Cascadia Associates, LLC

MEMORANDUM

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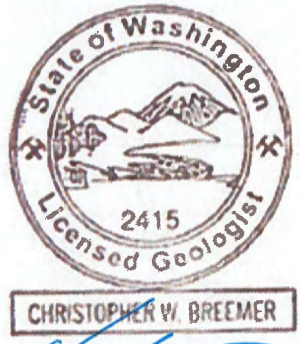
Date: March 13, 2018

Subject: NuStar Annex Terminal – Pilot Study Implementation



This Pilot Study Implementation Memorandum summarizes the field activities and observations made during implementation of the pilot study of injecting oxygen releasing compound and chemical oxidants to treat residual petroleum hydrocarbons at the NuStar Terminals Operations Partnership, L.P. (NuStar) Annex Terminal located at 5420 NW Fruit Valley Road, Vancouver, Washington (the Facility). The pilot study was completed in accordance with the Additional Investigation Summary Report and Pilot Study Work Plan (Apex, 2017; [Work Plan]), approved by Ecology on August 24, 2017, to assist in preparation of a Feasibility Study of remedial technologies for the Facility.

In a September 2016 meeting, Ecology stated that the Feasibility Study would need to evaluate active remediation to address petroleum hydrocarbons in groundwater near wells MW-5 and MW-6 based on the results from the additional groundwater investigations conducted from 2014 to 2016. As such, NuStar completed a preliminary review of possible remedial technologies and identified injection of oxygen releasing compound and/or *in-situ* chemical oxidation (ISCO) as possible alternatives. However, due to the presence of heavier hydrocarbons in the saturated soil and shallow groundwater, it was determined that a pilot test would be prudent to better evaluate the viability of this option prior to completing the Feasibility Study. In the Work Plan, NuStar proposed the use of RegenOx® (a proprietary ISCO substrate manufactured by Regenesis) and ORCAdvanced (an oxygen releasing formulation also manufactured by Regenesis) for the pilot study.

This memorandum documents the implementation of the Work Plan and presents the results of groundwater monitoring conducted directly before and one month following completion of the RegenOx® and ORCAdvanced injections. The groundwater monitoring event conducted prior to the injections is referred to as the baseline groundwater monitoring event herein; the groundwater monitoring event conducted one month following the injections was the first of four quarters of performance groundwater monitoring proposed in the approved Work Plan to assess the effectiveness of the injection of the RegenOx® and ORCAdvanced mixture.

The methods and procedures used for the pilot study are detailed below. A location map for the Facility is provided on Figure 1; a site plan is provided on Figure 2. A description of the site history and previous investigations is presented in the Additional Investigation Summary Report and Pilot Study Work Plan (Apex, 2017).

METHODS AND PROCEDURES FOR PILOT STUDY

The pilot study was implemented during October and November 2017 and included:

- Preparatory activities;
- Installation of monitoring well MW-5D;
- Conducting a baseline groundwater monitoring event;
- Completion of subsurface injections at 24 locations;
- Conducting the first of four quarterly post-injection performance groundwater monitoring events; and
- Surveying top-of-casing elevation of site monitoring wells.

A photograph log of the field activities is contained in Attachment A. The location of the pilot study area is shown on Figure 3 and the locations of the injection borings within the pilot study area are shown on Figure 4.

PREPATORY ACTIVITIES

Prior to pilot study field activities, the following tasks were completed:

- A site-specific health and safety plan was prepared.
- Obtained an Underground Injection Control (UIC) authorization from Ecology's Water Quality Department.
- The Washington Utility Notification Center was notified of the proposed work.
- The locations of monitoring well MW-5D and the 24 injection borings were identified and marked.
- The locations of subsurface utilities near the proposed borings were marked by a private utility locating contractor, Locates Down Under of Oregon City, Oregon. Because the pilot study area was located within a tank farm, a combination of electromagnetic and ground penetrating radar techniques were used to clear the pilot study area.
- Boring locations were physically cleared to a depth of 8 feet below the ground surface (bgs) using a hand-auger prior to advancing the borings to final depths via drilling equipment.

Monitoring Well Installation

Deeper well MW-5D was installed adjacent to shallow well MW-5 to assess the possible effect the injections have on deeper groundwater. Installation of monitoring well MW-5D was completed on October 20, 2017, using direct-push drilling equipment. The location of monitoring well MW-5D is shown on Figure 2.

Drilling Procedures

The boring was completed using Geoprobe 7720DT direct-push drilling equipment, owned and operated by Cascade Drilling of Clackamas, Oregon. Drilling equipment encountering soil and/or groundwater was decontaminated prior to use and after completion of the boring. The boring was advanced to a depth of 45 feet bgs. The lithology encountered is predominantly silt with some fine sand to a depth of about 22 feet bgs. Below approximately 22 feet bgs, the lithology transitioned to a fine to medium grained sand with varying amounts of silt. Groundwater was encountered at approximately 17.3 feet bgs in the boring.

The well was constructed in accordance with Washington Well Construction and Licensing System (WCLS) regulations and procedures and was installed under the oversight of a Washington Licensed Geologist.

A Cascadia field representative was present to observe and document drilling and sample collection procedures, perform field screening activities, and prepare a lithologic log for monitoring well MW-5D. The lithologic log, including field screening results, is included in Attachment B.

The well was constructed of 2-inch diameter schedule-40 PVC casing, with a screened interval of 0.01-inch slotted pre-packed PVC extending from 35 to 45 feet bgs. A 5-foot bentonite sleeve seal containing granular bentonite pre-packed around a section PVC well casing contained within a paper sleeve was used to create a seal above the pre-packed sand-pack. The bentonite sleeve seal was used due to the limited space between the well casing and the borehole; the paper sleeve ensured that the granular bentonite was correctly placed above the pre-packed sand-sand pack. When the sleeve seal is lowered below the water surface, the bentonite hydrates and expands, breaking away the paper sleeve and creating a seal around the well casing. Following installation and hydration of the bentonite sleeve seal, quarter-inch coated bentonite pellets were used to seal the remainder of the annular space, to within 2 feet of the ground surface. The monitoring well was completed with a flush-mount well monument set in a concrete pad.

Monitoring well MW-5D was developed on October 23, 2017, using a combination of surging and over-pumping to remove approximately five casing volumes and entrained sediment.

Field Screening Results

As shown on the boring log for monitoring well MW-5D contained in Attachment B, PID measurements on soil were below 5 parts per million (ppm) on unsaturated soil above the historical water table. Significant readings (e.g., greater than 100 ppm) were first encountered at a depth of 14 feet bgs and extended to a depth of approximately 20 feet bgs, corresponding to the shallow groundwater table, which was encountered at a depth of about 17 feet bgs. These results are consistent with field observations made in December 2014 during the construction of shallow monitoring well MW-5. Well MW-5D is located adjacent to well MW-5.

REGENOX/ORC-ADVANCED INJECTIONS

The pilot study field activities were performed from October 18 to November 1, 2017.

The Pilot Study Work Plan proposed using a mixture of RegenOx® and ORCAdvanced to remediate residual hydrocarbons in soil and groundwater below the water table at the Facility. RegenOx® is an injectable, two-

part ISCO reagent that combines a solid sodium percarbonate based alkaline oxidant (Part A), with a liquid solution of sodium silicates, silica gel, and ferrous sulfate (Part B). RegenOx® produces minimal heat and pressure and is noncorrosive, making it a relatively safe chemical oxidant that is compatible for use in direct contact with underground infrastructure such as utilities, tanks, piping communication lines, etc. In addition to chemical destruction, RegenOx® produces a significant short-term oxygen footprint that is optimal for establishing aerobic conditions capable of supporting follow-on, aerobic biodegradation of petroleum hydrocarbons. The ORCAdvanced then continues to release oxygen to the groundwater over a period of up to 12 months to support long-term aerobic biodegradation. ORCAdvanced is a calcium oxy-hydroxide based material that becomes hydrated upon contact with the groundwater, producing a controlled-release of molecular oxygen (17% by weight).

The RegenOx/ORCAdvanced mixture was injected into 24 borings located within the pilot study area, as shown on Figure 4. The borings were located on an approximate off-set gridded pattern on 15-foot spacing.

Boring Advancement

The borings were installed using direct push equipment (Geoprobe 7720DT) in accordance with the standard operating procedures (SOPs) in the approved Work Plan, contained in Attachment C. Each boring was manually cleared of subsurface infrastructure by hand-augering to a depth of 8 feet bgs. Following hand clearance, an injection probe was advanced to a depth of 25 feet bgs using the Geoprobe rig. Because several wells have been installed within or near the pilot study area and lithologic logs of these wells have been prepared, lithologic logs were not prepared for the subsurface injection locations.

Injection Equipment and Procedures

RegenOx® and ORCAdvanced were mixed in large totes and injected through the drill stem via air diaphragm pumps situated on the injection rig. Photographs of the mixing process are contained in Attachment A. The injection rig is specially designed to complete subsurface injections and is equipped with a pair of 150-gallon poly mixing tanks with built in mixers. Each mixing tank was equipped with an independent diaphragm pump connected to a pumping manifold capable of pumping the solution to up to six injection probes at a time; although only two injection probes were operated at a time during this Pilot Study to ensure adequate control over the injection rate. Each process train was equipped with its own digital flowmeter to measure the flowrate and total volume injected.

The RegenOx and ORCAdvanced mix was injected from the bottom depth of the boring up to 15 feet bgs (the approximate depth to groundwater) utilizing one of two types of injection probe tips:

- A pressure activated probe tip, designed to deliver the injection solution along a localized depth interval (approximately 1 foot); the high pressure required to activate the jet is designed to move the solution out from the injection point into the subsurface as the probe tip is withdrawn in 1-foot intervals.
- A slotted screen injection probe, designed to deliver the injection solution over a 5-foot screened interval. The injection screen consisted of a 5-foot steel rod with rows of injection ports around the circumference of the rod and spaced approximately 3 inches along the length of the screen. The injection screen was withdrawn in 5-foot intervals.

Initially, injections were attempted using the pressure activated probe tip because the design provided greater control over the delivery of the oxidant solution. However, field personnel were unable to prevent short-circuiting of injection fluids along the outside of the drilling rods to the surface. Therefore, Cascade primarily utilized the 5-foot injection rod designed to deliver the oxidant solution radially along the 5-foot interval. Approximately 300 gallons of the RegenOx/ORCAdvanced mixture were injected at each boring location.

Issues Encountered

Daylighting and slow injection rates. Even with changing the injection probe to the 5-foot injection screen and injecting the RegenOx®/ORCAdvanced solution at lower pressures, the oxidant solution was still observed at a number of locations in the form of either free-flowing liquid or foaming at the surface. Possible factors contributing to the observed daylighting include: the injection pressure (discussed below), tightness of drill stem connections, and the lithology at the injection boring location. The lithology in the pilot study area is predominantly silt with some fine sand to depths of about 22 feet bgs and the lower permeability of this soil type may have caused the mixture to follow preferential pathways such as along the drill stem casing at times. Additionally, the mixture pumping rate needed to be lowered to accommodate the fluid injections into the lower permeability of the soils.

Injection pressures. The initial injection locations utilized the pressure activated probe tip to introduce the RegenOX/ORCAdvanced solution into the subsurface. However, the higher pressures needed to depress the internal spring mechanism in the probe tip resulted in an injection flowrate greater than the subsurface conditions would accept; this resulted in a buildup of pressure and daylighting of the injection material either along the outside of the drill stem or through nearby soil to the surface.

Clogging. The in-line flowmeters used to measure injection flowrate and the total volume pumped at each location had a tendency to clog frequently. ORCAdvanced did not completely dissolve when mixed with water and RegenOx®, resulting in a solution with particles present that would build-up and clog the flowmeters. When this occurred, injection volumes were estimated from the volume of the mixing tanks. To the extent possible the clogging was mitigated by removing and cleaning the flowmeters after each injection was complete.

While the injection program was successfully completed, the above issues caused delays in completing the program and will need to be considered when evaluating the viability and cost of this remedial technology in the Feasibility Study.

Restoration

After the target volume was injected at each boring location (or the injection was halted due to surfacing), the drill stem was removed and decontaminated, and the boring was abandoned with bentonite. The injection borings were abandoned in accordance with WCLS regulations and procedures.

GROUNDWATER MONITORING

Prior to conducting the RegenOx®/ORCAdvanced injections, a groundwater monitoring event was conducted to assess the baseline constituent concentrations. Groundwater samples were collected from monitoring well MW-5 on October 23, 2017, and wells MW-6 and MW-5D on October 24, 2017.

The first of four rounds of quarterly post-injection performance groundwater monitoring was completed on November 30, 2017; approximately one month after completion of the pilot study injections. Groundwater samples were collected from monitoring wells MW-5, MW-5D, and MW-6.

During both monitoring events, depth to groundwater measurements were collected from site wells prior to initiating groundwater sampling. In the baseline event, depth to groundwater was collected at wells MW-5, MW-5D, and MW-6; during the first post-injection quarterly event, depth to groundwater measurements were collected from the 12 site monitoring wells. Following the measurement of the depth to groundwater, measurements of dissolved oxygen (DO) and oxidation-reduction potential (ORP) were collected at each well. The wells were then purged and sampled using low-flow techniques. Field parameters including DO and ORP measurements were collected during the purging process to assist in evaluating the pilot study results. Sampling methods and protocols used are described in Attachment C. Groundwater samples collected during the performance monitoring were submitted to ESC Lab Sciences, a Washington State-certified laboratory for gasoline-range total petroleum hydrocarbons (TPHg) using Pacific Northwest Method NW-TPH-Gx, diesel-range total petroleum hydrocarbons (TPHd) and oil-range total petroleum hydrocarbons (TPHo) using Pacific Northwest Method NW-TPH-Dx (with silica gel cleanup), and BTEX using EPA Method 8260B.

Laboratory data reports and monitoring field sheets are presented in Attachments D and E, respectively.

MONITORING WELL ELEVATION SURVEY

On November 30 and December 1, 2017, a licensed land surveyor and crew with Bluedot Group, out of Portland, Oregon, completed survey of the 12 monitoring wells, MW1 through MW10, MW-5D and MW-9D, at the Facility. For each of the 12 site monitoring wells the northing and easting coordinates were established (or confirmed) and the monument rim and well PVC top-of-casing elevations were measured to within +/- 0.01 foot, relative to the North American Vertical Datum of 1988 (NAVD88). A site plan containing the survey information is presented in Attachment F.

INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW), consisting of soil cuttings, purged groundwater, and decontamination water, was placed 55-gallon steel drums. At the end of the pilot study field activities, the drums were moved to the waste storage area at the Terminal pending the results of analytical data to complete the waste profile and arrange disposal. Four drums of soil cuttings were transported off-site for disposal at the Waste Management Subtitle D landfill in Hillsboro, Oregon. Two drums of purged groundwater and decontamination water were transported off-site and recycled at the Oil Re-Refining Company (ORRCO) in Portland, Oregon.

RESULTS AND DISCUSSION

DEPTH TO GROUNDWATER AND GROUNDWATER ELEVATIONS

Table 1 summarizes the depth to groundwater and groundwater elevation data from the two monitoring events. Depth to groundwater ranged from 17.50 to 18.12 feet in wells MW-5, MW-5D, and MW-6 during the baseline groundwater monitoring event. Depth to groundwater in the 12 site monitoring wells ranged from 11.12 to 29.59 feet during the first post-injection groundwater monitoring event.

Figure 5 shows the groundwater elevations from the first post-injection event calculated using the new monitoring well survey and the depth to groundwater measurements. As can be seen from the figure, the groundwater elevations are similar across the Facility and not easily contoured, indicating a flat groundwater gradient.

ANALYTICAL RESULTS

Analytical results for the baseline and first post-injection groundwater events are summarized on Table 2; results from the prior groundwater monitoring events conducted at these wells from 2014 to 2016 are also included on Table 2 for reference. Additionally, the baseline and first post-injection groundwater results for TPH and BTEX are shown on Figures 4 and 5, respectively.

Well MW-5 Results. Comparison of the baseline and first post quarterly sampling event results for well MW-5, the shallow monitoring well located within the pilot study area, indicate similar pre- and post-injection concentrations, and may indicate that the ISCO did not have a significant effect on reducing petroleum hydrocarbon concentrations because chemical oxidants are typically fast acting in the breakdown of hydrocarbons. However, the mixture of RegenOx and ORCAdvanced can act to desorb hydrocarbons adhered to soil particles, causing a short-term increase in hydrocarbon concentrations in groundwater. The slower acting oxygen-releasing agent then enhances natural biodegradation of the "liberated" hydrocarbons. Therefore, it will be important to continue to monitor the groundwater in the remaining three quarterly events to assess whether there is a statistically significant decreasing trend in the hydrocarbon concentrations which can be linked to the addition of the injectants from the pilot study.

Well MW-5D Results. TPHg, TPHd, TPHo, and BTEX concentrations in the newly installed deeper well located in the pilot study area were low to non-detect both before and after the pilot study injections.

Well MW-6 Results. Well MW-6 is located in a separate area containing residual petroleum hydrocarbons and associated constituents in groundwater at concentrations above MTCA Level A concentrations and is being sampled during the pilot study to provide reference for the pilot study results because it is not located sufficiently close to the pilot study area to be affected by the injections. BTEX concentrations were comparable between the baseline and post-injection groundwater monitoring event, and generally stable or decreasing from previous monitoring events. The TPH results were also comparable between the baseline and post-injection events; the total TPH concentrations are comparable to the historical results from this well, although the distribution between the carbon ranges differed during the recent sampling in comparison to the historical results. During the baseline groundwater monitoring event, a duplicate groundwater

sample was collected from well MW-6. Analysis of TPHd and TPHo was performed outside of the hold time for Method NW-TPH-Dx, which is 14 days when the pH is less than two, and hold time is 7 days when the pH is greater than two. As part of the procedure for preparing to perform TPHd and TPHo analysis the pH of the duplicate sample was measured. The pH of the duplicate sample was greater than two when measured 13 days after collection, as such the analytical results for TPHd and TPHo from the duplicate sample were flagged as being out-of-hold.

CONCLUSIONS

Evaluation of the pilot study activities and the baseline and first post-injections groundwater monitoring results indicate the following:

- RegenOx and ORCAdvanced can be successfully injected into the subsurface; however, due to the silty lithology in the upper 25 feet in the pilot study area and the mechanics of the injection equipment, the injection rate must be slower than typical to prevent short-circuiting, increasing the time and cost of this type of remedial technology.

- Comparison of the results from the baseline and the first post-injection groundwater monitoring events did not indicate a significant decrease in hydrocarbon concentrations in the pilot study area. However, this is a common occurrence directly following the injection of large volumes of a RegenOx/ORCAdvanced mixture due to desorption of hydrocarbons adhered to saturated soil. Therefore, it is too early to determine the effectiveness of the RegenOx® and ORCAdvanced injection technology and completion of the remaining three groundwater monitoring events will be important to assessing whether the technology is viable for a full scale remedial approach.

Tables

Figures

Attachments

References

Apex Companies, LLC, 2017. *Additional Investigation Summary Report and Pilot Study Work Plan, NuStar Vancouver Annex Terminal*, August 2, 2017.

TABLES

Table 1
Groundwater Elevations
NuStar Terminals Operations Partnership, L.P. - Vancouver Annex Terminal
Vancouver, Washington

Well ID	Date	Reference Elevation (feet)[1]	Depth To SPH (feet)	Depth To Groundwater (feet)	SPH Thickness (feet)	Groundwater Elevation (feet)	Notes
MW 1	11/30/2017	26.72	--	16.16	--	10.56	
MW 2	11/30/2017	38.27	--	27.66	--	10.61	
MW 3	11/30/2017	39.17	--	28.61	--	10.56	
MW 4	11/30/2017	40.23	--	29.59	--	10.64	
MW 5	10/23/2017	27.03	--	17.82	--	9.21	
	11/30/2017	27.03	--	16.39	--	10.64	
MW 5D	10/24/2017	26.71	--	17.50	--	9.21	
	11/30/2017	26.71	--	16.21	--	10.50	
MW 6	10/24/2017	27.33	--	18.12	--	9.21	
	11/30/2017	27.33	--	16.71	--	10.62	
MW 7	11/30/2017	21.67	--	11.12	--	10.55	
MW 8	11/30/2017	27.68	--	16.91	--	10.77	
MW 8D	11/30/2017	27.87	--	17.36	--	10.51	
MW 9	11/30/2017	29.39	--	18.78	--	10.61	
MW 10	11/30/2017	28.71	--	18.16	--	10.55	

Notes:

1. Survey elevations determined by Bluedot Group surveying, November 2017.
2. Reference elevation (i.e., top of casing) relative to NAVD 88, feet above mean sea level.

Table 2
Groundwater Analytical Data
NuStar Terminals Operations Partnership, L.P. - Vancouver Annex Terminal
Vancouver, Washington

Well ID	Sample Date	TPHg Gasoline (mg/L)	TPHd Diesel (mg/L)	TPHo Heavy Oil (mg/L)	Benzene (mg/L)	Toluene (mg/L)	Ethyl-Benzene (mg/L)	Xylenes (mg/L)
MW-5	12/16/2014	15.0	0.35	<0.500	0.0007	0.00066	0.12	1.2
	12/16/2014 DUP	15.0	<0.25	<0.500	0.00088	0.00081	0.18	1.3
	3/25/2015	18.1	<0.045	<0.091	<0.00050	0.00061	0.218	1.45
	3/25/2015 DUP	17.2	<0.046	<0.092	0.0005	0.00065	0.236	1.22
	6/24/2015	15.0	0.33 D (see note)	<0.250	<0.0012	<0.0012	0.228	1.51
	6/24/2015 DUP	16.8	0.56 D (see note)	<0.250	<0.0012	<0.0012	0.232	1.49
	9/15/2015	17.3	0.82 D (see note)	<0.34	<0.00050	0.0006	0.289	1.92
	7/11/2016	19.4	0.31	<0.29	<0.00084	0.001	0.215	1.17
	10/23/2017	7.93 J-	1.26	<0.25	<0.0010	0.00117	0.174	0.99
	11/30/2017	11.3	1.63	<0.25	<0.0250	<0.0250	0.187	1.21
	11/30/2017 DUP	10.9	1.75	<0.25	<0.0010	0.00112	0.187	1.48
MW-5D	10/24/2017	0.42	0.147 J	<0.25	<0.0010	<0.0010	0.00138	0.00296 J
	11/30/2017	0.41	0.49	<0.25	<0.0010	<0.0010	<0.0010	<0.0030
MW-6	12/16/2014	15	<0.250	<0.500	0.47	0.065	1.3	2.6
	3/25/2015	13.7	0.047	<0.092	0.516	0.0756	1.4	2.26
	6/24/2015	17.7	1.2 D (see note)	<0.250	0.423	0.0582	1.58	1.92
	9/15/2015	15.1	0.54 D (see note)	<0.34	0.306	0.0672	1.23	1.92
	9/15/2015 DUP	14	0.44 D (see note)	<0.35	0.328	0.0684	1.32	2.07
	7/11/2016	15.5	0.23	<0.28	0.358	0.0616	1.63	1.82
	10/24/2017	7.73	5.07	0.111 J	0.194	0.0512	1.51	1.29
	10/24/2017 DUP	4.19 J	8.96 Q, J	1.19 QJ	0.153	0.0462	1.18	1.04
	11/30/2017	9.42	7.44	0.69	0.223	0.0531	1.71	1.12
Washington DOE MTCA Method A Cleanup Level		0.8	0.5	0.5	0.005	1	0.7	1

Notes:

1. TPH = Total petroleum hydrocarbons by northwest methods, with samples for diesel- and motor-oil-range analyses prepared by silica gel cleanup.
2. TPHg = Total petroleum hydrocarbons measured in the gasoline range
3. TPHd = Total petroleum hydrocarbons measured in the diesel range
4. TPHo = Total petroleum hydrocarbons measured in the heavy oil range
5. TPHg by Method NWTPH-Gx; TPHd and TPHo by NWTPH-Dx; benzene, toluene, ethylbenzene, xylenes, MTBE analyzed by EPA Method 8260 B.
6. **Boldface** values represent concentration that exceeds MTCA Method A cleanup level.
7. Yellow highlight indicates the baseline groundwater monitoring event.
8. < = less than the method detection limit.
9. mg/L = milligrams(s) per liter.
10. DUP = Field Duplicate.
11. D = Laboratory report noted discreet peaks that are not indicative of diesel. The laboratory chemist confirmed the peaks were from non-petroleum organic material.

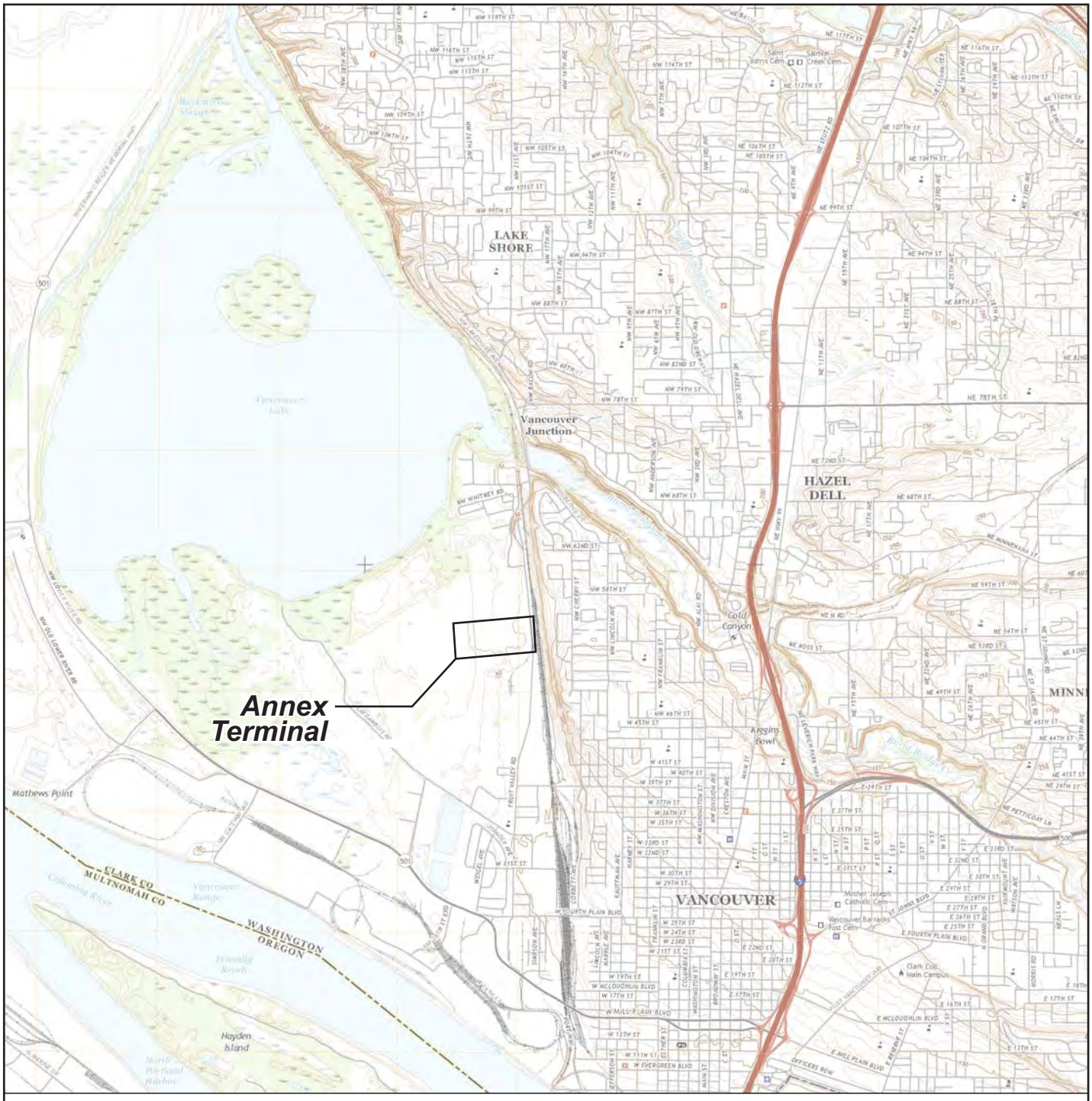
Quality Assurance/Quality Control Data Qualifiers

J = Reported result is an estimated value.

J- = Reported result is estimated and biased low.

Q = Sample prepared and/or analyzed outside of recommended holding time. Result is considered biased low.

FIGURES



Note: Base map prepared from USGS 7.5-minute quadrangle of Vancouver, WA, dated 2017 as provided by USGS.gov.

0 4,000 8,000

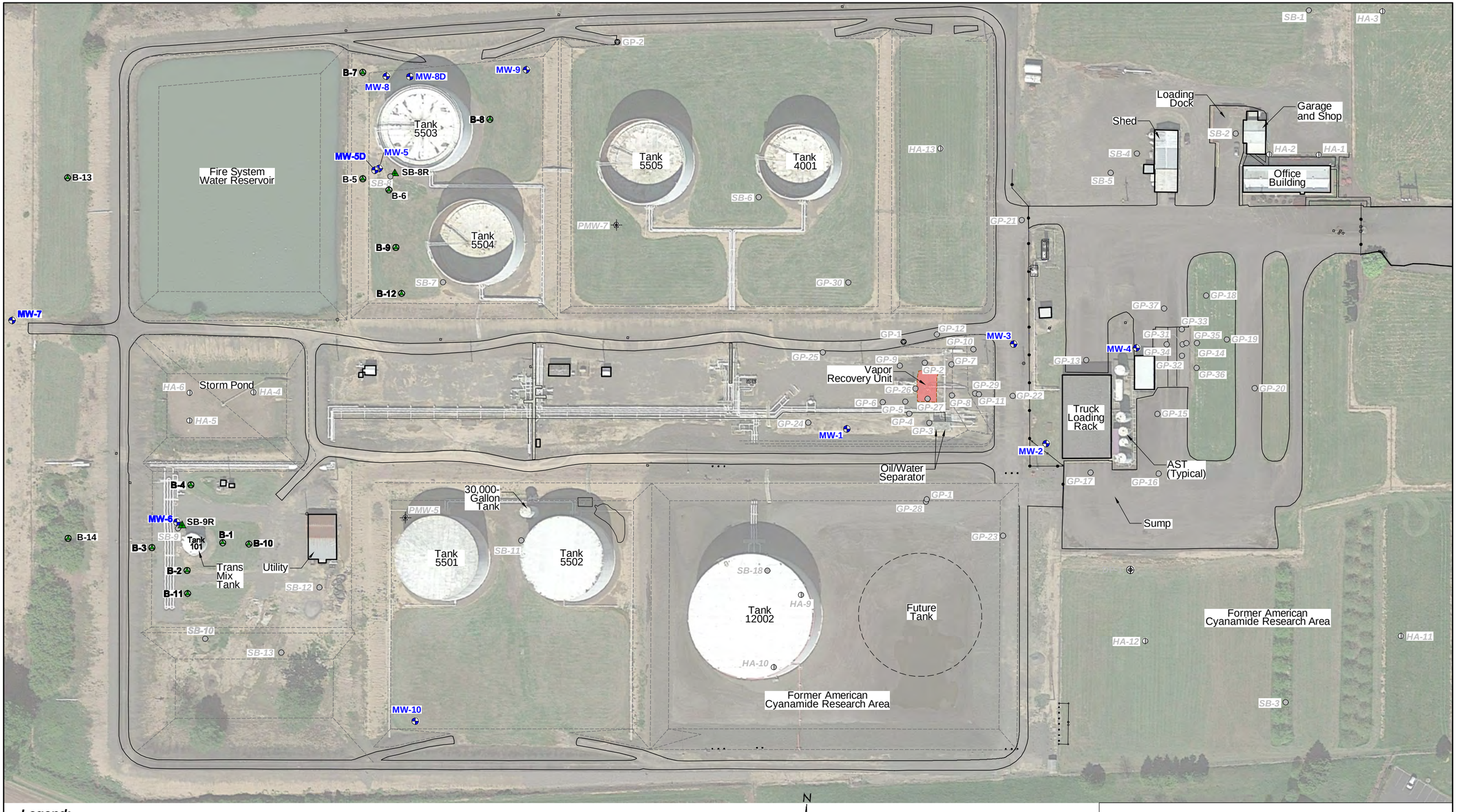
Approximate Scale in Feet

Site Location Map

Pilot Study Implementation Report
NuStar Terminals Operations Partnership, L.P.- Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure 1
	March 2018	



Legend:

- **B-1** Soil Boring Location (October 2015)
- **SB-8R** Soil Boring Location (September 2014)
- **MW-1** Groundwater Monitoring Well Location (MW-5D and MW-8D are Deep Monitoring Well Locations)
- DP-1 Grab Groundwater Sample Location
- GP-1 Deeper Direct-Push Geoprobe Location
- GP-1 Historical Direct-Push Boring Location (Approximate)
- PMW-5 Historical Temporary Well Location (Approximate)
- HA-1 Historical Hand Auger Location (Approximate)
- Excavation Location

N

0 100 200

Scale in Feet

NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate. Aerial photograph from Google Earth Pro (4/2015).

Site Plan

Pilot Study Implementation Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure 2
	March 2018	

Legend:

- **SB-8R** Soil Boring Location (September 2014)
- **MW-1** Groundwater Monitoring Well Location (MW-5D and MW-8D are Deep Monitoring Well Locations)
- DP-1 Grab Groundwater Sample Location
- GP-1 Deeper Direct-Push Geoprobe Location
- *GP-1* Historical Direct-Push Boring Location (Approximate)
- *PMW-5* Historical Temporary Well Location (Approximate)
- *HA-1* Historical Hand Auger Location (Approximate)
- **B-1** Soil Boring Location (October 2015)
- Pilot Study Area

N

0 100 200

Scale in Feet

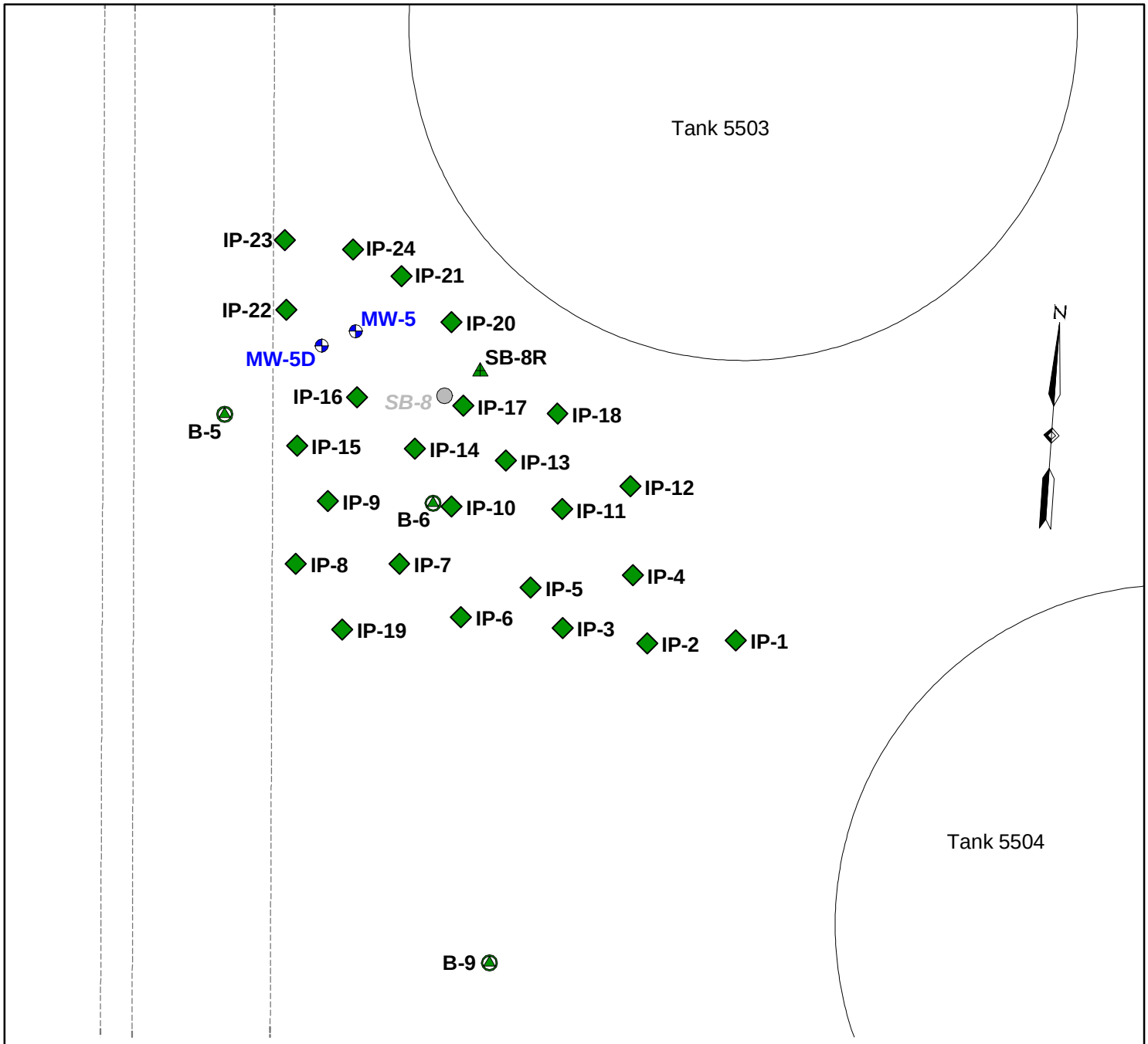
NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate. Aerial photograph from Google Earth Pro (4/2015).

Pilot Study Area

Pilot Study Implementation Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure 3
	March 2018	



Legend:

SB-8R ▲	Soil Boring Location (September 2014)
MW-5	Groundwater Monitoring Well Location (MW-5D is a Deep Monitoring Well Location)
SB-8	Historical Direct-Push Boring Location (Approximate)
B-6	Soil Boring Location (October 2015)
IP-1 ◆	Injection Boring Location

NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate.

0 20 40

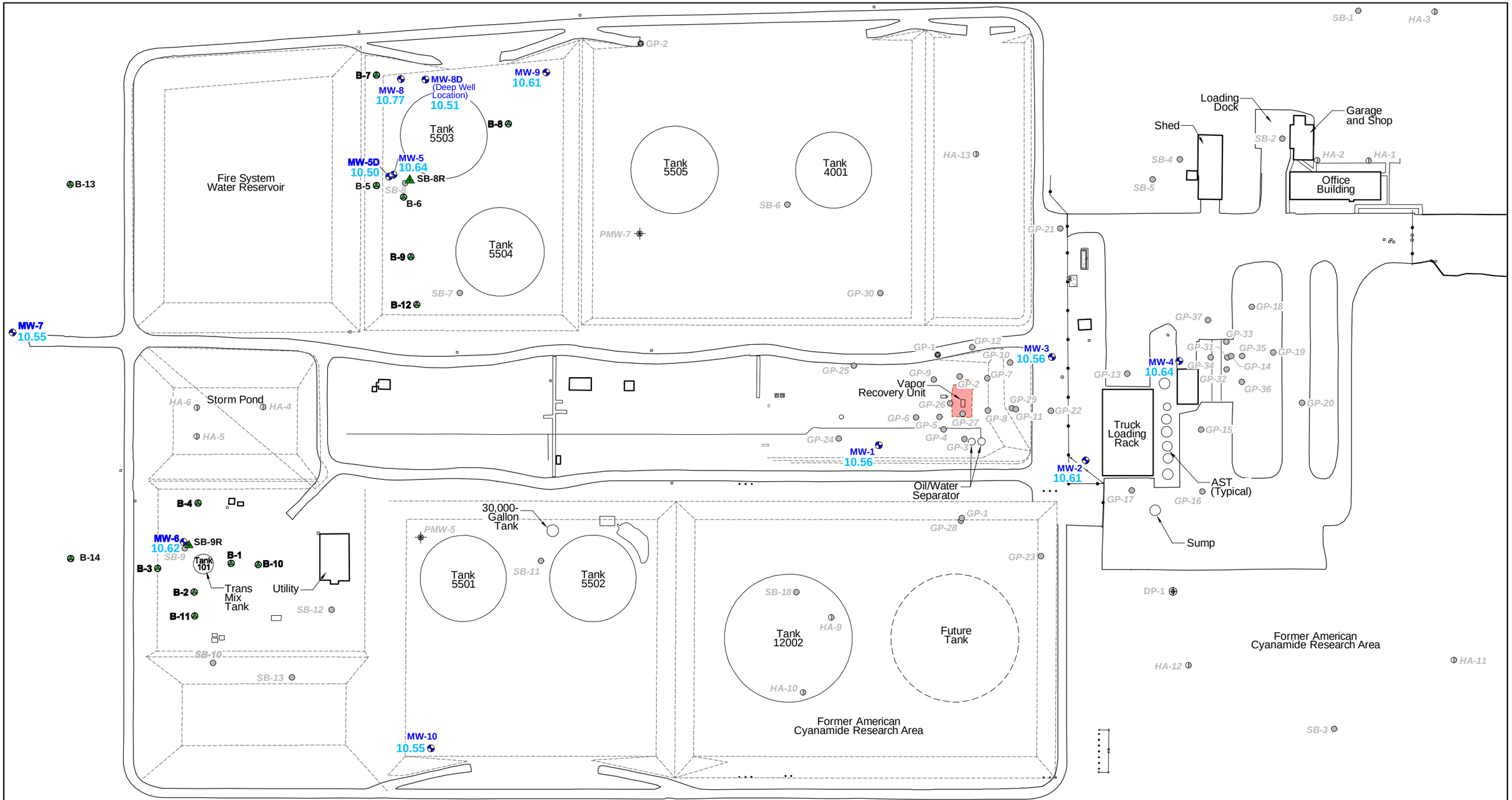
Scale in Feet

Pilot Study Injection Layout

Pilot Study Implementation Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure
March 2018		**4**



Legend:

- MW-1 10.56 — Groundwater Monitoring Well Location; Groundwater Elevation in Feet Above Mean Sea Limit (MSL)
- SB-9R — Direct-Push Geoprobe Location
- GP-1 — Soil Boring Location (September 2014)
- DP-1 — Grab Groundwater Sample Location
- GP-1 — Historical Direct-Push Boring Location (Approximate)
- PMW-5 — Historical Temporary Well Location (Approximate)
- HA-1 — Historical Hand Auger Location (Approximate).
- Excavation

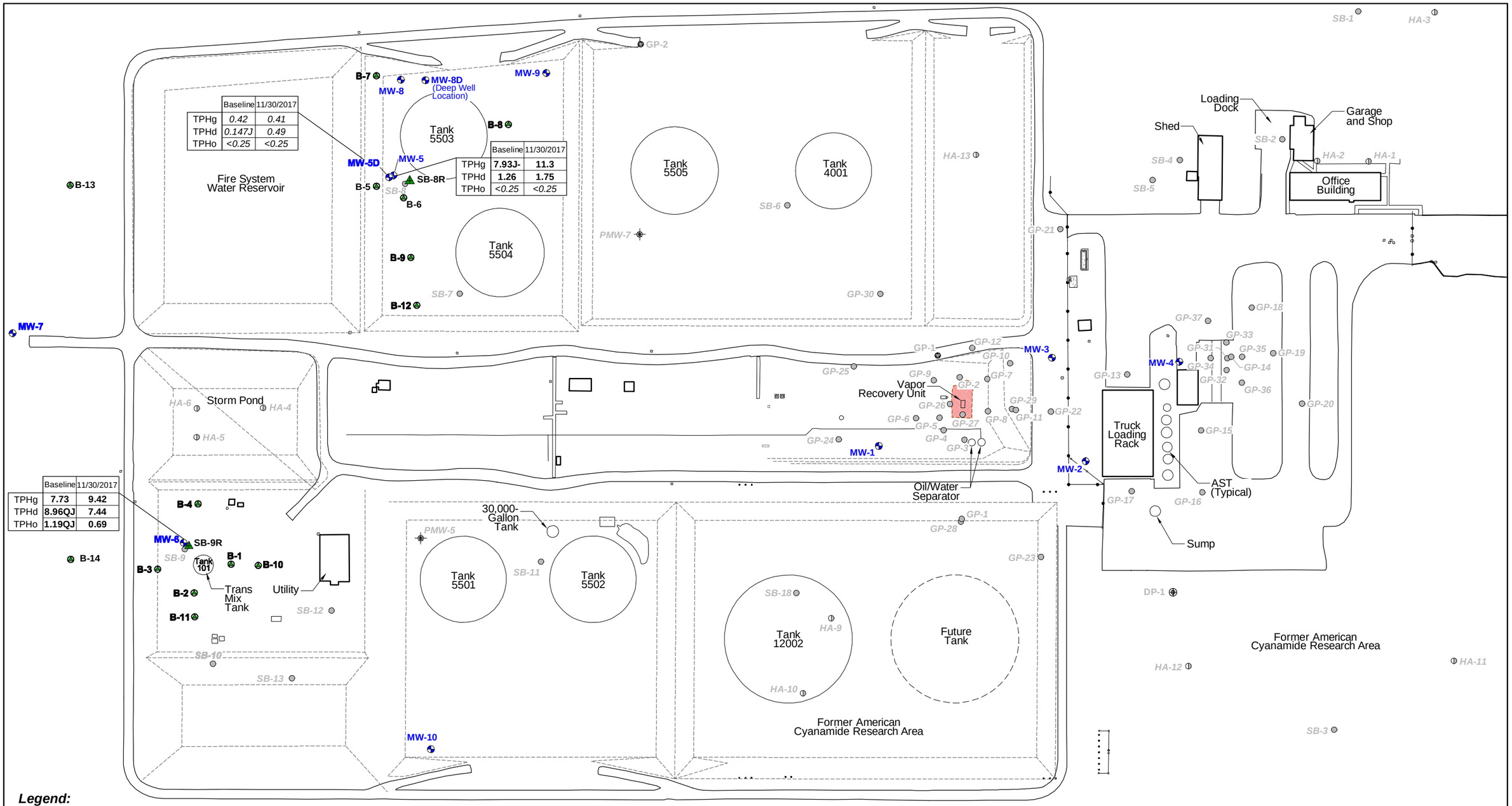
NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate.

Groundwater Elevations - November 2017

Pilot Study Implementation Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure
	March 2018	5



Legend:

- **SB-8R** Soil Boring Location (September 2014)
- **MW-1** Groundwater Monitoring Well Location (MW-5D and MW-8D are Deep Monitoring Well Locations)
- DP-1 Grab Groundwater Sample Location
- GP-1 Deeper Direct-Push Geoprobe Location
- GP-1 Historical Direct-Push Boring Location (Approximate)
- PMW-5 Historical Temporary Well Location (Approximate)
- HA-1 Historical Hand Auger Location (Approximate)

B-1 Soil Boring Location (October 2015)

	Baseline	11/30/2017
TPHg	7.73	9.42
TPHd	8.96QJ	7.44
TPHo	1.19QJ	0.69

Date Sampled
Concentration in mg/L
Analyte Sampled

Abbreviations	
TPHg	Total Petroleum Hydrocarbons Gasoline-Range
TPHd	Total Petroleum Hydrocarbons Diesel-Range
TPHo	Total Petroleum Hydrocarbons Organic-Range

Notes: Baseline = October 2017 monitoring event completed immediately before Pilot Study injections.
J = Reported result is an estimated value.
J- = Reported result is an estimate and biased low.
Q = Sample prepared and/or analyzed outside of recommended holding time. Result is considered biased low.

N

0 100 200
Scale in Feet

NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate.

TPH Concentrations in Groundwater

Pilot Study Implementation Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure
	March 2018	6

	Baseline	11/30/2017
BEN	<0.001	<0.001
TOL	<0.001	<0.001
ETH	0.00138	<0.001
XYL	0.00296J	<0.003

	Baseline	11/30/2017
BEN	<0.001	<0.025
TOL	0.00117	0.00112
ETH	0.174	0.187
XYL	0.988	**1.48**

	Baseline	11/30/2017
BEN	**0.194**	**0.223**
TOL	0.0512	0.0531
ETH	**1.51**	**1.71**
XYL	**1.29**	**1.12**

Fire System Water Reservoir
Storm Pond
Trans Mix Tank
Utility
30,000-Gallon Tank
Tank 101
Tank 5503
Tank 5504
Tank 5505
Tank 5501
Tank 5502
Tank 4001
Tank 12002
Future Tank
Vapor Recovery Unit
Oil/Water Separator
Truck Loading Rack
AST (Typical)
Sump
Loading Dock
Shed
Garage and Shop
Office Building
Former American Cyanamide Research Area
Former American Cyanamide Research Area

B-1 B-2 B-3 B-4 B-5 B-6 B-7 B-8 B-9 B-10 B-11 B-12 B-13 B-14
MW-1 MW-2 MW-3 MW-4 MW-5 MW-5D MW-6 MW-7 MW-8 MW-8D (Deep Well Location) MW-9 MW-10
SB-8R SB-9R
DP-1
GP-1 GP-2 GP-3 GP-4 GP-5 GP-6 GP-7 GP-8 GP-9 GP-10 GP-11 GP-12 GP-13 GP-14 GP-15 GP-16 GP-17 GP-18 GP-19 GP-20 GP-21 GP-22 GP-23 GP-24 GP-25 GP-26 GP-27 GP-28 GP-29 GP-30 GP-31 GP-32 GP-33 GP-34 GP-35 GP-36 GP-37
HA-1 HA-2 HA-3 HA-4 HA-5 HA-6 HA-9 HA-10 HA-11 HA-12 HA-13
PMW-5 PMW-7
SB-1 SB-2 SB-3 SB-4 SB-5 SB-6 SB-7 SB-9 SB-10 SB-11 SB-12 SB-13 SB-18

Legend:

- **SB-8R** Soil Boring Location (September 2014)
- **MW-1** Groundwater Monitoring Well Location (MW-5D and MW-8D are Deep Monitoring Well Locations)
- DP-1 Grab Groundwater Sample Location
- GP-1 Deeper Direct-Push Geoprobe Location
- *GP-1* Historical Direct-Push Boring Location (Approximate)
- *PMW-5* Historical Temporary Well Location (Approximate)
- *HA-1* Historical Hand Auger Location (Approximate)

B-1 Soil Boring Location (October 2015)

	Baseline	11/30/2017
BEN	**0.194**	**0.223**
TOL	0.0512	0.0531
ETH	**1.51**	**1.71**
XYL	**1.29**	**1.12**

Date Sampled
Concentration in mg/L
BOLD=Concentration exceeds MTCA Method A Cleanup Level
Analyte Sampled

Notes: Baseline = October 2017 monitoring event completed immediately before Pilot Study injections.
J = Reported result is an estimated value.

Abbreviations	
B	Benzene
T	Toluene
E	Ethylbenzene
X	Xylenes

N

0 100 200
Scale in Feet

NOTE: Base map completed from a number of sources including but not limited to; Figure VAN1-21-002 provided by NuStar (1/8/2007) and a Monitoring Well Survey by Statewide Land Surveying, Inc (10/30/2007). Locations of roads and containments are approximate.

BTEX Concentrations in Groundwater

Pilot Study Implementation Report
NuStar Terminals Operations Partnership, L.P. - Annex Terminal
Vancouver, Washington

Cascadia Associates, LLC

Project Number	1569-11	Figure
	March 2018	7

ATTACHMENT A

PHOTOGRAPH LOG

Photo 1 (top): Orientation – South Proposed injection layout.	NuStar
	Vancouver Annex
	5420 NW Fruit Valley Road
Photo 2 (bottom): Orientation – East Proposed injection point layout adjacent to Tank 5503. The pink marking paint represents the cathodic protection line for the tank. The injection points near the cathodic protection line or Tank 5503 were relocated to the south.	0060-001-001
	Cascadia Associates, LLC

Photo 1 (top): Orientation - Southwest Installation of monitoring well MW-5D	NuStar
	Vancouver Annex
	5420 NW Fruit Valley Road
Photo 2 (bottom): Orientation - NA Injection tooling including the 5-foot injection points used for much of the pilot study injections are present at the top of the picture.	0060-001-001
	Cascadia Associates, LLC

Photo 1 (top): Orientation - North Monitoring wells MW-5D (left) and MW-5 (right) are present in the foreground. The injection rig containing the mixing tanks and pumps is present in the background.	NuStar Vancouver Annex 5420 NW Fruit Valley Road
Photo 2 (bottom): Orientation - NA Example of injection point advanced.	0060-001-001 Cascadia Associates, LLC

Photo 1 (top): Orientation - South Injection rig on secondary containment and product (RegenOX and ORC) on the lift gate. A water truck (filled at an onsite fire hydrant) was used to supply water to the injection rig.	NuStar Vancouver Annex 5420 NW Fruit Valley Road
Photo 2 (bottom): Orientation - South Injection at location IP-1 using a 2-foot injection point. Surfacing of the injection material from the borehole is observed.	0060-001-001 Cascadia Associates, LLC

Photo 1 (top): Orientation - Northeast Pilot study injection area. The injection locations were hand augered to 8 feet bgs prior to advancing the injection rod. Cleared locations were covered with a steel plate cover or a large traffic cone.	NuStar Vancouver Annex 5420 NW Fruit Valley Road
Photo 2 (bottom): Orientation – South Injection at location IP-3. Surfacing of the injection material was observed at the borehole and locations up to 5 feet away while injecting at the 15 to 20 foot bgs interval.	0060-001-001 Cascadia Associates, LLC

Photo 1 (top): Orientation - NA Surfacing of injection material from borehole at location IP-7. A 2-foot injection point was used. Approximately 135 gallons had been injected at the location at the time the photo was taken.	NuStar Vancouver Annex 5420 NW Fruit Valley Road
Photo 2 (bottom): Orientation - Northeast Installation of the injection point at location IP-6.	0060-001-001 Cascadia Associates, LLC

Photo 1 (top): Orientation – Northwest Injection at location IP-6 using a 5-foot injection point screened between 20 and 25 feet bgs.	NuStar Vancouver Annex 5420 NW Fruit Valley Road
Photo 2 (bottom): Injection at location IP-9. Minor surfacing observed at the borehole.	0060-001-001 Cascadia Associates, LLC

Photo 1 (top): Orientation – NA RegenOX and ORC material was stored in a storage container box staged east of the tank farm.	NuStar Vancouver Annex 5420 NW Fruit Valley Road
Photo 2 (bottom): Orientation – East Filling the water truck from an onsite fire hydrant located west of the loading rack. The storage container for the injection material was staged just to the south of the fire hydrant.	0060-001-001 Cascadia Associates, LLC

Photo 1 (top): Orientation – NA Injectant flowing from the borehole around the drilling rods at injection point IP-8.	NuStar Vancouver Annex 5420 NW Fruit Valley Road
Photo 2 (bottom): Orientation – West Injectant flowing from the borehole around the drilling rods and also surfacing near monitoring well MW-5D (located in the center of the photo) at injection point IP-22.	0060-001-001 Cascadia Associates, LLC

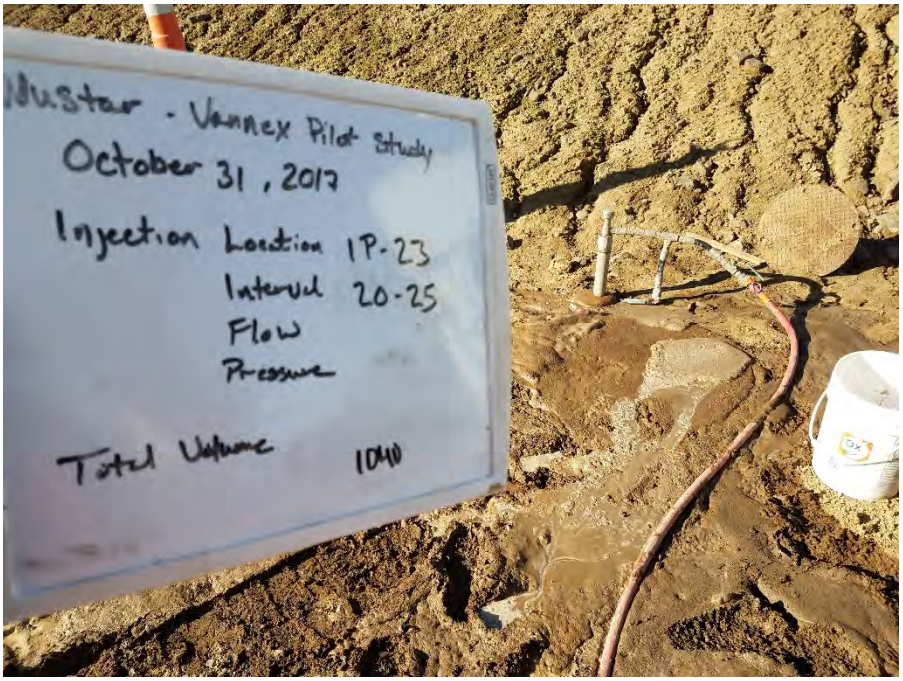


Photo 1 (top): Orientation – NA Injectant surfacing approximately 3 to 5 feet from injection point.	NuStar
	Vancouver Annex
	5420 NW Fruit Valley Road
Photo 2 (bottom): Orientation – West Injectant surfacing at injection point IP-23 from the borehole and approximately 3 to 5 feet from injection point.	0060-001-001
	Cascadia Associates, LLC

ATTACHMENT B

LITHOLOGIC LOG AND CONSTRUCTION DETAILS

FOR WELL MW-5D

Cascadia Associates, LLC	PROJECT: **NuStar Vancouver Annex Terminal Pilot Study**	BORING ID: **MW-5D**	
	LOCATION: **5420 NW Fruit Valley Road, Vancouver, WA**	WELL ID: **MW-5D**	
	DRILLING CONTRACTOR: **Cascade Drilling**	NORTHING:	EASTING:
	DRILLING EQUIPMENT: **Geoprobe 7822DT**	SURFACE ELEV. (NAVD88): **Not measured**	TOC ELEVATION: **NA**
	DRILLING METHOD: **Direct-push**	TOTAL DEPTH: **45**	DEPTH TO WATER: **17.3**
LOGGED BY: **Ian Maguire**	SAMPLING METHOD: **4-Inch Dual Tube Sampler**	DATE STARTED: **10/19/2017**	DATE COMPLETED: **10/20/2017**

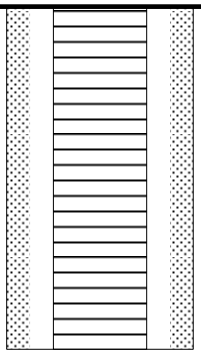
Elev. (feet)	USCS	Graphic Log	Description	Driven/Rec. (ft.)	Headspace Vapor (ppm)	Depth	Well Construction	Water Level
0			Physical Clearance - Not logged.			0		
2								
4				NA		4		
6								
8			No recovery.			8		
10			SILT with fine sand; light brown with dark brownish red mottling; slightly moist, medium stiff.		<5			
12	ML			5.0/5.0	<5	12		
14	ML		Becomes gray SILT; moist; medium stiff; odor observed.		110			
	ML		Becomes wet.					
16			SILT with fine sand; gray; wet; medium stiff.		63	16		▽
18				5.0/5.0				
	ML				340			
20						20		

Cascadia Associates, LLC	PROJECT: **NuStar Vancouver Annex Terminal Pilot Study**	BORING ID: **MW-5D**	
	LOCATION: **5420 NW Fruit Valley Road, Vancouver, WA**	WELL ID: **MW-5D**	
	DRILLING CONTRACTOR: **Cascade Drilling**	NORTHING:	EASTING:
	DRILLING EQUIPMENT: **Geoprobe 7822DT**	SURFACE ELEV. (NAVD88): **Not measured**	TOC ELEVATION: **NA**
	DRILLING METHOD: **Direct-push**	TOTAL DEPTH: **45**	DEPTH TO WATER: **17.3**
LOGGED BY: **Ian Maguire**	SAMPLING METHOD: **4-Inch Dual Tube Sampler**	DATE STARTED: **10/19/2017**	DATE COMPLETED: **10/20/2017**

Elev. (feet)	USCS	Graphic Log	Description	Driven/Rec. (ft.)	Headspace Vapor (ppm)	Depth	Well Construction	Water Level
20					625	20		
22			Fine grained SAND; gray; wet; loose; slight odor	2.5/5.0				
24	SP				10	24		
26								
26	SP		Sand becomes well graded medium to coarse grained; dark gray to black; medium dense; moist.		10			
28			No recovery.	2.5/5.0	33	28		
30								
32				1.8/5.0		32		
34	SP		SAND; gray; wet; medium dense; well graded fine to medium; mica present; 10-15% fines.		<5 <5			
36	SP		SAND; brown; moist to wet; medium dense; poorly graded fine sand with 10% silt.	5.0/5.0	<5 <5	36		
38	SP		Becomes wet. SAND; dark gray, wet, medium dense; well graded fine to medium sand with little to no fines.		<5			
40						40		

Cascadia Associates, LLC	PROJECT: **NuStar Vancouver Annex Terminal Pilot Study**	BORING ID: **MW-5D**	
	LOCATION: **5420 NW Fruit Valley Road, Vancouver, WA**	WELL ID: **MW-5D**	
	DRILLING CONTRACTOR: **Cascade Drilling**	NORTHING:	EASTING:
	DRILLING EQUIPMENT: **Geoprobe 7822DT**	SURFACE ELEV. (NAVD88): **Not measured**	TOC ELEVATION: **NA**
	DRILLING METHOD: **Direct-push**	TOTAL DEPTH: **45**	DEPTH TO WATER: **17.3**
LOGGED BY: **Ian Maguire**	SAMPLING METHOD: **4-Inch Dual Tube Sampler**	DATE STARTED: **10/19/2017**	DATE COMPLETED: **10/20/2017**

Elev. (feet)	USCS	Graphic Log	Description	Driven/Rec. (ft.)	Headspace Vapor (ppm)	Depth	Well Construction	Water Level
40	SP			5.0/5.0	<5	40		
42								
44					<5 <5	44		



ATTACHMENT C

STANDARD OPERATING PROCEDURES (SOPs)
FOR BORING ADVANCEMENT AND
GROUNDWATER SAMPLING

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes the methods for observing and sampling from push-probes (i.e., GeoProbe™). Subsurface soil cores may be obtained using this system for purposes of determining subsurface soil conditions and for obtaining soil samples for physical and/or chemical evaluation. Grab groundwater samples may be collected using temporary well screens. Soil vapor samples may be obtained using temporary well points. Shallow (less than 50 feet), small-diameter (2-inch max) pre-packed wells may also be installed using push-probe equipment. This procedure is applicable during all Apex Companies, LLC (Apex) push-probe activities.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Traffic cones, measuring tape, spatula, and buckets/drums
- Sampling equipment (water level probe, pumps, tubing) and laboratory-supplied sample containers
- Field documentation materials
- Decontamination materials
- Personal protective equipment (as required by project Health and Safety Plan)

3. METHODOLOGY

Coring Procedure (Conducted by Drilling Subcontractor):

The sampling procedure includes driving a 2-inch outside-diameter, 5-foot-long, push-probe soil sampler to the desired depth using a combination of hydraulic pressure and mechanical hammer blows. When the sampling depth is reached, the pin attaching the sampler's tip is released (if a tip is used), which allows the tip to slide inside the sampler (Macro-Core Sampler with removable plastic liner). The sampler is driven the length of the sampler to collect a soil core, which is then withdrawn from the exploration. When the sampler is retrieved from the borehole the drive head/cutting shoe is detached and the liner is removed. Soil cores are collected continuously to the full depth of the exploration unless otherwise specified in a project-specific sampling and analysis plan (SAP). Verify that the subcontractor decontaminates the sampling device (per SOP 1.2) prior to its initial use and following collection of each soil sample.

Logging and Soil Sample Collection:

Remove the soil core from the sampler for field screening, description, and placement into sample jars. Soil samples will be collected for field screening and possible chemical analysis on two foot intervals unless otherwise specified in a project-specific SAP. The sampling interval will be determined in the field based on recovery, soil variability, and evidence of contamination. Complete field screening as specified in SOP-2.1. Soil samples should be collected using different procedures for volatile on non-volatile analyses, as follows.

- **Volatile Analyses.** Sampling for volatile organics analysis (VOA) is different than other routine physical or chemical testing because of the potential loss of volatiles during sampling. To limit volatile loss, the soil sample must be obtained as quickly and as directly as possible. If a VOA sample is to collected as part of a multiple analyte sample, the VOA sample portion will be obtained first. The VOA sample should be obtained from a discrete portion of the entire collected sample and should not be composited or homogenized. Sample bottles should be filled to capacity, with no headspace. Specific procedures for collecting VOA samples using the EPA Method 5035 are discussed in SOP 2.7.
- **Other Analyses.** Soil samples for non-volatile analyses will be thoroughly homogenized in a stainless steel bowl prior to bottling. Sample homogenizing is accomplished by manually mixing the entire soil

sample in the stainless steel bowl with a clean sampling tool until a uniform mixture is achieved. The sample jar should be filled completely.

Any extra soil generated during probing activities will be placed in Department of Transportation (DOT) approved drums.

Grab Groundwater Sample Collection:

Collect grab groundwater samples using a sampling attachment with a 4 to 5-foot-long temporary screen (specify to drillers whether to use decontaminated stainless steel or disposable PVC. Also, specify whether a filter pack is necessary based on field observations). Obtain samples using a peristaltic pump unless otherwise specified in the SAP with new tubing for each boring. Record field parameters (e.g., temperature, conductivity, and pH) prior to sampling.

Backfilling the Excavation (Conducted by Drilling Subcontractor):

After sampling activities are completed, abandon each exploration in accordance with Oregon Water Resources Department (OWRD) regulations and procedures. The abandonment procedure typically consists of filling the exploration with granular bentonite and hydrating the bentonite with water. Match the surface completion to the surrounding materials.

MONITORING WELL INSTALLATION PROCEDURES

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes the methods for installing monitoring wells (using conventional PVC or pre-packed well screens). A pre-packed well screen generally consists of 5-foot sections of an inner PVC well screen and an outer stainless steel wire mesh. The sand filter pack is housed between the inner screen and outer wire mesh. Well installations are typically completed using push probe drilling to save time and cost but may include many other techniques for drilling a borehole to install the well. This procedure is applicable during all Ash Creek Associates (ACA) drilling activities for installation of monitoring wells.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Field documentation materials
- Personal protective equipment (as required by project Health and Safety Plan)

3. METHODOLOGY

The soil boring for the monitoring well will be completed in accordance with SOP-2.4.

Installation/Construction of Monitoring Well:

Filter Pack. Wells will be constructed of flush-threaded Schedule 40 PVC casing connected to a conventional PVC well screen or pre-packed well screen, placed at the bottom of the boring. A clean silica sand pack will be placed between the boring wall and the PVC screen/riser (i.e., the annulus) from the bottom of the well to approximately one to two feet above the screened interval. Prior to installation of the seal, the well will be surged using a surge block or similar technique. The depth to sand will be measured prior to setting the bentonite seal.

Seal. A bentonite seal, 1 to 2 feet thick, will be placed above the sand. The bentonite will be hydrated and allowed to sit for a minimum of 30 minutes for proper hydration and sealing. The depth to the top of the seal will be measured prior to placing grout. In Washington State and some California counties, the bentonite seal may be placed to within 1 foot of the ground surface in place of grout (per local/state regulations).

Grout. A cement-bentonite slurry will be placed above the bentonite seal following proper hydration. The cement-bentonite slurry will be placed to within 1 foot of the ground surface.

Surface Seal. A concrete surface seal will secure a flush-mounted, traffic-rated monument, or a bollard protected stove-pipe stickup. A locking cap and lock will secure the wellhead, and tamper-resistant bolts (either pentagonal or Allen wrench) will secure a monument cover if a flush-mounted monument is used for surface completion. Flush-mounted surface completions will be completed slightly above grade to prevent the ponding of water in, and around, the monument. All monuments will be permanently marked with well identification numbers. The identification number should be marked on the well (e.g., punched into monument ring, written on the well casing and/or cap with permanent marker, etc.). A survey point should also be added to the well casing (e.g., v-notch cut in PVC).

Documentation:

The field geologist will document the well construction activities. Details to be noted include the following:

- Length of well components;
- Measurements of bentonite, sand, and concrete depths;
- Types, brands, and amounts of materials used;
- Documentation of decontamination; and
- Any deviation from standard procedures or problems during the installation activities.

The drilling contractor will be responsible for conforming to all applicable regulations pertaining to well construction.

1. PURPOSE AND SCOPE

The objective of this standard operating procedure (SOP) is to define the methods and requirements for collection of groundwater samples from monitoring wells applying low flow protocols. Low flow sampling is a technique for collecting samples that does not require the removal of large volumes of water and therefore does not overly agitate the water, suspend particles, or potentially aspirate VOCs. Typical flow rates for low flow sampling should range from 0.1 L/min to 0.5 L/min depending on site characteristics. The groundwater monitoring activities will consist of measuring water levels, purging and sampling groundwater, and measuring groundwater field parameters. This procedure is applicable during all Cascadia Associates, LLC low flow groundwater sampling activities.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Traffic cones, tools, keys, and buckets/drums;
- Water quality meter with calibration solutions (record daily calibration/calibration check in field notes);
- Sampling equipment (water level indicator, pump, tubing);
- Laboratory-supplied sample containers (Consult the project-specific sampling and analysis plan (SAP) for sampling requirements);
- Field documentation materials;
- Decontamination materials; and
- Personal protective equipment (consult the site-specific Health and Safety Plan).

3. METHODOLOGY

Water Levels:

Water levels in the wells will be measured and recorded for the purpose of determining groundwater elevations and gradient. The wells will be opened and the water level allowed to equilibrate before the measurements are taken. Measurements of the depth to water will be made to the nearest 0.01 foot using an electronic water level indicator.

Purging:

Purge using low-flow sampling equipment (e.g., peristaltic or bladder pump) at a rate no greater than the recharge rate of the groundwater to prevent water table drawdown. Unless specified otherwise in the project-specific SAP the sample tubing/pump will be lowered to the middle of the screened interval. Groundwater field parameters (pH, electrical conductivity, and temperature) will be measured using a water quality meter and flow cell connected to the discharge tubing of the sample pump to assess the effectiveness of purging. Purging will be considered complete when the water quality parameters (i.e., pH, temperature, and specific conductance) stabilize within 10 percent for three consecutive 3-minute intervals. Consult the

project-specific SAP for additional parameters and stabilization criteria. Purge water will be placed in Department of Transportation (DOT) approved drums.

Sample Collection:

After the purging of each well is complete, collect groundwater samples for chemical analyses using the same pump used for the well purging.

Low Yield Sampling Procedure:

If a well pumps dry during purging discontinue measurement of water quality parameters. Collect groundwater samples once the water level recovers to 90 percent of the pre-purge water column. Contact project manager in the event of slow recharge conditions. Always collect samples for VOC analysis as soon after recharge as possible.

ATTACHMENT D

LABORATORY DATA WITH DATA QUALITY REVIEW

1.0 INTRODUCTION

This attachment documents the results of a quality assurance/quality control (QA/QC) review of the analytical data for the groundwater samples collected as part of the pilot study implementation at the NuStar Terminals Operations Partnership (NuStar) Annex Terminal in Vancouver, Washington (the Facility). Baseline groundwater sampling was completed between October 23 and 24, 2017. The initial performance sampling following completion of the pilot study injections was completed on November 30, 2017. Groundwater sample analyses were performed by an accredited environmental laboratory, Environmental Science Corporation of Mt. Juliet, Tennessee. Copies of the laboratory reports are included in this attachment.

Report	Report Date	Sampling Event
L946549	October 26, 2017	Groundwater Monitoring
L948749	October 28, 2017	Groundwater Monitoring
L954460	December 1, 2017	Groundwater Monitoring

2.0 DATA VALIDATION

The QA review included examination and validation of the laboratory data packages for the following:

- Analytical preparation and quantitation methods
- Analytical method holding times
- Sample handling
- Chain of custody handling
- Detection and reporting limits
- Method blank detections
- Laboratory control samples, matrix spikes and surrogates to assess laboratory accuracy
- Laboratory control sample duplicates and matrix spike duplicates to assess laboratory precision
- Field duplicates to assess sampling and laboratory precision

The QA/QC review did not include a review of raw data.

2.1 DATA QUALIFIERS

Any data that is found to have possible bias or error was qualified and flagged. The flags used in the data table are below.

B	Analyte is found in the associated method blank.
J	Result is an estimated value.
J+	Result is estimated and biased high.
J-	Result is estimated and biased low.
Q	Sample prepared and/or analyzed outside of recommended holding time. Result is considered biased low.

3.0 ANALYTICAL METHODS

Groundwater sample analyses included the following.

- Gasoline-range petroleum hydrocarbons (TPHg) by Method NWTPH-Gx;
- Diesel-range petroleum hydrocarbons (TPHd) and oil-range petroleum hydrocarbons (TPHo) by Method NWTPH-Dx with silica gel cleanup; and
- Benzene, toluene, ethylbenzene, and xylenes (collectively BTEX), methyl tert-butyl ether (MTBE) and ethanol by U.S. Environmental Protection Agency (EPA) Method 8260B.

4.0 QUALITY ASSURANCE OBJECTIONS AND REVIEW

The general QA objectives for this project were to develop and implement procedures for obtaining, evaluating, and confirming the usability of data of a specified quality for monitoring groundwater quality trends at the Facility. To collect such information, analytical data must have an appropriate degree of accuracy and reproducibility, samples collected must be representative of actual field conditions, and samples must be collected and analyzed using unbroken COC procedures.

Reporting limits and analytical results for the samples were compared to Washington Department of Ecology MTCA Method A Cleanup Levels for each parameter. Precision, accuracy, representativeness, completeness, and comparability parameters used to indicate data quality are defined below.

4.1 HOLDING TIMES AND SAMPLE RECEIPT

The holding time is the minimum amount of time the sample can be stored before analytes start to degrade and are not representative of initial sampling concentrations. Holding times are defined by analytical methods. The groundwater samples included in this QA/QC review were analyzed within the method recommended holding time, except for analysis of diesel range hydrocarbons in the duplicate sample collected from well MW-6 during the baseline sampling event. When the lab began sample preparation, a test of pH showed that the MW-6 DUP sample pH was greater than two. While the sample was prepared and analyzed within standard 14-day hold time, the hold time for the NWTPH-Dx analysis with a pH greater than two is seven days. The diesel- and residual-

range results were subsequently flagged as out-of-hold. Below is a table outlining sample holding times based on sampling preservation and matrix.

Method	Matrix	Analyte	Preservative	Hold Time
EPA 8260B	Water	Volatile Organic Compounds	Hydrochloric Acid (HCl) to pH<2; No headspace; Glass	14 days
NWTPH-Gx	Water	Gasoline Range Organics	Hydrochloric Acid (HCl) to pH<2; No headspace; Glass	14 days
NWTPH-Dx	Water	Diesel Range Organics	Hydrochloric Acid (HCl) to pH<2; Amber glass container	14 days

Samples were received on ice below 4^0C by the analytical laboratory. Sampling containers arrived intact and unbroken to the laboratories. Groundwater samples to be analyzed for VOCs were received without headspace in VOA sampling containers. All chain-of-custodies were appropriately relinquished by the Cascadia Associates sampler and received by the intentional environmental laboratory. They were filled out with the correct sample ID, sampling date, sampling time and analyses requested. There were no discrepancies found between the bottles and the chain of custodies received

4.2 REPORTING LIMITS

Reporting limits are the lowest concentration an instrument is capable of accurately detecting an analyte. They are determined by the laboratory and are based on instrumentation capabilities, the matrix of field samples, sample preparation procedures and suggested reporting limits by the EPA or the Oregon Department of Environmental Quality (DEQ). In some cases, the reporting limits may be raised due to high concentrations of analytes or matrix interferences. Detection limits were generally consistent with industry standards and regulatory standards. Reporting limits for individual samples varied based on the magnitude of the chemical impact.

4.3 METHOD BLANKS

A method - or laboratory - blank is a quality control sample prepared by the laboratory from an analyte-free matrix and analyzed in an analytical batch along with environmental and other QC samples. It is used to assess laboratory contamination or background interferences. Some analytes were detected in the laboratory method blanks for the groundwater analyses, as follows.

- For gasoline range organics in batch WG1049399, report L954460, TPH-g was detected in the method blank between the method detection limit (MDL) and the reported detection limit (RDL) but the concentration was less than one half the reporting limit. Sample data were accepted and not flagged.

4.4 ACCURACY

Accuracy compares the accepted reference concentration of an analyte to the concentration determined analytically. Accuracy is measured as a percent recovery. This recovery must be within

a certain range - or control limit - for the data in an analytical batch to be considered acceptable. The analytical laboratory provides quality control samples and surrogates to help determine the accuracy and acceptability of the data reported. These quality control samples and surrogates are discussed below.

4.4.1 Laboratory Control Samples

Laboratory control samples (LCS) and laboratory control duplicate samples (LCSD) were analyzed by the laboratory to assess the accuracy of the analytical methods. One set of LCS and LCSD was analyzed per analytical batch. The LCS and LCSD are prepared from an analyte-free matrix that is spiked with known levels of compounds of concern. The concentrations are measured and compared to the known spiked levels. This comparison is expressed as percent recovery. The percent recoveries for LCS and LCSD quality control samples were within method control limits.

4.4.2 Matrix Spikes

A matrix spike QC sample is used to assess the performance of the analytical method by determining potential matrix interferences. Matrix spike (MS) and matrix spike duplicate (MSD) analyses are performed on one environmental sample per analytical batch. A matrix spike sample uses an environmental sample that is spiked with known concentrations of analytes of interest. The matrix spike is then prepared and analyzed with the same analytical procedures as environmental samples in the analytical batch. The resulting concentration of the matrix spike is then compared to the known - or true - values plus the non-spiked environmental sample concentration. This comparison is expressed as a percent recovery. The percent recoveries for MS and MSD quality control samples were within method control limits.

4.4.3 Surrogates

Surrogates are organic compounds that are similar in chemical composition to the analytes of interest but are not likely to be found in the environment. They are spiked at a known concentration into environmental and batch QC samples prior to sample preparation and analysis. Surrogate recoveries for environmental samples are used to evaluate matrix interference, sample preparation efficiency and analysis performance on a sample-specific basis. Surrogate recoveries were within control limits with the following exceptions.

- Groundwater sample MW-5, report L946519 had a surrogate recovery for the gasoline range organics analysis that was below the method control limit. The gasoline range organics results for this sample are flagged with a J- in the data table as an estimated result that is biased low.

4.5 PRECISION

Precision is measured by how close values of duplicate analyses are to each other. These duplicate analyses are prepared from separate aliquots of the same sample and are analyzed at the same (or similar) time. Precision in the field ensures that samples taken are representative of field concentrations; this is demonstrated by field duplicates. Analytical precision is the ability of the

laboratory to reproduce results that are similar to each other; this is measured through duplicate analysis of environmental and batch QC samples. Precision is estimated by the relative percent difference (RPD) between the original analysis and the duplicate analysis.

4.5.1 Laboratory Control Sample Duplicates

The analytical batch LCS concentration of an analyte is compared to the LCSD concentration of the same analyte. The RPD is calculated from these two concentrations; which must be below a certain percentage to be considered acceptable. The RPD values for the laboratory control samples of the same batch were within the method control limits.

4.5.2 Matrix Spikes

Like the LCS/LCSD, the MS/MSD analyte concentrations are also compared to each other and expressed as a RPD. The RPD values for analytical batch MS/MSD were within the control limit.

4.5.3 Field Duplicate

A field duplicate is a second field sample collected from a selected sample location. Field duplicate samples serve as a check on laboratory precision, sampling quality, as well as potential variability of the sample matrix. The field duplicate is analyzed and compared to the original sample to assess precision. This comparison can be expressed by the RPD between the original and duplicate samples. Application of RPD values is appropriate when the analyte result is five times greater than the reporting limit. Laboratory precision decreases as the analytical result approaches the reporting limit. Some results did exceed the 30 percent control limit but were less than 5 times the reporting limit. Data was accepted and not flagged in the data table, except for the following.

- For sample MW-6 from the baseline sampling event (reports L946549 and L948749), the RPD for TPH-g, TPH-d, and TPH-o between the primary and duplicate sample collected from exceeded the 30 percent control limit. The detected concentrations were more than 5 times the reporting limit. The reported concentrations for TPH-g, TPH-d, and TPH-o in the sample from well MW-6 were J flagged as estimated values.

5.0 CONCLUSION

The overall QA objectives have been met and the data are of adequate quality for use in this project.

Table D-1
Summary of Field Duplicate Data for Analysis of Groundwater Samples
NuStar Terminals Operations Partnership, L.P. - Vancouver Annex Terminal
Vancouver, Washington

Sample Location	Collection Date	Compound	Units	Primary Reporting Limit	Duplicate Reporting Limit	Primary Sample	Duplicate Sample	RPD
MW-6	10/24/2017	TPHg Gasoline	mg/L	0.10	0.10	7.73	4.19	59
		TPHd Diesel	mg/L	1.0	1.0	5.07	8.96	55
		TPHo Motor Oil	mg/L	0.25	0.25	0.11	1.19	166
		Benzene	mg/L	0.05	0.05	0.194	0.153	24
		Toluene	mg/L	0.001	0.001	0.051	0.046	10
		Ethyl-Benzene	mg/L	0.05	0.05	1.51	1.18	25
		Xylenes	mg/L	0.15	0.02	1.29	1.04	21
MW-5	11/30/2017	TPHg Gasoline	mg/L	1.0	0.10	11.3	10.9	4
		TPHd Diesel	mg/L	0.20	0.20	1.63	1.75	7
		TPHo Motor Oil	mg/L	0.25	0.25	<0.25	<0.25	NA
		Benzene	mg/L	0.025	0.001	<0.0250	<0.0010	NA
		Toluene	mg/L	0.025	0.001	<0.0250	0.00112	NA
		Ethyl-Benzene	mg/L	0.025	0.001	0.187	0.187	0
		Xylenes	mg/L	0.075	0.075	1.21	1.48	20

Please see notes at end of table.

1. Only compounds detected in both primary and duplicate samples are shown.
2. Relative Percent Difference (RPD) is calculated as:

$$RPD\,\% = \left| \frac{2(S_1 - S_2)}{S_1 + S_2} \right| \times 100$$

   where: S_1 = primary sample concentration; and
   S_2 = duplicate sample concentration.
3. NA= Not applicable. RPD could not be calculated as one or more concentration value was below reporting limits.

ANALYTICAL REPORT

January 29, 2018

Cascadia Associates- Portland, OR

Sample Delivery Group:	L946549
Samples Received:	10/26/2017
Project Number:	0060-001-001
Description:	Nustar - Vannex Pilot Study
Site:	VANCOUVER, WA
Report To:	Ian Maguire 6915 SW Macadam Ave Ste. 250 Portland, OR 97219

Entire Report Reviewed By:

Brian Ford

Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

TABLE OF CONTENTS

MW-5 L946549-01 GW

Collected by: Ian Maguire | Collected date/time: 10/23/17 13:00 | Received date/time: 10/26/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1036093	1	10/27/17 10:29	10/27/17 10:29	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	1	10/27/17 16:20	10/27/17 16:20	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	25	11/02/17 02:51	11/02/17 02:51	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1036830	1	10/30/17 05:29	10/30/17 15:01	LM

MW-5D L946549-02 GW

Collected by: Ian Maguire | Collected date/time: 10/24/17 09:45 | Received date/time: 10/26/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1036093	1	10/27/17 10:51	10/27/17 10:51	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	1	10/27/17 16:41	10/27/17 16:41	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	1	11/02/17 03:11	11/02/17 03:11	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1036830	1	10/30/17 05:29	10/30/17 15:18	LM

MW-6 L946549-03 GW

Collected by: Ian Maguire | Collected date/time: 10/24/17 11:35 | Received date/time: 10/26/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1036093	1	10/27/17 11:13	10/27/17 11:13	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	1	10/27/17 17:01	10/27/17 17:01	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036371	50	11/02/17 03:31	11/02/17 03:31	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1036830	1	10/30/17 05:29	10/30/17 15:36	LM
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1036830	5	10/30/17 05:29	10/31/17 19:22	LM

HA-1 L946549-04 Solid

Collected by: Ian Maguire | Collected date/time: 10/24/17 15:30 | Received date/time: 10/26/17 08:45

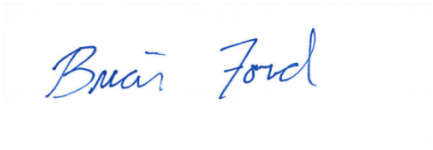
Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Total Solids by Method 2540 G-2011	WG1037601	1	11/01/17 11:06	11/01/17 11:19	KDW
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1036385	500	10/24/17 15:30	10/27/17 15:57	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1036716	1	10/24/17 15:30	11/02/17 11:38	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1037950	1	11/02/17 07:36	11/03/17 21:12	DMG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1037950	5	11/02/17 07:36	11/03/17 22:03	DMG

HA-1 L946549-05 GW

Collected by: Ian Maguire | Collected date/time: 10/24/17 15:30 | Received date/time: 10/26/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Preparation by Method 1312	WG1037226	1	10/31/17 08:01	10/31/17 08:01	TM
Preparation by Method 1312	WG1037796	1	11/01/17 11:45	11/01/17 11:45	KK
Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX	WG1038336	1	11/02/17 14:40	11/02/17 14:40	JHH
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1037937	1	11/01/17 22:37	11/02/17 20:49	CLG

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.



Brian Ford
Technical Service Representative

Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	7930		31.6	100	1	10/27/2017 10:29	WG1036093
(S) a,a,a-Trifluorotoluene(FID)	*67.5*	J2		*77.0-122*		*10/27/2017 10:29*	WG1036093

Sample Narrative:

L946549-01 WG1036093: Surrogate failure due to sample matrix.

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

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Benzene	U		0.331	1.00	1	10/27/2017 16:20	WG1036371
Toluene	1.17		0.412	1.00	1	10/27/2017 16:20	WG1036371
Ethylbenzene	174		9.60	25.0	25	11/02/2017 02:51	WG1036371
Total Xylenes	988		26.5	75.0	25	11/02/2017 02:51	WG1036371
(S) Toluene-d8	*100*			*80.0-120*		*10/27/2017 16:20*	WG1036371
(S) Toluene-d8	*109*			*80.0-120*		*11/02/2017 02:51*	WG1036371
(S) Dibromofluoromethane	*92.2*			*76.0-123*		*10/27/2017 16:20*	WG1036371
(S) Dibromofluoromethane	*99.1*			*76.0-123*		*11/02/2017 02:51*	WG1036371
(S) a,a,a-Trifluorotoluene	*99.7*			*80.0-120*		*10/27/2017 16:20*	WG1036371
(S) a,a,a-Trifluorotoluene	*110*			*80.0-120*		*11/02/2017 02:51*	WG1036371
(S) 4-Bromofluorobenzene	*90.7*			*80.0-120*		*11/02/2017 02:51*	WG1036371
(S) 4-Bromofluorobenzene	*95.7*			*80.0-120*		*10/27/2017 16:20*	WG1036371

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	1260		66.0	200	1	10/30/2017 15:01	WG1036830
Residual Range Organics (RRO)	U		82.5	250	1	10/30/2017 15:01	WG1036830
(S) o-Terphenyl	*85.7*			*52.0-156*		*10/30/2017 15:01*	WG1036830

Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	422		31.6	100	1	10/27/2017 10:51	WG1036093
(S) a,a,a-Trifluorotoluene(FID)	*98.9*			*77.0-122*		*10/27/2017 10:51*	WG1036093

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

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Benzene	U		0.331	1.00	1	10/27/2017 16:41	WG1036371
Toluene	U		0.412	1.00	1	10/27/2017 16:41	WG1036371
Ethylbenzene	1.38		0.384	1.00	1	11/02/2017 03:11	WG1036371
Total Xylenes	2.96	J	1.06	3.00	1	11/02/2017 03:11	WG1036371
(S) Toluene-d8	*108*			*80.0-120*		*11/02/2017 03:11*	WG1036371
(S) Toluene-d8	*106*			*80.0-120*		*10/27/2017 16:41*	WG1036371
(S) Dibromofluoromethane	*93.3*			*76.0-123*		*10/27/2017 16:41*	WG1036371
(S) Dibromofluoromethane	*98.5*			*76.0-123*		*11/02/2017 03:11*	WG1036371
(S) a,a,a-Trifluorotoluene	*104*			*80.0-120*		*10/27/2017 16:41*	WG1036371
(S) a,a,a-Trifluorotoluene	*110*			*80.0-120*		*11/02/2017 03:11*	WG1036371
(S) 4-Bromofluorobenzene	*95.2*			*80.0-120*		*10/27/2017 16:41*	WG1036371
(S) 4-Bromofluorobenzene	*90.3*			*80.0-120*		*11/02/2017 03:11*	WG1036371

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	147	J	66.0	200	1	10/30/2017 15:18	WG1036830
Residual Range Organics (RRO)	U		82.5	250	1	10/30/2017 15:18	WG1036830
(S) o-Terphenyl	*87.5*			*52.0-156*		*10/30/2017 15:18*	WG1036830

Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	7730		31.6	100	1	10/27/2017 11:13	WG1036093
(S) a,a,a-Trifluorotoluene(FID)	*82.2*			*77.0-122*		*10/27/2017 11:13*	WG1036093

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

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Benzene	194		16.6	50.0	50	11/02/2017 03:31	WG1036371
Toluene	51.2		0.412	1.00	1	10/27/2017 17:01	WG1036371
Ethylbenzene	1510		19.2	50.0	50	11/02/2017 03:31	WG1036371
Total Xylenes	1290		53.0	150	50	11/02/2017 03:31	WG1036371
(S) Toluene-d8	*105*			*80.0-120*		*11/02/2017 03:31*	WG1036371
(S) Toluene-d8	*102*			*80.0-120*		*10/27/2017 17:01*	WG1036371
(S) Dibromofluoromethane	*101*			*76.0-123*		*11/02/2017 03:31*	WG1036371
(S) Dibromofluoromethane	*90.2*			*76.0-123*		*10/27/2017 17:01*	WG1036371
(S) a,a,a-Trifluorotoluene	*104*			*80.0-120*		*10/27/2017 17:01*	WG1036371
(S) a,a,a-Trifluorotoluene	*115*			*80.0-120*		*11/02/2017 03:31*	WG1036371
(S) 4-Bromofluorobenzene	*86.0*			*80.0-120*		*11/02/2017 03:31*	WG1036371
(S) 4-Bromofluorobenzene	*97.5*			*80.0-120*		*10/27/2017 17:01*	WG1036371

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	5070		330	1000	5	10/31/2017 19:22	WG1036830
Residual Range Organics (RRO)	111	J	82.5	250	1	10/30/2017 15:36	WG1036830
(S) o-Terphenyl	*94.7*			*52.0-156*		*10/30/2017 15:36*	WG1036830
(S) o-Terphenyl	*95.5*			*52.0-156*		*10/31/2017 19:22*	WG1036830

Total Solids by Method 2540 G-2011

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	%			date / time	
Total Solids	70.8		1	11/01/2017 11:19	WG1037601

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Gasoline Range Organics-NWTPH	1890		24.0	70.6	500	10/27/2017 15:57	WG1036385
(S) a,a,a-Trifluorotoluene(FID)	*93.6*			*77.0-120*		*10/27/2017 15:57*	WG1036385

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

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Benzene	U		0.00183	0.00353	1	11/02/2017 11:38	WG1036716
Toluene	0.0128		0.00374	0.00706	1	11/02/2017 11:38	WG1036716
Ethylbenzene	0.0105		0.00182	0.00353	1	11/02/2017 11:38	WG1036716
Total Xylenes	0.0334		0.00176	0.0106	1	11/02/2017 11:38	WG1036716
(S) Toluene-d8	*109*			*80.0-120*		*11/02/2017 11:38*	WG1036716
(S) Dibromofluoromethane	*101*			*74.0-131*		*11/02/2017 11:38*	WG1036716
(S) a,a,a-Trifluorotoluene	*96.0*			*80.0-120*		*11/02/2017 11:38*	WG1036716
(S) 4-Bromofluorobenzene	*161*	J1		*64.0-132*		*11/02/2017 11:38*	WG1036716

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result (dry)	Qualifier	MDL (dry)	RDL (dry)	Dilution	Analysis	Batch
	mg/kg		mg/kg	mg/kg		date / time	
Diesel Range Organics (DRO)	427		9.32	28.2	5	11/03/2017 22:03	WG1037950
Residual Range Organics (RRO)	U		4.66	14.1	1	11/03/2017 21:12	WG1037950
(S) o-Terphenyl	*61.8*			*18.0-148*		*11/03/2017 21:12*	WG1037950
(S) o-Terphenyl	*72.0*			*18.0-148*		*11/03/2017 22:03*	WG1037950

Preparation by Method 1312

Analyte	Result	Qualifier	Prep date / time	Batch
SPLP Extraction	-		10/31/2017 8:01:58 AM	WG1037226
SPLP ZHE Extraction	-		11/1/2017 11:45:56 AM	WG1037796
Fluid	2		10/31/2017 8:01:58 AM	WG1037226
Initial pH	4.81		10/31/2017 8:01:58 AM	WG1037226
Final pH	4.74		10/31/2017 8:01:58 AM	WG1037226

Volatile Organic Compounds (GC) by Method 8021B/NWTPHGX

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Gasoline Range Organics-NWTPH	562		31.6	100	1	11/02/2017 14:40	WG1038336
Benzene	0.601	B	0.190	0.500	1	11/02/2017 14:40	WG1038336
Toluene	1.86	B	0.412	1.00	1	11/02/2017 14:40	WG1038336
Ethylbenzene	57.8		0.160	0.500	1	11/02/2017 14:40	WG1038336
Total Xylene	10.4		0.510	1.50	1	11/02/2017 14:40	WG1038336
(S) a,a,a-Trifluorotoluene(PID)	*102*			*80.0-121*		*11/02/2017 14:40*	WG1038336
(S) a,a,a-Trifluorotoluene(FID)	*94.7*			*77.0-122*		*11/02/2017 14:40*	WG1038336

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result ug/l	Qualifier	MDL ug/l	RDL ug/l	Dilution	Analysis date / time	Batch
Diesel Range Organics (DRO)	1620		66.0	200	1	11/02/2017 20:49	WG1037937
Residual Range Organics (RRO)	152	J	82.5	250	1	11/02/2017 20:49	WG1037937
(S) o-Terphenyl	*67.1*			*52.0-156*		*11/02/2017 20:49*	WG1037937

Method Blank (MB)

(MB) R3262355-1 11/01/17 11:19

Analyte	MB Result %	MB Qualifier	MB MDL %	MB RDL %
Total Solids	0.0007			

L946549-04 Original Sample (OS) • Duplicate (DUP)

(OS) L946549-04 11/01/17 11:19 • (DUP) R3262355-3 11/01/17 11:19

Analyte	Original Result %	DUP Result %	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Total Solids	70.8	70.5	1	0		5

Laboratory Control Sample (LCS)

(LCS) R3262355-2 11/01/17 11:19

Analyte	Spike Amount %	LCS Result %	LCS Rec. %	Rec. Limits %	LCS Qualifier
Total Solids	50.0	50.0	100	85-115	

Method Blank (MB)

(MB) R3262620-3 11/02/17 14:18

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Gasoline Range Organics-NWTPH	U		31.6	100
Benzene	0.313	J	0.190	0.500
Toluene	0.461	J	0.412	1.00
Ethylbenzene	U		0.160	0.500
Total Xylene	U		0.510	1.50
(S) a,a,a-Trifluorotoluene(PID)	*103*			*80.0-121*
(S) a,a,a-Trifluorotoluene(FID)	*93.8*			*77.0-122*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3262620-1 11/02/17 10:02 • (LCSD) R3262620-2 11/02/17 10:24

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	4240	3960	77.0	72.0	72.0-134			6.80	20
(S) a,a,a-Trifluorotoluene(FID)				*108*	*107*	*77.0-122*				

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3262620-6 11/03/17 03:52 • (LCSD) R3262620-7 11/03/17 04:51

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Benzene	50.0	48.6	47.4	97.3	94.9	71.0-121			2.48	20
Toluene	50.0	53.0	51.2	106	102	72.0-120			3.30	20
Ethylbenzene	50.0	53.4	51.9	107	104	75.0-122			2.74	20
Total Xylene	150	154	147	103	98.0	74.0-124			4.78	20
(S) a,a,a-Trifluorotoluene(PID)				*102*	*101*	*80.0-121*				
(S) a,a,a-Trifluorotoluene(FID)				*94.8*	*93.8*	*77.0-122*				

L946549-05 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946549-05 11/02/17 14:40 • (MS) R3262620-4 11/02/17 16:25 • (MSD) R3262620-5 11/02/17 16:47

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	562	5410	5490	88.1	89.7	1	23.0-159			1.61	20
(S) a,a,a-Trifluorotoluene(FID)					*107*	*107*		*77.0-122*				

Method Blank (MB)

(MB) R3261836-3 10/27/17 03:28

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Gasoline Range Organics-NWTPH	U		31.6	100
(S) a,a,a-Trifluorotoluene(FID)	*100*			*77.0-122*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3261836-1 10/27/17 02:21 • (LCSD) R3261836-2 10/27/17 02:43

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	5800	5820	105	106	72.0-134			0.310	20
(S) a,a,a-Trifluorotoluene(FID)				*102*	*102*	*77.0-122*				

L946549-03 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946549-03 10/27/17 11:13 • (MS) R3261836-4 10/27/17 11:35 • (MSD) R3261836-5 10/27/17 11:57

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	7730	10900	11100	57.4	61.6	1	23.0-159		E	2.10	20
(S) a,a,a-Trifluorotoluene(FID)					*97.6*	*96.6*		*77.0-122*				

Method Blank (MB)

(MB) R3261308-3 10/27/17 12:20

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Gasoline Range Organics-NWTPH	U		0.0339	0.100
(S) a,a,a-Trifluorotoluene(FID)	*93.9*			*77.0-120*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3261308-1 10/27/17 10:29 • (LCSD) R3261308-2 10/27/17 10:53

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5.50	6.47	6.35	118	115	70.0-133			1.81	20
(S) a,a,a-Trifluorotoluene(FID)				*100*	*101*	*77.0-120*				

L946549-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946549-04 10/27/17 15:57 • (MS) R3261308-4 10/27/17 20:20 • (MSD) R3261308-5 10/27/17 20:44

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	7.76	1890	6260	5740	112	99.0	500	10.0-146			8.70	30
(S) a,a,a-Trifluorotoluene(FID)					*97.9*	*98.0*		*77.0-120*				

Method Blank (MB)

(MB) R3262256-2 10/27/17 15:39

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Benzene	U		0.331	1.00
Ethylbenzene	U		0.384	1.00
Toluene	U		0.412	1.00
Xylenes, Total	U		1.06	3.00
(S) Toluene-d8	*111*			*80.0-120*
(S) Dibromofluoromethane	*94.4*			*76.0-123*
(S) 4-Bromofluorobenzene	*98.2*			*80.0-120*
(S) a,a,a-Trifluorotoluene	*106*			*80.0-120*

Laboratory Control Sample (LCS)

(LCS) R3262256-1 10/27/17 14:38

Analyte	Spike Amount ug/l	LCS Result ug/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Benzene	25.0	21.5	86.1	69.0-123	
Ethylbenzene	25.0	24.9	99.6	77.0-120	
Toluene	25.0	24.6	98.5	77.0-120	
Xylenes, Total	75.0	74.3	99.1	77.0-120	
(S) Toluene-d8			*103*	*80.0-120*	
(S) Dibromofluoromethane			*92.7*	*76.0-123*	
(S) 4-Bromofluorobenzene			*97.4*	*80.0-120*	
(S) a,a,a-Trifluorotoluene			*104*	*80.0-120*	

Method Blank (MB)

(MB) R3262116-3 11/01/17 11:07

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Benzene	U		0.00130	0.00250
Ethylbenzene	U		0.00129	0.00250
Toluene	U		0.00265	0.00500
Xylenes, Total	U		0.00125	0.00750
(S) Toluene-d8	*104*			*80.0-120*
(S) Dibromofluoromethane	*95.2*			*74.0-131*
(S) a,a,a-Trifluorotoluene	*100*			*80.0-120*
(S) 4-Bromofluorobenzene	*99.6*			*64.0-132*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3262116-1 11/01/17 09:52 • (LCSD) R3262116-2 11/01/17 10:11

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Benzene	0.625	0.613	0.587	98.1	93.9	72.6-120			4.39	20
Ethylbenzene	0.625	0.596	0.614	95.3	98.2	78.6-124			3.05	20
Toluene	0.625	0.586	0.608	93.8	97.3	76.7-116			3.62	20
Xylenes, Total	1.88	1.83	1.88	97.5	100	78.1-123			2.86	20
(S) Toluene-d8				*102*	*106*	*80.0-120*				
(S) Dibromofluoromethane				*105*	*98.0*	*74.0-131*				
(S) a,a,a-Trifluorotoluene				*102*	*102*	*80.0-120*				
(S) 4-Bromofluorobenzene				*98.7*	*98.4*	*64.0-132*				

L946651-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946651-04 11/01/17 15:45 • (MS) R3262116-4 11/01/17 18:52 • (MSD) R3262116-5 11/01/17 19:11

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Benzene	0.759	ND	0.397	0.544	52.3	71.6	1	47.8-131		J3	31.1	22.8
Ethylbenzene	0.759	ND	0.440	0.575	58.0	75.8	1	44.8-135			26.5	26.9
Toluene	0.759	ND	0.442	0.574	58.2	75.6	1	47.8-127		J3	26.0	24.3
Xylenes, Total	2.28	ND	1.37	1.74	59.9	76.3	1	42.7-135			24.0	26.6
(S) Toluene-d8					*105*	*106*		*80.0-120*				
(S) Dibromofluoromethane					*92.1*	*92.6*		*74.0-131*				
(S) a,a,a-Trifluorotoluene					*104*	*103*		*80.0-120*				
(S) 4-Bromofluorobenzene					*101*	*101*		*64.0-132*				

Method Blank (MB)

(MB) R3261738-1 10/30/17 13:33

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*87.5*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3261738-2 10/30/17 13:51 • (LCSD) R3261738-3 10/30/17 14:08

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	750	775	849	103	113	50.0-150			9.10	20
Residual Range Organics (RRO)	750	706	847	94.2	113	50.0-150			18.1	20
(S) o-Terphenyl				*84.9*	*90.7*	*52.0-156*				

Method Blank (MB)

(MB) R3263425-1 11/02/17 17:53

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*81.4*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3263425-2 11/02/17 18:09 • (LCSD) R3263425-3 11/02/17 18:25

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	750	733	705	97.8	94.0	50.0-150			3.91	20
Residual Range Organics (RRO)	750	785	777	105	104	50.0-150			1.03	20
(S) o-Terphenyl				*81.6*	*82.6*	*52.0-156*				

Method Blank (MB)

(MB) R3262687-1 11/02/17 17:35

Analyte	MB Result mg/kg	MB Qualifier	MB MDL mg/kg	MB RDL mg/kg
Diesel Range Organics (DRO)	U		1.33	4.00
Residual Range Organics (RRO)	U		3.33	10.0
(S) o-Terphenyl	*51.6*			*18.0-148*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3262687-2 11/02/17 17:52 • (LCSD) R3262687-3 11/02/17 18:09

Analyte	Spike Amount mg/kg	LCS Result mg/kg	LCSD Result mg/kg	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	30.0	19.1	20.5	63.5	68.4	50.0-150			7.40	20
Residual Range Organics (RRO)	30.0	17.3	17.8	57.7	59.2	50.0-150			2.61	20
(S) o-Terphenyl				*66.5*	*72.5*	*18.0-148*				

L946611-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L946611-01 11/03/17 20:21 • (MS) R3262971-1 11/03/17 20:38 • (MSD) R3262971-2 11/03/17 20:55

Analyte	Spike Amount (dry) mg/kg	Original Result (dry) mg/kg	MS Result (dry) mg/kg	MSD Result (dry) mg/kg	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	38.0	3.93	18.5	26.3	38.4	58.7	1	50.0-150	J6	J3	34.5	20
Residual Range Organics (RRO)	38.0	51.2	60.1	79.5	23.5	74.3	1	50.0-150	J6	J3	27.7	20
(S) o-Terphenyl					*39.3*	*50.3*		*18.0-148*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

(dry)	Results are reported based on the dry weight of the sample. [this will only be present on a dry report basis for soils].
MDL	Method Detection Limit.
MDL (dry)	Method Detection Limit.
RDL	Reported Detection Limit.
RDL (dry)	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
B	The same analyte is found in the associated blank.
E	The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration (ICAL).
J	The identification of the analyte is acceptable; the reported value is an estimate.
J1	Surrogate recovery limits have been exceeded; values are outside upper control limits.
J2	Surrogate recovery limits have been exceeded; values are outside lower control limits.
J3	The associated batch QC was outside the established quality control range for precision.
J6	The sample matrix interfered with the ability to make any accurate determination; spike value is low.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Connecticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1 4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

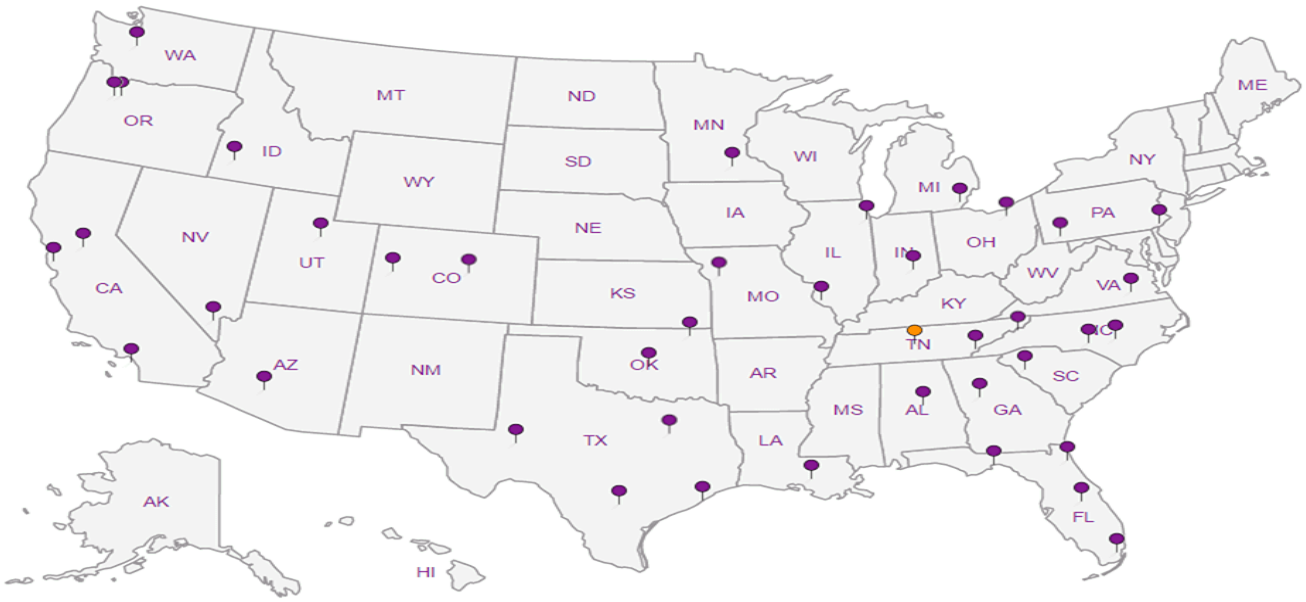
Third Party Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold n/a Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. ESC Lab Sciences performs all testing at our central laboratory.



Cascadia Associates- Portland, OR

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Report to: Ian Maguire

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Project Description: Nustar- Vannex Pilot Study

City/State Collected: Vancouver, WA

Phone: 503-906-6577
Fax:

Client Project # 0060-001-001

Lab Project # CASASCTOR-NUVANCOUVE

Collected by (print): Ian Maguire

Site/Facility ID # VANCOUVER, WA

P.O. # ~~0060-001-001~~

Collected by (signature): Ian Maguire
Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Date Results Needed

Quote #

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI (w/ SGT) 40mlAmb-HCl-BT	NWTPHGX 40mlAmb HCl	V8260BTEXC 40mlAmb-HCl	NWTPH-GX	NWTPH-DX	BTEX (8260)	SPLP *				Remarks	Sample # (lab only)
MW-5	Grab	GW	NA	10/23/17	1300	8	X	X	X									-01
MW-5D	Grab	GW	NA	10/24/17	945	8	X	X	X									-02
MW-6	Grab	GW	NA	10/24/17	1135	8	X	X	X									-03
MW-6 DUP	Grab	GW	NA	10/24/17	1135	8	H	H	H									
		~~GW~~																
HA-1	Grab	Soil	6'	10/24/17	1530	8				X	X	X	X					-04/05

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC LAB SCIENCES
a subsidiary of Accutest

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# L946549

Tab E124

Acctnum: CASASCTOR

Template: T128931

Prelogin: P622609

TSR: 110 - Brian Ford

PB:

Shipped Via:

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other

Remarks: * Contact Ian for specific metals.

pH ___ Temp ___

Flow ___ Other ___

Samples returned via:
__ UPS X FedEx __ Courier __ ___

Tracking # 7480 1463 3873

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
[signature]	10/25/17	1205	[signature] ESCLon
[signature] ESCLon	10/25/17	1230	

Trip Blank Received: Yes / No
HCL / MeoH
TBR

Temp: 0.4 °C Bottles Received: 40

If preservation required by Login: Date/Time

Received for lab by: (Signature) [signature] MW 860

Date: 10/26/17 Time: 8:45

10-145

Condition: NCF / OK

ANALYTICAL REPORT

November 14, 2017

Cascadia Associates- Portland, OR

Sample Delivery Group:	L948749
Samples Received:	10/28/2017
Project Number:	0060-001-001
Description:	Nustar - Vannex Pilot Study
Site:	VANCOUVER, WA
Report To:	Ian Maguire 6915 SW Macadam Ave Ste. 250 Portland, OR 97219

Entire Report Reviewed By:

Brian Ford

Technical Service Representative

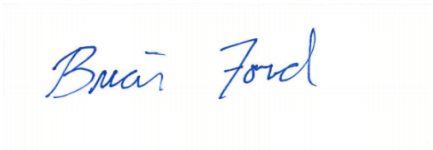
TABLE OF CONTENTS

MW-6 DUP L948749-01 GW

Collected by	Collected date/time	Received date/time
Ian Maguire	10/24/17 11:35	10/28/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1040147	1	11/07/17 19:15	11/07/17 19:15	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1039917	1	11/07/17 14:00	11/07/17 14:00	ACG
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1039917	50	11/07/17 15:19	11/07/17 15:19	ACG
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1039652	1	11/07/17 17:09	11/08/17 14:39	LM
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1039652	5	11/07/17 17:09	11/08/17 19:47	LM

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.



Brian Ford
Technical Service Representative

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	4190		31.6	100	1	11/07/2017 19:15	WG1040147
(S) a,a,a-Trifluorotoluene(FID)	*82.2*			*77.0-122*		*11/07/2017 19:15*	WG1040147

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

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	153		16.6	50.0	50	11/07/2017 15:19	WG1039917
Toluene	46.2		0.412	1.00	1	11/07/2017 14:00	WG1039917
Ethylbenzene	1180		19.2	50.0	50	11/07/2017 15:19	WG1039917
Total Xylenes	1040		53.0	150	50	11/07/2017 15:19	WG1039917
(S) Toluene-d8	*102*			*80.0-120*		*11/07/2017 14:00*	WG1039917
(S) Toluene-d8	*111*			*80.0-120*		*11/07/2017 15:19*	WG1039917
(S) Dibromofluoromethane	*103*			*76.0-123*		*11/07/2017 15:19*	WG1039917
(S) Dibromofluoromethane	*105*			*76.0-123*		*11/07/2017 14:00*	WG1039917
(S) a,a,a-Trifluorotoluene	*101*			*80.0-120*		*11/07/2017 14:00*	WG1039917
(S) a,a,a-Trifluorotoluene	*107*			*80.0-120*		*11/07/2017 15:19*	WG1039917
(S) 4-Bromofluorobenzene	*96.3*			*80.0-120*		*11/07/2017 15:19*	WG1039917
(S) 4-Bromofluorobenzene	*91.1*			*80.0-120*		*11/07/2017 14:00*	WG1039917

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	8960	Q	330	1000	5	11/08/2017 19:47	WG1039652
Residual Range Organics (RRO)	1190	Q	82.5	250	1	11/08/2017 14:39	WG1039652
(S) o-Terphenyl	*71.0*			*52.0-156*		*11/08/2017 19:47*	WG1039652
(S) o-Terphenyl	*112*			*52.0-156*		*11/08/2017 14:39*	WG1039652

Method Blank (MB)

(MB) R3263837-3 11/07/17 17:37

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Gasoline Range Organics-NWTPH	U		31.6	100
(S) a,a,a-Trifluorotoluene(FID)	*95.9*			*77.0-122*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3263837-1 11/07/17 16:30 • (LCSD) R3263837-2 11/07/17 16:52

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	4370	4300	79.5	78.2	72.0-134			1.61	20
(S) a,a,a-Trifluorotoluene(FID)				*97.7*	*102*	*77.0-122*				

L948847-14 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L948847-14 11/08/17 11:56 • (MS) R3263837-4 11/08/17 12:18 • (MSD) R3263837-5 11/08/17 12:41

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	U	2090	2010	38.1	36.6	1	23.0-159			3.97	20
(S) a,a,a-Trifluorotoluene(FID)					*97.1*	*96.6*		*77.0-122*				

Method Blank (MB)

(MB) R3263749-3 11/07/17 10:29

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	ug/l		ug/l	ug/l
Benzene	U		0.331	1.00
Ethylbenzene	U		0.384	1.00
Toluene	U		0.412	1.00
Xylenes, Total	U		1.06	3.00
(S) Toluene-d8	*108*			*80.0-120*
(S) Dibromofluoromethane	*100*			*76.0-123*
(S) a,a,a-Trifluorotoluene	*111*			*80.0-120*
(S) 4-Bromofluorobenzene	*99.7*			*80.0-120*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3263749-1 11/07/17 09:30 • (LCSD) R3263749-2 11/07/17 09:49

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	ug/l	ug/l	ug/l	%	%	%			%	%
Benzene	25.0	23.9	24.4	95.4	97.5	69.0-123			2.16	20
Ethylbenzene	25.0	25.1	25.2	101	101	77.0-120			0.100	20
Toluene	25.0	23.1	23.4	92.4	93.6	77.0-120			1.20	20
Xylenes, Total	75.0	79.9	78.3	107	104	77.0-120			2.02	20
(S) Toluene-d8				*104*	*104*	*80.0-120*				
(S) Dibromofluoromethane				*106*	*105*	*76.0-123*				
(S) a,a,a-Trifluorotoluene				*110*	*107*	*80.0-120*				
(S) 4-Bromofluorobenzene				*96.2*	*99.7*	*80.0-120*				

Method Blank (MB)

(MB) R3264068-1 11/08/17 11:08

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*73.6*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3264068-2 11/08/17 11:24 • (LCSD) R3264068-3 11/08/17 11:40

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	750	796	811	106	108	50.0-150			1.90	20
Residual Range Organics (RRO)	750	757	762	101	102	50.0-150			0.570	20
(S) o-Terphenyl				*76.6*	*74.1*	*52.0-156*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDL	Method Detection Limit.
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
Q	Sample was prepared and/or analyzed past recommended holding time. Concentrations should be considered minimum values.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
***** Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660
Alaska	UST-080
Arizona	AZ0612
Arkansas	88-0469
California	01157CA
Colorado	TN00003
Conneticut	PH-0197
Florida	E87487
Georgia	NELAP
Georgia [1]	923
Idaho	TN00003
Illinois	200008
Indiana	C-TN-01
Iowa	364
Kansas	E-10277
Kentucky [1]	90010
Kentucky [2]	16
Louisiana	AI30792
Maine	TN0002
Maryland	324
Massachusetts	M-TN003
Michigan	9958
Minnesota	047-999-395
Mississippi	TN00003
Missouri	340
Montana	CERT0086
Nebraska	NE-OS-15-05
Nevada	TN-03-2002-34
New Hampshire	2975
New Jersey–NELAP	TN002
New Mexico	TN00003
New York	11742
North Carolina	Env375
North Carolina [1]	DW21704
North Carolina [2]	41
North Dakota	R-140
Ohio–VAP	CL0069
Oklahoma	9915
Oregon	TN200002
Pennsylvania	68-02979
Rhode Island	221
South Carolina	84004
South Dakota	n/a
Tennessee [1 4]	2006
Texas	T 104704245-07-TX
Texas [5]	LAB0152
Utah	6157585858
Vermont	VT2006
Virginia	109
Washington	C1915
West Virginia	233
Wisconsin	9980939910
Wyoming	A2LA

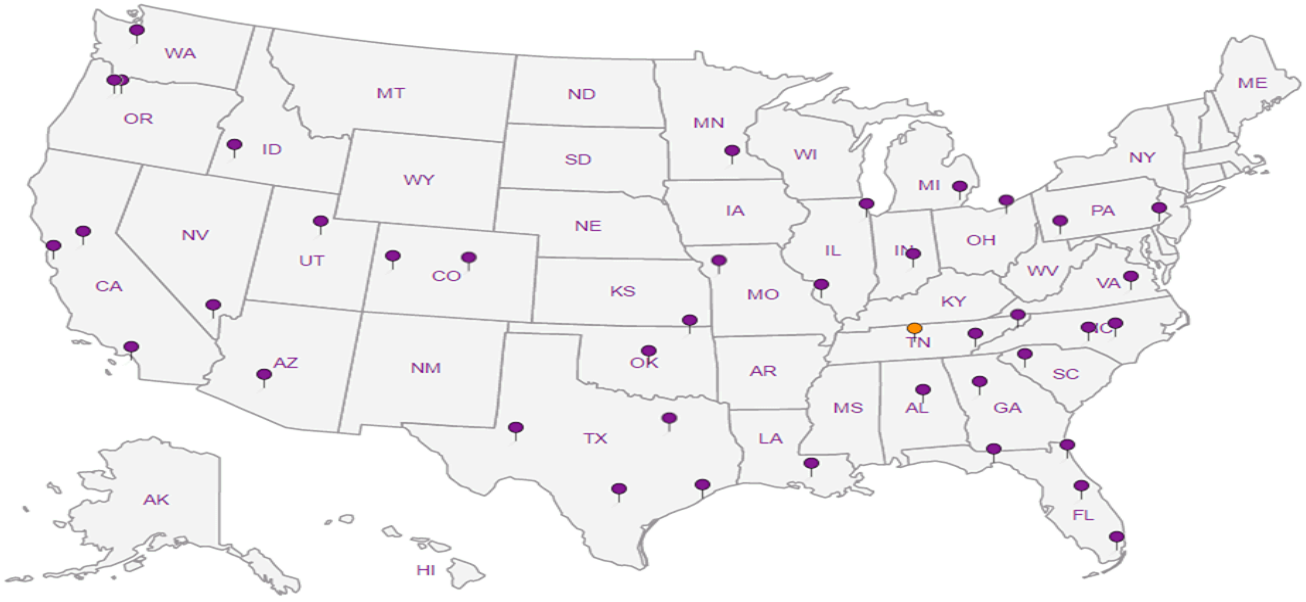
Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01
A2LA – ISO 17025 [5]	1461.02
Canada	1461.01
EPA–Crypto	TN00003
AIHA-LAP,LLC	100789
DOD	1461.01
USDA	S-67674

[1.] Drinking Water [2.] Underground Storage Tanks [3.] Aquatic Toxicity [4.] Chemical/Microbiological [5.] Mold [n/a] Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



Cascadia Associates- Portland, OR

6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Billing Information:
Accounts Payable- Chris Breemer
6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Email To: imaguire@cascadiaassociates.com

Report to: Ian Maguire

Project Description: Nustar- Vannex Pilot Study

City/State Collected: Vancouver, WA

Phone: 503-906-6577
Fax:

Client Project # 0060-001-001

Lab Project # CASASCTOR-NUVANCOUVE

Collected by (print): Ian Maguire

Site/Facility ID # VANCOUVER, WA

P.O. # ~~0060-001-001~~

Collected by (signature): Ian Maguire

Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Date Results Needed

Quote #

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC LAB SCIENCES
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# ~~L944549~~

Table E124

1948749

N 11/2/17

Acctnum: CASASCTOR

Template: T128931

Prelogin: P622609

TSR: 110 - Brian Ford

PB:

Shipped Via:

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI (w/ SGT) 40mlAmb-HCl-BT	NWTPHGX 40mlAmb HCl	V8260BTEXC 40mlAmb-HCl	NWTPH-GX	NWTPH-DX	BTEX (8260B)	SPLP	Remarks	Sample # (lab only)
MW-5	Grab	GW	NA	10/23/17	1300	8	X	X	X						~~-01~~
MW-5D	Grab	GW	NA	10/24/17	945	8	X	X	X						~~-02~~
MW-6	Grab	GW	NA	10/24/17	1135	8	X	X	X						~~-03~~
MW-6 DUP	Grab	GW	NA	10/24/17	1135	8	H	H	H						-01
		~~GW~~								X	X	X	X		~~04 thru 05~~
HA-1	Grab	Soil	6'	10/24/17	1530	8									

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other ___

Remarks: # Contact Ian for specific analysis.

pH ___ Temp ___
Flow ___ Other ___

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

Samples returned via: UPS FedEx Courier ___

Tracking # 7488 1463 3873

Trip Blank Received: Yes / No
HCL / MeoH
TBR

Temp: 6.4 mix 5.0 °C Bottles Received: 40

If preservation required by Login: Date/Time

Condition: NCF / OK

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
	10/25/17	1205	Esclon
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
Esclon	10/25/17	1230	
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)
			860

Date: 10/26/17 Time: 8:45

10-145

Andy Vann

From: Brian Ford
Sent: Monday, November 06, 2017 3:03 PM
To: Login; Brian Ford
Subject: L946549 *CASASCTOR* log off hold

Please log MW-6 DUP off hold label 10-145 for NWTPHGX, V8260BTEXC, and NWTPHDXLVI. Log as R5 due 11/13.

Thanks,

Brian Ford
Technical Service Representative
ESC Lab Sciences-a subsidiary of Pace Analytical
12065 Lebanon Road | Mt. Juliet, TN 37122
615.773.9772
bford@esclabsciences.com | www.esclabsciences.com

ANALYTICAL REPORT

December 12, 2017

Cascadia Associates- Portland, OR

Sample Delivery Group:	L954460
Samples Received:	12/01/2017
Project Number:	006-001-001
Description:	Vannex GWM
Site:	VANCOUVER, WA
Report To:	Ian Maguire 6915 SW Macadam Ave Ste. 250 Portland, OR 97219

Entire Report Reviewed By:

Brian Ford

Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

TABLE OF CONTENTS

MW-6 L954460-01 GW

Collected by: Joel Mattecheck | Collected date/time: 11/30/17 11:45 | Received date/time: 12/01/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1049399	10	12/06/17 12:22	12/06/17 12:22	DWR
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	50	12/03/17 02:12	12/03/17 02:12	BMB
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	1	12/06/17 22:35	12/07/17 21:02	LM
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	5	12/06/17 22:35	12/11/17 14:12	LM

MW-5 L954460-02 GW

Collected by: Joel Mattecheck | Collected date/time: 11/30/17 10:55 | Received date/time: 12/01/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1049399	10	12/06/17 12:46	12/06/17 12:46	DWR
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	25	12/03/17 02:28	12/03/17 02:28	BMB
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	1	12/06/17 22:35	12/07/17 21:18	LM

MW-5D L954460-03 GW

Collected by: Joel Mattecheck | Collected date/time: 11/30/17 10:10 | Received date/time: 12/01/17 08:45

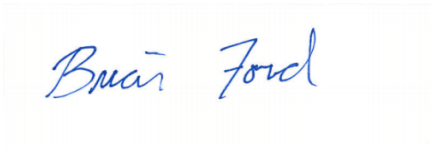
Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1049399	1	12/04/17 23:06	12/04/17 23:06	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	1	12/03/17 02:45	12/03/17 02:45	BMB
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	1	12/06/17 22:35	12/07/17 21:34	LM

MW-5 DUP L954460-04 GW

Collected by: Joel Mattecheck | Collected date/time: 11/30/17 10:55 | Received date/time: 12/01/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Volatile Organic Compounds (GC) by Method NWTPHGX	WG1049399	1	12/04/17 23:30	12/04/17 23:30	LRL
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	1	12/03/17 03:02	12/03/17 03:02	BMB
Volatile Organic Compounds (GC/MS) by Method 8260C	WG1048800	25	12/05/17 23:14	12/05/17 23:14	LRL
Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT	WG1049374	1	12/06/17 22:35	12/07/17 21:50	LM

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.



Brian Ford
Technical Service Representative

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	9420		316	1000	10	12/06/2017 12:22	WG1049399
(S) a,a,a-Trifluorotoluene(FID)	*95.6*			*77.0-122*		*12/06/2017 12:22*	WG1049399

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

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	223		16.6	50.0	50	12/03/2017 02:12	WG1048800
Toluene	53.1		20.6	50.0	50	12/03/2017 02:12	WG1048800
Ethylbenzene	1710		19.2	50.0	50	12/03/2017 02:12	WG1048800
Total Xylenes	1120		53.0	150	50	12/03/2017 02:12	WG1048800
(S) Toluene-d8	*107*			*80.0-120*		*12/03/2017 02:12*	WG1048800
(S) Dibromofluoromethane	*88.9*			*76.0-123*		*12/03/2017 02:12*	WG1048800
(S) a,a,a-Trifluorotoluene	*105*			*80.0-120*		*12/03/2017 02:12*	WG1048800
(S) 4-Bromofluorobenzene	*97.3*			*80.0-120*		*12/03/2017 02:12*	WG1048800

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	7440		330	1000	5	12/11/2017 14:12	WG1049374
Residual Range Organics (RRO)	686		82.5	250	1	12/07/2017 21:02	WG1049374
(S) o-Terphenyl	*120*			*52.0-156*		*12/07/2017 21:02*	WG1049374
(S) o-Terphenyl	*103*			*52.0-156*		*12/11/2017 14:12*	WG1049374

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	11300		316	1000	10	12/06/2017 12:46	WG1049399
(S) a,a,a-Trifluorotoluene(FID)	*95.0*			*77.0-122*		*12/06/2017 12:46*	WG1049399

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

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	U		8.28	25.0	25	12/03/2017 02:28	WG1048800
Toluene	U		10.3	25.0	25	12/03/2017 02:28	WG1048800
Ethylbenzene	187		9.60	25.0	25	12/03/2017 02:28	WG1048800
Total Xylenes	1210		26.5	75.0	25	12/03/2017 02:28	WG1048800
(S) Toluene-d8	*106*			*80.0-120*		*12/03/2017 02:28*	WG1048800
(S) Dibromofluoromethane	*87.9*			*76.0-123*		*12/03/2017 02:28*	WG1048800
(S) a,a,a-Trifluorotoluene	*105*			*80.0-120*		*12/03/2017 02:28*	WG1048800
(S) 4-Bromofluorobenzene	*97.0*			*80.0-120*		*12/03/2017 02:28*	WG1048800

Sample Narrative:

L954460-02 WG1048800: Target and non-target analytes too high to re-analyze at a lower dilution.

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	1630		66.0	200	1	12/07/2017 21:18	WG1049374
Residual Range Organics (RRO)	U		82.5	250	1	12/07/2017 21:18	WG1049374
(S) o-Terphenyl	*91.4*			*52.0-156*		*12/07/2017 21:18*	WG1049374

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	411		31.6	100	1	12/04/2017 23:06	WG1049399
(S) a,a,a-Trifluorotoluene(FID)	*104*			*77.0-122*		*12/04/2017 23:06*	WG1049399

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

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	U		0.331	1.00	1	12/03/2017 02:45	WG1048800
Toluene	U		0.412	1.00	1	12/03/2017 02:45	WG1048800
Ethylbenzene	U		0.384	1.00	1	12/03/2017 02:45	WG1048800
Total Xylenes	U		1.06	3.00	1	12/03/2017 02:45	WG1048800
(S) Toluene-d8	*105*			*80.0-120*		*12/03/2017 02:45*	WG1048800
(S) Dibromofluoromethane	*88.9*			*76.0-123*		*12/03/2017 02:45*	WG1048800
(S) a,a,a-Trifluorotoluene	*105*			*80.0-120*		*12/03/2017 02:45*	WG1048800
(S) 4-Bromofluorobenzene	*98.5*			*80.0-120*		*12/03/2017 02:45*	WG1048800

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	494		66.0	200	1	12/07/2017 21:34	WG1049374
Residual Range Organics (RRO)	U		82.5	250	1	12/07/2017 21:34	WG1049374
(S) o-Terphenyl	*84.9*			*52.0-156*		*12/07/2017 21:34*	WG1049374

Volatile Organic Compounds (GC) by Method NWTPHGX

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Gasoline Range Organics-NWTPH	10900		31.6	100	1	12/04/2017 23:30	WG1049399
(S) a,a,a-Trifluorotoluene(FID)	*101*			*77.0-122*		*12/04/2017 23:30*	WG1049399

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

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Benzene	U		0.331	1.00	1	12/03/2017 03:02	WG1048800
Toluene	1.12		0.412	1.00	1	12/03/2017 03:02	WG1048800
Ethylbenzene	187		0.384	1.00	1	12/03/2017 03:02	WG1048800
Total Xylenes	1480		26.5	75.0	25	12/05/2017 23:14	WG1048800
(S) Toluene-d8	*100*			*80.0-120*		*12/05/2017 23:14*	WG1048800
(S) Toluene-d8	*99.2*			*80.0-120*		*12/03/2017 03:02*	WG1048800
(S) Dibromofluoromethane	*87.7*			*76.0-123*		*12/03/2017 03:02*	WG1048800
(S) Dibromofluoromethane	*96.1*			*76.0-123*		*12/05/2017 23:14*	WG1048800
(S) a,a,a-Trifluorotoluene	*103*			*80.0-120*		*12/05/2017 23:14*	WG1048800
(S) a,a,a-Trifluorotoluene	*109*			*80.0-120*		*12/03/2017 03:02*	WG1048800
(S) 4-Bromofluorobenzene	*93.9*			*80.0-120*		*12/03/2017 03:02*	WG1048800
(S) 4-Bromofluorobenzene	*99.0*			*80.0-120*		*12/05/2017 23:14*	WG1048800

Semi-Volatile Organic Compounds (GC) by Method NWTPHDX-SGT

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	ug/l		ug/l	ug/l		date / time	
Diesel Range Organics (DRO)	1750		66.0	200	1	12/07/2017 21:50	WG1049374
Residual Range Organics (RRO)	U		82.5	250	1	12/07/2017 21:50	WG1049374
(S) o-Terphenyl	*85.5*			*52.0-156*		*12/07/2017 21:50*	WG1049374

Method Blank (MB)

(MB) R3270407-3 12/04/17 11:11

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Gasoline Range Organics-NWTPH	33.1	J	31.6	100
(S) a,a,a-Trifluorotoluene(FID)	*102*			*77.0-122*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3270407-1 12/04/17 09:59 • (LCSD) R3270407-2 12/04/17 10:23

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	5720	5870	104	107	72.0-134			2.58	20
(S) a,a,a-Trifluorotoluene(FID)				*108*	*108*	*77.0-122*				

L954576-05 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L954576-05 12/05/17 03:02 • (MS) R3270407-4 12/05/17 03:26 • (MSD) R3270407-5 12/05/17 03:50

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Gasoline Range Organics-NWTPH	5500	ND	2590	2670	46.3	47.9	1	23.0-159			3.15	20
(S) a,a,a-Trifluorotoluene(FID)					*101*	*101*		*77.0-122*				

Method Blank (MB)

(MB) R3270555-2 12/03/17 01:39

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Benzene	U		0.331	1.00
Ethylbenzene	U		0.384	1.00
Toluene	U		0.412	1.00
Xylenes, Total	U		1.06	3.00
(S) Toluene-d8	*106*			*80.0-120*
(S) Dibromofluoromethane	*89.7*			*76.0-123*
(S) a,a,a-Trifluorotoluene	*105*			*80.0-120*
(S) 4-Bromofluorobenzene	*98.2*			*80.0-120*

Laboratory Control Sample (LCS)

(LCS) R3270555-1 12/03/17 01:05

Analyte	Spike Amount ug/l	LCS Result ug/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Benzene	25.0	23.4	93.5	69.0-123	
Ethylbenzene	25.0	25.8	103	77.0-120	
Toluene	25.0	25.1	100	77.0-120	
Xylenes, Total	75.0	77.0	103	77.0-120	
(S) Toluene-d8			*105*	*80.0-120*	
(S) Dibromofluoromethane			*88.4*	*76.0-123*	
(S) a,a,a-Trifluorotoluene			*105*	*80.0-120*	
(S) 4-Bromofluorobenzene			*99.7*	*80.0-120*	

Method Blank (MB)

(MB) R3271729-1 12/07/17 18:21

Analyte	MB Result ug/l	MB Qualifier	MB MDL ug/l	MB RDL ug/l
Diesel Range Organics (DRO)	U		66.7	200
Residual Range Organics (RRO)	U		83.3	250
(S) o-Terphenyl	*77.2*			*52.0-156*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3271729-2 12/07/17 18:36 • (LCSD) R3271729-3 12/07/17 18:52

Analyte	Spike Amount ug/l	LCS Result ug/l	LCSD Result ug/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	750	719	697	95.9	93.0	50.0-150			3.05	20
Residual Range Organics (RRO)	750	633	614	84.4	81.9	50.0-150			3.00	20
(S) o-Terphenyl				*73.4*	*72.2*	*52.0-156*				

L954618-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L954618-01 12/07/17 22:06 • (MS) R3271729-4 12/07/17 22:22 • (MSD) R3271729-5 12/07/17 22:38

Analyte	Spike Amount ug/l	Original Result ug/l	MS Result ug/l	MSD Result ug/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Diesel Range Organics (DRO)	750	ND	619	622	74.2	74.5	1	50.0-150			0.418	20
Residual Range Organics (RRO)	750	ND	526	536	63.5	64.8	1	50.0-150			1.94	20
(S) o-Terphenyl					*63.3*	*61.8*		*52.0-156*				

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDL	Method Detection Limit.
RDL	Reported Detection Limit.
Rec.	Recovery.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
U	Not detected at the Reporting Limit (or MDL where applicable).
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
J	The identification of the analyte is acceptable; the reported value is an estimate.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
***** Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Conneticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1 4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

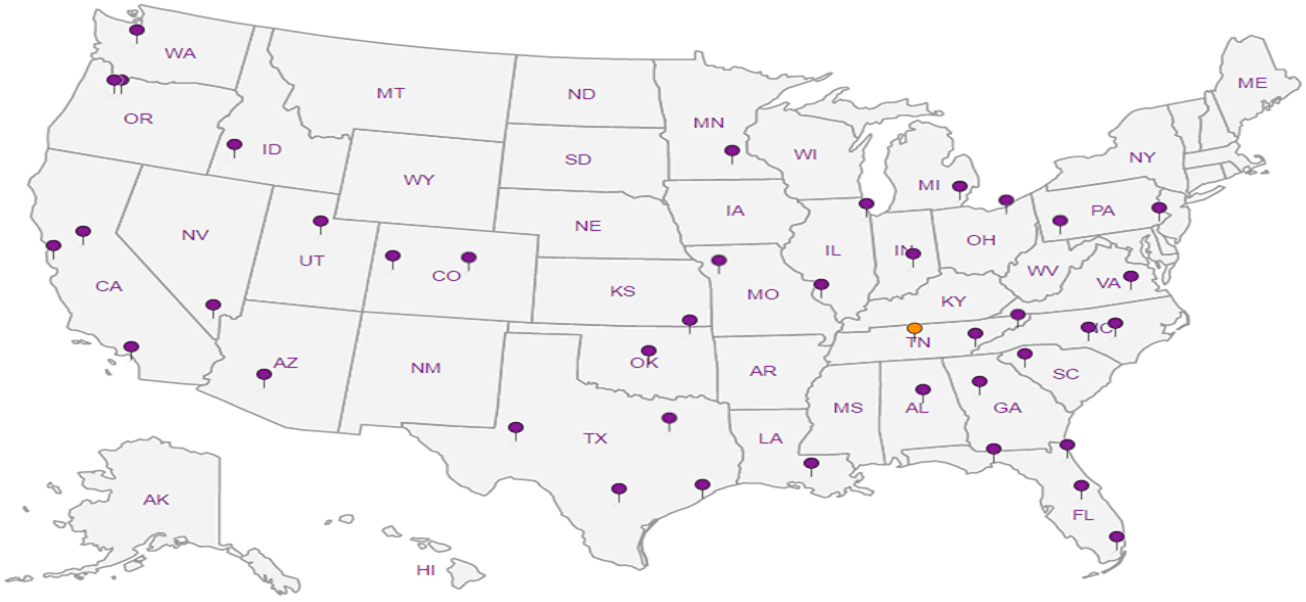
Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

[1.] Drinking Water [2.] Underground Storage Tanks [3.] Aquatic Toxicity [4.] Chemical/Microbiological [5.] Mold [n/a] Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



Cascadia Associates- Portland, OR

6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Billing Information:
Accounts Payable- Chris Breemer
6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Email To: imaguire@cascadiaassociates.com

Report to: Ian Maguire

Project Description: Vannex Comm

City/State Collected: Vancouver WA

Phone: 503-906-6577
Fax:

Client Project # 006-001-001

Lab Project # CASASCTOR-NUVANCOUVE

Collected by (print): Joel Mattecheck

Site/Facility ID # VANCOUVER, WA

P.O. # 006-001-001

Collected by (signature):

Quote #

Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day X Standard

Date Results Needed

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI w/ SG; 40mlAmb-HCl-BT	NWTPHGX 40mlAmb HCl	BTEX (8260B)
MW-6	Grab	GW	—	11/30/17	1145	8	X	X	X
MW-5	Grab	GW	—	11/30/17	1055	8	X	X	X
MW-50	Grab	GW	—	11/30/17	1010	8	X	X	X
MW-5 Dup	Grab	GW	—	11/30/17	1055	8	X	X	X
		GW							

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC LAB SCIENCES
a subsidiary of Accutest

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# L954460

B086

Acctnum: CASASCTOR
Template: T130154
Prelogin: P627256
TSR: 110 - Brian Ford
PB:
Shipped Via:

Remarks	Sample # (lab only)
	-01
	-02
	-03
	-04

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other

Remarks: email results to Ian Maguire

pH ___ Temp ___
Flow ___ Other ___

Samples returned via: ___ UPS X FedEx ___ Courier ___

Tracking # 746614664251

Trip Blank Received: Yes / No
HCl / MeoH
TBR

Temp: 0.3 °C Bottles Received: 32

If preservation required by Login: Date/Time

Hold:

Condition: NCF / OK

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
	11/30/17	1530	
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)
			535

Date: 12/01/17 Time: 0345

ATTACHMENT E

GROUNDWATER MONITORING FIELD NOTES

WELL GAGING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-5	Job Number:	0060-001-001
Client:	Nustar	Date:	10/23/17
Project:	Nyrex Pilot Study	Sampler:	LM
Weather:	Mostly Sunny (50's)?	Time In/Out:	1200

WELL DATA

Monument Type:	Flush-mount/Stick-up	Well Diameter:	2	Depth to Free Product:	
	Other:	Well Depth:	24.96	Free Product Thickness:	
Monument Condition:	Good	Depth to Water:	17.82	Water Column Length:	
Well Cap Lock Present:	Yes No	Screened Interval:		Purge Volume:	

Comments:

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal): 1-inch well = 0.041 | 2-inch = 0.162 | 4-inch = 0.653 | 1 gal = 3.785 liters

PURGING DATA

Purge Method:	Peri	Pump Intake Depth:	5' above bottom
Sampling Method:	Low Flow	Tubing Material & Type:	NEW / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
1231			18.20							
1234			18.48	~~0.3~~ ~0.15	6.42	14.2	488.7	0.36	-34.7	C
1237			18.70	0.2	6.53	14.3	489	~~0.31~~ 0.12	-33.9	C
1240			18.80		6.58	14.6	491	0.03	-32.7	C
1245			19.01		6.59	14.3	485	0.24	-36.1	C
1249			19.40		6.59	14.4	484	0.33	-37.3	C
1252			19.56		6.60	14.5	480	0.21	-37.3	C
				Pump off						

PURGING DATA

Sample ID:	MW-5	Sampling Flow Rate:	0.2 L/min			Analytical Laboratory:	ESC
Sample Time:	1300	Final Depth to Water:	19.05			Did Well Dewater:	
No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID	
3x40mL ~~NWTPH-GX~~	HCl	NWTPH-GX	N				
2x40mL ~~DX~~	↓	NWTPH-DX	↓	↓	↓	↓	
3x40mL ~~BTEX~~	↓	BTEX	↓	↓	↓	↓	

NOTES/ADDITIONAL COMMENTS

Water level did not ~~##~~ Stabalize, pump running as low as possible w/o stalling. Waited ~8min after parameters stabalized to begin sampling

WELL GAGING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-5D	Job Number:	0060-001-001
Client:	Nustar	Date:	10/24/17
Project:	Vannex Pilot Study	Sampler:	IM
Weather:	Clear (cool)	Time In/Out:	~~800~~ 830 /

WELL DATA

Monument Type:	(Flush-mount)/Stick-up	Well Diameter:	2-in	Depth to Free Product:	—
	Other:	Well Depth: DTC	44.69	Free Product Thickness:	—
Monument Condition:	Good	Depth to Water:	17.50	Water Column Length:	
Well Cap Lock Present:	(Yes) No YES	Screened Interval:	34.7-44.7	Purge Volume:	

Comments:

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal):	1-inch well = 0.041	2-inch = 0.162	4-inch = 0.653	1 gal = 3.785 liters

PURGING DATA

Purge Method:	Peri-Pump	Pump Intake Depth:	Mid Screen
Sampling Method:	Low-Flow	Tubing Material & Type:	LDPE (NEW) / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
915			17.48	0.16	6.08	12.8	269	1.28	-439	C
~~918~~										
921			17.48		6.39	12.9	260	0.51	-459	C
924			17.48		6.42	13.0	260	0.38	-455	C
927			17.47		6.45	12.9	258	0.37	-416	C
930			17.48		6.47	12.9	256	0.46	-407	C
933			17.48	0.16	6.49	12.9	257	0.19	-394	C
936			17.48		6.50	12.9	254	0.45	-388	C
939			17.48		6.55	12.9	253	0.40	-373	C

PURGING DATA

Sample ID:	MW-5D	Sampling Flow Rate:	0.16		Analytical Laboratory:	ESC
Sample Time:	945	Final Depth to Water:	17.48		Did Well Dewater:	NO

No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
			N	N	N	N

NOTES/ADDITIONAL COMMENTS

DO dropped @ end of purge. Variable readings.

WELL GAGING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-6	Job Number:	0060-001-007
Client:	Nustar	Date:	10/24/17
Project:	Summer Pilot Study	Sampler:	IM
Weather:	Clear (50's)	Time In/Out:	1045

WELL DATA

Monument Type:	Flush-mount/Stick-up	Well Diameter:	2-in	Depth to Free Product:	N
	Other:	Well Depth: btc	26.79	Free Product Thickness:	—
Monument Condition:	Good	Depth to Water:	18.12	Water Column Length:	
Well Cap Lock Present:	Yes No N/A on stick-up	Screened Interval:		Purge Volume:	
Comments:					

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)				
Water height multipliers (gal):	1-inch well = 0.041	2-inch = 0.162	4-inch = 0.653	1 gal = 3.785 liters

PURGING DATA

Purge Method:	Peri	Pump Intake Depth:	~5' above bottom
Sampling Method:	Low-Flow	Tubing Material & Type:	NEW / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
1100			18.57	0.16	6.21	13.7	811	0.51	-54.4	C
1104			19.12		6.24	13.7	810	0.39	-50.1	C
1107			19.41		6.27	13.8	812	0.31	-51.6	C
1110			19.73		6.28	13.7	811	0.29	-64.5	C
1113			19.94		6.29	13.8	811	0.30	-58.9	C
1116			20.11		6.30	13.8	811	0.29	-60.5	C
		Pump off.								
1135			18.41							

PURGING DATA

Sample ID:	MW-6	Sampling Flow Rate:	0.16		Analytical Laboratory:	ESC
Sample Time:	1135	Final Depth to Water:	19.23		Did Well Dewater:	
No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
						MW-6 Dup

NOTES/ADDITIONAL COMMENTS

Slight sheen, blotchy observed on surface of sample VOAs, Effervescent.

Vannex

11-30-17

	time	GW depth	total depth
MW-2	8:45	27.66	
MW-4	8:50	29.59	
MW-3	9:01	28.61	
MW-1	9:04	16.16	
MW-6	9:09	16.71	
MW-7	9:11	11.12	
MW-10	9:14	28.16	
MW-9	9:19	18.78	
MW-8D	9:20	17.36	
MW-8	9:22	16.91	
MW-5D	9:24	16.21	45'
MW-5	9:25	16.39	

WELL GAGING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-5D	Job Number:	006-001-001
Client:	NUSTAR	Date:	11-30-2017
Project:	VANNEX	Sampler:	A. Spencer / Joel Mathews
Weather:	CLOUDY, RAINING	Time In/Out:	9:40 /

WELL DATA

Monument Type:	(Flush-mount)/Stick-up	Well Diameter:	2"	Depth to Free Product:	/
	Other:	Well Depth:	45	Free Product Thickness:	/
Monument Condition:		Depth to Water:	16.21	Water Column Length:	~20'
Well Cap Lock Present:	(Yes) No	Screened Interval:	35-45	Purge Volume:	
Comments:					

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal):	1-inch well = 0.041	2-inch = 0.162	4-inch = 0.653	1 gal = 3.785 liters

PURGING DATA

Purge Method:	peristaltic	Pump Intake Depth:	mid-screen
Sampling Method:	low flow	Tubing Material & Type:	LDPE
			NEW / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
09:50			16.22	0.3	6.46	12.12	512	4.4	109.2	clear
09:53			16.24		6.51	12.06	516	3.40	97.1	
09:56			16.24		6.55	12.19	534	1.94	84.8	
09:59			16.24		6.56	11.70	532	1.00	79.0	
10:02			16.24		6.57	12.06	534	0.80	73.3	
10:10			16.24							

PURGING DATA

Sample ID:	MW-5D	Sampling Flow Rate:	0.3 L/min	Analytical Laboratory:		ESC	
Sample Time:	10:10	Final Depth to Water:	16.24	Did Well Dewater:		NO	
No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID	
8 VOAs	HCL						

NOTES/ADDITIONAL COMMENTS

WELL GAGING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-5	Job Number:	006-001-001
Client:	NUSTAR	Date:	11-30-2017
Project:	VANNEX	Sampler:	Spencer / Mathelier
Weather:	RAINY	Time In/Out:	10:27

WELL DATA

Monument Type:	(Flush-mount)/Stick-up	Well Diameter:	2"	Depth to Free Product:	
	Other:	Well Depth: (?)	25'	Free Product Thickness:	
Monument Condition:	Good	Depth to Water:	17.14	Water Column Length:	
Well Cap Lock Present:	(Yes) No	Screened Interval:		Purge Volume:	

Comments:

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal):	1-inch well = 0.041	2-inch = 0.162	4-inch = 0.653	1 gal = 3.785 liters

PURGING DATA

Purge Method:		Pump Intake Depth:	
Sampling Method:		Tubing Material & Type:	NEW / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
10:27			17.14	0.2	9.8	12.40	393	7.3	36.1	Clear
10:30					8.8	12.39	382	8.0	30.4	
10:35			17.81		10.7	12.50	384	7.7	28.8	
10:38			17.85		8.7	12.38	395	7.4	24.6	
10:42			17.91		6.5	12.16	396	7.1	24.5	
10:45			17.98		10.6	12.10	403	7.1	23.2	

PURGING DATA

Sample ID:	MW-5	Sampling Flow Rate:	0.2		Analytical Laboratory:	ESC
Sample Time:	10:55	Final Depth to Water:	17.98		Did Well Dewater:	No

No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID	
16	HCL						
8 -							
8 - Dup							

NOTES/ADDITIONAL COMMENTS

WELL GAGING DATA SHEET

Cascadia Associates, LLC

Well ID:	MW-6	Job Number:	006-001-001
Client:	NuStar	Date:	11/30/17
Project:	VANNEX	Sampler:	SPENCER/MaHelcheck
Weather:	RAINY	Time In/Out:	11:15

WELL DATA

Monument Type:	Flush-mount/Stick-up	Well Diameter:	2"	Depth to Free Product:	0
	Other:	Well Depth:	25	Free Product Thickness:	
Monument Condition:	Good	Depth to Water:		Water Column Length:	
Well Cap Lock Present:	Yes No	Screened Interval:	15-25	Purge Volume:	

Comments:

Purge Volume = (Water Height) X (Multiplier) X (# Casing Volumes)

Water height multipliers (gal):	1-inch well = 0.041	2-inch = 0.162	4-inch = 0.653	1 gal = 3.785 liters

PURGING DATA

Purge Method:		Pump Intake Depth:	
Sampling Method:		Tubing Material & Type:	NEW / DEDICATED

Time	Volume Purged (liters)	Cumulative Volume Purged (liters)	DTW (btc)	Purge Rate (L/min)	pH (not working)	Temp (°C)	Cond (µS/cm)	DO (ppm)	ORP (mV)	Clarity/Color Other Remarks
					+/-0.1	+/-0.5 °C	+/-5%	+/-0.5 ppm	+/-20 mV	
11:20			17.70	0.2	Ø	12.38	741	0.98	40.3	clear
11:23			18.00	0.2	/	12.30	755	0.84	23.0	
11:26			18.40			12.63	755	0.48	20.2	
11:29			18.75			12.74	768	0.46	36.0	
11:33			19.01			12.69	766	0.50	41.2	

PURGING DATA

Sample ID: MW-6		Sampling Flow Rate:	0.2		Analytical Laboratory:	ESC
Sample Time: 11:45		Final Depth to Water:			Did Well Dewater:	
No. of Containers/Type	Preservative	Analysis/Method	Field Filtered	Filter Size	MS/MSD	Duplicate ID
8	HCL					

NOTES/ADDITIONAL COMMENTS

Cascadia Associates- Portland, OR

6915 SW Macadam Ave
Ste. 250
Portland OR 97219

Billing Information:
Accounts Payable- Chris Breemer
6915 SW Macadam Ave
Ste. 250
Portland, OR 97219

Pres Chk

Report to: Ian Maguire

Email To: imaguire@cascadiaassociates.com

Project Description: Vannex Comm

City/State Collected: Vancouver WA

Phone: 503-906-6577
Fax:

Client Project # 006-001-001

Lab Project # CASASCTOR-NUVANCOUVE

Collected by (print): Joel Mattecheck

Site/Facility ID # VANCOUVER, WA

P.O. # 006-001-001

Collected by (signature):

Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day X Standard

Quote #

Date Results Needed

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L #

Table #

Acctnum: CASASCTOR
Template: T130154
Prelogin: P627256
TSR: 110 - Brian Ford
PB:

Shipped Via:

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	NWTPHDXLVI w/ SGT 40mlAmb-HCl-BT	NWTPHGX 40mlAmb HCl	~~VOC~~ BTEX (8260B)	Remarks	Sample # (lab only)
MW-6	Grab	GW	—	11/30/17	1145	8	X	X	X		
MW-5	Grab	GW	—	11/30/17	~~1055~~	8	X	X	X		
MW-50	Grab	GW	—	11/30/17	1010	8	X	X	X		
MW-5 Dup	Grab	GW	—	11/30/17	1055	8	X	X	X		
		GW									

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other_____

Remarks: email results to Ian Maguire

pH _____ Temp _____

Flow _____ Other _____

Samples returned via:
__ UPS __ FedEx __ Courier _____

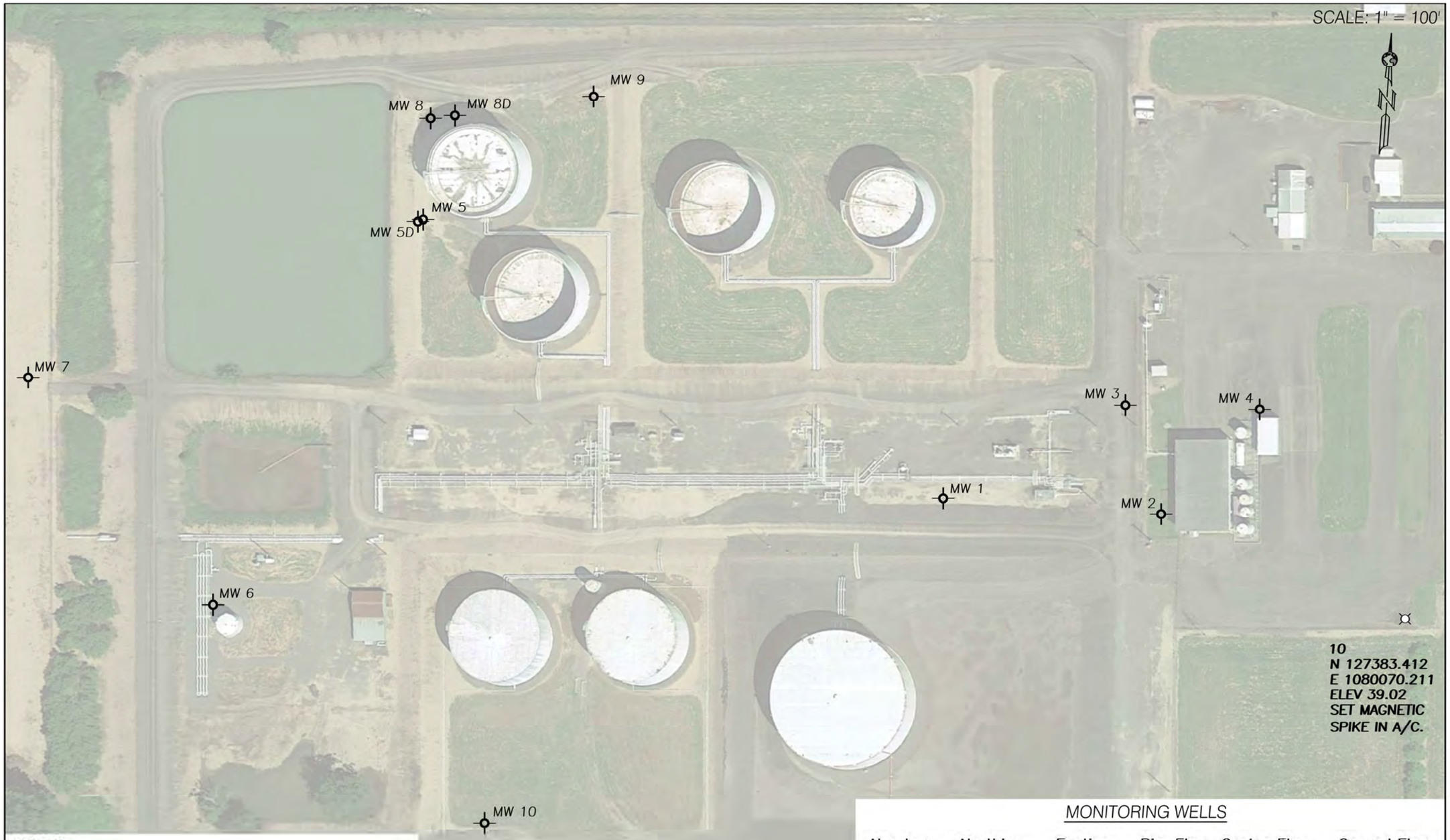
Tracking #

Sample Receipt Checklist
COC Seal Present/Intact: __NP __Y __N
COC Signed/Accurate: __Y __N
Bottles arrive intact: __Y __N
Correct bottles used: __Y __N
Sufficient volume sent: __Y __N
If Applicable
VOA Zero Headspace: __Y __N
Preservation Correct/Checked: __Y __N

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Trip Blank Received: Yes / No HCL / MeoH TBR	
Ian Maguire	11/30/17	1530			
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Temp: °C Bottles Received:	If preservation required by Login: Date/Time
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: Time:	Hold: / Condition: NCF / OK

ATTACHMENT F

MONITORING WELL SURVEY PLAN



NOTES:

1) THE ELEVATION DATUM IS NAVD88, DERIVED FROM WASHINGTON DEPARTMENT OF TRANSPORTATION BENCHMARK, DESIGNATION "WHITNEY", ID NO. 6434: A BRASS DISK SET LEVEL WITH THE CONCRETE SIDEWALK IN THE NORTHWEST SECTOR OF THE INTERSECTION OF NW 61ST ST. AND WHITNEY ROAD.
PUBLISHED ELEVATION: 32.264 USFT (NAVD88)

2) FIELD WORK WAS PERFORMED ON NOVEMBER 30 & DECEMBER 1, 2017.

MONITORING WELLS

Number	Northing	Easting	Rim Elev.	Casing Elev.	Ground Elev.
MW 1	127470.59	1079608.37	27.05	26.72	26.7
MW 2	127469.88	1079823.55	38.51	38.27	38.4
MW 3	127574.42	1079781.09	39.42	39.17	39.4
MW 4	127579.42	1079913.32	40.49	40.23	40.4
MW 5	127709.19	1079078.49	27.25	27.03	27.0
MW 5D	127706.85	1079073.53	27.21	26.71	27.1
MW 6	127316.35	1078898.24	27.54	27.33	25.2
MW 7	127527.41	1078701.16	22.06	21.67	21.9
MW 8	127809.18	1079079.01	28.10	27.68	28.0
MW 8D	127813.69	1079102.68	28.38	27.87	28.2
MW 9	127841.73	1079237.69	29.77	29.39	29.6
MW 10	127120.18	1079179.80	29.16	28.71	29.0

bluedot group
land surveying & mapping
11700 sw 67th ave
portland, or 97223
v. 503.624.0108
f. 503.624.9058

NUSTAR ANNEX MONITORING WELL SURVEY
5420 NW FRUIT VALLEY RD., VANCOUVER, WA, 98660

SURVEYED FOR:
CASCADIA ASSOC. LLC
6915 SW MACADAM AVE, STE 250
PORTLAND, OR, 97219

REGISTERED PROFESSIONAL LAND SURVEYOR

Robert Chennault

OREGON
JULY 14, 1998
ROBERT C. LENNOX
2886
RENEWAL: 12-31-18

DATE DEC. 6, 2017
JOB NO. 2017034

V1 OF 1