# Remedial Injection Implementation and Initial Results Report Vancouver Annex Terminal

5420 NW Fruit Valley Road
Vancouver, Washington 98660

*for*

**NuStar Terminals Operations Partnership L.P.**

May 17, 2024

GeoEngineers
Earth Science + Technology

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## 5420 NW Fruit Valley Road
## Vancouver, Washington

**File No. 19001-008-11**

**May 17, 2024**

Prepared for:

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# 1.0 INTRODUCTION

This Remedial Injection Implementation and Initial Results Report ("Injection Results Report") was prepared pursuant to Agreed Order No. DE19602 (Agreed Order) between the Washington State Department of Ecology (Ecology) and NuStar Terminals Operations Partnership L.P. (NuStar) for cleanup action at the NuStar Annex Terminal located at 5420 NW Fruit Valley Road, Vancouver, Washington (the Facility). The remedial injections were implemented during the pilot study phase of the cleanup to expedite remediation and provide additional site data, as detailed in the Revised Pilot Study and Aquifer Testing Work Plan ("Work Plan"; GeoEngineers, 2023), which was approved by Ecology on September 14, 2023. A location map for the Facility is provided on Figure 1; a Facility Plan is provided on Figure 2.

A remedial investigation (RI) was previously conducted at the Facility and identified petroleum hydrocarbons in soil or groundwater at concentrations exceeding Ecology's Model Toxics Control Act (MTCA) Method A cleanup levels in a few localized areas (Cascadia, 2020). A feasibility study (FS) for remedial action was completed to identify cleanup options and recommend a cleanup plan for the petroleum hydrocarbon constituents of potential concern (COPCs). The Agreed Order requires the implementation of a Cleanup Action Plan (CAP), attached to the Agreed Order as Attachment A. The CAP includes the following remedial elements:

- Injection of Liquid Activated Carbon in the Vapor Recovery Unit (VRU) area near well MW-11.
- Soil Management Plan and Institutional Controls for Truck Loading Rack Area Soil.
- Groundwater Extraction, Treatment, and Recirculation around wells MW-5 and MW-6.

In accordance with the Agreed Order and the Work Plan, direct injections of micron scale liquid carbon adsorbents and biostimulants were implemented in the VRU Area of the Facility as a cleanup action in October and November 2023 during the pilot study phase of the CAP to expedite remediation and collect additional data. A groundwater sample was collected from well MW-11, located near the VRU and within the injection area, in February 2024 along with other wells located adjacent to the VRU area to provide an initial assessment of the remedial injection action results. This Injection Results Report describes activities performed to complete the injections and conduct the monitoring well sampling, and reports on the initial results based on the analytical data from sampling the wells in and adjacent to the VRU Area. The locations of the VRU Area and well MW-11 are shown on Figure 2.

## 1.1. Purpose

The purpose of this report is to describe the scope, methods, and procedures used to implement the liquid activated carbon injections in the VRU area and present the initial results.

## 1.2. Report Organization

The report is organized as follows:

- **Section 2** presents Facility background information, and geologic/hydrogeologic conditions in the site vicinity.

- **Section 3** provides a summary of the environmental investigations and studies conducted at the Facility, which comprised the Supplemental Remedial Investigation and Feasibility Study (SRI/FS) and describes the scope of groundwater monitoring performed at the Facility.
- **Section 4** describes the scope, methods, and procedures used to complete the liquid activated carbon injections in the VRU Area.
- **Section 5** presents the initial results of the completed liquid activated carbon injections in the VRU Area.
- **Section 6** lists references used in this report.

## 2.0 BACKGROUND

### 2.1. Site Location, Description and History

The "Site" is defined consistent with Washington Model Toxics Control Act (MTCA) and the Agreed Order to include the area where a hazardous substance from a release at the Facility has "come to be located."

**Location**. The Facility address is 5420 NW Fruit Valley Road, Vancouver, Washington 98660 (Latitude: 45.6617°N, Longitude: 122.6932°W) (Section 16, Range 1E, Township 2N), as shown on Figure 1. The Facility is located on Clark County Tax Lot No. 147360.

**Physical Features**. Figure 2 is a Facility Site Plan. The Facility is approximately 31 acres and is roughly rectangular, with dimensions of approximately 800 by 1,800 feet. The Facility is located in a mixed industrial-agricultural area and currently includes a tank farm consisting of seven large aboveground storage tanks (ASTs) contained in four containment areas; a covered truck loading rack; smaller ASTs containing fuel additives; a 42,000-gallon transmix AST; and several buildings used for equipment storage and offices. The large ASTs are used to store jet fuel and range in capacity size from 1,680,000 to 4,599,378 gallons.

The central pipeway, running east/south through the center of the Facility between the two northern and two southern containment areas, houses the VRU and oil/water separator (OWS) at its east side, and is also the location of a decommissioned previous vapor recovery system. An underground storage tank (UST) associated with the previous vapor recovery system, also located on the east side of the central pipeway, was removed in 2001. Monitoring well MW-11 was installed in the VRU area near the current and previous vapor recovery systems in 2019.

**Property History**. Support Terminals Operating Partnership, L.P. (STOP) purchased the Facility from Cenex Harvest States Cooperative (Cenex) in 2003. In March 2008, STOP changed its name to NuStar.

The property was developed in 1957 as a truck loading terminal. Records are unclear as to whether the Facility was developed by Cenex. Historically, chemicals and other products stored at the Facility included liquid fertilizers and refined petroleum products such as gasoline, diesel and kerosene, de-natured alcohol, and petroleum product additives. The transmix tank is located in the western portion of the Facility (Figure 2), and this is typically where waste (such as from tank-bottom cleanouts or the OWS) would be stored prior to off-site disposal or recycling. There is no indication that materials from tank-bottom cleanouts were buried at the Facility.

## 2.2. Geology and Hydrogeology

This section presents the understanding of the geology and hydrogeology in the region and at the Facility, as discussed in the SRI/FS (Cascadia, 2020).

### 2.2.1. Geology

**Regional Geology**. The regional geology is summarized below and is based on reports prepared by Pacific Groundwater Group (PGG, 2001) and AMEC (AMEC, 2002). The Site and surrounding area are dominated by three primary geologic units: Recent Alluvial deposits, the Pleistocene Alluvial deposits, and the Troutdale Formation.

The Recent Alluvial deposits are the upper unit with deposits approximately up to 55 feet thick and consist of fine-grained silt and sand within the areas investigated near Vancouver Lake. The Pleistocene Alluvial deposits are approximately 95 to 115 feet thick and consist of coarse-grained sand and gravel. The Pleistocene Alluvial deposits originate from alluvial deposits from the Columbia River and deposits from the catastrophic Missoula Floods. The Troutdale Formation underlies the Pleistocene Alluvial deposits and can be in excess of 1,000 feet thick. It is made up of cemented sandy gravels and semi-consolidated sands, silts, and clays.

**Site Geology**. During site investigations, soil borings have been advanced to depths of up to 72 feet below ground surface (bgs) at the Facility. The Recent Alluvial deposits underlying the western portion of the Facility primarily consist of silts to depths of 21 to 35 feet bgs. Below 21 to 35 feet bgs, the Recent Alluvial deposits consist of layers of fine- to medium-grained sand to a depth of at least 65 feet bgs.

On the eastern portion of the Facility, the base of the silt layer is generally shallower, with fine- to medium-grained sand encountered at approximately 10 feet bgs near the VRU.

### 2.2.2. Hydrogeology

**Regional Hydrogeology**. The regional aquifers—Recent Alluvial Aquifer (RAA), Pleistocene Alluvial Aquifer (PAA), and the aquifers of the Troutdale Formation—follow the regional geology discussed above. The regional hydrogeology summarized below is based on reports prepared in support of Clark Public Utilities (CPU) South Lake Wellfield (PGG, 2001; PGG, 2009), and by Ash Creek (2008a and 2008b).

The RAA is unconfined and receives recharge directly from the land surface and/or surface water features. The PAA directly underlies the RAA and is a productive aquifer with high well yields (several thousand gallons per minute [gpm] without significant drawdown). The groundwater flow system is highly influenced by local surface water bodies. The Columbia River, Vancouver Lake, Vancouver Lake Flushing Channel, and Lake River form natural hydrologic boundaries to the groundwater flow system. Tidal influences and seasonal variations in surface water runoff cause dynamic variation in the stages of the Columbia River, resulting in adjustments in the stages of the other three connected surface water bodies. The groundwater flow system is also influenced by tidal and seasonal variations in the surface water bodies. Regionally, it is anticipated that groundwater within the RAA and PAA in the vicinity of the Facility would have a net gradient toward Vancouver Lake and the Columbia River.

The Troutdale Gravel Aquifer (TGA) has been observed at a depth of approximately 200 feet at the CPU wellfield located 500 feet north of the Facility. It is approximately 50 feet thick and is underlain by a

100-foot-thick clay confining layer. The Sand and Gravel Aquifer (SGA) of the Troutdale Formation is found beneath the confining layer.

**Site Hydrogeology**. First encountered groundwater is found in the sandy silt of the RAA. In the western portion of the Facility, depth to first encountered groundwater has ranged from approximately 8 to 22 feet bgs since 2014, and in the eastern portion of the Facility, near the former and current Truck Loading Rack, depth to first encountered groundwater has ranged from approximately 20 to 32 feet bgs since 2002 (Cascadia, 2020). Depth to shallow groundwater varies seasonally, with the shallower depths generally encountered between December and June and the deeper depths encountered between July and November. Deeper groundwater of the PAA is encountered at depths of approximately 50 to 70 feet bgs beneath the Facility (Ash Creek, 2008a).

Shallow groundwater flow at the Facility has remained, under static conditions, relatively flat with a slight gradient (typically ranging between 0.0001 to 0.0005 foot per foot [ft/ft]) predominantly to the southeast but at times to the east/northeast, or a divide is observed in the western portion of the Facility, with flow to the west on the western side of the divide and to the east/southeast on the eastern portion of the divide (Cascadia, 2020).

## 3.0 NATURE AND EXTENT OF COPSs IN VRU AREA

Several investigations were conducted at the Facility between 2001 and 2020 and the scope, methods, and results are detailed in the Supplemental Remedial Investigation and Feasibility Study report (SRI/FS; Cascadia, 2020). During the previous Facility investigations more than 150 soil samples and 100 grab groundwater samples were collected for chemical analysis of total petroleum hydrocarbons (TPHs), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), pesticides and/or lead. Thirteen monitoring wells were installed at the Facility during these investigations and groundwater sampling and analysis for TPH, VOCs, and PAHs have been performed. Screening of chemical data for the 2020 SRI/FS identified the COPCs in soil and groundwater at the Site to be petroleum hydrocarbons (gasoline and diesel), benzene, toluene, ethylbenzene and xylene (BTEX), and naphthalene (Cascadia, 2020). Three additional monitoring wells were installed following completion of the SRI/FS consistent with the CAP to provide additional compliance monitoring and deeper zone groundwater gradient information. Discussion of groundwater conditions at the Facility in this Injection Results Report is focused on the VRU Area; discussions of the groundwater conditions in the western area of the Facility, including the Well MW-5 and MW-6 Areas, are detailed in the SRI/FS (Cascadia, 2020).

Results of the previous investigations identified a localized area of groundwater in the VRU area near MW-11 containing TPH and BTEX at concentrations above MTCA Method A levels in shallow (first encountered) groundwater. Six of the 16 Facility monitoring wells, wells MW-1 through MW-3, MW-11, MW-12, and MW-12D, are located in or around the VRU area. Well locations are shown on Figure 2.

### 3.1. Summary of Groundwater Conditions in VRU Area

First encountered groundwater in the VRU Area is located within the sand layer of the Recent Alluvial Aquifer. Wells MW-1 through MW-3 were installed in 2002 to monitor first encountered shallow groundwater in the area around the former VRU and decommissioned UST. Groundwater samples from these wells were below MTCA Method A criteria since 2010. However, in 2019, it was noted that a historical grab groundwater sample collected in shallow groundwater from a boring located directly adjacent to the

former VRU contained petroleum constituents at concentrations above MTCA Method A criteria in 2003. Based on the historical results, the petroleum hydrocarbons were limited to shallow groundwater and were not present in the vadose zone (Cascadia, 2020). Therefore, a boring B-22 and monitoring well MW-11 were installed in this area to better assess current shallow groundwater conditions at this location. TPHg, benzene, ethylbenzene, xylenes, and naphthalene were identified in the grab sample from boring B-22 and from the groundwater samples from well MW-11 above MTCA Method A criteria. Monitoring wells MW-12 and MW-12D were installed to the north of well MW-11 to better define the extent of COPCs; well MW-12 screens first encountered groundwater and well MW-12D screens the next deeper groundwater unit. TPH, BTEX, and naphthalene concentrations in wells MW-12 and MW-12D were below MTCA Method A criteria and confirmed that the petroleum hydrocarbons detected in well MW-11 are localized to the immediate VRU area and limited to shallow groundwater. The SRI/FS (Cascadia, 2020) estimated the extent in the VRU area to be approximately 50 feet by 50 feet or less.

Table 1 summarizes well construction details for wells MW-1 through MW-3, MW-11, MW-12, and MW-12D. Analytical data for groundwater samples from these monitoring wells is provided in Table 2. The boring log for boring B-22, in addition to the well installation logs for wells MW-12 and MW-12D, are included in Appendix A. Monitoring well MW-11 was installed immediately adjacent to boring B-22 and was therefore not logged.

### 3.2. Groundwater Monitoring

Comprehensive groundwater monitoring events have been conducted since 2014. Ten comprehensive monitoring events were conducted at the Facility in the period from 2014 to 2019 and quarterly monitoring has been conducted since February 2019 with annual reporting. Monitoring includes gauging depth to groundwater and collecting groundwater samples from each well for chemical analyses. Groundwater samples are analyzed for TPHg (gasoline), TPHd (diesel), TPHo (oil), BTEX, and methyl tert-butyl ether (MTBE). Naphthalene was added to the analytical program in 2019.

Results from groundwater monitoring continue to confirm that TPH and related constituents in the VRU area are limited in extent. No MTCA Method A Cleanup Levels were exceeded in monitoring wells MW-1 through MW-3 or MW-12 and MW-12D through the fourth quarter, 2023 monitoring event.

## 4.0 LIQUID ACTIVATED CARBON INJECTION SUMMARY

Liquid activated carbon was injected in the VRU Area in accordance with the approved Work Plan from October 30 to November 3, 2023. The injections were performed at a total of 27 boring locations, shown in Figure 3. The liquid carbon media, PetroFix™ was injected to stabilize and treat in situ the dissolved-phase petroleum hydrocarbons in groundwater in the VRU Area. PetroFix, a proprietary solution made by Regenesis, contains liquid activated carbon and electron acceptors, which together are designed to immobilize the petroleum hydrocarbons and enhance biodegradation. The liquid colloidal activated carbon, approximately 1 to 2 microns in size, was injected throughout the targeted saturated zone, and works to cause dissolved phase hydrocarbons to adsorb to the carbon. The electron acceptors injected with the liquid activated carbon can then enhance biodegradation of the immobilized dissolved phase and adsorbed hydrocarbons to remediate the groundwater.

A summary of the activities to prepare for and conduct the injections is provided below.

### 4.1. Preparatory Activities

Preparatory activities included:

- Coordinating with terminal staff to understand the presence and layout of above grade and below grade piping;
- Marking the injection areal extent and each proposed injection point to clear the locations of utilities or other subsurface infrastructure using a utility clearance subcontractor; and
- Hand clearing each boring location to 8 feet.

An on-site meeting was held on June 1, 2023, with the drilling subcontractor, terminal staff, and GeoEngineers to prepare for the pilot study injection program and review safety requirements. Following the meeting, the areal extent of the injection program was marked and Alpha Locates, a utility clearance company, was retained to identify and mark subsurface features within the injection area. Alpha Locates completed the utility survey on October 23, 2023. Marking paint was then used to mark the 27 planned boring locations during the week of October 23, 2023. Seven borings were relocated due to access constraints based on the meeting with terminal staff and/or the utility clearance, including borings B-1, B-4, B-5, B-17, and B-30. The relocation of borings did not impact the overall distribution of the boring locations within the injection area and is not expected to reduce the effectiveness of the injections.

In addition to clearance by a utility clearance subcontractor, standard operating procedures (SOPs) for drilling at the Facility include clearing boring locations to a depth of 8 feet bgs using a hand auger or other approved techniques. All of the injection borings in this pilot study were cleared to 8 feet using a hand auger. To prevent the clearing process from becoming a bottleneck for the injections, borings were continuously cleared beginning on the morning of October 30 by the drilling subcontractor or GeoEngineers staff. Hand clearing continued until October 31, when all borings were cleared. Once borings were cleared to 8 feet bgs, they were closed and sealed with bentonite by Cascade Environmental of Clackamas, Oregon (Cascade). Sealing the cleared borings with bentonite minimized the potential for the PetroFix daylighting through an adjacent cleared borehole annulus space, prevented holes to the subsurface from remaining open during the pilot study, and reduced trip hazards in the work area.

Soil waste from the clearing was placed in labeled, DOT-approved 55-gallon drums and stored in the waste storage area at the Facility.

### 4.2. Injection Activities

The injections were completed on approximately 6-foot centers within an approximately 25-foot radius of well MW-11 as shown on Figure 4. Cascade provided drilling services and Regenesis Remediation Services of San Clemente, California (Regenesis) provided the PetroFix solution and injection services including operating the mixing and pumping equipment and monitoring injection volumes and rates. Petrofix literature provided by Regenesis is presented in Appendix B. In total, PetroFix was injected in 27 borings from 18 to 25 feet bgs to target the shallow groundwater zone in the VRU Area. Approximately 2,800 pounds of PetroFix and 140 pounds of electron acceptor blend were applied to the subsurface. The resultant dose of PetroFix was 13.5 pounds per cubic yard. The total volume of PetroFix solution injected was 5,864 gallons, and the injection volume per vertical foot for each injection point was 31 gallons.

The injection process included injecting the PetroFix into the subsurface at 1- and 2-foot depth intervals using a 2-foot injection screen with a 1-foot unscreened point. To inject the PetroFix across the prescribed 7-foot injection interval from 18 to 25 feet bgs, Cascade advanced the tooling to 26 feet bgs and lifted the tooling up 1 foot exposing the injection screen from 24 to 25 feet bgs. After this initial 1-foot injection interval, Cascade would lift the injection tooling another 2 feet to expose the remaining 1 foot of screen and raise the screen to the 22- to 24-foot injection interval. Cascade and Regenesis proceeded with this process for each boring until the entire interval from 18 to 25 feet bgs had been injected with PetroFix. Cascade decontaminated injection tooling between borings.

The starting time, injection pressure, flow rate, and volume injected were recorded for each injection interval at every injection point; these data are tabulated on Table 3 of the Regenesis field report, which is contained in Appendix C. Injection pressure ranged from 18 pounds per square inch (PSI) to 141 PSI. Generally, higher pressures were necessary to achieve adequate injection rates in the initial 24- to 25-foot injection interval. This was likely a result of the shorter screen height used for the initial 1-foot injection interval before the full 2-foot screen was exposed for the remaining injection intervals. Regenesis did not observe any indications of subsurface fracturing caused by the higher initial injection pressures.

With the exception of borings B-9, B-14, and B-16, injection volumes were completed as planned. Borings B-14 and B-16 were the first two borings completed. When injection rates were low for the initial 24- to 25-foot interval in borings B-14 and B-16, the injection volume was reduced and tooling pulled up 1 foot to expose the full screen. This resulted in injections at intervals of 19 to 21 feet and 18 to 20 feet. As a result, the 18- to 20-foot interval was only injected with 15 pounds of PetroFix, and the interval from 19 to 20 feet bgs was injected twice due to overlap. This alternative injection procedure is not expected to have impacted the effectiveness or results of the injections. With the exception of boring B-9, later injections followed the procedure outlined in the paragraph above. In boring B-9, the PetroFix solution could not be injected in the initial 24- to 25-foot interval. The 15 pounds of PetroFix not injected in the 24- to 25-foot interval were added to the 18- to 20-foot interval.

There was no daylighting or surfacing of PetroFix for the majority of the injection points. Daylighting was observed three times during the injection program. While injecting in boring B-23, approximately 1 gallon of PetroFix surfaced from boring B-24. The injection was temporarily paused while additional bentonite was added to B-24 to improve the boring seal. A small amount of PetroFix surfaced around the injection tooling at boring B-27. Cascade packed additional bentonite around the injection tooling and the surfacing stopped. Later, approximately 5 gallons of PetroFix surfaced from the area surrounding a ground penetration of piping approximately 10 feet southwest when injecting in boring B-29, possibly following a preferential path of underground piping adjacent to the boring. In all, the total volume of PetroFix that surfaced during the injections is estimated to have been less than 10 gallons.

At the end of the first day of injections on October 30, a soil core was collected from boring B-6, located approximately 8 feet west of completed injection point B-14, from a depth interval of 8 to 25 feet, to confirm expected soil conditions and observe for the presence of Petrofix from nearby borings to confirm radius of influence. Black staining from the PetroFix injection at boring B-14 was present from 21 to 25 feet bgs confirming a radius of influence of at least 8 feet from the previous injections. An additional soil core was collected from boring B-2 at a depth interval from 8 to 25 feet on November 3, 2023, after all other injection points had been completed. Gray staining was observed in the soil from 22 to 25 feet bgs, however it did

not appear to be PetroFix based on the color; the closest adjacent injection point was boring B-7, located approximately 5 feet from boring B-2. Boring B-2 and B-6 field logs are provided in Appendix D.

Waste soil and water generated during the injection program were drummed. The drummed waste, including the waste soil from the preparatory clearing activities, was profiled as non-hazardous and transported to Hillsboro Landfill by Waste Management.

## 5.0 POST-INJECTION GROUNDWATER MONITORING RESULTS

Quarterly groundwater monitoring was completed in November 2023 and results were reported in the 2023 Annual Groundwater Monitoring Report (GeoEngineers, 2024). However, water collected from well MW-11 contained visible liquid activated carbon solution and the sample from this well was not submitted for analysis. The water in well MW-11 was checked again in February 2024 and a sample was collected for chemical analysis using a modified approach approved by Ecology, discussed below in section 6.2.

The event scope and procedures are discussed in section 6.1 below; the analytical data sheets for the first quarter, 2024 monitoring event are provided in Appendix E. SOPs for the monitoring event are provided in Appendix F.

### 5.1. Scope and Procedures of Monitoring Event

Groundwater monitoring events are conducted at the Facility quarterly and reported annually. Analytical results from the first quarter 2024 for wells in the VRU Area are presented herein to assess initial results from the remediation injections.

During the first quarter 2024 event, fluid level measurements were recorded to the nearest 0.01 foot from the surveyed top of monitoring well casing. Depth to groundwater was measured using an electronic water level indicator probe. Although separate phase hydrocarbons (SPH) have not been observed at the Facility, the wells are assessed using an electronic water/hydrocarbon interface probe to document their absence.

Samples were collected in accordance with the low-flow sampling SOPs provided in Appendix F. In brief, Facility monitoring wells were purged prior to sample collection, utilizing a peristaltic pump with the intake of the tubing placed midway within the saturated screened interval of the monitoring well. Monitoring wells were purged until field parameters (pH, conductivity, temperature, oxidation-reduction potential [ORP] and dissolved oxygen [DO]) stabilized. Following stabilization of parameters, groundwater samples were collected directly from the discharge tube of the peristaltic pump into laboratory-supplied containers.

Samples were labeled and placed in ice-cooled chests for transport, under chain-of-custody protocol, to Apex Laboratories of Tigard, Oregon, for the following analyses:

- BTEX, MTBE and naphthalene by U.S. Environmental Protection Agency (EPA) Method 8260D; and
- TPHg by Method NWTPH-Gx, and TPHd and TPHo by Method NWTPH-Dx.

### 5.2. Modified Analytical Approach for Well MW-11

As described above, a groundwater sample from well MW-11 was not submitted for chemical analysis during the November 2023 monitoring event because the water in the well contained a visible amount of

activated carbon. The concentration of activated carbon in the sample collected from well MW-11 in November 2023 could influence an accurate analysis of the analytes and could damage analytical equipment at the laboratory. For the February 2024 event, groundwater was purged from well MW-11 and observed in a 40-milliliter (mL) volatile organic compound analysis (VOA) vial to visually estimate the amount of carbon in the groundwater[1]. The water purged from well MW-11 appeared slightly transparent, therefore, it was determined that the concentration of activated carbon in the groundwater at well MW-11 was likely within the acceptable analysis range based on guidance from Regenesis. However, due to the uncertainty about the ability to visually quantify the amount of activated carbon in the groundwater, two samples were collected from MW-11, and one sample was analyzed using standard procedures and the second used a modified approach recommended by Regenesis. The modified approach consisted of adding alum to the sample VOA prior to collection of the samples to be analyzed for TPHg, BTEX and naphthalene, and collecting samples for diesel- and oil-range hydrocarbon analysis in 1-liter laboratory-supplied containers and having the samples filtered in the laboratory using a 0.7-micron filter to remove the activated carbon prior to analysis[2]. Ecology approved the modified method in an email on January 16, 2024. The Ecology approval email, the method literature, and the Regenesis SOPs for the analytical approach are provided in Appendix G.

### 5.3. Results

TPHg, TPHd, BTEX, MTBE and naphthalene were not detected in the samples from well MW-11 in February 2024, including the results using standard analysis procedures and using the modified approach supplied by Regenesis. From November 2022 through August 2023, TPHg and TPHd have ranged in concentration from 22.8 to 78.8 milligrams per liter (mg/L), and 0.121 to 0.814 mg/L, respectively, in well MW-11, representing baseline conditions. The median concentrations of TPHg and TPHd since the installation of well MW-11 in 2019 are 8.17 mg/L and 0.230 mg/L, respectively. The February 2024 TPHg and TPHd results in MW-11 indicate that a significant reduction in dissolved petroleum hydrocarbons in groundwater in the VRU Area has occurred following the injections. As shown on Figure 2, well MW-11 is surrounded by shallow wells MW-1 through MW-3, MW-12, and deeper well MW-12D. TPHg, TPHd, BTEX, MTBE and naphthalene were either non-detect or below MTCA Method A Cleanup Levels in shallow wells MW-1 through MW-3 and MW-12, and deeper well MW-12D in November 2023 (GeoEngineers, 2024) and February 2024 with the exception of a detection of TPHd in well MW-1 (Table 2). These results are consistent with historical results for these wells and demonstrate that the TPH and BTEX concentrations in groundwater remain limited in extent in the VRU Area.

These initial results indicate that the subsurface application of liquid activated carbon in the VRU Area was effective. Through the quarterly monitoring program, GeoEngineers will continue to collect groundwater

[1] Regenesis guidance states that water samples containing PetroFix can be safely and accurately sampled at concentrations below 100 mg/L. The guidance also states that in a 40 mL VOA container, water with a colloidal activated carbon concentration of 100 mg/L appears dark and only slightly transparent.

[2] The first sample was collected as standard in hydrochloric acid preserved sample containers. For the second sample, alum was added to the VOA viles at the time of sampling to flocculate the activated carbon from the sample and allow for analysis. The portion of the sample collected in 1-Liter glass containers, used for analysis of diesel- and oil-range hydrocarbons, was passed through a 0.7 micrometer (µm) filter by Apex laboratory to remove the activated carbon from the sample prior to analysis. Sample volumes that were lab-filtered were collected unpreserved and were later preserved by the lab after filtration.

samples from well MW-11 in the VRU Area. Chemical analytical groundwater data will be evaluated annually in the Annual Groundwater Monitoring Report.

## 6.0 REFERENCES


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TABLES

GeoEngineers

# Table 1

## Groundwater Elevation Data

NuStar Terminals Operations Partnership, L.P.—Annex Terminal

Vancouver, Washington

| Well Number | Date of Measurement | Top of Casing Elevation (feet above MSL) | Screened Interval (feet bgs) | Depth To SPH (feet) | Depth to Groundwater (feet) | SPH Thickness (feet) | Groundwater Elevation (feet) |
|---|---|---|---|---|---|---|---|
| MW-1 | 05/14/02 | NS | 14.5 - 24.5 | -- | 16.00 | -- | NS |
| | 05/25/07 | 26.66 | | -- | 14.92 | -- | 11.74 |
| | 08/24/07 | 26.66 | | -- | 18.67 | -- | 7.99 |
| | 11/26/07 | 26.66 | | -- | 17.91 | -- | 8.75 |
| | 02/27/08 | 26.66 | | -- | 16.92 | -- | 9.74 |
| | 03/30/10 | 26.66 | | -- | 17.09 | -- | 9.57 |
| | 09/01/10 | 26.66 | | -- | 19.19 | -- | 7.47 |
| | 12/16/14 | 26.66 | | -- | 16.19 | -- | 10.47 |
| | 03/25/15 | 26.66 | | -- | 15.25 | -- | 11.41 |
| | 06/24/15 | 26.66 | | -- | 18.43 | -- | 8.23 |
| | 09/15/15 | 26.66 | | -- | 19.05 | -- | 7.61 |
| | 11/30/17 | 26.72 | | -- | 16.16 | -- | 10.56 |
| | 02/28/18 | 26.72 | | -- | 15.07 | -- | 11.65 |
| | 05/29/18 | 26.72 | | -- | 8.43 | -- | 18.29 |
| | 08/30/18 | 26.72 | | -- | 18.37 | -- | 8.35 |
| | 02/18/19 | 26.72 | | -- | 16.51 | -- | 10.21 |
| | 05/20/19 | 26.72 | | -- | 13.22 | -- | 13.50 |
| | 08/28/19 | 26.72 | | -- | 19.04 | -- | 7.68 |
| | 11/18/19 | 26.72 | | -- | 18.64 | -- | 8.08 |
| | 02/24/20 | 26.72 | | -- | 16.26 | -- | 10.46 |
| | 06/01/20 | 26.72 | | -- | 12.97 | -- | 13.75 |
| | 08/17/20 | 26.72 | | -- | 18.19 | -- | 8.53 |
| | 11/16/20 | 26.72 | | -- | 17.59 | -- | 9.13 |
| | 02/25/21 | 26.72 | | -- | 14.52 | -- | 12.20 |
| | 05/04/21 | 26.72 | | -- | 17.08 | -- | 9.64 |
| | 08/10/21 | 26.72 | | -- | 19.77 | -- | 6.95 |
| | 11/16/21 | 26.72 | | -- | 16.74 | -- | 9.98 |
| | 02/14/22 | 26.73 | | -- | 17.11 | -- | 9.62 |
| | 05/16/22 | 26.73 | | -- | 13.65 | -- | 13.08 |
| | 08/15/22 | 26.73 | | -- | 16.92 | -- | 9.81 |
| | 11/16/22 | 26.73 | | -- | 18.43 | -- | 8.30 |
| | 02/15/23 | 26.73 | | -- | 17.85 | -- | 8.88 |
| | 05/10/23 | 26.73 | | -- | 12.85 | -- | 13.88 |
| | 08/09/23 | 26.73 | | -- | 18.47 | -- | 8.26 |
| | 11/20/23 | 26.73 | | -- | 18.06 | -- | 8.67 |
| | 02/14/24 | 26.73 | | -- | 15.79 | -- | 10.94 |
| MW-2 | 05/14/02 | NS | 20 - 35 | -- | 27.46 | -- | NS |
| | 05/25/07 | 38.21 | | -- | 26.46 | -- | 11.75 |
| | 08/24/07 | 38.21 | | -- | 30.17 | -- | 8.04 |
| | 11/26/07 | 38.21 | | -- | 29.42 | -- | 8.79 |
| | 02/27/08 | 38.21 | | -- | 28.50 | -- | 9.71 |
| | 03/30/10 | 38.21 | | -- | 28.66 | -- | 9.55 |
| | 09/01/10 | 38.21 | | -- | 30.74 | -- | 7.47 |
| | 12/16/14 | 38.21 | | -- | 27.77 | -- | 10.44 |
| | 03/25/15 | 38.21 | | -- | 26.79 | -- | 11.42 |
| | 06/24/15 | 38.21 | | -- | 30.05 | -- | 8.16 |
| | 09/15/15 | 38.21 | | -- | 30.65 | -- | 7.56 |
| | 11/30/17 | 38.27 | | -- | 27.66 | -- | 10.61 |
| | 02/28/18 | 38.27 | | -- | 26.70 | -- | 11.57 |
| | 05/29/18 | 38.27 | | -- | 19.96 | -- | 18.31 |
| | 08/30/18 | 38.27 | | -- | 29.94 | -- | 8.33 |
| | 02/18/19 | 38.27 | | -- | 28.04 | -- | 10.23 |
| | 05/20/19 | 38.27 | | -- | 24.73 | -- | 13.54 |
| | 08/28/19 | 38.27 | | -- | 30.63 | -- | 7.64 |
| | 11/18/19 | 38.27 | | -- | 30.16 | -- | 8.11 |
| | 02/24/20 | 38.27 | | -- | 27.91 | -- | 10.36 |

Please refer to notes at end of table.

# Table 1

## Groundwater Elevation Data

NuStar Terminals Operations Partnership, L.P.—Annex Terminal

Vancouver, Washington

| Well Number | Date of Measurement | Top of Casing Elevation (feet above MSL) | Screened Interval (feet bgs) | Depth To SPH (feet) | Depth to Groundwater (feet) | SPH Thickness (feet) | Groundwater Elevation (feet) |
|---|---|---|---|---|---|---|---|
| MW-2 (cont'd) | 06/01/20 | 38.27 | | -- | 24.51 | -- | 13.76 |
| | 08/17/20 | 38.27 | | -- | 29.81 | -- | 8.46 |
| | 11/16/20 | 38.27 | | -- | 29.01 | -- | 9.26 |
| | 02/25/21 | 38.27 | | -- | 27.11 | -- | 11.16 |
| | 05/04/21 | 38.27 | | -- | 28.59 | -- | 9.68 |
| | 08/10/21 | 38.27 | | -- | 30.34 | -- | 7.93 |
| | 11/16/21 | 38.27 | | -- | 28.13 | -- | 10.14 |
| | 02/14/22 | 38.27 | | -- | 28.76 | -- | 9.51 |
| | 05/16/22 | 38.27 | | -- | 25.15 | -- | 13.12 |
| | 08/15/22 | 38.27 | | -- | 28.52 | -- | 9.75 |
| | 11/16/22 | 38.27 | | -- | 30.05 | -- | 8.22 |
| | 02/15/23 | 38.27 | | -- | 29.50 | -- | 8.77 |
| | 05/10/23 | 38.27 | | -- | 24.47 | -- | 13.80 |
| | 08/09/23 | 38.27 | | -- | 30.12 | -- | 8.15 |
| | 11/20/23 | 38.27 | | -- | 29.59 | -- | 8.68 |
| | 02/14/24 | 38.27 | | -- | 27.66 | -- | 10.61 |
| MW-3 | 05/14/02 | NS | 24.5 - 34.5 | -- | 28.15 | -- | NS |
| | 05/25/07 | 39.11 | | -- | 27.17 | -- | 11.94 |
| | 08/24/07 | 39.11 | | -- | 31.04 | -- | 8.07 |
| | 11/06/07 | 39.11 | | -- | 30.36 | -- | 8.75 |
| | 02/27/08 | 39.11 | | -- | 28.71 | -- | 10.40 |
| | 03/30/10 | 39.11 | | -- | 29.55 | -- | 9.56 |
| | 09/01/10 | 39.11 | | -- | 31.65 | -- | 7.46 |
| | 12/16/14 | 39.11 | | -- | 28.54 | -- | 10.57 |
| | 03/25/15 | 39.11 | | -- | 27.72 | -- | 11.39 |
| | 06/24/15 | 39.11 | | -- | 30.85 | -- | 8.26 |
| | 09/15/15 | 39.11 | | -- | 31.52 | -- | 7.59 |
| | 11/30/17 | 39.17 | | -- | 28.61 | -- | 10.56 |
| | 02/28/18 | 39.17 | | -- | 27.18 | -- | 11.99 |
| | 05/29/18 | 39.17 | | -- | 20.91 | -- | 18.26 |
| | 08/30/18 | 39.17 | | -- | 30.80 | -- | 8.37 |
| | 02/18/19 | 39.17 | | -- | 28.94 | -- | 10.23 |
| | 05/20/19 | 39.17 | | -- | 26.03 | -- | 13.14 |
| | 08/28/19 | 39.17 | | -- | 31.51 | -- | 7.66 |
| | 11/18/19 | 39.17 | | -- | 31.06 | -- | 8.11 |
| | 02/24/20 | 39.17 | | -- | 28.76 | -- | 10.41 |
| | 06/01/20 | 39.17 | | -- | 25.73 | -- | 13.44 |
| | 08/17/20 | 39.17 | | -- | 30.53 | -- | 8.64 |
| | 11/16/20 | 39.17 | | -- | 29.88 | -- | 9.29 |
| | 02/25/21 | 39.17 | | -- | 27.91 | -- | 11.26 |
| | 05/04/21 | 39.17 | | -- | 29.47 | -- | 9.70 |
| | 08/10/21 | 39.17 | | -- | 31.22 | -- | 7.95 |
| | 11/16/21 | 39.17 | | -- | 29.06 | -- | 10.11 |
| | 02/14/22 | 39.17 | | -- | 29.60 | -- | 9.57 |
| | 05/16/22 | 39.17 | | -- | 26.42 | -- | 12.75 |
| | 08/15/22 | 39.17 | | -- | 29.33 | -- | 9.84 |
| | 11/16/22 | 39.17 | | -- | 30.98 | -- | 8.19 |
| | 02/15/23 | 39.17 | | -- | 30.38 | -- | 8.79 |
| | 05/10/23 | 39.17 | | -- | 25.85 | -- | 13.32 |
| | 08/09/23 | 39.17 | | -- | 31.26 | -- | 7.91 |
| | 11/20/23 | 39.17 | | -- | 30.51 | -- | 8.66 |
| | 02/14/24 | 39.17 | | -- | 28.22 | -- | 10.95 |
| MW-11 | 02/18/19 | NS | 10 - 25 | -- | 17.27 | -- | NS |
| | 05/20/19 | NS | | -- | 14.32 | -- | NS |
| | 08/28/19 | NS | | -- | 19.55 | -- | NS |
| | 11/18/19 | NS | | -- | 19.36 | -- | NS |

Please refer to notes at end of table.

# Table 1

## Groundwater Elevation Data

**NuStar Terminals Operations Partnership, L.P.—Annex Terminal**

**Vancouver, Washington**

| Well Number | Date of Measurement | Top of Casing Elevation (feet above MSL) | Screened Interval (feet bgs) | Depth To SPH (feet) | Depth to Groundwater (feet) | SPH Thickness (feet) | Groundwater Elevation (feet) |
|---|---|---|---|---|---|---|---|
| MW-11 | 02/24/20 | NS | | -- | 16.28 | -- | NS |
| (cont'd) | 06/01/20 | NS | | -- | 13.95 | -- | NS |
| | 08/17/20 | NS | | -- | 18.58 | -- | NS |
| | 11/16/20 | NS | | -- | 18.70 | -- | NS |
| | 02/25/21 | NS | | -- | 15.91 | -- | NS |
| | 05/04/21 | NS | | -- | 17.79 | -- | NS |
| | 08/10/21 | NS | | -- | 19.31 | -- | NS |
| | 11/16/21 | NS | | -- | 17.75 | -- | NS |
| | 02/14/22 | 27.41 | | -- | 17.28 | -- | 10.13 |
| | 05/16/22 | 27.41 | | -- | 14.76 | -- | 12.65 |
| | 08/15/22 | 27.41 | | -- | 17.43 | -- | 9.98 |
| | 11/16/22 | 27.41 | | -- | 19.03 | -- | 8.38 |
| | 02/15/23 | 27.41 | | -- | 18.27 | | 9.14 |
| | 02/15/23 | 27.41 | | -- | 18.27 | -- | 9.14 |
| | 05/10/23 | 27.41 | | -- | 14.03 | -- | 13.38 |
| | 08/09/23 | 27.41 | | -- | 19.05 | -- | 8.36 |
| | 11/20/23 | 27.41 | | -- | 18.67 | -- | 8.74 |
| | 02/14/24 | 27.41 | | -- | 16.34 | -- | 11.07 |
| MW-12 | 02/14/22 | 33.12 | 18-33 | -- | 23.47 | -- | 9.65 |
| | 05/16/22 | 33.12 | | -- | 20.29 | -- | 12.83 |
| | 08/15/22 | 33.12 | | -- | 23.33 | -- | 9.79 |
| | 11/16/22 | 33.12 | | -- | 25.04 | -- | 8.08 |
| | 02/15/23 | 33.12 | | -- | 24.35 | -- | 8.77 |
| | 05/10/23 | 33.12 | | -- | 19.59 | -- | 13.53 |
| | 08/09/23 | 33.12 | | -- | 24.95 | -- | 8.17 |
| | 11/20/23 | 33.12 | | -- | 24.58 | -- | 8.54 |
| | 02/14/24 | 33.12 | | -- | 22.07 | -- | 11.05 |
| MW-12D | 02/14/22 | 32.06 | 45-55 | -- | 22.66 | -- | 9.40 |
| | 05/16/22 | 32.06 | | -- | 18.78 | -- | 13.28 |
| | 08/15/22 | 32.06 | | -- | 22.37 | -- | 9.69 |
| | 11/16/22 | 32.06 | | -- | 24.11 | -- | 7.95 |
| | 02/15/23 | 32.06 | | -- | 23.46 | -- | 8.60 |
| | 05/10/23 | 32.06 | | -- | 17.92 | -- | 14.14 |
| | 08/09/23 | 32.06 | | -- | 24.01 | -- | 8.05 |
| | 11/20/23 | 32.06 | | -- | 23.60 | -- | 8.46 |
| | 02/14/24 | 32.06 | | -- | 21.37 | -- | 10.69 |

**Notes:**

1. All wells in the groundwater monitoring program were gauged during the February, 2024 monitoring event. Data for monitoring wells not relevant to the VRU Area will be reported and discussed in the 2024 Annual Groundwater Monitoring Report
2. Survey elevations determined by Bluedot Group surveying, November 2017. The following wells were surveyed by MacKay Sposito on 2/7/22: MW-1, MW-6D, MW-11, MW-12, MW-12D.
3. Reference elevation (i.e., top of casing) relative to NAVD 88, feet above mean sea level.
4. feet above MSL = feet above mean sea level.
5. NS = Not surveyed
6. -- = SPH not measured/observed.
7. bgs = below ground surface.

# Table 2

## Summary of Groundwater Analytical Results—Monitoring Wells

### NuStar Terminals Operations Partnership, L.P.—Annex Terminal

### Vancouver, Washington

| Well Number | Sample Date | TPHg Gasoline (mg/L) | TPHd Diesel (mg/L) | TPHo Heavy Oil (mg/L) | Benzene (mg/L) | Toluene (mg/L) | Ethylbenzene (mg/L) | Xylenes (mg/L) | MTBE (mg/L) | Naphthalene (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| MW-1 | 5/11/2023 | <0.100 | 0.111 F-11 | <0.155 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.002 |
| | 8/9/2023 | <0.100 | 0.302 F-11 | <0.154 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.004 |
| | 11/20/2023 | <0.100 | 0.257 F-11 | <0.157 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.005 |
| | 2/14/2024 | <0.100 | **0.511 F-11** | <0.160 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.005 |
| MW-2 | 5/10/2023 | <0.100 | <0.0762 | <0.152 | <0.0002 | <0.001 | <0.0005 | <0.0015 | 0.00678 | <0.002 |
| | 8/10/2023 | <0.100 | <0.0769 | <0.154 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.004 |
| | 11/21/2023 | <0.100 | 0.0997 F-11 | <0.154 | <0.0002 | <0.001 | <0.0005 | <0.0015 | 0.00278 | <0.005 |
| | 2/14/2024 | <0.100 | <0.0800 | <0.160 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.005 |
| MW-3 | 5/10/2023 | <0.100 | 0.0838 F-11 | <0.155 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.002 |
| | 8/10/2023 | <0.100 | <0.0769 | <0.154 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.004 |
| | 11/21/2023 | <0.100 | 0.0875 F-11 | <0.157 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.005 |
| | 2/15/2024 | <0.100 | <0.0833 | <0.167 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.005 |
| MW-11 | 5/11/2023 | **4.81** | 0.108 F-11, F-20 | <0.152 | **0.0135** | <0.01 | **0.762** | 0.0843 | <0.01 | <0.02 |
| | 5/11/2023 DUP | **4.89** | 0.121 F-11, F-20 | <0.154 | **0.0138** | <0.01 | **0.790** | 0.0849 | <0.01 | <0.02 |
| | 8/10/2023 | **58.0** | 0.496 F-11, F-20 | <0.154 | **0.0122** | 0.419 | **3.60** | **13.90** | <0.01 | **0.407** |
| | 8/10/2023 DUP | **62.4** | **0.532 F-11, F-20** | <0.154 | **0.0119** | 0.440 | **3.760** | **14.00** | <0.01 | **0.420** |
| | 2/15/2024 | <0.200 R-04 | <0.0842 DCNT | <0.168 DCNT | <0.0004 R-04 | <0.002 R-04 | <0.001 R-04 | <0.003 R-04 | <0.002 R-04 | <0.010 R-04 |
| | 2/15/2024 (Alum or Filtered) | <0.200 R-04 | <0.0777 PRO | <0.155 PRO | <0.002 R-04 | <0.010 R-04 | <0.005 R-04 | <0.015 R-04 | <0.01 R-04 | <0.05 R-04 |
| | 2/15/2024 (Alum or Filtered) DUP | <0.200 R-04 | <0.0769 PRO | <0.154 PRO | <0.0004 R-04 | <0.002 R-04 | <0.001 R-04 | <0.003 R-04 | <0.002 R-04 | <0.01 R-04 |
| MW-12 | 5/10/2023 | <0.100 | 0.0949 F-11 | <0.151 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.002 |
| | 8/9/2023 | <0.100 | <0.0769 | <0.154 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.004 |
| | 11/20/2023 | <0.100 | <0.0769 | <0.154 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.005 |
| | 2/15/2024 | <0.100 | 0.176 F-11 | <0.158 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.005 |
| MW-12D | 5/11/2023 | <0.100 | <0.0769 | <0.154 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.002 |
| | 8/9/2023 | <0.100 | <0.0769 | <0.154 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.004 |
| | 11/20/2023 | <0.100 | <0.0769 | <0.154 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.005 |
| | 2/15/2024 | <0.100 | <0.0792 | <0.158 | <0.0002 | <0.001 | <0.0005 | <0.0015 | <0.001 | <0.005 |
| **Washington DOE MTCA Method A Cleanup Level** | | 0.8 | 0.5 | 0.5 | 0.005 | 1 | 0.7 | 1 | 0.02 | 0.16 |

**Please refer to notes at end of table**

# Table 2

## Summary of Groundwater Analytical Results—Monitoring Wells

### NuStar Terminals Operations Partnership, L.P.—Annex Terminal

### Vancouver, Washington

**Notes:**

1. TPHg = Total petroleum hydrocarbons in gasoline carbon range by NW-TPHgx method.
2. TPHd = Total petroleum hydrocarbons in diesel carbon range by NW-TPHdx method.
3. TPHho = Total petroleum hydrocarbons in heavy oil carbon range NW-TPHdx method.
4. **Bold** values represent concentration that exceeds MTCA Method A cleanup level.
5. mg/L (ppm) = Milligrams per liter (parts per million).
6. TPHg cleanup level dependent on presence of benzene in groundwater. Cleanup level = 0.800 mg/L if benzene is present and 1.00 mg/L if benzene is not present.
7. Washington Department of Ecology Model Toxics Control Act Method A cleanup level = DOE MTCA Method A cleanup level.
8. < = Not detected at or above the specified laboratory method reporting limit (MRL).
9. bgs = below ground surface
10. -- = Sample not analyzed for constituent.
11. DCNT = Sample decanted due to the presence of sediment. Sample bottle not rinsed with solvent.
12. PRO = Sample was filtered via a glass filter prior to extraction and analysis.
13. All wells in the groundwater monitoring program were sampled during the February, 2024 monitoring event. Data for monitoring wells not relevant to the VRU Area will be reported and discussed in the 2024 Annual Groundwater Monitoring Report.

**Notes on Quality Assurance/Quality Control Data Qualifiers**

A: Data flagged F-11 = The hydrocarbon pattern indicates possible weathered diesel, mineral oil, or a contribution from a related component.

B: Data flagged F-13 = The chromatographic pattern does not resemble the fuel standard used for quantitation.

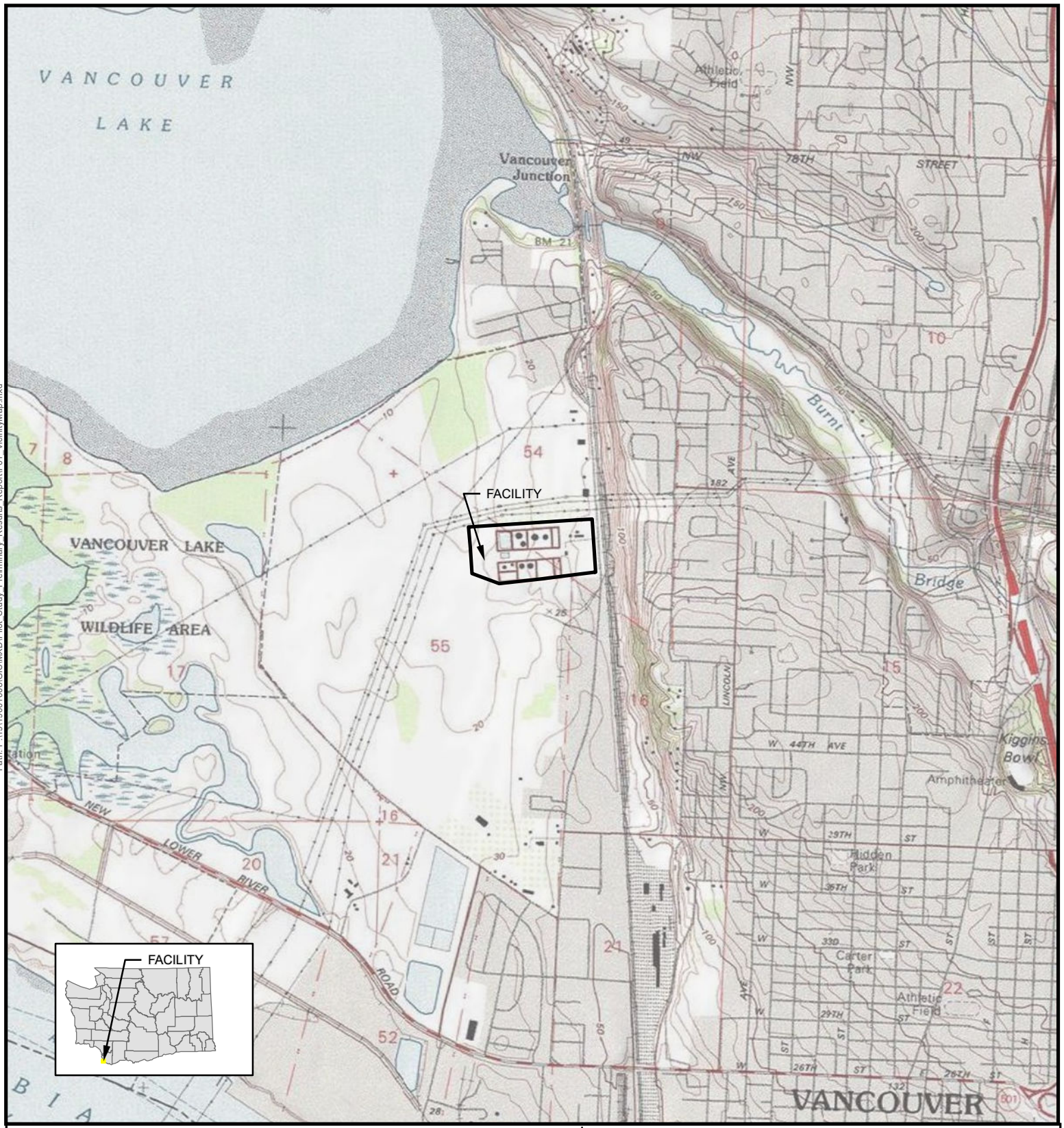
D: Data flagged F-18 = Result for Diesel (Diesel Range Organics, C12-C24) is due to overlap from Gasoline or a Gasoline Range product.

F: Data flagged F-20 = Result for Diesel is estimated due to overlap from Gasoline Range Organics or other volatile organic compounds (VOCs).

G: Data flagged Q-54a = Daily Continuing Calibration Verification recovery for this analyte failed the +/-20% criteria listed in EPA method 8260/8270 by -9%. The results are reported as Estimated Values.

FIGURES

GeoEngineers




Source: USGS Map obtained from Esri ArcGIS Online

Facility Boundary

0 1,000 2,000
Feet

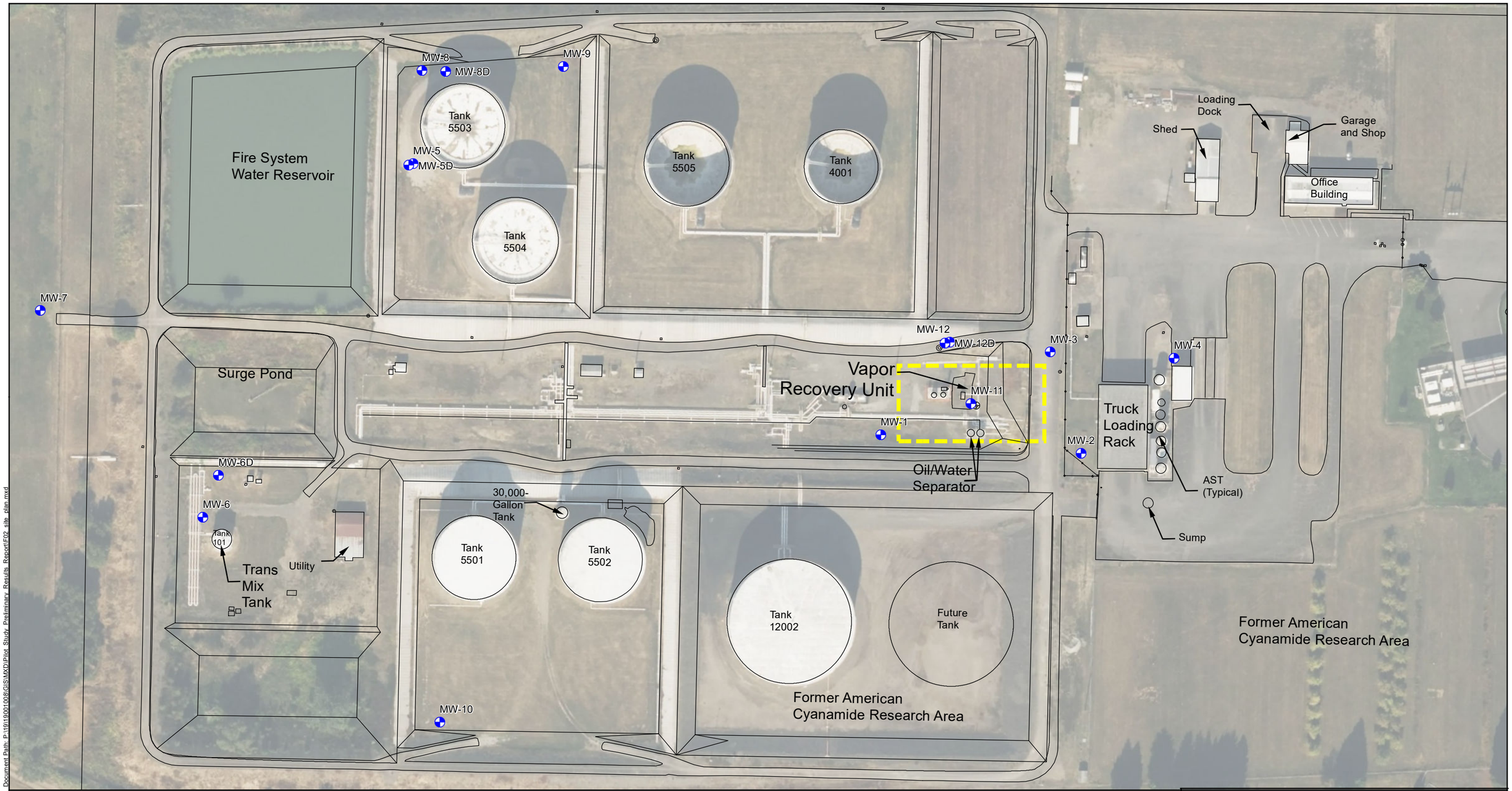
**Facility Location Map**

Remedial Injection Implementation and Initial Results Report
NuStar Terminals Operations Partnership L.P. - Annex Terminal
Vancouver, Washington

GeoEngineers

**Figure 1**

Project:
Produced By: estrandhagen
Approved By:
Print Date: 5/6/2024
Path: P:\191\19001008\GIS\MXD\Pilot Study Preliminary Results Report\F01 VicinityMap.mxd




Document Path: P:\191\190010008\GIS\MXD\Pilot_Study_Preliminary_Results_Report\Fig2_site_plan.mxd

Notes:
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.

Source:
Aerial from Mapbox.

Groundwater Monitoring Well Location (MW-5D, MW-6D, MW-8D and MW-12D are Deep Monitoring Well Locations)

Extent of Figure 3

0 25 50 100 Feet

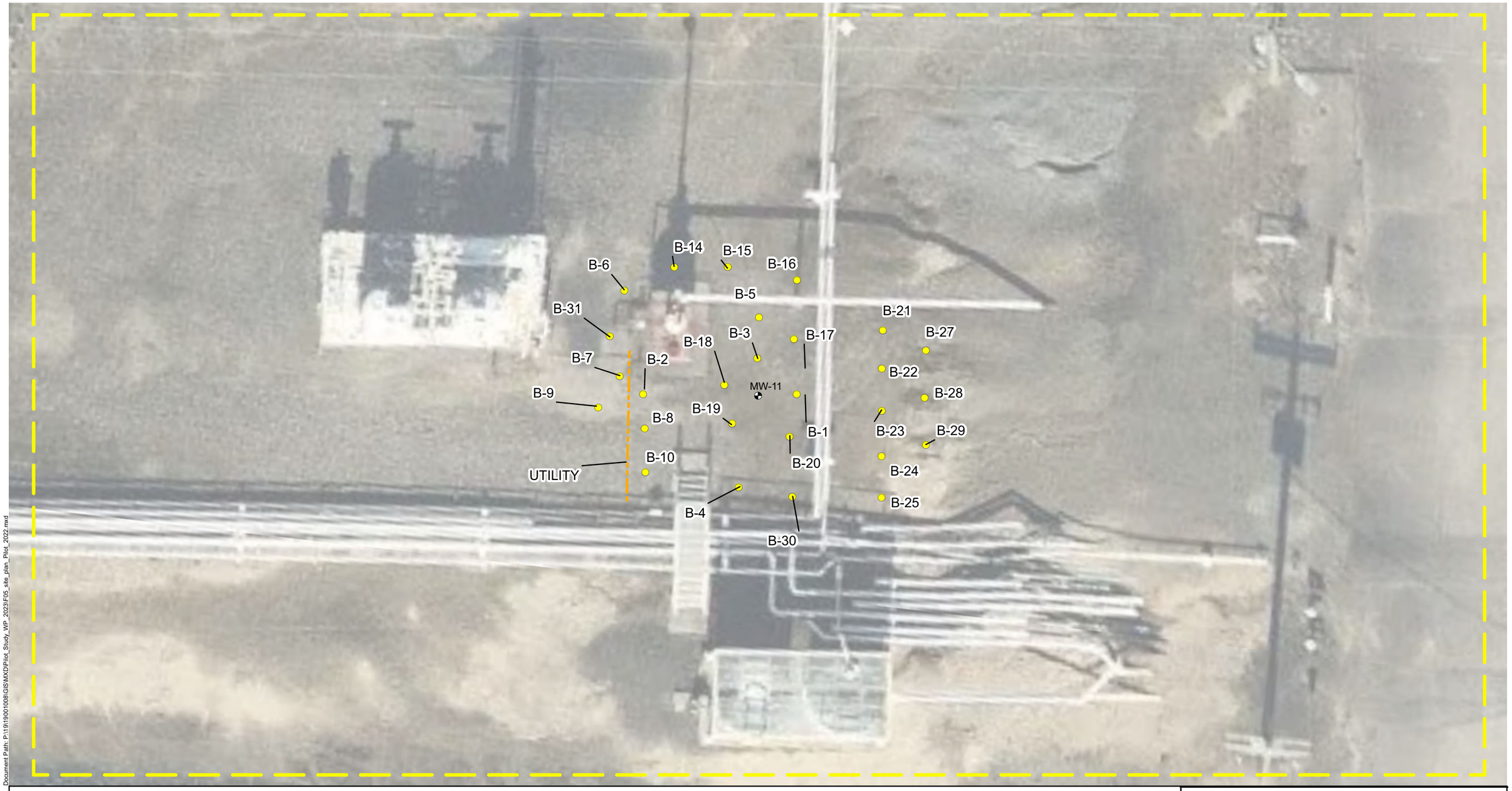
# Facility Plan

Remedial Injection Implementation and Initial Results Report
NuStar Terminals Operations Partnership L.P. - Annex Terminal
Vancouver, Washington

| 5/6/2024 | | Drawn by: ES | | |
|---|---|---|---|---|

GeoEngineers

Figure 2




Document Path: P:\191900\006\GIS\MXD\Pilot_Study_WP_2023\F05_site_plan_Pilot_2022.mxd

Notes:
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.

Source:
Aerial from Mapbox.

Groundwater Monitoring Well Location

Injection Location

Utility

0 5 10 Feet

# Injection Locations

Remedial Injection Implementation and Initial Results Report
NuStar Terminals Operations Partnership L.P. - Annex
Terminal Vancouver, Washington

| 4/22/2024 | | Drawn by: ES | | |
|---|---|---|---|---|

GeoEngineers

Figure 3

APPENDICES

GeoEngineers

# APPENDIX A
## Boring Logs for B-22, MW-12, and MW-12D

| | | | |
|---|---|---|---|
| | PROJECT: **Additional Soil and Groundwater Investigation** | BORING ID: **B-22** | |
| | LOCATION: **5420 NW Fruit Valley Rd, Vancouver, WA.** | WELL ID: **NA** | |
| | DRILLING CONTRACTOR: **NuStar Vancouver Annex Facility** | NORTHING: | EASTING: |
| | DRILLING EQUIPMENT: **Hand auger to 8', Geoprobe 7730 to depth** | SURFACE ELEV. (NAVD88): **Not measured** | TOC ELEVATION: |
| | DRILLING METHOD: **Direct-Push** | TOTAL DEPTH: **25** | DEPTH TO WATER: **17.9** |
| LOGGED BY: **LW** | SAMPLING METHOD: **2.25-Inch Single Tube Sampler** | DATE STARTED: **1/29/19** | DATE COMPLETED: **1/29/19** |

| Elev. (feet) | USCS | Graphic Log | Description | Driven/Rec. (ft.) | Headspace Vapor (ppm) | Sheen | Soil Sample | Sample Depth | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 0 | ML | | Clayey SILT with trace fine sand, brown, slightly moist, medium stiff. | 2.0/2.0 | <5 | NS | | | |
| 2 | ML | | SILT with trace clay and fine sand, brown, slightly moist, medium stiff. | 2.0/2.0 | <5 | NS | | | |
| 4 | | | | 2.0/2.0 | <5 | NS | | | |
| 6 | ML | | Sand increasing. | 2.0/2.0 | <5 | NS | | | |
| 8 | SM | | SAND with silt, brown, slightly moist, medium-grained, medium dense. | 2.0/2.0 | <5 | NS | | | |
| 10 | SM | | Becomes dark gray. | 5.0/5.0 | <5 | NS | | | |
| 12 | ML | | Clayey SILT lens with trace fine sand, brown, wet, medium stiff. | | <5 | NS | | | |
| 14 | SM | | SAND with silt, gray, slightly moist, medium-grained, medium dense. | | <5 | NS | | | |
| 16 | SM | | Silt increasing. | 5.0/5.0 | <5 | NS | | | |
| 18 | SM | | Becomes moist. | | <5 | NS | | | |
| 20 | | | Silty SAND; gray, wet, medium grained, medium dense | | <5 | NS | B-22 (1) | ☒ | |

NOTES: Bottom of boring at 25 feet bgs.

| | | | |
|---|---|---|---|
| | PROJECT: **Additional Soil and Groundwater Investigation** | BORING ID: **B-22** | |
| | LOCATION: **5420 NW Fruit Valley Rd, Vancouver, WA.** | WELL ID: **NA** | |
| | DRILLING CONTRACTOR: **NuStar Vancouver Annex Facility** | NORTHING: | EASTING: |
| | DRILLING EQUIPMENT: **Hand auger to 8', Geoprobe 7730 to depth** | SURFACE ELEV. (NAVD88): **Not measured** | TOC ELEVATION: |
| | DRILLING METHOD: **Direct-Push** | TOTAL DEPTH: **25** | DEPTH TO WATER: **17.9** |
| LOGGED BY: **LW** | SAMPLING METHOD: **2.25-Inch Single Tube Sampler** | DATE STARTED: **1/29/19** | DATE COMPLETED: **1/29/19** |

| Elev. (feet) | USCS | Graphic Log | Description | Driven/Rec. (ft.) | Headspace Vapor (ppm) | Sheen | Soil Sample | Sample Depth | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 22 | SM | | | 5.0/5.0 | 65 | NS | | | |
| 24 | | | | | 45 | NS | | | |

NOTES: Bottom of boring at 25 feet bgs.

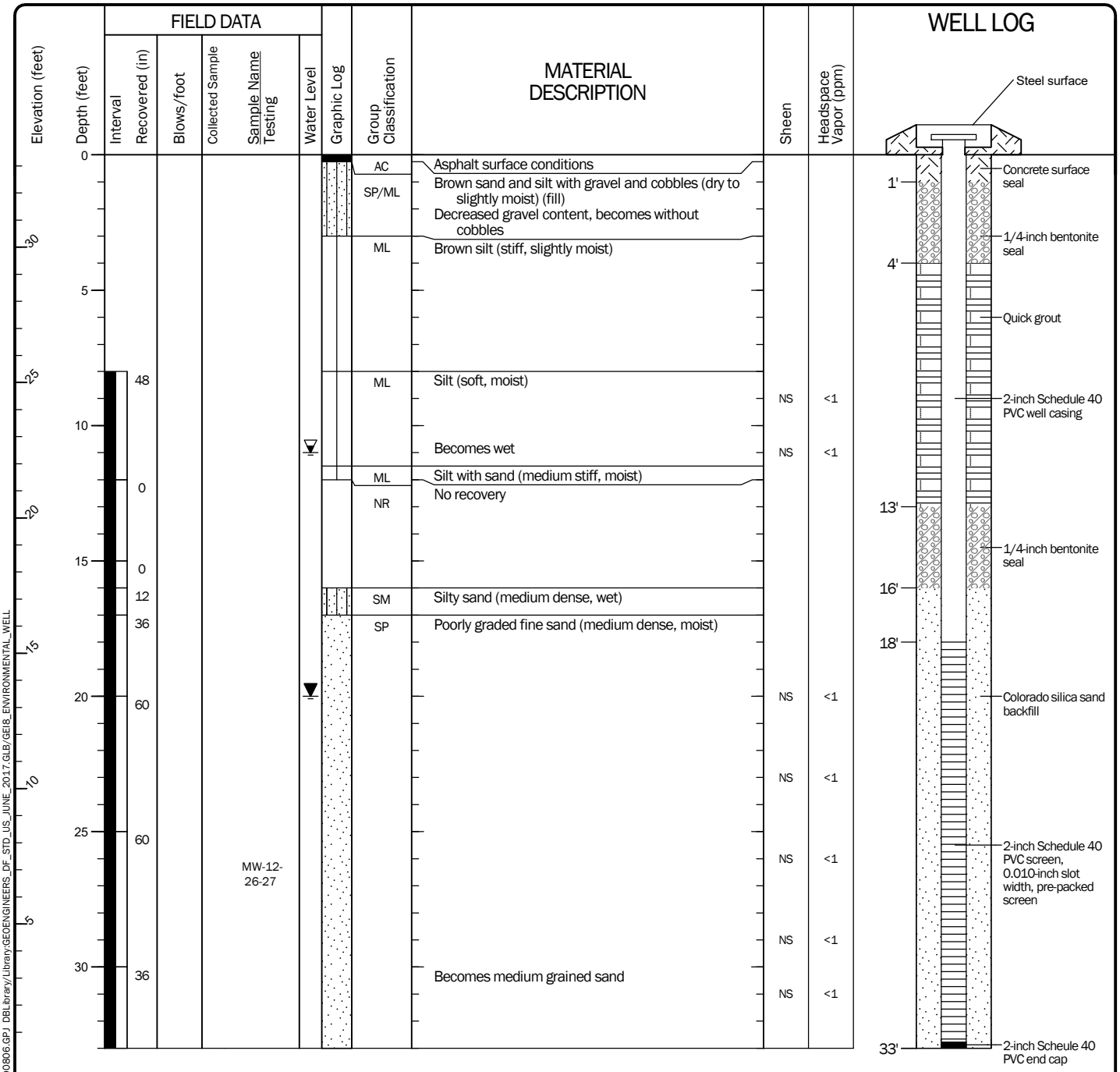
| Drilled | Start | End | Total Depth (ft) | Logged By | Checked By | Driller | Drilling Method |
|---|---|---|---|---|---|---|---|
| | 2/1/2022 | 2/2/2022 | 33 | JP/NP | NER/SBS | Cascade Drilling | Hand Auger/ Direct Push |

| | | | |
|---|---|---|---|
| Hammer Data | N/A | Drilling Equipment | Hand Auger/ GeoProbe 3230 DT |
| Surface Elevation (ft) Vertical Datum | 33.41 NAVD88 | Top of Casing Elevation (ft) | 33.12 |
| Easting (X) Northing (Y) | 1079672.99 127575.18 | Horizontal Datum | WA State Plane South NAD83 (feet) |

A 2-in well was installed on 2/1/2022 to a depth of 33 ft.

| Groundwater Date Measured | Depth to Water (ft) | Elevation (ft) |
|---|---|---|
| 2/1/2022 | 20.00 | 13.41 |

Notes: Hand augered to approximately 8 feet, then drilled beyond with GeoProbe equipment.




Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey by Mackay Sposito. Vertical approximated based on survey by Mackay Sposito.

# Log of Monitoring Well MW-12

GeoEngineers

Project: NuStar Energy - Vancouver Annex - 2021 Remediation
Project Location: Vancouver, Washington
Project Number: 19001-008-06

Figure A-3
Sheet 1 of 1

| Drilled | Start | End | Total Depth (ft) | Logged By | Checked By | Driller | Drilling Method |
|---|---|---|---|---|---|---|---|
| | 2/2/2022 | 2/2/2022 | 55 | JP/NP | NER/SBS | Cascade Drilling | Hand Auger/ Direct Push |

| | | | |
|---|---|---|---|
| Hammer Data | N/A | Drilling Equipment | Hand Auger/ GeoProbe 3230 DT |
| Surface Elevation (ft) Vertical Datum | 32.8 NAVD88 | Top of Casing Elevation (ft) | 32.06 |
| Easting (X) Northing (Y) | 1079668.19 127574.17 | Horizontal Datum | WA State Plane South NAD83 (feet) |

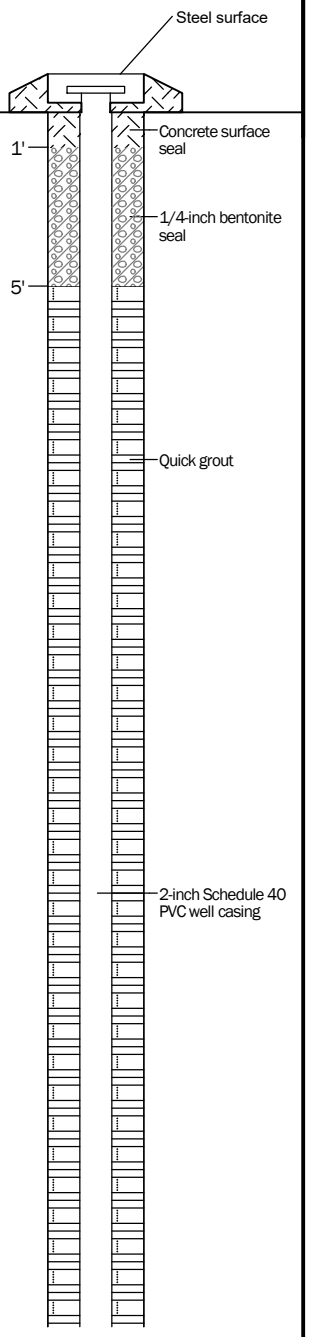
A 2-in well was installed on 2/2/2022 to a depth of 55 ft.

| Groundwater Date Measured | Depth to Water (ft) | Elevation (ft) |
|---|---|---|

Notes: Hand augered to approximately 8 feet, then drilled beyond with GeoProbe equipment.

| Elevation (feet) | Depth (feet) | Interval Recovered (in) | Blows/foot | Collected Sample | Sample Name Testing | Water Level | Graphic Log | Group Classification | MATERIAL DESCRIPTION | Sheen | Headspace Vapor (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 0 | | | | | | | AC | Asphalt surface conditions | | |
| | | | | | | | | SP-SM | Brown sand and silt with gravel and cobbles (dry to slightly moist) (fill) | | |
| | | | | | | | | ML | Brown silt (stiff, slightly moist) | | |
| 25 | 5 | | | | | | | | | | |
| | | | | | | | | | Refer to boring log MW-12 for soil description from 8 to 30 feet | | |
| 20 | 10 | | | | | | | | | | |
| 15 | 15 | | | | | | | | | | |
| 10 | 20 | | | | | | | | | | |
| 5 | 25 | | | | | | | | | | |
| 0 | 30 | 60 | | | | | | SP | Gray-brown poorly graded medium sand with trace silt (medium dense, wet) | NS | <1 |
| -5 | 35 | | | | | | | | | | |

WELL LOG



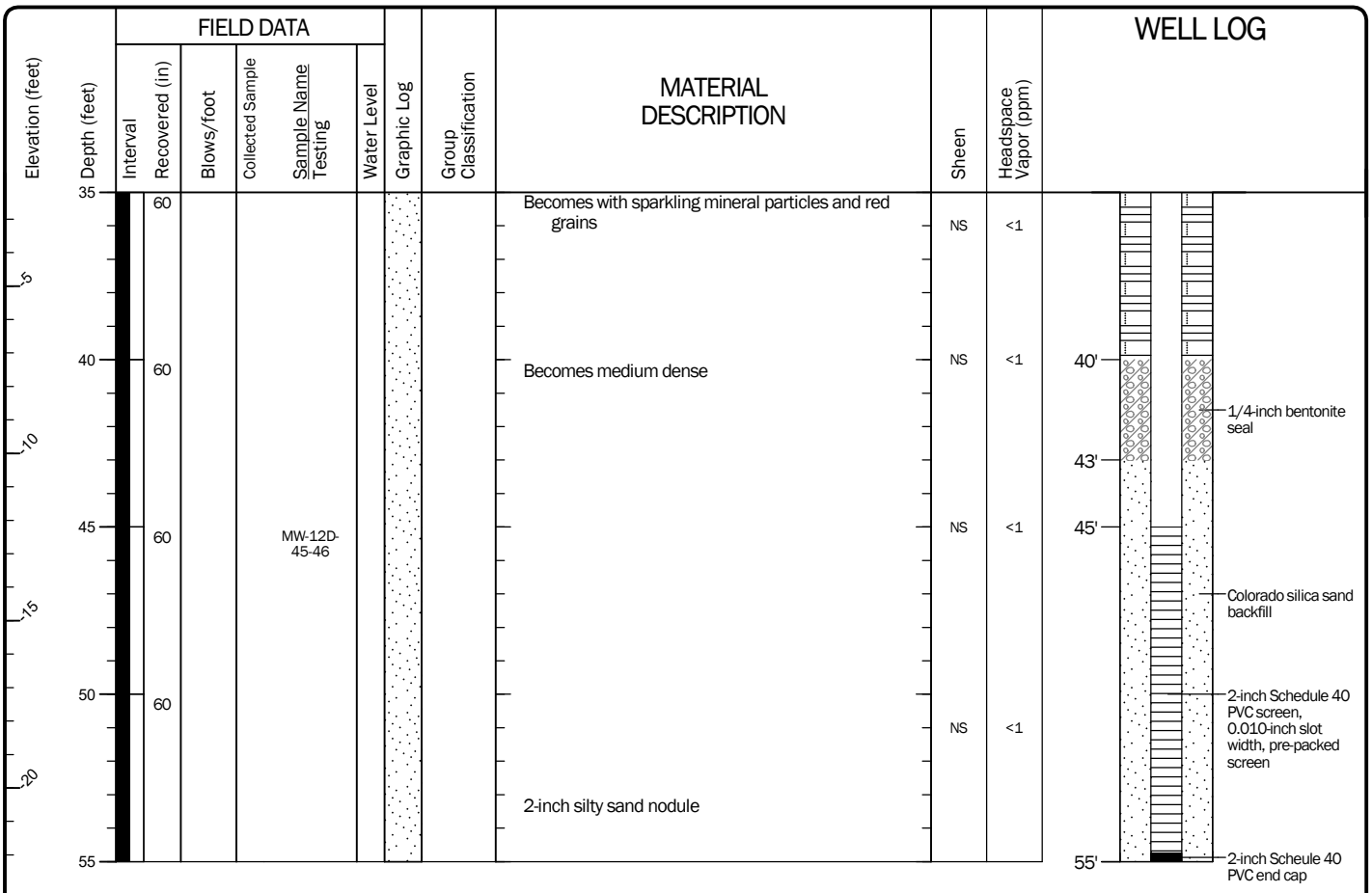

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on survey by Mackay Sposito. Vertical approximated based on survey by Mackay Sposito.

# Log of Monitoring Well MW-12D

GeoEngineers

Project: NuStar Energy - Vancouver Annex - 2021 Remediation
Project Location: Vancouver, Washington
Project Number: 19001-008-06

Figure A-4
Sheet 1 of 2




## Log of Monitoring Well MW-12D (continued)

GeoEngineers

Project: NuStar Energy - Vancouver Annex - 2021 Remediation
Project Location: Vancouver, Washington
Project Number: 19001-008-06

Figure A-4
Sheet 2 of 2

# APPENDIX B
## Regenesis Petrofix™ Literature

PetroFIX™
Remediation Fluid

# DIRECT PUSH APPLICATION INSTRUCTIONS

PetroFIX™
Remediation Fluid

# TABLE OF CONTENTS

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PetroFIX™
Remediation Fluid

## INTRODUCTION

One of the methods to deliver PetroFix™ Remediation Fluid (PetroFix) into the subsurface is to inject the material through direct push rods using hydraulic equipment. This approach increases the spreading and mixing of PetroFix into the aquifer. This set of instructions is specific to the direct push injection of PetroFix. For advice on other potential delivery techniques please contact REGENESIS directly at 949-366-8000 or send an inquiry to info@petrofix.com.

PetroFix should be installed with the goal of having the material fully coat all conductive zones of an aquifer to prevent any mobility or escape of contaminants to downgradient locations. Because PetroFix is a liquid-carbon suspension amended with soluble electron acceptors, it flows easily into most aquifers using relatively low-pressure. Adequate injection volume is needed to ensure that PetroFix contacts enough aquifer pore-space to fully coat aquifer transmissive zones and the starting volumes recommended to achieve this goal is provided as part of the PetroFix design assistant output. To achieve optimal contact and coverage with PetroFix, we recommend that the user consider these estimates as a starting point and be willing to adjust injection volumes and injection tooling as described later in this document.

When PetroFix is injected properly it will evenly coat the soil matrix across the horizontal and vertical transport zones of an aquifer and will appear as if the aquifer was "painted" black as shown in Figure 1. Most soils prior to PetroFix application are either brown or grayish in color and the presence of PetroFix post-application should be evident.

### *PetroFix Distribution Goal*

***Fully coat all aquifer conductive pathways in the treatment zone with PetroFix and adjust field injection spacing, injection volumes, injection pressure, or injection tooling to accomplish that goal.***

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Remediation Fluid


**FIGURE 1** *The photo on the left shows a soil core collected before a PetroFix application. The photo on the right shows a soil core collected after a PetroFix application exhibiting black soil where the PetroFix was successfully distributed.*

## DIRECT PUSH GUIDANCE

### *Typical Installation Equipment and Supplied Needed*

- Secure storage area
- Qualified driller/applicator
- Water source for mixing
- Access to electricity
- Appropriate Personal Protective Equipment (PPE) PetroFix SDS
- Direct Push Rig (such as a Geoprobe®) and associated probe tooling
- Mixing tanks – size based on product quantity to be applied per injection point
- Grout and mortar mixer with paddle for homogenizing PetroFix in its 55-gallon drums
- Injection tooling with fluid delivery sub-assembly (see injection tooling section)
- Injection pump rated to at least 200 psi and at least 5 gpm
- Injection hosing and pressure relief valve with a bypass (make sure all equipment is rated for expected injection pressures required)
- Hosing between mixing tank/drum and pump
- Pressure gauges to monitor injection pressure
- Flow meter for tracking injection volumes (or use visual drops in tank volumes over time)
- Pressure regulator to prevent pressure spikes (recommended, but not mandatory)
- Granular bentonite or grout to abandon completed injection boreholes. Some regulatory agencies have specific requirements for backfilling subsurface borings, so check with your local agency prior to beginning field work.
- Quick-set concrete or asphalt patch for surface closing


**FIGURE 2** *PetroFix ships in 55-gallon poly drums (400 lb of product) plus one 20 lb bucket of electron acceptor blend per drum*

## PERSONAL PROTECTIVE EQUIPMENT

Personnel working with or in areas where there is a potential for contact with PetroFix should be required at a minimum to be fitted with Level D personal protective equipment. However, this recommendation is only for PetroFix and does not supersede additional precautions due to site conditions and potential exposures.

PPE should be upgraded from modified Level D based on site-specific hazards and requirements.

## STORAGE AND HANDLING GUIDELINES

### Storage:

- Store away from incompatible materials
- Store in original container
- Store at temperatures between 40$^0$F and 95$^0$F
- Do not allow material to freeze or store in direct sunlight
- Freezing and hot weather technical memo can be accessed at www.petrofix.com resources or at this ***link*** here
- Dispose of waste and residues in accordance with local authority requirements

### Handling:

- Never add additives to solution prior to mixing with water
- Wear appropriate personal protective equipment
- Do not taste or ingest
- Observe good industrial hygiene practices
- Wash hands after handling

## PETROFIX APPLICATION STEPS

### *Injection Preparation and Mixing*

1) Print a copy of the Area Summaries for your site created in the PetroFix App.
2) Review design with drilling crew.
3) Review SDS during health and safety tailgate.

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4) Walk the site and make note of any obstacles or infrastructure that may impede application based on utility locates.

a. Make sure you have called in Public utility locates before mobilizing to the site.

b. Prior to the installation of PetroFix, identify any surface or overhead impediments as well as the location of all underground structures. Underground structures include but are not limited to: utility lines, tanks, distribution piping, sewers, drains, and landscape irrigation systems. If locations are unknown, a private utility locating service can be contracted to locate these structures.

c. The planned installation locations should be adjusted to account for all impediments and obstacles while being mindful of PetroFix distribution needs.

5) Mark injection points based on site design provided in the PetroFix App.

a. Outline injection area.

b. Mark all points and note any points that may have different vertical application requirements or total depth.

c. Ensure points are spaced appropriately based on recommended design provided by the PetroFix App.

6) Set up area for mixing PetroFix Remediation Fluid with water and PetroFix Electron Acceptor Blend.

7) Assemble product transfer system.

8) Assemble injection system.

**9) NOTE:** REGENESIS recommends injecting clean water (i.e. water without PetroFix mixed in) prior to mixing a PetroFix batch to check for leaks within the mixing and injection system. Repair any leaking equipment prior to mixing PetroFix in the mix tank.

a. It is critical to always depressurize the injection lines before disconnecting any fittings. This can be accomplished by fitting a bleed off valve near the injection pull cap (see Figure 3 below).

10) Advance the probe rods to the first vertical treatment interval and inject clean water into the interval while monitoring for leaks. If the leak test proved successful, continue to mix PetroFix into the mixing system.

a. During this step confirm the equipment pressure ratings are matched to the injection pressures.

11) Always add water to mixing tank prior to adding PetroFix Remediation Fluid.

12) Always pre-mix PetroFix in its container prior to pumping material out of the container. The best type of mixer for all circumstances would be a high torque, double handle mixer such as a *QEP or Rigid thinset grout and mortar power mixer* with QEP 30" pro spiral mixing paddle, or equivalent. Such equipment can be purchased at most Home Depots or large box hardware stores.

a. **Note:** PetroFix drums are not completely full and PetroFix fills to roughly 10 to 12 inches below the top of the drum (See Figure 4).

13) Transfer designed ratio of PetroFix remediation fluid to the water in the mix tank. **Recommended batch sizes should range from 50 to 350 gallons to aid in easy mixing and for measuring injection volumes per point.**

14) Thoroughly mix PetroFix solution in the mixing tank using an impeller type drum mixer or by recirculating the product inside the tank.

15) Add recommended ratio of PetroFix Electron Acceptor Blend to the mixed solution in the tank. One tip is to use a scale to measure mass of electron acceptor blend needed for partial mix batches (Figure 4). Standard dosing is one bucket of electron acceptor blend per one drum of PetroFix.

a. **DO NOT mix PetroFix Electron Acceptor (EA) blend from the 20 lb buckets into undiluted PetroFix Remediation Fluid in the drums or totes. Only add the PetroFix EA blend into the diluted PetroFix solution in the mix tank.**

**FIGURE 3** *LEFT: Geoprobe injection pull cap (1.5").* *RIGHT: The pull cap can be outfitted with a bleed off valve to depressurize injection lines prior to breaking probe rods to advance to next vertical treatment interval.*


**FIGURE 4** *Image on left shows undiluted PetroFix in a drum prior to homogenization. PetroFix doesn't fully fill the drum and this is normal (a 400 lb drum of PetroFix contains approximately 41 gallons of product). The image in the middle shows an example transfer and PetroFix mixing setup where a 330-gallon tote was chosen as the mix tank. The picture on the right shows some PetroFix electron acceptor being weighed before placement into the mixing tank.*

## *Injecting PetroFix*

1) Set up the direct push unit over each specific point and follow the manufacturer standard operating procedures (SOP) for the direct push equipment. Care should be taken to ensure that the probe holes remain vertical. If there are enough personnel, this step can be accomplished while others attend to the mixing phase.

a. To prevent fluid and pressure loss between probe rod connections, we advise that the probe rod threads be Teflon® taped for the best possible seal.

2) Advance drive rods through the surface and through any pavement or concrete at locations cleared for utilities, as necessary, following SOP.

a. Ensure that all personnel in the working area have hearing protection during this step.

3) Push the drive rod assembly with your selected tool tip to the desired depth. This depth will depend on if you are performing a bottom-up or top-down injection – see section on "Examples of PetroFix Injection Tooling". REGENESIS suggests pre-counting the number of drive rods needed to reach depth prior to beginning injection activities.

4) After the drive rods have been pushed to the desired depth, apply the designed quantity of prepared PetroFix solution at the target treatment intervals specified in the design. The target injection volume will be determined by multiplying the volume per foot by the injection tooling length. Regenesis recommends dual batch mixing PetroFix such that one mix tank is used for injection while the other is being prepared to follow after it is empty. This allows for uninterrupted fluid injection and minimizes field downtime for mixing.

**a. As a rule-of-thumb, 20 to 100 psi and 2 to 7 gpm flow rates are common through a single injection point.**

**b. Whip checks should be used throughout the process when working with pressurized hoses.**

5) Once target volume is reached, close off the injection line leading to the probe rods and depressurize the injection lines by draining the product into a bucket or similar. Use caution before and during opening any injection lines as there might be backpressure that could kick back or spray. See Figure 3 for an example of an injection pull cap outfitted with a bleed off valve.

6) Continue mixing and injecting the combined solution using the target injection volumes for the injection point described in the PetroFix design output page.

7) Once all injection points are completed, begin site cleanup by emptying the drums and flushing all injection lines using clean water. Product containers can be recycled after they are rinsed.

8) Dispose of any waste and residue in accordance with local authority requirements.

## EXAMPLES OF PETROFIX INJECTION TOOLING

Injection tooling can be selected based on the type of soil present, logistic needs of the site, and prior experience of the consultant and injection crews. Our suggestions below are not exhaustive, but enough to outline injection tips common to most injection contractors. We advise that injection distribution is verified in field regardless of injection tooling used (see section of **"Verifying PetroFix Distribution In The Field"**). Injection tooling can be chosen in a variety of sizes (1.25", 1.5", 1.75", and 2.25"). Most environmental drillers will carry probe rods with 1.5" and 2.25" diameters for soil sampling and these same sizes can be used for injection. Geoprobe manufactures an injection pull cap that is designed to thread directly onto Geoprobe threaded probe rods. These pull caps can be outfitted with a bleed off valve steel pipe fittings available from McMaster-Carr®, Grainger®, or pipe fitting supply stores.

### *Multi-Port Bottom-Up Retractable or Multi-Port Top-Down Injection Tooling.*

For injecting at lower pressures (typically below 60 psi) and maintaining relatively high volumetric injection rates, **REGENESIS recommends using multi-port retractable or top-down injection tooling** using 1-foot, 2-foot, or larger exposed injection screens (See Figure 5). An advantage of these types of tooling is they usually require no pre-probing and allows targeting larger vertical intervals of the aquifer. Retractable injection tooling also allows for semi-discrete targeting of the aquifer and allowing PetroFix to flow into hard to identify small or large conductive zones that are likely contaminant transport pathways.

## EXAMPLES OF BOTTOM-UP RETRACTABLE OR TOP-DOWN INJECTION TOOLING:

- Variety of 1.5" OD bottom-up retractable and top-down injection tooling in different lengths available (Figure 5).
  *https://www.shop-esp.com/ESP-Injection-Tooling-C517.aspx*

- See section on remediation injection tooling for retractable remedial Injection tooling (RRIT) options.
  *https://www.ams-samplers.com/powerprobe/direct-push-tooling-catalog.html*

**FIGURE 5** *Image on the left is an Environmental Service Products (ESP) bottom-up retractable tool. Image on the right is an ESP top-down injection tool.*

## TIPS ON USING BOTTOM-UP RETRACTABLE OR TOP-DOWN INJECTION TOOLING:

- It is advisable not to exceed 24" of exposed retractable screen in silts and clays which will give you better control of the vertical distribution of the PetroFix solution.

- Larger than 24" injection tooling can be used in homogeneous, permeable soils (sand and gravel) where more even product distribution is expected through exposed screen if enough flow rate and pressure can be maintained.

- The selection of bottom-up retractable or top-down injection depends on the preference and experience of the drilling operator. A top-down tool is more robust when hammered into hard soils and allows the applicator to more quickly set a vertical interval without the need to pull the rods back. A narrow slotted well screen can be slipped through the middle of the top-down tool to prevent silts and clays from clogging the injection ports.

## PRESSURE ACTIVATED TOOL TIP

Many injection companies make use of a pressure activated injection probe (Figure 6) that is supplied by Geoprobe®. These probes are effective in aquifers that have a higher permeability (high percentage of sand); however, in tighter formations these tool tips tend to generate enough pressure to cause hydraulic fracturing of PetroFix that may result in uncontrolled placement or surfacing.

## TIPS ON USING PRESSURE ACTIVATED TOOLING:

- Top-down injection usually recommended in most formations with this tip.
- Be cautious of hydraulic fracturing with this tip. To get the uniform distribution shown in Figure 1 this approach may require that the vertical distance between push-and-inject intervals as low as 1 to 2 feet to prevent gaps in product coverage vertically.

**FIGURE 6** *Image of Geoprobe® pressure activated injection probe*

## EXPENDABLE DRIVE POINTS AND INJECTION THROUGH ROD BOTTOM

Bottom-up injection using expendable tool tips (Figure 7) is an option if the aquifer grades from tight soils at maximum injection depth to permeable soils at minimum injection depth, for instance injecting into clay or silt that grades to sand as you approach the surface. If the geology were reversed, one needs to be concerned about preferential delivery of PetroFix into deeper zones as the rod is raised and the PetroFix fluid preferentially flows to the zone of least resistance down the injection hole. For flowing sands and highly permeable environments, injection through rod bottom can achieve effective product delivery. The vertical distance between pull-and-inject lifts may need to be as low as 1 to 2 feet to prevent gaps in product coverage vertically. Bottom-up injection with expendable drive points offers the least control over injection and is least recommended, particularly for soils with silts and clays.

**FIGURE 7** *Geoprobe® expendable steel point allowing for bottom-up injection through rod opening.*

## VERIFYING PETROFIX DISTRIBUTION IN THE FIELD

PetroFix has the unique advantage of being its own tracer due to its black appearance which can be used to verify its distribution in the field. The PetroFix Design assistant **(https://petrofix.com/design/)** is an excellent starting point to estimate spacing and volumes to use for an application, but one should expect to make some minor adjustments in field due to natural variability of geology and pore space.

The easiest way to determine if PetroFix is distributing is to collect one or more soil cores at your site after the first 2 to 4 injection points have been completed. Most direct push operators have the tools required for rapid soil core sampling and we recommend that you double check this when bidding out your work. We recommend that a soil core be collected with the following criteria:

1. Take the observational soil core half-way between two PetroFix injection points or half the spacing distance away from any given injection point;

2. Take the observational soil core over the entire vertical interval. This may require more than one core be taken.

If you see a strong black color (like Figure 1 or Figure 8 below) coating the conductive zones of your aquifer, then congratulations as you are achieving product distribution. If you don't observe a black color in the soil, then you are not achieving sufficient distribution and should diagnose the reason why. It is important that PetroFix be observed both laterally and vertically at your site. It also is important to investigate if your injection is distributing PetroFix into the one or more geologic conductive zones at your site. A small percentage of sites may have dark or black soils because of hydrocarbon staining and it is important to distinguish if this is the case. Ideally, we recommend that you take a baseline soil core before injection and then compare this to one or more post-injection samples to see the difference.


**FIGURE 8** *Photo showing an in-field verification of PetroFix distribution and its optimal coverage. Gray soil in upper right shows the edge of the injection zone where PetroFix not injected.*

Here are a few tips if PetroFix is not observed in your soil core:

- **Double check injection pressures** – Am I injecting with a steady pressure? If not, consider increasing pressure (which will also be increasing volumetric flow rate). If you are very low in pressure (<10 psi) it may be that you are not achieving enough product velocity to cause delivery far enough from your injection points. As a general rule-of-thumb most sites range in pressure from 20 to 100 psi and volumetric injection rates of 5 to 7 gpm. If you are not exceeding fracture pressures and are getting uniform distribution, then feel free to use the maximum volumetric flow rates or pressures that you can achieve.

- **Double check spacing** – Am I within the recommended spacing suggested by the PetroFix design assistant? If not, consider tightening spacing.

- **Double check volumes** – Have I injected the recommended volume of water and PetroFix together? If not, inject recommended volumes of water and PetroFix.

If spacing, volumes, and injection pressures are as initially designed, and you are still not getting distribution, it may be that the aquifer has a higher pore space than assumed for design purposes. Consider increasing the dilution water used for PetroFix by increments of 10% to 15% volume until distribution is achieved. Furthermore, it may be that the injection tooling you are using is not suited to your aquifer type and you should consider changing injection tooling.

Alternatively, you may find that you need less mix water and PetroFix verification testing can be used to minimize needed water if your effective porosity is less than designed for. If less water is needed to obtain the required ROI then we recommend that you reduce the overall injection volume, but keep the same design spacing versus spreading the points farther apart.

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***Q: "How do I know if I am fracturing soil and having uncontrolled product placement?"***

***A:*** *Fractures are induced by rapid pressure build-up followed by high volumetric flow rates. If you notice a spike in pressure followed by a rapid drop in pressure, yet high-volumetric flow rates are sustained it is likely that you are pushing PetroFix into created fractures. You may not see any observable evidence of this happening or you may begin to see surfacing into utility corridors, ground surface, etc. We advise that pump pressures are slowly increased as well as volumetric flow rates where everything is steady without big pressure spikes and big pressure drops. The use of a pressure regulator as mentioned in the equipment list to prevent pressure spikes and the use of pressure gauges between the pump and the injection rods is very important to be able to monitor this process. Soil sampling is a good visual method to answer your questions as to if you are getting uniform and complete coverage or if you are creating fractures.*

*Regarding the monitoring of pressures, it is common to see pressures rise to the point that fluid begins moving into the formation and then those pressures gradually decrease (versus a rapid decrease). This is different than the hydraulic fracturing of soil. We see this as a normal initiation pressure as the PetroFix fluid needs to overcome either partially occluded pore space immediately around the tooling because of soil smearing or through the compaction of soils around the tooling that can happen when the tooling is pushed into the formation.*

***Q: "What if I want to try and achieve larger injection spacing than the PetroFix Design Assistant Specifies?"***

***A:*** *Many customers ask if they can use injection spacing larger than specified by our PetroFix Design Assistant. Our answer is that we believe that our recommended spacing is a good recommendation and starting point (typically 5 ft- to 6.5 ft-on-center), particularly for sites with more silt and clay than sand. However, sites do vary in their characteristic effective porosities and percentage of fine-grained to course-grained materials and how they are layered. If stable pressures and flows are maintained, then it may be that larger ROI's can be achieved given the starting volumes that were calculated. If this is the case, our recommendation is to maintain injection spacing but reduce injection volumes to cut down on field time.*

*However, if you want to spread injection points out, we encourage you to explore the ability to do so by performing an injection and follow the PetroFix distribution verification process we discussed earlier to document that you achieved distribution. If you can document distribution and are able to accommodate the change in volume injected and time spent per point you should feel free to use whatever spacing can be accommodated.*

## PETROFIX PUMP INFORMATION

REGENESIS strongly recommends using a pump with a minimum pressure rating of 200 pounds per square inch (psi) and a minimum delivery rate of 5 gallons per minute (gpm). A lower gpm rated pump can be used; however, they are not recommended due to the amount of time required to inject the volume typically associated with a PetroFix injection (i.e. 1,200 lb of PetroFix with 60 lb PetroFix Electron Acceptor will require 2,460 gallons of water to make a 5% by volume PetroFix solution).

## PUMP CLEANING

Internal pump mechanisms and hoses can be easily cleaned by circulating water through the pump and injection lines until clear. Flush water can be injected into the treatment zone. Further cleaning and decontamination (if necessary due to subsurface conditions) should be performed according to the equipment supplier's standard procedures and local regulatory requirements.

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# PetroFix™ Specification Sheet

## PetroFix Technical Description

PetroFix is a new remedial technology designed to treat petroleum fuel spills in soil and groundwater. A simple-to-use fluid that can be applied under low pressure into the subsurface or simply poured into open excavations, PetroFix offers a cost-effective solution for environmental practitioners and responsible parties to address petroleum hydrocarbon contaminants quickly and effectively.

PetroFix has a dual function; quickly removing hydrocarbons from the dissolved phase, by absorbing them onto the activated carbon particles, while added electron acceptors stimulate hydrocarbon biodegradation in-place. PetroFix does not require high pressure "fracking" for application and can be applied with ease using readily available equipment associated with direct push technology.

The remedial fluid is a highly concentrated water-based suspension consisting of micron-scale activated carbon and biostimulating electron acceptors. PetroFix has a viscosity higher than water and is black in appearance. Its environmentally-compatible formulation of micron-scale activated carbon (1-2 microns) is combined with both slow and quick-release inorganic electron acceptors. A blend of additional electron acceptors is included along with the PetroFix fluid. Practitioners can select between a sulfate and nitrate combination blend (recommended), or sulfate only for the additional electron acceptors required.

## PetroFix Design Assistant


REGENESIS has developed a proprietary web-based design assistant called PetroFix Design Assistant™ that provides environmental professionals the ability to input their site parameters, determine the required product amount, and order the product through REGENESIS' customer service. The PetroFix Design Assistant includes defaults and warnings throughout the process to guide users toward effective designs that will offer best results.

**To access the PetroFix Design Assistant, create an account and login at www.PetroFix.com**

PetroFIX™ Remediation Fluid

| PetroFix Fluid Chemical Composition | Properties |
|---|---|
| Activated Carbon - CAS 7440-44-0 > 30%<br>Calcium Sulfate Dihydrate - CAS 10101-41-4 < 10% | **Appearance:** Black Fluid<br>**Viscosity:** 1500-3500 cP (corn syrup-like)<br>**pH:** 8-10 |

| PetroFix Electron Acceptor Powder Chemical Composition | Properties |
|---|---|
| OPTION 1 - EA Blend (preferred)<br>Sodium Nitrate - CAS 7631-99-4, 50%<br>Ammonium Sulfate - CAS 7783-20-2, 50%<br><br>OPTION 2 - EA Blend NF<br>Potassium Sulfate - CAS 7778-80-5, 50%<br>Ammonium Sulfate - CAS 7783-20-2, 50% | **Appearance:** White Powder |

## Storage and Handling Guidelines

Storage:

- Store away from incompatible materials
- Store in original closed container
- Store at temperatures between 40°F and 95°F
- Do not allow material to freeze or store in direct sunlight.
- Freezing and hot weather technical memo can be accessed at www.petrofix.com/resources or at this ***link*** here.
- Dispose of waste and residues in accordance with local authority requirements

Handling:

- Never add additives to solution prior to mixing with water
- Wear appropriate personal protective equipment
- Do not taste or ingest
- Observe good industrial hygiene practices
- Wash hands after handling

## Applications

PetroFix is mixed with water on-site and easily applied onto the sub-surface using low pressure injections, or mixed in excavations. PetroFix is compatible with and can be used with ORC Advanced® to expedite rates of biodegradation. For more information about co-application with ORC Advanced, contact REGENESIS.

REGENESIS®

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# APPENDIX C
## Regenesis Remediation Services Application Summary Report

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11/10/2023

**REGENESIS Proposal No. BRG59263**

Philip Cordell
GeoEngineers

**SUBJECT: Application Summary Report for NuStar – Vancouver Terminal Annex – Pilot Test (MW-11)**

Phil,

REGENESIS Remediation Services (RRS) has recently completed an in-situ injection application of PetroFix™ (PetroFix) at the Vancouver Terminal Annex site in Vancouver, WA. The goal of this pilot application was to reduce TPH concentrations in the MW-11 area to levels consistently below MTCA criteria.

RRS mobilized a support pickup truck, injection trailer, and personnel to the site to complete work over five days at the subject site. On-site injection operations began on October 30th, 2023. The pilot test was completed on November 3rd, 2023. RRS staffed this project with experienced project personnel who ensured a safe, successful injection application.

RRS applied PetroFix to twenty-seven (27) Direct Push Technology (DPT) injection point locations over the event duration. The target treatment zone for the contaminants ranges from 18 to 25 feet below ground surface (ft. bgs).

Please review the attached application summary page, map, injection log, and photo log for more detail on the pilot application.

RRS appreciates the opportunity to work at this site with GeoEngineers. RRS will be available to interpret the field data or answer any questions. If you require additional information regarding the application process or attached field notes, please contact Isaac Gregg (igregg@regenesis.com), Keith Munsey (kmunsey@regenesis.com) or Will Mohan (wmohan@regenesis.com).

Sincerely,

Will Mohan
Senior Project Supervisor
REGENESIS Remediation Services

Isaac Gregg
Central Region Project Manager
REGENESIS Remediation Services

REGENESIS
REMEDIATION SERVICES
Technology-Based Solutions for the Environment

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# Table of Contents

**Global Headquarters**
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# Application Summary

## 1. Overview

***Client:*** GeoEngineers
***Project Name:*** NuStar – Vancouver Terminal Annex
***Site Address:*** 5420 Fruit Valley Rd, Vancouver, WA 98660
***Project Dates:*** 10/30/2023 – 11/3/2023
***Client Project Manager:*** Philip Cordell
***RRS Project Manager:*** Isaac Gregg
***RRS Project Supervisors***: Will Mohan and Spencer Lindgren

## 2. Treatment Technology

RRS applied PetroFix to remediate the treatment area.

**PetroFix™ Remediation Fluid**

**PetroFix** has a dual function: it removes hydrocarbons from the dissolved phase by adsorbing them onto activated carbon particles and then stimulates hydrocarbon biodegradation by adding electron acceptors. PetroFix is a highly concentrated water-based suspension consisting of micron-scale activated carbon and biostimulating electron acceptors. The environmentally-compatible formulation of micron-scale activated carbon (1-2 microns) is combined with both slow and quick-release inorganic electron acceptors.

Additional information about PetroFix can be found at regenesis.com.

## 3. Design

### A. Pilot Test Area (MW-11)

The pilot test design required 2,800 pounds of PetroFix and 140 pounds of electron acceptor (EA) blend**.** The products were mixed with water in the same batch tanks and injected at the same time. A total of twenty-seven (27) DPT points were drilled during the pilot test application. The target treatment interval ranged from 18 to 25 ft. bgs. Prior to drilling each injection point, predetermined locations were hand-augured to eight feet. Injection point locations are provided in **Figure 1**. Additional design specifications are provided in **Table 1**.

# Geoengineers - Vancouver Annex Terminal - Injection Map


**Legend**

- PetroFix Injection Point
- Monitoring Wells

Figure 1: Pilot Test Area

0 6 12 18 24
Feet

5420 Fruit Valley Rd
Vancouver, WA 98660

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REMEDIATION SERVICES

Map created: November 10th, 2023
Created by: SWGL

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**Table 1:** Pilot Test PetroFix Design Summary.

REGENESIS

# Injection Grid Application Summary

*Vancouver Annex*

*Vapor Recovery Unit Area*

PetroFIX Remediation Fluid

| PetroFix Amount | 2,800 lb |
|---|---|
| Electron Acceptor | 140 lb |
| Treatment Surface Area | 800.0 ft$^2$ |
| Delivery Points | 27 |
| Point Spacing | 5.4 ft |
| Top of Treatment Interval | 18.0 ft bgs |
| Bottom of Treatment Interval | 25.0 ft bgs |
| Vertical Treatment Interval Thickness | 7.0 ft |
| Treatment Volume | 207 yd$^3$ |
| PetroFix Dose | 13.5 lb/yd$^3$ |

| Total Volume | 5,864 gal |
|---|---|
| Product Volume | 287 gal |
| Water Volume | 5,577 gal |
| Injection Volume/Point | 217 gal |
| Inject Volume/Vertical ft | 31 gal |
| Product/Point | 10.6 gal |
| Water/Point | 206.6 gal |
| Soil Type | >75% silt/clay |
| Effective Pore Volume Fill % | 93% |

| Mix Tank Volume* | 275.0 gal |
|---|---|
| Dilution Factor* | 20.46 |
| PetroFix per Mix Tank | 13 gal |
| Water per Mix Tank | 262 gal |
| Electron Acceptor per Mix Tank | 7 lb |
| Total Batches Required | 21.32 |

**Specific Area Notes**
Native Soil Type: >75% silt/clay

**Reported Ground Water Concentrations (µg/L)**

| | | | |
|---|---|---|---|
| Benzene | 10 | Naphthalenes | 130 |
| Toluene | 50 | MTBE | 0 |
| Ethylbenzene | 1,160 | TPH-GRO | 19,200 |
| Xylenes | 2,250 | TPH-DRO | 320 |
| Trimethylbenzenes | 0 | **Sum of Dissolved Concentrations:** | **19,650** |

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# 4. Application

## A. Job Site Inspection

REGENESIS Remediation Services (RRS) arrived on-site on 10/30/2023. Prior to accessing the injection area all field staff were required to watch a NuStar health and safety training video. RRS performed site reconnaissance to become familiar with the project site, water source, traffic pattern adjustments, hospital locations, and potential hazards. A jobsite safety inspection was completed and documented. Other hazards discussed included slips, trips, and falls resulting from several injection and transfer hoses lying on the ground. Once completed, the injection trailer was staged and prepared for product transfer and mixing.

## B. Injection Sequence

RRS applied the Regenesis technologies by mixing the products in the RRS injection trailer and injecting through 1.5-inch DPT injection tool string fitted for 0.75-inch diameter injection hosing, as shown on **Figure 2**. The injection trailer is fully enclosed and contains mixing tanks, pumps, and delivery system equipped for direct connection to the injection wells. The application pump is a multiple diaphragm positive displacement pump designed to prevent pulsation of the remediation products while being applied. The application pump can deliver the remediation products at up to 250 pounds per square inch (PSI) and 20 gallons per minute (GPM).

Safety bypass mechanisms are installed to release back pressure buildup in the event injection pressures exceed commonly accepted application ranges. RRS delivered the remediation products at up to two (2) separate delivery lines simultaneously, each having the capability of monitoring injection pressures and injection flowrates/totals at any given time. Each delivery line can reach beyond the injection trailer at least 100 linear feet, limiting the need to move the injection trailer from point to point or in this case limiting the need to move the trailer several times each day. Additional line extensions were utilized when necessary to increase the trailer range without being moved.

The remedial solution was prepared in two (2) 350-gallon conical tanks that are configured with chemically resistant materials. Mixing water was provided by a nearby hydrant. Water was transferred from the hydrant to the injection trailer by using a 1.5-inch firehose. Once water was filled to the appropriate volume per the design concentration, each product was transferred from their respective container via an air-driven diaphragm pump. Product containers were measured and marked to track volumetric batch amounts to ensure accurate product dosing.

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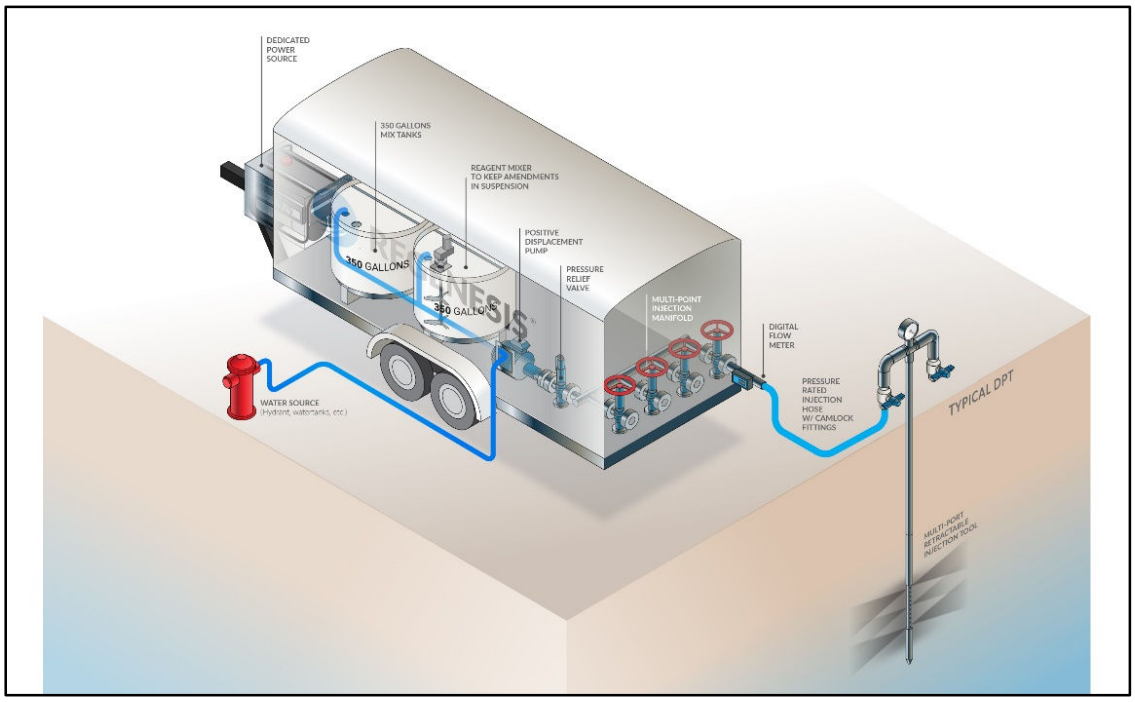


**Figure 2:** RRS Trailer Schematic - DPT injection.

## 5. On-Site Work Summary

### A. Pilot Test Area (MW-11)

**Table 2:** Total Amount Applied.

| | |
|---|---|
| *PetroFix* | *2800 pounds* |
| *EA Blend* | *140 pounds* |

A total of 5,864 gallons of PetroFix mix fluid was applied in the treatment area.

**Application Method:** DPT utilizing 2-foot retractable injection screens
**Injection Depth:** 18-25 feet below ground surface
**Number of Injection Points:** 27

**Average Injection Rate:** 3.6 GPM; **Average Injection Pressure:** 72.4 PSI

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**Distribution monitoring:**

-MW-11 was monitored over the course of pilot test event. A maximum concentration of 15,000 milligrams of carbon per liter (mg C/L) was recorded on 11/02/2023. The concentration dropped to 5,000 mg C/L on 11/02/2023.

For a detailed injection log of the remediation application, please see **Appendix A; Table 3** for details.

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# Appendix A: Injection Log

PetroFIX Remediation Fluid

**GeoEngineers - NuStar - Vancouver Annex**
**Injection Summary Log**
**MW-11 Pilot Test Area**
**Table 3**

REGENESIS REMEDIATION SERVICES
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| Injection Point | Date | Time | Injection Depth (feet) | Injection Pressure (psi) | Flow Rate (gpm) | Volume of Solution Injected | | | Pounds of PetroFix Per Interval | Total Gallons Per Location | Pounds of PetroFix Injected Per Location | Comments | Injection Tooling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Beginning Flow Meter (gal) | Ending Flow Meter (gal) | Gallons Injected Per Interval | | | | | |
| B-1 | 11/2/2023 | 9:10 | 24-25 | 38.0 | 3.0 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/2/2023 | 9:22 | 22-24 | 33.0 | 3.0 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 9:50 | 20-22 | 20.0 | 2.9 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 10:17 | 18-20 | 18.0 | 2.8 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-2 | 11/3/2023 | 9:24 | 24-25 | 101.0 | 3.9 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/3/2023 | 9:38 | 22-24 | 67.0 | 4.6 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/3/2023 | 10:00 | 20-22 | 20.0 | 4.0 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/3/2023 | 10:17 | 18-20 | 19.0 | 4.8 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-3 | 11/1/2023 | 12:08 | 24-25 | 138.0 | 2.7 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/1/2023 | 12:39 | 22-24 | 118.0 | 3.8 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 12:59 | 20-22 | 74.0 | 3.7 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 13:12 | 18-20 | 66.0 | 4.8 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-4 | 10/31/2023 | 14:14 | 24-25 | 138.0 | 2.7 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 10/31/2023 | 15:30 | 22-24 | 90.0 | 5.0 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 15:49 | 20-22 | 60.0 | 3.4 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 16:10 | 18-20 | 52.0 | 4.2 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-5 | 10/31/2023 | 11:17 | 24-25 | 88.0 | 3.4 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 10/31/2023 | 11:30 | 22-24 | 54.0 | 3.8 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 11:54 | 20-22 | 55.0 | 3.7 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 12:16 | 18-20 | 61.0 | 3.8 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-6 | 10/31/2023 | 9:00 | 24-25 | 68.0 | 3.2 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 10/31/2023 | 9:19 | 22-24 | 30.0 | 3.3 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 9:49 | 20-22 | 40.0 | 3.0 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 10:06 | 18-20 | 46.0 | 3.8 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-7 | 10/31/2023 | 15:29 | 24-25 | 141.0 | 3.0 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 10/31/2023 | 15:29 | 22-24 | 99.0 | 3.4 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 15:49 | 20-22 | 72.0 | 4.7 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 16:08 | 18-20 | 55.0 | 4.4 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-8 | 10/31/2023 | 16:25 | 24-25 | 130.0 | 2.7 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 10/31/2023 | 14:05 | 22-24 | 67.0 | 4.3 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 14:23 | 20-22 | 55.0 | 4.1 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 14:40 | 18-20 | 37.0 | 4.0 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-9 | 11/1/2023 | 8:37 | 24-25 | 112.0 | 3.2 | 0.0 | 0.0 | 0.0 | 0 | 217.2 | 104 | | 2-Foot Screen |
| | 11/1/2023 | 9:04 | 22-24 | 76.0 | 3.0 | 0.0 | 62.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 9:19 | 20-22 | 54.0 | 3.7 | 62.0 | 124.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 9:38 | 18-20 | 44.0 | 4.0 | 124.0 | 217.2 | 93.2 | 45 | | | | |
| B-10 | 10/31/2023 | 9:25 | 24-25 | 96.0 | 3.3 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 10/31/2023 | 9:40 | 22-24 | 60.0 | 4.0 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 10:00 | 20-22 | 52.0 | 4.4 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 10:17 | 18-20 | 33.0 | 5.0 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-14 | 10/30/2023 | 13:13 | 24-25 | 80.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 217.2 | 104 | | 2-Foot Screen |
| | 10/30/2023 | 13:13 | 23-25 | 130.0 | 1.8 | 0.0 | 62.0 | 62.0 | 30 | | | pressure dropped to 85 psi | |
| | 10/30/2023 | 13:56 | 21-23 | 66.0 | 3.5 | 62.0 | 124.0 | 62.0 | 30 | | | | |
| | 10/30/2023 | 14:18 | 19-21 | 67.0 | 3.2 | 124.0 | 186.0 | 62.0 | 30 | | | | |
| | 10/30/2023 | 14:47 | 18-20 | 48.0 | 3.3 | 186.0 | 217.2 | 31.2 | 15 | | | | |
| B-15 | 10/30/2023 | 15:21 | 24-25 | 86.0 | 3.3 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | 125 psi to initiate flow | 2-Foot Screen |
| | 10/30/2023 | 15:35 | 22-24 | 61.5 | 3.7 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 10/30/2023 | 15:47 | 20-22 | 57.0 | 3.7 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 8:30 | 18-20 | 39.0 | 3.6 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-16 | 10/30/2023 | 13:05 | 24-25 | 130.0 | 0.0 | 0.0 | 31.0 | 31.0 | 15 | 217.0 | 104 | no flow | 2-Foot Screen |
| | 10/30/2023 | 13:12 | 23-25 | 128.0 | 2.5 | 31.0 | 62.0 | 31.0 | 15 | | | pull up one foot to initiate flow | |
| | 10/30/2023 | 13:56 | 21-23 | 58.0 | 4.0 | 62.0 | 124.0 | 62.0 | 30 | | | | |
| | 10/30/2023 | 14:19 | 19-21 | 65.0 | 3.8 | 124.0 | 186.0 | 62.0 | 30 | | | | |
| | 10/30/2023 | 14:47 | 18-20 | 43.0 | 3.5 | 186.0 | 217.0 | 31.0 | 15 | | | | |
| B-17 | 11/1/2023 | 8:57 | 24-25 | 140.0 | 2.9 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/1/2023 | 9:07 | 22-24 | 110.0 | 4.3 | 0.0 | 62.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 10:01 | 20-22 | 57.0 | 3.8 | 62.0 | 124.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 9:41 | 18-20 | 38.0 | 3.5 | 124.0 | 217.2 | 62.0 | 30 | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-18 | 11/1/2023 | 15:08 | 24-25 | 130.0 | 2.8 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/1/2023 | 15:19 | 22-24 | 67.0 | 3.6 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 15:39 | 20-22 | 57.0 | 4.4 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 16:11 | 18-20 | 38.0 | 4.0 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-19 | 11/2/2023 | 13:30 | 24-25 | 100.0 | 2.5 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/2/2023 | 13:46 | 22-24 | 82.0 | 2.8 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 14:03 | 20-22 | 42.0 | 2.7 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 14:36 | 18-20 | 41.0 | 2.5 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-20 | 11/1/2023 | 13:56 | 24-25 | 100.0 | 4.0 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/1/2023 | 14:03 | 22-24 | 82.0 | 4.4 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 14:22 | 20-22 | 61.0 | 5.5 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 14:40 | 18-20 | 38.0 | 3.9 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-21 | 11/2/2023 | 8:30 | 24-25 | 128.0 | 2.9 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/2/2023 | 8:42 | 22-24 | 104.0 | 4.4 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 9:10 | 20-22 | 80.0 | 4.0 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 9:51 | 18-20 | 70.0 | 4.0 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-22 | 11/1/2023 | 16:10 | 24-25 | 128.0 | 3.7 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/1/2023 | 16:18 | 22-24 | 80.0 | 4.5 | 31.0 | 93.0 | 62.0 | 30 | | | minor surfacing out of B-23 borehole, reseal and resume injuections | |
| | 11/1/2023 | 16:37 | 20-22 | 58.0 | 5.4 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 16:54 | 18-20 | 38.0 | 4.8 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-23 | 11/1/2023 | 15:09 | 24-25 | 85.0 | 3.7 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/1/2023 | 15:18 | 22-24 | 56.0 | 3.8 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 15:30 | 20-22 | 56.0 | 4.9 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 15:42 | 18-20 | 56.0 | 4.9 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-24 | 11/1/2023 | 13:31 | 24-25 | 103.0 | 4.0 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/1/2023 | 13:50 | 22-24 | 85.0 | 4.3 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 14:03 | 20-22 | 70.0 | 4.4 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 14:22 | 18-20 | 62.0 | 5.3 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-25 | 11/1/2023 | 12:17 | 24-25 | 88.0 | 3.0 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/1/2023 | 12:32 | 22-24 | 73.0 | 3.5 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 12:53 | 20-22 | 75.0 | 4.3 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/1/2023 | 13:11 | 18-20 | 70.0 | 4.4 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-27 | 11/2/2023 | 13:24 | 24-25 | 102.0 | 3.0 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/2/2023 | 13:40 | 22-24 | 110.0 | 3.2 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 14:00 | 20-22 | 62.0 | 2.9 | 93.0 | 155.0 | 62.0 | 30 | | | minor surfacing around rod annulus, reseal with bentonite and resume injection | |
| | 11/2/2023 | 14:33 | 18-20 | 51.0 | 2.7 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-28 | 11/2/2023 | 15:33 | 24-25 | 128.0 | 3.4 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/2/2023 | 15:42 | 22-24 | 76.0 | 4.3 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 15:59 | 20-22 | 63.0 | 4.4 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 16:14 | 18-20 | 55.0 | 4.0 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-29 | 11/2/2023 | 10:47 | 24-25 | 128.0 | 1.9 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 11/2/2023 | 11:10 | 22-24 | 98.0 | 2.2 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 11:42 | 20-22 | 60.0 | 3.7 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 11/2/2023 | 11:49 | 18-20 | 82.0 | 4.0 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-30 | 10/31/2023 | 13:11 | 24-25 | 104.0 | 3.1 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 10/31/2023 | 13:48 | 22-24 | 39.0 | 3.1 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 14:04 | 20-22 | 32.0 | 4.7 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 14:30 | 18-20 | 27.0 | 4.0 | 155.0 | 217.2 | 62.2 | 30 | | | | |
| B-31 | 10/31/2023 | 11:33 | 24-25 | 104.0 | 2.9 | 0.0 | 31.0 | 31.0 | 15 | 217.2 | 104 | | 2-Foot Screen |
| | 10/31/2023 | 11:48 | 22-24 | 59.0 | 3.7 | 31.0 | 93.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 12:10 | 20-22 | 58.0 | 3.3 | 93.0 | 155.0 | 62.0 | 30 | | | | |
| | 10/31/2023 | 12:28 | 18-20 | 45.0 | 4.4 | 155.0 | 217.2 | 62.2 | 30 | | | | |

| Total Gallons: | Total Lbs. of PetroFix |
|---|---|
| 5864 | 2800 |

# Appendix B: Photo Log

▲**Figure 1)** Cascade personnel hand auguring to eight feet before advancing injection tooling.

▼**Figure 2)** RRS injection trailer.

▲**Figure 3)** Mix water was provided by a nearby hydrant. Hose ramps were used to allow vehicles to still pass by.

▼**Figure 4)** PetroFix was transferred to the injection trailer by using an air powered diaphragm pump.

# Appendix C: Injection Point Location Data

## GeoEngineers - Vancouver Annex Terminal
## Injection Point Location Data
## WGS84 Web Mercator Auxiliary Sphere
## Appendix C; Table 4

REGENESIS
REMEDIATION SERVICES
Technology-Based Solutions for the Environment

| Project ID | Location ID | Latitude (°) | Longitude (°) | Altitude (HAE) | x (m) | y (m) |
|---|---|---|---|---|---|---|
| BrG592631 | 1 | 45.661622 | -122.693143 | 27.87 | -13635993.22 | 5074787.007 |
| BrG592631 | 2 | 45.661623 | -122.693196 | 27.31 | -13635999.11 | 5074787.119 |
| BrG592631 | 3 | 45.661631 | -122.693161 | 27.73 | -13635995.22 | 5074788.008 |
| BrG592631 | 4 | 45.661591 | -122.693157 | 27.63 | -13635994.78 | 5074783.562 |
| BrG592631 | 5 | 45.661644 | -122.693163 | 27.87 | -13635995.44 | 5074789.453 |
| BrG592631 | 6 | 45.661655 | -122.693215 | 27.62 | -13636001.22 | 5074790.675 |
| BrG592631 | 7 | 45.661626 | -122.693212 | 27.32 | -13636000.89 | 5074787.452 |
| BrG592631 | 8 | 45.661607 | -122.693196 | 27.33 | -13635999.11 | 5074785.34 |
| BrG592631 | 9 | 45.661620 | -122.693228 | 27.31 | -13636002.67 | 5074786.785 |
| BrG592631 | 10 | 45.661593 | -122.693196 | 27.34 | -13635999.11 | 5074783.784 |
| BrG592631 | 14 | 45.661661 | -122.693186 | 27.84 | -13635998.00 | 5074791.342 |
| BrG592631 | 15 | 45.661662 | -122.693165 | 28.01 | -13635995.66 | 5074791.453 |
| BrG592631 | 16 | 45.661660 | -122.693146 | 28.26 | -13635993.55 | 5074791.231 |
| BrG592631 | 17 | 45.661638 | -122.693145 | 27.94 | -13635993.44 | 5074788.786 |
| BrG592631 | 18 | 45.661622 | -122.693173 | 27.55 | -13635996.55 | 5074787.007 |
| BrG592631 | 19 | 45.661608 | -122.693169 | 27.52 | -13635996.11 | 5074785.452 |
| BrG592631 | 20 | 45.661609 | -122.693142 | 27.86 | -13635993.11 | 5074785.563 |
| BrG592631 | 21 | 45.661645 | -122.693100 | 28.71 | -13635988.44 | 5074789.564 |
| BrG592631 | 22 | 45.661632 | -122.693099 | 28.66 | -13635988.33 | 5074788.119 |
| BrG592631 | 23 | 45.661620 | -122.693099 | 28.52 | -13635988.33 | 5074786.785 |
| BrG592631 | 24 | 45.661610 | -122.693098 | 28.52 | -13635988.22 | 5074785.674 |
| BrG592631 | 25 | 45.661600 | -122.693097 | 28.54 | -13635988.11 | 5074784.562 |
| BrG592631 | 27 | 45.661639 | -122.693084 | 30.13 | -13635986.66 | 5074788.897 |
| BrG592631 | 28 | 45.661626 | -122.693084 | 30.04 | -13635986.66 | 5074787.452 |
| BrG592631 | 29 | 45.661614 | -122.693084 | 29.86 | -13635986.66 | 5074786.118 |
| BrG592631 | 30 | 45.661592 | -122.693139 | 27.81 | -13635992.78 | 5074783.673 |
| BrG592631 | 31 | 45.661638 | -122.693225 | 27.56 | -13636002.33 | 5074788.786 |

Disclaimer: The data provided is at mapping quality for reference only. This is not an offical survey. Data should be used at your own risk due to the accuracy limitaions listed in the table

# APPENDIX D
## Field Notes

LOCATION OF BORING

North Arrow


B-2

Datum

Elevation

| Job No. | Project Name | Boring No. |
|---|---|---|
| 19001-008-11 | Annex Injection | B-2 |

| | |
|---|---|
| Drilling Method: Continuous | Location: Vancouver, WA |
| Hammer Data: N/A | |
| Auger Data: N/A | |
| Drilling Equipment: | |
| Sampling Method: GeoProbe | Sheet 1 of 2 |

| | | | | Drilling Time | | |
|---|---|---|---|---|---|---|
| Water Level: | | | | Start | | Finish |
| Time: | | | | | | |
| Date: | | | | Date | | Date |
| Casing Depth: | | | | 11/3/23 | | 11/3/23 |

SURFACE CONDITIONS: Gravel

| SAMPLER TYPE | INCHES DRIVEN / INCHES RECOVERED | Blow Counts | SAMPLE NO. / SAMPLE DEPTH | PID (ppm) | Odor/Sheen | DEPTH IN FEET | GROUP SYMBOL | SOIL DESCRIPTION | Other Tests/Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1 | | No recovery, hand clearing to 8 ft. | |
| | | | | | | 2 | | | |
| | | | | | | 3 | | | |
| | | | | | | 4 | | | |
| | | | | | | 5 | | | |
| | | | | | | 6 | | | |
| | | | | | | 7 | | | |
| | | | | | | 8 | | 8- Light brown SILT, wet | |
| | | | | | | 9 | | 9- Sand, coarse grained | |
| | | | | | | 10 | | | |
| | | | | | | 11 | | | |
| | | | | | | 12 | | | |
| | | | | | | 13 | | | |
| | | | | | | 14 | | | |
| | | | | | | 15 | | | |
| | | | | | | 16 | | | |
| | | | | | | 17 | | | |
| | | | | | | 18 | | | |
| | | | | | | 19 | | | |
| | | | | | | 20 | | | |

DRILLING CONTR

DATE

CHK'D BY

LOGGED BY

LOCATION OF BORING

North Arrow

Datum

Elevation

| Job No. | Project Name | Boring No. |
|---|---|---|
| 19001-008-11 | | B-2 |

Drilling Method: Continuous

Location

Hammer Data: N/A

Auger Data: N/A

Drilling Equipment:

Sampling Method: GeoProbe

Sheet 2 of 2

| | | | | Drilling Time | | |
|---|---|---|---|---|---|---|
| Water Level: | | | | Start | | Finish |
| Time: | | | | | | |
| Date: | | | | Date | | Date |
| Casing Depth: | | | | | | |

SURFACE CONDITIONS:

| SAMPLER TYPE | INCHES DRIVEN / INCHES RECOVERED | Blow Counts | SAMPLE NO. / SAMPLE DEPTH | PID (ppm) | Odor/Sheen | DEPTH IN FEET | GROUP SYMBOL | SOIL DESCRIPTION | Other Tests/Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 21 | | | |
| | | | | | | 22 | | 22- Sand becomes dark gray. | |
| | | | | | | 23 | | | |
| | | | | | | 24 | | | |
| | | | | | | 25 | | 25- EOB | |
| | | | | | | 6 | | | |
| | | | | | | 7 | | | |
| | | | | | | 8 | | | |
| | | | | | | 9 | | | |
| | | | | | | 0 | | | |
| | | | | | | 1 | | | |
| | | | | | | 2 | | | |
| | | | | | | 3 | | | |
| | | | | | | 4 | | | |
| | | | | | | 5 | | | |
| | | | | | | 6 | | | |
| | | | | | | 7 | | | |
| | | | | | | 8 | | | |
| | | | | | | 9 | | | |
| | | | | | | 0 | | | |

DRILLING CONTR

DATE

CHK'D BY

LOGGED BY

LOCATION OF BORING

B-6


North Arrow

Datum

Elevation

| Job No. | Project Name | Boring No. |
|---|---|---|
| 17001-008-11 | Annex Injections | B-6 |

Drilling Method: Continuous

Location: Vancouver, WA

Hammer Data: N/A

Auger Data: N/A

Drilling Equipment: GeoProbe 7822 DT

Sampling Method: GeoProbe

Sheet 1 of 2

| | | | | Drilling Time | | |
|---|---|---|---|---|---|---|
| Water Level: | — | | | Start | | Finish |
| Time: | — | | | — | | — |
| Date: | — | | | Date | | Date |
| Casing Depth: | — | | | 10/30/23 | | 10/30/23 |

SURFACE CONDITIONS: Gravel

| SAMPLER TYPE | INCHES DRIVEN / INCHES RECOVERED | Blow Counts | SAMPLE NO. / SAMPLE DEPTH | PID (ppm) | Odor/Sheen | DEPTH IN FEET | GROUP SYMBOL | SOIL DESCRIPTION | Other Tests/Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1 | | NR, hand clearing 0-8 ft BGS | |
| | | | | | | 2 | | | |
| | | | | | | 3 | | | |
| | | | | | | 4 | | | |
| | | | | | | 5 | | | |
| | | | | | | 6 | | | |
| | | | | | | 7 | | | |
| | | | | | | 8 | SP | Brown 8 - Brown/Gray Sand, medium - coarse grained, well sorted, dry. | |
| | | | | | | 9 | | | |
| | | | | | | 10 | | | |
| | | | | | | 11 | | | |
| | | | | | | 12 | | | |
| | | | | | | 13 | | | |
| | | | | | | 14 | | | |
| | | | | | | 15 | | | |
| | | | | | | 16 | | | |
| | | | | | | 17 | | | |
| | | | | | | 18 | | | |
| | | | | | | 19 | | | |
| | | | | | | 20 | | | |

DRILLING CONTR

LOGGED BY

CHK'D BY

DATE

LOCATION OF BORING

North Arrow

Datum

Elevation

| Job No. | Project Name | Boring No. |
|---|---|---|
| 19001-008-11 | Annex Injection | B-6 |

Drilling Method: Continuous

Hammer Data: N/A

Auger Data: N/A

Drilling Equipment:

Location: Vancouver, WA

Sampling Method: GeoProbe

Sheet 2 of 2

| | | | | Drilling Time | | |
|---|---|---|---|---|---|---|
| Water Level: | | | | Start | | Finish |
| Time: | | | | | | |
| Date: | | | | Date | | Date |
| Casing Depth: | | | | | | |

SURFACE CONDITIONS:

| SAMPLER TYPE | INCHES DRIVEN / INCHES RECOVERED | Blow Counts | SAMPLE NO. / SAMPLE DEPTH | PID (ppm) | Odor/Sheen | DEPTH IN FEET | GROUP SYMBOL | SOIL DESCRIPTION | Other Tests/Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 21 | | 21 - Sand becomes black | |
| | | | | | | 22 | | | |
| | | | | | | 23 | | | |
| | | | | | | 24 | | | |
| | | | | | | 25 | | 25 - EOB | |
| | | | | | | 6 | | | |
| | | | | | | 7 | | | |
| | | | | | | 8 | | | |
| | | | | | | 9 | | | |
| | | | | | | 0 | | | |
| | | | | | | 1 | | | |
| | | | | | | 2 | | | |
| | | | | | | 3 | | | |
| | | | | | | 4 | | | |
| | | | | | | 5 | | | |
| | | | | | | 6 | | | |
| | | | | | | 7 | | | |
| | | | | | | 8 | | | |
| | | | | | | 9 | | | |
| | | | | | | 0 | | | |

DRILLING CONTR

DATE

CHK'D BY

LOGGED BY

# APPENDIX E
## First Quarter, 2024 Groundwater Monitoring Lab Report

**Apex Laboratories, LLC**
**6700 S.W. Sandburg Street**
**Tigard, OR 97223**
**503-718-2323**
ORELAP ID: **OR100062**

**ANALYTICAL REPORT**

Monday, March 4, 2024

Philip Cordell
GeoEngineers - Portland
5820 S Kelly Ave Unit B
Portland, OR 97239

RE: A4B1224 - Nustar Vannex GWM 1Q24 - 19001-008

Thank you for using Apex Laboratories. We greatly appreciate your business and strive to provide the highest quality services to the environmental industry.

Enclosed are the results of analyses for work order A4B1224, which was received by the laboratory on 2/15/2024 at 2:12:00PM.

If you have any questions concerning this report or the services we offer, please feel free to contact me by email at: DAuvil@apex-labs.com, or by phone at 503-718-2323.

Please note: All samples will be disposed of within 30 days of sample receipt, unless prior arrangements have been made.

| Cooler Receipt Information | | | | | |
|---|---|---|---|---|---|
| Acceptable Receipt Temperature is less than, or equal to, 6 degC (not frozen), or received on ice the same day as sampling. | | | | | |
| (See Cooler Receipt Form for details) | | | | | |
| Cooler #1 | 5.9 | degC | Cooler #2 | 1.8 | degC |
| Cooler #3 | 3.9 | degC | | | |

This Final Report is the official version of the data results for this sample submission, unless superseded by a subsequent, labeled amended report.
All other deliverables derived from this data, including Electronic Data Deliverables (EDDs), CLP-like forms, client requested summary sheets, and all other products are considered secondary to this report.

Apex Laboratories

Darrell Auvil, Client Services Manager

*The results in this report apply to the samples analyzed in accordance with the chain of custody document(s) and updated by any subsequent written communications. This analytical report must be reproduced in its entirety.*

Apex Laboratories, LLC
6700 S.W. Sandburg Street
Tigard, OR 97223
503-718-2323
ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## ANALYTICAL REPORT FOR SAMPLES

### SAMPLE INFORMATION

| Client Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|---|---|---|---|---|
| MW-1 | A4B1224-01 | Water | 02/14/24 11:36 | 02/15/24 14:12 |
| MW-2 | A4B1224-02 | Water | 02/14/24 12:40 | 02/15/24 14:12 |
| MW-3 | A4B1224-03 | Water | 02/15/24 08:36 | 02/15/24 14:12 |
| MW-4 | A4B1224-04 | Water | 02/14/24 13:46 | 02/15/24 14:12 |
| MW-5 | A4B1224-05 | Water | 02/15/24 08:30 | 02/15/24 14:12 |
| MW-5 DUP | A4B1224-06 | Water | 02/15/24 08:30 | 02/15/24 14:12 |
| MW-6 | A4B1224-07 | Water | 02/14/24 11:54 | 02/15/24 14:12 |
| MW-5D | A4B1224-08 | Water | 02/15/24 09:15 | 02/15/24 14:12 |
| MW-6D | A4B1224-09 | Water | 02/14/24 11:18 | 02/15/24 14:12 |
| MW-7 | A4B1224-10 | Water | 02/14/24 10:36 | 02/15/24 14:12 |
| MW-8 | A4B1224-11 | Water | 02/14/24 13:12 | 02/15/24 14:12 |
| MW-8D | A4B1224-12 | Water | 02/15/24 10:03 | 02/15/24 14:12 |
| MW-9 | A4B1224-13 | Water | 02/14/24 12:38 | 02/15/24 14:12 |
| MW-10 | A4B1224-14 | Water | 02/14/24 10:39 | 02/15/24 14:12 |
| MW-11 | A4B1224-15 | Water | 02/15/24 10:57 | 02/15/24 14:12 |
| MW-11 (Alum/Filtered) | A4B1224-17 | Water | 02/15/24 10:57 | 02/15/24 14:12 |
| MW-11 (Alum/Filtered) DUP | A4B1224-18 | Water | 02/15/24 10:57 | 02/15/24 14:12 |
| MW-12 | A4B1224-19 | Water | 02/15/24 09:52 | 02/15/24 14:12 |
| MW-12D | A4B1224-20 | Water | 02/15/24 10:39 | 02/15/24 14:12 |
| MW-11 (Alum/Filtered) | A4B1224-21 | Water | 02/15/24 10:57 | 02/15/24 14:12 |
| MW-11 (Alum/Filtered) DUP | A4B1224-22 | Water | 02/15/24 10:57 | 02/15/24 14:12 |

Apex Laboratories

Darrell Auvil, Client Services Manager

*The results in this report apply to the samples analyzed in accordance with the chain of custody document(s) and updated by any subsequent written communications. This analytical report must be reproduced in its entirety.*

APEX LABORATORIES

**Apex Laboratories, LLC**
**6700 S.W. Sandburg Street**
**Tigard, OR 97223**
**503-718-2323**
ORELAP ID: **OR100062**

**ANALYTICAL REPORT**

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Diesel and/or Oil Hydrocarbons by NWTPH-Dx

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-1 (A4B1224-01)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| **Diesel** | **0.511** | --- | 0.0800 | mg/L | 1 | 02/21/24 22:50 | NWTPH-Dx LL | **F-11** |
| Oil | ND | --- | 0.160 | mg/L | 1 | 02/21/24 22:50 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 80 %* | | *Limits: 50-150 %* | *1* | *02/21/24 22:50* | *NWTPH-Dx LL* | |
| **MW-2 (A4B1224-02)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| Diesel | ND | --- | 0.0800 | mg/L | 1 | 02/21/24 23:10 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.160 | mg/L | 1 | 02/21/24 23:10 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 78 %* | | *Limits: 50-150 %* | *1* | *02/21/24 23:10* | *NWTPH-Dx LL* | |
| **MW-3 (A4B1224-03)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| Diesel | ND | --- | 0.0833 | mg/L | 1 | 02/21/24 23:51 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.167 | mg/L | 1 | 02/21/24 23:51 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 82 %* | | *Limits: 50-150 %* | *1* | *02/21/24 23:51* | *NWTPH-Dx LL* | |
| **MW-4 (A4B1224-04)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| **Diesel** | **0.198** | --- | 0.0833 | mg/L | 1 | 02/22/24 00:12 | NWTPH-Dx LL | **F-11** |
| Oil | ND | --- | 0.167 | mg/L | 1 | 02/22/24 00:12 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 85 %* | | *Limits: 50-150 %* | *1* | *02/22/24 00:12* | *NWTPH-Dx LL* | |
| **MW-5 (A4B1224-05)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| **Diesel** | **1.46** | --- | 0.0777 | mg/L | 1 | 02/22/24 00:53 | NWTPH-Dx LL | **F-18** |
| Oil | ND | --- | 0.155 | mg/L | 1 | 02/22/24 00:53 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 78 %* | | *Limits: 50-150 %* | *1* | *02/22/24 00:53* | *NWTPH-Dx LL* | |
| **MW-5 DUP (A4B1224-06)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| **Diesel** | **1.32** | --- | 0.0784 | mg/L | 1 | 02/22/24 01:14 | NWTPH-Dx LL | **F-18** |
| Oil | ND | --- | 0.157 | mg/L | 1 | 02/22/24 01:14 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 76 %* | | *Limits: 50-150 %* | *1* | *02/22/24 01:14* | *NWTPH-Dx LL* | |
| **MW-6 (A4B1224-07)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| **Diesel** | **4.27** | --- | 0.0784 | mg/L | 1 | 02/22/24 01:55 | NWTPH-Dx LL | **F-20** |
| Oil | ND | --- | 0.157 | mg/L | 1 | 02/22/24 01:55 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 84 %* | | *Limits: 50-150 %* | *1* | *02/22/24 01:55* | *NWTPH-Dx LL* | |

Apex Laboratories

Darrell Auvil, Client Services Manager

*The results in this report apply to the samples analyzed in accordance with the chain of custody document(s) and updated by any subsequent written communications. This analytical report must be reproduced in its entirety.*

Apex Laboratories, LLC
6700 S.W. Sandburg Street
Tigard, OR 97223
503-718-2323
ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## ANALYTICAL SAMPLE RESULTS

### Diesel and/or Oil Hydrocarbons by NWTPH-Dx

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-5D (A4B1224-08)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| Diesel | ND | --- | 0.0784 | mg/L | 1 | 02/22/24 03:38 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.157 | mg/L | 1 | 02/22/24 03:38 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 72 %* | | *Limits: 50-150 %* | *1* | *02/22/24 03:38* | *NWTPH-Dx LL* | |
| **MW-6D (A4B1224-09)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| **Diesel** | **0.269** | --- | 0.0769 | mg/L | 1 | 02/22/24 04:19 | NWTPH-Dx LL | **F-11** |
| Oil | ND | --- | 0.154 | mg/L | 1 | 02/22/24 04:19 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 85 %* | | *Limits: 50-150 %* | *1* | *02/22/24 04:19* | *NWTPH-Dx LL* | |
| **MW-7 (A4B1224-10)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| Diesel | ND | --- | 0.0769 | mg/L | 1 | 02/22/24 04:40 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.154 | mg/L | 1 | 02/22/24 04:40 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 73 %* | | *Limits: 50-150 %* | *1* | *02/22/24 04:40* | *NWTPH-Dx LL* | |
| **MW-8 (A4B1224-11)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | **DCNT** |
| Diesel | ND | --- | 0.0816 | mg/L | 1 | 02/22/24 05:21 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.163 | mg/L | 1 | 02/22/24 05:21 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 83 %* | | *Limits: 50-150 %* | *1* | *02/22/24 05:21* | *NWTPH-Dx LL* | |
| **MW-8D (A4B1224-12)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| Diesel | ND | --- | 0.0777 | mg/L | 1 | 02/22/24 05:48 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.155 | mg/L | 1 | 02/22/24 05:48 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 74 %* | | *Limits: 50-150 %* | *1* | *02/22/24 05:48* | *NWTPH-Dx LL* | |
| **MW-9 (A4B1224-13)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| Diesel | ND | --- | 0.0784 | mg/L | 1 | 02/22/24 06:29 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.157 | mg/L | 1 | 02/22/24 06:29 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 83 %* | | *Limits: 50-150 %* | *1* | *02/22/24 06:29* | *NWTPH-Dx LL* | |
| **MW-10 (A4B1224-14)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| Diesel | ND | --- | 0.0792 | mg/L | 1 | 02/22/24 06:50 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.158 | mg/L | 1 | 02/22/24 06:50 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 88 %* | | *Limits: 50-150 %* | *1* | *02/22/24 06:50* | *NWTPH-Dx LL* | |

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ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## ANALYTICAL SAMPLE RESULTS

### Diesel and/or Oil Hydrocarbons by NWTPH-Dx

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-11 (A4B1224-15)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | **DCNT** |
| Diesel | ND | --- | 0.0842 | mg/L | 1 | 02/22/24 07:31 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.168 | mg/L | 1 | 02/22/24 07:31 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 54 %* | *Limits: 50-150 %* | | *1* | *02/22/24 07:31* | *NWTPH-Dx LL* | |
| **MW-12 (A4B1224-19)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| **Diesel** | **0.176** | --- | 0.0792 | mg/L | 1 | 02/22/24 07:52 | NWTPH-Dx LL | **F-11** |
| Oil | ND | --- | 0.158 | mg/L | 1 | 02/22/24 07:52 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 85 %* | *Limits: 50-150 %* | | *1* | *02/22/24 07:52* | *NWTPH-Dx LL* | |
| **MW-12D (A4B1224-20)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | |
| Diesel | ND | --- | 0.0792 | mg/L | 1 | 02/22/24 09:19 | NWTPH-Dx LL | |
| Oil | ND | --- | 0.158 | mg/L | 1 | 02/22/24 09:19 | NWTPH-Dx LL | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 82 %* | *Limits: 50-150 %* | | *1* | *02/22/24 09:19* | *NWTPH-Dx LL* | |

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**ANALYTICAL REPORT**

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Dissolved Diesel and/or Oil Hydrocarbons by NWTPH-Dx

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-11 (Alum/Filtered) (A4B1224-21)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | **PRO** |
| Diesel | ND | --- | 0.0777 | mg/L | 1 | 02/22/24 09:39 | NWTPH-Dx (Diss) | |
| Oil | ND | --- | 0.155 | mg/L | 1 | 02/22/24 09:39 | NWTPH-Dx (Diss) | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 46 %* | | *Limits: 50-150 %* | *1* | *02/22/24 09:39* | *NWTPH-Dx (Diss)* | *S-06* |
| **MW-11 (Alum/Filtered) DUP (A4B1224-22)** | | | | **Matrix: Water** | | **Batch: 24B0725** | | **PRO** |
| Diesel | ND | --- | 0.0769 | mg/L | 1 | 02/22/24 10:00 | NWTPH-Dx (Diss) | |
| Oil | ND | --- | 0.154 | mg/L | 1 | 02/22/24 10:00 | NWTPH-Dx (Diss) | |
| *Surrogate: o-Terphenyl (Surr)* | | *Recovery: 51 %* | | *Limits: 50-150 %* | *1* | *02/22/24 10:00* | *NWTPH-Dx (Diss)* | |

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**ANALYTICAL REPORT**

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| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-1 (A4B1224-01RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 19:53 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 91 %* | | *Limits: 50-150 %* | *1* | *02/20/24 19:53* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *105 %* | *50-150 %* | *1* | *02/20/24 19:53* | *NWTPH-Gx (MS)* | |
| **MW-2 (A4B1224-02RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 20:18 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 90 %* | | *Limits: 50-150 %* | *1* | *02/20/24 20:18* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *105 %* | *50-150 %* | *1* | *02/20/24 20:18* | *NWTPH-Gx (MS)* | |
| **MW-3 (A4B1224-03RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 20:43 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 91 %* | | *Limits: 50-150 %* | *1* | *02/20/24 20:43* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *107 %* | *50-150 %* | *1* | *02/20/24 20:43* | *NWTPH-Gx (MS)* | |
| **MW-4 (A4B1224-04RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 21:08 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 91 %* | | *Limits: 50-150 %* | *1* | *02/20/24 21:08* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *106 %* | *50-150 %* | *1* | *02/20/24 21:08* | *NWTPH-Gx (MS)* | |
| **MW-5 (A4B1224-05)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| **Gasoline Range Organics** | **24.5** | --- | 1.00 | mg/L | 10 | 02/20/24 19:00 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 103 %* | | *Limits: 50-150 %* | *1* | *02/20/24 19:00* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *106 %* | *50-150 %* | *1* | *02/20/24 19:00* | *NWTPH-Gx (MS)* | |
| **MW-5 DUP (A4B1224-06)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| **Gasoline Range Organics** | **25.4** | --- | 1.00 | mg/L | 10 | 02/20/24 19:55 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 100 %* | | *Limits: 50-150 %* | *1* | *02/20/24 19:55* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *105 %* | *50-150 %* | *1* | *02/20/24 19:55* | *NWTPH-Gx (MS)* | |
| **MW-6 (A4B1224-07)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| **Gasoline Range Organics** | **16.2** | --- | 1.00 | mg/L | 10 | 02/20/24 20:22 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 100 %* | | *Limits: 50-150 %* | *1* | *02/20/24 20:22* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *103 %* | *50-150 %* | *1* | *02/20/24 20:22* | *NWTPH-Gx (MS)* | |

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ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## ANALYTICAL SAMPLE RESULTS

### Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-5D (A4B1224-08)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 14:27 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *107 %* | *Limits: 50-150 %* | *1* | *02/20/24 14:27* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *112 %* | *50-150 %* | *1* | *02/20/24 14:27* | *NWTPH-Gx (MS)* | |
| **MW-6D (A4B1224-09)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 14:55 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *104 %* | *Limits: 50-150 %* | *1* | *02/20/24 14:55* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *111 %* | *50-150 %* | *1* | *02/20/24 14:55* | *NWTPH-Gx (MS)* | |
| **MW-7 (A4B1224-10)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 16:44 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *106 %* | *Limits: 50-150 %* | *1* | *02/20/24 16:44* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *108 %* | *50-150 %* | *1* | *02/20/24 16:44* | *NWTPH-Gx (MS)* | |
| **MW-8 (A4B1224-11)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 18:33 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *105 %* | *Limits: 50-150 %* | *1* | *02/20/24 18:33* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *110 %* | *50-150 %* | *1* | *02/20/24 18:33* | *NWTPH-Gx (MS)* | |
| **MW-8D (A4B1224-12)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 17:11 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *103 %* | *Limits: 50-150 %* | *1* | *02/20/24 17:11* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *107 %* | *50-150 %* | *1* | *02/20/24 17:11* | *NWTPH-Gx (MS)* | |
| **MW-9 (A4B1224-13)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 17:38 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *103 %* | *Limits: 50-150 %* | *1* | *02/20/24 17:38* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *108 %* | *50-150 %* | *1* | *02/20/24 17:38* | *NWTPH-Gx (MS)* | |
| **MW-10 (A4B1224-14)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 18:05 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *104 %* | *Limits: 50-150 %* | *1* | *02/20/24 18:05* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | | *109 %* | *50-150 %* | *1* | *02/20/24 18:05* | *NWTPH-Gx (MS)* | |

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**ANALYTICAL REPORT**

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-11 (A4B1224-15RE1)** | | | | **Matrix: Water** | | **Batch: 24B0707** | | **R-04** |
| Gasoline Range Organics | ND | --- | 0.200 | mg/L | 2 | 02/21/24 13:27 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 98 %* | *Limits: 50-150 %* | | *1* | *02/21/24 13:27* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | *111 %* | *50-150 %* | | *1* | *02/21/24 13:27* | *NWTPH-Gx (MS)* | |
| **MW-11 (Alum/Filtered) (A4B1224-17RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | **R-04** |
| Gasoline Range Organics | ND | --- | 0.200 | mg/L | 2 | 02/20/24 21:33 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 67 %* | *Limits: 50-150 %* | | *1* | *02/20/24 21:33* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | *107 %* | *50-150 %* | | *1* | *02/20/24 21:33* | *NWTPH-Gx (MS)* | |
| **MW-11 (Alum/Filtered) DUP (A4B1224-18RE1)** | | | | **Matrix: Water** | | **Batch: 24B0707** | | **R-04** |
| Gasoline Range Organics | ND | --- | 0.200 | mg/L | 2 | 02/21/24 13:54 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 100 %* | *Limits: 50-150 %* | | *1* | *02/21/24 13:54* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | *112 %* | *50-150 %* | | *1* | *02/21/24 13:54* | *NWTPH-Gx (MS)* | |
| **MW-12 (A4B1224-19)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 21:58 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 90 %* | *Limits: 50-150 %* | | *1* | *02/20/24 21:58* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | *108 %* | *50-150 %* | | *1* | *02/20/24 21:58* | *NWTPH-Gx (MS)* | |
| **MW-12D (A4B1224-20)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | 02/20/24 22:23 | NWTPH-Gx (MS) | |
| *Surrogate: 4-Bromofluorobenzene (Sur)* | | *Recovery: 88 %* | *Limits: 50-150 %* | | *1* | *02/20/24 22:23* | *NWTPH-Gx (MS)* | |
| *1,4-Difluorobenzene (Sur)* | | *107 %* | *50-150 %* | | *1* | *02/20/24 22:23* | *NWTPH-Gx (MS)* | |

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**ANALYTICAL REPORT**

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|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-1 (A4B1224-01RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 19:53 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 19:53 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 19:53 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 19:53 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 19:53 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 19:53 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *104 %* | *Limits: 80-120 %* | *1* | *02/20/24 19:53* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *102 %* | *80-120 %* | *1* | *02/20/24 19:53* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *97 %* | *80-120 %* | *1* | *02/20/24 19:53* | *EPA 8260D* | |
| **MW-2 (A4B1224-02RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 20:18 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 20:18 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 20:18 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 20:18 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 20:18 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 20:18 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *104 %* | *Limits: 80-120 %* | *1* | *02/20/24 20:18* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *103 %* | *80-120 %* | *1* | *02/20/24 20:18* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *99 %* | *80-120 %* | *1* | *02/20/24 20:18* | *EPA 8260D* | |
| **MW-3 (A4B1224-03RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 20:43 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 20:43 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 20:43 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 20:43 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 20:43 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 20:43 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *104 %* | *Limits: 80-120 %* | *1* | *02/20/24 20:43* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *103 %* | *80-120 %* | *1* | *02/20/24 20:43* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *98 %* | *80-120 %* | *1* | *02/20/24 20:43* | *EPA 8260D* | |
| **MW-4 (A4B1224-04RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 21:08 | EPA 8260D | |

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**Apex Laboratories, LLC**
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**Tigard, OR 97223**
**503-718-2323**
ORELAP ID: **OR100062**

**ANALYTICAL REPORT**

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-4 (A4B1224-04RE1)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 21:08 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 21:08 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 21:08 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 21:08 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 21:08 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *104 %* | *Limits: 80-120 %* | *1* | *02/20/24 21:08* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *106 %* | *80-120 %* | *1* | *02/20/24 21:08* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *97 %* | *80-120 %* | *1* | *02/20/24 21:08* | *EPA 8260D* | |
| **MW-5 (A4B1224-05)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Benzene | ND | --- | 2.00 | ug/L | 10 | 02/20/24 19:00 | EPA 8260D | |
| Toluene | ND | --- | 10.0 | ug/L | 10 | 02/20/24 19:00 | EPA 8260D | |
| **Ethylbenzene** | **114** | --- | 5.00 | ug/L | 10 | 02/20/24 19:00 | EPA 8260D | |
| **Xylenes, total** | **453** | --- | 15.0 | ug/L | 10 | 02/20/24 19:00 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 10.0 | ug/L | 10 | 02/20/24 19:00 | EPA 8260D | |
| **Naphthalene** | **1750** | --- | 50.0 | ug/L | 10 | 02/20/24 19:00 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *106 %* | *Limits: 80-120 %* | *1* | *02/20/24 19:00* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *102 %* | *80-120 %* | *1* | *02/20/24 19:00* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *93 %* | *80-120 %* | *1* | *02/20/24 19:00* | *EPA 8260D* | |
| **MW-5 DUP (A4B1224-06)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Benzene | ND | --- | 2.00 | ug/L | 10 | 02/20/24 19:55 | EPA 8260D | |
| Toluene | ND | --- | 10.0 | ug/L | 10 | 02/20/24 19:55 | EPA 8260D | |
| **Ethylbenzene** | **106** | --- | 5.00 | ug/L | 10 | 02/20/24 19:55 | EPA 8260D | |
| **Xylenes, total** | **436** | --- | 15.0 | ug/L | 10 | 02/20/24 19:55 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 10.0 | ug/L | 10 | 02/20/24 19:55 | EPA 8260D | |
| **Naphthalene** | **1880** | --- | 50.0 | ug/L | 10 | 02/20/24 19:55 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *105 %* | *Limits: 80-120 %* | *1* | *02/20/24 19:55* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *102 %* | *80-120 %* | *1* | *02/20/24 19:55* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *94 %* | *80-120 %* | *1* | *02/20/24 19:55* | *EPA 8260D* | |
| **MW-6 (A4B1224-07)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| **Benzene** | **258** | --- | 2.00 | ug/L | 10 | 02/20/24 20:22 | EPA 8260D | |
| **Toluene** | **21.6** | --- | 10.0 | ug/L | 10 | 02/20/24 20:22 | EPA 8260D | |

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**Tigard, OR 97223**
**503-718-2323**
ORELAP ID: **OR100062**

**ANALYTICAL REPORT**

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-6 (A4B1224-07)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| **Xylenes, total** | **138** | --- | 15.0 | ug/L | 10 | 02/20/24 20:22 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 10.0 | ug/L | 10 | 02/20/24 20:22 | EPA 8260D | |
| **Naphthalene** | **525** | --- | 50.0 | ug/L | 10 | 02/20/24 20:22 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *104 %* | *Limits: 80-120 %* | *1* | *02/20/24 20:22* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *101 %* | *80-120 %* | *1* | *02/20/24 20:22* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *97 %* | *80-120 %* | *1* | *02/20/24 20:22* | *EPA 8260D* | |
| **MW-6 (A4B1224-07RE1)** | | | | **Matrix: Water** | | **Batch: 24B0707** | | |
| **Ethylbenzene** | **1710** | --- | 50.0 | ug/L | 100 | 02/21/24 12:59 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *108 %* | *Limits: 80-120 %* | *1* | *02/21/24 12:59* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *101 %* | *80-120 %* | *1* | *02/21/24 12:59* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | *80-120 %* | *1* | *02/21/24 12:59* | *EPA 8260D* | |
| **MW-5D (A4B1224-08)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 14:27 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 14:27 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 14:27 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 14:27 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 14:27 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 14:27 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *109 %* | *Limits: 80-120 %* | *1* | *02/20/24 14:27* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *101 %* | *80-120 %* | *1* | *02/20/24 14:27* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *95 %* | *80-120 %* | *1* | *02/20/24 14:27* | *EPA 8260D* | |
| **MW-6D (A4B1224-09)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 14:55 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 14:55 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 14:55 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 14:55 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 14:55 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 14:55 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *109 %* | *Limits: 80-120 %* | *1* | *02/20/24 14:55* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *101 %* | *80-120 %* | *1* | *02/20/24 14:55* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | *80-120 %* | *1* | *02/20/24 14:55* | *EPA 8260D* | |

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ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## ANALYTICAL SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-7 (A4B1224-10)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 16:44 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 16:44 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 16:44 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 16:44 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 16:44 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 16:44 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *108 %* | *Limits: 80-120 %* | *1* | *02/20/24 16:44* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *99 %* | *80-120 %* | *1* | *02/20/24 16:44* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *93 %* | *80-120 %* | *1* | *02/20/24 16:44* | *EPA 8260D* | |
| **MW-8 (A4B1224-11)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 18:33 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 18:33 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 18:33 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 18:33 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 18:33 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 18:33 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *109 %* | *Limits: 80-120 %* | *1* | *02/20/24 18:33* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *100 %* | *80-120 %* | *1* | *02/20/24 18:33* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | *80-120 %* | *1* | *02/20/24 18:33* | *EPA 8260D* | |
| **MW-8D (A4B1224-12)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 17:11 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 17:11 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 17:11 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 17:11 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 17:11 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 17:11 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *108 %* | *Limits: 80-120 %* | *1* | *02/20/24 17:11* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *101 %* | *80-120 %* | *1* | *02/20/24 17:11* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | *80-120 %* | *1* | *02/20/24 17:11* | *EPA 8260D* | |
| **MW-9 (A4B1224-13)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |

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| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-9 (A4B1224-13)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 17:38 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 17:38 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 17:38 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 17:38 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 17:38 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 17:38 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *107 %* | *Limits: 80-120 %* | *1* | *02/20/24 17:38* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *101 %* | *80-120 %* | *1* | *02/20/24 17:38* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *95 %* | *80-120 %* | *1* | *02/20/24 17:38* | *EPA 8260D* | |
| **MW-10 (A4B1224-14)** | | | | **Matrix: Water** | | **Batch: 24B0665** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 18:05 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 18:05 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 18:05 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 18:05 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 18:05 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 18:05 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *108 %* | *Limits: 80-120 %* | *1* | *02/20/24 18:05* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *100 %* | *80-120 %* | *1* | *02/20/24 18:05* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *95 %* | *80-120 %* | *1* | *02/20/24 18:05* | *EPA 8260D* | |
| **MW-11 (A4B1224-15RE1)** | | | | **Matrix: Water** | | **Batch: 24B0707** | | **R-04** |
| Benzene | ND | --- | 0.400 | ug/L | 2 | 02/21/24 13:27 | EPA 8260D | |
| Toluene | ND | --- | 2.00 | ug/L | 2 | 02/21/24 13:27 | EPA 8260D | |
| Ethylbenzene | ND | --- | 1.00 | ug/L | 2 | 02/21/24 13:27 | EPA 8260D | |
| Xylenes, total | ND | --- | 3.00 | ug/L | 2 | 02/21/24 13:27 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 2.00 | ug/L | 2 | 02/21/24 13:27 | EPA 8260D | |
| Naphthalene | ND | --- | 10.0 | ug/L | 2 | 02/21/24 13:27 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *109 %* | *Limits: 80-120 %* | *1* | *02/21/24 13:27* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *101 %* | *80-120 %* | *1* | *02/21/24 13:27* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *110 %* | *80-120 %* | *1* | *02/21/24 13:27* | *EPA 8260D* | |
| **MW-11 (Alum/Filtered) (A4B1224-17)** | | | | **Matrix: Water** | | **Batch: 24B0610** | | **R-04** |
| Benzene | ND | --- | 2.00 | ug/L | 10 | 02/19/24 22:05 | EPA 8260D | |

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**Apex Laboratories, LLC**
**6700 S.W. Sandburg Street**
**Tigard, OR 97223**
**503-718-2323**
ORELAP ID: **OR100062**

**ANALYTICAL REPORT**

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-11 (Alum/Filtered) (A4B1224-17)** | | | | **Matrix: Water** | | **Batch: 24B0610** | | **R-04** |
| Toluene | ND | --- | 10.0 | ug/L | 10 | 02/19/24 22:05 | EPA 8260D | |
| Ethylbenzene | ND | --- | 5.00 | ug/L | 10 | 02/19/24 22:05 | EPA 8260D | |
| Xylenes, total | ND | --- | 15.0 | ug/L | 10 | 02/19/24 22:05 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 10.0 | ug/L | 10 | 02/19/24 22:05 | EPA 8260D | |
| Naphthalene | ND | --- | 50.0 | ug/L | 10 | 02/19/24 22:05 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *110 %* | *Limits: 80-120 %* | *1* | *02/19/24 22:05* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *101 %* | *80-120 %* | *1* | *02/19/24 22:05* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | *80-120 %* | *1* | *02/19/24 22:05* | *EPA 8260D* | |
| **MW-11 (Alum/Filtered) DUP (A4B1224-18RE1)** | | | | **Matrix: Water** | | **Batch: 24B0707** | | **R-04** |
| Benzene | ND | --- | 0.400 | ug/L | 2 | 02/21/24 13:54 | EPA 8260D | |
| Toluene | ND | --- | 2.00 | ug/L | 2 | 02/21/24 13:54 | EPA 8260D | |
| Ethylbenzene | ND | --- | 1.00 | ug/L | 2 | 02/21/24 13:54 | EPA 8260D | |
| Xylenes, total | ND | --- | 3.00 | ug/L | 2 | 02/21/24 13:54 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 2.00 | ug/L | 2 | 02/21/24 13:54 | EPA 8260D | |
| Naphthalene | ND | --- | 10.0 | ug/L | 2 | 02/21/24 13:54 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *109 %* | *Limits: 80-120 %* | *1* | *02/21/24 13:54* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *102 %* | *80-120 %* | *1* | *02/21/24 13:54* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *102 %* | *80-120 %* | *1* | *02/21/24 13:54* | *EPA 8260D* | |
| **MW-12 (A4B1224-19)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 21:58 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 21:58 | EPA 8260D | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 21:58 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 21:58 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 21:58 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 21:58 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *105 %* | *Limits: 80-120 %* | *1* | *02/20/24 21:58* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *103 %* | *80-120 %* | *1* | *02/20/24 21:58* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *97 %* | *80-120 %* | *1* | *02/20/24 21:58* | *EPA 8260D* | |
| **MW-12D (A4B1224-20)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | 02/20/24 22:23 | EPA 8260D | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | 02/20/24 22:23 | EPA 8260D | |

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**ANALYTICAL REPORT**

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|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## ANALYTICAL SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Sample Result | Detection Limit | Reporting Limit | Units | Dilution | Date Analyzed | Method Ref. | Notes |
|---|---|---|---|---|---|---|---|---|
| **MW-12D (A4B1224-20)** | | | | **Matrix: Water** | | **Batch: 24B0607** | | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | 02/20/24 22:23 | EPA 8260D | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | 02/20/24 22:23 | EPA 8260D | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | 02/20/24 22:23 | EPA 8260D | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | 02/20/24 22:23 | EPA 8260D | |
| *Surrogate: 1,4-Difluorobenzene (Surr)* | | *Recovery:* | *105 %* | *Limits: 80-120 %* | *1* | *02/20/24 22:23* | *EPA 8260D* | |
| *Toluene-d8 (Surr)* | | | *105 %* | *80-120 %* | *1* | *02/20/24 22:23* | *EPA 8260D* | |
| *4-Bromofluorobenzene (Surr)* | | | *95 %* | *80-120 %* | *1* | *02/20/24 22:23* | *EPA 8260D* | |

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| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Diesel and/or Oil Hydrocarbons by NWTPH-Dx

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0725 - EPA 3510C (Fuels/Acid Ext.)** | | | | | | | | | Water | | | |
| **Blank (24B0725-BLK1)** | | | Prepared: 02/21/24 11:09 | | Analyzed: 02/21/24 21:27 | | | | | | | |
| NWTPH-Dx LL | | | | | | | | | | | | |
| Diesel | ND | --- | 0.0800 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| Oil | ND | --- | 0.160 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: o-Terphenyl (Surr)* | | | *Recovery: 80 %* | | *Limits: 50-150 %* | | | | *Dilution: 1x* | | | |
| **Blank (24B0725-BLK2)** | | | Prepared: 02/21/24 11:09 | | Analyzed: 02/21/24 21:48 | | | | | | | |
| NWTPH-Dx LL | | | | | | | | | | | | |
| Diesel | ND | --- | 0.0800 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| Oil | ND | --- | 0.160 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: o-Terphenyl (Surr)* | | | *Recovery: 79 %* | | *Limits: 50-150 %* | | | | *Dilution: 1x* | | | |
| **LCS (24B0725-BS1)** | | | Prepared: 02/21/24 11:09 | | Analyzed: 02/21/24 22:08 | | | | | | | |
| NWTPH-Dx LL | | | | | | | | | | | | |
| Diesel | 0.233 | --- | 0.0800 | mg/L | 1 | 0.500 | --- | 47 | 36-132% | --- | --- | |
| *Surr: o-Terphenyl (Surr)* | | | *Recovery: 84 %* | | *Limits: 50-150 %* | | | | *Dilution: 1x* | | | |
| **LCS Dup (24B0725-BSD1)** | | | Prepared: 02/21/24 11:09 | | Analyzed: 02/21/24 22:29 | | | | | | | **Q-19** |
| NWTPH-Dx LL | | | | | | | | | | | | |
| Diesel | 0.259 | --- | 0.0800 | mg/L | 1 | 0.500 | --- | 52 | 36-132% | 11 | 30% | |
| *Surr: o-Terphenyl (Surr)* | | | *Recovery: 83 %* | | *Limits: 50-150 %* | | | | *Dilution: 1x* | | | |

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ANALYTICAL REPORT

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| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Dissolved Diesel and/or Oil Hydrocarbons by NWTPH-Dx

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0725 - EPA 3510C (Fuels/Acid Ext.)** | | | | | | | | | Water | | | |
| **Blank (24B0725-BLK1)** | | | Prepared: 02/21/24 11:09 | | Analyzed: 02/21/24 21:27 | | | | | | | |
| NWTPH-Dx (Diss) | | | | | | | | | | | | |
| Diesel | ND | --- | 0.0800 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| Oil | ND | --- | 0.160 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: o-Terphenyl (Surr)* | | *Recovery: 80 %* | *Limits: 50-150 %* | | *Dilution: 1x* | | | | | | | |
| **Blank (24B0725-BLK2)** | | | Prepared: 02/21/24 11:09 | | Analyzed: 02/21/24 21:48 | | | | | | | FILT3 |
| NWTPH-Dx (Diss) | | | | | | | | | | | | |
| Diesel | ND | --- | 0.0800 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| Oil | ND | --- | 0.160 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: o-Terphenyl (Surr)* | | *Recovery: 79 %* | *Limits: 50-150 %* | | *Dilution: 1x* | | | | | | | |
| **LCS (24B0725-BS1)** | | | Prepared: 02/21/24 11:09 | | Analyzed: 02/21/24 22:08 | | | | | | | |
| NWTPH-Dx (Diss) | | | | | | | | | | | | |
| Diesel | 0.233 | --- | 0.0800 | mg/L | 1 | 0.500 | --- | 47 | 36-132% | --- | --- | |
| *Surr: o-Terphenyl (Surr)* | | *Recovery: 84 %* | *Limits: 50-150 %* | | *Dilution: 1x* | | | | | | | |
| **LCS Dup (24B0725-BSD1)** | | | Prepared: 02/21/24 11:09 | | Analyzed: 02/21/24 22:29 | | | | | | | Q-19 |
| NWTPH-Dx (Diss) | | | | | | | | | | | | |
| Diesel | 0.259 | --- | 0.0800 | mg/L | 1 | 0.500 | --- | 52 | 36-132% | 11 | 30% | |
| *Surr: o-Terphenyl (Surr)* | | *Recovery: 83 %* | *Limits: 50-150 %* | | *Dilution: 1x* | | | | | | | |

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ANALYTICAL REPORT

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| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0607 - EPA 5030C** | | | | | | | | | Water | | | |
| **Blank (24B0607-BLK1)** | | | Prepared: 02/20/24 15:58 Analyzed: 02/20/24 19:03 | | | | | | | | | |
| NWTPH-Gx (MS) | | | | | | | | | | | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | | *Recovery: 88 %* | | *Limits: 50-150 %* | | | | *Dilution: 1x* | | | |
| *1,4-Difluorobenzene (Sur)* | | | *103 %* | | *50-150 %* | | | | *"* | | | |
| **LCS (24B0607-BS2)** | | | Prepared: 02/20/24 15:58 Analyzed: 02/20/24 18:38 | | | | | | | | | |
| NWTPH-Gx (MS) | | | | | | | | | | | | |
| Gasoline Range Organics | 0.550 | --- | 0.100 | mg/L | 1 | 0.500 | --- | 110 | 80-120% | --- | --- | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | | *Recovery: 95 %* | | *Limits: 50-150 %* | | | | *Dilution: 1x* | | | |
| *1,4-Difluorobenzene (Sur)* | | | *104 %* | | *50-150 %* | | | | *"* | | | |
| **Duplicate (24B0607-DUP1)** | | | Prepared: 02/20/24 15:58 Analyzed: 02/21/24 04:12 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1270-04) | | | | | | | | | | | | |
| Gasoline Range Organics | **15.6** | --- | 10.0 | mg/L | 100 | --- | 13.1 | --- | --- | 18 | 30% | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | | *Recovery: 92 %* | | *Limits: 50-150 %* | | | | *Dilution: 1x* | | | |
| *1,4-Difluorobenzene (Sur)* | | | *115 %* | | *50-150 %* | | | | *"* | | | |

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ANALYTICAL REPORT

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| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0610 - EPA 5030C** | | | | | | | | | Water | | | |
| **Blank (24B0610-BLK1)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/19/24 12:32 | | | | | | | | | |
| NWTPH-Gx (MS) | | | | | | | | | | | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | | *Recovery: 96 %* | *Limits: 50-150 %* | | | *Dilution: 1x* | | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *107 %* | *50-150 %* | | | *"* | | | | | |
| **LCS (24B0610-BS2)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/19/24 11:56 | | | | | | | | | |
| NWTPH-Gx (MS) | | | | | | | | | | | | |
| Gasoline Range Organics | 0.494 | --- | 0.100 | mg/L | 1 | 0.500 | --- | 99 | 80-120% | --- | --- | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | | *Recovery: 97 %* | *Limits: 50-150 %* | | | *Dilution: 1x* | | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *103 %* | *50-150 %* | | | *"* | | | | | |
| **Duplicate (24B0610-DUP1)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/19/24 18:27 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1226-01) | | | | | | | | | | | | |
| Gasoline Range Organics | ND | --- | 1.00 | mg/L | 10 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | | *Recovery: 104 %* | *Limits: 50-150 %* | | | *Dilution: 1x* | | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *110 %* | *50-150 %* | | | *"* | | | | | |
| **Duplicate (24B0610-DUP2)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/20/24 00:21 | | | | | | | | | T-02 |
| QC Source Sample: MW-4 (A4B1224-04) | | | | | | | | | | | | |
| NWTPH-Gx (MS) | | | | | | | | | | | | |
| Gasoline Range Organics | ND | --- | 1.00 | mg/L | 10 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | | *Recovery: 106 %* | *Limits: 50-150 %* | | | *Dilution: 1x* | | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *113 %* | *50-150 %* | | | *"* | | | | | |

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| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0665 - EPA 5030C** | | | | | | | | | Water | | | |
| **Blank (24B0665-BLK1)** | | | Prepared: 02/20/24 09:08 | | Analyzed: 02/20/24 11:44 | | | | | | | |
| **NWTPH-Gx (MS)** | | | | | | | | | | | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *102 %* | *Limits:* | *50-150 %* | | *Dilution:* | *1x* | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *111 %* | | *50-150 %* | | | *"* | | | | |
| **LCS (24B0665-BS2)** | | | Prepared: 02/20/24 09:08 | | Analyzed: 02/20/24 11:16 | | | | | | | |
| **NWTPH-Gx (MS)** | | | | | | | | | | | | |
| Gasoline Range Organics | 0.506 | --- | 0.100 | mg/L | 1 | 0.500 | --- | 101 | 80-120% | --- | --- | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *101 %* | *Limits:* | *50-150 %* | | *Dilution:* | *1x* | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *106 %* | | *50-150 %* | | | *"* | | | | |
| **Duplicate (24B0665-DUP1)** | | | Prepared: 02/20/24 09:08 | | Analyzed: 02/20/24 19:27 | | | | | | | |
| **QC Source Sample: MW-5 (A4B1224-05)** | | | | | | | | | | | | |
| **NWTPH-Gx (MS)** | | | | | | | | | | | | |
| Gasoline Range Organics | **23.1** | --- | 1.00 | mg/L | 10 | --- | 24.5 | --- | --- | 6 | 30% | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *102 %* | *Limits:* | *50-150 %* | | *Dilution:* | *1x* | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *104 %* | | *50-150 %* | | | *"* | | | | |
| **Duplicate (24B0665-DUP2)** | | | Prepared: 02/20/24 09:08 | | Analyzed: 02/20/24 21:16 | | | | | | | |
| **QC Source Sample: MW-11 (A4B1224-15)** | | | | | | | | | | | | |
| **NWTPH-Gx (MS)** | | | | | | | | | | | | |
| Gasoline Range Organics | ND | --- | 2.00 | mg/L | 20 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *101 %* | *Limits:* | *50-150 %* | | *Dilution:* | *1x* | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *106 %* | | *50-150 %* | | | *"* | | | | |

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## QUALITY CONTROL (QC) SAMPLE RESULTS

### Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0707 - EPA 5030C** | | | | | | | | | Water | | | |
| **Blank (24B0707-BLK1)** | | | Prepared: 02/21/24 09:00 Analyzed: 02/21/24 12:32 | | | | | | | | | |
| NWTPH-Gx (MS) | | | | | | | | | | | | |
| Gasoline Range Organics | ND | --- | 0.100 | mg/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *102 %* | *Limits:* | *50-150 %* | | *Dilution:* | *1x* | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *111 %* | | *50-150 %* | | | *"* | | | | |
| **LCS (24B0707-BS2)** | | | Prepared: 02/21/24 09:00 Analyzed: 02/21/24 12:05 | | | | | | | | | |
| NWTPH-Gx (MS) | | | | | | | | | | | | |
| Gasoline Range Organics | 0.488 | --- | 0.100 | mg/L | 1 | 0.500 | --- | 98 | 80-120% | --- | --- | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *101 %* | *Limits:* | *50-150 %* | | *Dilution:* | *1x* | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *105 %* | | *50-150 %* | | | *"* | | | | |
| **Duplicate (24B0707-DUP1)** | | | Prepared: 02/21/24 10:16 Analyzed: 02/21/24 16:37 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1323-01) | | | | | | | | | | | | |
| Gasoline Range Organics | ND | --- | 5.00 | mg/L | 50 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *100 %* | *Limits:* | *50-150 %* | | *Dilution:* | *1x* | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *108 %* | | *50-150 %* | | | *"* | | | | |
| **Duplicate (24B0707-DUP2)** | | | Prepared: 02/21/24 10:16 Analyzed: 02/21/24 22:59 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1323-04) | | | | | | | | | | | | |
| Gasoline Range Organics | ND | --- | 5.00 | mg/L | 50 | --- | 4.87 | --- | --- | *** | 30% | |
| *Surr: 4-Bromofluorobenzene (Sur)* | | *Recovery:* | *100 %* | *Limits:* | *50-150 %* | | *Dilution:* | *1x* | | | | |
| *1,4-Difluorobenzene (Sur)* | | | *105 %* | | *50-150 %* | | | *"* | | | | |

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Darrell Auvil, Client Services Manager

Apex Laboratories, LLC
6700 S.W. Sandburg Street
Tigard, OR 97223
503-718-2323
ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0607 - EPA 5030C** | | | | | | | | | | | | Water |
| **Blank (24B0607-BLK1)** | | | Prepared: 02/20/24 15:58 Analyzed: 02/20/24 19:03 | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 103 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *103 %* | | *80-120 %* | | | *"* | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *99 %* | | *80-120 %* | | | *"* | | | | |
| **LCS (24B0607-BS1)** | | | Prepared: 02/20/24 15:58 Analyzed: 02/20/24 18:13 | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | 20.5 | --- | 0.200 | ug/L | 1 | 20.0 | --- | 102 | 80-120% | --- | --- | |
| Toluene | 19.1 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 95 | 80-120% | --- | --- | |
| Ethylbenzene | 19.8 | --- | 0.500 | ug/L | 1 | 20.0 | --- | 99 | 80-120% | --- | --- | |
| Xylenes, total | 59.6 | --- | 1.50 | ug/L | 1 | 60.0 | --- | 99 | 80-120% | --- | --- | |
| Methyl tert-butyl ether (MTBE) | 23.3 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 116 | 80-120% | --- | --- | |
| Naphthalene | 16.8 | --- | 5.00 | ug/L | 1 | 20.0 | --- | 84 | 80-120% | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 104 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *101 %* | | *80-120 %* | | | *"* | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *93 %* | | *80-120 %* | | | *"* | | | | |
| **Duplicate (24B0607-DUP1)** | | | Prepared: 02/20/24 15:58 Analyzed: 02/21/24 04:12 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1270-04) | | | | | | | | | | | | |
| Benzene | ND | --- | 20.0 | ug/L | 100 | --- | ND | --- | --- | --- | 30% | |
| Toluene | ND | --- | 100 | ug/L | 100 | --- | ND | --- | --- | --- | 30% | |
| Ethylbenzene | ND | --- | 50.0 | ug/L | 100 | --- | ND | --- | --- | --- | 30% | |
| Xylenes, total | ND | --- | 150 | ug/L | 100 | --- | ND | --- | --- | --- | 30% | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 100 | ug/L | 100 | --- | ND | --- | --- | --- | 30% | |
| Naphthalene | ND | --- | 500 | ug/L | 100 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 109 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *103 %* | | *80-120 %* | | | *"* | | | | |

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Darrell Auvil, Client Services Manager

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ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0607 - EPA 5030C** | | | | | | | | | | | | **Water** |
| **Duplicate (24B0607-DUP1)** | | | | Prepared: 02/20/24 15:58 Analyzed: 02/21/24 04:12 | | | | | | | | |
| **QC Source Sample: Non-SDG (A4B1270-04)** | | | | | | | | | | | | |
| *Surr: 4-Bromofluorobenzene (Surr)* | | | *Recovery: 95 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| **Matrix Spike (24B0607-MS1)** | | | | Prepared: 02/20/24 15:58 Analyzed: 02/21/24 00:28 | | | | | | | | |
| **QC Source Sample: Non-SDG (A4B1281-02)** | | | | | | | | | | | | |
| **EPA 8260D** | | | | | | | | | | | | |
| Benzene | 23.4 | --- | 0.200 | ug/L | 1 | 20.0 | ND | 117 | 79-120% | --- | --- | |
| Toluene | 21.3 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 107 | 80-121% | --- | --- | |
| Ethylbenzene | 22.1 | --- | 0.500 | ug/L | 1 | 20.0 | ND | 110 | 79-121% | --- | --- | |
| Xylenes, total | 66.9 | --- | 1.50 | ug/L | 1 | 60.0 | ND | 111 | 79-121% | --- | --- | |
| Methyl tert-butyl ether (MTBE) | 25.9 | --- | 1.00 | ug/L | 1 | 20.0 | ND | **130** | **71-124%** | --- | --- | NR |
| Naphthalene | 16.9 | --- | 5.00 | ug/L | 1 | 20.0 | ND | 84 | 61-128% | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 105 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| *Toluene-d8 (Surr)* | | | *100 %* | *80-120 %* | | | *"* | | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *90 %* | *80-120 %* | | | *"* | | | | | |

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Darrell Auvil, Client Services Manager

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503-718-2323
ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0610 - EPA 5030C** | | | | | | | | | | | | Water |
| **Blank (24B0610-BLK1)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/19/24 12:32 | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 105 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *103 %* | | *80-120 %* | | | *"* | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *99 %* | | *80-120 %* | | | *"* | | | | |
| **LCS (24B0610-BS1)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/19/24 10:53 | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | 19.9 | --- | 0.200 | ug/L | 1 | 20.0 | --- | 100 | 80-120% | --- | --- | |
| Toluene | 18.6 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 93 | 80-120% | --- | --- | |
| Ethylbenzene | 19.9 | --- | 0.500 | ug/L | 1 | 20.0 | --- | 99 | 80-120% | --- | --- | |
| Xylenes, total | 57.7 | --- | 1.50 | ug/L | 1 | 60.0 | --- | 96 | 80-120% | --- | --- | |
| Methyl tert-butyl ether (MTBE) | 18.3 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 92 | 80-120% | --- | --- | |
| Naphthalene | 17.7 | --- | 5.00 | ug/L | 1 | 20.0 | --- | 88 | 80-120% | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 103 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *99 %* | | *80-120 %* | | | *"* | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | | *80-120 %* | | | *"* | | | | |
| **Duplicate (24B0610-DUP1)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/19/24 18:27 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1226-01) | | | | | | | | | | | | |
| Benzene | ND | --- | 2.00 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Toluene | ND | --- | 10.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Ethylbenzene | ND | --- | 5.00 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Xylenes, total | ND | --- | 15.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 10.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Naphthalene | ND | --- | 50.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 108 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *101 %* | | *80-120 %* | | | *"* | | | | |

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Darrell Auvil, Client Services Manager

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ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0610 - EPA 5030C** | | | | | | | | | | | | **Water** |
| **Duplicate (24B0610-DUP1)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/19/24 18:27 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1226-01) | | | | | | | | | | | | |
| *Surr: 4-Bromofluorobenzene (Surr)* | | | *Recovery: 95 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| **Duplicate (24B0610-DUP2)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/20/24 00:21 | | | | | | | | | **T-02** |
| QC Source Sample: MW-4 (A4B1224-04) | | | | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | ND | --- | 2.00 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Toluene | ND | --- | 10.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Ethylbenzene | ND | --- | 5.00 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Xylenes, total | ND | --- | 15.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 10.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Naphthalene | ND | --- | 50.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 111 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| *Toluene-d8 (Surr)* | | | *100 %* | *80-120 %* | | | *"* | | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | *80-120 %* | | | *"* | | | | | |
| **Matrix Spike (24B0610-MS1)** | | | Prepared: 02/19/24 08:16 Analyzed: 02/19/24 13:54 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1220-04) | | | | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | 21.6 | --- | 0.200 | ug/L | 1 | 20.0 | 0.730 | 104 | 79-120% | --- | --- | |
| Toluene | 19.2 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 96 | 80-121% | --- | --- | |
| Ethylbenzene | 22.2 | --- | 0.500 | ug/L | 1 | 20.0 | 1.66 | 103 | 79-121% | --- | --- | |
| Xylenes, total | 59.7 | --- | 1.50 | ug/L | 1 | 60.0 | 1.70 | 97 | 79-121% | --- | --- | |
| Methyl tert-butyl ether (MTBE) | 18.4 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 92 | 71-124% | --- | --- | |
| Naphthalene | 16.6 | --- | 5.00 | ug/L | 1 | 20.0 | ND | 83 | 61-128% | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 103 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| *Toluene-d8 (Surr)* | | | *98 %* | *80-120 %* | | | *"* | | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | *80-120 %* | | | *"* | | | | | |

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**503-718-2323**
ORELAP ID: **OR100062**

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0665 - EPA 5030C** | | | | | | | **Water** | | | | | |
| **Blank (24B0665-BLK1)** | | | Prepared: 02/20/24 09:08 | | Analyzed: 02/20/24 11:44 | | | | | | | |
| **EPA 8260D** | | | | | | | | | | | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| 1,2-Dibromoethane (EDB) | ND | --- | 0.500 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| 1,2-Dichloroethane (EDC) | ND | --- | 0.400 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Isopropylbenzene | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| 1,2,4-Trimethylbenzene | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| 1,3,5-Trimethylbenzene | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 109 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *101 %* | | *80-120 %* | | | *"* | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | | *80-120 %* | | | *"* | | | | |
| **LCS (24B0665-BS1)** | | | Prepared: 02/20/24 09:08 | | Analyzed: 02/20/24 10:49 | | | | | | | |
| **EPA 8260D** | | | | | | | | | | | | |
| Benzene | 20.5 | --- | 0.200 | ug/L | 1 | 20.0 | --- | 102 | 80-120% | --- | --- | |
| Toluene | 18.6 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 93 | 80-120% | --- | --- | |
| Ethylbenzene | 20.3 | --- | 0.500 | ug/L | 1 | 20.0 | --- | 102 | 80-120% | --- | --- | |
| Xylenes, total | 58.2 | --- | 1.50 | ug/L | 1 | 60.0 | --- | 97 | 80-120% | --- | --- | |
| Methyl tert-butyl ether (MTBE) | 16.8 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 84 | 80-120% | --- | --- | |
| Naphthalene | 16.5 | --- | 5.00 | ug/L | 1 | 20.0 | --- | 82 | 80-120% | --- | --- | |
| 1,2-Dibromoethane (EDB) | 20.2 | --- | 0.500 | ug/L | 1 | 20.0 | --- | 101 | 80-120% | --- | --- | |
| 1,2-Dichloroethane (EDC) | 21.4 | --- | 0.400 | ug/L | 1 | 20.0 | --- | 107 | 80-120% | --- | --- | |
| Isopropylbenzene | 20.2 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 101 | 80-120% | --- | --- | |
| 1,2,4-Trimethylbenzene | 20.0 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 100 | 80-120% | --- | --- | |
| 1,3,5-Trimethylbenzene | 20.3 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 102 | 80-120% | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 105 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *98 %* | | *80-120 %* | | | *"* | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *92 %* | | *80-120 %* | | | *"* | | | | |
| **Duplicate (24B0665-DUP1)** | | | Prepared: 02/20/24 09:08 | | Analyzed: 02/20/24 19:27 | | | | | | | |

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Tigard, OR 97223
503-718-2323
ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0665 - EPA 5030C** | | | | | | | | | | | | **Water** |
| **Duplicate (24B0665-DUP1)** | | | | Prepared: 02/20/24 09:08 Analyzed: 02/20/24 19:27 | | | | | | | | |
| **QC Source Sample: MW-5 (A4B1224-05)** | | | | | | | | | | | | |
| **EPA 8260D** | | | | | | | | | | | | |
| Benzene | ND | --- | 2.00 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Toluene | ND | --- | 10.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Ethylbenzene | **110** | --- | 5.00 | ug/L | 10 | --- | 114 | --- | --- | 3 | 30% | |
| Xylenes, total | **432** | --- | 15.0 | ug/L | 10 | --- | 453 | --- | --- | 5 | 30% | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 10.0 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Naphthalene | **1690** | --- | 50.0 | ug/L | 10 | --- | 1750 | --- | --- | 3 | 30% | |
| 1,2-Dibromoethane (EDB) | ND | --- | 5.00 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| 1,2-Dichloroethane (EDC) | ND | --- | 4.00 | ug/L | 10 | --- | ND | --- | --- | --- | 30% | |
| Isopropylbenzene | **139** | --- | 10.0 | ug/L | 10 | --- | 142 | --- | --- | 2 | 30% | |
| 1,2,4-Trimethylbenzene | **743** | --- | 10.0 | ug/L | 10 | --- | 764 | --- | --- | 3 | 30% | |
| 1,3,5-Trimethylbenzene | **932** | --- | 10.0 | ug/L | 10 | --- | 958 | --- | --- | 3 | 30% | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 104 %* | | *Limits: 80-120 %* | | | | *Dilution: 1x* | | | |
| *Toluene-d8 (Surr)* | | | *102 %* | | *80-120 %* | | | | *"* | | | |
| *4-Bromofluorobenzene (Surr)* | | | *95 %* | | *80-120 %* | | | | *"* | | | |
| **Duplicate (24B0665-DUP2)** | | | | Prepared: 02/20/24 09:08 Analyzed: 02/20/24 21:16 | | | | | | | | |
| **QC Source Sample: MW-11 (A4B1224-15)** | | | | | | | | | | | | |
| **EPA 8260D** | | | | | | | | | | | | |
| Benzene | ND | --- | 4.00 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| Toluene | ND | --- | 20.0 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| Ethylbenzene | ND | --- | 10.0 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| Xylenes, total | ND | --- | 30.0 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 20.0 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| Naphthalene | ND | --- | 100 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| 1,2-Dibromoethane (EDB) | ND | --- | 10.0 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| 1,2-Dichloroethane (EDC) | ND | --- | 8.00 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| Isopropylbenzene | ND | --- | 20.0 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| 1,2,4-Trimethylbenzene | ND | --- | 20.0 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| 1,3,5-Trimethylbenzene | ND | --- | 20.0 | ug/L | 20 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 107 %* | | *Limits: 80-120 %* | | | | *Dilution: 1x* | | | |
| *Toluene-d8 (Surr)* | | | *100 %* | | *80-120 %* | | | | *"* | | | |

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503-718-2323
ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: | Nustar Vannex GWM 1Q24 |
| 5820 S Kelly Ave Unit B | Project Number: | 19001-008 |
| Portland, OR 97239 | Project Manager: | Philip Cordell |

Report ID:
A4B1224 - 03 04 24 1625

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0665 - EPA 5030C** | | | | | | | | | | | | **Water** |
| **Duplicate (24B0665-DUP2)** | | | | Prepared: 02/20/24 09:08 Analyzed: 02/20/24 21:16 | | | | | | | | |
| QC Source Sample: MW-11 (A4B1224-15) | | | | | | | | | | | | |
| *Surr: 4-Bromofluorobenzene (Surr)* | | | *Recovery: 97 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| **Matrix Spike (24B0665-MS1)** | | | | Prepared: 02/20/24 09:08 Analyzed: 02/20/24 22:11 | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1277-01) | | | | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | 21.6 | --- | 0.200 | ug/L | 1 | 20.0 | ND | 108 | 79-120% | --- | --- | |
| Toluene | 19.2 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 96 | 80-121% | --- | --- | |
| Ethylbenzene | 20.5 | --- | 0.500 | ug/L | 1 | 20.0 | ND | 103 | 79-121% | --- | --- | |
| Xylenes, total | 56.6 | --- | 1.50 | ug/L | 1 | 60.0 | ND | 94 | 79-121% | --- | --- | |
| Methyl tert-butyl ether (MTBE) | 17.7 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 89 | 71-124% | --- | --- | |
| Naphthalene | 11.4 | --- | 5.00 | ug/L | 1 | 20.0 | ND | **57** | **61-128%** | --- | --- | Q-01 |
| 1,2-Dibromoethane (EDB) | 20.6 | --- | 0.500 | ug/L | 1 | 20.0 | ND | 103 | 77-121% | --- | --- | |
| 1,2-Dichloroethane (EDC) | 21.4 | --- | 0.400 | ug/L | 1 | 20.0 | ND | 107 | 73-128% | --- | --- | |
| Isopropylbenzene | 19.4 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 97 | 72-131% | --- | --- | |
| 1,2,4-Trimethylbenzene | 17.1 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 86 | 76-124% | --- | --- | |
| 1,3,5-Trimethylbenzene | 17.9 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 90 | 75-124% | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 105 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| *Toluene-d8 (Surr)* | | | *97 %* | *80-120 %* | | | *"* | | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *95 %* | *80-120 %* | | | *"* | | | | | |

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ANALYTICAL REPORT

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|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0707 - EPA 5030C** | | | | | | | | | | | | **Water** |
| **Blank (24B0707-BLK1)** | | | Prepared: 02/21/24 09:00 Analyzed: 02/21/24 12:32 | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | ND | --- | 0.200 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Toluene | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Ethylbenzene | ND | --- | 0.500 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Xylenes, total | ND | --- | 1.50 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 1.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| Naphthalene | ND | --- | 5.00 | ug/L | 1 | --- | --- | --- | --- | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 109 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *101 %* | | *80-120 %* | | | *"* | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *96 %* | | *80-120 %* | | | *"* | | | | |
| **LCS (24B0707-BS1)** | | | Prepared: 02/21/24 09:00 Analyzed: 02/21/24 11:10 | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | 20.3 | --- | 0.200 | ug/L | 1 | 20.0 | --- | 102 | 80-120% | --- | --- | |
| Toluene | 18.4 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 92 | 80-120% | --- | --- | |
| Ethylbenzene | 19.9 | --- | 0.500 | ug/L | 1 | 20.0 | --- | 100 | 80-120% | --- | --- | |
| Xylenes, total | 56.6 | --- | 1.50 | ug/L | 1 | 60.0 | --- | 94 | 80-120% | --- | --- | |
| Methyl tert-butyl ether (MTBE) | 17.6 | --- | 1.00 | ug/L | 1 | 20.0 | --- | 88 | 80-120% | --- | --- | |
| Naphthalene | 16.3 | --- | 5.00 | ug/L | 1 | 20.0 | --- | 81 | 80-120% | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 105 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *98 %* | | *80-120 %* | | | *"* | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *94 %* | | *80-120 %* | | | *"* | | | | |
| **Duplicate (24B0707-DUP1)** | | | Prepared: 02/21/24 10:16 Analyzed: 02/21/24 16:37 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1323-01) | | | | | | | | | | | | |
| Benzene | ND | --- | 10.0 | ug/L | 50 | --- | ND | --- | --- | --- | 30% | |
| Toluene | ND | --- | 50.0 | ug/L | 50 | --- | ND | --- | --- | --- | 30% | |
| Ethylbenzene | ND | --- | 25.0 | ug/L | 50 | --- | ND | --- | --- | --- | 30% | |
| Xylenes, total | ND | --- | 75.0 | ug/L | 50 | --- | ND | --- | --- | --- | 30% | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 50.0 | ug/L | 50 | --- | ND | --- | --- | --- | 30% | |
| Naphthalene | ND | --- | 250 | ug/L | 50 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 108 %* | | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | |
| *Toluene-d8 (Surr)* | | | *101 %* | | *80-120 %* | | | *"* | | | | |

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ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## QUALITY CONTROL (QC) SAMPLE RESULTS

### Selected Volatile Organic Compounds by EPA 8260D

| Analyte | Result | Detection Limit | Reporting Limit | Units | Dilution | Spike Amount | Source Result | % REC | % REC Limits | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch 24B0707 - EPA 5030C** | | | | | | | | | | | | **Water** |
| **Duplicate (24B0707-DUP1)** | | | Prepared: 02/21/24 10:16 Analyzed: 02/21/24 16:37 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1323-01) | | | | | | | | | | | | |
| *Surr: 4-Bromofluorobenzene (Surr)* | | | *Recovery: 96 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| **Duplicate (24B0707-DUP2)** | | | Prepared: 02/21/24 10:16 Analyzed: 02/21/24 22:59 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1323-04) | | | | | | | | | | | | |
| Benzene | **120** | --- | 10.0 | ug/L | 50 | --- | 117 | --- | --- | 2 | 30% | |
| Toluene | **145** | --- | 50.0 | ug/L | 50 | --- | 142 | --- | --- | 2 | 30% | |
| Ethylbenzene | **76.0** | --- | 25.0 | ug/L | 50 | --- | 71.5 | --- | --- | 6 | 30% | |
| Xylenes, total | **380** | --- | 75.0 | ug/L | 50 | --- | 343 | --- | --- | 10 | 30% | |
| Methyl tert-butyl ether (MTBE) | ND | --- | 50.0 | ug/L | 50 | --- | ND | --- | --- | --- | 30% | |
| Naphthalene | ND | --- | 250 | ug/L | 50 | --- | ND | --- | --- | --- | 30% | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 105 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| *Toluene-d8 (Surr)* | | | *100 %* | *80-120 %* | | | *"* | | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *95 %* | *80-120 %* | | | *"* | | | | | |
| **Matrix Spike (24B0707-MS1)** | | | Prepared: 02/21/24 10:16 Analyzed: 02/21/24 15:16 | | | | | | | | | |
| QC Source Sample: Non-SDG (A4B1329-02) | | | | | | | | | | | | |
| EPA 8260D | | | | | | | | | | | | |
| Benzene | 22.1 | --- | 0.200 | ug/L | 1 | 20.0 | ND | 111 | 79-120% | --- | --- | |
| Toluene | 19.8 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 99 | 80-121% | --- | --- | |
| Ethylbenzene | 48.4 | --- | 0.500 | ug/L | 1 | 20.0 | 25.7 | 114 | 79-121% | --- | --- | |
| Xylenes, total | 64.8 | --- | 1.50 | ug/L | 1 | 60.0 | 2.31 | 104 | 79-121% | --- | --- | |
| Methyl tert-butyl ether (MTBE) | 18.4 | --- | 1.00 | ug/L | 1 | 20.0 | ND | 92 | 71-124% | --- | --- | |
| Naphthalene | 24.5 | --- | 5.00 | ug/L | 1 | 20.0 | 4.03 | 102 | 61-128% | --- | --- | |
| *Surr: 1,4-Difluorobenzene (Surr)* | | | *Recovery: 106 %* | *Limits: 80-120 %* | | | *Dilution: 1x* | | | | | |
| *Toluene-d8 (Surr)* | | | *97 %* | *80-120 %* | | | *"* | | | | | |
| *4-Bromofluorobenzene (Surr)* | | | *97 %* | *80-120 %* | | | *"* | | | | | |

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ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## SAMPLE PREPARATION INFORMATION

### Diesel and/or Oil Hydrocarbons by NWTPH-Dx

Prep: EPA 3510C (Fuels/Acid Ext.)

| Lab Number | Matrix | Method | Sampled | Prepared | Sample Initial/Final | Default Initial/Final | RL Prep Factor |
|---|---|---|---|---|---|---|---|
| Batch: 24B0725 | | | | | | | |
| A4B1224-01 | Water | NWTPH-Dx LL | 02/14/24 11:36 | 02/21/24 11:09 | 1000mL/2mL | 1000mL/2mL | 1.00 |
| A4B1224-02 | Water | NWTPH-Dx LL | 02/14/24 12:40 | 02/21/24 11:09 | 1000mL/2mL | 1000mL/2mL | 1.00 |
| A4B1224-03 | Water | NWTPH-Dx LL | 02/15/24 08:36 | 02/21/24 11:09 | 960mL/2mL | 1000mL/2mL | 1.04 |
| A4B1224-04 | Water | NWTPH-Dx LL | 02/14/24 13:46 | 02/21/24 11:09 | 960mL/2mL | 1000mL/2mL | 1.04 |
| A4B1224-05 | Water | NWTPH-Dx LL | 02/15/24 08:30 | 02/21/24 11:09 | 1030mL/2mL | 1000mL/2mL | 0.97 |
| A4B1224-06 | Water | NWTPH-Dx LL | 02/15/24 08:30 | 02/21/24 11:09 | 1020mL/2mL | 1000mL/2mL | 0.98 |
| A4B1224-07 | Water | NWTPH-Dx LL | 02/14/24 11:54 | 02/21/24 11:09 | 1020mL/2mL | 1000mL/2mL | 0.98 |
| A4B1224-08 | Water | NWTPH-Dx LL | 02/15/24 09:15 | 02/21/24 11:09 | 1020mL/2mL | 1000mL/2mL | 0.98 |
| A4B1224-09 | Water | NWTPH-Dx LL | 02/14/24 11:18 | 02/21/24 11:09 | 1040mL/2mL | 1000mL/2mL | 0.96 |
| A4B1224-10 | Water | NWTPH-Dx LL | 02/14/24 10:36 | 02/21/24 11:09 | 1040mL/2mL | 1000mL/2mL | 0.96 |
| A4B1224-11 | Water | NWTPH-Dx LL | 02/14/24 13:12 | 02/21/24 11:09 | 980mL/2mL | 1000mL/2mL | 1.02 |
| A4B1224-12 | Water | NWTPH-Dx LL | 02/15/24 10:03 | 02/21/24 11:09 | 1030mL/2mL | 1000mL/2mL | 0.97 |
| A4B1224-13 | Water | NWTPH-Dx LL | 02/14/24 12:38 | 02/21/24 11:09 | 1020mL/2mL | 1000mL/2mL | 0.98 |
| A4B1224-14 | Water | NWTPH-Dx LL | 02/14/24 10:39 | 02/21/24 11:09 | 1010mL/2mL | 1000mL/2mL | 0.99 |
| A4B1224-15 | Water | NWTPH-Dx LL | 02/15/24 10:57 | 02/21/24 11:09 | 950mL/2mL | 1000mL/2mL | 1.05 |
| A4B1224-19 | Water | NWTPH-Dx LL | 02/15/24 09:52 | 02/21/24 11:09 | 1010mL/2mL | 1000mL/2mL | 0.99 |
| A4B1224-20 | Water | NWTPH-Dx LL | 02/15/24 10:39 | 02/21/24 11:09 | 1010mL/2mL | 1000mL/2mL | 0.99 |

### Dissolved Diesel and/or Oil Hydrocarbons by NWTPH-Dx

Prep: EPA 3510C (Fuels/Acid Ext.)

| Lab Number | Matrix | Method | Sampled | Prepared | Sample Initial/Final | Default Initial/Final | RL Prep Factor |
|---|---|---|---|---|---|---|---|
| Batch: 24B0725 | | | | | | | |
| A4B1224-21 | Water | NWTPH-Dx (Diss) | 02/15/24 10:57 | 02/21/24 11:09 | 1030mL/2mL | 1000mL/2mL | 0.97 |
| A4B1224-22 | Water | NWTPH-Dx (Diss) | 02/15/24 10:57 | 02/21/24 11:09 | 1040mL/2mL | 1000mL/2mL | 0.96 |

### Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

Prep: EPA 5030C

| Lab Number | Matrix | Method | Sampled | Prepared | Sample Initial/Final | Default Initial/Final | RL Prep Factor |
|---|---|---|---|---|---|---|---|
| Batch: 24B0607 | | | | | | | |
| A4B1224-01RE1 | Water | NWTPH-Gx (MS) | 02/14/24 11:36 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-02RE1 | Water | NWTPH-Gx (MS) | 02/14/24 12:40 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-03RE1 | Water | NWTPH-Gx (MS) | 02/15/24 08:36 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-04RE1 | Water | NWTPH-Gx (MS) | 02/14/24 13:46 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-17RE1 | Water | NWTPH-Gx (MS) | 02/15/24 10:57 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |

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ANALYTICAL REPORT

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|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## SAMPLE PREPARATION INFORMATION

### Gasoline Range Hydrocarbons (Benzene through Naphthalene) by NWTPH-Gx

Prep: EPA 5030C

| Lab Number | Matrix | Method | Sampled | Prepared | Sample Initial/Final | Default Initial/Final | RL Prep Factor |
|---|---|---|---|---|---|---|---|
| A4B1224-19 | Water | NWTPH-Gx (MS) | 02/15/24 09:52 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-20 | Water | NWTPH-Gx (MS) | 02/15/24 10:39 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| Batch: 24B0665 | | | | | | | |
| A4B1224-05 | Water | NWTPH-Gx (MS) | 02/15/24 08:30 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-06 | Water | NWTPH-Gx (MS) | 02/15/24 08:30 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-07 | Water | NWTPH-Gx (MS) | 02/14/24 11:54 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-08 | Water | NWTPH-Gx (MS) | 02/15/24 09:15 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-09 | Water | NWTPH-Gx (MS) | 02/14/24 11:18 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-10 | Water | NWTPH-Gx (MS) | 02/14/24 10:36 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-11 | Water | NWTPH-Gx (MS) | 02/14/24 13:12 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-12 | Water | NWTPH-Gx (MS) | 02/15/24 10:03 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-13 | Water | NWTPH-Gx (MS) | 02/14/24 12:38 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-14 | Water | NWTPH-Gx (MS) | 02/14/24 10:39 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| Batch: 24B0707 | | | | | | | |
| A4B1224-15RE1 | Water | NWTPH-Gx (MS) | 02/15/24 10:57 | 02/21/24 10:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-18RE1 | Water | NWTPH-Gx (MS) | 02/15/24 10:57 | 02/21/24 10:16 | 5mL/5mL | 5mL/5mL | 1.00 |

### Selected Volatile Organic Compounds by EPA 8260D

Prep: EPA 5030C

| Lab Number | Matrix | Method | Sampled | Prepared | Sample Initial/Final | Default Initial/Final | RL Prep Factor |
|---|---|---|---|---|---|---|---|
| Batch: 24B0607 | | | | | | | |
| A4B1224-01RE1 | Water | EPA 8260D | 02/14/24 11:36 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-02RE1 | Water | EPA 8260D | 02/14/24 12:40 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-03RE1 | Water | EPA 8260D | 02/15/24 08:36 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-04RE1 | Water | EPA 8260D | 02/14/24 13:46 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-19 | Water | EPA 8260D | 02/15/24 09:52 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-20 | Water | EPA 8260D | 02/15/24 10:39 | 02/20/24 16:20 | 5mL/5mL | 5mL/5mL | 1.00 |
| Batch: 24B0610 | | | | | | | |
| A4B1224-17 | Water | EPA 8260D | 02/15/24 10:57 | 02/19/24 08:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| Batch: 24B0665 | | | | | | | |
| A4B1224-05 | Water | EPA 8260D | 02/15/24 08:30 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-06 | Water | EPA 8260D | 02/15/24 08:30 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-07 | Water | EPA 8260D | 02/14/24 11:54 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-08 | Water | EPA 8260D | 02/15/24 09:15 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-09 | Water | EPA 8260D | 02/14/24 11:18 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |

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Darrell Auvil, Client Services Manager

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6700 S.W. Sandburg Street
Tigard, OR 97223
503-718-2323
ORELAP ID: OR100062

ANALYTICAL REPORT

| | | |
|---|---|---|
| GeoEngineers - Portland | Project: Nustar Vannex GWM 1Q24 | |
| 5820 S Kelly Ave Unit B | Project Number: 19001-008 | Report ID: |
| Portland, OR 97239 | Project Manager: Philip Cordell | A4B1224 - 03 04 24 1625 |

## SAMPLE PREPARATION INFORMATION

### Selected Volatile Organic Compounds by EPA 8260D

Prep: EPA 5030C

| Lab Number | Matrix | Method | Sampled | Prepared | Sample Initial/Final | Default Initial/Final | RL Prep Factor |
|---|---|---|---|---|---|---|---|
| A4B1224-10 | Water | EPA 8260D | 02/14/24 10:36 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-11 | Water | EPA 8260D | 02/14/24 13:12 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-12 | Water | EPA 8260D | 02/15/24 10:03 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-13 | Water | EPA 8260D | 02/14/24 12:38 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-14 | Water | EPA 8260D | 02/14/24 10:39 | 02/20/24 09:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| Batch: 24B0707 | | | | | | | |
| A4B1224-07RE1 | Water | EPA 8260D | 02/14/24 11:54 | 02/21/24 10:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-15RE1 | Water | EPA 8260D | 02/15/24 10:57 | 02/21/24 10:16 | 5mL/5mL | 5mL/5mL | 1.00 |
| A4B1224-18RE1 | Water | EPA 8260D | 02/15/24 10:57 | 02/21/24 10:16 | 5mL/5mL | 5mL/5mL | 1.00 |

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**503-718-2323**
ORELAP ID: **OR100062**

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## QUALIFIER DEFINITIONS

### Client Sample and Quality Control (QC) Sample Qualifier Definitions:

**Apex Laboratories**

| | |
|---|---|
| **DCNT** | Sample decanted due to the presence of sediment. Sample bottle not rinsed with solvent. |
| **F-11** | The hydrocarbon pattern indicates possible weathered diesel, mineral oil, or a contribution from a related component. |
| **F-18** | Result for Diesel (Diesel Range Organics, C12-C25) is due to overlap from Gasoline or a Gasoline Range product. |
| **F-20** | Result for Diesel is Estimated due to overlap from Gasoline Range Organics or other VOCs. |
| **FILT3** | This is a laboratory filtration blank, associated with filtration batch 24B0640. See Prep page of report for associated samples. |
| **NR** | Not Reported. |
| **PRO** | Sample has undergone sample processing prior to extraction and analysis. |
| **Q-01** | Spike recovery and/or RPD is outside acceptance limits. |
| **Q-19** | Blank Spike Duplicate (BSD) sample analyzed in place of Matrix Spike/Duplicate samples due to limited sample amount available for analysis. |
| **R-04** | Reporting levels elevated due to preparation and/or analytical dilution necessary for analysis. |
| **S-06** | Surrogate recovery is outside of established control limits. |
| **T-02** | This Batch QC sample was analyzed outside of the method specified 12 hour analysis window. Results are estimated. |

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**ANALYTICAL REPORT**

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## REPORTING NOTES AND CONVENTIONS:

**Abbreviations:**

DET Analyte DETECTED at or above the detection or reporting limit.

ND Analyte NOT DETECTED at or above the detection or reporting limit.

NR Result Not Reported

RPD Relative Percent Difference. RPDs for Matrix Spikes and Matrix Spike Duplicates are based on concentration, not recovery.

**Detection Limits: Limit of Detection (LOD)**

Limits of Detection (LODs) are normally set at a level of one half the validated Limit of Quantitation (LOQ).
If no value is listed ('-----'), then the data has not been evaluated below the Reporting Limit.

**Reporting Limits: Limit of Quantitation (LOQ)**

Validated Limits of Quantitation (LOQs) are reported as the Reporting Limits for all analyses where the LOQ, MRL, PQL or CRL are requested. The LOQ represents a level at or above the low point of the calibration curve, that has been validated according to Apex Laboratories' comprehensive LOQ policies and procedures.

**Reporting Conventions:**

Basis: Results for soil samples are generally reported on a 100% dry weight basis.
The Result Basis is listed following the units as " dry", " wet", or " " (blank) designation.

" dry" Sample results and Reporting Limits are reported on a dry weight basis. (i.e. "ug/kg dry")
See Percent Solids section for details of dry weight analysis.

" wet" Sample results and Reporting Limits for this analysis are normally dry weight corrected, but have not been modified in this case.

" " Results without 'wet' or 'dry' designation are not normally dry weight corrected. These results are considered 'As Received'.

Results for Volatiles analyses on soils and sediments that are reported on a “dry weight” basis include the water miscible solvent (WMS) correction referenced in the EPA 8000 Method guidance documents. Solid and Liquid samples reported on an “As Received” basis do not have the WMS correction applied, as dry weight was not performed.

**QC Source:**

In cases where there is insufficient sample provided for Sample Duplicates and/or Matrix Spikes, a Lab Control Sample Duplicate (LCS Dup) may be analyzed to demonstrate accuracy and precision of the extraction batch.

Non-Client Batch QC Samples (Duplicates and Matrix Spike/Duplicates) may not be included in this report. Please request a Full QC report if this data is required.

**Miscellaneous Notes:**

" --- " QC results are not applicable. For example, % Recoveries for Blanks and Duplicates, % RPD for Blanks, Blank Spikes and Matrix Spikes, etc.

" *** " Used to indicate a possible discrepancy with the Sample and Sample Duplicate results when the %RPD is not available. In this case, either the Sample or the Sample Duplicate has a reportable result for this analyte, while the other is Non Detect (ND).

Apex Laboratories

Darrell Auvil, Client Services Manager

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| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## REPORTING NOTES AND CONVENTIONS (Cont.):

**Blanks:**

Standard practice is to evaluate the results from Blank QC Samples down to a level equal to ½ the Reporting Limit (RL).

-For Blank hits falling between ½ the RL and the RL (J flagged hits), the associated sample and QC data will receive a 'B-02' qualifier.

-For Blank hits above the RL, the associated sample and QC data will receive a 'B' qualifier, per Apex Laboratories' Blank Policy.
For further details, please request a copy of this document.

-Sample results flagged with a 'B' or 'B-02' qualifier are potentially biased high if the sample results are less than ten times the level found in the blank for inorganic analyses, or less than five times the level found in the blank for organic analyses.

'B' and 'B-02' qualifications are only applied to sample results detected above the Reporting Level, if results are not reported to the MDL.

**Preparation Notes:**

Mixed Matrix Samples:

Water Samples:

Water samples containing significant amounts of sediment are decanted or separated prior to extraction, and only the water portion analyzed, unless otherwise directed by the client.

Soil and Sediment Samples:

Soil and Sediment samples containing significant amounts of water are decanted prior to extraction, and only the solid portion analyzed, unless otherwise directed by the client.

**Sampling and Preservation Notes:**

Certain regulatory programs, such as National Pollutant Discharge Elimination System (NPDES), require that activities such as sample filtration (for dissolved metals, orthophosphate, hexavalent chromium, etc.) and testing of short hold analytes (pH, Dissolved Oxygen, etc.) be performed in the field (on-site) within a short time window. In addition, sample matrix spikes are required for some analyses, and sufficient volume must be provided, and billable site specific QC requested, if this is required. All regulatory permits should be reviewed to ensure that these requirements are being met.

Data users should be aware of which regulations pertain to the samples they submit for testing. If related sample collection activities are not approved for a particular regulatory program, results should be considered estimates. Apex Laboratories will qualify these analytes according to the most stringent requirements, however results for samples that are for non-regulatory purposes may be acceptable.

Samples that have been filtered and preserved at Apex Laboratories per client request are listed in the preparation section of the report with the date and time of filtration listed.

Apex Laboratories maintains detailed records on sample receipt, including client label verification, cooler temperature, sample preservation, hold time compliance and field filtration. Data is qualified as necessary, and the lack of qualification indicates compliance with required parameters.



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| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## LABORATORY ACCREDITATION INFORMATION

**ORELAP Certification ID: OR100062 (Primary Accreditation) - EPA ID: OR01039**

All methods and analytes reported from work performed at Apex Laboratories are included on Apex Laboratories' ORELAP Scope of Certification, with the exception of any analyte(s) listed below:

### Apex Laboratories

| Matrix | Analysis | TNI_ID | Analyte | TNI_ID | Accreditation |
|---|---|---|---|---|---|

All reported analytes are included in Apex Laboratories' current ORELAP scope.

### Secondary Accreditations

Apex Laboratories also maintains reciprocal accreditation with non-TNI states (Washington DOE), as well as other state specific accreditations not listed here.

### Subcontract Laboratory Accreditations

Subcontracted data falls outside of Apex Laboratories' Scope of Accreditation.
Please see the Subcontract Laboratory report for full details, or contact your Project Manager for more information.

### Field Testing Parameters

Results for Field Tested data are provded by the client or sampler, and fall outside of Apex Laboratories' Scope of Accreditation.

Apex Laboratories

Darrell Auvil, Client Services Manager

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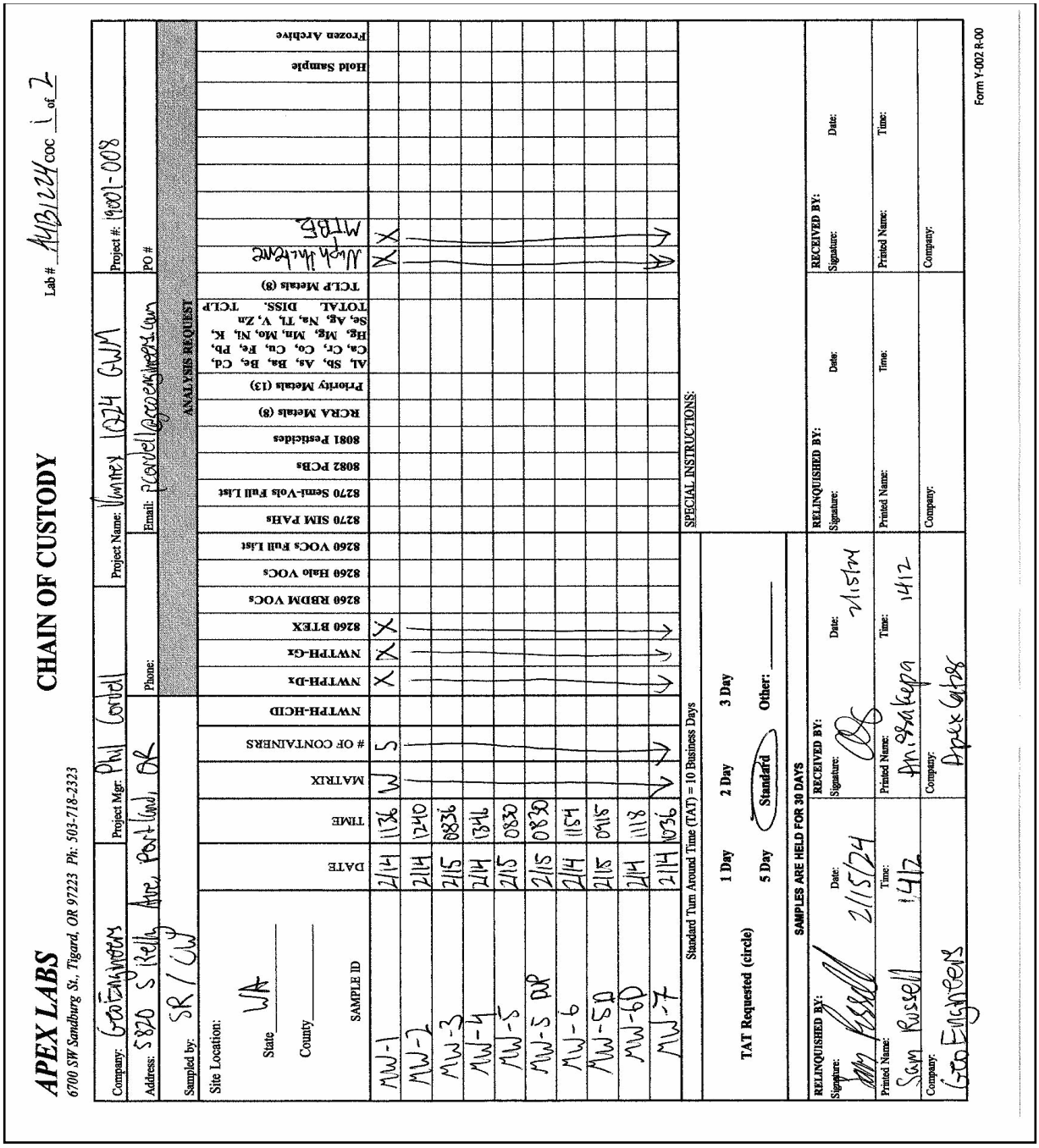
ORELAP ID: **OR100062**

# ANALYTICAL REPORT

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |



APEX LABS
6700 SW Sandburg St., Tigard, OR 97223 Ph: 503-718-2323

CHAIN OF CUSTODY

Lab # A4B1224 COC 1 of 2

Company: GeoEngineers | Project Mgr: Phil Cordell | Project Name: Vannex 1Q24 GWM | Project #: 19001-008
Address: 5820 S Kelly Ave Portland OR | Phone: | Email: pcordell@geoengineers.com | PO #
Sampled by: SR / CW

Site Location: State WA County

ANALYSIS REQUEST

| SAMPLE ID | DATE | TIME | MATRIX | # OF CONTAINERS | NWTPH-HCID | NWTPH-Dx | NWTPH-Gx | 8260 BTEX | 8260 RBDM VOCs | 8260 Halo VOCs | 8260 VOCs Full List | 8270 SIM PAHs | 8270 Semi-Vols Full List | 8082 PCBs | 8081 Pesticides | RCRA Metals (8) | Priority Metals (13) | Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Hg, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Tl, V, Zn | TOTAL DISS. TCLP | TCLP Metals (8) | Mtbe | Hold Sample | Frozen Archive |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-1 | 2/14 | 1136 | W | 5 | | X | X | X | | | | | | | | | | | | | X | |
| MW-2 | 2/14 | 1240 | | | | | | | | | | | | | | | | | | | | |
| MW-3 | 2/15 | 0836 | | | | | | | | | | | | | | | | | | | | |
| MW-4 | 2/14 | 1346 | | | | | | | | | | | | | | | | | | | | |
| MW-5 | 2/15 | 0830 | | | | | | | | | | | | | | | | | | | | |
| MW-5 DUP | 2/15 | 0830 | | | | | | | | | | | | | | | | | | | | |
| MW-6 | 2/14 | 1154 | | | | | | | | | | | | | | | | | | | | |
| MW-5D | 2/15 | 0915 | | | | | | | | | | | | | | | | | | | | |
| MW-6D | 2/14 | 1118 | | | | | | | | | | | | | | | | | | | | |
| MW-7 | 2/14 | 1036 | W | 5 | | X | X | X | | | | | | | | | | | | | X | |

Standard Turn Around Time (TAT) = 10 Business Days

TAT Requested (circle): 1 Day 2 Day 3 Day 5 Day Standard Other: _____

SPECIAL INSTRUCTIONS:

SAMPLES ARE HELD FOR 30 DAYS

RELINQUISHED BY: Signature: Printed Name: Sam Russell Company: GeoEngineers Date: 2/15/24 Time: 1412

RECEIVED BY: Signature: Printed Name: Ann Sharkey Company: Apex Labs Date: 2/15/24 Time: 1412

RELINQUISHED BY: Signature: Printed Name: Company: Date: Time:

RECEIVED BY: Signature: Printed Name: Company: Date: Time:

RELINQUISHED BY: Signature: Printed Name: Company: Date: Time:

RECEIVED BY: Signature: Printed Name: Company: Date: Time:

Form Y-002 R-00

Apex Laboratories

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Tigard, OR 97223
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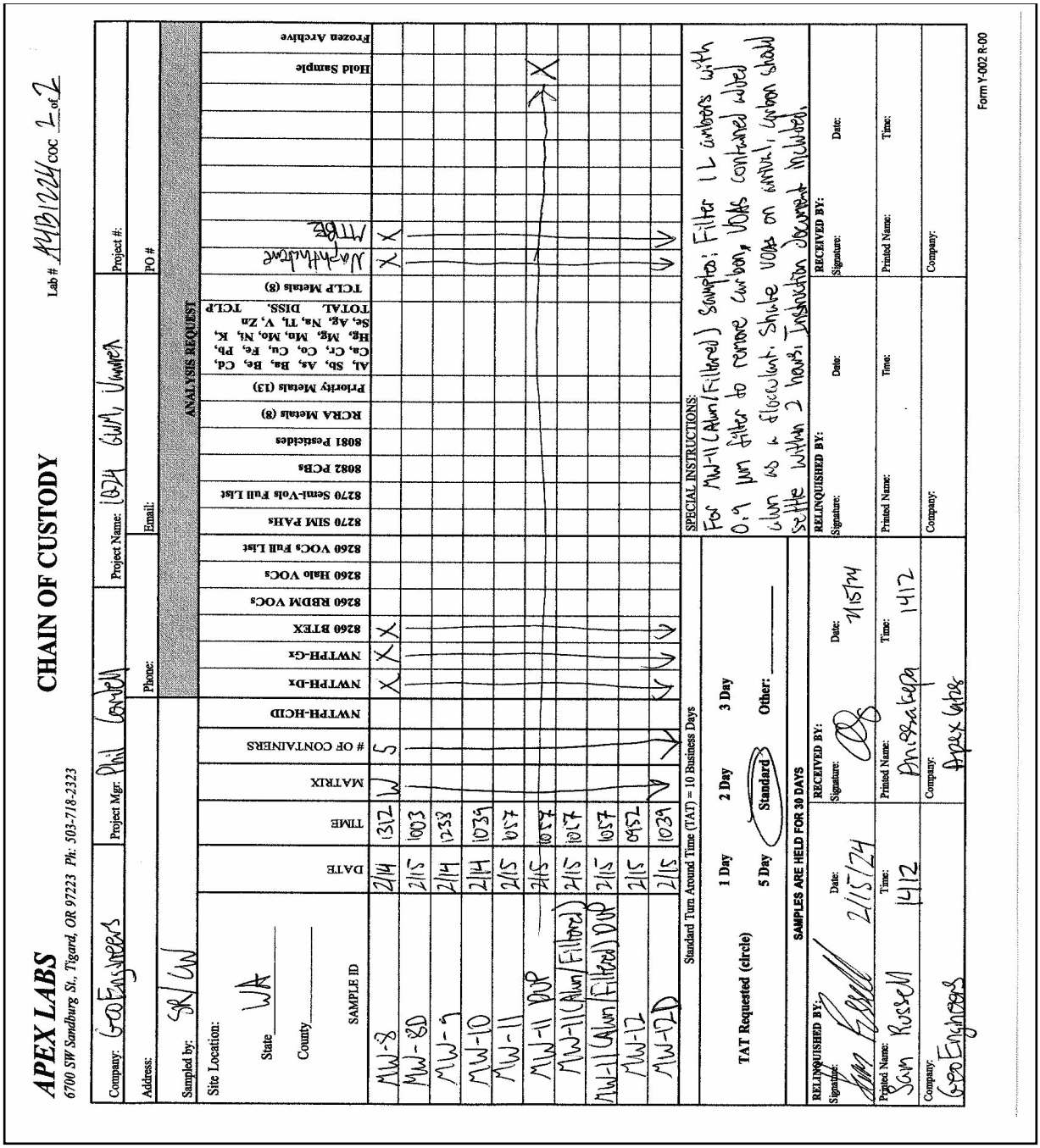
ORELAP ID: **OR100062**

# ANALYTICAL REPORT

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |



APEX LABS
6700 SW Sandburg St., Tigard, OR 97223 Ph: 503-718-2323

CHAIN OF CUSTODY

Lab # A4B1224 COC 1 of 2

Company: GeoEngineers | Project Mgr: Phil Cordell | Project Name: 1Q24 GWM Summer | Project #:
Address: | Phone: | Email: | PO #
Sampled by: SR/LW
Site Location: State WA County

ANALYSIS REQUEST

| SAMPLE ID | DATE | TIME | MATRIX | # OF CONTAINERS | NWTPH-HCID | NWTPH-Dx | NWTPH-Gx | 8260 BTEX | 8260 RBDM VOCs | 8260 Halo VOCs | 8260 VOCs Full List | 8270 SIM PAHs | 8270 Semi-Vols Full List | 8082 PCBs | 8081 Pesticides | RCRA Metals (8) | Priority Metals (13) | Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Hg, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Tl, V, Zn TOTAL DISS. TCLP | TCLP Metals (8) | Manganese | MTBE | Hold Sample | Frozen Archive |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-8 | 2/14 | 1312 | W | 5 | | X | X | | | | | | | | | | | | | X | | | |
| MW-8D | 2/15 | 1003 | | | | | | | | | | | | | | | | | | | | | |
| MW-9 | 2/14 | 1238 | | | | | | | | | | | | | | | | | | | | | |
| MW-10 | 2/14 | 1039 | | | | | | | | | | | | | | | | | | | | | |
| MW-11 | 2/15 | 0857 | | | | | | | | | | | | | | | | | | | | | |
| MW-11 DUP | 2/15 | 0857 | | | | | | | | | | | | | | | | | | | | X | |
| MW-11 (Alum Filtered) | 2/15 | 0857 | | | | | | | | | | | | | | | | | | | | | |
| MW-11 (Alum Filtered) DUP | 2/15 | 0857 | | | | | | | | | | | | | | | | | | | | | |
| MW-12 | 2/15 | 0952 | | | | | | | | | | | | | | | | | | | | | |
| MW-12D | 2/15 | 1039 | V | V | | V | V | | | | | | | | | | | | | V | | | |

Standard Turn Around Time (TAT) = 10 Business Days

TAT Requested (circle): 1 Day | 2 Day | 3 Day | 5 Day | Standard | Other: _____

SPECIAL INSTRUCTIONS:
For MW-11 (Alum/Filtered) Samples: Filter 1 L amber with 0.9 µm filter to remove carbon, VOAs contained vials with no headspace. Shake VOAs on arrival, carbon should settle within 2 hours. Instruction document included.

SAMPLES ARE HELD FOR 30 DAYS

RELINQUISHED BY: Signature: Date: 2/15/24 Printed Name: Sam Russell Time: 1412 Company: GeoEngineers
RECEIVED BY: Signature: Date: 2/15/24 Printed Name: Brandon Kepa Time: 1412 Company: Apex Labs
RELINQUISHED BY: Signature: Date: Printed Name: Time: Company:
RECEIVED BY: Signature: Date: Printed Name: Time: Company:
RELINQUISHED BY: Signature: Date: Printed Name: Time: Company:
RECEIVED BY: Signature: Date: Printed Name: Time: Company:

Form Y-002 R-00

Apex Laboratories

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ORELAP ID: **OR100062**

**ANALYTICAL REPORT**

| | | |
|---|---|---|
| **GeoEngineers - Portland** | Project: **Nustar Vannex GWM 1Q24** | |
| **5820 S Kelly Ave Unit B** | Project Number: **19001-008** | **Report ID:** |
| **Portland, OR 97239** | Project Manager: **Philip Cordell** | **A4B1224 - 03 04 24 1625** |

## APEX LABS COOLER RECEIPT FORM

**Client:** GeoEngineers Element WO#: A4 B1224

**Project/Project #:** Vannex 1Q24 GWM #19001-008

**Delivery Info:**

Date/time received: 2/15/24 @ 1412 By: AKK

Delivered by: Apex__Client X ESS__FedEx__UPS__Radio__Morgan__SDS__Evergreen__Other__

**Cooler Inspection** Date/time inspected: 2/15/24 @ 1412 By: AKK

Chain of Custody included? Yes X No ____

Signed/dated by client? Yes X No ____

| | Cooler #1 | Cooler #2 | Cooler #3 | Cooler #4 | Cooler #5 | Cooler #6 | Cooler #7 |
|---|---|---|---|---|---|---|---|
| Temperature (°C) | 5.9 | 1.8 | 3.9 | | | | |
| Custody seals? (Y/N) | N | N | N | | | | |
| Received on ice? (Y/N) | Y | Y | Y | | | | |
| Temp. blanks? (Y/N) | Y | Y | Y | | | | |
| Ice type: (Gel/Real/Other) | Real | Real | Real | | | | |
| Condition (In/Out): | In | In | In | | | | |

Cooler out of temp? (Y/(N)) Possible reason why: ____

Green dots applied to out of temperature samples? Yes/(No)

Out of temperature samples form initiated? Yes/(No)

**Sample Inspection:** Date/time inspected: 2/16/24 @ 1102 By: JS

All samples intact? Yes X No ___ Comments: ____

Bottle labels/COCs agree? Yes X No ___ Comments: ____

COC/container discrepancies form initiated? Yes ___ No X

Containers/volumes received appropriate for analysis? Yes X No ___ Comments: ____

Do VOA vials have visible headspace? Yes ___ No X NA ___

Comments ____

Water samples: pH checked: Yes X No___NA___ pH appropriate? Yes X No___NA___ pH ID: A23H12

Comments: ____

Additional information: ____

Labeled by: ____ Witness: APW Cooler Inspected by: ____

Form Y-003 R-01

Apex Laboratories

*The results in this report apply to the samples analyzed in accordance with the chain of custody document(s) and updated by any subsequent written communications. This analytical report must be reproduced in its entirety.*

Darrell Auvil, Client Services Manager

# APPENDIX F
## Groundwater Monitoring Standard Operating Procedures

# FIELD NOTES AND DOCUMENTATION

## 1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes the methods for documenting environmental field activities. The purpose of establishing SOPs for field notes and documentation is to establish a consistent method and format for the use and control of documentation generated during daily field activities. Field notes and records are intended to provide sufficient information that can be used to recreate the field activities, as well as, the collection of environmental data. Information placed in these documents and/or records shall be factual, detailed and objective.

## 2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Bound field books;
- Black waterproof and/or indelible ink pens; and
- Field forms.

## 3. METHODOLOGY

This SOP primarily includes the documentation procedures for the field logbooks. However, procedures discussed in this SOP are applicable to all other types of field documentation collected, and should be universal in application. Details of other field records and forms (e.g. boring logs, sample labels, chain of custody records, and waste containment labels are discussed in the specific SOP associated with that field activity (e.g. borehole drilling, sample handling, investigative derived waste), and not covered in detail in this SOP.

**Field Logbooks:**

Field personnel will keep accurate written records of their daily activities in a bound logbook that will be sufficient to recreate the project field activities without reliance on memory. This information will be recorded in chronological order. All entries will be legible, written in black waterproof or indelible ink, and contain accurate and inclusive documentation of field activities, including field data observations, deviations from project plans, problems encountered, and actions taken to solve the problem. Each page of the field logbook will be consecutively numbered, signed and dated by the field author(s). Pages should not be removed for any reason.

There should be no blank lines on a page. A single blank line or a partial blank line (such as at the end of a paragraph) should be lined to the end of the page. If only part of a page is used, the remainder of the page should have an "X" drawn across it.

In addition to documenting field activities, field logbooks will include the following:

- Date and time of activities,
- Site location,
- Purpose of site visit,
- Site and weather conditions,

- Personnel present, including sampling crew, facility/site personnel and representatives (including site arrival and departure times),
- Subcontractors present,
- Regulatory agencies and their representatives (including phone numbers, site arrival and departure times),
- Level of health and safety protection,
- Sampling methodology and information,
- Sample locations (sketches are helpful),
- Source of sample(s), sample identifications, sample container types and preservatives used, and lot numbers for bottles and preservatives (if applicable and if not recorded on other forms or in a sample control logbook),
- A chronological description of the field observations and events,
- Specific considerations associated with sample acquisition (e.g., field parameter measurements, field screening data, HASP monitoring data, etc.) (if not recorded on another form),
- Wastes generated, containment units (including volumes, matrix, etc), and storage location (if not recorded on another form),
- Field quality assurance/quality control samples collection, preparation, and origin (if not recorded on other forms or in a sample control logbook),
- The manufacturer, model and serial number of field instruments (e.g., PID, water quality, etc.) shall be recorded, if not using a calibration form. Also, source lot # and expiration date of standard shall be recorded if calibrated in the field.
- Well construction materials, water source(s), and other materials used on-site (if not recorded on another form).
- Sample conditions that could potentially affect the sample results,
- If deviating from plan, clearly state the reason(s) for deviation,
- Persons contacted and topics discussed,
- Documentation of exclusion zone set-up and location,
- Documentation of decontamination procedures, and
- Daily Summary.

Field situations vary widely. No general rules can specify the extent of information that must be entered in a logbook. However, records should contain sufficient information so that someone can reconstruct the field activity without relying on the collector's memory. Language used shall be objective, factual, and free of personal opinions. Hypothesis for observed phenomena may be

recorded, however, they must be clearly indicated as such and only relate to the subject observation.

Logbooks will be assigned to a specific sampling team. If it is necessary to transfer the log book to alternative team member during field work, the person relinquishing the log book will sign and date the log book at the time of transfer.

Field logbooks should consist of a bound book, in which the insertion or removal of pages will be visibly noticeable after the logbook has been assembled. Logbooks can be prepared by gluing or laminating pages together either at the left side or top of the page. If inclement weather is expected, logbooks may have plastic laminated front and back covers to protect the interior pages, and should not be broken apart for coping. Loose-leaf binding, such as comb binding is not considered hard binding. To maintain the integrity of the logbook, pages should be consecutively numbered prior to use. Logbook pages can be of any format, and may include blank pages for recording or field forms that are used for specific tasks. As an alternative, commercially bound and consecutive page numbered field logbooks may also be used.

**Additional Field Forms/Records:**

Additional field records may be required for each specific field event. The use of these records and examples are described in other SOPs specific for the activity (e.g. Borehole Logging SOP, Groundwater Sampling and Purging SOP, etc.). These other records may include:

- Borehole Logs during drilling,
- Well Construction and Development records,
- Groundwater Purge and Sample Collection Records,
- Water Level Monitoring,
- Investigation Derived Waste (IDW) Tracking Records,
- Instrument Calibration Records, and
- Health and Safety Monitoring Records and sign-off sheets.

Prior to field activities, the field sampling personnel will coordinate with the Project Manager, or designee, to determine which additional records will be required for the specific field task. These additional records will be maintained in a field file or a three-ring notebook throughout the duration of the field activities, or included in a specially prepared site-specific notebook. If the field notebook is being created, the forms may be part of the laminated book.

**Corrections:**

If an error is made in the field, logbook corrections will be made by drawing a single line through the error, entering the correct information, and initialing and dating the change. Materials that obliterate the original information, such as correction fluids and/or mark-out tapes, are prohibited. All corrections will be initialed and dated. Some projects require that a brief reason for the change must also be added where the correction was made. Ask the Project Manager, if this requirement is necessary.

**Documentation Reviews:**

Periodically, the Project Manager, or designee, will review the field logbooks pertaining to the activities under their supervision. The elements of this review will include technical content, consistency, and compliance with the project plans and SOPs. Discrepancies and errors identified during the review should be resolved between reviewer and author of the field documentation. Corrections and/or additions of information shall be initialed and dated by the field author or reviewer.

# Low Flow Groundwater Sampling

## 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.

# APPENDIX G
## Ecology Approval of Colloidal Activated Carbon Flocculation Method, Method Validation, and SOP

## Sam J. Russell

**From:** Smith, Andrew (ECY) <ansm461@ECY.WA.GOV>
**Sent:** Tuesday, January 16, 2024 3:38 PM
**To:** Sam J. Russell; Amanda Spencer
**Cc:** Robinson, Renee; Philip Cordell
**Subject:** RE: NuStar Vannex terminal - Petrofix monitoring



Thanks Everyone.

---

**From:** Sam J. Russell <srussell@geoengineers.com>
**Sent:** Tuesday, January 16, 2024 2:34 PM
**To:** Amanda Spencer <aspencer@geoengineers.com>; Smith, Andrew (ECY) <ansm461@ECY.WA.GOV>
**Cc:** Robinson, Renee <Renee.Robinson@nustarenergy.com>; Philip Cordell <pcordell@geoengineers.com>
**Subject:** RE: NuStar Vannex terminal - Petrofix monitoring

Hi Andy,

Yes, the alum will already be in the VOAs before the sampling occurs. As you alluded to, we're doing this to prevent any changes to the normal VOC sampling process that may allow volatiles to escape. Aside from the VOAs containing alum (added prior to sampling), the sampling and lab analysis will be performed as usual.

Thanks,
Sam

**Samuel J. Russell**
**Staff Environmental Engineer 1 | GeoEngineers, Inc.**
**Telephone:** 503.603.6689
**Mobile:** 503.891.3055

---

**From:** Amanda Spencer <aspencer@geoengineers.com>
**Sent:** Tuesday, January 16, 2024 2:23 PM
**To:** Smith, Andrew (ECY) <ansm461@ecy.wa.gov>
**Cc:** Robinson, Renee <Renee.Robinson@nustarenergy.com>; Philip Cordell <pcordell@geoengineers.com>; Sam J. Russell <srussell@geoengineers.com>
**Subject:** RE: NuStar Vannex terminal - Petrofix monitoring

I believe it is already in the sample container, so added in before the sample is collected.

Sam – can you confirm?

.

**Amanda Spencer, R.G., P.E.**
**Senior Principal Hydrogeologist | GeoEngineers, Inc.**

**Mobile:** 503.577.1535
**Email:** aspencer@geoengineers.com

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Portland, OR 97239
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**From:** Smith, Andrew (ECY) <ansm461@ECY.WA.GOV>
**Sent:** Tuesday, January 16, 2024 12:57 PM
**To:** Amanda Spencer <aspencer@geoengineers.com>
**Cc:** Robinson, Renee <Renee.Robinson@nustarenergy.com>; Philip Cordell <pcordell@geoengineers.com>; Sam J. Russell <srussell@geoengineers.com>
**Subject:** RE: NuStar Vannex terminal - Petrofix monitoring



Amanda,
Will it be added before sample is collected since you are collecting volatiles?
Thanks
Andy

**From:** Amanda Spencer <aspencer@geoengineers.com>
**Sent:** Tuesday, January 16, 2024 11:49 AM
**To:** Smith, Andrew (ECY) <ansm461@ECY.WA.GOV>
**Cc:** Robinson, Renee <Renee.Robinson@nustarenergy.com>; Philip Cordell <pcordell@geoengineers.com>; Sam J. Russell <srussell@geoengineers.com>; Amanda Spencer <aspencer@geoengineers.com>
**Subject:** RE: NuStar Vannex terminal - Petrofix monitoring

Hi Andy – we just noticed that you mentioned the use of Alum in the well; I wanted to clarify that the alum is actually added to the samples collected from well MW-11 not to the well itself. We are hoping to avoid having to add anything into the well itself.

Feel free to give me a call if you have any questions or concerns.

Thank you!
Amanda

**Amanda Spencer, R.G., P.E.**
**Senior Principal Hydrogeologist | GeoEngineers, Inc.**
**Mobile:** 503.577.1535
**Email:** aspencer@geoengineers.com

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**From:** Smith, Andrew (ECY) <ansm461@ECY.WA.GOV>
**Sent:** Tuesday, January 16, 2024 10:33 AM
**To:** Amanda Spencer <aspencer@geoengineers.com>
**Cc:** Robinson, Renee <Renee.Robinson@nustarenergy.com>; Philip Cordell <pcordell@geoengineers.com>; Sam J. Russell <srussell@geoengineers.com>
**Subject:** RE: NuStar Vannex terminal - Petrofix monitoring



Amanda,
Ecology approves the use of aluminum sulfate (Alum) in monitoring well MW-11 to help flocculate the colloidal activated carbon in the well. How many times do you think you will need to add the Alum to the well? Please let me know the affects after initial application.
Thanks
Andy

Andrew Smith, PE, LHG
Unit Supervisor UST/Technical Support Unit
Department of Ecology
Toxics Cleanup Program
360-485-3987

**From:** Amanda Spencer <aspencer@geoengineers.com>
**Sent:** Tuesday, January 9, 2024 3:39 PM
**To:** Smith, Andrew (ECY) <ansm461@ECY.WA.GOV>
**Cc:** Robinson, Renee <Renee.Robinson@nustarenergy.com>; Philip Cordell <pcordell@geoengineers.com>; Sam J. Russell <srussell@geoengineers.com>; Amanda Spencer <aspencer@geoengineers.com>
**Subject:** NuStar Vannex terminal - Petrofix monitoring

Hi Andy – I wanted for follow-up on some of our Vannex discussions we had in December. As mentioned, we were not able to sample well MW-11 during the last quarterly monitoring event because the Petrofix material had entered into the well. Which is a good thing, since it demonstrates that we were achieving our desired radius of influence. However, it make collecting a representative sample more challenging. As I mentioned, it could take several months for the Petrofix to settle out in the well.

Sam Russell, our engineer who lead the Petrofix effort, did some research and worked with Regenesis (makers of Petrofix) to identify the best option to be able to collect a sample from the well in the interim so we can start tracking the concentration trends in the well post injections. He identified the addition of alum to the samples as the best option. The alum makes the carbon from the Petrofix settle out without influencing the concentration of dissolved phase hydrocarbons in the sample, allowing for a result representative of the concentrations in the adjacent water bearing unit. The information on this approach is attached. We were hoping to go out in the next couple of weeks to sample well MW-11 using this approach – is this acceptable to you?

If you'd like to discuss it in more detail with Sam and I, let me know and I can set up a call time.

Thank you,
Amanda

.

**Amanda Spencer, R.G., P.E.**
**Senior Principal Hydrogeologist | GeoEngineers, Inc.**
**Mobile:** 503.577.1535
**Email:** aspencer@geoengineers.com

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REGENESIS®

# Colloidal Activated Carbon Flocculation Method Validation

PetroFIX® Remediation Fluid

PLUME STOP® Liquid Activated Carbon

# Description and Contaminant Analytical Impacts

## Test Vial Settling Agent

**Figure 1 –** Two vials containing 2,000 mg/L of CAC. The recommended dose of settling agent was also added to the vial on the right, resulting in clear water.

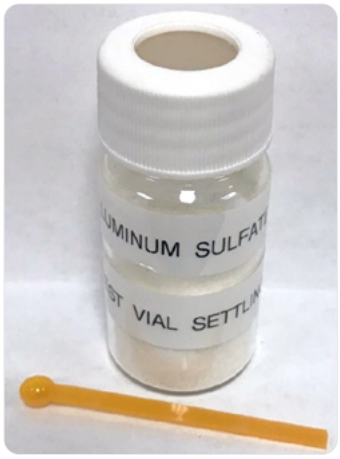



**Figure 2 –** ALUM kit with dosing scoop

After application of REGENESIS® colloidal activated carbon (CAC) products, groundwater and occasionally the water in monitoring wells will be impacted by the presence of suspended CAC. Within weeks or occasionally months, the CAC will fully attach to the aquifer matrix and the water will again become clear. The presence of CAC above approximately 100 mg/L (i.e.- water in a standard VOA vial too dark to see through) can have a negative impact on the methods and instruments used to quantify volatile organic compounds (VOCs) in water by standard methods like EPA 8260. To remove the CAC from analytical samples and permit VOC sampling, REGENESIS developed a method for flocculating suspended colloidal activated carbon directly in sampling vials **(Figure 1)**. For further information about the method and its use, please refer to the REGENESIS document: *Settling Agent for Test Vials*.

# Verification of Settling Method: Effect on Aqueous VOC Concentrations

The objective for this method is to remove the suspended CAC from the water column while leaving the aqueous VOC concentration in the samples undisturbed. By adding a small amount of aluminum sulfate (ALUM) to a sample, the CAC will flocculate and fall to the bottom of the vial. This addition of a flocculant has minimal effect on any dissolved contaminants that may be present, as the ALUM does not affect the partitioning between the CAC and the water. A series of samples at various contaminant, ALUM, and CAC concentrations were evaluated to verify that ALUM does not cause changes in aqueous VOC concentrations.

# About the Test Development

## Effect of ALUM in the Absence of CAC

The presence of ALUM on the aqueous concentration for selected contaminants of interest was explored. Chlorinated volatile organic compounds and BTEX concentrations were tested after mixing with ALUM. Tetrachloroethylene, trichloroethylene, and cis-dichloroethylene were analyzed from 0.25 mg/L to 10 mg/L in the presence of 1 g/L ALUM. Analysis was performed via gas chromatography–mass spectrometry (GC-MS) using a head space sampling method. Samples were prepared in VOA vials with 40 mL of water and then spiked with CVOCs from a mixed 1000 mg/L stock to the concentrations listed. Alum was then added to each sample and the samples allowed to equilibrate for over 24 hours before aliquots were taken for analysis. The data showed that the addition of ALUM had a minimal effect on the contaminant levels vs control **(Table 1)**. The results were biased high and biased low with an average deviation of under 5% which is within the range of error for calibration and preparation. Benzene, toluene, ethylbenzene, and o-xylene were analyzed from 0.25 mg/L to 10 mg/L in the presence of 1 g/L ALUM via gas chromatography–mass spectrometry (GC-MS). Samples were prepared in VOA vials with 40 mL of water and then spiked with BTEX from a mixed 1000 mg/L stock to the concentrations listed. Alum was then added to each sample and allowed to shake for over 24 hours to equilibrate before aliquots were taken for analysis. The data showed that the addition of ALUM had a minimal effect on the contaminant levels vs control **(Table 3)**. The results were biased high and biased low with an average deviation of under 5% which is within the range of error for calibration and preparation.

### Chlorinated Volatile Organic Compounds (CVOCs) with ALUM

| Contaminant Concentration (mg/L) | Deviation from Control | | |
|---|---|---|---|
| | PCE | TCE | Cis-DCE |
| 0.25 | -4.38% | -1.47% | 4.32% |
| 0.5 | 9.95% | 0.76% | 0.97% |
| 2 | -5.69% | -16.81% | -19.14% |
| 5 | 5.87% | -4.82% | -8.62% |
| 10 | 0.63% | 0.38% | 0.59% |
| **Average** | **-1.27%** | **-4.39%** | **-4.38%** |

**Table 1 –** Effect of 1g/L ALUM on CVOC concentration analysis via GCMS.

### Benzene, Toluene, Ethylbenzene, and O-Xylene with ALUM

| Contaminant Concentration (mg/L) | Deviation from Control | | | |
|---|---|---|---|---|
| | Benzene | Toluene | Ethylbenzene | O-Xylene |
| 1 | 0.24% | 2.01% | 3.77% | 4.14% |
| 2 | -4.94% | -5.86% | -6.81% | -7.94% |
| 5 | -1.22% | -1.34% | -2.07% | -2.16% |
| 10 | -8.28% | -9.95% | -10.67% | -10.62% |
| **Average** | **-3.55%** | **-3.79%** | **-3.95%** | **-4.14%** |

**Table 3 –** Effect of 1g/L ALUM on BTEX concentration analysis via GCMS.

# Effect of ALUM in the Presence of CAC

Chlorinated volatile organic compound concentrations were analyzed with colloidal activated carbon after addition of ALUM to determine ALUM's effect on contaminant analysis. This experiment was performed using 500 mg/L CAC, 0.5 mg/L to 10 mg/L of CVOC, and 2 g/L ALUM in all samples with analysis via gas chromatography with an Electron Capture Detector (GC-ECD) by headspace. PCE and cis-DCE were selected to represent CVOCs as the contaminants with the highest and lowest sensitivity on GC-ECD respectively. To obtain 0.5 mg/L to 10 mg/L of contaminant in samples in the presence of CAC, isotherms were used to calculate the correct amount of neat contaminant to spike into each sample.

PCE and cis-DCE samples were prepared individually to match the isotherms calculated. Samples were prepared in VOA vials with 38 mL of 500 mg/L CAC and then injected with either neat PCE or cis-DCE to the concentrations listed. Then the samples were allowed to shake for 24 hours and then refrigerated for 24 hours to allow all contaminants to fully dissolve in solution. The samples were then injected with 2 mL of 35 g/L ALUM to obtain 2 g/L ALUM in the samples and allowed 2 hours to settle before aliquots were run on GC-ECD headspace. The data showed that the addition of ALUM had a minimal effect which caused the results to bias high for both contaminants **(Table 2)**. The data from this experiment support the notion that the addition of ALUM to flocculate CAC from aqueous samples may only slightly increase the measured CVOC concentrations, and that the use of ALUM as a settling agent is not leading to biased favorable results.

## Chlorinated Volatile Organic Compounds (CVOCs) with Activated Carbon

| Contaminant Concentration (mg/L) | Activated Carbon Concentration (mg/L) | Deviation from Control | |
|---|---|---|---|
| | | PCE | Cis-DCE |
| 0.25 | 500 | 29.41% | NA |
| 0.5 | 500 | 34.87% | NA |
| 2 | 500 | 31.47% | 18.33% |
| 5 | 500 | 8.3% | 4.75% |
| 10 | 500 | NA | 9.69% |
| **Average** | | **26.01%** | **10.93%** |

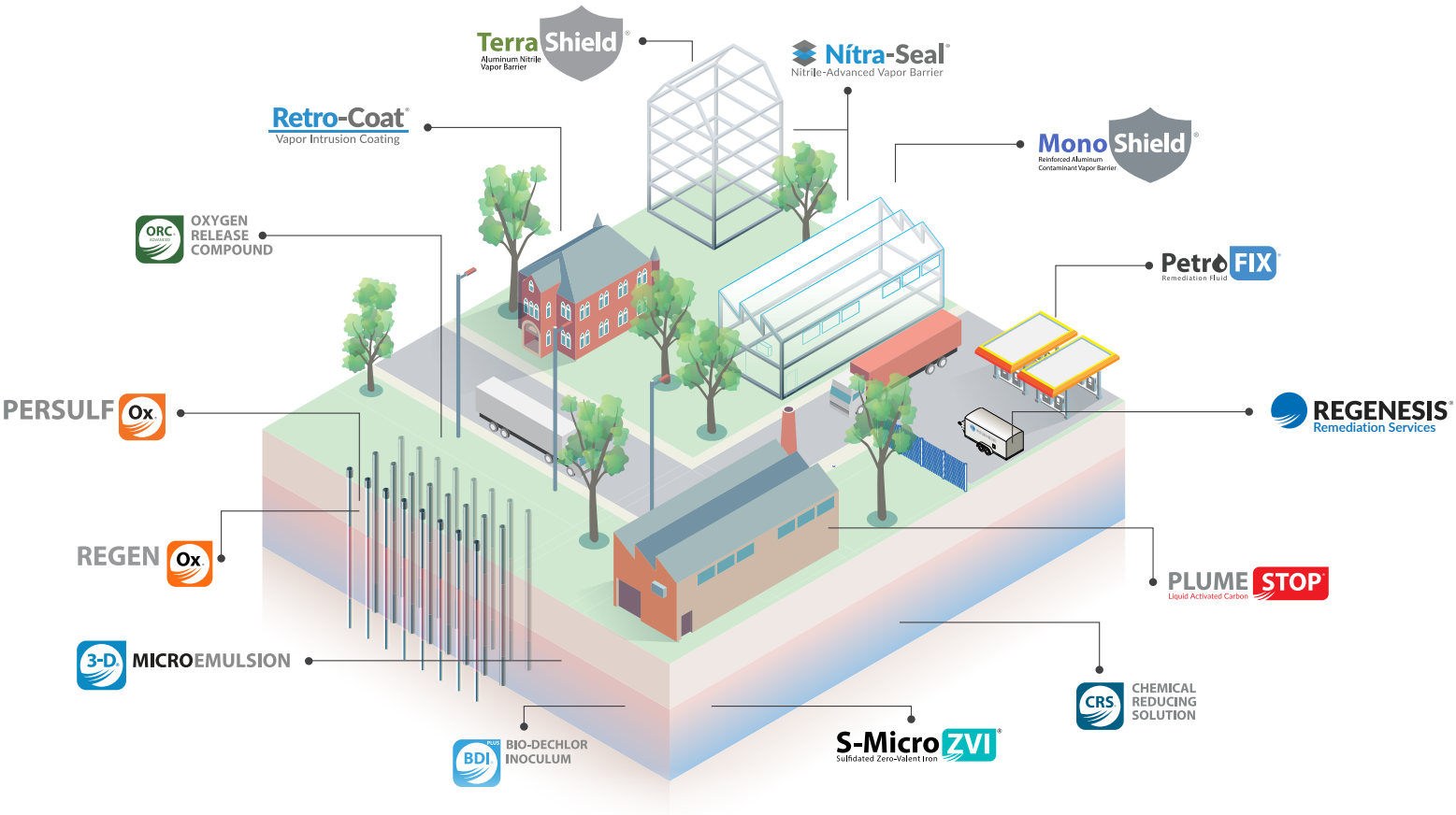
**Table 2 –** Effect of 2g/L ALUM on CVOC concentration analysis with 500 mg/L activated carbon analysis via GC-ECD.

## Benzene and O-Xylene with Activated Carbon

| Contaminant Concentration (mg/L) | Activated Carbon Concentration (mg/L) | Deviation from Control | |
|---|---|---|---|
| | | Benzene | O-Xylene |
| 1 | 500 | 24.31% | NA |
| 2 | 500 | 2.99% | 24.31% |
| 5 | 500 | 2.87% | 17.51% |
| 10 | 500 | 15.09% | 19.11% |
| **Average** | | **11.32%** | **20.31%** |

**Table 4 –** Effect of 2g/L ALUM on BTEX concentration analysis with 500 mg/L activated carbon analysis via GC-FID.

BTEX concentrations were analyzed with colloidal activated carbon after addition of ALUM to determine ALUM's effect on contaminant analysis. This experiment was performed using 500 mg/L CAC, 1 mg/L to 10 mg/L of BTEX, and 2 g/L ALUM in all samples with analysis via gas chromatography with a Flame Ionization Detector (GC-FID) by headspace. Benzene and o-xylene were selected to represent BTEX as the contaminants with the highest and lowest sensitivity on GC-FID respectively. To obtain 1 mg/L to 10 mg/L of contaminant in samples in the presence of CAC, isotherms were used to calculate the correct amount of neat contaminant to spike into each sample. Benzene and o-xylene samples were prepared individually to match the isotherms calculated. Samples were prepared in VOA vials with 38 mL of 500 mg/L CAC and then injected with either neat benzene or o-xylene to the concentrations listed. Then the samples were allowed to shake for 24 hours and then refrigerated for another 24 hours to allow all contaminants to fully dissolve in solution. The samples were then injected with 2 mL of 35 g/L ALUM to obtain 2 g/L ALUM in the samples and allowed 2 hours to settle before aliquots were run on GC-FID headspace. The data showed that the addition of ALUM had a minimal effect which caused the results to bias high for both contaminants **(Table 4)**. The data from this experiment support the notion that the addition of ALUM to flocculate CAC from aqueous samples may only slightly increase the measured BTEX concentrations, and that the use of ALUM as a settling agent is not leading to biased favorable results.




## About REGENESIS

At REGENESIS we value innovation, technology, expertise and people which together form the unique framework we operate in as an organization. We see innovation and technology as inseparably linked with one being born out of the other.

Inherently, innovation imparts new and better ways of thinking and doing. For us this means delivering expert environmental solutions in the form of the most advanced and effective technologies and services available today.

We value expertise, both our customers' and our own. We find that when our experienced staff collaborates directly with customers on complex problems there is a high potential for success including savings in time, resources and cost.

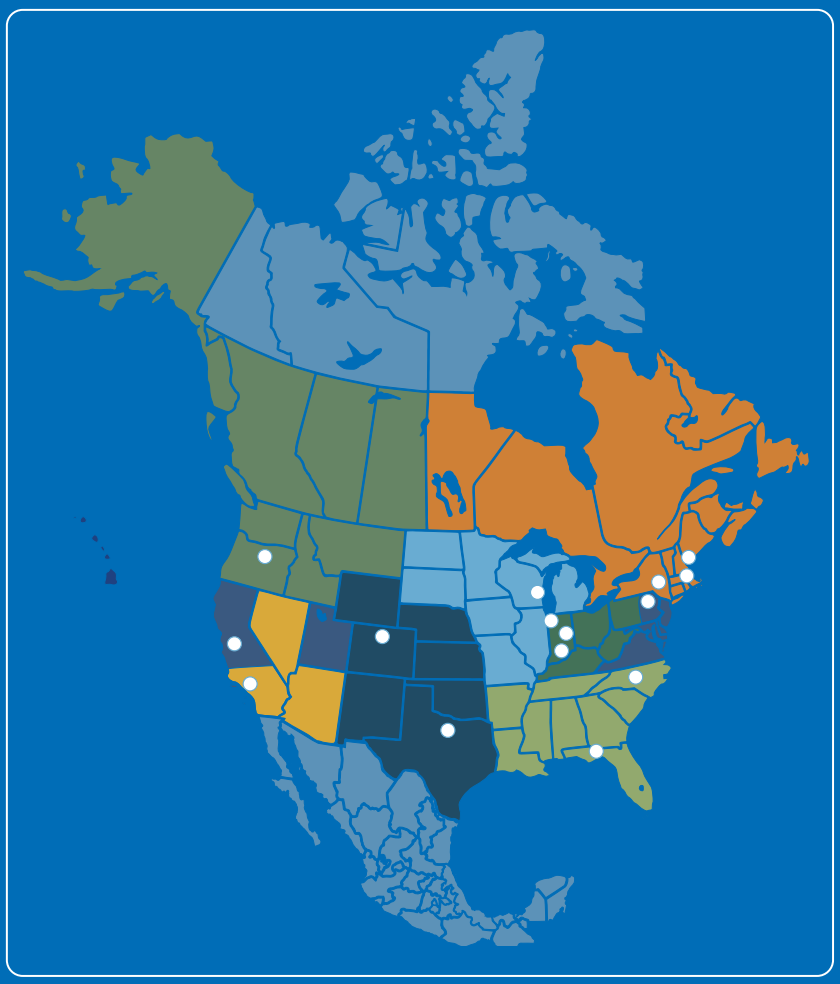
At REGENESIS we are driven by a strong sense of responsibility to the people charged with managing the complex environmental problems we encounter and to the people involved in developing and implementing our technology-based solutions. We are committed to investing in lasting relationships by taking time to understand the people we work with and their circumstances. We believe this is a key factor in achieving successful project outcomes.

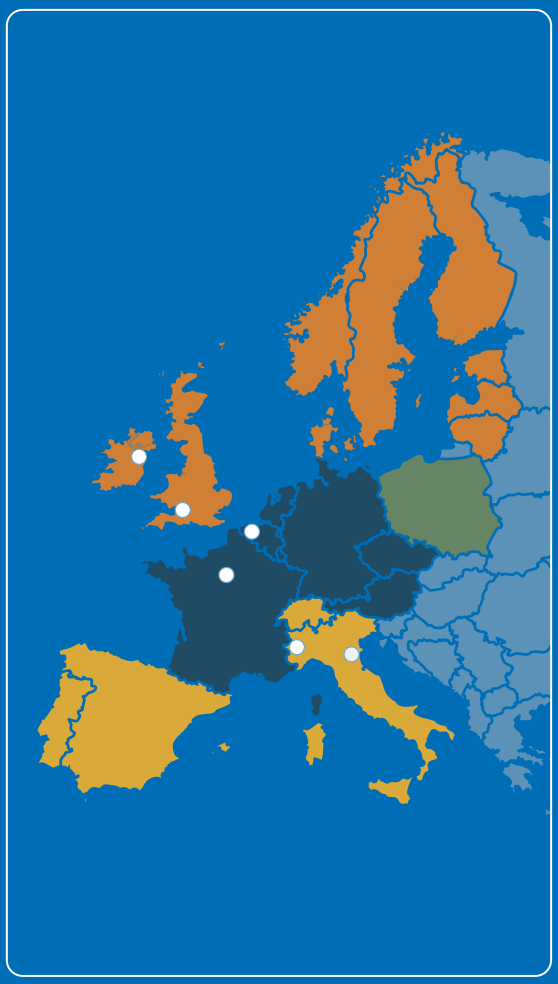
We believe that by acting under this set of values, we can work with our customers to achieve a cleaner, healthier, and more prosperous world.

REGENESIS®

# We're Ready to Help You

## Find the Right Solution For Your Site





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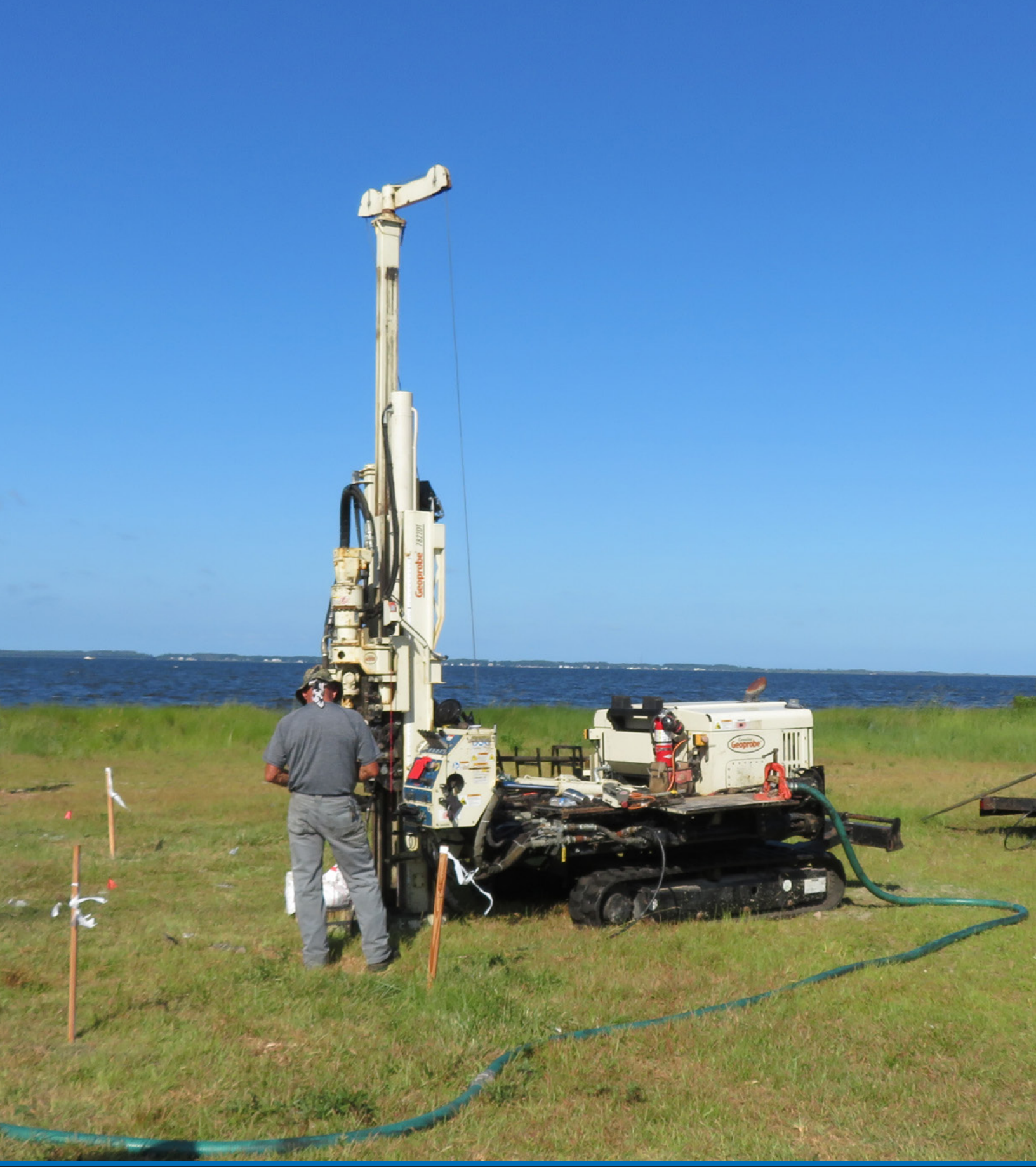






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# Settling Agent for Test Vials

This kit is used for settling suspended colloidal activated carbon (CAC) in VOA vials or other field sampling containers so that the remaining clear solution (supernatant) can be analyzed for contaminants by standard analytical methods (ex. EPA 8260). Once the settling agent (aluminum sulfate) is added to the sample of black water, the carbon will begin to flocculate rapidly and fall to the bottom of the vial (see Figure 1). After about 2 hours, aliquots of the clear water can be taken for analysis.

This method is appropriate for water samples containing approximately 5000 mg/L of CAC or less. **See CAC Alum Flocculation Method Validation Document for an explanation of the impacts to sample analyte integrity after applying this preparation method.**

Kit Contents:

- 1x Vial containing 10 g of settling agent (aluminum sulfate)*
- Dosing spoon to deliver 30-40 mg of aluminum sulfate hydrate

Procedure:

1. Deposit 2 scoops of settling agent in a 40 mL VOA vial.
2. Fill the VOA vial with the water sample, per typical sampling procedures.
3. Shake the vial for 30 seconds.
4. **Upon arrival at the analytical lab:** Shake treated vials again for 10 seconds. Place vials upright while the CAC settles. After at least 2 hours, the CAC will have settled to the bottom of the vial.
5. Once clear, remove an aliquot of water from the vial for analysis, taking care not to disturb the settled CAC at the bottom.

***Figure 1-*** *Two vials containing 2,000 mg/L of CAC. The recommended dose of settling agent was also added to the vial on the right, resulting in clear water.*

**Settling Agent Dosing Guide**

| **Sample Volume (mL)** | Required Settling agent (mg) | Settling agent (scoops) |
|---|---|---|
| **40** | 70 | 2 |
| **60** | 105 | 3 |
| **100** | 175 | 5 |
| **200** | 350 | 10 |
| **240-250** | 420 | 12 |
| **1000** | 2000 | 2 grams |

*Aluminum sulphate hydrate at 98%+ purity can be sourced if needed in large quantities

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