Vol (ml)	3000 ml	Purge Rate (ml/min)	200	Time Required	15 min

start purge = 9:00

Purge Readings

	Time	9:05	9:10	9:15					
PID	PPM	0	0	0.1					
Methane (CH4)	% Vol	0	0	0					
Helium (He)	PPM	–	–	–					
Oxygen	% Vol	20.9	20.9	20.9					
LEL	% Vol	0	0	0					
CO	% Vol	0	0	0					
Helium in the shroud	PPM	–	–	–					

Shut-In Testing (minimum duration 5 minutes, system should maintain >10" of vacuum)

Start Time	8:39	End Time	8:46
Start Pressure (" Hg)	28.5	End Pressure (" Hg)	28.5

- Helium in the shroud shall be maintained between 10-20 percent
- If methane is above LEL, sorbent tube sampling is required. Methane LEL is 5%, the UEL is 15%

- purge volume assumes 3 volumes removed.
- Helium detector not working. Helium pumped into shroud till shroud puffed out due to pressure

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Soil Vapor Sampling - Field Form	
Project	Port of Tacoma VI Assessment, Administration Building
Sampler	Jamie Stevens
Date and Start Time	12/30/17 0935
Date and End Time	12/30/17 10:13
Weather (attach copies of detailed weather reports)	Clear, mid 40's

Location ID	sub. slab 02 # 201						
Surface Conditions	conference room						
Start Sample Time	10:09	Start Pressure (" Hg)	29	End Sample Time	10:13	End Pressure (" Hg)	5
Analysis	TO-15 Full VOC						

Purging Volumes and Purge Time

Purge Vol (ml)	3000ml	Purge Rate (ml/min)	200	Time Required	15

start purge = 9:52

Purge Readings

	Time	9:55	10:00	10:05					
PID	PPM	0	0.2	0.3					
Methane (CH4)	% Vol	0	0	0					
Helium (He)	PPM	–	–	–					
Oxygen	% Vol	0	0	0					
LEL	% Vol	0	0	0					
CO	% Vol	20.8	20.8	20.8					
Helium in the shroud	PPM	–	–	–					

Shut-In Testing (minimum duration 5 minutes, system should maintain >10" of vacuum)

Start Time	9:45	End Time	9:52
Start Pressure (" Hg)	10	End Pressure (" Hg)	10

- Helium in the shroud shall be maintained between 10-20 percent
- If methane is above LEL, sorbent tube sampling is required. Methane LEL is 5%, the UEL is 15%

3 pore volumes removed
helium meter not working

CRETE CONSULTING, INC.

Soil Vapor Sampling - Field Form	
Project	Port of Tacoma VI Assessment, Administration Building
Sampler	Jamie Stevens
Date and Start Time	12/30/17 10:20
Date and End Time	12/30/17 10:58
Weather (attach copies of detailed weather reports)	Clear, mid 40's

Location ID	Sub. slab. 03 #203						
Surface Conditions	by operations station						
Start Sample Time	10:52	Start Pressure (" Hg)	30	End Sample Time	10:58	End Pressure (" Hg)	5
Analysis	TO-15 Full VOC						

Purging Volumes and Purge Time

Purge Vol (ml)	3000 ml	Purge Rate (ml/min)	200	Time Required	15

start purge = 10:38

Purge Readings

	Time	10:40	10:45	10:50				
PID	PPM	0	0	0				
Methane (CH4)	% Vol	0	0	0				
Helium (He)	PPM	—	—	—				
Oxygen	% Vol	20.8	20.9	20.9				
LEL	% Vol	0	0	0				
CO	% Vol	0	0	0				
Helium in the shroud	PPM	—	—	—				

Shut-In Testing (minimum duration 5 minutes, system should maintain >10" of vacuum)

Start Time	10:31	End Time	10:36
Start Pressure (" Hg)	28	End Pressure (" Hg)	28

- Helium in the shroud shall be maintained between 10-20 percent
- If methane is above LEL, sorbent tube sampling is required. Methane LEL is 5%, the UEL is 15%

3 pore volumes removed
helium meter not working

CRETE
CONSULTING, INC.

Soil Vapor Sampling - Field Form

Project	Port of Tacoma VI Assessment, Administration Building
Sampler	Jamie Stevens
Date and Start Time	12/30/17 10:05
Date and End Time	12/30/17 11:51
Weather (attach copies of detailed weather reports)	Clear, mid 40's

Location ID	Subslab.04						
Surface Conditions	near Jai's office						
Start Sample Time	11:45	Start Pressure (" Hg)	29.0	End Sample Time	11:45	End Pressure (" Hg)	5.0
Analysis	TO-15 Full VOC						

Purging Volumes and Purge Time

Purge Vol (ml)	3000 ml	Purge Rate (ml/min)	200	Time Required	15

start purge 11:26

Purge Readings

	Time	11:28	11:33	11:38	11:42				
PID	PPM	0.3	0.3	0.2	0.2				
Methane (CH4)	% Vol	0	0	0	0				
Helium (He)	PPM	–	–	–	–				
Oxygen	% Vol	20.9	20.9	20.9	20.9				
LEL	% Vol	0	0	0	0				
CO	% Vol	0	0	0	0				
Helium in the shroud	PPM	–	–	–	–				

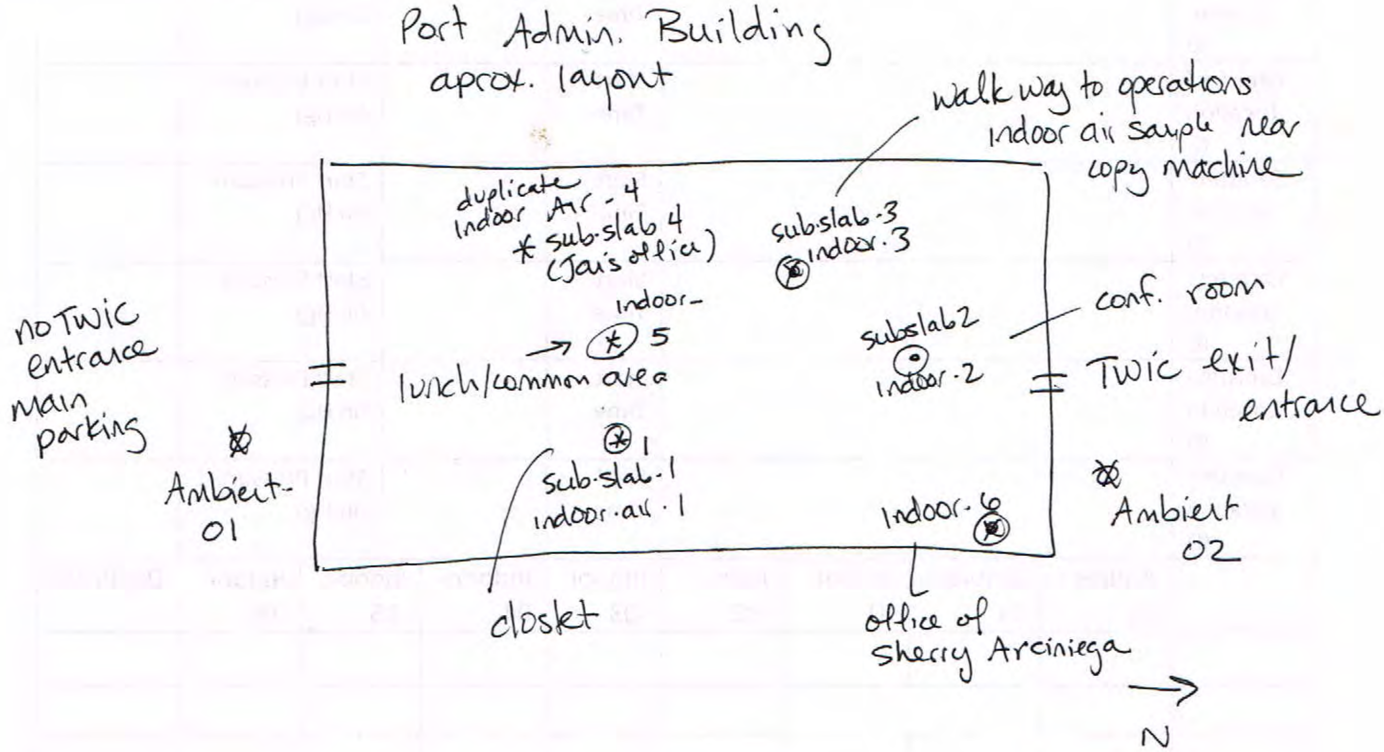
Shut-In Testing (minimum duration 5 minutes, system should maintain >10" of vacuum)

Start Time	11:21	End Time	11:26
Start Pressure (" Hg)	26.5	End Pressure (" Hg)	26.5

- Helium in the shroud shall be maintained between 10-20 percent
- If methane is above LEL, sorbent tube sampling is required. Methane LEL is 5%, the UEL is 15%

3 pore volumes removed
helium meter not working.

Dec 30, 2017
Port of Tacoma VI Sampling
Sample layout



Station TCMW1 - 9446482 - T acoma Met, W A

Owned and maintained by NOAA's National Ocean Service (http://tidesandcurrents.noaa.gov/)
47.276 N 122.418 W (47°16'33" N 122°25'4" W)

Historical data for station TCMW1 available from NDBC include:

- Quality contr olled data for 2017 (data descriptions)
  - Standard meteor ological data: Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
- Historical data (data descriptions)
  - Standard meteor ological data: 2009 2010 2011 2012 2013 2014 2015 2016
- Sear ch historical meteor ological data for observations that meet your thr eshold conditions
- Climatic summary table (TXT) and plots of (description of tables and plots)
  - wind speed
  - wind gust

Other Available Historical Data

For data before the dates listed above, go to the National Ocean Service's Meteorological Observations page for this station by clicking here:
http://tidesandcurr ents.noaa.gov/stationhome.html?id=9446482
(http://tidesandcurrents.noaa.gov/stationhome.html?id=9446482)

Some data files have been compressed with the GNU gzip program.

View Station Page
View Real T ime Data

1 INTRODUCTION

The purpose of this SOP is to provide field personnel with an outline of the specific information needed to collect and document representative subsurface soil vapor samples. The recommended soil vapor sampling technique, as presented in this SOP, is based on the assumption that soil vapor samples should be representative of chemicals that may volatilize from the uppermost aquifer into the vadose zone or from soil contamination within the vadose zone.

This SOP includes Sub Slab Soil Vapor and soil vapor from established monitoring points. A typical sampling set up is shown on Figure 1.

2 Sampling Equipment and Materials

The following equipment and materials are necessary to properly soil vapor sampling from an established sampling point:

- Sample port connector and tamper resistant lid screwdriver (if a tamper resistant lid is on the soil gas sample port)
- Summa canister sample manifold kit provided by laboratory
- Air pump and appropriate connection tubing, tee fittings, valves, and flow metering device for purging and sampling vapor ports.
- 1-liter Tedlar® bags to collect purged vapors if venting is not used.
- Sufficient number of Summa canisters and appropriate flow controllers to collect samples per the sampling and analysis plan.
- Equipment required for collection of samples using Summa canisters, including appropriate wrenches and pressure gauges.
- An accurate and reliable watch that has been properly set.
- A calculator.
- Field notebook, applicable sampling analysis plan, and Chain of Custody.
- Health-and-safety equipment and supplies (e.g., personal protective equipment [PPE]) as described in the relevant site health-and-safety plan (HSP).
- Shipping package for the Summa canisters.
- Meters to measure for oxygen, carbon dioxide and methane (typically a landfill gas meter) and a PID meter (for volatile organic compounds).

When leak testing is required, additional equipment and materials include:

- Leak test shroud of sufficient size to cover soil gas vapor probe and sampling train (including Summa canister).
- A soft gasket to seal the leak test shroud to the floor.

- Tracer gas (helium), supplied in a 20 cubic foot gas cylinder with flow regulator (note, helium used for inflating balloons 'balloon grade' is not acceptable for leak testing as it may have inpurtities which can contaminate the soil gas sample).
- Flow regulator with 1/8-inch barbed outlet and tubing to connect the helium gas cylinder to the shroud.
- MGD-2002 helium meter or equivalent.

If the sample probe is not established you will all need the following equipment:

The following equipment and materials are necessary to conduct sub-slab soil vapor sampling:

Rotary hammer drill with a 1-inch and a 1/2-inch carbide tipped bit.

Extension cord and/or generator (if no power outlets are available).

- For the sample probe – Stainless Steel 3" (length) implant, Rubber Shaft Plug, Connectors, Top Plug, Hose B, Stainless Steel Tube 1/4" x 12" x 0.35" (the sample tube may need to be cut to length to fit the slab thickness)
- sealant, or suitable substitute, to seal vapor port borehole annulus.
- Concrete hole patch, to seal vapor port borehole annulus.

3 Sampling Procedure

3.1 Preparation

- Prior to beginning, clear sampling locations for utilities, verify access agreements are in place, and obtain required permits, as appropriate.
- Install sub-slab soil vapor sampling ports at locations described in the sampling and analysis plan as follows:
    - Drill a 1/2-inch borehole through the concrete floor of the building foundation to a depth of approximately 12-inches below the surface.
    - Over-drill a 1-inch borehole centered over the top of the 1/2-inch hole to a depth of approximately 3-inches. Construct the vapor point using the brass fittings and tubing described and insert in borehole. The vapor point should fit snug in the 1/2-inch borehole.
    - Seal the vapor port by installing approximately 1-inch of sealant above the vapor point and 2-inches of concrete patch flush to the floor surface to minimize short-circuiting.
    - Concrete should fully cure based on manufactures recommendations. Sufficient time should be allowed for soil gas to equilibrate.
- Assemble sampling train. The sampling train will be set up so that the Summa canister is in-line between the vapor port and the air pump, with a valve between the canister and the pump (see Figure 1 and Figure 2). Below are detailed manifold instructions specific to sample train manifolds provided by Friedman and Bruya laboratory in Seattle Washington. These general procedures would apply to most sample train configurations.

1. Attach a section of FEP tubing to the sample point
2. Attach the other end of the sample point tubing to a ¼ turn ball valve
3. Connect the FEP tubing to the vinyl tee using a 1”-2” piece of silicon tubing on each end of the tee. The FEP tubing should be pushed up against the sample tee.
4. Attach a piece of FEP tubing to the sample point ¼ turn valve, a second piece as the sample line and a third piece as the purge line
5. Attach a ¼ turn ball valve to the purge line
6. Make sure the cap is on the sample canister flow controller and quickly open and close the sample canister to measure the initial vacuum. The initial vacuum should read 30” of Hg. If the vacuum is below 25” of Hg, do not use – contact the laboratory (206)285-8282
7. Ensure the sample canister valve is closed and remove the flow controller end cap
8. Attach the sample line tubing to the flow controller on the canister using a ¼” nut and a PTFE ferrule. Do not open the sample canister.
9. Attach a pump or purge canister to the purge line ¼ turn valve using a short piece of FEP or other tubing
10. If using a purge can, attach with a ¼” nut and a PTFE ferrule

- Verify the Summa canister number engraved on the canister matches the number listed on the certified clean tag to insure proper decontamination of the canister was completed. Fill out the sample tag.
- Verify the canister valve is closed tightly and remove the threaded cap at the inlet of the canister.
- Attach the flow controller to the inlet of the canister, the flow controller will have a built in pressure gauge.
- Connect the Summa canister/flow controller to one outlet of the tee fitting.
- Connect air pump to the other outlet of the tee fitting, insert a 1/4-inch shutoff valve between the tee fitting and the air pump.

Leak Testing

Where leak testing is required, a shroud will be placed over the vapor port and the Summa canister to keep tracer gas in contact with the vapor port and fittings.

The shroud consists of a plastic bin of a known volume. Two holes will be drilled near the top of the shroud, one for connection of the helium gas cylinder and one for connection of the air pump located outside the shroud. A third hole will be drilled near the base of the shroud to monitor the helium concentration inside during sampling.

3.2 Sampling Methodology Sample Collection

- Purge the vapor port and sampling train at approximately 100 ml/min using the air pump to ensure the sample is representative of subsurface conditions. Capture purged vapor in 1-liter Tedlar® bags at the outlet of the air pump and release the vapor outdoors or purge directly to a well vented location.

Volume of Tubing

Three-five tubing volumes should be removed. Use the following equation to calculate volume to be purged:

$V = \pi \times r^2 \times l$

Where:
V = Volume of tubing
r = the inner radius of the tubing being used [inches]
l = the length of the tubing being used [inches]
$\pi = 3.14$
(Convert to ml using 1-inch^3 = 16.387 ml to determine how long to purge port)

Volume and Purge Time for One Probe Volume

Three probe volumes should be removed Use the following equation to calculate the time required to purge one probe volume:

$$\frac{D^2 \times P_d \times 9.24}{P_r} = P_t$$

Where:
D = Diameter of probe, inches
P_d = Probe depth, feet
P_r = Pump rate, liters per minute
P_t = Purge time for one probe volume, seconds

- **Shut-In Test Procedure -** Shut-In Test procedures should be performed to ensure that there is no loss in the sample train. Below are detailed shut-in test procedures specific to sample train manifolds provided by Friedman and Bruya laboratory in Seattle Washington. These general procedures would apply to most sample train configurations.

1. Close the sample point ¼ turn valve
2. Open the purge line ¼ turn valve
3. Open the purge canister or turn on purge line pump until the vacuum gauge on the sample canister reads 10" of Hg or greater.
4. Close the purge line ¼ turn valve
5. Let the system sit at >10" of Hg vacuum for a minimum of 5 minutes.
6. The manifold is not leaking if the reading on the vacuum gauge is unchanged after a minimum of 5 minutes.

Sample Collection

- Begin sample collection by closing the 1/4-inch shutoff valve between the Summa canister and the air pump and opening the valve on the Summa canister. Immediately record the pressure on the gauge as the "initial pressure" on the tag attached to the canister. Document the time and initial vacuum on the COC
- After sampling begins and the apparatus is verified to be operating correctly, leave the canister to fill.
- Record all sample information in the field book and/or applicable field forms including the following:

- Canister number and sample identification, Sample start date and times, Location of sample (distance from walls shown on building floor plan), Initial and final pressure of canister, Notes regarding leak test, if applicable.
- Return to check canisters periodically (depending on length of sample period), to ensure proper operation. It is necessary to check the canister prior to completion because the accuracy of the flow regulators can vary, causing the canisters to fill faster than expected.
- The final pressure at the end of sampling should be approximately -5 to -6 inches mercury (Hg). If the canister has already reached this point, sampling is complete, the canister valve should be closed, and the pressure recorded as the "final pressure" on the sample tag, the field book, and applicable field forms. Sample collection will be considered complete, regardless of final pressure, after the stated sample period has elapsed. Sample until the vacuum gauge reads 5" of Hg
    - 1L samples will take ~5 minutes; 6L samples will take ~30 minutes
- Record the exact pressure of the canister and time at the end of sampling on the sample tag for that canister, in the field book and on the applicable field forms.
- Verify that the canister valve is closed tightly, remove the flow controller, and replace the threaded cap at the top of the canister. Discard all sample tubing.
- Abandon vapor port by removing vapor screen and tubing, backfilling with glass bead, and patching with concrete.

Leak Testing

Before purging or sampling begins, place the leak test shroud over the vapor port/Summa canister sampling apparatus. The tubing from the tee connection above the canister will pass through the wall of the shroud to connect with the air pump outside.

Connect the helium cylinder to the leak test shroud using tubing from the flow regulator on the cylinder, through a hole in the wall of the shroud. Be sure to keep the cylinder in an upright position at all times.

Connect the helium meter to the leak test shroud using the hole near the base.

Use the flow regulator to slowly release helium into the leak test shroud until a predetermined concentration of helium is contained within the enclosed area. The helium concentration will be measured using the helium meter. Maintain helium concentrations throughout the sampling period by continuously bleeding cylinder gas into the shroud as needed.

Prior to collecting the canister sample, the vapor port will be purged as described in the previous section. Purged vapor contained in the Tedlar® bags will be field screened using the helium meter to ensure that the concentration of helium inside the bags is less than 5-percent of the shroud concentration. If leakage is detected, the vapor port seal will be enhanced and connections will be inspected and tightened. This process will be repeated until no significant leakage has been demonstrated.

After confirming no significant leakage, the 1/4-inch shutoff valve between the Summa canister and the air pump will be closed and the canister valve will be opened to begin collecting the sample.

3.3 Post-Sample Collection Procedures

Label all sample containers with the following information: sample identification, date and time sample was collected, the starting and ending canister pressure, the site name, and the company name. Include all this information in the field book plus the ending time of sample collection, and transfer pertinent information to the chain-of-custody record. Pack all Summa canisters in the original shipping containers, sealed with a custody seal, and send to the lab for analysis. The official holding time for this analysis is 30 days. However, attempt to get samples to the lab as soon as possible to allow lab time to conduct re-runs, dilutions, and low-level analyses, as necessary prior to sample expiration.

4 Analysis

The soil gas samples should be analyzed using EPA Methods TO-14 or TO-15, and when necessary/possible, low-level analysis or Selective Ion Mode (SIM) analysis to obtain the lowest achievable detection and reporting limits. Note the desired analytical methods on the Chain of Custody form, and be sure analysis for helium is specified for leak-tested samples. Additional analysis may be required based on the sampling program.

5 Decontamination

The equipment used for soil gas sampling does not require decontamination in the field. The Summa canisters will be individually cleaned and certified to 0.02 ppbv THC for the project-specific analyte list by the contract laboratory prior to shipment, or batch cleaned and certified. Sample manifold kits provided from the laboratory are decontaminated and purged for off-gassing. Insure that documentation of this certification is included on a tag attached to the canister and in the paperwork that accompanies the canister shipment from the lab.

6 Documentation

Record all field activities, environmental and building conditions, and sample documentation on the appropriate field forms and field notebook.

7 References

EPRI, Reference Handbook for Site Specific Assessment of Sub-Surface Vapor Intrusion to Indoor Air, March 2005.

Department of Environmental Protection, Commonwealth of Massachusetts, Indoor Air Sampling and Evaluation Guide, WSC Policy #02-430, Boston, Massachusetts, April 2002.

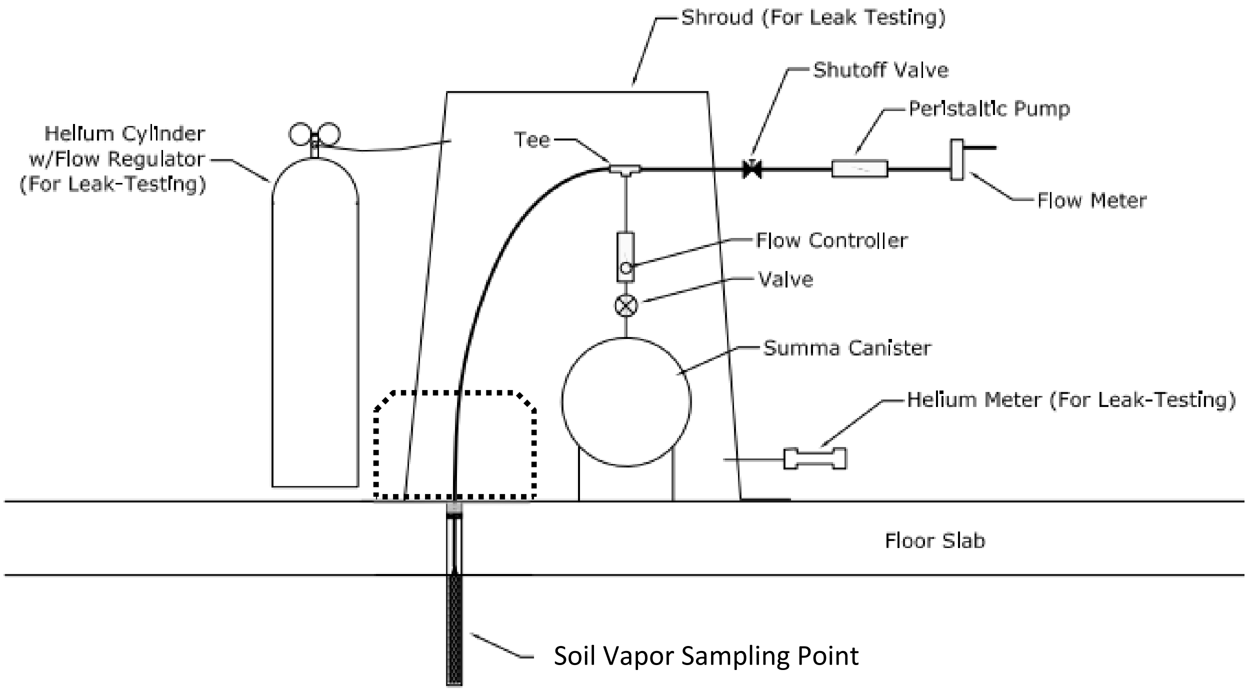
New Jersey Department of Environmental Protection, Vapor Intrusion Guidance, October 2005.

New York State Department of Health, Guidance for Evaluation Soil Vapor Intrusion in the State of New York, October 2006.

USEPA, Center for Environmental Research Information, Office of Research and Development, Compendium of Methods for Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method To-14A, Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Specially Prepared Canisters with Subsequent Analysis by Gas Chromatography, January 1999.

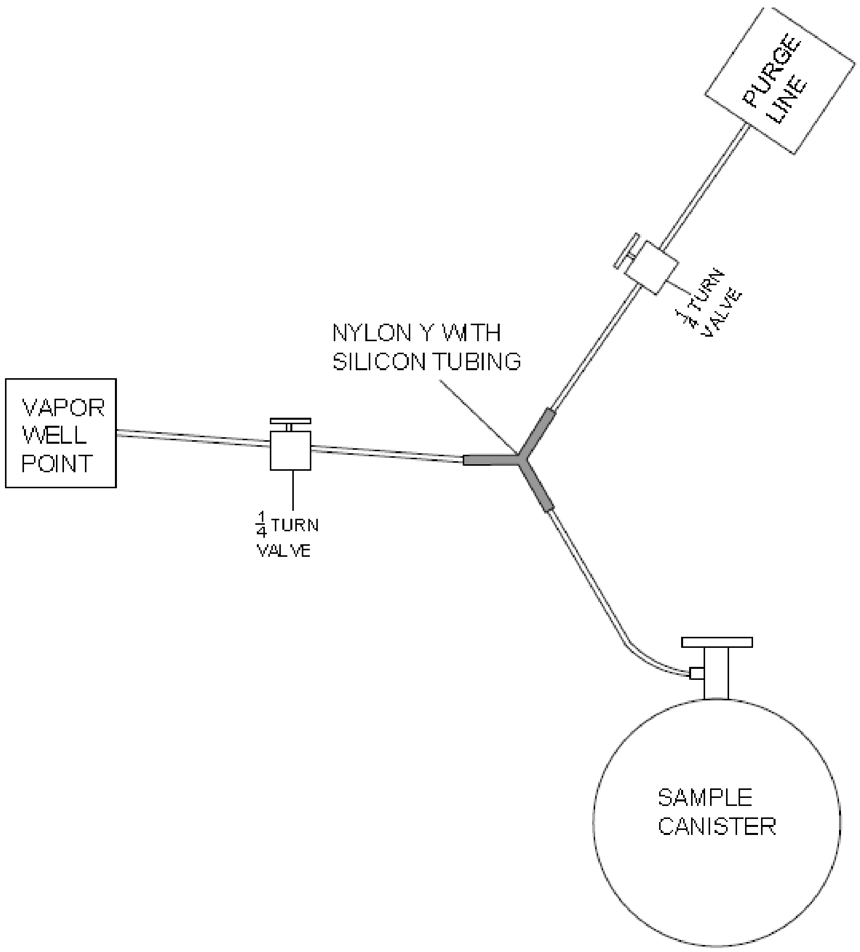
USEPA, Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway Form Groundwater and Soils, EPA530-F-02-052, November 2002.

Figure 1 – Typical Soil Vapor Sampling Train



Notes: Alternative shroud is shown as a dash line. A smaller shroud can be used around the surface of the sampling port.

Figure 2 – Typical Soil Vapor Sampling Train Layout



CRETE
CONSULTING, INC.

Ambient/Indoor Air Sampling - Field Form	
Project	Port of Tacoma VI Assessment, Administration Building
Sampler	Jamie Stevens
Date and Start Time	12/30/17
Date and End Time	12/30/17
Weather	Clear, mid 40's

Canister/ Location ID		Start Time		Start Pressure (in Hg)	
Canister/ Location ID		Start Time		Start Pressure (in Hg)	
Canister/ Location ID		Start Time		Start Pressure (in Hg)	
Canister/ Location ID		Start Time		Start Pressure (in Hg)	
Canister/ Location ID		Start Time		Start Pressure (in Hg)	
Canister/ Location ID		Start Time		Start Pressure (in Hg)	
Canister/ Location ID		Start Time		Start Pressure (in Hg)	
Canister/ Location ID		Start Time		Start Pressure (in Hg)	

	Ambient 01	Ambient 01	Indoor-01	Indoor -02	Indoor -03	Indoor - 04	Indoor -05	Indoor -06	Duplicate

Notes

CRETE CONSULTING, INC.

Soil Vapor Sampling - Field Form	
Project	Port of Tacoma VI Assessment, Administration Building
Sampler	Jamie Stevens
Date and Start Time	12/30/17
Date and End Time	12/30/17
Weather (attach copies of detailed weather reports)	Clear, mid 40's

Location ID							
Surface Conditions							
Start Sample Time		Start Pressure (" Hg)		End Sample Time		End Pressure (" Hg)	
Analysis	TO-15 Full VOC						

Purging Volumes and Purge Time

Purge Vol (ml)		Purge Rate (ml/min)		Time Required	

Purge Readings

	Time								
PID	PPM								
Methane (CH4)	% Vol								
Helium (He)	PPM								
Oxygen	% Vol								
LEL	% Vol								
CO	% Vol								
Helium in the shroud	PPM								

Shut-In Testing (minimum duration 5 minutes, system should maintain >10" of vacuum)

Start Time		End Time	
Start Pressure (" Hg)		End Pressure (" Hg)	

- Helium in the shroud shall be maintained between 10-20 percent
- If methane is above LEL, sorbent tube sampling is required. Methane LEL is 5%, the UEL is 15%

Appendix B

Laboratory Reports

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

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

3012 16th Avenue West
Seattle, WA 98119-2029
(206) 285-8282
fbi@isomedia.com
www.friedmanandbruya.com

January 9, 2018

Jamie Stevens, Project Manager
Crete Consulting
108 S. Washington St., Suite 300
Seattle, WA 98104

Dear Ms Stevens:

Included are the results from the testing of material submitted on January 2, 2018 from the 1940-Port of Tacoma, F&BI 801001 project. There are 19 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
CTC0109R.DOC

CASE NARRATIVE

This case narrative encompasses samples received on January 2, 2018 by Friedman & Bruya, Inc. from the Crete Consulting 1940-Port of Tacoma, F&BI 801001 project. Samples were logged in under the laboratory ID's listed below.

Laboratory ID	Crete Consulting
801001 -01	Subslab-01
801001 -02	Subslab-02
801001 -03	Subslab-03
801001 -04	Subslab-04
801001 -05	Ambient-01
801001 -06	Ambient-02
801001 -07	Indoor-01
801001 -08	Indoor-02
801001 -09	Indoor-03
801001 -10	Indoor-04
801001 -11	Indoor-05
801001 -12	Indoor-06
801001 -13	Indoor-duplicate

All quality control requirements were acceptable.

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Ambient-01	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-05 1/5
Date Analyzed:	01/03/18	Data File:	010310.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

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

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.13	<0.05
Chloroethane	<0.13	<0.05
1,1-Dichloroethene	<0.2	<0.05
trans-1,2-Dichloroethene	<0.2	<0.05
1,1-Dichloroethane	<0.2	<0.05
cis-1,2-Dichloroethene	<0.2	<0.05
1,2-Dichloroethane (EDC)	<0.2	<0.05
1,1,1-Trichloroethane	<0.27	<0.05
Trichloroethene	<0.27	<0.05
1,1,2-Trichloroethane	<0.27	<0.05
Tetrachloroethene	1.3	0.19

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Ambient-02	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-06 1/5
Date Analyzed:	01/03/18	Data File:	010311.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	96	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.13	<0.05
Chloroethane	<0.13	<0.05
1,1-Dichloroethene	<0.2	<0.05
trans-1,2-Dichloroethene	<0.2	<0.05
1,1-Dichloroethane	<0.2	<0.05
cis-1,2-Dichloroethene	<0.2	<0.05
1,2-Dichloroethane (EDC)	<0.2	<0.05
1,1,1-Trichloroethane	<0.27	<0.05
Trichloroethene	<0.27	<0.05
1,1,2-Trichloroethane	<0.27	<0.05
Tetrachloroethene	<0.34	<0.05

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Indoor-01	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-07 1/5
Date Analyzed:	01/03/18	Data File:	010312.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	98	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.13	<0.05
Chloroethane	<0.13	<0.05
1,1-Dichloroethene	<0.2	<0.05
trans-1,2-Dichloroethene	<0.2	<0.05
1,1-Dichloroethane	<0.2	<0.05
cis-1,2-Dichloroethene	<0.2	<0.05
1,2-Dichloroethane (EDC)	<0.2	<0.05
1,1,1-Trichloroethane	<0.27	<0.05
Trichloroethene	<0.27	<0.05
1,1,2-Trichloroethane	<0.27	<0.05
Tetrachloroethene	<0.34	<0.05

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Indoor-02	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-08 1/5
Date Analyzed:	01/03/18	Data File:	010313.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

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

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.13	<0.05
Chloroethane	<0.13	<0.05
1,1-Dichloroethene	<0.2	<0.05
trans-1,2-Dichloroethene	<0.2	<0.05
1,1-Dichloroethane	<0.2	<0.05
cis-1,2-Dichloroethene	<0.2	<0.05
1,2-Dichloroethane (EDC)	<0.2	<0.05
1,1,1-Trichloroethane	<0.27	<0.05
Trichloroethene	<0.27	<0.05
1,1,2-Trichloroethane	<0.27	<0.05
Tetrachloroethene	0.34	0.050

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Indoor-03	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-09 1/5
Date Analyzed:	01/03/18	Data File:	010314.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

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

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.13	<0.05
Chloroethane	<0.13	<0.05
1,1-Dichloroethene	<0.2	<0.05
trans-1,2-Dichloroethene	<0.2	<0.05
1,1-Dichloroethane	<0.2	<0.05
cis-1,2-Dichloroethene	<0.2	<0.05
1,2-Dichloroethane (EDC)	<0.2	<0.05
1,1,1-Trichloroethane	<0.27	<0.05
Trichloroethene	<0.27	<0.05
1,1,2-Trichloroethane	<0.27	<0.05
Tetrachloroethene	0.34	0.050

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Indoor-04	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-10 1/5
Date Analyzed:	01/03/18	Data File:	010315.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

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

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.13	<0.05
Chloroethane	<0.13	<0.05
1,1-Dichloroethene	<0.2	<0.05
trans-1,2-Dichloroethene	<0.2	<0.05
1,1-Dichloroethane	<0.2	<0.05
cis-1,2-Dichloroethene	<0.2	<0.05
1,2-Dichloroethane (EDC)	<0.2	<0.05
1,1,1-Trichloroethane	<0.27	<0.05
Trichloroethene	<0.27	<0.05
1,1,2-Trichloroethane	<0.27	<0.05
Tetrachloroethene	0.34	0.050

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Indoor-05	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-11 1/5
Date Analyzed:	01/03/18	Data File:	010316.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

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

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.13	<0.05
Chloroethane	<0.13	<0.05
1,1-Dichloroethene	<0.2	<0.05
trans-1,2-Dichloroethene	<0.2	<0.05
1,1-Dichloroethane	<0.2	<0.05
cis-1,2-Dichloroethene	<0.2	<0.05
1,2-Dichloroethane (EDC)	<0.2	<0.05
1,1,1-Trichloroethane	<0.27	<0.05
Trichloroethene	<0.27	<0.05
1,1,2-Trichloroethane	<0.27	<0.05
Tetrachloroethene	<0.34	<0.05

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Indoor-06	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-12 1/5
Date Analyzed:	01/03/18	Data File:	010317.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	100	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.13	<0.05
Chloroethane	<0.13	<0.05
1,1-Dichloroethene	<0.2	<0.05
trans-1,2-Dichloroethene	<0.2	<0.05
1,1-Dichloroethane	<0.2	<0.05
cis-1,2-Dichloroethene	<0.2	<0.05
1,2-Dichloroethane (EDC)	<0.2	<0.05
1,1,1-Trichloroethane	<0.27	<0.05
Trichloroethene	<0.27	<0.05
1,1,2-Trichloroethane	<0.27	<0.05
Tetrachloroethene	<0.34	<0.05

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Indoor-duplicate	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-13 1/5
Date Analyzed:	01/04/18	Data File:	010318.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	104	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.13	<0.05
Chloroethane	<0.13	<0.05
1,1-Dichloroethene	<0.2	<0.05
trans-1,2-Dichloroethene	<0.2	<0.05
1,1-Dichloroethane	<0.2	<0.05
cis-1,2-Dichloroethene	<0.2	<0.05
1,2-Dichloroethane (EDC)	<0.2	<0.05
1,1,1-Trichloroethane	<0.27	<0.05
Trichloroethene	<0.27	<0.05
1,1,2-Trichloroethane	<0.27	<0.05
Tetrachloroethene	<0.34	<0.05

Analysis For Volatile Compounds By Method TO-15 SIM

Client Sample ID:	Method Blank	Client:	Crete Consulting
Date Received:	Not Applicable	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	Not Applicable	Lab ID:	08-0039 mb
Date Analyzed:	01/03/18	Data File:	010309.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

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

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.026	<0.01
Chloroethane	<0.026	<0.01
1,1-Dichloroethene	<0.04	<0.01
trans-1,2-Dichloroethene	<0.04	<0.01
1,1-Dichloroethane	<0.04	<0.01
cis-1,2-Dichloroethene	<0.04	<0.01
1,2-Dichloroethane (EDC)	<0.04	<0.01
1,1,1-Trichloroethane	<0.055	<0.01
Trichloroethene	<0.054	<0.01
1,1,2-Trichloroethane	<0.055	<0.01
Tetrachloroethene	<0.068	<0.01

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	Subslab-01	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-01 1/10
Date Analyzed:	01/04/18	Data File:	010408.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

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

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<2.6	<1
Chloroethane	<2.6	<1
1,1-Dichloroethene	<4	<1
trans-1,2-Dichloroethene	<4	<1
1,1-Dichloroethane	<4	<1
cis-1,2-Dichloroethene	<4	<1
1,2-Dichloroethane (EDC)	<4	<1
1,1,1-Trichloroethane	<5.5	<1
Trichloroethene	<5.4	<1
1,1,2-Trichloroethane	<5.5	<1
Tetrachloroethene	<6.8	<1

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	Subslab-02	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-02 1/10
Date Analyzed:	01/04/18	Data File:	010409.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	94	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<2.6	<1
Chloroethane	<2.6	<1
1,1-Dichloroethene	<4	<1
trans-1,2-Dichloroethene	<4	<1
1,1-Dichloroethane	<4	<1
cis-1,2-Dichloroethene	<4	<1
1,2-Dichloroethane (EDC)	<4	<1
1,1,1-Trichloroethane	<5.5	<1
Trichloroethene	<5.4	<1
1,1,2-Trichloroethane	<5.5	<1
Tetrachloroethene	<6.8	<1

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	Subslab-03	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-03 1/10
Date Analyzed:	01/04/18	Data File:	010410.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	101	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<2.6	<1
Chloroethane	<2.6	<1
1,1-Dichloroethene	<4	<1
trans-1,2-Dichloroethene	<4	<1
1,1-Dichloroethane	<4	<1
cis-1,2-Dichloroethene	<4	<1
1,2-Dichloroethane (EDC)	<4	<1
1,1,1-Trichloroethane	<5.5	<1
Trichloroethene	<5.4	<1
1,1,2-Trichloroethane	<5.5	<1
Tetrachloroethene	<6.8	<1

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	Subslab-04	Client:	Crete Consulting
Date Received:	01/02/18	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	12/30/17	Lab ID:	801001-04 1/10
Date Analyzed:	01/04/18	Data File:	010411.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

Surrogates:	% Recovery:	Lower Limit:	Upper Limit:
4-Bromofluorobenzene	98	70	130

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<2.6	<1
Chloroethane	<2.6	<1
1,1-Dichloroethene	<4	<1
trans-1,2-Dichloroethene	<4	<1
1,1-Dichloroethane	<4	<1
cis-1,2-Dichloroethene	<4	<1
1,2-Dichloroethane (EDC)	<4	<1
1,1,1-Trichloroethane	<5.5	<1
Trichloroethene	<5.4	<1
1,1,2-Trichloroethane	<5.5	<1
Tetrachloroethene	11	1.7

Analysis For Volatile Compounds By Method TO-15

Client Sample ID:	Method Blank	Client:	Crete Consulting
Date Received:	Not Applicable	Project:	1940-Port of Tacoma, F&BI 801001
Date Collected:	Not Applicable	Lab ID:	08-0043 mb
Date Analyzed:	01/04/18	Data File:	010407.D
Matrix:	Air	Instrument:	GCMS7
Units:	ug/m3	Operator:	MP

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

Compounds:	Concentration ug/m3	ppbv
Vinyl chloride	<0.26	<0.1
Chloroethane	<0.26	<0.1
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)	<0.4	<0.1
1,1,1-Trichloroethane	<0.55	<0.1
Trichloroethene	<0.54	<0.1
1,1,2-Trichloroethane	<0.55	<0.1
Tetrachloroethene	<0.68	<0.1

Date of Report: 01/09/18
Date Received: 01/02/18
Project: 1940-Port of Tacoma, F&BI 801001

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

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Vinyl chloride	ppbv	1	98	70-130
Chloroethane	ppbv	1	93	70-130
1,1-Dichloroethene	ppbv	1	107	70-130
trans-1,2-Dichloroethene	ppbv	1	109	70-130
1,1-Dichloroethane	ppbv	1	108	70-130
cis-1,2-Dichloroethene	ppbv	1	106	70-130
1,2-Dichloroethane (EDC)	ppbv	1	110	70-130
1,1,1-Trichloroethane	ppbv	1	111	70-130
Trichloroethene	ppbv	1	108	70-130
1,1,2-Trichloroethane	ppbv	1	111	70-130
Tetrachloroethene	ppbv	1	106	70-130

Date of Report: 01/09/18
Date Received: 01/02/18
Project: 1940-Port of Tacoma, F&BI 801001

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

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Acceptance Criteria
Vinyl chloride	ppbv	10	114	70-130
Chloroethane	ppbv	10	95	70-130
1,1-Dichloroethene	ppbv	10	104	70-130
trans-1,2-Dichloroethene	ppbv	10	109	70-130
1,1-Dichloroethane	ppbv	10	119	70-130
cis-1,2-Dichloroethene	ppbv	10	114	70-130
1,2-Dichloroethane (EDC)	ppbv	10	115	70-130
1,1,1-Trichloroethane	ppbv	10	109	70-130
Trichloroethene	ppbv	10	112	70-130
1,1,2-Trichloroethane	ppbv	10	116	70-130
Tetrachloroethene	ppbv	10	101	70-130

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. 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 compound 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. Compounds in the sample matrix interfered with the quantitation of the analyte.

j - The analyte concentration is reported below the lowest calibration standard. 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.

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.

801001 [redacted]

SAMPLE CHAIN OF CUSTODY

ME 01/02/18 [redacted] Page # 1 of 2

Report To: Janie Stevens

Company: Crete Consulting

Address: 108 S. Washington St, Suite 300

City, State, ZIP: Seattle WA

Phone: 206-799-2744 Email: janie.stevens@creteconsulting.com

SAMPLERS (signature)	
J. Stevens	
PROJECT NAME	PO #
1940- Port of Tacoma	
REMARKS	INVOICE TO
	J. Stevens

TURNAROUND TIME
☒ Standard
☐ RUSH
Rush charges authorized by:

SAMPLE DISPOSAL
☐ Dispose after 30 days
☐ Archive Samples
☐ Other

ANALYSIS REQUESTED

Sample Name	Lab ID	Canister ID	Flow Contr. ID	Date Sampled	Field Initial Press. (Hg)	Field Initial Time	Field Final Press. (Hg)	Field Final Time	TO-15 Full Scan	TO-15 BTEXN	TO-15 cVOCs	TO-15 SIM cVOCs	Notes
Subslab-01	01	07		12/30	29	9:18	5	9:20			X		can # 202 not used.
Subslab-02	02	201		12/30	29.0	10:09	5	10:13			X		gauge seems off
Subslab-03	03	203		12/30	30.0	10:52	5	10:58			X		
Subslab-04	04	108		12/30	29.0	11:45	5	11:51			X		
Ambient-01	05	20545		12/30	28.5	7:05	6	15:08				X	
Ambient-02	06	18570		12/30	30	7:09	7	15:10				X	
Indoor-01	07	20547		12/30	29	7:35	6	15:04				X	
Indoor-02	08	21453		12/13	30	7:37	8	15:11				X	

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by: [signature]	Grant Hainsworth	CRETE	1/2/18	1330
Received by: [signature]	Matt Langston	FBI	1/2/18	1330
Relinquished by:				
Received by:		Samples received at 19 °C		

FORMS\COC\COCTO-15.DOC

801 001

SAMPLE CHAIN OF CUSTODY

ME 01/02/18

Page # 2 of 2

Report To: Janie Stevens

Company: Crek Consulting

Address: 108 S. Washington St, Suite 300

City, State, ZIP: Seattle WA

Phone: 206 799-2744 Email: janie.stevens@crekconsulting.com

SAMPLERS (signature): J. Stevens

PROJECT NAME: 1940-Port of Tacoma

PO #:

REMARKS:

INVOICE TO: J. Stevens

TURNAROUND TIME

☒ Standard
☐ RUSH
Rush charges authorized by:

SAMPLE DISPOSAL

☐ Dispose after 30 days
☐ Archive Samples
☐ Other

ANALYSIS REQUESTED

Sample Name	Lab ID	Canister ID	Flow Contr. ID	Date Sampled	Field Initial Press. (Hg)	Field Initial Time	Field Final Press. (Hg)	Field Final Time	TO-15 Full Scan	TO-15 BTEXN	TO-15 cVOCs	TO-15 cVOCs SIM	Notes
Indoor-03	09	21440		12/30	30	7:33	5	14:41				X	
Indoor-04	10	18576		↓	30	7:30	7	15:15				X	
Indoor-05	11	23227		↓	30	7:25	8	15:17				X	
Indoor-06	12	20555		↓	30	7:39	8	15:13				X	
Indoor-duplicate	13	23229		↓	30	7:30	7	15:15				X	

Samples received at 19 °C

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by: [signature]	Grant Hainsworth	CRETE	1/2/18	1330
Received by: [signature]	Matt Langston	FB Inc	1/2/18	1330
Relinquished by:				
Received by:				