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Lakewood Plaza Cleaners, Groundwater Monitoring Results

May and October 2008

by
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Abstract

This progress report is one in a series describing results of long-term groundwater sampling at the former Lakewood Plaza Cleaners site south of Tacoma. The report includes results of volatile organics in samples collected from project monitoring wells and Lakewood Water District municipal wells in May and October 2008.

- Monitoring wells MW-20B and MW-16A, as well as municipal wells H1 and H2, continue to have tetrachloroethene (PCE) concentrations higher than the Model Toxic Control Act (MTCA) cleanup level of 5 µg/L. PCE concentrations in these wells during May and October were: MW-20B (143 and 258 µg/L), MW-16A (55 and 31 µg/L), H2 (9.6 µg/L in May), and H1 (5.1 µg/L in October).

- PCE was also detected in well LPMW-2 in May at a concentration of 2.5 µg/L. This well is located near the former septic system of Plaza Cleaners which was identified as the source of the contamination.

- Trichloroethene (TCE) was detected in MW-20B during May and October at concentrations of 5.5 and 4.5 µg/L. The May result exceeds the MTCA cleanup level for TCE of 5 µg/L.

- Cis-1,2-dichloroethene (cis-1,2-DCE) was detected in wells MW-20B (12 and 9 µg/L) and MW-16A (2.8 and an estimated 0.6 J µg/L). The federal maximum contaminant level for cis-1,2-DCE is 70 µg/L.

Most concentrations remain within the range of those reported in previous samplings conducted by the Washington State Department of Ecology since 1991. However, PCE concentrations in well MW-16A appear to be steadily rising. Average PCE concentrations rose from 8 µg/L in 1992 to 77 µg/L in 2006. The average PCE concentration in well MW-16A in 2008 was 43 µg/L.

Compliance with the groundwater cleanup goals have not been met for this project. The project should be evaluated to determine what follow-up actions are needed for this site to meet the cleanup goals in a reasonable timeframe.

Introduction

In 1981, the U.S. Environmental Protection Agency (EPA) confirmed that the Lakewood Water District production wells H1 and H2 were contaminated with tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE). Lakewood is south of Tacoma in Pierce County. The source of the contamination was identified as the Lakewood Plaza Cleaners (EPA, 1983). Remedial activities were conducted between 1984 to 1993.

In 1991, the Washington State Department of Ecology (Ecology) began semi-annual, long-term groundwater monitoring at the site. The objective of this sampling is to collect groundwater quality data for Ecology's Toxics Cleanup Program. The Toxics Cleanup Program will use this data to evaluate the effectiveness of Lakewood water supply wells H1 and H2 to contain, remove, and treat groundwater contaminated by Plaza Cleaners.

In 1996, the monitoring program was evaluated. Based on data collected from 1986 to 1996, it was decided to decommission half of the remaining wells and reduce the monitoring program to wells in the immediate vicinity of Plaza Cleaners. The monitoring program is evaluated every five years. The most recent evaluations occurred in 2002 and 2007. The current monitoring program was determined to be sufficient to meet project objectives (EPA, 2007).

Three wells (LPMW-1, LPMW-2, and LPMW-3) were added to the monitoring program in May 2006. These wells are located on a property adjoining the former Plaza Cleaners property. PCE was detected in these wells during their installation in December 2004. In May 2008, wells LPMW-1 and LPMW-3 were removed from the monitoring program because Ecology had not detected PCE in the wells and access to the wells had been restricted. Ecology continues to sample well LPMW-2.

Methods

In May 2008, groundwater samples were collected from monitoring wells MW-16A, MW-20A, MW-20B, MW-27, MW-33, LPMW-2 and municipal well H2 (Figure 1).

In October 2008, groundwater samples were collected from wells MW-16A, MW-20A, MW-20B, MW-27 and municipal well H1. Well LPMW-2 was not sampled because it was dry.

Wells MW-16A, MW-20A, MW-27, and MW-33 are screened in the Advanced Outwash deposits, the primary water-supply aquifer for the area. Groundwater flow direction in the Advanced Outwash is west-northwest when municipal water-supply wells H1 and H2 are not in use. When in use, these two wells create a large cone of depression (EPA, 1985).

Well MW-20B is screened in the Vashon Till, which forms an aquitard over most of the site. Wells LPMW-1, LPMW-2, and LPMW-3 range in depth from 28-32 feet and are screened in the Steilacoom Gravel, which generally contains perched water above the impermeable Vashon Till and regional water table.

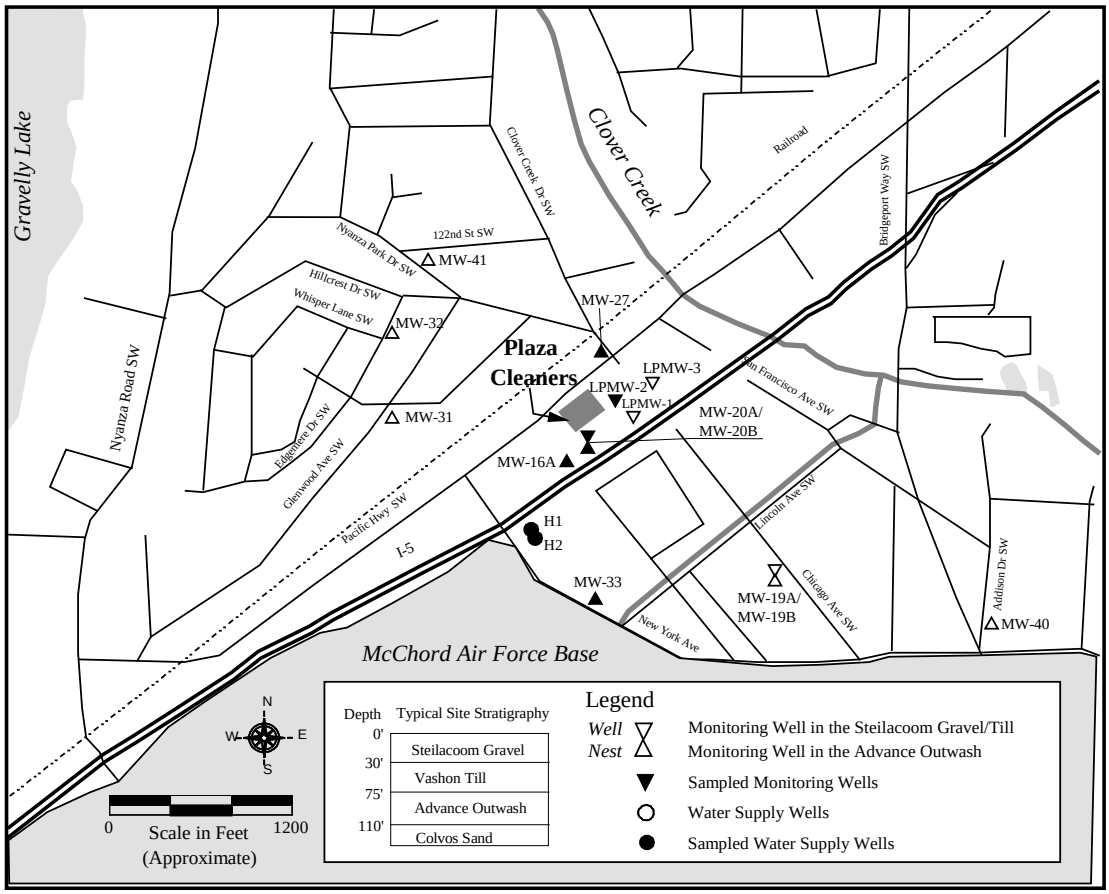

Figure 1. Lakewood Plaza Cleaners Sampling Locations.

Static water levels were measured in all the wells using a calibrated Solinst water level meter prior to well purging and sampling. Measurements were recorded to 0.01 foot and are accurate to 0.03 foot. The probe was rinsed with deionized water between measurements.

Monitoring wells MW-16A, MW-20A, and MW-33 were purged and sampled using dedicated bladder pumps.

Wells MW-20B, MW-27, and LPMW-2 were purged and sampled with a stainless-steel submersible pump with dedicated tubing using low-flow sampling techniques. The submersible pump was decontaminated between wells by circulating laboratory-grade detergent/water through the pump followed by a clean water rinse, with each cycle lasting five minutes.

The monitoring wells were purged until pH, temperature, and specific conductance readings stabilized or three well volumes of water had been removed. Purge water from the monitoring wells was collected and stored in 55-gallon drums. The purge water waste was transported and disposed of in accordance with Washington State regulations (Chapter 173-340-400 WAC). At the completion of purging, samples were collected from the monitoring wells directly from the dedicated pump discharge tubing into laboratory-supplied containers. Municipal wells H1 and H2, which pump continuously, were sampled from the tap nearest the wells.

Volatile organics samples were collected free of headspace in three 40-mL glass vials with Teflon-lined septa lids and preserved with 1:1 hydrochloric acid. Upon sample collection and proper labeling, all samples were stored in an ice-filled cooler. Samples were transported to Ecology's Operations Center in Lacey. Samples were kept in the walk-in cooler until taken by the courier to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Laboratory protocol (Ecology, 2003).

Results

Analysis

Table 1 lists analytes, analytical methods, and detection limits for both field and laboratory parameters. All groundwater samples were analyzed for volatile organics.

Table 1. Field and Laboratory Methods, May and October 2008.

Field Measurements	Instrument Type	Method	Accuracy
Water Level	Solinst Water Level Meter	SOP EAP052	±0.03 feet
pH	Orion 25A Field Meter	EPA 150.1	±0.1 std. units
Temperature	Orion 25A Field Meter	EPA 150.1	±0.1 ºC
Specific Conductance	YSI 3520 Conductivity Cell	EPA 120.1	±10 µmhos/cm
Laboratory Analytes	**Reference**	**Method**	**Reporting Limit**
Volatile Organics	EPA 1996	EPA SW-846 Method 8260B	1-5 µg/L

SOP = Standard Operating Procedure.

The quality of the data is acceptable. Quality control samples collected in the field consisted of blind field duplicates obtained from well MW-16A. Field duplicates were collected by splitting the pump discharge between two sets of sample bottles, which provides a measure of the overall sampling and analytical precision. Precision estimates are influenced not only by the random error introduced by collection and measurement procedures, but also by the natural variability of the concentrations in the media (e.g., groundwater) being sampled.

The numeric comparison of duplicate results is expressed as the relative percent difference (RPD). The RPD is calculated as the difference between sample results, divided by the mean and expressed as a percent. Table 2 shows the results of the duplicate samples and their RPD. The RPD for the May data ranged from 11% to 18%, and in October the RPD for PCE was 6%.

Table 2. Relative Percent Difference (RPD) of Duplicate Sample Results (µg/L), May and October 2008.

Well	PCE		TCE		cis-1,2-DCE	
	5/08	10/08	5/08	10/08	5/08	10/08
MW-16A	55	31	1.2	0.45 J	2.8	0.6 J
MW-16B	48	33	1	0.45 J	2.5	0.62 J
RPD (%)	14%	6%	18%	--	11%	--

A review of the data quality control and quality assurance from laboratory case narratives indicates that analytical performance was good. The reviews include descriptions of analytical methods, holding times, instrument calibration checks, blank results, surrogate recoveries, and laboratory control samples. No major problems were reported that compromised the usefulness

or validity of the sample results; therefore, all results are usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

Field

Depth-to-water measurements and purge volume, as well as pH, specific conductance, and temperature readings, at the time of sampling are listed in Table 3.

Table 3. Summary of Field Parameter Results, May 28 and October 23, 2008.

Well	Total Depth (feet)[1]	Depth to Water (feet)[1]	pH (standard units)	Specific Conductance (µmhos/cm)	Temperature (°C)	Purge Volume (gallons)
May						
MW-16A	109	38.23	7.1	207	13.2	62
MW-20A	97.3	31.33	8.1	123	13.3	20
MW-20B	50.4	30.65	6.7	451	14.2	6
MW-27	96.4	29.91	6.8	181	14.6	15
MW-33	99.3	++	7.0	--	11.7	24
LPMW-2	29	24.9	6.4	170	15.2	2.5
H2	110	++	6.3	257	12.8	>1000
October						
MW-16A	109	43.76	7.0	206	12.5	54
MW-20A	97.3	36.32	7.6	206	12.1	17
MW-20B	50.4	37.48	6.5	346	14.1	8
MW-27	96.4	34.42	--	176	13.6	21
H1	110	++	6.9	166	11.5	>1000

[1] Measured from top of PVC casing.
++ Dedicated pump obstructed water-level measurement.
-- Not measured.

All field parameters were within expected ranges. The specific conductance in well MW-20B (346-451 µmhos/cm) was greater than the other wells. Well MW-20B is screened in a fine-grained till unit. Specific conductance readings are typically higher for water from fine-grained units.

Analytical

May and October 2008 analytical results for volatile organics of interest are summarized in Table 4 and presented in Figure 2.

All field measurements and analytical results data are available in electronic format from Ecology's EIM data management system: www.ecy.wa.gov/eim/index.htm. Search study ID LAKEWOOD.

Table 4. Results (µg/L) of Volatile Organics of Interest, May 28 and October 23, 2008.

Well	Tetrachloroethene (PCE)	Trichloroethene (TCE)	Cis-1,2-Dichloroethene (cis-1,2-DCE)
May			
MW-16A	**55**	**1.2**	**2.8**
MW-20A	1 U	1 U	1 U
MW-20B	**143**	**5.5**	**12**
MW-27	1 U	1 U	1 U
MW-33	1 U	1 U	1 U
LPMW-2	**2.5**	1 U	1 U
H2	**9.6**	1 U	1 U
October			
MW-16A	**31**	**0.45 J**	**0.6 J**
MW-20A	1 U	1 U	1 U
MW-20B	**258**	**4.5**	**9**
MW-27	1 U	1 U	1 U
H1	**5.1**	1 U	1 U

Bold: Analyte detected.
U: Analyte was not detected at or above the reported value.
J: Analyte was positively identified. The associated numerical result is an estimate.

In May, PCE, TCE, and cis-1,2-DCE concentrations in well MW-20B were 143 µg/L, 5.5 µg/L, and 12 µg/L, respectively. These analytes were also detected in well MW-16A at concentrations of 55 µg/L (PCE), 1.2 µg/L (TCE), and 2.8 µg/L (cis-1,2-DCE). PCE was detected in municipal well H2 at a concentration of 9.6 µg/L. PCE was also detected in well LPMW-2 at a concentration of 2.5 µg/L. This well is located near the former septic system of Plaza Cleaners which was identified as the source of the contamination.

In October, PCE, TCE, and cis-1,2-DCE concentrations in well MW-20B were 258 µg/L, 4.5 µg/L, and 9 µg/L, respectively. PCE was also detected in wells MW-16A and H1 at concentrations of 31 µg/L and 5.1 µg/L, respectively. MW-16A also contained TCE and cis-1,2-DCE at concentrations below the practical quantitation limit of 1 µg/L.

Monitoring wells MW-20B and MW-16A, as well as municipal wells H1 and H2, continue to have PCE concentrations exceeding the MTCA cleanup level of 5 µg/L. Well MW-20B also continues to have TCE concentrations near the MTCA cleanup level of 5 µg/L

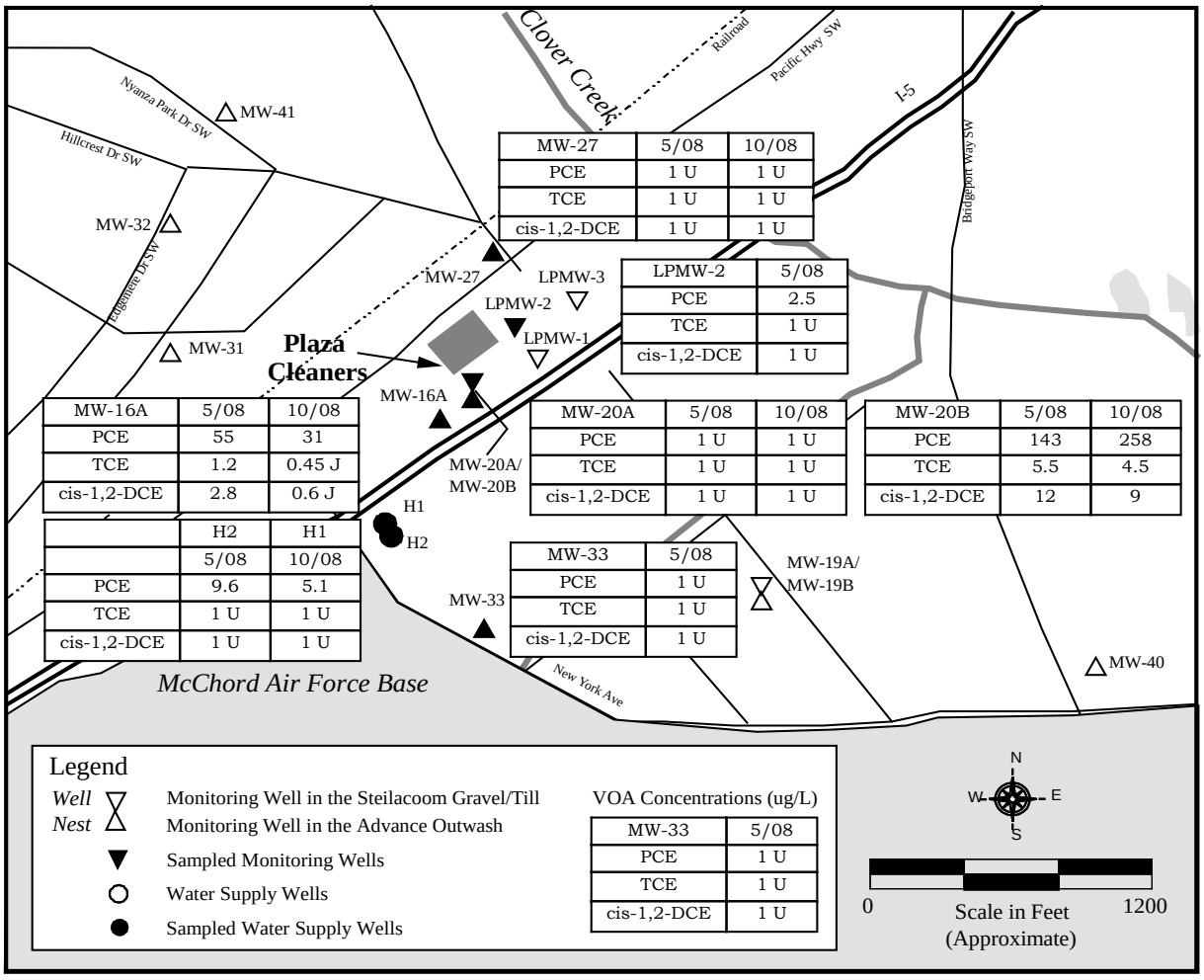

Figure 2. Lakewood Plaza Cleaners PCE, TCE, and Cis-1,2-DCE Concentrations (µg/L), May and October 2008.

Discussion

In 1991, Ecology assumed long-term groundwater monitoring of the site with the goal of collecting groundwater data to evaluate the effectiveness of municipal wells H1 and H2 to contain and remove the contaminated groundwater. Contaminant concentrations were projected to meet cleanup standards by the mid-1990s (EPA, 1992).

Table 5 shows average PCE and TCE concentrations that have exceeded the MTCA cleanup level of 5 µg/L during Ecology's sample period of 1991 to 2008. All PCE, TCE, and cis-1,2-DCE concentrations from January 1991 through October 2008 are presented in Appendix A. PCE concentrations for wells MW-20B and MW-16A for the same time period are also presented as graphs in Appendix A.

Table 5. Average Annual PCE and TCE Concentrations (µg/L) for Wells that Exceed MTCA Method A Cleanup Level for Groundwater of 5 µg/L.

Year	MW-20B		MW-16A	H1/H2
	PCE	TCE	PCE	PCE
1991	657	12	19	---
1992	640	14	8	---
1993	443	12	28	---
1994	279	8.6	21	---
1995	340[a]	8.4[a]	27[a]	9[a]
1996	370	7	45	4
1997	297	4	50	13
1998	515	8	33	10
1999	715	7	22[a]	3
2000	416	6	31	9
2001	489	7	28	9
2002	309	8.5	34	9
2003	234	5.4	42	6.4
2004	293	6.6	39	5.3
2005	484	6.5	62	10.2
2006	367	4.9	77	6.1
2007	348	6	54	4.5
2008	201	5	43	7.4

--: Not tested.
a: Single annual result.

Figures 3 and 4 show the average annual PCE concentrations for MW-20B and MW-16A from 1985 through 2008. PCE concentrations in both wells have varied substantially.

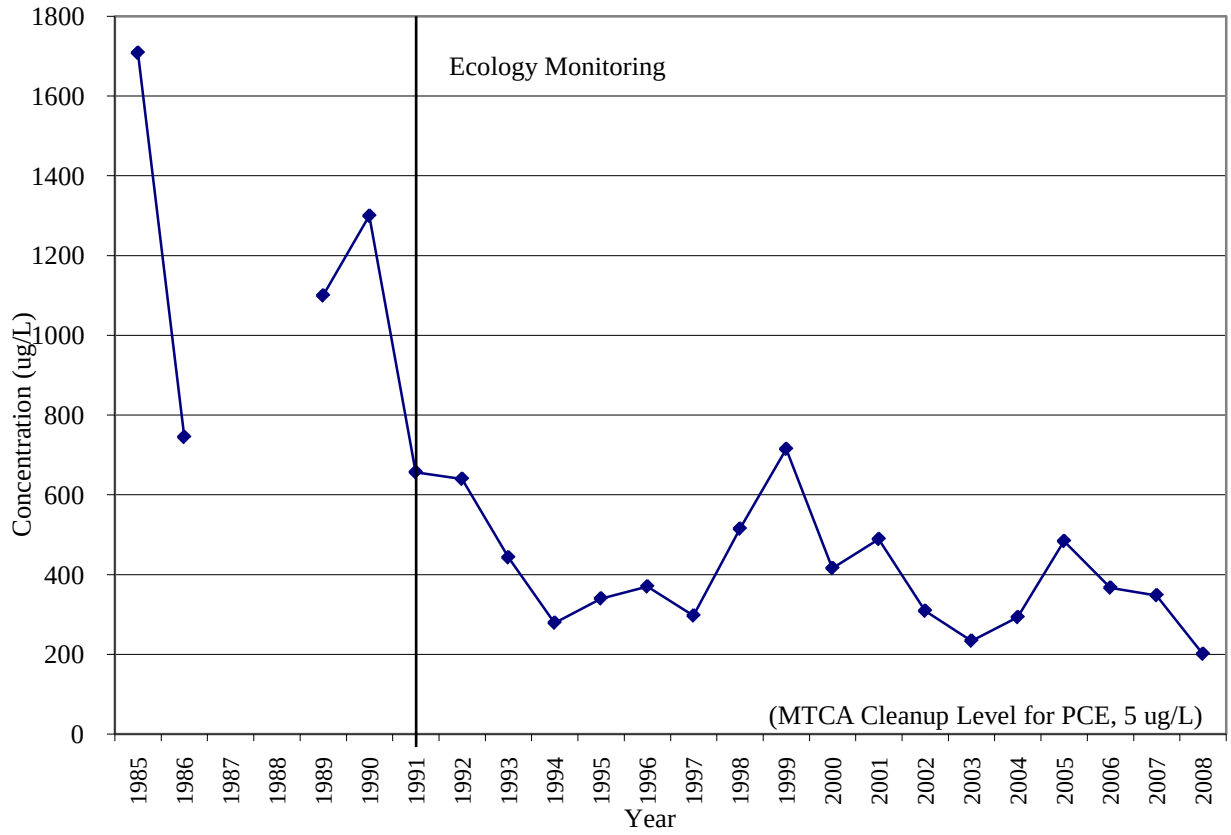

Figure 3. Average Annual PCE Concentrations for Well MW-20B, 1985 through 2008.

PCE concentrations decreased initially in MW-20B from 4850 µg/L in March 1985 to 570 µg/L in May 1985. The average PCE concentration for 1985 was 1700 µg/L. Well MW-20B was sampled annually in 1986, 1989, and 1990 and had a PCE concentration range of 745 to 1300 µg/L.

From 1991 to 1994, Ecology collected samples in the spring and fall which corresponded to the high-water/low-water seasons. In well MW-20B, PCE concentrations decreased from a 1991 average of 657 to 279 µg/L in 1994.

In 1995, the sampling routine changed to a winter/summer schedule. Seasonal fluctuations in concentrations which occurred from 1991 to 1994 leveled off with the change in the sample schedule (Figure A1). In 1995, average PCE concentrations were 340 µg/L. Average concentrations then increased to a high of 715 µg/L in 1999, before decreasing to 234 µg/L in 2003.

In the fall of 2003, sampling returned to the spring/fall schedule, which led to a corresponding return to seasonal variations in concentrations. Average annual PCE concentrations have since ranged from 234 µg/L in 2003, to 484 µg/L in 2005, and then decreased to 201 µg/L in 2008.

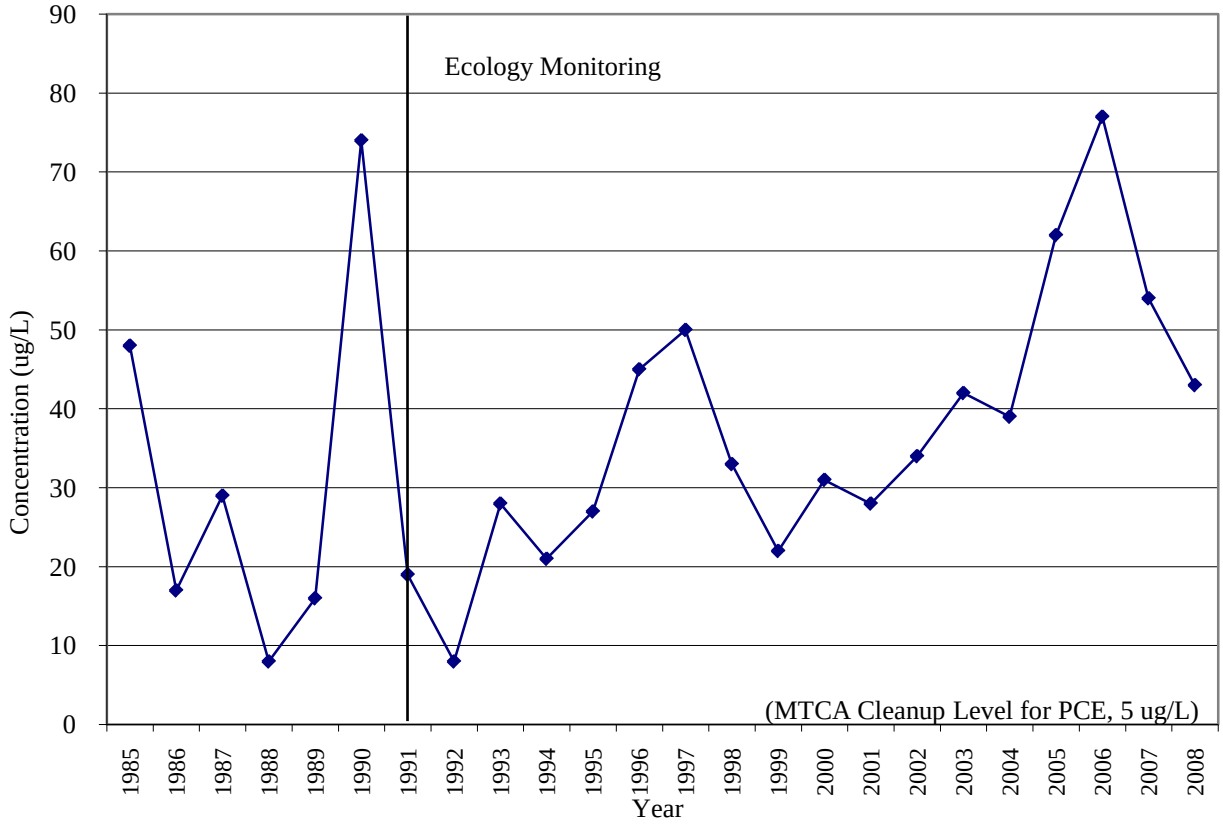

Figure 4. Average Annual PCE Concentrations for Well MW-16A, 1985 through 2008.

In 1985, PCE concentrations also initially decreased in well MW-16A, dropping from 110 µg/L in March to 12 µg/L in August, with an average annual PCE concentration of 48 µg/L. From 1986 to 1990, PCE concentrations of individual samples ranged from 8 to 74 µg/L.

Since Ecology began monitoring in 1991, average annual PCE concentrations have gone from 8 µg/L in 1992 to 50 µg/L in 1997, decreasing to 22 µg/L in 1999, then steadily increasing to 77 µg/L in 2006. Average PCE concentrations in 2008 were 43 µg/L. PCE concentrations for well MW-16A from 1991 to 2008 (Ecology sampling) are presented in Figure A-2.

PCE concentrations continue to exceed the MTCA cleanup level of 5 µg/L in monitoring wells MW-20B and MW-16A. Samples collected from municipal wells H1 and H2 prior to treatment also have PCE concentrations above the MTCA cleanup level. Compliance with the groundwater cleanup goals have not been met for this project.

Conclusions

Monitoring was conducted in May 2008 at six monitoring wells and one municipal well, and in October 2008 at four monitoring wells and one municipal well, to evaluate volatile organics in groundwater at the Lakewood Plaza Cleaners site.

- Monitoring wells MW-20B and MW-16A, as well as municipal wells H1 and H2, continue to have PCE concentrations higher than the MTCA cleanup level of 5 µg/L.
- Monitoring well MW-20B continues to have TCE concentrations near the MTCA cleanup level of 5 µg/L.
- PCE concentrations in well LPMW-2 have been above or near the cleanup level of 5 µg/L in past samplings, but was below the cleanup level in May (2.5 µg/L). This well is located near the former septic system of Plaza Cleaners which was identified as the source of the contamination.

Concentrations of PCE have decreased from their original 1985 levels, but continue to remain elevated. Average annual PCE concentrations in wells MW-20B and MW-16A have decreased since their 1985 concentrations of 4850 µg/L and 110 µg/L, respectively. Since Ecology began sampling in 1991, average annual PCE concentrations in well MW-20B have ranged from a high of 715 µg/L in 1999 to a low of 201 µg/L in 2008. Although PCE concentrations were lower during the 2008 sampling, concentrations continue to be within the range of those reported during previous monitoring.

PCE concentrations in well MW-16A appear to be steadily increasing. Average annual PCE concentrations in 1992 were 8 µg/L, increasing to 77 µg/L in 2006. The average PCE concentrations in 2008 were 43 µg/L. Although average annual concentrations have decreased during 2007 and 2008 (54 µg/L and 43 µg/L), overall PCE concentrations in wells MW-16A appear to be steadily rising.

Since 1984, municipal wells H1 and H2 have been used to contain and remove contaminated groundwater associated with the Lakewood Plaza Cleaners site. Based on early monitoring results, it was projected that compliance with cleanup goals of 5 ug/L for PCE and TCE would be achieved throughout the contaminated plume by the mid-1990s. PCE concentrations in monitoring wells MW-20B, MW-16A, and municipal wells H1 and H2 continue to exceed the cleanup levels. At this time, it is unknown when compliance with the cleanup goals will be reached.

Recommendations

Monitoring wells MW-20B and MW-16A, as well as municipal wells H1 and H2, continue to have PCE concentrations higher than the MTCA cleanup level and the site cleanup goal of 5 µg/L. Most concentrations remain within the range of those reported in previous samplings conducted by Ecology since 1991. However, PCE concentrations in well MW-16A appear to be steadily rising. Municipal wells H1 and H2 have been used to contain, remove, and treat the groundwater contaminated by the Lakewood Plaza Cleaners site. Compliance with the project goals has not been achieved within the projected timeframe.

Project data should be evaluated to determine what follow-up actions are needed for this project to meet the cleanup goals in a reasonable timeframe.

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Appendix A. Summary of Results

Table A-1. Summary of Sample Results (ug/L), January 1991 to October 2008.

Well	January 1991			May 1991			November 1991			May 1992			December 1992		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**28**	**1 J**	**2.4 J**	**26**	**0.6 J**	**2**	**2.7 J**	1 U	**0.6 J**	**7**	1 U	**1**	**9 J**	**0.3 J**	**0.8 J**
MW-20A	1 U	1 U	1 U	**0.4 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.5 J**	1 U	1 U	**0.8 J**	1 UJ	1 UJ
MW-20B	**1100 D**	**18**	**33**	**752**	**16**	**30**	**120**	**2.6 J**	**6.7**	**940**	**13**	**32**	**340 J**	**14 J**	**20 J**
MW-21	**2.1 J**	1 U	**1 J**	**2**	1 U	**0.7 J**	**2.2 J**	1 U	**1.0 J**	**2**	1 U	**0.6 J**	**2**	**0.2 J**	**0.3 J**
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 UJ	1 UJ
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-31	**1 J**	1 U	**1.9 J**	**0.6 J**	1 U	**2**	**0.9 J**	1 U	**2.2 J**	**0.8 J**	1 U	**1**	**0.5 J**	1 UJ	**0.9 J**
MW-32	**1 J**	1 U	**1.1 J**	**1**	1 U	**2**	**0.6 J**	1 U	**0.6 J**	**0.7 J**	1 U	**1**	**0.7 J**	1 UJ	**0.5 J**
MW-41	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 UJ	1 UJ
MW-19A	--	--	--	--	--	--	1 U	**0.5 J**	1 U	--	--	--	1 UJ	1 UJ	1 UJ
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-40	1 U	1 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--	1 UJ	1 UJ	1 UJ
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well	May 1993			December 1993			April 1994			November 1994			July 1995		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**44**	10 U	**2 J**	**13**	**0.3 J**	**0.7 J**	**33**	**0.6**	**1.4**	**9.7**	**0.3 J**	**0.5 J**	**27**	**0.5 J**	**0.8 J**
MW-20A	10 U	10 U	10 U	**0.3 J**	1 U	1 U	**0.4**	0.2 U	0.2 U	**0.3 J**	1 U	1 U	**0.4 J**	1 U	1 U
MW-20B	**700 D**	**12**	**21**	**187**	50 U	**8.2 J**	**472**	**8.6 J**	**12.6**	**86**	50 U	**3 J**	**340 D**	**8.4**	**17**
MW-21	**1 J**	10 U	10 U	**1.6**	1 U	**0.4 J**	**1.5**	**0.2 J**	**0.3**	**1.8**	**0.2 J**	**0.3 J**	--	--	--
MW-27	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-28A	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-31	10 U	10 U	10 U	**0.8 J**	1 U	**1.2 J**	**0.7**	0.2 U	**1.0**	**0.8 J**	1 U	**1**	**0.6 J**	1 U	**0.5 J**
MW-32	10 U	10 U	10 U	**0.7 J**	1 U	**0.6 J**	**0.7**	0.2 U	**0.6**	**0.6 J**	1 U	**0.5 J**	**0.7 J**	1 U	**0.5 J**
MW-41	10 U	10 U	10 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-19A	--	--	--	1 U	**0.4**	1 U	0.2 U	**0.5**	0.2 U	--	--	--	1 U	**0.4 J**	1 U
MW-33	--	--	--	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	--	--	--	1 U	1 U	1 U
H1/H2	--	--	--	--	--	--	--	--	--	--	--	--	**9**	**0.3 J**	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2008.

Well	January 1996			July 1996			January 1997			July 1997			February 1998		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**47 E**	**0.8 J**	**1.5**	**43**	**0.7 J**	**1.9**	**54**	**1.1**	**3.1**	**47**	**0.7 J**	**2.5**	**36**	**0.7 J**	**2 J**
MW-20A	**0.2 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.4 J**	1 U	1 U	**0.3 J**	1 U	2 U	**0.4 J**	1 U	1 U
MW-20B	**353**	**7.2**	**15**	**387**	**7.6**	**15**	**373**	100 U	**6.4 J**	**222**	**4**	**6.4**	**456**	**7 J**	**12**
MW-21	--	--	--	Well Decommissioned											
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U
MW-28A	1 U	1 U	1 U	Well Decommissioned											
MW-31	**0.6 J**	1 U	**0.7 J**	--	--	--	--	--	--	**0.9 J**	1 U	**0.9 J**	--	--	--
MW-32	**0.8 J**	1 U	**0.6 J**	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	1 U	1 U	1 U	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	--	--	--	1 U	**0.3 J**	2 U	--	--	--
MW-33	--	--	--	1 U	1 U	1 U	--	--	--	1 U	1 U	2 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	**8.4**	**0.2 J**	**0.2 J**	**0.1 J**	1 U	1 U	**18**	**0.4 J**	**0.4 J**	**8.8**	**0.3 J**	**0.6 J**	**11**	**0.4 J**	**0.3 J**

Well	July 1998			January 1999			August 1999			January 2000			August 2000		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**30**	1 U	**1.5 J**	--	--	--	**22**	**0.4 J**	**1.1**	**40**	**0.7 J**	**1.9**	**22**	**0.3 J**	**0.7**
MW-20A	**0.6 J**	1 U	1 U	1 U	2 U	1 U	**0.8 J**	2 U	1 U	**0.2 J**	2 U	1 U	**0.1 J**	2 U	1 U
MW-20B	**575 D**	**10**	**23**	**708**	**5.2**	**12**	**722**	**8.4 J**	**16 J**	**184**	**6**	**13**	**648**	200 U	100 U
MW-27	**0.05 J**	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U
MW-31	--	--	--	--	--	--	**0.9 J**	2 U	**0.4 J**	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	**0.8 J**	2 U	1 U
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
MW-19A	--	--	--	--	--	--	1 U	**0.4 J**	1 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	1 U	2 U	1 U	--	--	--	1 U	2 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	1 U	2 U	1 U
H1/H2	**10**	1 U	**0.1 J**	**1.5**	1 U	1 U	**5.2**	**0.2 J**	1 U	**10**	1 U	1 U	**8.7**	**0.03 J**	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2008.

Well	January 2001			August 2001			February 2002			August 2002			February 2003		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**31**	**0.4 J**	**1**	**25**	**0.3 J**	**0.7 J**	**47**	**0.8 J**	**2.3**	**22**	**0.3 J**	**0.8 J**	**59 J**	**0.2 J**	**2.4**
MW-20A	**0.2 J**	1 U	1 U	1 U	2 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U
MW-20B	**493**	**6.6 J**	**12**	**486**	**8.2**	**18**	**248**	200 U	100 U	**371**	**8.5**	**16**	**230**	100 U	100 U
MW-27	1 U	1 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	2 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	**0.4 J**	2 U	**0.3 J**	--	--	--	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	1 U	**0.3 J**	1 U	--	--	--	--	--	--	--	--	--
MW-33	--	--	--	1 U	2 U	1 U	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
H1/H2	**11**	**0.2 J**	1 U	**6.8**	**0.2 J**	1 U	**12**	**0.2 J**	**0.2 J**	**6.1**	1 U	1 U	**1.3**	1 U	1 U

Well	September 2003			June 2004			November 2004			June 2005			November 2005		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**26**	**0.3 J**	**0.5 J**	**30**	**0.4 J**	**0.8 J**	**48**	1 U	**1.4**	**80**	**1.3**	**2.8**	**43**	**0.7 J**	**1.0 J**
MW-20A	**0.1 J**	1 U	1 U	**0.2 J**	1 U	1 U	**0.3 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-20B	**239**	**5.4 J**	**12**	**344**	**6.5 J**	**15**	**241**	**6.7**	**13**	**413**	**6.6**	**12**	**555**	**6.4**	**11**
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
MW-31	**0.5 J**	1 U	**0.1 NJ**	--	--	--	--	--	--	**0.5 J**	1 U	1 U	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	**1.4**	1 U	1 U	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-19A	1 U	**0.4 NJ**	1 U	--	--	--	--	--	--	1 U	**0.6 J**	1 U	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
MW-40	--	--	--	--	--	--	--	--	--	1 U	1 U	1 U	--	--	--
H1/H2	**6.4**	**0.2 NJ**	1 U	**7.9**	**0.2 J**	**0.1 J**	**2.6**	1 U	1 U	**14**	**0.3 J**	1 U	**6.4**	1 U	1 U

Table A-1 (cont.). Summary of Sample Results (ug/L) from January 1991 to October 2008.

Well	May 2006			September 2006			June 2007			October 2007			May 2008		
Number	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE	PCE	TCE	cis-1,2-DCE
MW-16A	**124**	**1.8**	**4.6**	**29**	**0.3 J**	**0.48 J**	**83**	**1.2**	**2.5**	**24**	1 U	**0.64 J**	**55**	**1.2**	**2.8**
MW-20A	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-20B	**216**	**4.2**	**6.6**	**518**	**5.6**	**11**	**204**	**4.4**	**7.8**	**491**	**7.5**	**15**	**143**	**5.5**	**12**
MW-27	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U	1 U
MW-31	--	--	--	--	--	--	**1.6 J**	2 U	2 U	--	--	--	--	--	--
MW-32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-19A	--	--	--	--	--	--	2 U	**1.2 J**	2 U	--	--	--	--	--	--
MW-33	1 U	1 U	1 U	--	--	--	2 U	2 U	2 U	--	--	--	1 U	1 U	1 U
MW-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LPMW-2	**9.9**	1 U	1 U	--	--	--	**4.8**	1 U	1 U	--	--	--	**2.5**	1 U	1 U
LPMW-3	1 U	1 U	1 U	--	--	--	2 U	1 U	1 U	--	--	--	--	--	--
H1/H2	**7.3**	**0.2 J**	1 U	**4.8**	1 U	1 U	**5.2**	2 U	2 U	**3.8**	1 U	1 U	**9.6**	1 U	1 U

Well	October 2008		
Number	PCE	TCE	cis-1,2-DCE
MW-16A	**31**	**0.45 J**	**0.6 J**
MW-20A	1 U	1 U	1 U
MW-20B	**258**	**4.5**	**9**
MW-27	1 U	1 U	1 U
MW-31	--	--	--
MW-32	--	--	--
MW-41	--	--	--
MW-19A	--	--	--
MW-33	--	--	--
MW-40	--	--	--
LPMW-2	--	--	--
H1/H2	**5.1**	1 U	1 U

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.
D = Analysis performed at secondary dilution.
E = The concentration of the associated value exceeds the known calibration range.
-- = Not tested
Bold = The analyte was positively identified.

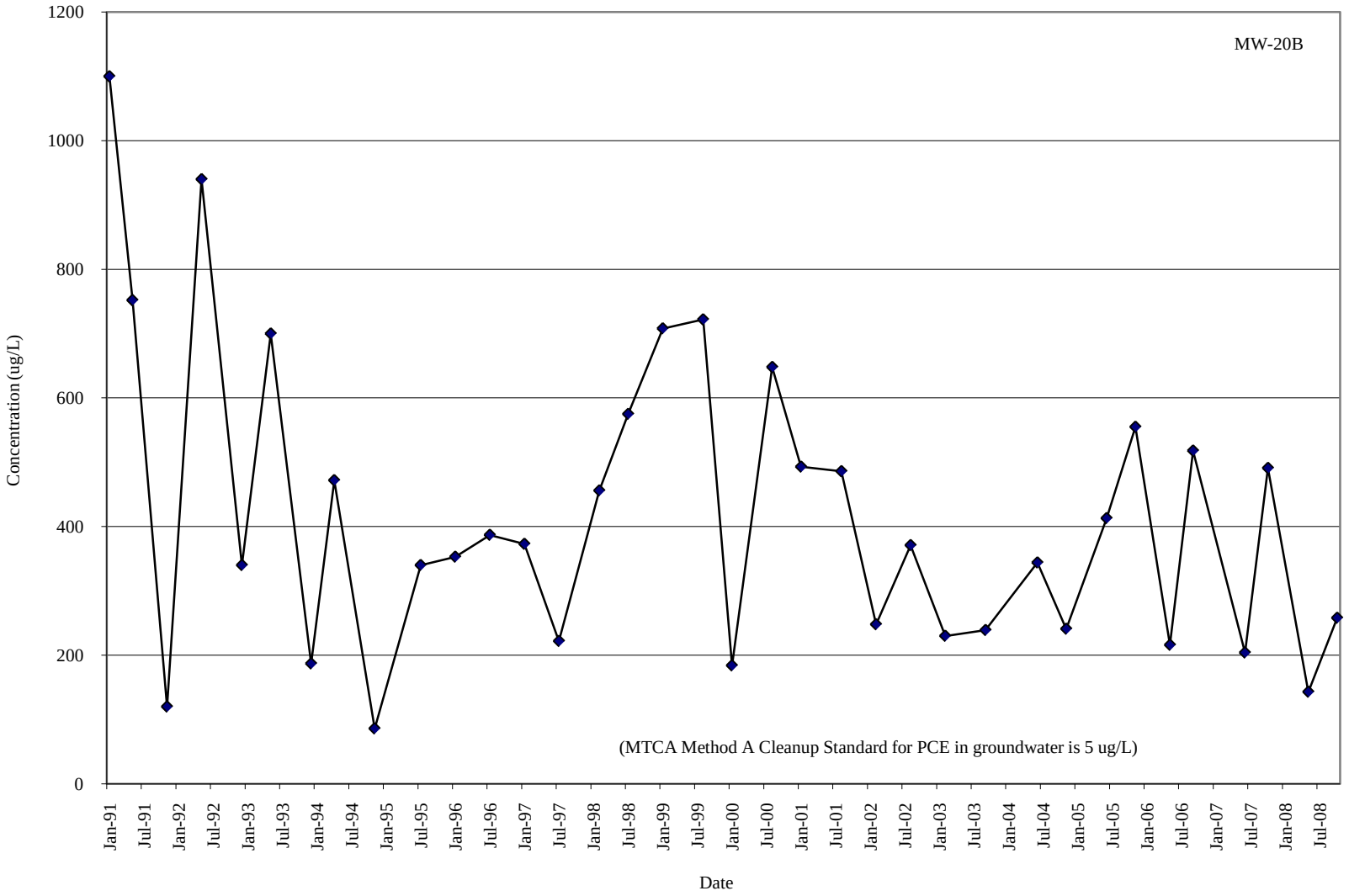

Figure A-1. PCE Concentrations for Well MW-20B, January 1991 to October 2008.

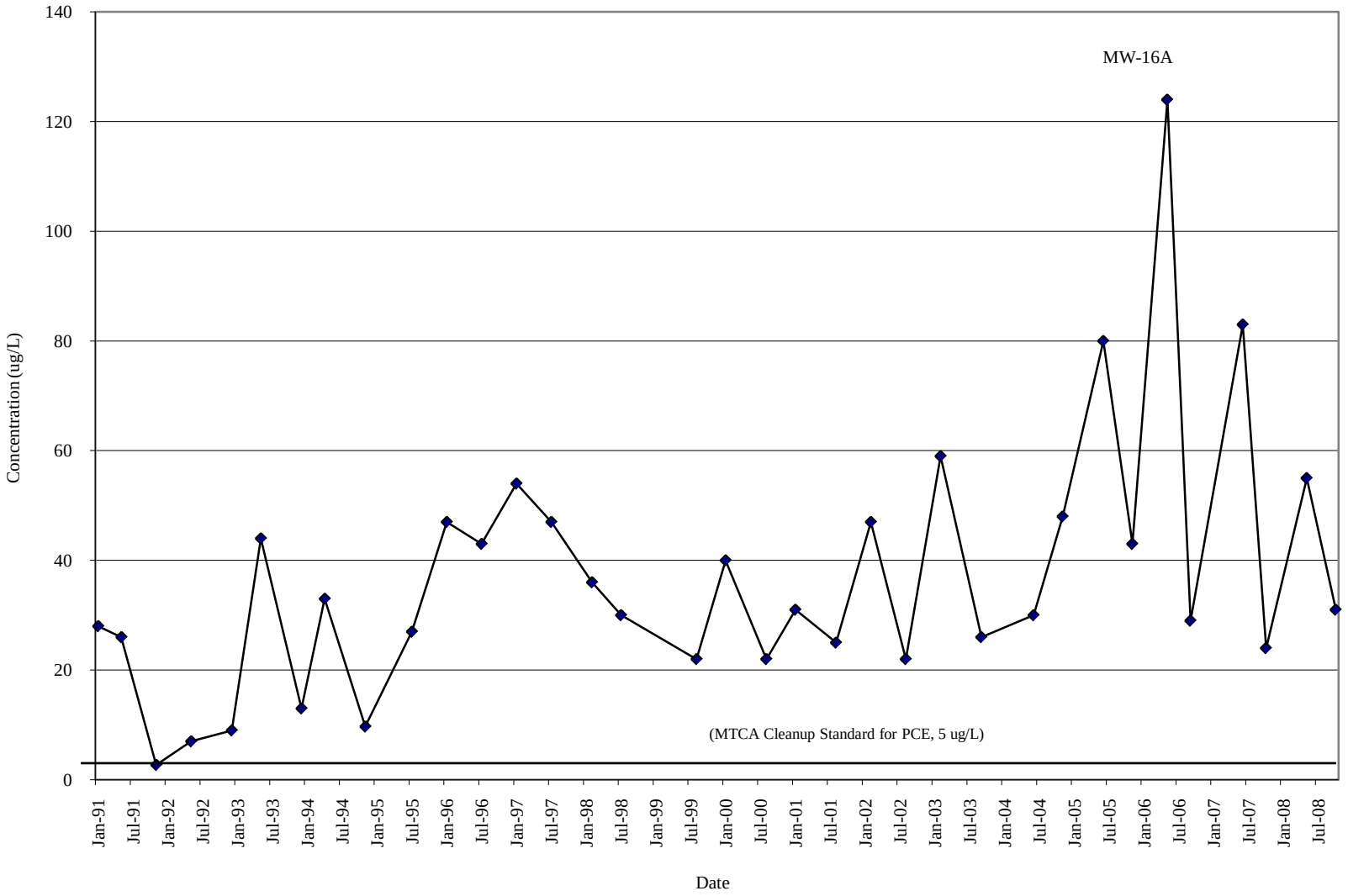

Figure A-2. PCE Concentrations for Well MW-16A, January 1991 to October 2008.

Appendix B. Acronyms and Abbreviations

Cis-1,2-DCE	Cis-1,2-dichloroethene
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	Environmental Protection Agency
MTCA	Model Toxic Control Act
PCE	Tetrachloroethene
RPD	Relative Percent Difference
TCE	Trichloroethene
VOA	Volatile Organics Analysis
WAC	Washington Administrative Code