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Yakima Railroad Area PCE Contamination

Groundwater Quality Monitoring, Data Summary, 2018-2020

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Groundwater Quality Monitoring, Data Summary, 2018-2020

by

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Abstract

During 2018 through 2020, the Washington State Department of Ecology conducted semi-annual sampling of the Yakima Railroad Area (YRRA) groundwater monitoring network. The YRRA is a six-square-mile area located along the railroad corridor in the cities of Yakima and Union Gap. Groundwater within the project area is contaminated with tetrachloroethene (PCE) which is attributed to numerous local sources. Since the YRRA project area was defined in 1991, cleanup activities have occurred at several of the source areas and appear to have been effective in reducing contaminant concentrations.

Of the 41 wells sampled during 2018-2020, 22 wells (54%) had PCE concentrations above (not meeting) the Model Toxics Control Act (MTCA) cleanup level of 5 ug/L. The maximum PCE concentrations ranged from 5.02 to 26,300 ug/L.

The elevated PCE concentrations primarily occurred in shallow wells at three of the source areas: Goodwill - City of Yakima, Cameron Yakima, and Frank Wear Cleaners. Two of the shallow Remedial Investigation (RI) wells located along the western portion of the YRRA also had elevated PCE concentrations. The source of contamination for the RI wells has not been identified.

PCE concentrations higher than the 5 ug/L cleanup level were also detected in the deeper Washington Central Railroad Roundhouse (WCRR) wells. PCE concentrations ranged from 11.8 ug/L in WDOE-3D, the deepest well in the cluster, to 20.3 ug/L in WDOE-3S. PCE concentrations in these wells indicate the contaminant plume has a vertical extent that reaches the lower confined water-bearing zone in this portion of the YRRA.

The 2018-2020 groundwater data confirm that PCE and associated contaminants remain present in groundwater throughout the YRRA project area. Concentrations have decreased at some of the identified source areas; however, high PCE concentrations are still detected at sites located in the central portion of the YRRA.

Introduction

Background

During routine inspections of industrial facilities in the 1980s, tetrachloroethene (PCE)-contaminated soil and groundwater were discovered at multiple locations in the Yakima area (Secor, 1998). The U.S. Environmental Protection Agency (EPA) referred these findings to the State of Washington. After many investigations, the Washington State Department of Ecology (Ecology) defined the affected area as the Yakima Railroad Area (YRRA) in 1991.

Ecology identified 13 commercial and industrial facilities as potential sources of PCE contamination to groundwater within the YRRA. The YRRA encompasses about 6 square miles of mixed industrial/commercial and residential property adjacent to the rail corridor in the cities of Yakima and Union Gap (Figure 1). The identified PCE sources include dry cleaners, machine shops, a carbon regeneration facility, and a former pesticide formulation plant.

During the 1990s, cleanup activities were conducted at many of the facilities. An area-wide remedial investigation (RI) for the YRRA was completed in 1998 (Secor, 1998). From 1999 to 2012, 59 monitoring wells were routinely sampled during an ongoing program to characterize groundwater PCE concentrations in groundwater across the YRRA. Results indicated that the highest PCE concentrations continued to be found near known sources. There was also evidence that PCE was present in the shallow aquifer in areas where no known source has been identified.

In 2013, Ecology's Environmental Assessment Program (EAP) assumed responsibility for the area-wide monitoring program. In consultation with Ecology's Toxics Cleanup Program (TCP), a subset of 36 wells was selected for continued monitoring. In 2017, 10 additional wells located at the Frank Wear Cleaners site were added, and two wells were removed from the monitoring program. These two wells are at the north end of the project area.

The goal of the current 2018-2020 monitoring is to provide TCP with groundwater quality data to assist in evaluating the effectiveness of remedial actions taken at the identified source areas under the Model Toxics Control Act (MTCA). These data may also be used to identify additional areas of contamination within the YRRA that require further source investigation and remedial action.

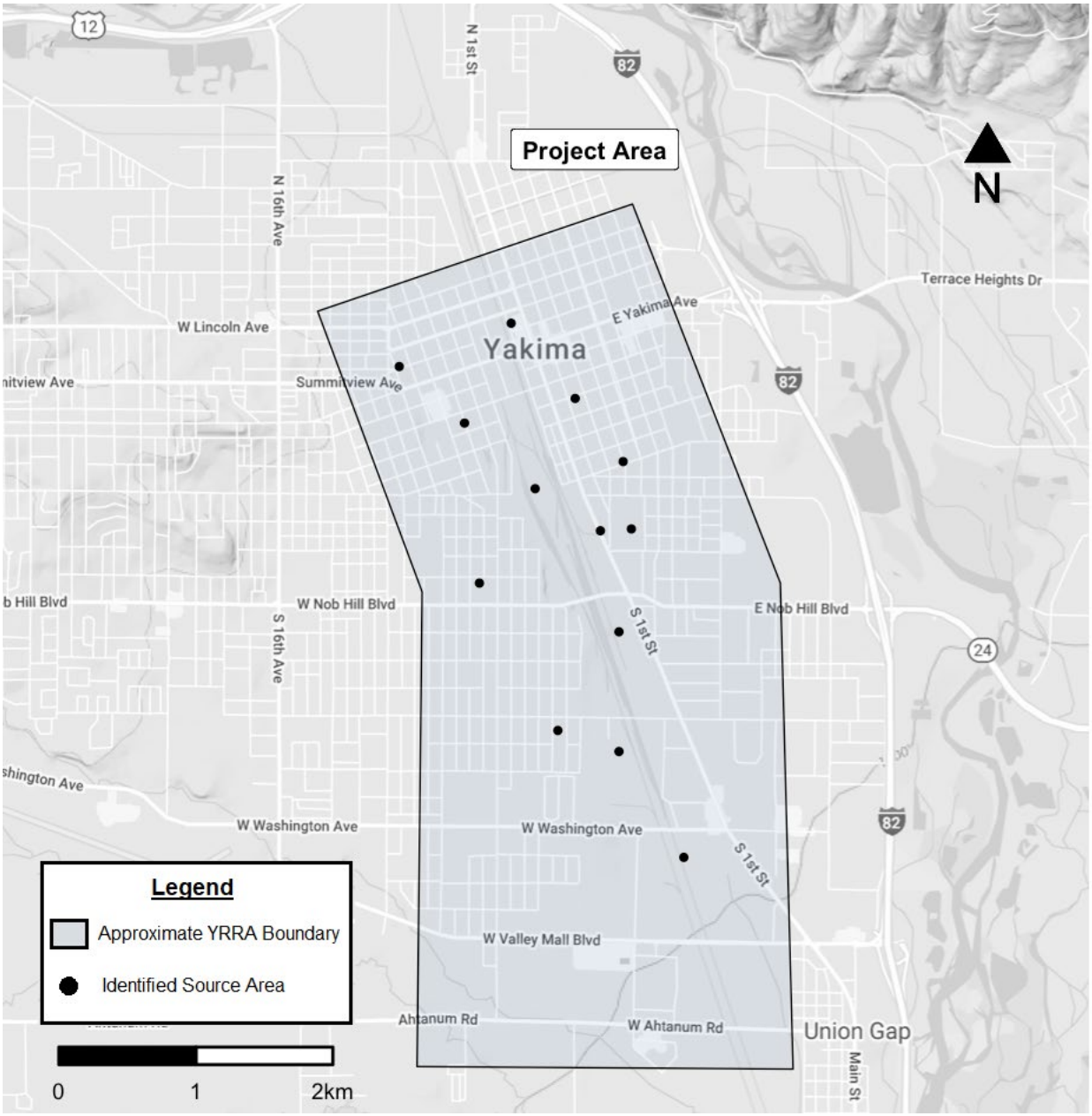


Figure 1. Yakima Railroad Area (YRRA) Project Location Map, Yakima, WA.

Physical Setting

The YRRA is located within the flood plain of the Yakima River and is underlain in most areas by Quaternary-age alluvium and unconsolidated terrace deposits. The alluvium is composed of unconsolidated silt, sand, gravel, and cobble. It ranges in thickness from 0 to 120 feet with an average thickness of 20 feet (USGS, 2009). The underlying terrace deposits consist of coarse-grained gravel with discontinuous layers of silt, clay, sand, or cemented gravel. The terrace gravels generally occur at the surface away from the river and beneath the alluvium adjacent to the river. The thickness of this unit ranges up to 350 feet, with an average thickness of 90 feet (USGS, 2009). These unconsolidated Quaternary deposits are overlain in some areas by artificial fill material up to 20 feet deep, and underlain by consolidated Tertiary-age continental sediments of the Upper Ellensburg Formation.

PCE monitoring in the YRRA focuses on groundwater in the upper portion of the shallow, unconfined aquifer in the unconsolidated sands and gravels. This portion of the aquifer is highly permeable near the Yakima River; however, fine-grained material and cemented gravels are more prevalent in the north and west portions of the project area, resulting in geologic units of contrasting permeability. For this reason, both shallow and deep water-bearing zones were identified within the YRRA project area in the RI/Feasibility Study (Secor, 1998). The shallow and deep water-bearing zones appear to be hydraulically separate in the northern portion of the YRRA and interconnected in the southern portion of the project area.

Groundwater within the YRRA is encountered from about 3 to 30 feet below ground surface (bgs) depending on the topography, precipitation, and seasonal irrigation practices. The depth to groundwater is greatest to the north and least to the south in the YRRA. The Yakima Valley is heavily irrigated with surface water from area rivers during late March through early October. Accordingly, the water table is typically deeper in the spring before irrigation begins and shallower in the fall. Groundwater levels fluctuate seasonally, typically between 1 and 12 feet.

At the time of the RI, the direction of groundwater flow in the shallow water-bearing zone was characterized as being to the southeast with an approximate horizontal gradient of 0.005 ft/ft across the YRRA project area. The estimated direction of groundwater flow in the deep water-bearing zone is also primarily to the southeast, with an approximate gradient of 0.004 ft/ft across the YRRA. Overall, the vertical gradient across the project area is downward. The downward gradients between the shallow and deep water-bearing zones ranged from -0.278 ft/ft in the northern portion of the YRRA to -0.005 ft/ft in the southern portion of the project area (Secor, 1998).

Methods

Groundwater Sampling

In 2013, when selecting the 36 wells for continued sampling, Ecology excluded wells that had consistently shown low or no detections for chlorinated volatile organic compounds (cVOCs) during prior sample collection. The cVOC compounds include tetrachloroethene (PCE), as well as decay products trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride.

In 2015, the frequency of monitoring the 36 wells was adjusted. Previously, all wells had been sampled twice a year. To improve cost-effectiveness of the monitoring program, the new sample frequency was determined by PCE concentration, seasonal pattern, and temporal trend for each well. Seven wells displayed higher PCE concentrations in the spring, 13 wells had higher PCE concentrations in the fall, and the remaining wells displayed no seasonal pattern.

In 2017, 10 additional wells were added to the monitoring network, and two wells were removed. The 10 new wells are located at the Frank Wear Cleaners site at the north end of the YRRA project area. At this time, these 10 wells are being sampled twice a year. Monitoring frequency for these wells may change if seasonal patterns or trends can be established. Additionally, two wells were removed from the monitoring program, including NMW-2 at the Nu-Way Cleaners site, which was decommissioned in 2016. Figure 2 shows the relative locations of the 44 remaining wells in the monitoring program.

During 2018-2020, 32 of the wells sampled are associated with the following seven facilities: Goodwill - City of Yakima, Nu-Way Cleaners, Southgate Laundry, Fifth Wheel Truck Repair, Cameron Yakima, the Washington Central Railroad Roundhouse (WCRR), and Frank Wear Cleaners. Wells at these seven locations are monitored to evaluate the effectiveness of site-specific cleanup activities.

The 12 remaining wells were installed during the YRRA Remedial Investigation (RI). RI wells selected for continued monitoring are primarily located in the western and southern areas of the YRRA. Data collected from these wells may be used to identify areas of groundwater contamination within the YRRA that require additional source investigation and remedial action.

Construction details for the sampled wells are provided in Appendix A (Table A-1).

In 2020, logistical challenges related to the unfolding COVID-19 epidemic restricted sample collection to the fall monitoring event only.

During 2018-2020, Ecology sampled 41 of the 44 wells in the monitoring network in accordance with Ecology's Standard Operating Procedures (SOPs) EAP052 (Marti, 2018) and EAP078 (Marti, 2020), as well as the site-specific Quality Assurance Project Plan (Marti, 2013).

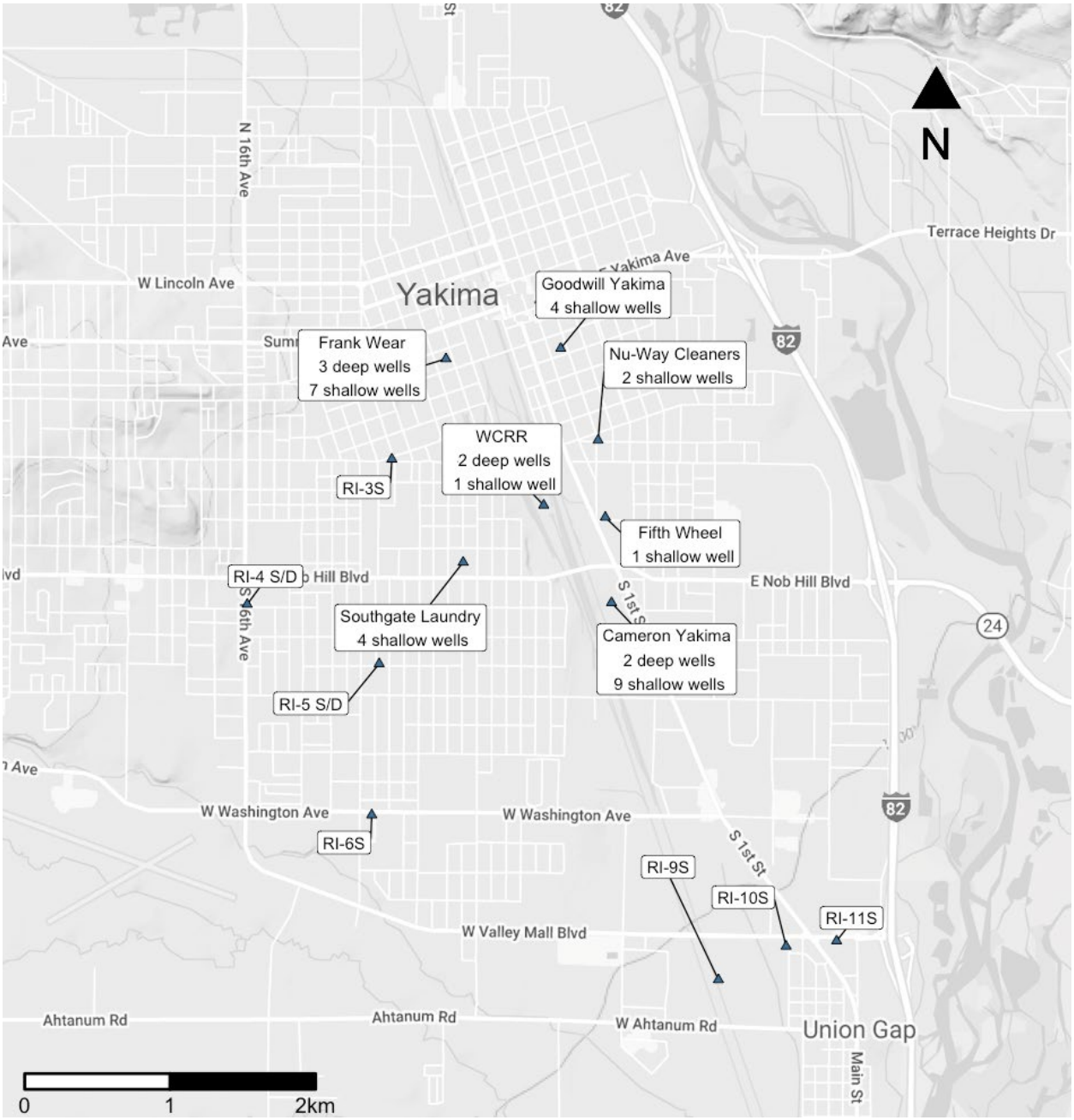


Figure 2. YRRA Groundwater Monitoring Locations, 2018-2020.

Analysis

Samples were submitted to Ecology's Manchester Environmental Laboratory for analysis of volatile organic compounds (VOCs) to determine concentrations in groundwater throughout the YRRA project area. Samples were analyzed following a modification of EPA SW-846 Method 8260C.

Field Observations

Ecology measured depth-to-water in each of the 41 monitoring wells prior to purging. The end-of-purge temperature, pH, dissolved oxygen, oxidation-reduction potential (ORP), and specific conductance measurements are listed in Table A-2 in Appendix A.

In 2018, depth-to-water below ground surface (bgs) ranged from about 39.5 feet bgs at the northern end of the YRRA project area to about 10.3 feet bgs at the southern end of the area in the spring, and from about 26.5 to 4.9 feet bgs in the fall. In 2019, depth-to-water ranged from about 39.2 to 10 feet bgs in the spring, and about 26.9 to 7.3 feet bgs in the fall. In 2020, groundwater monitoring was restricted to the fall only, with depth-to-water ranging from about 30.5 to 4.9 feet bgs.

In both spring and fall, the overall flow direction for the shallow groundwater appears to be consistently to the southeast, toward the Yakima River. There were not enough measurement points during a given sampling event to reliably determine the groundwater flow direction in the deep water-bearing zone, but previous investigations have described the groundwater flow as also being to the southeast (Kane, 2011).

Field measurement data for 2018-2020 were within expected ranges (Table 1).

Of special note are the dissolved oxygen measurements. The majority of the wells had measurements that ranged from about 5 to 7 mg/L, indicating aerobic conditions in both the shallow and deep wells. In contrast, dissolved oxygen in three of the Frank Wear wells (FWMW-10, FWMW-16, and FWMW-20) was below 1 mg/L, indicating an anaerobic environment. In addition, there was no measurable dissolved oxygen in groundwater at Washington Central Railroad Roundhouse well WDOE-3D during November 2020 monitoring.

Table 1. Summary of YRRA Stable Field Measurements, 2018-2020.

Parameter	n	Min	Q_1	Q_2	Q_3	Max
Conductivity (umhos/cm)	127	201	276	325	391	742
Dissolved Oxygen (mg/L)	127	0	4.81	6.37	7.2	13.83
Oxidation-Reduction Potential (mV)	125	-104	64	136	248	467
pH (Std. units)	127	5.84	6.33	6.5	6.7	7.85
Temperature (deg C)	127	14.6	15.7	16.3	17.1	19.1

n: Number of observations
Min: Minimum value
Q1: First quartile; equivalent to the 25th percentile
Q2: Second quartile; equivalent to the 50th percentile, or median value
Q3: Third quartile; equivalent to the 75th percentile
Max: Maximum value

Analytical Results

Analytical results from the 2018-2020 sampling are presented by the seven contaminant source areas and are summarized in the associated site figures in the body and data tables in the appendices of this report. *Analytes that were detected are presented in bold; analytes that exceeded (did not meet) the applicable cleanup levels for groundwater are shaded.*

Potential sampling bias and overall analytical precision were assessed by collecting field quality control samples consisting of field replicates, equipment blank, and transport blank samples.

In April 2019, replicate samples collected from well FWMW-10 exceeded the 30% relative percent difference (RPD) quality criteria for all analytes. In October 2019, replicate samples also exceeded the 30% RPD criteria for vinyl chloride in FWMW-10, and for PCE and TCE in FWMW-20.

In April 2019, PCE results for FWMW-10 were rejected because the RPD exceeded 50% (78.4%). The remaining results affected by RPDs that exceeded the 30% criteria were averaged and qualified "J", indicating that the reported result is an estimate. In 2018-2020, the remaining results for replicate samples met the measurement quality objectives established in the Quality Assurance Project Plan (Marti, 2013).

In October 2018, equipment blank samples had detections of PCE at an estimated concentration of 0.82 ug/L. PCE results from October 2018 that were less than 5 times the method reporting limit (MRL) are qualified with "JL", indicating that the result is an estimate with a potential high bias. In 2018-2020, the remaining equipment blank samples did not have detections for any of the target analytes, and none of the target analytes were detected in any of the transport blank samples.

All data are considered to be of good quality and are usable as presented here without further qualification. Appendix B contains additional detail regarding project quality assurance.

Historical groundwater data for the wells in the monitoring program are available in the Appendix C tables (Tables C-1 through C-9). Long-term project data are also presented in the Appendix C timeseries plots (Figures C-1 through C-51) of contaminant concentrations in individual wells for the duration of the monitoring program.

Goodwill - City of Yakima

The Goodwill - City of Yakima site is the present location of the City of Yakima Police and Justice Center (Figure 2) and is located at the northern end of the YRRA project area. Contaminated soil was removed from this site during an interim action in 1995 (Huntingdon Engineering, 1995).

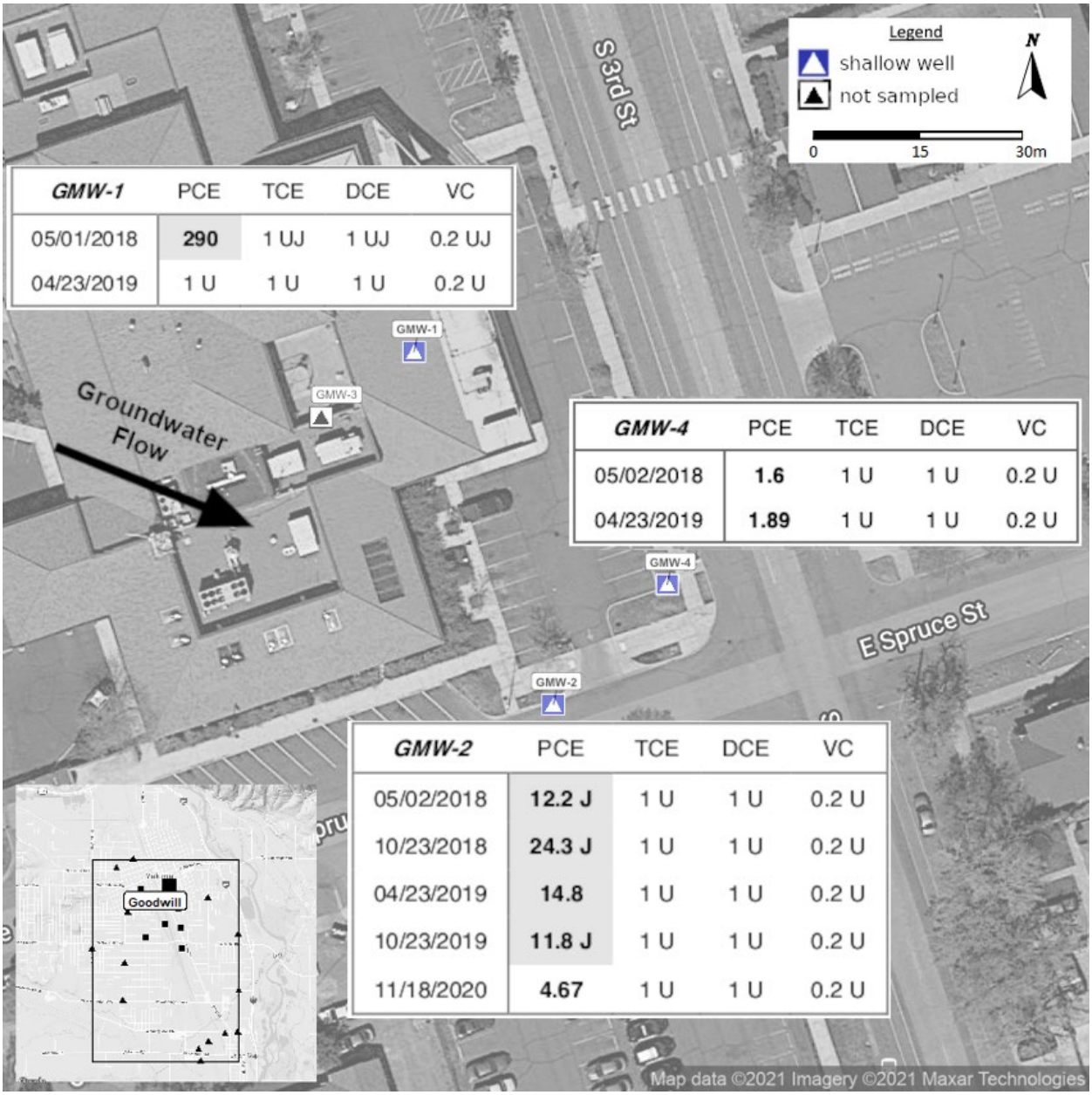
During the 2018-2020 monitoring, tetrachloroethene (PCE) was the only chlorinated solvent detected (Figure 3). The other contaminants of concern – trichloroethene (TCE), cis-1,2-dichloroethene (DCE), and vinyl chloride (VC) – were not detected.

During all four monitoring events in 2018 and 2019, PCE was detected in downgradient well GMW-2 at concentrations above the MTCA Method A cleanup level of 5 ug/L, ranging from estimated (J) concentration of 12.20 ug/L in May 2018 to 24.30 J ug/L in October 2018.

In November 2020, PCE was detected at 4.67 ug/L, and did not exceed the cleanup level. Concentrations of PCE below the 5 ug/L cleanup level in GMW-2 were last reported during October 2016 (Appendix C, Figure C-2).

Wells GMW-1 and GMW-4 are sampled on an annual rotation during the spring. In May 2018, PCE in GMW-1 had increased significantly to a concentration (290 ug/L) higher than the 5 ug/L cleanup level. In April 2017, PCE was reported in GMW-1 at an estimated concentration of 0.57 J ug/L (Figure C-1). In April 2019, PCE decreased to concentrations below the analytical reporting limit (<1 ug/L) and no longer exceeded the cleanup level. However, PCE was detected in a replicate sample at 3.19 ug/L. During April 2018 and April 2019, PCE in GMW-4 (Figure C-3) remained below the 5 ug/L cleanup level, with concentrations of 1.6 ug/L and 1.89 ug/L, respectively.

An evaluation of data quality that includes the comparison of replicate samples is available in Appendix B, Table B-3.



GMW-1	PCE	TCE	DCE	VC
05/01/2018	**290**	1 UJ	1 UJ	0.2 UJ
04/23/2019	1 U	1 U	1 U	0.2 U

GMW-4	PCE	TCE	DCE	VC
05/02/2018	**1.6**	1 U	1 U	0.2 U
04/23/2019	**1.89**	1 U	1 U	0.2 U

GMW-2	PCE	TCE	DCE	VC
05/02/2018	**12.2 J**	1 U	1 U	0.2 U
10/23/2018	**24.3 J**	1 U	1 U	0.2 U
04/23/2019	**14.8**	1 U	1 U	0.2 U
10/23/2019	**11.8 J**	1 U	1 U	0.2 U
11/18/2020	**4.67**	1 U	1 U	0.2 U

Figure 3. Goodwill - City of Yakima Well Locations and cVOC Results (ug/L), 2018-2020.

Nu-Way Cleaners

The Nu-Way Cleaners site is located about 0.5 miles southeast of the Goodwill site (Figure 2). In 1996, source removal activities occurred at this site (Enviros, 1996).

During 2018-2020, only well NMW-1 was sampled. PCE was detected in this well at concentrations of 2.06 and 1.97 ug/L in May 2018 and April 2019, respectively (Figure 4). PCE concentrations did not exceed the 5 ug/L cleanup level during either monitoring event. None of the remaining target analytes were detected during May 2018 or April 2019.

In 2016, well NMW-2 was decommissioned and is no longer part of the monitoring program.

Since regular monitoring began in 1997, with a few exceptions, PCE concentrations have consistently been below the cleanup level in all three of the Nu-Way wells (Appendix C, Figures C-4, C-5, and C-6). PCE concentrations have ranged from less than 1 to 5.5 ug/L (Table C-2). Downgradient PCE concentrations at this site have been consistent with upgradient conditions, indicating that this site is no longer a significant source of PCE contamination to the larger YRRA plume.

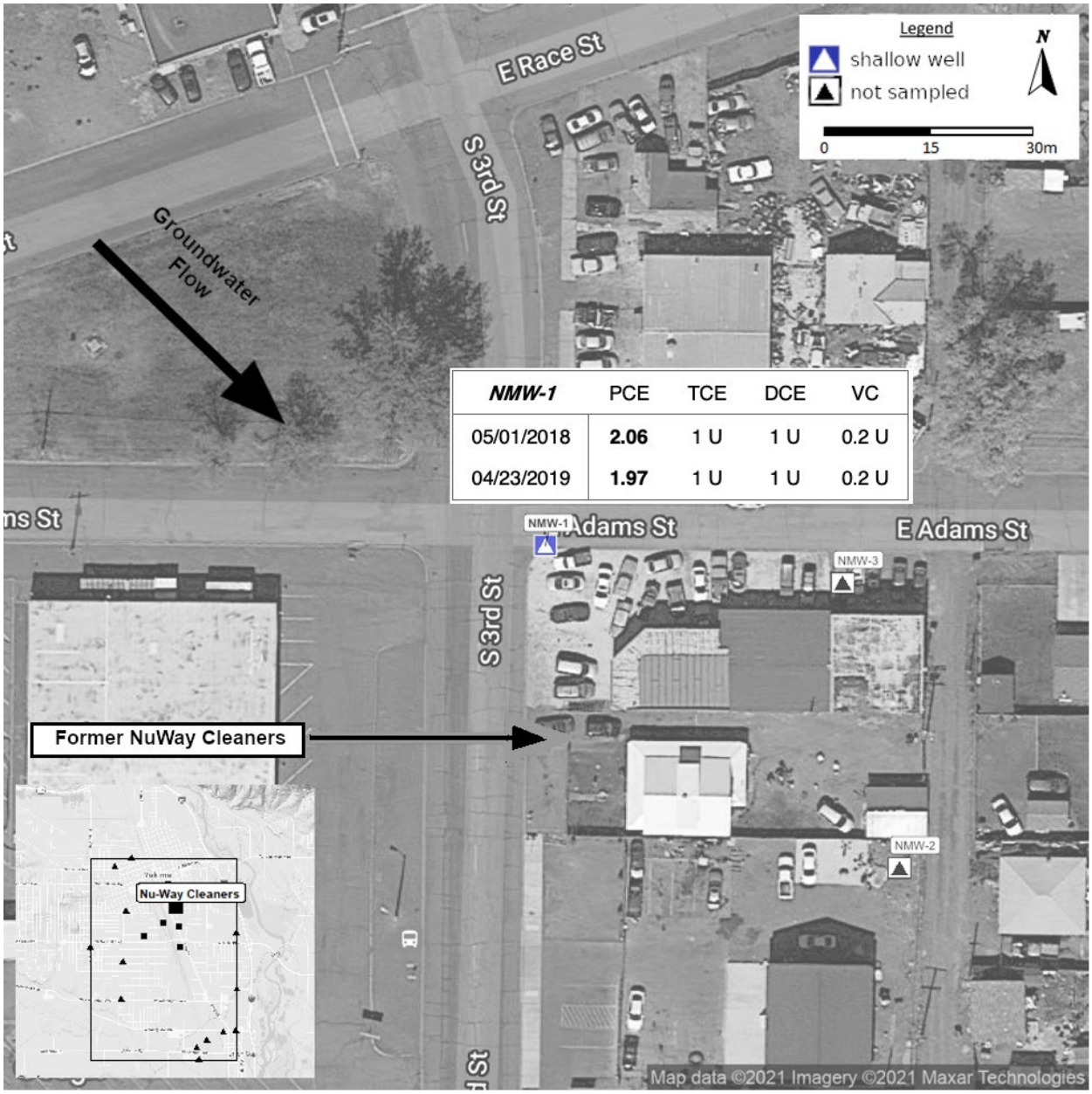


Figure 4. Nu-Way Cleaners Well Locations and cVOC Results (ug/L), 2018-2020.

Southgate Laundry

Southgate Laundry is located west of the railroad tracks along Nob Hill Road (Figure 2). In 1997, contaminated soils were removed from the Southgate Laundry site as part of an interim action (Maxim Technologies, 1998).

During 2018-2020, PCE was the only contaminant detected in the wells sampled at this site (Figure 5). PCE concentrations were near the reporting limit of 1 ug/L in both downgradient wells SGMW-2 (1.34 ug/L) and SGMW-3 (1.32 ug/L); these results are well below the MTCA cleanup level. PCE was detected in well SGMW-1 at estimated concentrations below the reporting limit in October 2018 (0.65 J ug/L) and November 2020 (0.42 J ug/L). PCE in SGMW-1 did not exceed the cleanup level during either monitoring event.

The historic results for upgradient well SGMW-1 show that PCE concentrations have consistently been below the MTCA cleanup level (Figure C-7). Until 2005, PCE concentrations in downgradient wells SGMW-2 (Figure C-8) and SGMW-3 (Figure C-9) were often above the cleanup level, with concentrations ranging from about 2 to 29 ug/L.

Since 2006, PCE concentrations have decreased to less than 1 to 4.5 ug/L. This suggests that past source-removal activities have been successful in reducing PCE in groundwater at the site.

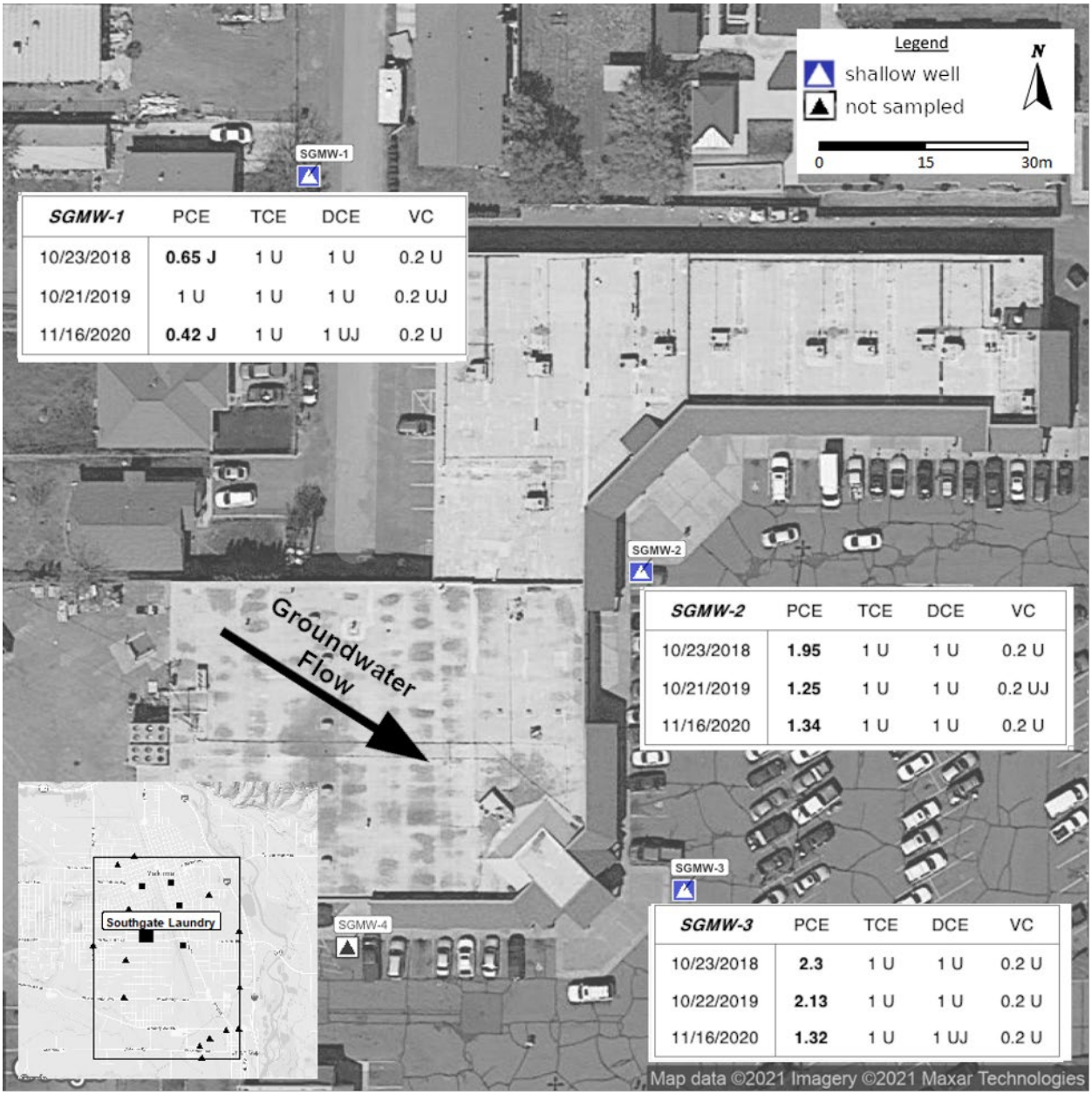


Figure 5. Southgate Laundry Well Locations and cVOC Results (ug/L), 2018-2020.

Washington Central Railroad Roundhouse (WCRR)

The WCRR is located in the central portion of the YRRA study area (Figure 2). There is no record of direct remediation at this site to address PCE contamination. The three WCRR wells are clustered (Figure 6) and are completed at about 30 feet (WDOE-3S), 58 feet (WDOE-3I), and 100 feet (WDOE-3D) bgs. These wells continue to have elevated concentrations (Table C-4) of PCE and corresponding breakdown products, indicating that the WCRR site is still a significant source of groundwater contamination

Due to site access issues, the three WCRR wells were not sampled in 2017 or 2018.

Well WDOE-3S

Well WDOE-3S was dry during April 2019, but in November 2020, PCE was detected above the cleanup level at 20.3 ug/L (Figure C-10). TCE (1.11 ug/L) and DCE (1.51 ug/L) were detected at concentrations below the associated cleanup levels.

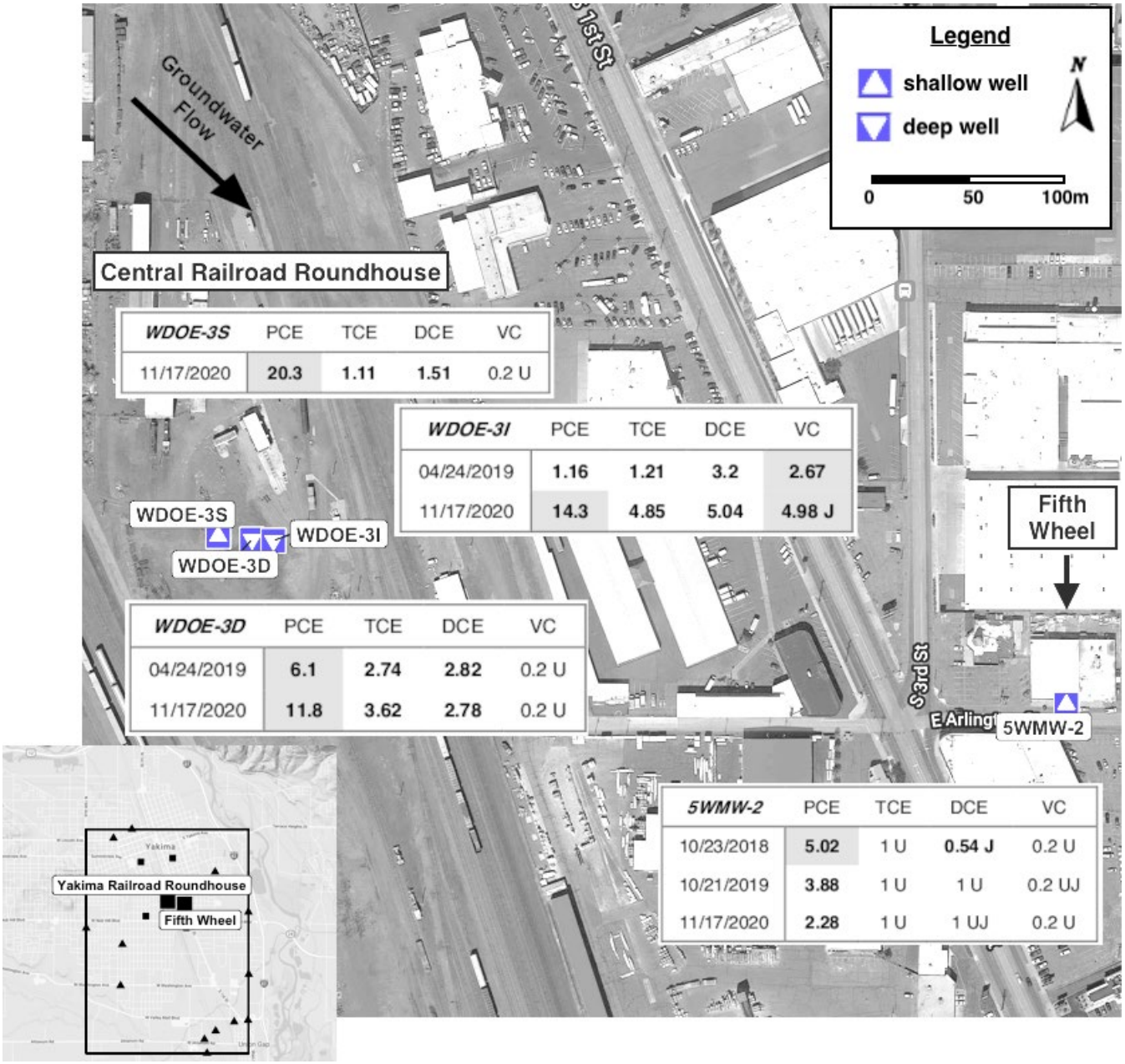
Wells WDOE-3I and WDOE-3D

Wells WDOE-3I and WDOE-3D were sampled in April 2019 and November 2020. PCE concentrations in well WDOE-3I ranged from 1.16 ug/L in April 2019 to 14.3 ug/L in November 2020 (Figure C-11). PCE concentrations in well WDOE-3D ranged from 6.1 ug/L in April 2019 to 11.8 ug/L in November 2020 (Figure C-12). PCE concentrations exceeded the 5 ug/L cleanup level in both wells during November 2020.

PCE metabolic breakdown products are typically detected in all three of the above wells.

- TCE was detected in all three wells during November 2020 at concentrations ranging from 1.11 ug/L in WDOE-3S to 4.85 ug/L in WDOE-3I; these results did not exceed the cleanup level of 5 ug/L. Increasing TCE concentrations in WDOE-3I were observed during the 2009-2014 (Figure C-13), reaching a local maximum of 15 ug/L in October 2014. TCE concentrations in WDOE-3I have since decreased to 4.95 ug/L in November 2020, just below the 5 ug/L cleanup level. TCE was detected in WDOE-3I and WDOE-3D during April 2019, with respective concentrations of 1.21 and 2.74 ug/L.
- DCE was also detected at concentrations below the 70 ug/L cleanup level, ranging from 2.78 ug/L in WDOE-3D to 5.04 ug/L in WDOE-3I during November 2020.
- Vinyl chloride was present during both April 2019 and November 2020, with samples from WDOE-3I at concentrations above the 0.2 ug/L cleanup level at 2.67 and 4.98 J ug/L, respectively. Vinyl chloride was not detected in samples from WDOE-3S or WDOE-3D during 2019-2020.

Contaminant concentrations in wells WDOE-3I and WDOE-3D indicate that the plume has a vertical extent that reaches the deep water-bearing zone in this portion of the YRRA. The data indicate that the WCRR facility continues to act as a significant source of groundwater contamination, including to deeper portions of the aquifer system.



WDOE-3S	PCE	TCE	DCE	VC
11/17/2020	20.3	1.11	1.51	0.2 U

WDOE-3I	PCE	TCE	DCE	VC
04/24/2019	1.16	1.21	3.2	2.67
11/17/2020	14.3	4.85	5.04	4.98 J

WDOE-3D	PCE	TCE	DCE	VC
04/24/2019	6.1	2.74	2.82	0.2 U
11/17/2020	11.8	3.62	2.78	0.2 U

5WMW-2	PCE	TCE	DCE	VC
10/23/2018	5.02	1 U	0.54 J	0.2 U
10/21/2019	3.88	1 U	1 U	0.2 UJ
11/17/2020	2.28	1 U	1 UJ	0.2 U

Figure 6. Washington Central Railroad Roundhouse and Fifth Wheel Truck Repair Well Locations and cVOC Results (ug/L), 2018-2020.

Fifth Wheel Truck Repair

Fifth Wheel Truck Repair is located about 0.3 miles east (cross-gradient) of the WCRR wells (Figure 2). From 1991 to 2001, cleanup activities at this site occurred (Maxim Technologies, 1996).

During 2018-2020, Ecology sampled one downgradient well at the site.

- PCE was detected in October 2018, October 2019, and November 2020 at concentrations ranging from 5.02 ug/L in October 2018 to 2.28 ug/L in November 2020 (Figure 6), and do not currently exceed the cleanup level.
- DCE was also detected during October 2018 at an estimated concentration of 0.54 ug/L, well below the 70 ug/L cleanup level.
- TCE and vinyl chloride were not detected.

The groundwater quality data record for well 5WMW-2 spans from 1999 to the present. During that time, PCE concentrations have ranged from less than 1 ug/L to 11 ug/L, with higher concentrations consistently occurring in the fall. PCE concentrations appear to be gradually decreasing; however, they still exceed the cleanup level on occasion (Figure C-14).

Cameron Yakima

Cameron Yakima is located in the central portion of the YRRA, about 0.5 miles southeast (downgradient) of the WCRR wells (Figure 2). Cleanup activities occurred at this site from 1998 to 2001.

During 2018-2020, Ecology collected groundwater samples from 11 wells on the Cameron Yakima site. PCE was detected in all 11 wells at concentrations ranging from 2.77 ug/L in CYIMW103D during April 2019 to 13.10 J ug/L in CYIMW102S during October 2019 (Figure 7).

Wells CYIMW106S and CYIMW107S

PCE was detected in these two upgradient wells at concentrations ranging from about 3.58 to 8.79 ug/L during 2018-2020. Concentrations exceeded the cleanup level of 5 ug/L in well CYIMW107S (Figure C-20) during October 2018, October 2019, and November 2020.

CYIMW106S PCE concentrations (Figure C-19) exceeded the cleanup level in October 2018 and October 2019, with concentrations of 7.67 ug/L and 8.79 ug/L, respectively. PCE in CYIMW106S decreased to 4.77 ug/L in November 2020, and did not exceed the cleanup level.

Since the 2000 cleanup activities, PCE concentrations have been decreasing in these two wells but continue to exceed the cleanup level. PCE concentrations are consistently higher in the fall than in the spring for CYIMW106S, but no seasonal pattern is seen in CYIMW107S. Consistently elevated PCE concentrations in both upgradient wells may indicate continued groundwater contamination from sources upgradient from the Cameron site.

Wells CYIMW102S, CYIMW103S, and CYIMW103D

These three wells are located in the northwest corner of the Cameron site. PCE concentrations in the two shallow wells ranged from 9.3 ug/L in CYIMW103S to an estimated 13 .1 ug/L in

CYIMW102S during 2018-2019, and decreased to 7.4 and 7.9 ug/L during November 2020. PCE in both wells continues to exceed the 5 ug/L cleanup level.

In September 1999, prior to soil removal, these wells had some of the highest PCE concentrations in the YRRA, at about 72 ug/L (CYIMW102S) and 139 ug/L (CYIMW103S) (Table C-6). During December 2000 and March 2001, PCE concentrations decreased substantially, with maximum concentrations of 17 and 57 ug/L, respectively (Figures C-16 and C-17. Although PCE concentrations continue to exceed the cleanup level in the two shallow wells, post-2006 concentrations of PCE in groundwater are consistently lower, often below 10 ug/L.

PCE concentrations in the deep well (CYIMW103D) are consistently below the 5 ug/L cleanup level, most recently detected at 2.8 ug/L during April 2019. Since monitoring began in 1997, PCE concentrations in CYIMW103D ranged from 1.9 ug/L in April 2012 to 5.23 ug/L in June 1999 (Figure C-18).

Wells CYIMW108S and CYIMW111S

These two wells are located in the northeast corner of the site. PCE concentrations in these wells have typically been lower than in the other site monitoring wells. In August 1998, PCE in CYIMW108S (Figure C-21) reached a maximum concentration of 7.8 J ug/L, and has been between 0.13 J and 5.9 ug/L after source removal, with only two detections above the cleanup level since the 2000 cleanup.

Similarly, PCE concentrations in CYIMW111S (Figure C-24) reached a maximum of 9.4 J ug/L prior to the 2000 cleanup, and has typically been below the 5 ug/L cleanup level post-source removal, with sporadic exceedances, with the most recent exceedance during October 2009, at a concentration of 5.5 ug/L.

Wells CYIMW112S, CYIMW113S, and CYIMW114S

These three wells (Figures C-25, C-26, and C-28) are located on the southeast corner of the property. During December 2000 and March 2001, PCE concentrations in wells CYIMW112S and CYIMW113S exceeded the cleanup level, with concentrations ranging from 8 to 11.6 ug/L in CYIMW112S and from 9.8 to 10.3 ug/L in CYIMW113S. During October 2019, PCE concentrations in CYIMW114S exceeded the cleanup level at 11.2 ug/L. During 2018-2020,TCE and DCE were detected at concentrations below the analytical reporting limit (< 1ug/L) , and do not exceed the applicable cleanup levels.

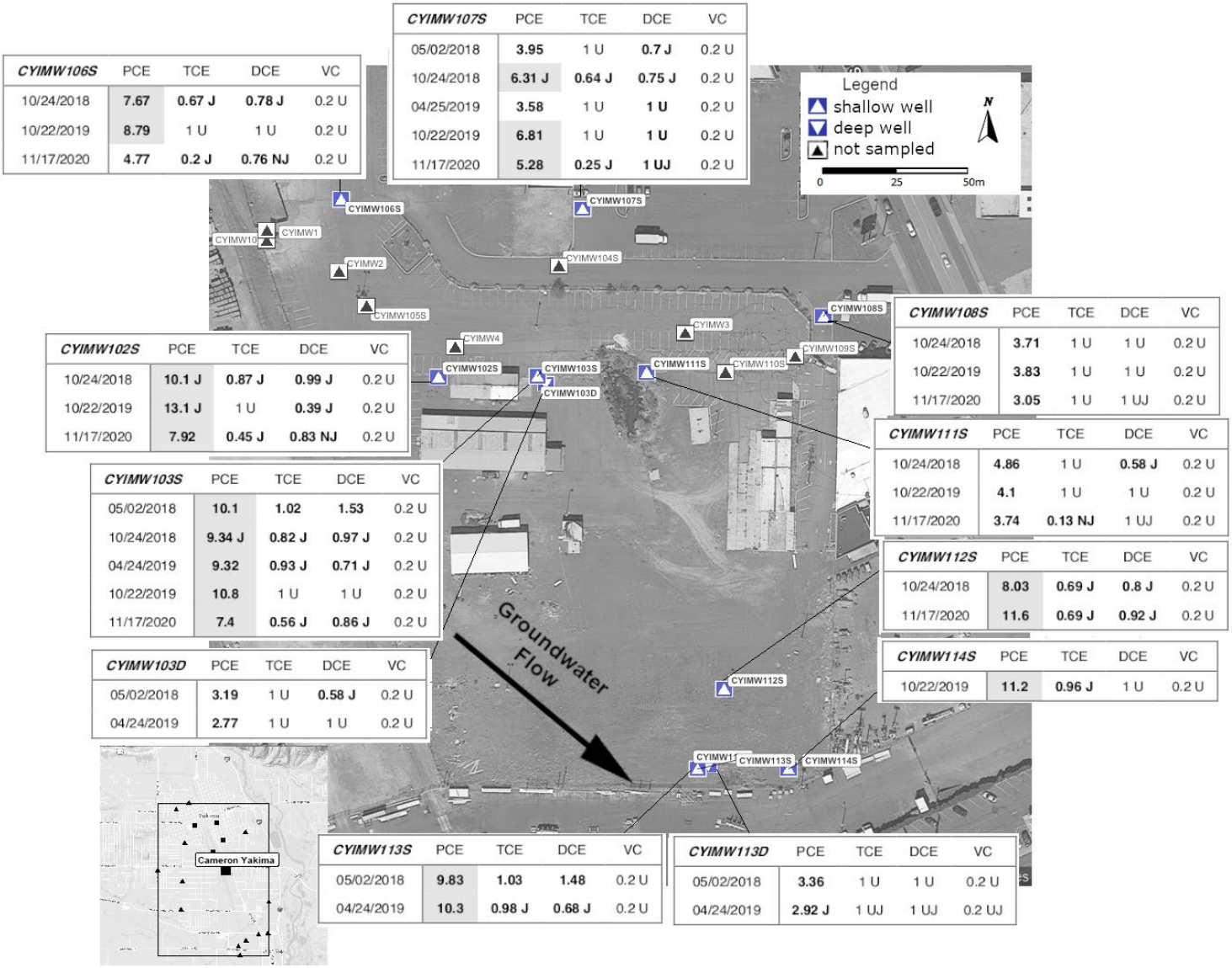
Contaminant concentrations in these three wells gradually decreased after the 2000 cleanup activities but have displayed an increasing trend since 2009. PCE concentrations are now consistently above the MTCA cleanup level of 5 ug/L. The elevated PCE concentrations along the downgradient boundary of the site indicate possible off-site migration of the contaminant plume.

Deep well CYIMW113D

During 1998 through 2019, PCE concentrations in this well have remained within an approximate range of 3 to 6 ug/L (Figure C-27). Since March 2001, PCE concentrations have exceeded the cleanup level once, at 6.1 ug/L in June 2011.

During 2018-2020, TCE and DCE were detected in the majority of the wells sampled at low concentrations below the applicable cleanup levels, and were within the range of historical data collected since 1997.

Vinyl chloride has remained undetected since sampling began in 1997 (Table C-6).



CYIMW106S	PCE	TCE	DCE	VC
10/24/2018	7.67	0.67 J	0.78 J	0.2 U
10/22/2019	8.79	1 U	1 U	0.2 U
11/17/2020	4.77	0.2 J	0.76 NJ	0.2 U

CYIMW107S	PCE	TCE	DCE	VC
05/02/2018	3.95	1 U	0.7 J	0.2 U
10/24/2018	6.31 J	0.64 J	0.75 J	0.2 U
04/25/2019	3.58	1 U	1 U	0.2 U
10/22/2019	6.81	1 U	1 U	0.2 U
11/17/2020	5.28	0.25 J	1 UJ	0.2 U

CYIMW102S	PCE	TCE	DCE	VC
10/24/2018	10.1 J	0.87 J	0.99 J	0.2 U
10/22/2019	13.1 J	1 U	0.39 J	0.2 U
11/17/2020	7.92	0.45 J	0.83 NJ	0.2 U

CYIMW103S	PCE	TCE	DCE	VC
05/02/2018	10.1	1.02	1.53	0.2 U
10/24/2018	9.34 J	0.82 J	0.97 J	0.2 U
04/24/2019	9.32	0.93 J	0.71 J	0.2 U
10/22/2019	10.8	1 U	1 U	0.2 U
11/17/2020	7.4	0.56 J	0.86 J	0.2 U

CYIMW103D	PCE	TCE	DCE	VC
05/02/2018	3.19	1 U	0.58 J	0.2 U
04/24/2019	2.77	1 U	1 U	0.2 U

CYIMW108S	PCE	TCE	DCE	VC
10/24/2018	3.71	1 U	1 U	0.2 U
10/22/2019	3.83	1 U	1 U	0.2 U
11/17/2020	3.05	1 U	1 UJ	0.2 U

CYIMW111S	PCE	TCE	DCE	VC
10/24/2018	4.86	1 U	0.58 J	0.2 U
10/22/2019	4.1	1 U	1 U	0.2 U
11/17/2020	3.74	0.13 NJ	1 UJ	0.2 U

CYIMW112S	PCE	TCE	DCE	VC
10/24/2018	8.03	0.69 J	0.8 J	0.2 U
11/17/2020	11.6	0.69 J	0.92 J	0.2 U

CYIMW114S	PCE	TCE	DCE	VC
10/22/2019	11.2	0.96 J	1 U	0.2 U

CYIMW113S	PCE	TCE	DCE	VC
05/02/2018	9.83	1.03	1.48	0.2 U
04/24/2019	10.3	0.98 J	0.68 J	0.2 U

CYIMW113D	PCE	TCE	DCE	VC
05/02/2018	3.36	1 U	1 U	0.2 U
04/24/2019	2.92 J	1 UJ	1 UJ	0.2 UJ

Figure 7. Cameron Yakima Well Locations and cVOC Results (ug/L), 2018-2020.

Frank Wear Cleaners

In 2017, the Frank Wear Cleaners site was added to the YRRA monitoring program. Frank Wear is located at the northern end of the YRRA project area, about 0.7 miles upgradient of the WCRR wells (Figure 2).

The dry-cleaning facility had a history of dangerous waste violations and was identified as a PCE source to the YRRA in 1991. In 1995, site soils and groundwater were found to be highly contaminated with PCE (Maxim, 1996). In 1995, a series of cleanup activities were initiated: (1) removal of contaminated soil, (2) removal of the Frank Wear building in 2001, (3) installation of a soil vapor extraction (SVE) system in 2012, and (4) installation of a groundwater recirculation system (GRS) in 2014. The SVE unit remains operational, but the GRS was shut down in 2016 due to financial constraints.

During 2018-2020, Ecology collected groundwater samples from 10 of the 24 wells at this site: seven shallow wells and three deep wells.

- PCE was detected in all 10 wells at concentrations ranging from an estimated 0.37 to 21,800 ug/L (Figure 8).
- TCE was detected in nine of the wells sampled at concentrations ranging from an estimated 0.11 to 3,910 ug/L.
- DCE was also detected in nine wells at concentrations ranging from an estimated 0.58 to 719 ug/L.
- Vinyl chloride was detected in five of the wells sampled during the 2018-2020 monitoring at concentrations ranging from 0.77 to 323 ug/L.

Shallow well FWMW-16 and deep well FWMW-17

These two wells are located in the northwest corner of the Frank Wear site.

PCE concentrations in FWMW-16 reached 100 ug/L (Figure C-37) while the SVE and GRS: operated at the site. More recent results are significantly lower.

- PCE concentrations in FWMW-16 ranged from 4.04 ug/L in April 2019 to 35 ug/L in May 2018, and exceeded the 5 ug/L cleanup level during May 2018 (35 ug/L), October 2018 (12.1 ug/L), October 2019 (28.3 J ug/L), and November 2020 (20.2 ug/L) .
- TCE concentrations ranged from 3.21 ug/L in May 2018 to 8.99 ug/L in April 2019, and exceeded the 5 ug/L cleanup level during October 2018 (6.49 ug/L), April 2019 (8.99 ug/L), October 2019 (5.72 ug/L), and November 2020 (5.86 ug/L).
- DCE concentrations ranged from 2.55 ug/L in October 2018 to 16 ug/L in November 2020, and did not exceed the 70 ug/L cleanup level.
- Vinyl chloride concentrations ranged from 2.88 J ug/L in October 2019 to 25.2 J ug/L in April 2019, and exceeded the 0.2 ug/L cleanup level during the May 2018 (5.03 ug/L), October 2018 (6.11 ug/L), April 2019 (25.2 J ug/L), October 2019 (2.88 J ug/L), and November 2020 (19.8 J ug/L) monitoring.

PCE in deep well FWMW-17 ranged from 0.42 J ug/L in November 2020 to 0.66 J ug/L in October 2018, and did not exceed the 5 ug/L cleanup level during 2018-2020.

- TCE was detected in FWMW-17 at 0.66 J ug/L in April, and was below the MRL (1 ug/L) for the remainder of 2018-2020.
- DCE was detected in April 2018 at 0.95 J ug/L, and did not exceed the 70 ug/L cleanup level.
- Vinyl chloride was not detected in FWMW-17 during 2018-2020.

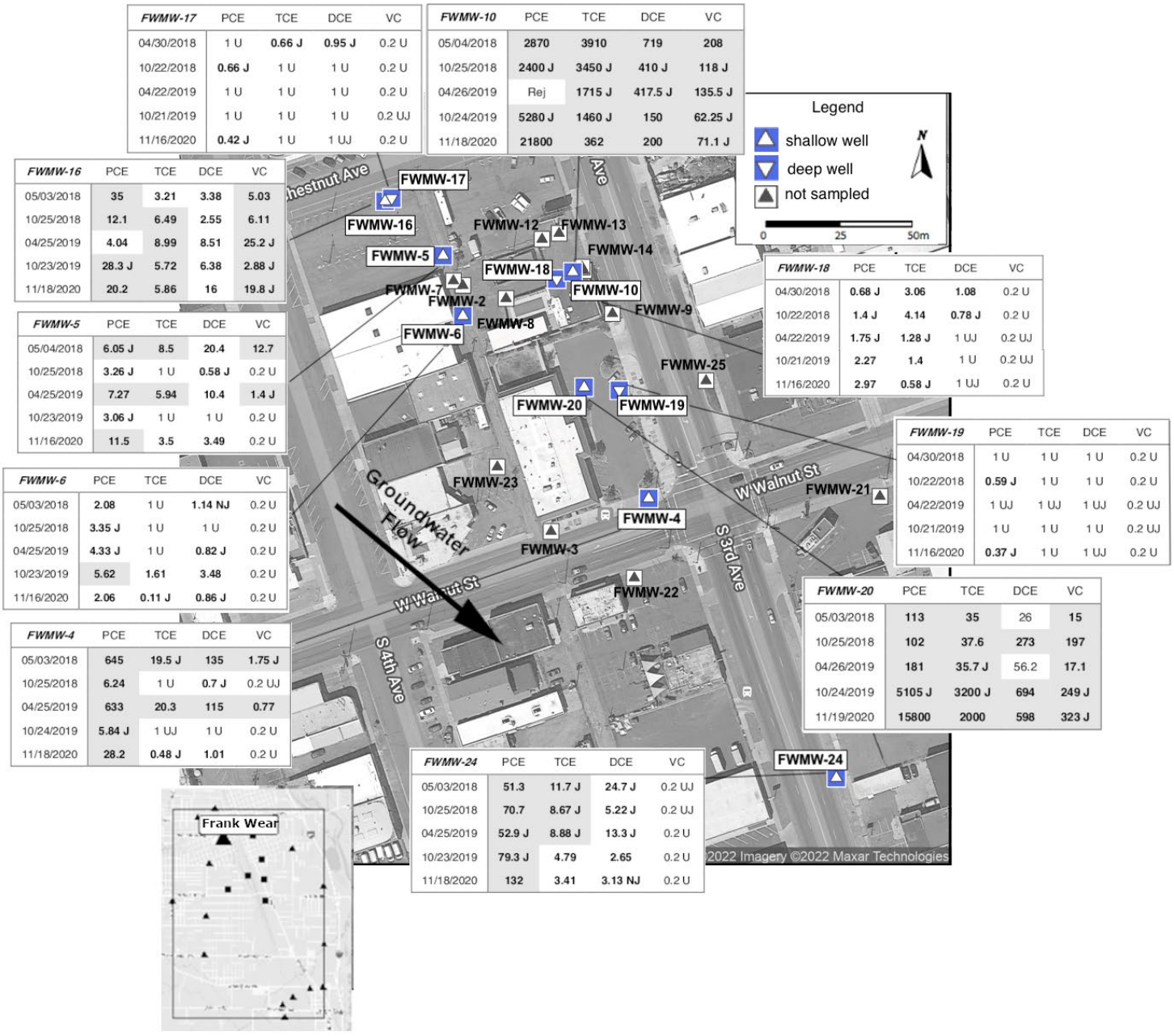


Figure 8. Frank Wear Cleaners Well Locations and cVOC Results (ug/L), 2018-2020.

Well FWMW-5

PCE concentrations in this well ranged from 3.06 J ug/L in October 2019 to 11.5 ug/L in November 2020, and exceeded the cleanup level during May 2018 (6.05 J ug/L), April 2019 (7.27 ug/L), and November 2020 (11.5 ug/L).

- TCE in FWMW-5 ranged from 3.5 ug/L in November 2020 to 8.5 ug/L in May 2018, and exceeded the 5 ug/L cleanup level during May 2018 (8.5 ug/L) and April 2019 (5.94 ug/L).
- DCE concentrations ranged from 0.58 J ug/L in October 2018 to 20.4 ug/L in May 2018, and did not exceed the 70 ug/L cleanup level during 2018-2020.
- Vinyl chloride was detected at concentrations higher than the 0.2 ug/L cleanup level at 12.7 ug/L in May 2018 and 1.4 J ug/L in April 2019.

Well FWMW-6

PCE concentrations in this well ranged from 2.06 ug/L in November 2020 to 5.62 ug/L in October 2019, and exceeded the 5 ug/L cleanup level during October 2019 (5.62 ug/L).

- TCE concentrations in FWMW-6 ranged from 0.11 J ug/L in November 2020 to 1.61 ug/L in October 2019, and did not exceed the 5 ug/L cleanup level during 2018-2020.
- DCE ranged from 0.82 J ug/L in April 2019 to 3.48 ug/L in October 2019, and did not exceed the 70 ug/L cleanup level.
- Vinyl chloride was not detected in FWMW-6 during 2018-2020.

Historically, concentrations of metabolic breakdown products TCE, DCE, and vinyl chloride in FWMW-6 exceeded the applicable cleanup levels (Table C-7). Results from 2018-2020 were either non-detect or below 5 ug/L. In 2014, monitoring data show a spike in contaminant concentrations in both FWMW-5 (Figures C-40, C-41) and FWMW-6 (Figures C-42, C-43), which may be associated with the operation of the GRS.

Well FWMW-19 and Shallow Well FWMW-20

These two wells are located in the adjacent parking lot to the south of the former dry-cleaning facility. The shallow well FWMW-20 consistently has elevated concentrations of PCE and metabolic breakdown products that exceed the applicable cleanup levels.

FWMW-19 is completed in the lower aquifer and has low concentrations of PCE that generally do not exceed the applicable cleanup levels (Table C-8).

- PCE concentrations in this well ranged from 0.37 J ug/L in November 2020 to 0.59 J ug/L in October 2018, and did not exceed the 5 ug/L cleanup level during 2018-2020.
- TCE, DCE , and vinyl chloride were not detected during 2018-2020.

PCE concentrations in FWMW-20 ranged from 102 ug/L in October 2018 to 15,800 ug/L in November 2020, and exceeded the 5 ug/L cleanup level October 2018 (102 ug/L), April 2019 (181 ug/L), May 2018 (113 ug/L), October 2019 (4,120 J ug/L), November 2020 (15,800 ug/L).

- TCE concentrations in this well ranged from 35 ug/L in May 2018 to 2,690 J ug/L in October 2019, and exceeded the 5 ug/L cleanup level during May 2018 (35 ug/L), April 2019 (35.7 J ug/L), October 2018 (37.6 ug/L), November 2020 (2000 ug/L), October 2019 (2,690 J ug/L) .

- DCE concentrations ranged from 26 ug/L in May 2018 to 694 ug/L in October 2019, and exceeded the 70 ug/L cleanup level during October 2019 (694 ug/L), October 2018 (273 ug/L), November 2020 (598 ug/L) .
- Vinyl chloride concentrations in ranged from 15 ug/L in May 2018 to 323 J ug/L in November 2020, and exceeded the 0.2 ug/L cleanup level during May 2018 (15 ug/L), October 2018 (197 ug/L), April 2019 (17.1 ug/L), October 2019 (249 J ug/L), November 2020 (323 J ug/L).
- Replicate samples collected during October 2019 exceeded the 30% RPD criteria for PCE and TCE in FWMW-20. These results were averaged and qualified "J", indicating that the reported result is an estimate.

Wells FWMW-4 and FWMW-24

These two wells are located about 265 and 640 feet downgradient from the former dry-cleaning facility.

In the spring of 2018, PCE and TCE (Figure C-30) in FWMW-4 (Table C-7; Figure C-29) exceeded the applicable cleanup levels with concentrations of 645 ug/L and 19.5 J ug/L, respectively.

- PCE in this well remained above the cleanup level at 28.2 ug/L in November 2020, while TCE was detected below the 5 ug/L cleanup level at 0.48 J ug/L.
- DCE concentrations ranged from 0.7 J ug/L in October 2018 to 135 ug/L in May 2018, and exceeded the 70 ug/L cleanup level during the May 2018 (135 ug/L), and April 2019 (115 ug/L) monitoring.
- Vinyl chloride concentrations ranged from 0.77 ug/L in April 2019 to 1.75 J ug/L in May 2018, and exceeded the 0.2 ug/L cleanup level during the May 2018 (1.75 J ug/L), and April 2019 (0.77 ug/L) monitoring.

FWMW-24 is the furthest downgradient well at the Frank Wear site.

- PCE concentrations in this well ranged from 51.3 ug/L in May 2018 to 132 ug/L in November 2020, and exceeded the 5 ug/L cleanup for the entirety of the 2018-2020 monitoring.
- TCE concentrations ranged from 3.41 ug/L in November 2020 to 11.7 J ug/L in May 2018, and exceeded the 5 ug/L cleanup level during the May 2018 (11.7 J ug/L), October 2018 (8.67 J ug/L), and April 2019 (8.88 J ug/L) monitoring.
- DCE concentrations ranged from 2.65 ug/L in October 2019 to 24.7 J ug/L in May 2018, and did not exceed the 70 ug/L cleanup level.
- Vinyl chloride was not detected in FWMW-24 during 2018-2020.

Wells FWMW-10 and FWMW-18

These two wells are located on the north wall of the former dry-cleaning facility.

FWMW- 18 is completed in the deeper water bearing zone and during 2018-2020:

- PCE concentrations in this well ranged from 0.68 J ug/L in April 2018 to 2.97 ug/L in November 2020, and did not exceed the 5 ug/L cleanup level.

- TCE concentrations ranged from 0.58 J ug/L in November 2020 to 4.14 ug/L in October 2018, and did not exceed the 5 ug/L cleanup level.
- DCE concentrations ranged from 0.78 J ug/L in October 2018 to 1.08 ug/L in April 2018, and did not exceed the 70 ug/L cleanup level .
- Vinyl chloride was not detected in FWMW-18.

FWMW-10 consistently has the highest concentrations of PCE and breakdown products at the site. In April 2019, replicate samples collected from FWMW-10 exceeded the 30% relative percent difference (RPD) quality criteria for all analytes. The PCE result was rejected because the calculated RPD exceeded 50% (78.4%). The remaining results affected by RPDs that exceeded the 30% criteria were averaged and qualified "J", indicating that the reported result is an estimate.

Replicate samples from FWMW-10 collected during October 2019 also exceeded the 30% RPD criteria for vinyl chloride. These results were averaged and "J" qualified.

- PCE concentrations in replicates from this well ranged from 2,400 J ug/L in October 2018 to 21,800 ug/L in November 2020, and exceeded the 5 ug/L cleanup level during October 2018 (2,400 J ug/L), May 2018 (2,870 ug/L), October 2019 (5,280 J ug/L), and November 2020 (21,800 ug/L).
- TCE concentrations ranged from 362 ug/L in November 2020 to 3,910 ug/L in May 2018, and exceeded the 5 ug/L cleanup level during October 2019 (1,460 J ug/L), April 2019 (1,310 ug/L), May 2018 (3,910 ug/L), October 2018 (3,450 J ug/L), and November 2020 (362 ug/L).
- DCE concentrations ranged from 150 ug/L in October 2019 to 719 ug/L in May 2018, and exceeded the 70 ug/L cleanup level during October 2019 (150 ug/L), October 2018 (410 J ug/L), May 2018 (719 ug/L), November 2020 (200 ug/L), and April 2019 (336 ug/L) .
- Vinyl chloride concentrations ranged from 71.1 J ug/L in November 2020 to 208 ug/L in May 2018, and exceeded the 0.2 ug/L cleanup level during May 2018 (208 ug/L), April 2019 (104 ug/L), November 2020 (71.1 J ug/L), October 2018 (118 J ug/L), and October 2019 (72.8 J ug/L) .

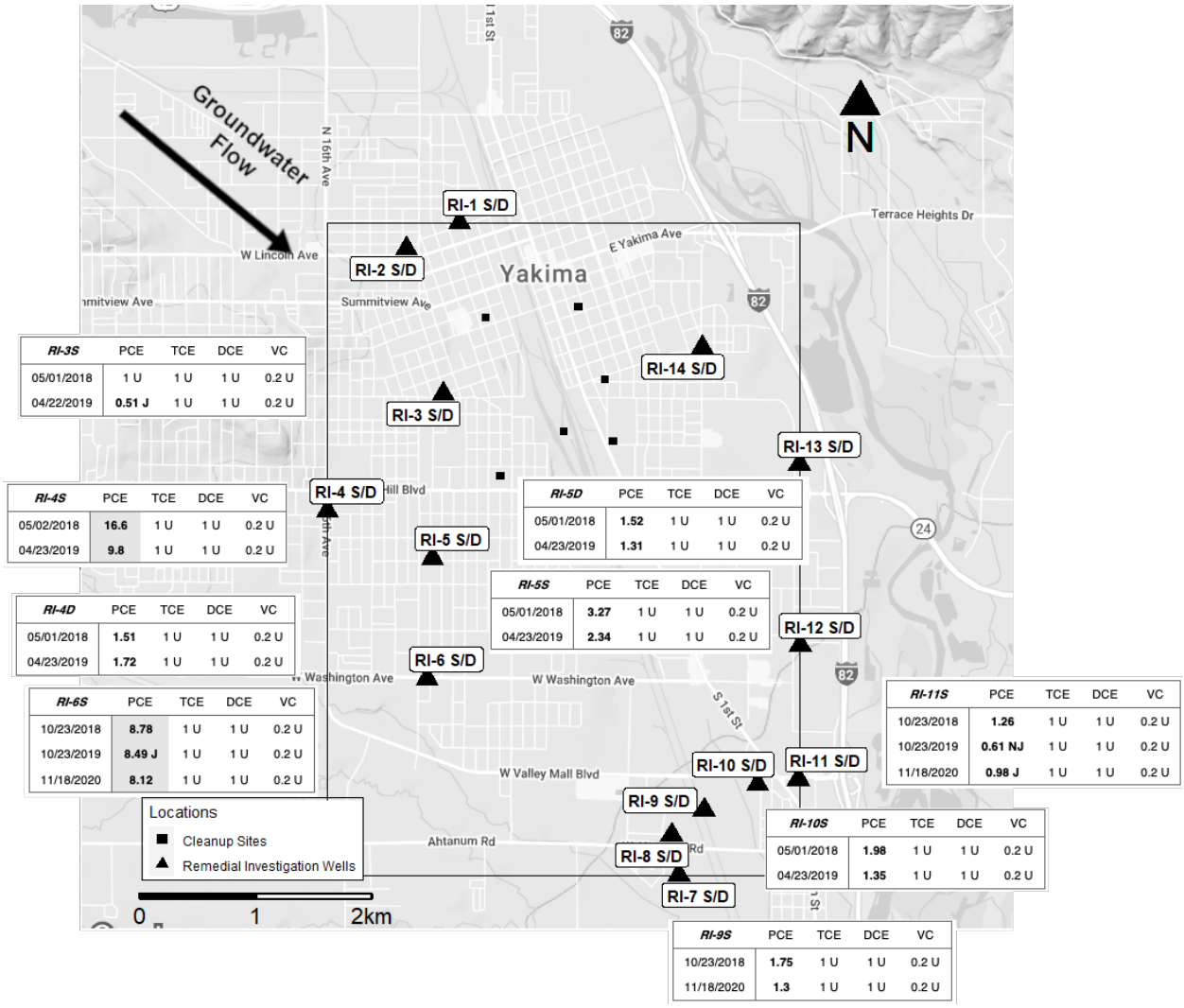
Operation of the remediation systems appear to have substantially reduced contaminant concentrations at the site. During the operation of the GRS, consultants from Hart Crowser (2015) noted that there was evidence that PCE had been mobilized from the soil matrix, and that reducing conditions had been propagated to enhance reductive dechlorination of cVOCs in groundwater and soil beneath the site.

Despite significant improvement in groundwater quality achieved with remedial action, high concentrations of PCE, TCE, and Vinyl chloride remain present in the shallow onsite and downgradient off-site wells. Concentrations of cVOCs in groundwater beneath the site continue to exceed the applicable cleanup levels. Additionally, monitoring data indicate that the PCE plume extends beyond the boundaries of the monitoring network and the full extent of groundwater contamination from the site is not fully delineated.

YRRA Remedial Investigation Wells

During 2018-2020, nine Remedial Investigation (RI) wells were sampled: seven shallow and two deep wells. The RI wells were installed throughout the YRRA to determine the extent of the PCE contamination in groundwater away from known source areas. These RI wells were installed as shallow and deep pairs to characterize groundwater quality in the upper and lower water-bearing zones. Nine wells were selected for continued monitoring; these are primarily located along the western and southern edges of the YRRA (Figure 2).

During 2018-2020, PCE was detected in all nine RI wells. Concentrations ranged from an estimated 0.51 ug/L in RI-3S to 16.6 ug/L in RI-4S (Figure 9).



RI-3S	PCE	TCE	DCE	VC
05/01/2018	1 U	1 U	1 U	0.2 U
04/22/2019	**0.51 J**	1 U	1 U	0.2 U

RI-4S	PCE	TCE	DCE	VC
05/02/2018	**16.6**	1 U	1 U	0.2 U
04/23/2019	**9.8**	1 U	1 U	0.2 U

RI-5D	PCE	TCE	DCE	VC
05/01/2018	**1.52**	1 U	1 U	0.2 U
04/23/2019	**1.31**	1 U	1 U	0.2 U

RI-5S	PCE	TCE	DCE	VC
05/01/2018	**3.27**	1 U	1 U	0.2 U
04/23/2019	**2.34**	1 U	1 U	0.2 U

RI-4D	PCE	TCE	DCE	VC
05/01/2018	**1.51**	1 U	1 U	0.2 U
04/23/2019	**1.72**	1 U	1 U	0.2 U

RI-6S	PCE	TCE	DCE	VC
10/23/2018	**8.78**	1 U	1 U	0.2 U
10/23/2019	**8.49 J**	1 U	1 U	0.2 U
11/18/2020	**8.12**	1 U	1 U	0.2 U

RI-11S	PCE	TCE	DCE	VC
10/23/2018	**1.26**	1 U	1 U	0.2 U
10/23/2019	**0.61 NJ**	1 U	1 U	0.2 U
11/18/2020	**0.98 J**	1 U	1 U	0.2 U

RI-10S	PCE	TCE	DCE	VC
05/01/2018	**1.98**	1 U	1 U	0.2 U
04/23/2019	**1.35**	1 U	1 U	0.2 U

RI-9S	PCE	TCE	DCE	VC
10/23/2018	**1.75**	1 U	1 U	0.2 U
11/18/2020	**1.3**	1 U	1 U	0.2 U

Figure 9. YRRA Remedial Investigation Well Locations and cVOC Results (ug/L).

Well RI-3S

RI-3S is the farthest upgradient RI well currently being sampled.

PCE was detected in this well during April 2019 at an estimated concentration below the reporting limit of 1 ug/L at 0.51 J ug/L. Low concentrations of PCE (ranging from 0.2 to 2.5 ug/L) have been detected in this well since monitoring began in 1999 (Figure C-43). Because PCE is not naturally occurring, the data indicate that a low-level source of PCE is contaminating the shallow aquifer at the upgradient end of the YRRA.

Wells RI-4S and RI-4D

These two wells are located along the western boundary of the YRRA.

RI-4S continues to have the highest PCE concentrations of the RI wells. PCE concentrations in RI-4S ranged from 9.8 ug/L in April 2019 to 16.6 ug/L in May 2018, and exceeded the 5 ug/L cleanup level during the May 2018 (16.6 ug/L) and April 2019 (9.8 ug/L) monitoring.

PCE was also detected in the deep well (RI-4D) during May 2018 and April 2019 ingat 1.51 ug/L and 1.72 ug/L, respectively (Table C-9; Figure C-44).

Although concentrations have been fairly stable over most of the 2018-2020 monitoring period, they appear to have increased since 2009 (Figure C-45). The source of contamination in these wells is under investigation. Data from these wells indicate that the western extent of the YRRA PCE plume is still undefined.

Wells RI-5S and RI-5D

These two wells are located in a residential area, about 0.7 miles southeast (downgradient) of RI-4S and RI-4D.

PCE was detected in both wells during 2018-2020, with concentrations ranging from 1.31 ug/L in RI-5D to 3.27 ug/L in RI-5S, and do not exceed the 5 ug/L cleanup level (Figures C-46 and C-47). Concentrations are typically higher in the shallow well, which exhibits a seasonal pattern of spring maximums. Concentrations in both wells appear to be increasing. Because these wells are in a residential area, the low PCE levels are most likely from an upgradient source.

Well RI-6S

This well is located in the southeast portion of the project area.

PCE continues to be detected above the cleanup level, with concentrations ranging from 8.12 to 8.79 ug/l during 2018-2020. PCE concentrations in this well appear to be increasing and have a seasonal pattern with higher concentrations occurring in the fall (Figure C-48). Currently, there is no known source for the contamination in this well. The extent of PCE contamination in the shallow aquifer needs to be better characterized in this portion of the YRRA.

Wells RI-9S, RI-10S, and RI-11S

These three wells are located at the southern boundary of the YRRA study area and are the farthest downgradient wells being sampled.

These wells continue to have low levels of PCE, ranging from an estimated 0.61 ug/L in RI-11S to 1.98 ug/L in RI-10S during 2018-2020 (Figure C-49, C-50, C-51).

TCE, DCE, and vinyl chloride were not detected in samples collected from these wells during 2018-2020.

Summary of Results

Of the 41 wells sampled during 2018-2020, 22 (54%) had PCE concentrations that exceeded (did not meet) the MTCA Method A cleanup level. These 22 wells are located at four sites: Goodwill, Frank Wear Cleaners, Washington Central Railroad Roundhouse (WCRR), and Cameron Yakima. Remedial Investigation (RI) wells RI-4S and RI-6S had PCE concentrations that exceeded the 5 ug/L cleanup level. These two wells are located located along the western edge of the YRRA study area.

Figure 10 shows maximum annual PCE concentrations in shallow groundwater for 2018-2020. The majority of the wells with elevated PCE are screened in the shallow, water-bearing zone, ranging in depth from 26 to 40 feet below ground surface (bgs). The maximum PCE concentrations in these wells ranged from 5 to 21,800 ug/L.

The Frank Wear Cleaners site, added to the monitoring program in 2017, has the highest concentrations of PCE, TCE, DCE, and vinyl chloride in the YRRA. This site continues to be a significant source of cVOC contamination in groundwater across the study area.

At the WCRR site, PCE, TCE, DCE, and vinyl chloride have been consistently detected .

At the Cameron Yakima site, PCE breakdown products were observed at concentrations below the MTCA cleanup levels.

Monitoring data from the Frank Wear, WCRR, and Cameron wells confirm that the shallow groundwater in the central portion of the YRRA remains contaminated with PCE. It is not clear whether the contaminant plumes are separate or co-mingled.

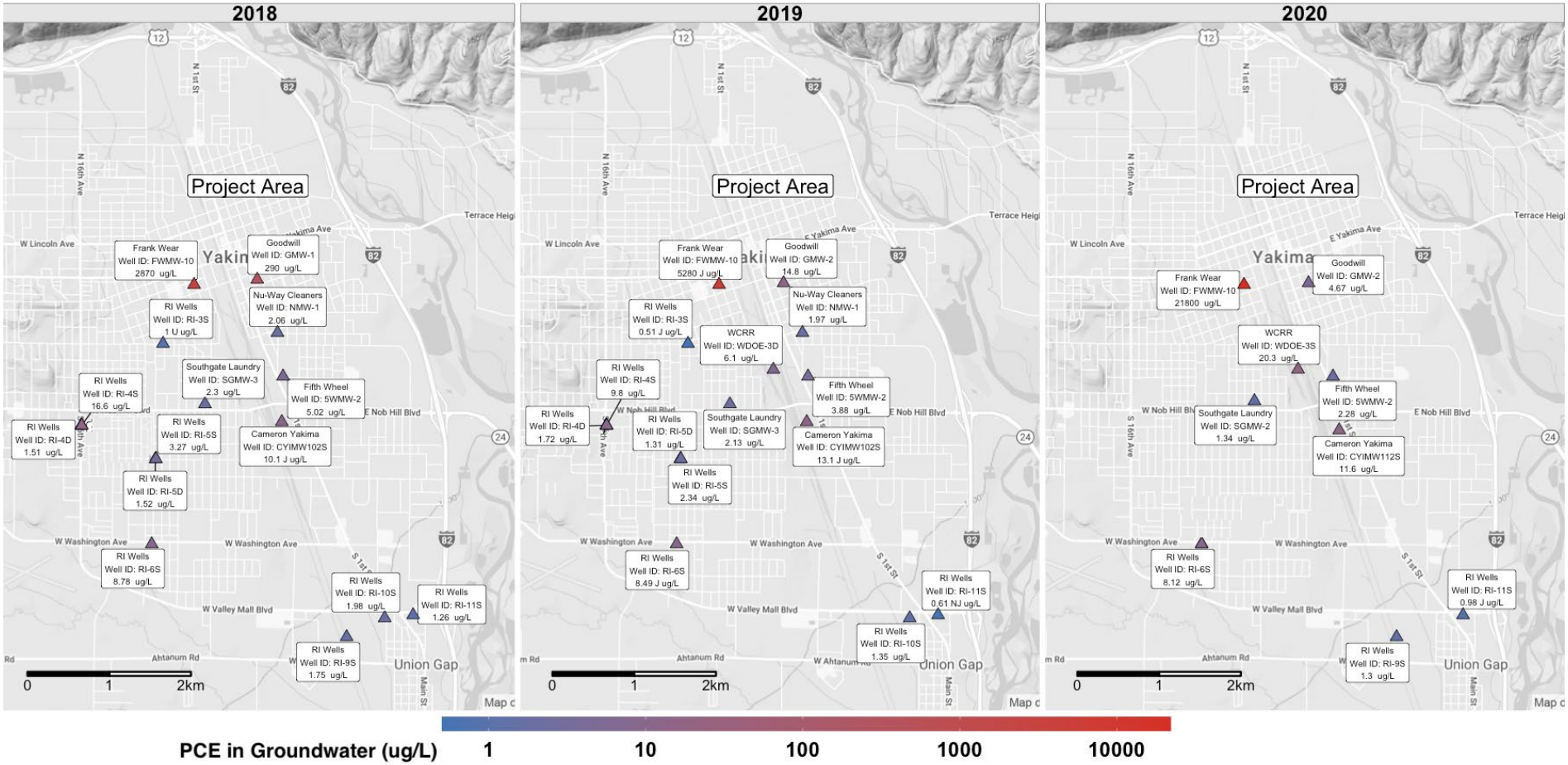


Figure 10. Maximum Shallow Zone PCE Concentrations, 2018-2020.

Discussion and Conclusions

Dissolved tetrachloroethene (PCE) remains present in the shallow, unconfined aquifer throughout the Yakima Railroad Area (YRRA) project area. Remediation performed at individual sites over the years appears to have been effective in reducing contaminant concentrations in groundwater at many of the identified source areas; however, there are still areas where contaminant concentrations continue to exceed (not meet) the established MTCA cleanup levels.

There have been 59 wells in the long-term YRRA monitoring program.

- In 2013, Ecology selected a subset of 36 wells for continued monitoring. Wells were removed from the active monitoring program if they consistently showed low or no detections of the contaminants of concern, primarily PCE.
- In 2017, the network of 36 wells was augmented with an additional 10 wells at the Frank Wear site, and two wells were discontinued: (1) a well at Agri-Tech, a former pesticide formulations plant, and (2) a well at the Nu-Way Cleaners site that was decommissioned in 2016.

During 2018-2020, Ecology collected groundwater samples from 41 of the 44 wells that remain in the monitoring network. The selected subset of wells continues to provide data to evaluate groundwater conditions throughout the project area.

Existing Cleanup Sites

Thirty-five of the 44 wells that remain in the monitoring network are associated with seven identified source areas.

- Six of the source areas (Goodwill, Nu-Way Cleaners, Southgate Laundry, Fifth Wheel, Cameron Yakima, and Frank Wear Cleaners) have undergone some level of remedial action to address PCE contamination. Remediation at these sites appears to have reduced the impact or eliminated sources of PCE contamination in groundwater.
- There is no record of any direct remediation at the seventh source area (Washington Central Railroad Roundhouse; WCRR). The three wells at this site were installed as a well cluster of varying depths. PCE concentrations in the shallow and deep wells indicate that the contaminant plume has a vertical component that reaches the deep water-bearing zone in this portion of the YRRA. Also present in the two deeper wells are PCE metabolic breakdown products, including TCE and DCE, that are typically detected at concentrations above the cleanup level. The WCRR site continues to act as a significant source of groundwater contamination by cVOCs that include the deeper portions of the aquifer system.

In 2017, the Frank Wear Cleaners site was added to the YRRA monitoring program. Ecology collected groundwater samples from 10 of the 24 site wells, seven shallow wells and three deep wells. Although in-situ remediation at the site has reduced the contaminant mass, this site continues to be a substantial source of PCE contamination to the YRRA project area. PCE metabolic breakdown products also occur at concentrations above the associated cleanup levels. Elevated cVOC concentrations in both the shallow onsite and downgradient off-site wells indicate that the full extent of the plume beyond the monitoring well network is still unknown.

cVOCs were detected at concentrations near or below the reporting limit in two of the deep wells, suggesting limited vertical migration.

The 2018-2020 monitoring data show that the highest contaminant concentrations continue to occur in the central portion of the YRRA, at Frank Wear Cleaners, WCRR, and Cameron Yakima. Although cleanup activities have occurred at two of these locations, the lateral and vertical extent of the contaminant plume is still poorly defined. Further investigation is needed at these three sites to determine the full extent of the PCE plumes and whether the plumes have comingled.

Remedial Investigation Wells

In 1997, 29 wells were installed for the YRRA Remedial Investigation (RI). These RI wells were installed as shallow and deep pairs at 15 locations throughout the YRRA project area to characterize aquifer properties and to determine the lateral and vertical extent of PCE contamination in groundwater.

Nine RI wells, RI-10S, RI-11S, RI-3S, RI-4D, RI-4S, RI-5D, RI-5S, RI-6S, and RI-9S, were selected for continued monitoring. These are primarily located along the western and southern boundaries of the YRRA.

- PCE was detected at concentrations below the MTCA cleanup level in seven of the nine RI wells. Because PCE is not naturally occurring, the low concentrations detected in these wells indicate low-level sources of PCE exist and are contributing to the contamination in the YRRA.
- The other two wells, RI-4S and RI-6S, are located on the western edge of the YRRA and consistently have elevated PCE concentrations that appear to be increasing. The sources of PCE contamination in these wells are still being identified and require remedial action.

Contaminant Impacts to Deep Water-Bearing Zones

During 2018-2020, nine of the 41 wells sampled in the YRRA project area are screened in the deeper zone (60 -120 feet bgs). Only two deep wells (WDOE-3I and WDOE-3D) have contaminant concentrations that exceeded the MTCA cleanup level.

PCE concentrations in the seven other deep wells are consistently below the cleanup levels and have remained fairly constant over the 1997-2020 monitoring period. Three of these seven wells are located at the Frank Wear Cleaners site, two are at the Cameron Yakima site, and two are RI wells on the western boundary of the YRRA.

Summary and Recommendations

Because groundwater within the Yakima Railroad Area (YRRA) project area continues to be contaminated by both identified and unidentified sources, cleanup activities and investigations continue to be conducted across the area.

Based on the 2018-2020 monitoring results for the YRRA, the following recommendations are provided:

- Additional PCE source investigations at the Washington Central Railroad Roundhouse site and the Cameron Yakima site to determine the full lateral and vertical extent of the contaminant plumes, since off-site migration at the two sites is most likely occurring.
- Continued investigation at the Frank Wear Cleaners site, because the PCE contaminant plume extends beyond the current site monitoring well network.
- Continued investigation into the sources of PCE contamination detected in Remedial Investigation wells RI-4S/4D and RI-6S.
- Continued monitoring of the well network within the YRRA project area, based on seasonally fluctuating PCE concentrations.

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Glossary, Acronyms, and Abbreviations

Glossary

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Dissolved oxygen: A measure of the amount of oxygen dissolved in water.

Parameter: Water quality constituent being measured (analyte).

Acronyms and Abbreviations

FS	Feasibility study
DCE	Cis-1,2-dichloroethene
Dup	Duplicate
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
FS	Feasibility study
GRS	Groundwater recirculation system
LDPE	Low Density Polyethylene
MEL	Manchester Environmental Laboratory
MSL	Mean Sea Level
MTCA	Model Toxics Control Act
MQO	Measurement Quality Objective
MW	Monitoring well
ORP	Oxidation-reduction potential
PCE	Tetrachloroethene
PVC	Polyvinyl chloride
RI	Remedial investigation
RPD	Relative percent difference
SOP	Standard operating procedure
SVE	Soil vapor extraction
TCE	Trichloroethene
TOC	Top of casing
USGS	U.S. Geological Survey
VC	Vinyl chloride
VOA	Volatile Organic Analysis
cVOC	chlorinated Volatile Organic Compounds
WAC	Washington Administrative Code
YRRA	Yakima Railroad Area (the project area)

Units of Measurement

°C	degrees centigrade
ft	feet

mg/L	milligrams per liter
mV	milli volts
s.u.	standard units
ug/L	micrograms per liter (parts per billion)
umhos/cm	micromhos per centimeter
uS/cm	microsiemens per centimeter, a unit of conductivity

Appendices

The following Appendices are linked to this report at https://apps.ecology.wa.gov/publications/SummaryPages/2203014.html.

Appendix A. Well Construction Details and Field Measurement Data

Appendix B. Quality Assurance Review

Appendix C. Project Results, December 1997 – November 2020