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Memorandum

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Subject **Passive Soil Gas Investigation Results and Proposed Well Locations**
Northwest Pipe Company, Portland Plant

Attention Stephanie Heldt-Sheller, Northwest Pipe Company

Date August 19, 2021

1. Objective

This technical memorandum presents the results of a soil gas investigation implemented in the Southeast Area of the Northwest Pipe Company site in Portland, Oregon. Soil gas investigation results have long been recognized as a useful tool to investigate the presence of volatile organic constituents in groundwater and to assist in siting monitoring wells (Devitt, et al. 1987). Using passive soil gas (PSG) technology, this investigation focused on the area downgradient of previously detected volatile organic compound (VOC) concentrations in shallow groundwater.

The objective of this data collection effort was to provide a basis for siting additional groundwater monitoring wells in areas of high VOC concentration along the groundwater flow path between Northwest Pipe monitoring well MW-03, near the southern boundary of the Northwest Pipe Site, and Port of Portland (Port) monitoring wells T4S1MW-03s and T4S1MW-09, near Terminal 4 Slip 1 on the Port's Terminal 4 property (Figure 1). This investigation was implemented in response to the Oregon Department of Environmental Quality (DEQ) and the Environmental Protection Agency Region 10 (EPA) request to support a monitored natural attenuation (MNA) remedy for groundwater containing VOCs in the Southeast Area of the site. An MNA remedy uses ongoing natural attenuation processes for chlorinated solvents to protect potential receptors, such as surface water in the Willamette River downgradient of the Southeast Area, consistent with reasonably likely beneficial use of the aquifer (EPA 1999, DEQ 2017).

2. Background

Past sampling work in the Southeast Area began in 1988 during Northwest Pipe's due diligence effort prior to purchasing the property. Groundwater sampling in the area began in 2001 under a DEQ-approved work plan, continued in subsequent years with sampling events occurring at different times for specific investigation purposes, and has been ongoing since 2016 in response to DEQ request (Jacobs 2020a). Investigations have shown concentrations of VOCs are present in Southeast Area shallow groundwater, principally the chlorinated solvents tetrachloroethene (PCE) and its breakdown products trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC). TCE is both a breakdown product of PCE and a commercially available solvent.

Groundwater monitoring data dating back to 2001 (Jacobs 2020a) show that VOCs in groundwater are mostly below detection limits. Figures 2a and 2b show the results of the April 2021 groundwater

monitoring event along with the historical results. VOCs were analyzed in groundwater from 2001 through 2007, with only PCE, TCE, cis-1,2-DCE, and VC having concentrations above the Portland Harbor Record of Decision Cleanup Levels (CULs) since 2002 when those CULs were developed. The constituents of interest (COIs) for the Southeast Area of Northwest Pipe are PCE, TCE, cis-1,2-DCE, and VC.

Groundwater containing VOC concentrations above Portland Harbor Record of Decision CULs are limited to the shallow unconfined aquifer (Jacobs 2020a). The shallow aquifer is located within hydraulic fill (dredged river sediment) placed prior to 1940 to facilitate the construction of the shipyard, which was in full operation by 1941. The fill was placed over the periodically inundated silt overbank deposits that formerly formed the ground surface in the site vicinity. The hydraulic fill is characterized by fine to medium sand and silty sand extending from the current ground surface to approximately 28 feet below ground surface (bgs). The fill is saturated in its lower portion under unconfined conditions, and is underlain by a thick, low-permeability alluvial confining layer, the top of which was the former (pre-fill) ground surface. The confining layer consists of low-permeability silt with interbedded sand from approximately 28 feet to 161 feet bgs.

The current groundwater monitoring network consists of six monitoring wells installed in the shallow aquifer located on the southeast portion of the Northwest Pipe property, along with four wells owned by the Port of Portland on its property to the south/southwest (Figure 2a and 2b). The direction of groundwater flow is to the southwest toward Terminal 4 Slip 1 on the Port property. Groundwater elevation contours are shown from the most recent sampling event in April 2021 in Figure 1. Given the direction of groundwater flow, recent (2016 and later) supplemental groundwater sampling has included selected shallow aquifer wells downgradient of the Southeast Area on the Port property.

3. Soil Gas Investigation

To enhance the current MNA monitoring network in the Southeast Area, passive soil gas samplers were installed to provide information for the selection of additional well locations. (Figure 1). A targeted array of 37 PSG samples was installed pursuant to the work plan submitted in December 2020 (Jacobs 2020b) and approved by DEQ (DEQ, 2021). The following sections describe the investigation and results.

3.1 Installation and Retrieval of PSG Samplers

The samplers were installed over a three-day period (March 24, 25, and 26, 2021). PSG samplers were placed in rows transverse to the southwest groundwater flow direction, as shown in Figure 3. Due to the presence of underground utilities and other obstructions, several locations (PSG29, PSG20, PSG02, PSG33, and PSG01) were shifted slightly from the proposed locations in the work plan (Jacobs 2020b). Both the proposed locations and actual installation points are shown in Figure 3. The PSG samplers were installed in pilot holes advanced using a hammer drill. Installation began by advancing approximately 1 ½ inch diameter holes to a depth of 1foot bgs. The holes were then extended to a depth of approximately 3 feet bgs using a smaller ½ inch diameter drill bit. For locations that involved drilling through asphalt pavement, the upper 1-foot of the hole was outfitted with a pre-cleaned metal pipe sleeve provided in the PSG sample kit. These sleeves prevent horizontal migration of vapors in the potentially more porous subgrade often present beneath pavement from influencing the soil gas samplers. The PSG samplers were then installed in the upper portion of the hole, sealed with an aluminum foil plug, and covered with soil or a thin concrete patch for locations through asphalt surfacing.

The samplers were removed on April 7, 2021, at either 12, 13, or 14 days from installation. To retrieve the PSG samplers, the samplers were extracted from each location by a length of wire wrapped around the vial. Once samplers were removed, the holes were filled in with surrounding dirt or gravel and the surface

was restored. Cold patch asphalt was used in locations where samplers had been installed through asphalt. Following extraction, the samplers were placed in individual glass vials and shipped to Beacon Environmental Services (Beacon) of Forest Hill, Maryland consistent with Beacon's recommended sample handling protocol, including chain of custody procedures. Two duplicates were analyzed for samples PSG01 and PSG016, and two trip blanks were collected. Duplicates were selected from one on-site location where VOCs were anticipated to be detected, and one off-site location downgradient of the known groundwater VOC plume. A summary of the sample locations, depths, and surface conditions at each location are included in Table 1.

3.2 Analysis and Data Validation

The PSG samplers contain two sets of hydrophobic adsorbent cartridges to absorb organic compounds that may be present in soil gas. The cartridges were analyzed using gas chromatography/mass spectrometry (GC/MS) instrumentation pursuant to EPA Method 8260C (EPA 2015) for PCE, TCE, cis-1,2-DCE, and vinyl chloride – the COIs present at Northwest Pipe for VOCs, as supported by groundwater monitoring data from 2001 to present (Jacobs 2020b). Data analysis was performed by Beacon. Constituent detections were reviewed and validated by the Jacobs project chemist. The analytical data from the PSG samplers is included in Appendix B and data are summarized in Table 1 and Figure 4.

3.3 Results and Comparison to Groundwater Data

PSG results were below the detection limits across all but the northernmost portion of the Port of Portland property (Figure 4) indicating minimal downgradient migration has occurred. These results support the conclusion that natural attenuation processes are providing an effective control of VOC migration.

More generally, the results of the PSG sampling showed few detections of VOCs in soil gas, with just six of the 37 locations having detected constituents. PCE was detected in five of the samples (with a sixth sample showing a value below the reporting limit in the original analysis and a value slightly above the reporting limit in a duplicate analysis), TCE was detected in three samples and cis-1,2-DCE in one sample location. The detections were nearest the Southeast Area (PSG01 and PSG02, collocated with MW-03 and MW-04) and near the northeast corner of the PSG array (near T4S1MW-22). Two lower level PCE detections were found: one downgradient of MW-03 in the center of the flow path (duplicate for PSG16) and one at the western extent of the array at PSG03, near T4S1MW-23.

Except for the result for PSG10, which is adjacent to monitoring well T4S1MW-22 and has results consistent with known conditions in groundwater samples from this well, PSG results were below detection limits along the eastern side of the sampling array in the area presumed to have been the location of the former Gatton Creek channel, including the location of hypothetical meander channels. The non-detect readings downgradient of PSG10 and T4S1MW-22 confirm that any remnant of the buried Gatton Creek is not acting as a preferential pathway for contaminant migration.

The groundwater and soil gas results are not directly comparable because one is reported as a concentration (groundwater) while the other is reported as adsorbed mass (soil gas). However, the results of the two measurement methods tell a very similar story when data for the three paired sampling points and the total mass or concentrations of chlorinated ethenes for each medium sampled are summed[1], as follows:

[1] The sums presented were calculating by including constituents below their reporting limit with a value equivalent to one-half of the reporting limit.

- The groundwater sample with the highest total aqueous concentration (755 micrograms per liter [μg/L] in MW-03) is located next to the soil gas sampler with the highest total mass adsorbed (10,743 nanograms [ng] in PSG01)

- The groundwater sample with an intermediate total aqueous concentration (136.7 μg/L in MW-04) is located next to the soil gas sampler with an intermediate total mass adsorbed (8,580 ng in PSG02)

- The groundwater sample with the lowest total aqueous concentration (9.54 μg/L in T4S1MW-22) is located next to the soil gas sampler with the lowest total mass adsorbed (708 ng in PSG10)

Similarly, the soil gas samplers positioned closest to the downgradient monitoring wells near the Terminal 4 Slip (wells T4SWMW-03s and T4S1MW-09), which had no chlorinated ethenes above reporting limits in groundwater, also had no chlorinated ethene mass in soil gas above reporting limits. Based on the comparison of the groundwater to soil gas results, the PSG results provide a useful indication of the presence of chlorinated ethenes in groundwater in the study area.

When individual VOCs are compared, the two methods provided consistent results for PCE and TCE, somewhat less consistent results for cis-1,2-DCE, and weak consistency with VC, because no VC was detected in samplers near monitoring wells where groundwater contained detectable VC. This outcome could be attributable to the high volatility of vinyl chloride, which – unlike TCE and PCE – exists as a gas at standard temperature and pressure. The lower volatility of heavier chlorinated ethenes would understandably make them more prone to partitioning and adsorption onto the PSG samplers, whereas the higher volatility of VC would make it less prone to adsorb onto PSG samplers, leading the samplers to be less sensitive to the presence of VC compared to more highly chlorinated ethenes.

In summary, the PSG samplers were determined to be useful at detecting the presence of chlorinated ethenes in groundwater; they provided an indication of the magnitude of the concentration in groundwater relative to other sample points; and they showed an absence of chlorinated ethenes in the general area where groundwater data confirmed none were present.

PSG results, therefore, provide useful information for siting supplemental monitoring wells in the area downgradient of the Northwest Pipe site.

4. Recommendations and Rationale for Additional Wells

The objective of this data collection effort was to provide a basis for siting additional groundwater monitoring wells in areas of high VOC concentration along the groundwater flow path between Northwest Pipe monitoring well MW-03 and Port of Portland (Port) monitoring wells T4S1MW-03S and T4S1MW-09. However, the results of the soil gas sampling indicate that the downgradient migration of contaminants in groundwater is very limited because nearly all the PSG sampler results on Port property showed no detectable chlorinated ethenes. *See* the 31 non-detect locations on Figure 5.

Because no high-concentration plume of VOCs in groundwater was identified by PSG samplers, the original intent of positioning supplemental monitoring wells along the flow path of a high-concentration plume core is moot. As an alternative, Northwest Pipe proposes installing two monitoring wells downgradient of the zone of elevated VOC concentrations represented by samples from MW-03, with the objective of providing early warning of downgradient migration, should it occur in the future, prior to the plume reaching wells further downgradient near the Willamette River. These proposed well locations are depicted on Figure 5.

Wells will be drilled and constructed consistent with *Groundwater Monitoring Well Drilling, Construction, and Decommissioning,* DEQ 1992. New wells will be flush mounted with a locking cap and constructed of 2-inch diameter PVC piping, and screened across the entire thickness of the aquifer. Screen size and sand pack will be determined based on sieve analysis collected during drilling. Based on existing wells in the area, construction is anticipated to consist of a 10 foot long section of 10-slot screen with 10x20 Colorado silica sand pack and a bentonite seal. Existing and new monitoring wells will be surveyed upon completion by a licensed surveyor.

5. References

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Tables

Table 1. Passive Soil Gas Sample Summary

Sample Location	Date Installed	Date Removed	Sample depth (cm)	Surface	Soil Gas Results (ng)			
					Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	Vinyl Chloride
PSG01	3/26/2021	4/7/2021	91	Asphalt	**10,900 / 9,950**	**446 / 170**	<10 / <10	<10 / <10
PSG02	3/26/2021	4/7/2021	91	Asphalt	**7,370**	**1,180**	**25**	<10
PSG03	3/24/2021	4/7/2021	91	Soil	**17**	<10	<10	<10
PSG04	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG05	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG06	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG07	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG08	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG09	3/25/2021	4/7/2021	91	Soil/Gravel	**136**	<10	<10	<10
PSG10	3/25/2021	4/7/2021	91	Gravel	**674**	**24**	<10	<10
PSG11	3/24/2021	4/7/2021	91	Gravel	<10	<10	<10	<10
PSG12	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG13	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG14	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG15	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG16	3/24/2021	4/7/2021	91	Soil	**<10 / 17**	<10 / <10	<10 / <10	<10 / <10
PSG17	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG18	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG19	3/24/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG20	3/25/2021	4/7/2021	91	Gravel	<10	<10	<10	<10
PSG21	3/24/2021	4/7/2021	91	Gravel	<10	<10	<10	<10
PSG22	3/25/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG23	3/25/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG24	3/25/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG25	3/25/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG26	3/25/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG27	3/25/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG28	3/25/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG29	3/25/2021	4/7/2021	91	Soil	<10	<10	<10	<10
PSG30	3/24/2021	4/7/2021	91	Soil/Gravel	<10	<10	<10	<10
PSG31	3/25/2021	4/7/2021	91	Soil/Gravel	<10	<10	<10	<10
PSG32	3/25/2021	4/7/2021	91	Soil/Gravel	<10	<10	<10	<10
PSG33	3/26/2021	4/7/2021	91	Soil/Gravel	<10	<10	<10	<10
PSG34	3/25/2021	4/7/2021	76	Asphalt	<10	<10	<10	<10
PSG35	3/25/2021	4/7/2021	76	Asphalt	<10	<10	<10	<10
PSG36	3/26/2021	4/7/2021	91	Asphalt	<10	<10	<10	<10
PSG37	3/26/2021	4/7/2021	91	Soil/Gravel	<10	<10	<10	<10

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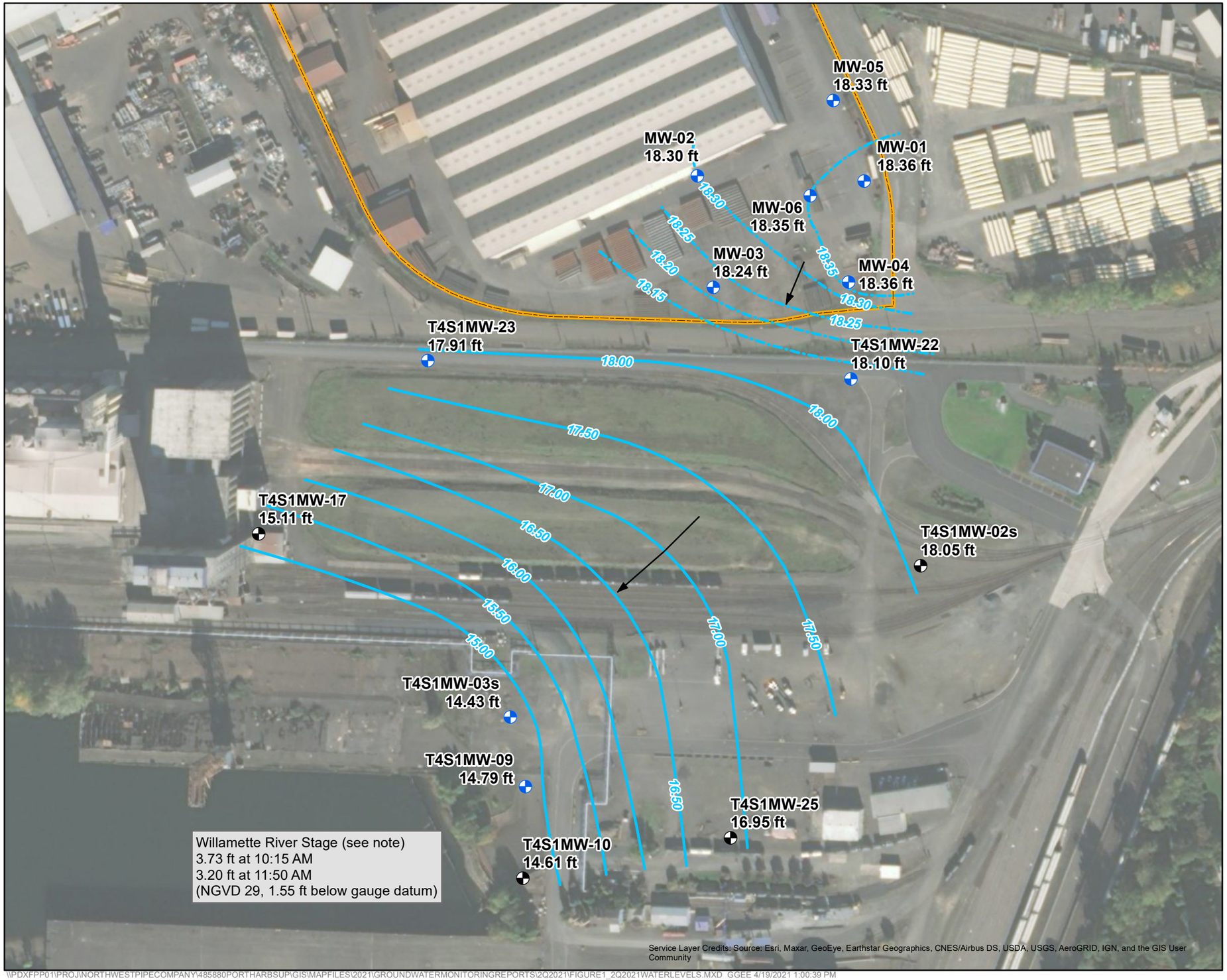
Figures



\\PDXFPP01\PROJ\NORTHWESTPIPECOMPANY\485880PORTHARBSUP\GIS\MAPFILES\2021\GROUNDWATERMONITORINGREPORTS\2Q2021\FIGURE1_2Q2021WATERLEVELS.MXD GGEE 4/19/2021 1:00:39 PM

LEGEND

Investigation Wells

- Groundwater Quality Monitoring
- Water Level Only
- Groundwater Elevation Contour (0.5 ft contour interval, ft NGVD29)
- Groundwater Elevation Contour (0.05 ft contour interval, to show detail in the NW Pipe Southeast Area, ft NGVD29)
- Groundwater Flow Direction
- Northwest Pipe Site Boundary

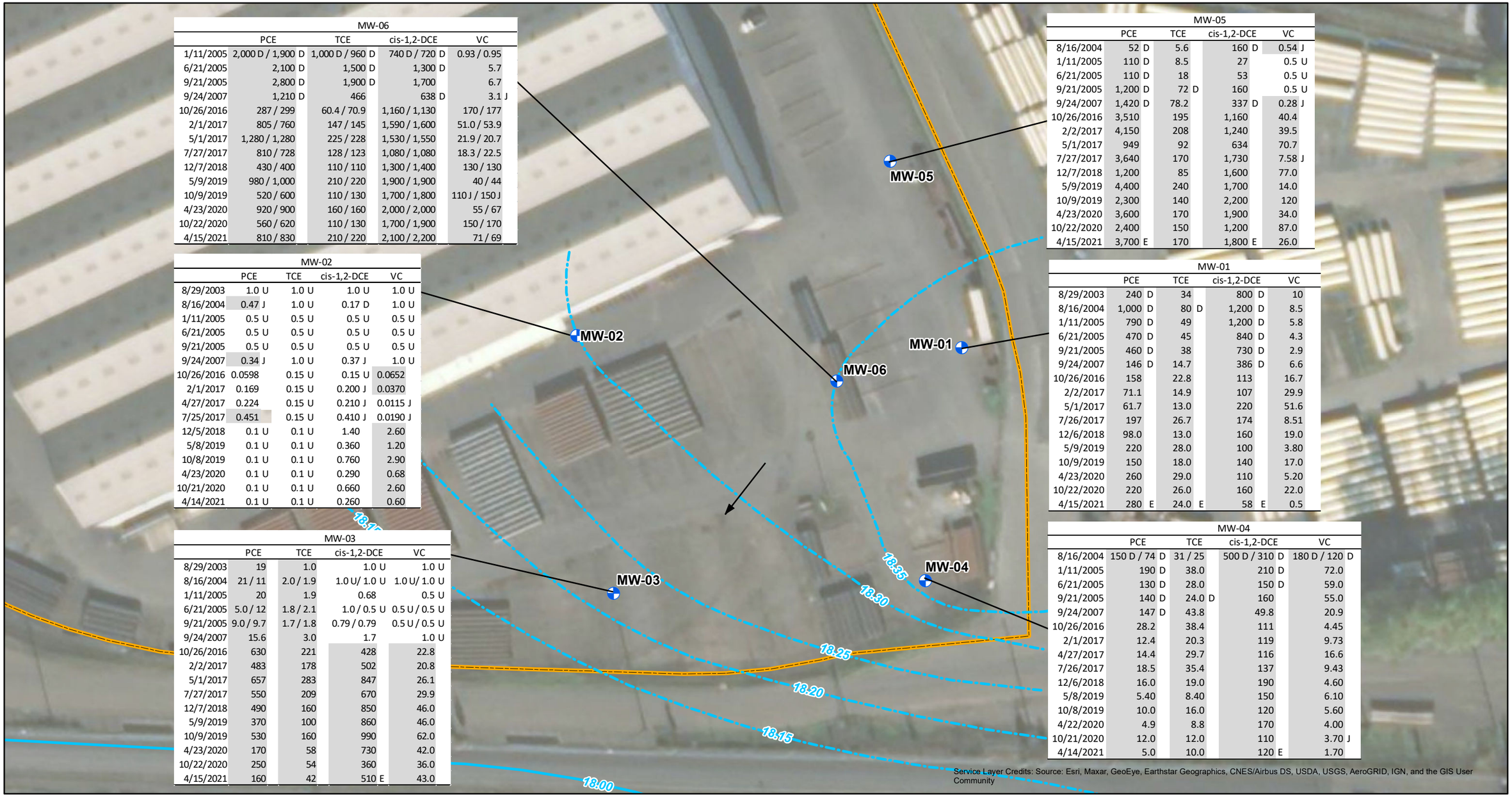
Note: Groundwater levels measured between 10:16 AM and 11:52 AM on April 13, 2021. During this period, the Willamette River stage decreased by 0.53 feet, as measured at the Morrison Bridge river gauge (USGS 14211720).

N

0 100 200 400
Feet

Figure 1. Groundwater Elevation Contour Map
Southeast Area, April 13, 2021
Northwest Pipe Company
Portland, Oregon

Jacobs



MW-06

	PCE	TCE	cis-1,2-DCE	VC
1/11/2005	2,000 D / 1,900 D	1,000 D / 960 D	740 D / 720 D	0.93 / 0.95
6/21/2005	2,100 D	1,500 D	1,300 D	5.7
9/21/2005	2,800 D	1,900 D	1,700	6.7
9/24/2007	1,210 D	466	638 D	3.1 J
10/26/2016	287 / 299	60.4 / 70.9	1,160 / 1,130	170 / 177
2/1/2017	805 / 760	147 / 145	1,590 / 1,600	51.0 / 53.9
5/1/2017	1,280 / 1,280	225 / 228	1,530 / 1,550	21.9 / 20.7
7/27/2017	810 / 728	128 / 123	1,080 / 1,080	18.3 / 22.5
12/7/2018	430 / 400	110 / 110	1,300 / 1,400	130 / 130
5/9/2019	980 / 1,000	210 / 220	1,900 / 1,900	40 / 44
10/9/2019	520 / 600	110 / 130	1,700 / 1,800	110 J / 150 J
4/23/2020	920 / 900	160 / 160	2,000 / 2,000	55 / 67
10/22/2020	560 / 620	110 / 130	1,700 / 1,900	150 / 170
4/15/2021	810 / 830	210 / 220	2,100 / 2,200	71 / 69

MW-05

	PCE	TCE	cis-1,2-DCE	VC
8/16/2004	52 D	5.6	160 D	0.54 J
1/11/2005	110 D	8.5	27	0.5 U
6/21/2005	110 D	18	53	0.5 U
9/21/2005	1,200 D	72 D	160	0.5 U
9/24/2007	1,420 D	78.2	337 D	0.28 J
10/26/2016	3,510	195	1,160	40.4
2/2/2017	4,150	208	1,240	39.5
5/1/2017	949	92	634	70.7
7/27/2017	3,640	170	1,730	7.58 J
12/7/2018	1,200	85	1,600	77.0
5/9/2019	4,400	240	1,700	14.0
10/9/2019	2,300	140	2,200	120
4/23/2020	3,600	170	1,900	34.0
10/22/2020	2,400	150	1,200	87.0
4/15/2021	3,700 E	170	1,800 E	26.0

MW-02

	PCE	TCE	cis-1,2-DCE	VC
8/29/2003	1.0 U	1.0 U	1.0 U	1.0 U
8/16/2004	0.47 J	1.0 U	0.17 D	1.0 U
1/11/2005	0.5 U	0.5 U	0.5 U	0.5 U
6/21/2005	0.5 U	0.5 U	0.5 U	0.5 U
9/21/2005	0.5 U	0.5 U	0.5 U	0.5 U
9/24/2007	0.34 J	1.0 U	0.37 J	1.0 U
10/26/2016	0.0598	0.15 U	0.15 U	0.0652
2/1/2017	0.169	0.15 U	0.200 J	0.0370
4/27/2017	0.224	0.15 U	0.210 J	0.0115 J
7/25/2017	0.451	0.15 U	0.410 J	0.0190 J
12/5/2018	0.1 U	0.1 U	1.40	2.60
5/8/2019	0.1 U	0.1 U	0.360	1.20
10/8/2019	0.1 U	0.1 U	0.760	2.90
4/23/2020	0.1 U	0.1 U	0.290	0.68
10/21/2020	0.1 U	0.1 U	0.660	2.60
4/14/2021	0.1 U	0.1 U	0.260	0.60

MW-01

	PCE	TCE	cis-1,2-DCE	VC
8/29/2003	240 D	34	800 D	10
8/16/2004	1,000 D	80 D	1,200 D	8.5
1/11/2005	790 D	49	1,200 D	5.8
6/21/2005	470 D	45	840 D	4.3
9/21/2005	460 D	38	730 D	2.9
9/24/2007	146 D	14.7	386 D	6.6
10/26/2016	158	22.8	113	16.7
2/2/2017	71.1	14.9	107	29.9
5/1/2017	61.7	13.0	220	51.6
7/26/2017	197	26.7	174	8.51
12/6/2018	98.0	13.0	160	19.0
5/9/2019	220	28.0	100	3.80
10/9/2019	150	18.0	140	17.0
4/23/2020	260	29.0	110	5.20
10/22/2020	220	26.0	160	22.0
4/15/2021	280 E	24.0 E	58 E	0.5

MW-03

	PCE	TCE	cis-1,2-DCE	VC
8/29/2003	19	1.0	1.0 U	1.0 U
8/16/2004	21 / 11	2.0 / 1.9	1.0 U/ 1.0 U	1.0 U/ 1.0 U
1/11/2005	20	1.9	0.68	0.5 U
6/21/2005	5.0 / 12	1.8 / 2.1	1.0 / 0.5 U	0.5 U / 0.5 U
9/21/2005	9.0 / 9.7	1.7 / 1.8	0.79 / 0.79	0.5 U / 0.5 U
9/24/2007	15.6	3.0	1.7	1.0 U
10/26/2016	630	221	428	22.8
2/2/2017	483	178	502	20.8
5/1/2017	657	283	847	26.1
7/27/2017	550	209	670	29.9
12/7/2018	490	160	850	46.0
5/9/2019	370	100	860	46.0
10/9/2019	530	160	990	62.0
4/23/2020	170	58	730	42.0
10/22/2020	250	54	360	36.0
4/15/2021	160	42	510 E	43.0

MW-04

	PCE	TCE	cis-1,2-DCE	VC
8/16/2004	150 D / 74 D	31 / 25	500 D / 310 D	180 D / 120 D
1/11/2005	190 D	38.0	210 D	72.0
6/21/2005	130 D	28.0	150 D	59.0
9/21/2005	140 D	24.0 D	160	55.0
9/24/2007	147 D	43.8	49.8	20.9
10/26/2016	28.2	38.4	111	4.45
2/1/2017	12.4	20.3	119	9.73
4/27/2017	14.4	29.7	116	16.6
7/26/2017	18.5	35.4	137	9.43
12/6/2018	16.0	19.0	190	4.60
5/8/2019	5.40	8.40	150	6.10
10/8/2019	10.0	16.0	120	5.60
4/22/2020	4.9	8.8	170	4.00
10/21/2020	12.0	12.0	110	3.70 J
4/14/2021	5.0	10.0	120 E	1.70

LEGEND

- Groundwater Quality Monitoring Well (CVOC concentrations in µg/L)
- Well Used for Water Level Measurements Only
- Groundwater Elevation Contour (0.5 ft contour interval, ft NGVD29)
- Groundwater Elevation Contour (0.05 ft contour interval, to show detail in the NW Pipe Southeast Area, ft NGVD29)
- Groundwater Flow Direction
- Northwest Pipe Facility Boundary

Notes:
All chlorinated volatile organic compound (CVOC) concentrations are reported in micrograms per liter (µg/L).
PCE = Tetrachloroethene; TCE = Trichloroethene; cis-1,2-DCE = cis-1,2-Dichloroethene; VC = Vinyl Chloride
D - the sample was diluted for analysis.
U - the analyte was analyzed for but was not detected above the detection limit.
J - the analyte was detected, but the analytical laboratory has flagged the associated numerical value as estimated.
UJ - the analyte was not detected above the detection limit. However, the detection limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
Shaded values exceed ROD concentrations selected from Table 17 of the Portland Harbor Record of Decision (U.S. Environmental Protection Agency Region 10, 2017). Values were selected from remedial action objectives (RAOs) 4 and 8 associated with migration of contaminated groundwater. The following values are used:
PCE = 0.24, TCE = 0.6, cis-1,2-DCE = 70, and VC = 0.022. All values in µg/L.

N

0 25 50 100
Feet

Figure 2a. Southeast Area CVOC Concentrations
August 2003 through April 2021
Northwest Pipe Company
Portland, Oregon

Jacobs

T4S1MW-23

	PCE	TCE	cis-1,2-DCE	VC
9/2/2004	8.0	6.2	16	0.48 J
2/4/2005	5.3	1.2	0.86	0.5 U
5/6/2005	7.8	2.2	4.1	0.5 U
10/25/2016	1.59 J	0.15 UJ	0.70 J	0.008 UJ
2/1/2017	0.937	0.41 J	0.65	0.0188 J
4/27/2017	1.07	0.39 J	0.42 J	0.008 U
7/26/2017	1.21	0.29 J	0.15 U	0.008 U
12/6/2018	1.80	0.61	1.40	0.0230 J
5/9/2019	1.90	0.50	0.34	0.02 U
10/8/2019	1.60	0.40	0.58	0.02 U
4/22/2020	1.60	0.37	0.18 J	0.02 U
10/21/2020	1.80	0.33	1.50	0.02 U
4/14/2021	1.30	0.37	0.23	0.02 U

T4S1MW-22

	PCE	TCE	cis-1,2-DCE	VC
9/2/2004	12	36	23	0.23 J
2/4/2005	27	64	36	0.97
5/6/2005	34	83 D	49	0.88
10/25/2016	1.46 J	4.60 J	2.77 J	0.0499 J
2/1/2017	1.28	4.29	5.36	0.106
4/27/2017	1.43	3.56	2.11	0.022
7/26/2017	1.71	3.00	3.78	0.0638
12/6/2018	1.40	4.60	5.80	0.0760 J
5/8/2019	1.80	4.40	7.50	0.330
10/8/2019	1.30	3.40	7.40	0.180
4/22/2020	1.10	3.30	7.00	0.320
10/21/2020	0.94	2.80	7.90 J	0.170
4/14/2021	1.70	2.70	5.00	0.140

T4S1MW-03S

	PCE	TCE	cis-1,2-DCE	VC
4/21/2004	0.77	0.29 J	2.3	0.5 U
8/30/2004	1.8	1.3	89	5.4
1/31/2005	14	3.5	15	1.3
5/5/2005	1.9	0.42 J	7.6	0.5 U
10/25/2016	0.112 J	0.15 UJ	0.15 UJ	0.008 UJ
2/1/2017	0.230	0.15 U	0.15 U	0.008 U
4/26/2017	0.117	0.15 U	0.15 U	0.008 U
7/25/2017	0.0508	0.15 U	0.15 U	0.008 U
12/5/2018	0.1 U	0.1 U	0.1 U	0.02 U
5/8/2019	0.1 U	0.1 U	0.1 U	0.02 U
10/7/2019	0.1 U	0.1 U	0.1 U	0.02 U
4/21/2020	0.1 U	0.1 U	0.1 U	0.02 U
10/20/2020	0.1 U	0.1 U	0.1 U	0.02 U
4/13/2021	0.1 U	0.1 U	0.1 U	0.02 U

T4S1MW-09

	PCE	TCE	cis-1,2-DCE	VC
4/20/2004	0.15	0.5 U	0.5 U	0.5 U
9/1/2004	0.5 U	0.5 U	0.5 U	0.5 U
2/9/2005	0.5 U	0.5 U	0.5 U	0.5 UJ
5/9/2005	0.13 U	0.14 U	0.12 U	0.22 U
10/25/2016	0.0191 J	0.15 UJ	0.15 UJ	0.0197 J
2/1/2017	0.0177 J	0.15 U	0.15 U	0.0113 J
4/26/2017	0.005 U	0.15 U	0.15 U	0.008 U
7/25/2017	0.0139 J	0.15 U	0.15 U	0.008 U
12/5/2018	0.1 U	0.1 U	0.1 U	0.02 U
5/8/2019	0.1 U	0.1 U	0.1 U	0.02 U
10/7/2019	0.1 U	0.1 U	0.1 U	0.02 U
4/21/2020	0.1 U	0.1 U	0.1 U	0.02 U
10/20/2020	0.1 U	0.1 U	0.1 U	0.02 U
4/13/2021	0.1 U	0.1 U	0.1 U	0.02 U

LEGEND

- Groundwater Quality Monitoring Well (CVOC concentrations in µg/L)
- Well Used for Water Level Measurements Only
- Groundwater Elevation Contour (0.5 ft contour interval, ft NGVD29)
- Groundwater Elevation Contour (0.05 ft contour interval, to show detail in the NW Pipe Southeast Area, ft NGVD29)
- Groundwater Flow Direction
- Northwest Pipe Facility Boundary

Notes:
All chlorinated volatile organic compound (CVOC) concentrations are reported in micrograms per liter (µg/L).
PCE = Tetrachloroethene; TCE = Trichloroethene; cis-1,2-DCE = cis-1,2-Dichloroethene; VC = Vinyl Chloride
D - the sample was diluted for analysis.
U - the analyte was analyzed for but was not detected above the detection limit.
J - the analyte was detected, but the analytical laboratory has flagged the associated numerical value as estimated.
UJ - the analyte was not detected above the detection limit. However, the detection limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
Shaded values exceed ROD concentrations selected from Table 17 of the Portland Harbor Record of Decision (U.S. Environmental Protection Agency Region 10, 2017). Values were selected from remedial action objectives (RAOs) 4 and 8 associated with migration of contaminated groundwater. The following values are used:
PCE = 0.24, TCE = 0.6, cis-1,2-DCE = 70, and VC = 0.022. All values in µg/L.

N

0 45 90 180
Feet

Figure 2b. Southeast Area CVOC Concentrations
August 2003 through April 2021
Northwest Pipe Company
Portland, Oregon

Jacobs

\\PDXFPP01\PROJ\NORTHWESTPIPECOMPANY\485880PORTHARBSUP\GIS\MAPFILES\2021\GROUNDWATERMONITORINGREPORTS\2Q2021\FIGURE2B_VOC_CONCENTRATIONS_2003-2020.MXD GGEE 5/24/2021 3:03:38 PM

\\PDXFPP01\PROJ\NORTHWESTPIPECOMPANY\485880PORTHARBSUP\GIS\MAPFILES\2021\SOIL GAS INVESTIGATION\FIGUREX_PSG_INVESTIGATION.MXD GGEE 4/5/2021 1:21:21 PM

LEGEND

- Actual Soil Gas Investigation Location
- Proposed Soil Gas Investigation Location

Current Monitoring Network

- Groundwater Quality Monitoring Well
- Well Used for Water Level Only
- Northwest Pipe Facility Boundary

1897 Surface Water Features

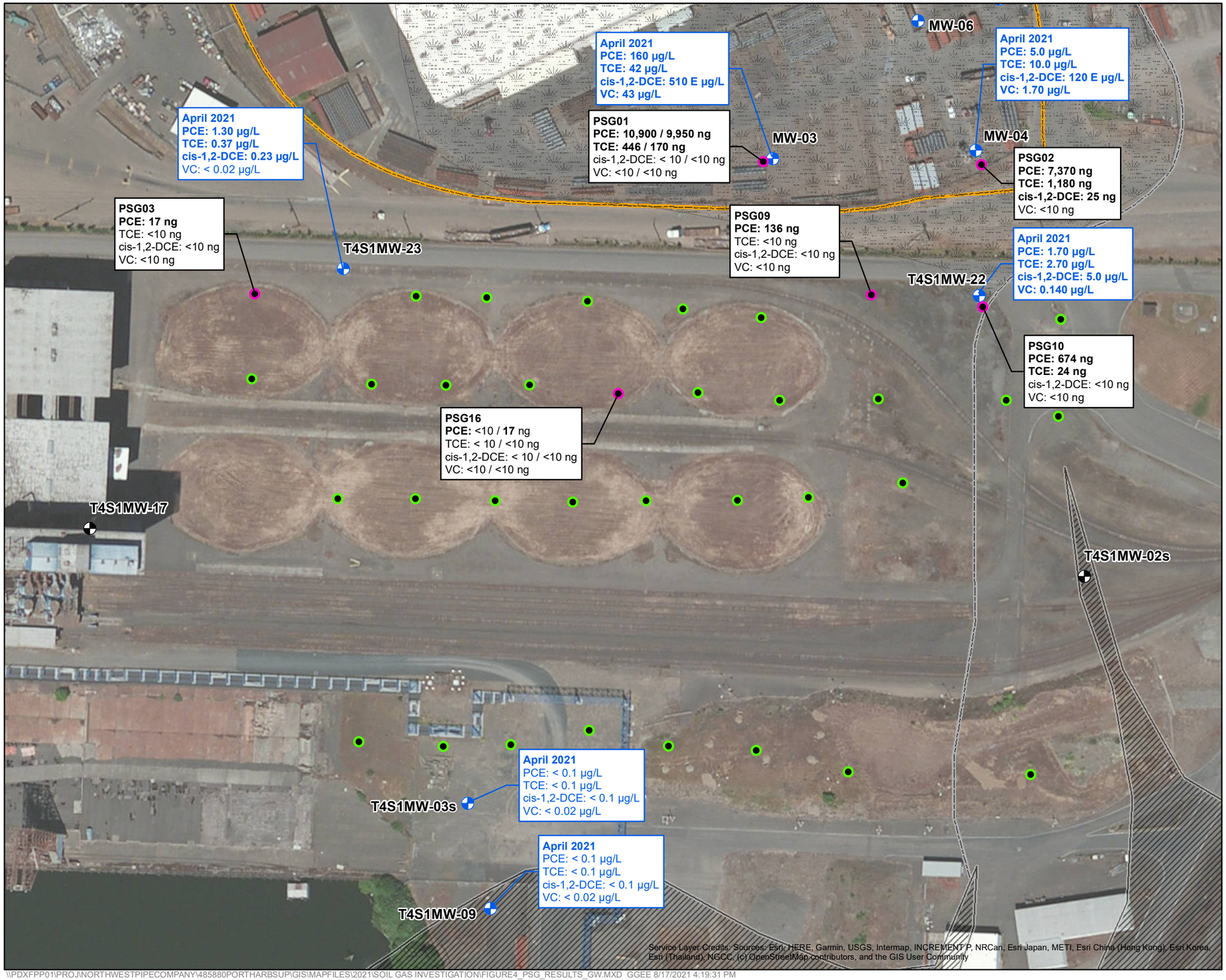
- Historical Waterbody
- Historical Marsh/Mudflat
- Historical Gatton Creek

N

0 50 100 200
Feet

Figure 3. Soil Gas Investigation Sample Locations
Northwest Pipe Company
Portland, Oregon

Jacobs



\\PDXFPP01\PROJ\NORTHWESTPIPECOMPANY\485880PORTHARBSUP\GIS\MAPFILES\2021\SOIL GAS INVESTIGATION\FIGURE4_PSG_RESULTS_GW.MXD GGEE 8/17/2021 4:19:31 PM

LEGEND

Soil Gas Investigation Location

- No Detected Constituents
- Detected Constituents (see point labels)

Current Monitoring Network

- Groundwater Quality Monitoring Well
- Well Used for Water Level Only
- Northwest Pipe Facility Boundary

1897 Surface Water Features

- Historical Waterbody
- Historical Marsh/Mudflat
- Historical Gatton Creek[1]

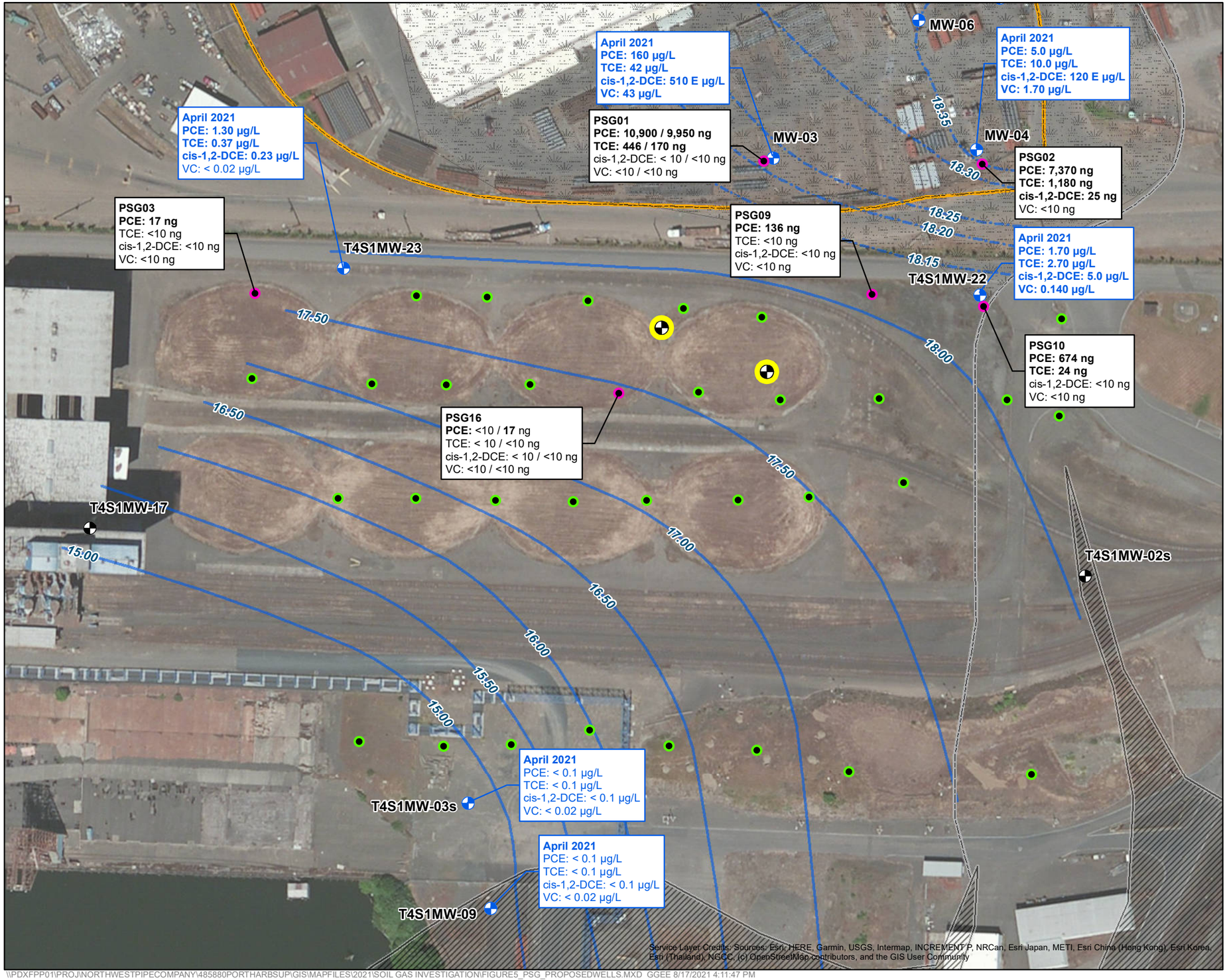
Notes:
PCE = Tetrachloroethene
TCE = Trichloroethene
cis-1,2-DCE = cis-1,2-Dichloroethene
VC = Vinyl Chloride
ng = nanograms
< 10 = nondetect above reported value
Detected constituents are shown in bold text.
[1]The depicted location of Gatton Creek is based on its mapped location shown by the U.S. Geological Survey in its 1897 topographic map of the area. However, the creek channel may have shifted to the east or west over time, as is common for stream channels, before it was buried by fill placed in the area in the early 1940s.

N

0 50 100 200
Feet

Figure 4. Soil Gas and Groundwater Monitoring Results
Northwest Pipe Company
Portland, Oregon

Jacobs



LEGEND

- Proposed Monitoring Well

Soil Gas Investigation Location

- No Detected Constituents
- Detected Constituents (see point labels)

Current Monitoring Network

- Groundwater Quality Monitoring Well
- Well Used for Water Level Only
- Northwest Pipe Facility Boundary

1897 Surface Water Features

- Historical Waterbody
- Historical Marsh/Mudflat
- Historical Gatton Creek[1]
- Groundwater Elevation Contour, April 13, 2021 (0.5 ft contour interval, ft NGVD29)
- Groundwater Elevation Contour, April 13, 2021 (0.05 ft contour interval, to show detail in the NW Pipe Southeast Area, ft NGVD29)

Notes:
PCE = Tetrachloroethene
TCE = Trichloroethene
cis-1,2-DCE = cis-1,2-Dichloroethene
VC = Vinyl Chloride
ng = nanograms
< 10 = nondetect above reported value
Detected constituents are shown in bold text.
[1]The depicted location of Gatton Creek is based on its mapped location shown by the U.S. Geological Survey in its 1897 topographic map of the area. However, the creek channel may have shifted to the east or west over time, as is common for stream channels, before it was buried by fill placed in the area in the early 1940s.

N

0 50 100 200
Feet

Figure 5. Proposed Monitoring Wells
Northwest Pipe Company
Portland, Oregon

Jacobs

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