Lakewood Plaza Cleaners/Ponders Corner Groundwater Monitoring Results, October 2018 and October 2020

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Abstract

This data summary report presents water quality results for groundwater samples collected in October 2018 and October 2020 at the former Lakewood Plaza Cleaners site, in Lakewood, WA. The site, listed on the National Priorities List (NPL) as Lakewood Ponders Corner, was added to the NPL due to chlorinated solvent contamination impacting municipal supply wells operated by the Lakewood Water District. The contamination was caused by improper waste disposal at the former cleaners. Groundwater monitoring has been conducted at this site since 1985. The Washington State Department of Ecology's (Ecology's) groundwater sampling program at the site has been ongoing since the early 1990s.

The U.S. Environmental Protection Agency selected the remedial option of installation and operation of wellhead treatment systems on the Lakewood Water District municipal supply wells H1 and H2. This remedial activity is ongoing. The purpose of Ecology's monitoring program is to evaluate the effectiveness of wells H1 and H2 in containing and treating contaminated groundwater.

This report presents data for two sampling events. In October 2018, Ecology collected groundwater samples from four monitoring wells and Lakewood Water District municipal well H1. In October 2020, Ecology sampled eight monitoring wells and Lakewood Water District municipal well H1.

Tetrachloroethene (PCE) concentrations in monitoring wells MW-20B and MW-16A continue to exceed (not meet) the project cleanup level of 5 micrograms per liter (µg/L). Well MW-20B had a PCE concentration of 124 µg/L and 157 µg/L in 2018 and 2020, respectively. In 2018, the concentration of PCE in MW-16A was 54.7 µg/L. In 2020, an estimated concentration of 28.4 µg/L PCE was found in MW-16A.

In October 2018, no PCE was detected in the sample from the municipal supply well H1 collected prior to treatment. In October 2020, PCE was detected in H1 at a concentration of 3.1 µg/L, below the cleanup level of 5 µg/L.

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This report was prepared under the supervision of a licensed hydrogeologist. A signed and stamped copy of the report is available upon request.

Background

Site History

In 1981, the U.S. Environmental Protection Agency (EPA) first detected volatile organic compound (VOC) contamination in two Lakewood Water district production wells. The affected production wells, H1 and H2, are located at 5612 New York Ave. SW, in Lakewood (Figure 1), adjacent to Interstate-5 in Pierce County (EPA, 1983). Contaminants found in the wells included the chlorinated solvent tetrachloroethene (PCE) and its degradation products trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE).

The EPA identified the former Lakewood Plaza Cleaners as the source of the contamination. Lakewood Plaza Cleaners was a laundry facility that performed dry cleaning until the mid-1980s and other laundry services into the early 1990s. The former dry cleaning facility was located across Interstate-5, approximately 800 feet north of the production wells (Figure 1). Improper waste disposal at the cleaners, including PCE dumped into on-site septic tanks, and dry cleaning sludge disposed of on the ground surface, was the cause of groundwater contamination (EPA, 1983). In 1982, the Lakewood Plaza Cleaners site was added to the National Priorities List (NPL) under the site name Lakewood/Ponders Corner. Rainier Lighting and Electric Supply is the current occupant of the former Lakewood Plaza Cleaners facility. The site is listed on Ecology's Confirmed and Suspected Contaminated Sites List under the name Lakewood Ponders Corner, cleanup site ID 735.

In 1983, EPA began remedial activities at the Lakewood Plaza Cleaners site. Remediation activities included:

1. Installation of air-strippers at Lakewood Water District production wells to treat groundwater.
2. Removal and off-site disposal of contaminated soils and sludge from the source area.
3. Vapor extraction treatment of contaminated soils associated with the septic field from 1988 to 1989 (EPA, 2017).

In 1993, EPA determined remediation of the contaminated soil was complete. In 1996, EPA removed the soils component of the site from the NPL (EPA, 1996).

Since the early 1990s, the Washington State Department of Ecology (Ecology) has had an active role at the Lakewood Plaza Cleaners site. In 1991, Ecology began semi-annual groundwater compliance monitoring at the site. In 1997, Ecology assumed responsibilities for operation and maintenance of the remedial actions; however, the Lakewood Water District performs the routine operation and maintenance of the air-stripping treatment system. The purpose of Ecology's sampling is to produce groundwater quality data for use in evaluating the effectiveness of Lakewood water supply wells H1 and H2 to contain, remove, and treat the groundwater contaminated by Plaza Cleaners.

Air-stripping treatment of groundwater pumped by wells H1 and H2 continues because groundwater cleanup levels for PCE of 5 µg/L have not been consistently achieved for pre-treatment production well samples.

Hydrogeologic Setting

The current monitoring plan for the Lakewood Ponders Corner site includes 10 monitor wells and the two Lakewood Water District supply wells. Eight of the 10 monitoring wells are completed in Advance Outwash deposits at depths between 93 feet (ft.) and 118 ft. One well (MW-20B) is completed in the Vashon Till at a depth of 53 ft., and the remaining well (LPMW-2) is completed in the Steilacoom Gravels at a depth of 29 ft. The two municipal supply wells, H1 and H2, are completed in the Advance Outwash to depths of 108 ft. and 105 ft., respectively. Construction details for all wells in the monitoring plan are given in Table 1.

Table 1. Well construction details.

Well ID	Well Depth (feet bgs)	Screen Interval (feet bgs)	Surface Elevation (feet, NAVD88)
MW-16A	109	105 – 109	278.4
MW-19A	106	96 – 106	289.9
MW-20A	103	93 – 103	279.8
MW-20B	53	43 – 53	279.8
MW-28R	102	88 – 98	280.6
MW-31	93	79 – 93	283.4
MW-32	118	102 – 118	300.4
MW-33	97	75 – 97	277.7
MW-41R	97	84.5 – 94.5	274.1
LPMW-2	29	15 – 29	280.3
H1	108	85 – 106	282.6
H2	105	86 – 105	281.8

bgs: below ground surface

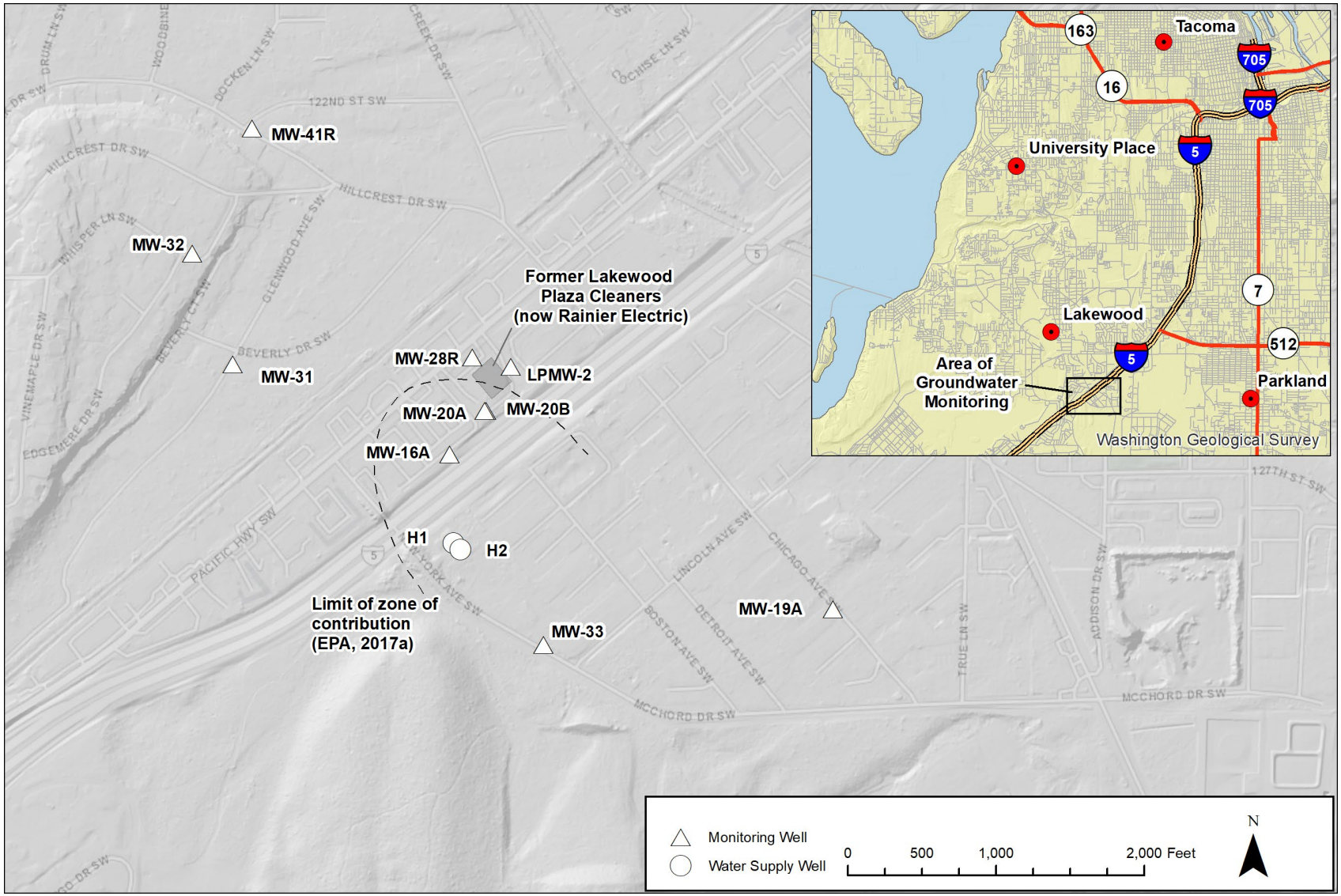

Figure 1. Locations of the Lakewood Plaza Cleaners site, project monitoring wells, and the Lakewood Water District supply wells.

The two relatively shallow wells screened in the Steilacoom Gravel and Vashon Till units are located near the contaminant source area. The Steilacoom Gravel is composed of permeable Vashon recessional sand and gravel deposits. This is the uppermost unit underlying the site, typically encountered up to a depth of about 30 feet below ground surface (bgs). The Steilacoom gravels, which are typically unsaturated, contain an area of perched groundwater in the immediate vicinity of the former Plaza Cleaners and near the production wells H1 and H2 (EPA, 1985a).

Underlying the Steilacoom Gravel is the Vashon Till, which consists of semi-confining silt and clay-rich layers that contain lenses of clean gravel. This unit, which is highly variable in thickness, is typically encountered from about 30 to 75 feet bgs. Within the project area, the Vashon Till is thickest to the north and west of the former Plaza Cleaners site; the unit thins and possibly pinches out to the southeast of the production wells H1 and H2 (USACE, 2012).

Within the Vashon Till is at least one gravel lens present beneath the former Plaza Cleaners site; this lens appears to be large in its lateral extent. This permeable interval appears to be hydraulically interconnected with the Steilacoom Gravel (EPA, 1985b).

The remaining wells are screened in the highly permeable sands and gravels of the deeper Advance Outwash deposits, the primary water supply aquifer for the area. This unit is typically 75 to 110 feet bgs. Regional groundwater flow in the Advance Outwash is generally to the west-northwest toward Gravelly Lake. The horizontal hydraulic conductivity in the Advance Outwash ranges from 400 to 2000 feet per day, with linear flow velocities reaching up to 100 feet per day (USACE, 2012). The production wells H1 and H2 create a capture zone (Figure 1) influencing groundwater flow directions in the area when the wells are pumping (EPA, 2017a).

Ongoing monitoring and review

Since 1985, groundwater monitoring has been conducted at this site. In accordance with EPA policy and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA § 121(42 U.S.C. Section 9621)) and the National Contingency Plan, five-year reviews are required on projects where cleanup goals have not been achieved. Six five-year reviews for the Lakewood Plaza Cleaners/Ponders Corner site have been completed: In 1992, 1997, 2007, and 2017, EPA conducted five-year reviews. In 2002, Ecology conducted a five-year review. In 2012, the U.S. Army Corps of Engineers (USACE) conducted a five-year review.

In 2016, EPA conducted a study to address questions raised during the 2012 five-year review regarding (1) the fate of contaminants in the low-permeability Vashon Till, and (2) the effectiveness of groundwater captured by wells H1 and H2 (USACE, 2012). EPA's study included groundwater sampling and hydraulic monitoring from April to November 2016. A primary goal of the study was to assess the ability of H1 and H2 to capture contaminated groundwater when wells H1 and H2 are operating in a non-continuous manner (EPA, 2017a).

The EPA study found that, contrary to the existing conceptual site model, the vertical hydraulic gradient was upward from the Advance Outwash deposits to the Vashon Till during the April through November study period. During the wetter months of December through March, EPA hypothesizes that the vertical gradient reverses to downward from the Vashon Till to the Advance Outwash. Regional groundwater flow is to the northwest, towards Gravelly Lake.

In the sixth five-year review (EPA, 2017b), EPA concluded that hydraulic control cannot be maintained at all times without continuous pumping of supply wells H1 and H2. Although the 2016 groundwater sampling events did not find contaminants of concern in four monitoring wells (MW-28R, MW-31, MW-32, MW-41R) beyond the supply wells' zone of influence (EPA 2017a), in 2017 PCE was detected in MW-31 and MW-32 at concentrations below the 5 µg/L cleanup limit (Marti, 2018).

EPA recommends installation of a new monitoring well west of MW-16A at the corner of Pacific Highway Southwest and New York Avenue Southwest in order to determine whether contaminants are migrating beyond the capture zone of wells H1 and H2 (EPA, 2017b).

Because the cleanup goals have not been achieved at the Lakewood Plaza Cleaners/Ponders Corner site, remediation and monitoring of the groundwater is ongoing under a long-term response action.

Data collected by Ecology, and the associated monitoring reports for this project, are available at Ecology's Environmental Information Management (EIM) website EIM Database. Search Study ID: LAKEWOOD.

Methods and Results

In October 2018, Ecology sampled groundwater from the two shallow (LPMW-2, MW-20B) and three deep (MW-16A, MW-20A, H1) wells in order to evaluate volatile organics in groundwater at the Lakewood Plaza Cleaners/Ponders Corner site (Figure 2). In October 2020, Ecology sampled groundwater from the one shallow well (MW-20B) and seven deep wells (MW-16A, MW-19A, MW-20A, MW-31, MW-32, MW-33, H1).

Ecology sampled the Lakewood Plaza Cleaners monitoring wells in accordance with Standard Operating Procedure (SOP) EAP078 (Marti, 2020). Prior to sampling, wells were purged through a continuous flow cell until field parameters (pH, temperature, specific conductance, dissolved oxygen, and oxidation reduction potential) stabilized, as specified in SOP EAP078 (Marti, 2020). Stabilized field parameters collected during the 2018 and 2020 sampling events are presented in Tables 2 and 3, respectively.

A stainless steel submersible pump was used to purge and sample all monitoring wells except for LPMW-2. In 2018, LPMW-2 was purged and sampled with a peristaltic pump due to low water levels. In 2020, the low water level in LPMW-2 prevented sampling. Municipal well H1 was operating at the time of both the October 2018 and October 2020 sampling. The sample for well H1 was collected from a tap before any water treatment, in accordance with Ecology's SOP EAP077 (Marti, 2016a).

Table 2. October 2018 field data.

Well ID	Groundwater Elevation (feet, NAVD88)	pH (std. units)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)
MW-16A	243.79	6.9	205	3.5	47
MW-20A	250.42	7.3	200	3.4	49
MW-20B	250.41	6.5	231	4.7	61
LPMW-2 [a]	256.07	--	213	5.4	47

[a] The pH sensor on the field meter malfunctioned while purging LPMW-2

Table 3. October 2020 field data.

Well ID	Groundwater Elevation (feet, NAVD88)	pH (std. units)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)
MW-16A	235.13	6.8	218	5.6	63
MW-19A	249.28	6.4	184	4.8	49
MW-20A	245.13	7.3	223	4	7
MW-20B	243.14	6.4	263	4.9	46
MW-28R	243.90	6.7	216	5.9	90
MW-31	239.95	6.5	174	3.8	61
MW-32	234.63	6.6	190	4.5	78
MW-33	239.88	6.5	197	8.46	32
LPMW-2 [a]	252.06	--	--	--	--
H1	--	6.2	165	5.6	9

[a] LPMW-2 was not purged or sampled due to low water level.

Samples were collected in clean laboratory-supplied bottles and submitted for analysis of volatile organic compounds (VOCs). All analyses were performed by Ecology's Manchester Environmental Laboratory. Analytical results for VOCs of concern (PCE, TCE, cis-1,2-DCE, and vinyl chloride) for the two sampling events are presented in Tables 4 and 5 and Figure 2.

Table 4. October 2018 analytical results.

Well ID	PCE	TCE	Cis-1,2-DCE
MW-16A	**54.7**	**0.73J**	**0.99J**
MW-16A (duplicate)	**59.3**	**0.77J**	**0.98J**
MW-20A	1U	1U	1U
MW-20B	**124**	**1.77**	**2.72**
LPMW-2	**18.8**	1U	1U
H1	1U	1U	1U
Project Cleanup Level[a]	*5*	*5*	*70*

U: The analyte was not detected at or above the reported result.
J: The analyte was positively identified. The associated numerical result is an estimate.
Bold: The analyte was positively identified.
Bold and Underlined: Values are greater than project cleanup levels.
[a] Project Cleanup Levels are based on the Federal Maximum Contaminant Levels.

Table 5. October 2020 analytical results.

Well ID	PCE	TCE	Cis-1,2-DCE
MW-16A	**28.4J**	**0.44J**	**0.78J**
MW-16A (duplicate)	**27.8**	**0.47J**	**0.77J**
MW-19A	1U	**0.39J**	1U
MW-20A	1U	1U	1U
MW-20B	**157**	**4.34**	**6.73**
MW-28R	1U	1U	1U
MW-31	**0.97J**	1U	1U
MW-32	**1.28**	1U	1U
MW-32 (duplicate)	**1.34**	1U	1U
MW-33	1U	1U	1U
H1	**3.13**	1U	1U
Project Cleanup Level[a]	*5*	*5*	*70*

U: The analyte was not detected at or above the reported result.
J: The analyte was positively identified. The associated numerical result is an estimate.
Bold: The analyte was positively identified.
Bold and Underlined: Values are greater than project cleanup levels.
[a] Project Cleanup Levels are based on the Federal Maximum Contaminant Levels.

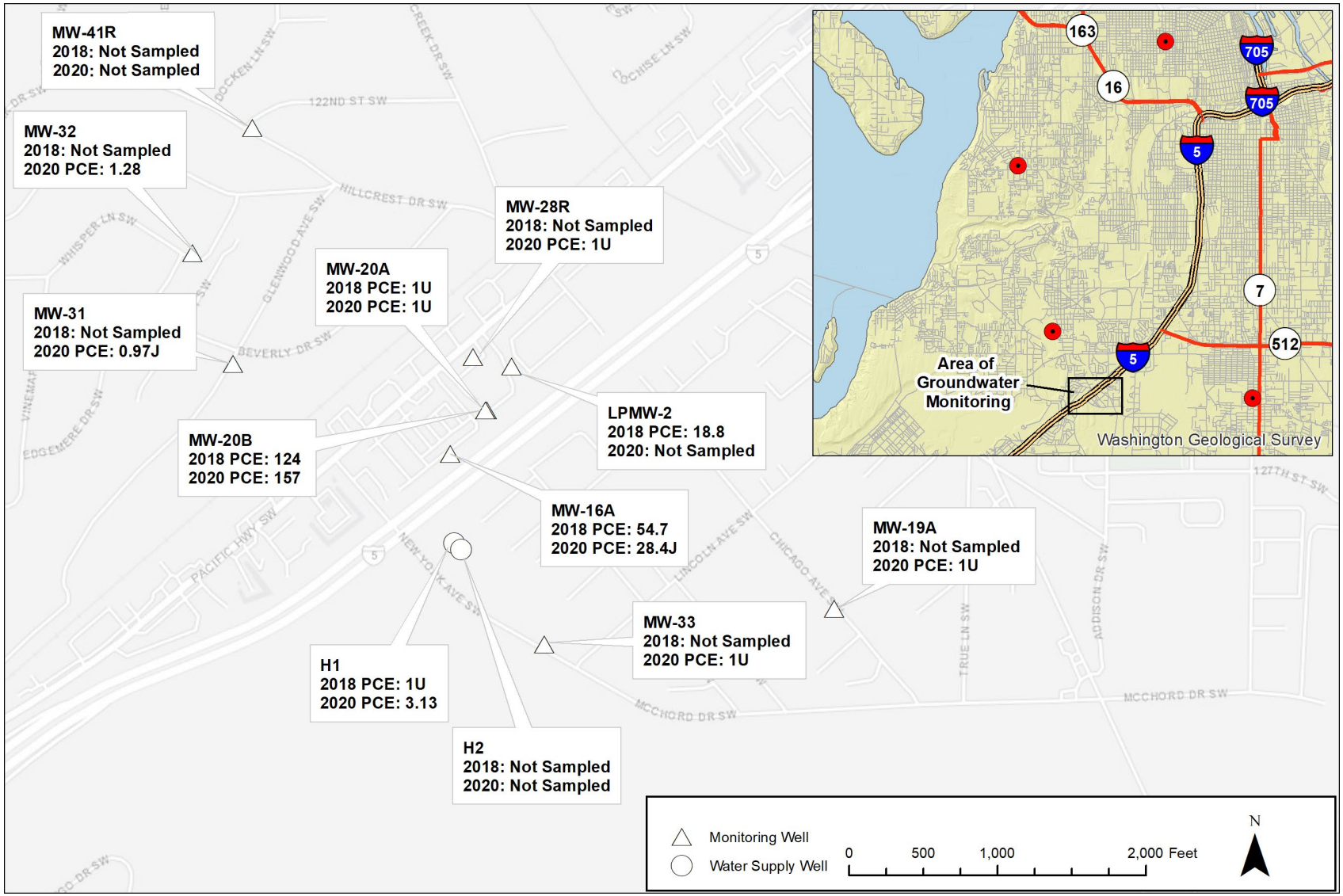

Figure 2. PCE concentrations (µg/L) in samples from October 2018 and October 2020.

Quality control samples collected in the field consisted of a blind field duplicate collected from well MW-16A in 2018, and from wells MW-16A and MW-32 in October 2020. The relative percent difference (RPD) for PCE was 8.1% in MW-16A for the October 2018 data, and 4.6% in MW-32 for the October 2020 data. The RPD is not calculated for estimated results. The duplicate data meet the laboratory data quality objective (DQO) of 30% for this analysis.

Results reported below the method reporting limit (1 µg/L) are automatically qualified as estimates. The laboratory data quality control and quality assurance results indicate that the analytical performance was good and the results are usable as qualified.

In both 2018 and 2020, PCE concentrations in wells MW-16A and MW-20B continued to far exceed (not meet) the cleanup level of 5µg/L. Both of these wells contained detectable concentrations of TCE and cis-1,2,-DCE below the cleanup limits in both sampling events. In MW-16A, TCE and cis-1,2-DCE concentrations were detected below the reporting 1 µg/L reporting limit.

In 2018, the PCE concentration in well LPMW-2 exceeded the cleanup level. TCE and cis-1,2,-DCE were not detected. This well could not be sampled in 2020 because of low water level. Well LPMW-2 is in the vicinity of the former Lakewood Plaza Cleaners septic system that was a source of the site's contamination.

In 2018, no detectable PCE was found in the sample collected from municipal well H1 before treatment (Table 4). The October 2020 sample from well H1 did have detectable PCE below the cleanup limit (Table 5).

In the 2020 sampling, wells MW-31 and MW-32 had PCE at concentrations below the cleanup limits.

Vinyl chloride was not detected in any of the sampled wells in either sampling event. Although the reporting limit was 1 µg /L, the method detection limit for the October 2018 and October 2020 analyses was 0.04 µg /L. Vinyl chloride has not been detected in any of the samples collected by Ecology since taking over the monitoring in 1991.

Long-term VOC data for wells monitored during the Lakewood Plaza Cleaners/Ponders Corner project are presented in Tables A1 – A12. Figure 3 shows PCE concentration data for wells MW-16A and MW-20B for the same time period.

Discussion and Conclusions

Groundwater in the vicinity of the former Lakewood Plaza Cleaners site continues to have PCE concentrations higher than the project cleanup level of 5 µg/L. In wells MW16-A and MW-20B, PCE concentrations far exceed (do not meet) the cleanup level in both 2018 and 2020. Both of these wells contained detectable concentrations of TCE and cis-1,2,-DCE below the respective cleanup limits of 5 µg/L and 70 µg/L for both sampling events.

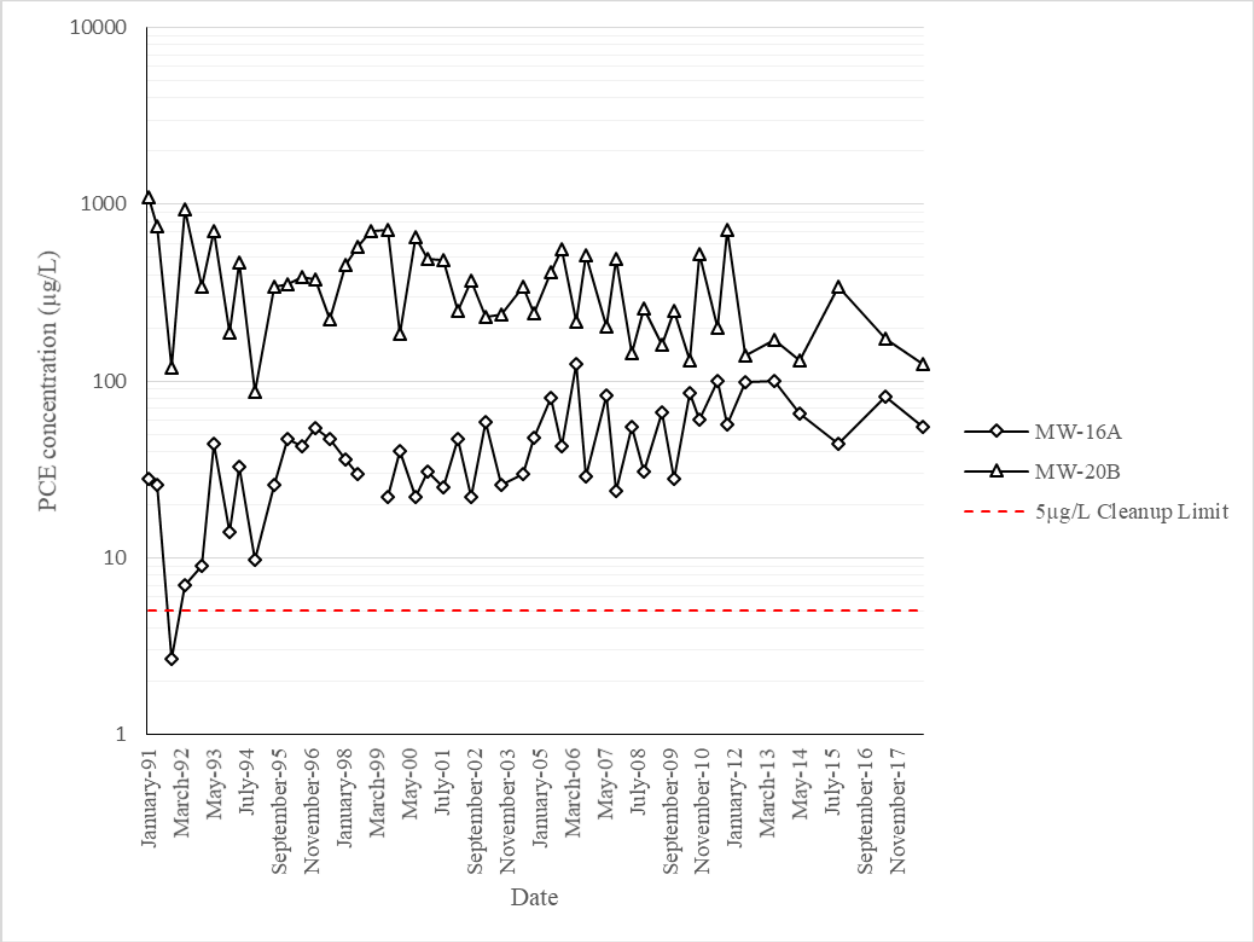

Figure 3. PCE concentrations (µg/L) over time in wells MW-16A and MW-20B.

Hydraulic data collected by EPA show that, for at least part of the year, the vertical groundwater gradient in the vicinity of MW-16A and MW-20B is upward from the Advance Outwash to the Vashon Till (EPA, 2017a, 2017b). This finding is counter to the original conceptual site model, which assumed a persistent downward gradient. EPA hydraulic monitoring was conducted over the relatively dry months of April to November (EPA, 2017a). EPA hypothesizes that the vertical gradient reverses when aquifer recharge occurs during the wetter months of December to March (EPA, 2017a, 2017b). Such a seasonal reversal may explain the apparent seasonal variations observed in MW-16A and MW-20B (Figure 3).

Similar to previous data summary reports (e.g. Marti, 2018), data from wells MW-16A and MW-20B were analyzed with the Mann-Kendall trend test using ProUCL Software. For 1991 through 2020, the trend analysis suggests that PCE concentrations in well MW-20B are decreasing, while concentrations in well MW-16A are increasing.

In 2018, PCE concentrations were detected in well LPMW-2 higher than the 5 µg/L cleanup limit; this well was not sampled in 2020 due to insufficient water volume in the well. The water level in LPMW-2 has been low enough to require sampling with a peristaltic pump, or to prevent sampling, since 2015 (e.g. Marti, 2016b, Marti, 2018). LPMW-2 is the only monitoring well completed within the Steilacoom Gravel in the monitoring plan.

Supply well H1 was operating during both the 2018 and 2020 sampling. In 2018, no contaminants were detected in H1. In 2020, PCE was detected at a concentration of 3.13 µg/L, below the cleanup limit of 5 µg/L. The PCE concentrations in groundwater samples from supply wells H1 and H2 have not been higher than the cleanup level since June 2011.

Recommendations

1. **Determine the vertical hydraulic gradient over an entire year**. The hydraulic study conducted by EPA (EPA 2016) found that the vertical hydraulic gradient in the vicinity of Lakewood Plaza Cleaners is upwards from the Advance Outwash to the Vashon Till for at least part of the year. A longer duration study (at least one full year) to collect hydraulic data at the former Lakewood Plaza Cleaners site will help determine the timing and magnitude in seasonal reversals in the vertical hydraulic gradient.
2. **Install a new monitoring well as recommended by EPA**. EPA has recommended the installation of a new monitoring well to the west (regionally downgradient) of MW-16A. The proposed location for this new monitoring well is at the corner of Pacific Highway Southwest and New York Avenue Southwest. The recommended completion depth for this well is 115 feet, similar to that of MW-16A. The now decommissioned monitoring well MW-21 was located near the same intersection. Samples from MW-21 had PCE concentrations of about 2 µg/L before the well was decommissioned in 1996.
3. **Assess options to better characterize groundwater flow gradients and contaminant extent in the Steilacoom Gravel and Vashon Till**. Currently, the groundwater monitoring plan includes only one monitoring well in either of these geologic units. Additionally, Ecology's ability to sample the lone well in the Steilacoom Gravel (LPMW-2) may be hindered by low water levels. New monitoring wells installed within these units near the contaminant source will help to define the current state of groundwater contamination above the Advance Outwash.
4. **Continue sampling existing monitoring wells according to the monitoring plan**. Because groundwater contamination in the vicinity of Lakewood Plaza Cleaners continues to far exceed the 5 µg/L cleanup level for PCE, ongoing groundwater monitoring is needed to gauge the effectiveness of the cleanup strategy.

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Appendix.

The tables in this appendix summarize groundwater quality results from supply and monitoring wells, as well as groundwater levels in monitoring wells, for the Lakewood Plaza Cleaners/Ponders Corner site collected by Ecology since 1991. Groundwater levels are given as depth below top of well casing. Project Cleanup Levels are based on Federal Maximum Contaminant Levels. The following qualifiers, symbols, and abbreviations are used in the tables:

- U: The analyte was not detected at or above the reported result.
- J: The analyte was positively identified. The associated numerical result is an estimate.
- UJ: The analyte was not detected at or above the reported estimated result.
- NJ: The analyte has been tentatively identified. The associated numerical result is an estimate.
- E: The concentration of the associated value exceeds the known calibration range.
  - Not Measured or Not Sampled
- **Bold:** The analyte was positively identified.
- Shade: Values are greater than project cleanup levels.

Table A1. Summary of sample results (µg/L) in wells H1 or H2 from July 1995 to October 2020.

Date	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
7/1995	**9**	**0.3 J**	1 U	1 U
1/1996	**8.4**	**0.2 J**	**0.2 J**	2 U
7/1996	**0.1 J**	1 U	1 U	1 U
1/1997	**18**	**0.4 J**	**0.4 J**	1 U
7/1997	**8.8**	**0.3 J**	**0.6 J**	1 U
2/1998	**11**	**0.4 J**	**0.3 J**	1 U
7/1998	**9.8**	1 U	**0.1 J**	1 U
1/1999	**1.5**	1 U	1 U	1 U
8/1999	**5.2**	**0.2 J**	1 U	1 U
1/2000	**10**	2 U	1 U	1 U
8/2000	**8.7**	**0.03 J**	1 U	1 U
1/2001	**11**	**0.2 J**	1 U	1 U
8/2001	**6.8**	**0.2 J**	1 U	1 U
2/2002	**12**	**0.2 J**	**0.2 J**	1 UJ
8/2002	**6.1**	1 U	1 U	1 U
2/2003	**1.3**	1 U	1 U	1 U
9/2003	**6.4**	**0.2 NJ**	1 U	5 U
6/2004	**7.9**	**0.2 J**	**0.1 J**	1 U
11/2004	**2.6**	1 U	1 U	5 U
6/2005	**14**	**0.3 J**	1 U	2 U
11/2005	**6.4**	1 U	1 U	2 U
5/2006	**7.3**	**0.2 J**	1 U	5 U
9/2006	**4.8**	1 U	1 U	2 U
6/2007	**5.2**	2 U	2 U	2 U
10/2007	**3.8**	1 U	1 U	2 U
5/2008	**9.6**	1 U	1 U	1 U
10/2008	**5.1**	1 U	1 U	1 U
6/2009	**6.8**	1 U	1 U	1 U
6/2010	**4.3**	1 U	1 U	1 U
6/2011	**5.9**	1 U	1 U	1 UJ
10/2011	**1.4**	1 U	1 U	2 U
6/2012	**5.2**	1 U	1 U	1 U
6/2013	**4.9**	1 U	1 U	1 U
5/2014	**2.9**	1 U	1 U	1 U
10/2015	**1.8**	**0.2 J**	1 U	1 U
6/2017	**3 J**	1 U	1 U	1 UJ
10/2018	1 U	1 U	1 U	1 U
10/2020	**3.13**	1 U	1 U	1 U
Project Cleanup Level	**5**	**5**	**70**	**0.2**

Table A2. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-16A from January 1991 to October 2020.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
1/1991	41.32	**28**	**1 J**	**2.4 J**	1 U
5/1991	39.48	**26**	**0.6 J**	**2**	1 U
11/1991	45.18	**2.7 J**	1 U	**0.6 J**	1 U
5/1992	45.15	**7**	1 U	**1**	1 U
12/1992	--	**9 J**	**0.3 J**	**0.8 J**	1 UJ
5/1993	38.96	**44**	10 U	**2 J**	10 U
12/1993	45.53	**13**	**0.3 J**	**0.7 J**	1 U
4/1994	41.67	**33**	**0.6**	**1.4**	1 U
11/1994	46.95	**9.7**	**0.3 J**	**0.5 J**	1 U
7/1995	42.34	**27**	**0.5 J**	**0.8 J**	1 U
1/1996	36.03	**47 E**	**0.8 J**	**1.5**	2 U
7/1996	38.65	**43**	**0.7 J**	**1.9**	1 U
1/1997	26.32	**54**	**1.1**	**3.1**	1 U
7/1997	39.07	**47**	**0.7 J**	**2.5**	1 U
2/1998	33.82	**36**	**0.7 J**	**2 J**	5 U
7/1998	42.58	**30**	1 U	**1.5**	1 U
8/1999	44.14	**22**	**0.4 J**	**1.1**	1 U
1/2000	36.24	**40**	**0.7 J**	**1.9**	1 U
8/2000	45.06	**22**	**0.3 J**	**0.7**	1 U
1/2001	40.93	**31**	**0.4 J**	**1**	1 U
8/2001	44.46	**25**	**0.3 J**	**0.7 J**	1 U
2/2002	32.47	**47**	**0.8 J**	**2.3**	1 UJ
8/2002	44.64	**22**	**0.3 J**	**0.8 J**	1 U
2/2003	32.60	**59 J**	**0.2 J**	**2.4**	1 U
9/2003	47.91	**26**	**0.3 J**	**0.5 J**	5 U
6/2004	43.29	**30**	**0.4 J**	**0.8 J**	1 U
11/2004	38.47	**48**	1 U	**1.4**	5 U
6/2005	35.06	**80**	**1.3**	**2.8**	5 U
11/2005	38.01	**43**	**0.7 J**	**1 J**	2 U
5/2006	36.59	**124**	**1.8**	**4.6**	5 U
9/2006	41.93	**29**	**0.3 J**	**0.5 J**	2 U
6/2007	35.95	**83**	**1.2**	**2.5**	2 U
10/2007	40.61	**24**	1 U	**0.6 J**	2 U
5/2008	38.23	**55**	**1.2**	**2.8**	1 U
10/2008	43.76	**31**	**0.5 J**	**0.6 J**	1 U
6/2009	34.43	**67**	**0.9 J**	**2.2**	1 U
11/2009	36.75	**28**	**0.5 J**	**0.8 J**	1 U
6/2010	32.04	**85**	**1.3**	**1.6**	1 U
10/2010	36.52	**61**	**0.9 J**	**1.2**	1 U
6/2011	32.93	**100**	**1.4**	**1.6**	1 UJ
10/2011	37.76	**57**	**0.8 J**	**1**	2 U

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
6/2012	33.37	**98**	**1.3**	**2.4**	1 U
6/2013	34.81	**100**	**1.3**	**2.6**	1 U
5/2014	28.8	**65**	**1.1**	**1.3**	1 U
10/2015	42.5	**44**	**0.5 J**	**0.6 J**	1 U
6/2017	34.54	**82 J**	**0.82 J**	**1.3**	1 UJ
10/2018	36.71	**55**	**0.73 J**	**0.99 J**	1 U
10/2020	45.37	**28.4 J**	**0.44 J**	**0.78 J**	1 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A3. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-20A from January 1991 to October 2020.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
1/1991	31.74	1 U	1 U	1 U	1 U
5/1991	29.93	**0.4 J**	1 U	1 U	1 U
11/1991	37.77	**0.4 NJ**	1 U	1 U	1 U
5/1992	35.75	**0.5 J**	1 U	1 U	1 U
12/1992	37.17	**0.8 J**	1 UJ	1 UJ	1 UJ
5/1993	30.87	10 U	10 U	10 U	10 U
12/1993	37.82	**0.3 J**	1 U	1 U	1 U
4/1994	33.27	**0.4**	0.2 U	0.2 U	1 U
11/1994	38.30	**0.3 J**	1 U	1 U	1 U
7/1995	34.51	**0.4 J**	1 U	1 U	1 U
1/1996	27.89	**0.2 J**	1 U	1 U	2 U
7/1996	33.02	**0.4 J**	1 U	1 U	1 U
1/1997	18.45	**0.4 J**	1 U	1 U	1 U
7/1997	30.78	**0.3 J**	1 U	2 U	1 U
2/1998	25.50	**0.4 J**	1 U	1 U	1 U
7/1998	34.68	**0.6 J**	1 U	1 U	1 U
1/1999	25.02	1 U	2 U	1 U	1 U
8/1999	35.57	**0.8 J**	2 U	1 U	1 U
1/2000	26.68	**0.2 NJ**	2 U	1 U	1 U
8/2000	36.53	**0.1 J**	2 U	1 U	1 U
1/2001	32.92	**0.2 J**	1 U	1 U	1 U
8/2001	36.23	1 U	2 U	1 U	1 U
2/2003	27.73	1 U	1 U	1 U	1 U
9/2003	37.27	**0.1 J**	1 U	1 U	5 U
6/2004	34.58	**0.2 J**	1 U	1 U	1 U
11/2004	31.88	**0.3 J**	1 U	1 U	5 U
6/2005	30.15	1 U	1 U	1 U	2 U
11/2005	31.98	1 U	1 U	1 U	2 U
5/2006	29.22	1 U	1 U	1 U	5 U
9/2006	36.19	1 U	1 U	1 U	2 U
6/2007	30.54	2 U	2 U	2 U	2 U
10/2007	35.02	2 U	1 U	1 U	2 U
5/2008	31.33	1 U	1 U	1 U	1 U
10/2008	36.32	1 U	1 U	1 U	1 U
6/2009	29.07	1 U	1 U	1 U	1 U
11/2009	31.10	**0.6 J**	1 U	1 U	1 U
6/2010	26.90	1 U	1 U	1 U	1 U
10/2010	31.69	2 U	1 U	1 U	1 U
6/2011	26.18	1 U	1 U	1 U	1 UJ
10/2011	32.57	1 U	1 U	1 U	2 U

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
6/2012	27.70	1 U	1 U	1 U	1 U
6/2013	29.52	1 U	1 U	1 U	1 U
5/2014	24.02	1 U	1 U	1 U	1 U
10/2015	35.58	**0.2 J**	1 U	1 U	1 U
6/2017	28.85	1 U	1 U	1 U	1 UJ
10/2018	31.98	1 U	1 U	1 U	1 U
10/2020	37.27	1 U	1 U	1 U	1 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A4. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-20B from January 1991 to October 2020.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
1/1991	33.94	**1100**	**18**	**33**	1 U
5/1991	30.57	**752**	**16**	**30**	1 U
11/1991	40.99	**120**	**2.6 J**	**6.7**	1 U
5/1992	38.57	**940**	**13**	**32**	1 U
12/1992	40.57	**340 J**	**14 J**	**20 J**	5 UJ
5/1993	32.48	**700**	**12**	**21**	10 U
12/1993	41.38	**187**	50 U	**8.2 J**	50 U
4/1994	35.49	**472**	**8.6 J**	**12.6**	50 U
11/1994	41.12	**86**	50 U	**3 J**	50 U
7/1995	36.48	**340**	**8.4**	**17**	1 U
1/1996	27.90	**353**	**7.2**	**15**	2 U
7/1996	33.15	**387**	**7.6**	**15**	1 U
1/1997	15.60	**373**	100 U	**6.4 J**	100 U
7/1997	30.31	**222**	**4**	**6.4**	1 U
2/1998	25.28	**456**	**7 J**	**12**	10 U
7/1998	35.78	**575**	**10**	**23**	1 U
1/1999	27.14	**708**	**5.2**	**12**	1 U
8/1999	37.18	**722**	**8.4 J**	**16 J**	1 U
1/2000	27.87	**184**	**6**	**13**	1 U
8/2000	38.39	**648**	200 U	100 U	100 U
1/2001	33.88	**493**	**6.6 J**	**12**	10 U
8/2001	37.67	**486**	**8.2**	**18**	100 U
2/2002	23.50	**248**	200 U	100 U	100 UJ
8/2002	37.92	**371**	**8.5**	**16**	1 U
2/2003	26.60	**230**	100 U	100 U	100 U
9/2003	39.49	**239**	**5.4 J**	**12**	50 U
6/2004	35.76	**344**	**6.5 J**	**15**	10 U
11/2004	32.36	**241**	**6.7**	**13**	5 U
6/2005	29.06	**413**	**6.6**	**12**	5 U
11/2005	32.58	**555**	**6.4**	**11**	2 U
5/2006	27.56	**216**	**4.2**	**6.6**	5 U
9/2006	39.00	**518**	**5.6**	**11**	2 U
6/2007	29.64	**204**	**4.4**	**7.8**	2 U
10/2007	36.9	**491**	**7.5**	**15**	2 U
5/2008	30.65	**143**	**5.5**	**12**	1 U
10/2008	37.48	**258**	**4.5**	**9**	1 U
6/2009	28.24	**160**	**4.1**	**7.4**	1 U
11/2009	32.04	**250**	**4.7**	**9.6**	1 U
6/2010	25.86	**130**	**3.7**	**6.3**	1 U
10/2010	31.79	**520**	**5.8**	**10**	1 U
6/2011	23.39	**200**	**3.5**	**5.6**	1 UJ

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
10/2011	33.18	**720**	**4.8**	**7.9**	2 U
6/2012	26.85	**140**	**3.3**	**5.7**	1 U
6/2013	29.00	**170**	**3.9**	**7**	1 U
5/2014	21.80	**130**	**2.1**	**3**	1 U
10/2015	36.91	**340**	**5.4**	**12**	1 U
6/2017	27.71	**174 J**	**2.9**	**4.5**	1 UJ
10/2018	31.59	**124**	**1.8**	**2.7**	1 U
10/2020	38.86	**157**	**4.34**	**6.73**	1 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A5. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-27 from January 1991 to October 2011.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
1/1991	--	1 U	1 U	1 U	1 U
5/1991	--	1 U	1 U	1 U	1 U
11/1991	--	1 U	1 U	1 U	1 U
5/1992	--	1 U	1 U	1 U	1 U
12/1992	--	1 UJ	1 UJ	1 UJ	1 UJ
5/1993	--	10 U	10 U	10 U	10 U
12/1993	--	1 U	1 U	1 U	1 U
4/1994	--	0.2 U	0.2 U	0.2 U	1 U
11/1994	--	1 U	1 U	1 U	1 U
7/1995	--	1 U	1 U	1 U	1 U
1/1996	--	1 U	1 U	1 U	2 U
7/1996	--	1 U	1 U	1 U	1 U
1/1997	--	1 U	1 U	1 U	1 U
7/1997	--	1 U	1 U	1 U	1 U
2/1998	--	1 U	1 U	1 U	1 U
7/1998	--	**0.05 J**	1 U	1 U	1 U
1/1999	--	1 U	2 U	1 U	1 U
8/1999	--	1 U	2 U	1 U	1 U
1/2000	--	1 U	2 U	1 U	1 U
8/2000	--	1 U	2 U	1 U	1 U
1/2001	--	1 U	1 U	1 U	1 U
8/2001	--	1 U	2 U	1 U	1 U
2/2002	--	1 U	2 U	1 U	1 UJ
8/2002	--	1 U	2 U	1 U	1 U
2/2003	--	1 U	1 U	1 U	1 U
9/2003	--	1 U	1 U	1 U	5 U
6/2004	--	1 U	1 U	1 U	1 U
11/2004	--	1 U	1 U	1 U	5 U
6/2005	--	1 U	1 U	1 U	2 U
11/2005	--	1 U	1 U	1 U	2 U
5/2006	--	1 U	1 U	1 U	5 U
9/2006	34.20	1 U	1 U	1 U	2 U
6/2007	28.95	2 U	2 U	2 U	2 U
10/2007	33.31	2 U	1 U	1 U	2 U
5/2008	29.91	1 U	1 U	1 U	1 U
10/2008	34.42	1 U	1 U	1 U	1 U
6/2009	28.35	1 U	1 U	1 U	1 U
11/2009	29.05	1 U	1 U	1 U	1 U
6/2010	26.62	1 U	1 U	1 U	1 U
6/2011	25.58	1 U	1 U	1 U	1 UJ
10/2011	31.58	1 U	1 U	1 U	2 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A6. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well LPMW-2 from May 2006 to October 2020.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
5/2006	22.62	**9.9**	1 U	1 U	5 U
6/2007	23.99	**4.8**	1 U	1 U	2 U
5/2008	24.90	**2.5**	1 U	1 U	1 U
6/2009	22.48	**4.1**	1 U	1 U	1 U
11/2009	22.81	**11**	1 U	1 U	1 U
6/2010	21.60	**4.4**	1 U	1 U	1 U
10/2010	25.27	**5**	1 U	1 U	1 U
6/2011	20.07	**3.2**	1 U	1 U	1 UJ
6/2012	22.27	**2.4**	1 U	1 U	1 U
6/2013	22.90	**2.2**	1 U	1 U	1 U
5/2014	19.22	**2.7**	1 U	1 U	1 U
6/2017	22.87	**5.7**	1 U	1 U	1 U
10/2018	23.89	**19**	1 U	1 U	0.2 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A7. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-19A from May 1991 to October 2020.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
11/1991	43.40	1 U	**0.5 NJ**	1 U	1 U
12/1992	42.80	1 UJ	1 UJ	1 UJ	1 UJ
12/1993	43.00	1 U	**0.4 J**	1 U	1 U
4/1994	38.62	0.2 U	**0.5**	0.2 U	1 U
7/1995	39.42	1 U	**0.4 J**	1 U	1 U
7/1997	35.94	1 U	**0.3 J**	2 U	1 U
8/1999	40.37	1 U	**0.4 J**	1 U	1 U
8/2001	41.18	1 U	**0.3 J**	1 U	1 U
9/2003	42.69	1 U	**0.4 NJ**	1 U	5 U
6/2005	35.26	1 U	**0.6 J**	1 U	2 U
6/2007	35.00	2 U	**1.2 J**	2 U	2 U
6/2009	34.59	1 U	1 U	1 U	1 U
10/2011	38.41	1 U	**0.4 J**	1 U	2 U
6/2017	33.58	1 U	1 U	1 U	1 U
10/2020	42.42	1 U	**0.39 J**	1 U	1 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A8. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-31 from May 1991 to October 2020.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
1/1991	--	**1 J**	1 U	**1.9 J**	1 U
5/1991	--	**0.6 J**	1 U	**2**	1 U
11/1991	--	**0.9 NJ**	1 U	**2.2 J**	1 U
5/1992	--	**0.8 J**	1 U	**1**	1 U
12/1992	--	**0.5 J**	1 UJ	**0.9 J**	1 UJ
5/1993	--	10 U	10 U	10 U	10 U
12/1993	--	**0.8 J**	1 U	**1.2 J**	1 U
4/1994	--	**0.7**	0.2 U	**1**	1 U
11/1994	--	**0.8 J**	1 U	**1**	1 U
7/1995	--	**0.6 J**	1 U	**0.5 J**	1 U
1/1996	--	**0.6 J**	1 U	**0.7 J**	2 U
7/1997	--	**0.9 J**	1 U	**0.9 J**	1 U
8/1999	--	**0.9 J**	2 U	**0.4 J**	1 U
8/2001	--	**0.4 J**	2 U	**0.3 J**	1 U
9/2003	--	**0.5 J**	1 U	**0.1 NJ**	5 U
6/2005	--	**0.5 J**	1 U	1 U	2 U
6/2007	--	**1.6 J**	2 U	2 U	2 U
10/2011	38.05	**0.7 J**	1 U	1 U	2 U
6/2017	34.61	**0.7 J**	1 U	1 U	1 U
10/2020	41.95	**0.97 J**	1 U	1 U	1 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A9. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-32 from May 1991 to October 2020.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
1/1991	60.1	**1 J**	1 U	**1.1 J**	1 U
5/1991	58.66	**1**	1 U	**2**	1 U
11/1991	64.71	**0.6 NJ**	1 U	**0.6 J**	1 U
5/1992	62.54	**0.7 J**	1 U	**1**	1 U
12/1992	64.67	**0.7 J**	1 UJ	**0.5 J**	1 UJ
5/1993	60.03	10 U	10 U	10 U	10 U
12/1993	65.02	**0.7 J**	1 U	**0.6 J**	1 U
4/1994	61.44	**0.7**	0.2 U	**0.6**	1 U
11/1994	65.63	**0.6 J**	1 U	**0.5 J**	1 U
7/1995	62.31	**0.7 J**	1 U	**0.5 J**	1 U
1/1996	57.2	**0.8 J**	1 U	**0.6 J**	2 U
8/2000	63.08	**0.8 J**	2 U	1 U	1 U
6/2005	59.41	**1.4**	1 U	1 U	2 U
6/2010	57.93	**1.8**	1 U	1 U	1 U
6/2017	58.18	**1.4**	1 U	1 U	1 U
10/2020	64.57	**1.28**	1 U	1 U	1 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A10. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-33 from July 1995 to October 2020.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
7/1995	--	1 U	1 U	1 U	1 U
7/1996	--	1 U	1 U	1 U	1 U
7/1997	--	1 U	1 U	2 U	1 U
7/1998	--	1 U	1 U	1 U	1 U
8/1999	--	1 U	2 U	1 U	1 U
8/2000	--	1 U	2 U	1 U	1 U
8/2001	--	1 U	2 U	1 U	1 U
8/2002	--	1 U	1 U	1 U	1 U
9/2003	--	1 U	1 U	1 U	5 U
6/2005	--	1 U	1 U	1 U	2 U
5/2006	--	1 U	1 U	1 U	5 U
6/2007	--	2 U	2 U	2 U	2 U
5/2008	--	1 U	1 U	1 U	1 U
6/2009	--	1 U	1 U	1 U	1 U
6/2010	--	1 U	1 U	1 U	1 U
10/2011	34.83	1 U	1 U	1 U	2 U
6/2013	31.41	1 U	1 U	1 U	1 U
10/2015	38.18	1 U	**0.2 J**	1 U	1 U
6/2017	29.95	1 U	1 U	1 U	1 UJ
10/2020	40.12	1 U	1 U	1 U	1 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A11. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-40 from January 1991 to October 2011.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
1/1991	32.76	1 U	1 U	1 U	1 U
11/1991	37.65	1 U	1 U	1 U	1 U
12/1992	36.60	1 UJ	1 UJ	1 UJ	1 UJ
12/1993	37.83	1 U	1 U	1 U	1 U
4/1994	34.20	0.2 U	0.2 U	0.2 U	1 U
7/1995	35.25	1 U	1 U	1 U	1 U
8/2000	37.82	1 U	2 U	1 U	1 U
6/2005	34.3	1 U	1 U	1 U	2 U
10/2011	35.98	1 U	1 U	1 U	2 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**

Table A12. Summary of water levels (ft. below measuring point) and sample results (µg/L) in monitoring well MW-41 from January 1991 to June 2010.

Date	Water Level	PCE	TCE	Cis-1,2-DCE	Vinyl Chloride
1/1991	28.45	1 U	1 U	1 U	1 U
5/1991	27.26	1 U	1 U	1 U	1 U
11/1991	32.29	1 U	1 U	1 U	1 U
5/1992	30.36	1 U	1 U	1 U	1 U
12/1992	31.49	1 UJ	1 UJ	1 UJ	1 UJ
5/1993	27.95	10 U	10 U	10 U	10 U
12/1993	32.90	1 U	1 U	1 U	1 U
4/1994	29.40	0.2 U	0.2 U	0.2 U	1 U
7/1995	30.17	1 U	1 U	1 U	1 U
1/1996	25.87	1 U	1 U	1 U	2 U
8/2000	30.98	1 U	2 U	1 U	1 U
6/2005	28.42	1 U	1 U	1 U	2 U
6/2010	26.69	1 U	1 U	1 U	1 U
Project Cleanup Level	**n/a**	**5**	**5**	**70**	**0.2**