A Department of Ecology Report

American Plating Post-Interim-Action Groundwater Monitoring Results March and August, 2005

Abstract

Groundwater samples for select dissolved metals (cadmium, chromium, hexavalent chromium, copper, and nickel), weak acid dissociable cyanide, and volatile organic compounds were collected from five monitoring wells during March and August, 2005, at the former American Plating site located on the Thea Foss Waterway in Tacoma, Washington. Samples were collected to provide the Department of Ecology's Toxics Cleanup Program with post-interim-action groundwater monitoring data.

Dissolved cadmium, chromium, copper, and nickel were detected in groundwater at the site during March and August.

- Nickel was detected in all five wells, with average concentrations ranging from 3.3 to 35 ug/L. During March and August, nickel concentrations exceeded the groundwater cleanup level of 8.2 ug/L in wells MW-5 and MW-10.
- Copper was detected in three wells. During August, copper concentrations slightly exceeded the cleanup level of 3.1 ug/L in well MW-3.
- Chromium was detected in all five wells. During March, chromium concentrations in four of the wells ranged from 16 to 38 ug/L. During August, chromium concentrations increased in all the wells, ranging from 9 to 88 ug/L.

  In 2004, dissolved chromium concentrations exceeded Washington State surface water quality standards for protection of aquatic organisms in marine waters for acute exposure to hexavalent chromium of 50 ug/L. Since it was not possible to determine which form of chromium, trivalent or hexavalent, was present, samples were collected and analyzed for hexavalent chromium in August 2005. Dissolved hexavalent chromium was not detected in any of the samples. Therefore, it is assumed that the less toxic and immobile trivalent chromium was present.

Because dissolved nickel exceeded the established groundwater cleanup standard during both monitoring rounds, some level of groundwater monitoring should continue.

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Background

American Plating, a metal electroplating company formerly operating on the Thea Foss Waterway in Tacoma (Figure 1), ceased production in 1986 when it was discovered that facility operations potentially violated state dangerous waste regulations. The Washington State Department of Ecology (Ecology) conducted several site inspections from 1980 to 1985. These inspections determined that discharges, leaks, and spills of plating materials had occurred at the site. The site had been occupied by plating companies since 1955. All companies performed metal electroplating including brass, cadmium, chromium, copper, nickel, and zinc plating.

A preliminary site assessment conducted by EPA in 1986 concluded that high levels of plating waste and contaminated materials were present on the site. Removal of waste material and site cleanup began in June 1987. A series of site investigations, which included the installation of 12 monitoring wells, was conducted from 1988 to 1994. In 1997, the site was ranked as a *2* under the Washington Ranking Method and placed on Ecology's Hazardous Site List.

An interim action was initiated by Ecology in the summer of 2003, with the primary objective of reducing the human health risk from contact with contaminated soil. The interim action included the removal of site buildings, a concrete pad, sumps, and an underground storage tank. Soil was excavated and removed from the site from depths of three-to-eight feet or to the water table. Clean fill and top soil were added to the excavated areas. It is anticipated that additional soil cleanup will be performed by the new site owner under the provisions of a Prospective Purchaser Consent Decree.

Contaminants of concern in groundwater include cadmium, chromium, copper, nickel, cyanide, and volatile organic compounds (VOCs), specifically vinyl chloride. Elevated metal concentrations were detected throughout the site soils. Elevated metal concentrations in groundwater are probably associated with leaching from the contaminated soils. Cyanide solutions are very common components of electroplating processes and were widely used at the site. Elevated levels of cyanide have been detected in the site soils and are the likely source of cyanide observed in the groundwater. A 1,000-gallon degreasing tank had been located in building 1 (Figure 2). Chlorinated solvents stored in the tank were used to degrease parts prior to plating. The source of the vinyl chloride is most likely from leaks or spills of degreasing solvents and their subsequent degradation in the environment. Historical data for the wells sampled during this monitoring period are presented in the Appendix.

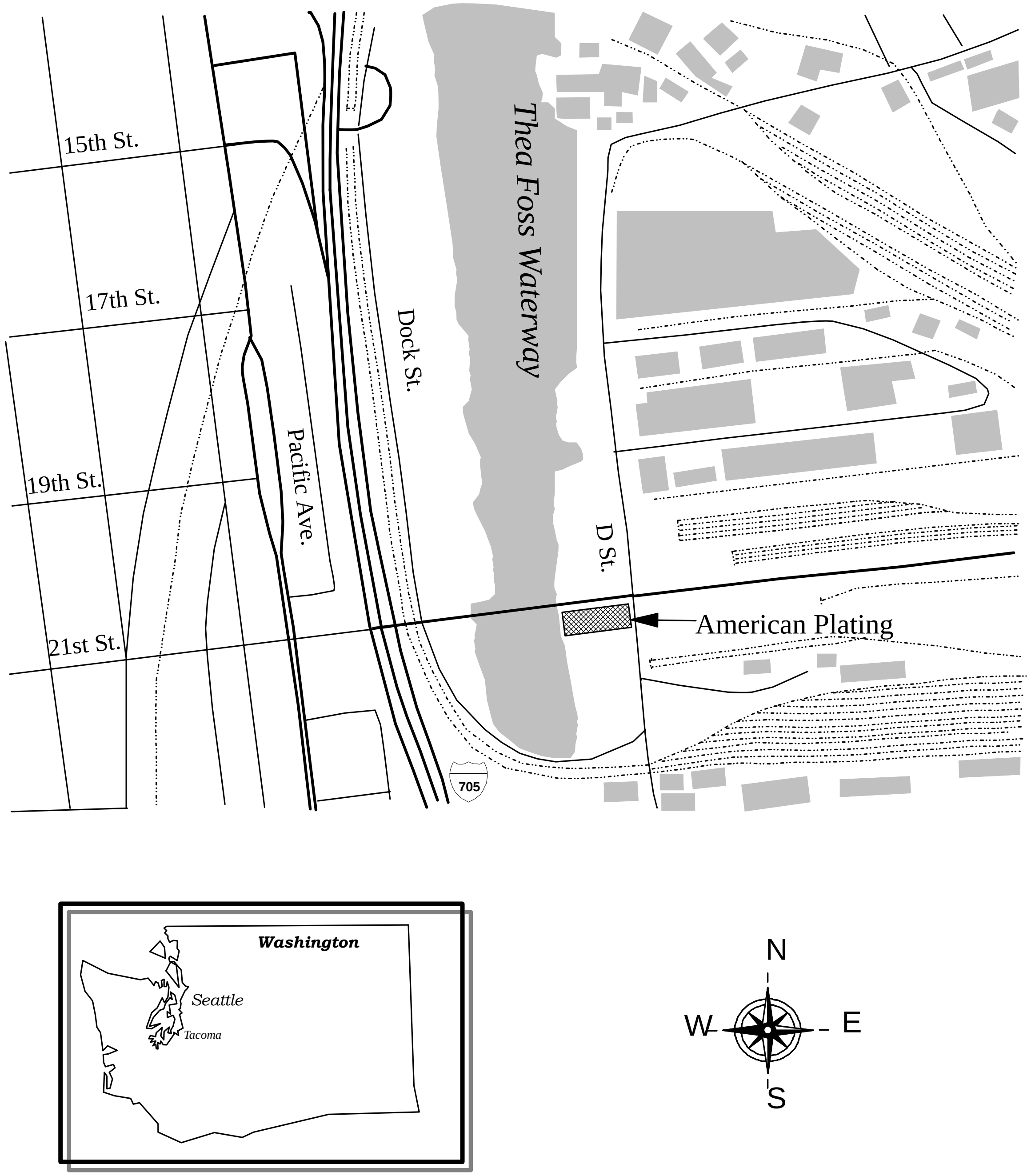


Figure 1: American Plating Site Location

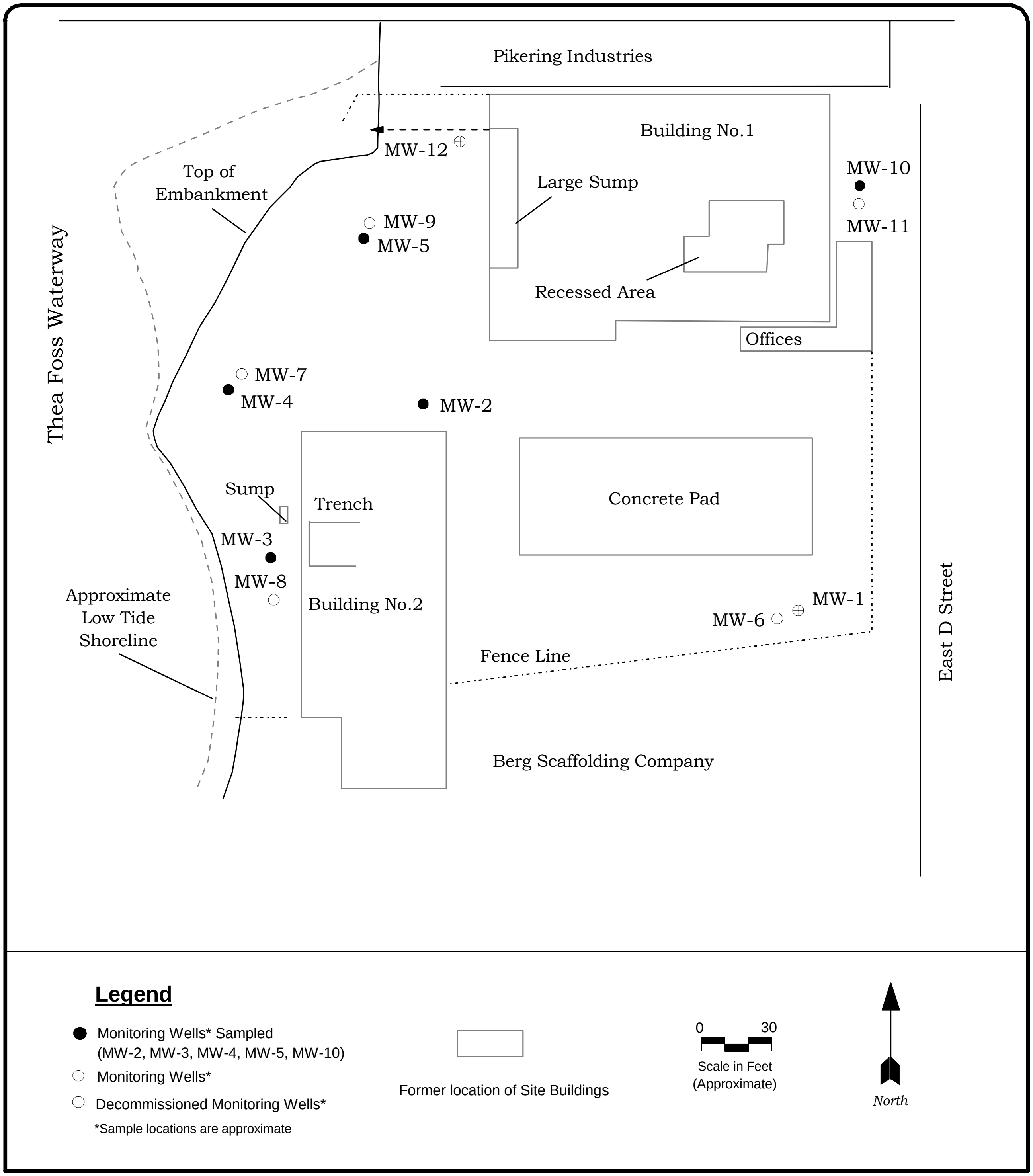


Figure 2: American Plating Sample Locations

Site geology has been described in several documents (SAIC, 1994; PRC, 1995) and is summarized as follows. Geology of the site consists of sedimentary deposits including, from the surface down, fill materials, undifferentiated fill and marsh deposits, deltaic deposits, and glacial till. Prior to the interim action, the fill materials were heterogeneous, consisting of gravels, silty sand, and wood debris to a depth of 5-to-18 feet below the surface. The fill and marsh deposits are undifferentiated, consisting of very soft sandy silts to clayey silts that are generally encountered at depths of about 3-to-12 feet below surface and range up to 15 feet thick. The wells sampled in March and August, 2005, are screened in the fill and marsh aquifer that is encountered in these deposits. The deltaic deposits are medium dense silty sand and silty gravel, encountered at a depth of about 18 feet, and are about five feet thick. These deposits appear to be relatively continuous beneath the site and seem to thicken to the northwest across the site. The sand aquifer is encountered in this unit. The till is generally encountered at depths of about 23-to-29 feet with an unknown thickness, and consists of slightly consolidated, very dense, silty sand to silty gravel.

Groundwater in the fill/marsh aquifer and the sand aquifer occurs under unconfined and semi-confined conditions, respectively; the two aquifers are interconnected and tidally influenced. The unconfined water table ranges from approximately 5-to-9 feet below ground surface. Variations in groundwater elevations reflect tidal phases in both aquifers. Groundwater flow is interpreted to be in a general northwesterly direction towards the Thea Foss Waterway. However, the hydraulic gradient in the unconfined aquifer may reverse at high tide phases at least beneath the western portion of the site.

Methods

Groundwater Sampling

Groundwater samples were collected in March and August, 2005, from five monitoring wells to determine post-interim-action groundwater concentrations of dissolved metals and weak acid dissociable (WAD) cyanide. Samples for VOCs were collected from well MW-10 (Figure 2).

The five wells that were sampled (MW-2, MW-3, MW-4, MW-5, and MW-10) are screened in the upper fill/marsh deposits aquifer. The monitoring wells were completed to depths of 10-to-17 feet, with five foot screened intervals at the base of the completion depth.

Static water levels were measured in all wells using a 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.

The monitoring wells were purged and sampled using a Grundfos Redi-Flo2 stainless steel submersible pump with dedicated tubing for each well. The pump intake was placed at the middle of the screened interval in each monitoring well and purged at a rate of 0.5-liter/minute or less. Wells were purged through a continuous flow cell until pH, specific conductivity, and temperature readings stabilized or the well was purged dry. Purge water from the wells was collected and stored on site in a 55-gallon drum. The purge water waste was transported and disposed of in accordance with state of Washington 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. The pump was decontaminated between each well by circulating laboratory grade detergent/water through the pump followed by a clean water rinse, with each cycle lasting five minutes.

Metal samples were field filtered using a clean, high capacity 0.45 micron membrane filter into a 1/2-liter, high density polyethylene container and acidified with nitric acid to a pH <2. Hexavalent chromium samples were field filtered into 125-mL polyethylene bottle. In August, the samples for dissolved metals analysis from MW-10 were filtered and preserved at the lab. WAD cyanide samples were collected in a 250-mL amber polyethylene bottle with sodium hydroxide preservative. VOC 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 Operation Center in Lacey. Samples were kept in the walk-in cooler until picked up by the courier and transported to the Ecology/EPA Manchester Environmental Laboratory in Manchester, Washington. Chain-of-custody procedures were followed according to Manchester Environmental Laboratory protocol (Ecology, 2003).

Analysis

Analytes, analytical methods, and reporting limits for both field and laboratory parameters are listed in Table 1. Groundwater samples were analyzed for select dissolved metals (cadmium, chromium, hexavalent chromium, copper, and nickel), weak acid dissociable (WAD) cyanide, and VOCs.

Table 1: Field and Laboratory Methods

Analytes	Method	Reference	Accuracy
Field			
Water Level	Solinst Water Level Meter	NA	±0.03 feet
pH	Orion 25A Field Meter	NA	±0.1 std. units
Temperature	YSI 3510 Temperature Probe	NA	±0.1 C
Specific Conductance	YSI 3520 Conductivity Cell	NA	±10 umhos/cm
Laboratory			Reporting Limit
Dissolved Metals	EPA Method 200.8	U.S. EPA 1996	0.1-0.5 ug/L
Hexavalent Chromium	SM3500-CR-D	SM 1998	2 ug/L
WAD Cyanide	SM4500CN-I	SM 1998	5-10 ug/L
VOCs	EPA SW-846 Method 8260B	U.S. EPA 1996	1-5 ug/L

In general, the quality of the data is acceptable. Quality control samples collected in the field consisted of blind replicate samples, which were obtained from well MW-3 during both rounds of sampling. The numeric comparison of replicate 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. The RPD for the dissolved metals in March was 26% for cadmium, 12% for chromium, 8% for copper, and 13% for nickel. In August, the RPD for dissolved metals was lower for each metal: 4% for chromium, 3% for copper, and 11% for nickel.

Overall, 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 problems were reported that compromised the usefulness, or validity, of the sample results. The only exception is that hexavalent chromium samples collected in March were not analyzed, because sample preparation was not started within the 24-hour required holding time. Dissolved hexavalent chromium results for August 2005 are qualified as *UJ*, because the requested quantitation limit of 2 ug/L was below the lowest concentration standard analyzed but above the MDL of 0.7 ug/L. Because linearity was not established below the lowest concentration on the curve, all reporting limits are estimated. No data were rejected, and all results were usable as qualified. Quality assurance case narratives and laboratory reporting sheets are available upon request.

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

Results

Field Observations

Total depth and depth-to-water of each monitoring well were determined prior to sampling. pH, specific conductivity, and turbidity readings measured at the time of sampling, as well as the total purge volume, are listed in Table 2.

Table 2: Summary of Field Parameter Results for March 14 and August 22, 2005

Monitoring Well	Total Depth (feet)[1]	Depth-to-Water (feet)[1] March		Depth-to-Water (feet)[1] August		pH (standard units)		Specific Conductivity (umhos/cm)		Turbidity (NTU)		Purge Volume (gallons)	
		Time	3/05	Time	8/05	3/05	8/05	3/05	8/05	3/05	8/05	3/05	8/05
MW-2	16.65	10:15	6.40	13:20	6.78	7.0	6.7	1,811	1,920	10	7.5	3.5	3.5
MW-3	14.67	10:05	4.15	10:00	4.09	6.7	6.6	22,500	23,900	1.7	0.5	3	3.5
MW-4	16.89	10:17	6.10	14:00	6.56	7.6	7.5	16,800	17,680	2	0.6	3.5	3.5
MW-5	16.84	10:21	6.70	11:10	6.96	7.6	7.4	17,700	18,800	29	80	4	2
MW-10	10.15	09:45	5.85	16:00	6.41	7.3	7.1	9,250	--	--	--	1	1

[1] Measured from top of PVC casing.
-- Not Measured.

Completion depths for the five monitoring wells ranged from 10.15 to 16.89 feet. Depth-to water was measured prior to purging each well. Figure 3 shows the tidal phase when water levels were measured and samples collected. Monitoring was conducted during falling tides in both March and August.

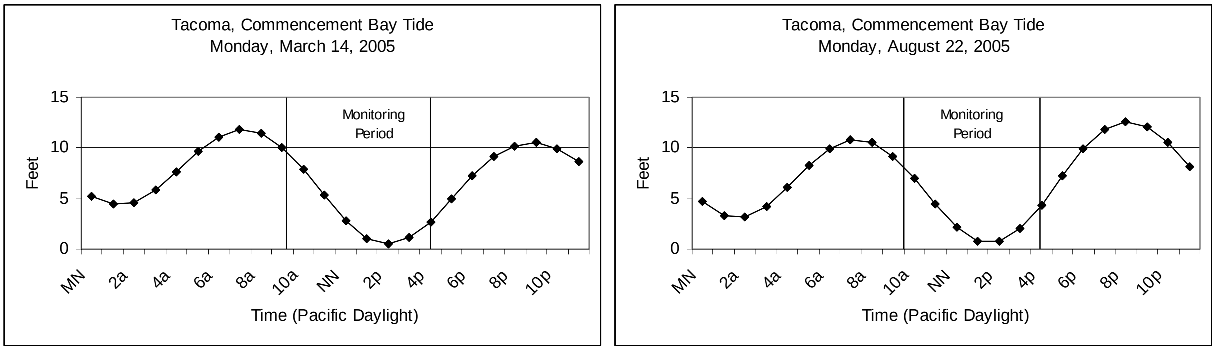


Figure 3: Tide Phase for Monitoring Period in March and August, 2005

Depth-to-water ranged from 4.15 to 6.70 feet below the measuring point in March and 4.09 to 6.96 feet in August. Groundwater flow direction for the project area is shown in Figure 4. The location of the water-table contours was determined using a geostatistical gridding method known as kriging which was applied to the groundwater elevation data for March 2005. The groundwater flow direction is approximately perpendicular to the contours. Groundwater flow direction during a falling tide is generally to the northwest, towards the Thea Foss Waterway.

The shallow wells sampled are screened in the soft sandy silt, silt, and clayey silt of the fill/marsh deposits. All the wells are low yielding. While purging at the lowest flow possible, water levels dropped in wells MW-2, MW-3, MW-4, and MW-5. Water levels in wells MW-4 and MW-5 dropped below the pump intake. The pump was shut off during purging to allow the wells to recover. Well MW-10 was purged dry and allowed six hours to recover before the well had a sufficient amount of water to sample.

During the monitoring period, the pH of groundwater ranged from 6.6 to 7.6. Groundwater temperatures measured in the flow cell in March ranged from 13.5º to 15.0ºC, increasing to 15.8º to 19.9ºC in August. The higher temperatures in August are partly caused by the combination of purging at a low flow rate through a flow cell. Specific conductivity measurements were high, ranging from 1,800 to 24,000 umhos/cm. Specific conductivity values were higher for those wells closer to the waterway. The high conductivity is consistent to the close proximity to the salt water. Specific conductivity of the waterway has been reported between 15,000 to 35,000 umhos/cm. Turbidity measurements ranged from 0.5 to 80 NTUs, with well MW-5 representing the higher end. Turbidity measurements in well MW-5 were lower during purging before the pump was shut off because of the dropping water levels. Turbidity increased when the pump was restarted just prior to sampling.

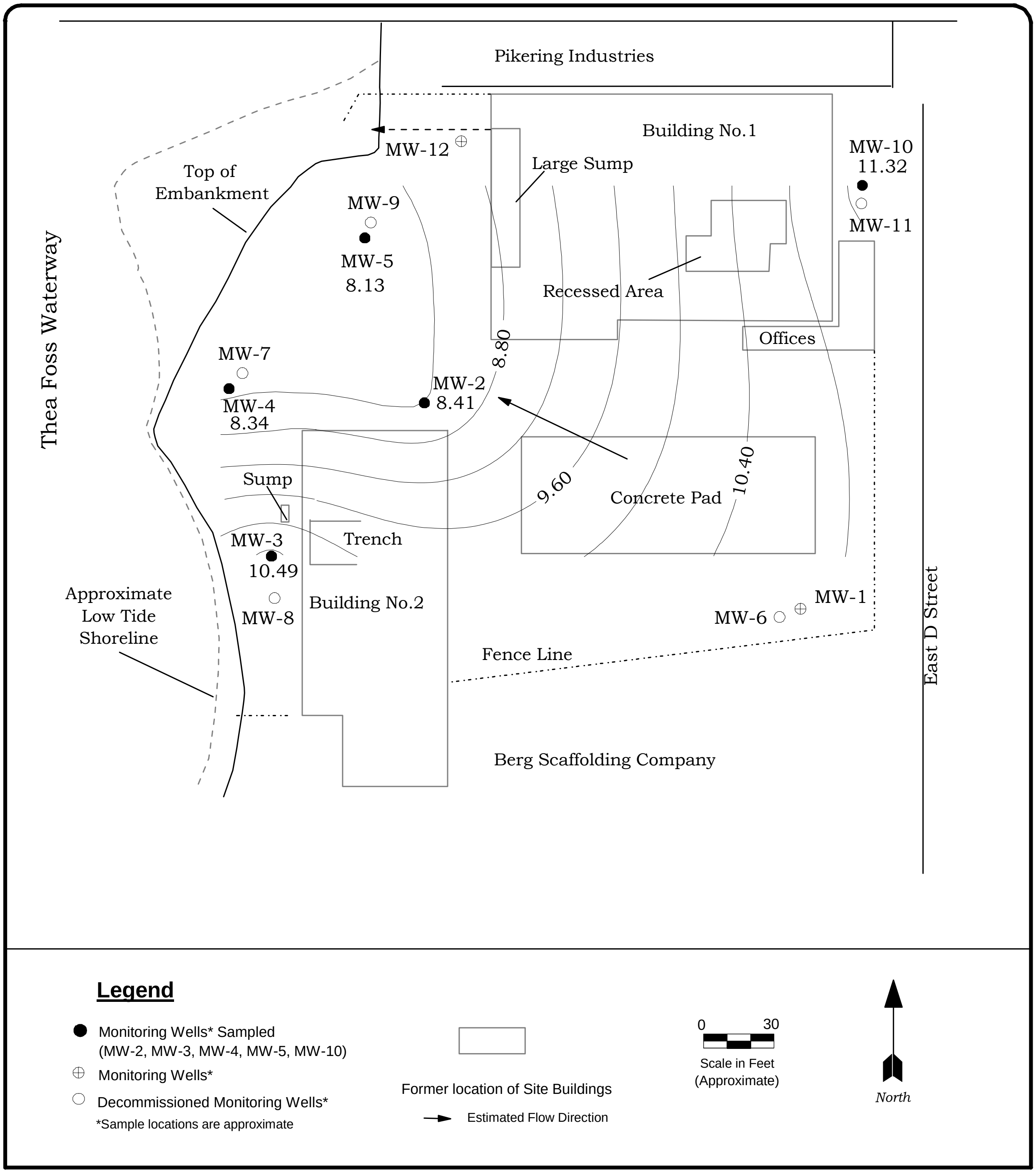


Figure 4: American Plating Groundwater Flow Direction, March 2005

Analytical Results

Analytical results for dissolved metals and WAD cyanide are summarized in Table 3. Dissolved metals' results are also presented in Figure 5. Analytical results for VOCs are summarized in Table 4. A summary of historical data for this project is presented in the Appendix.

Table 3: Summary of Analytical Results (ug/L) for March and August, 2005

Well	Dissolved Cadmium		Dissolved Chromium		Dissolved Hexavalent Chromium		Dissolved Copper		Dissolved Nickel		WAD Cyanide	
	3/05	8/05	3/05	8/05	3/05	8/05	3/05	8/05	3/05	8/05	3/05	8/05
MW-2	0.2 U	0.2 U	**18**	**21**	**--**	2 UJ	1 U	1 U	**3.7**	**3.1**	10 U	5 U
MW-3	**0.48**	0.2 U	**16**	**28**	**--**	2 UJ	**2.5**	**3.6**	**6.6**	**4.8**	10 U	5 U
MW-4	**0.35**	0.2 U	**51**	**76**	**--**	2 UJ	**1.3**	**2.4**	**3.4**	**3.2**	10 U	5 U
MW-5	**0.37**	0.2 U	**37.7**	**88**	**--**	2 UJ	**2.0**	**2.8**	**9.2**	**7.9**	10 U	5 U
MW-10	**0.32**	**0.026**	2.5 U	**9.1 J**	--	2 UJ	1 U	1 U	**40.3**	**29**	10 U	5 U

-- Not analyzed.
U – Analyte was not detected at, or above, the reported value.
J – Analyte was positively identified. The associated numerical result is an estimate.
UJ – Analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may, or may not, represent the actual limit of quantitation necessary to accurately, and precisely, measure the analyte in the sample.
Bold – Analyte was detected.

Dissolved chromium and nickel were detected in all the sampled wells. In March, chromium concentrations in four of the wells ranged from 16 to 38 ug/L. In August, chromium concentrations increased in these wells, ranging from 21 to 88 ug/L. The reason for the apparent increase in chromium concentrations could not be determined with the available data. Dissolved chromium was not detected in well MW-10 in March; however, an estimated concentration of 9 ug/L was detected in August. Dissolved hexavalent chromium was not detected.

Nickel was detected in all five wells with average concentrations ranging from 3.3 to 35 ug/L.

Dissolved copper was detected in three of the wells (MW-3, MW-4, MW-5) at an average concentration of 2.4 ug/L.

Dissolved cadmium, which was not detected during the 2004 monitoring, was detected in four of the wells in March with an average concentration of 0.38 ug/L. It was also detected in well MW-10 in August near the reporting limit of 0.2 ug/L.

WAD cyanide was not detected during 2005 at the reporting limits of 5 to 10 ug/L.

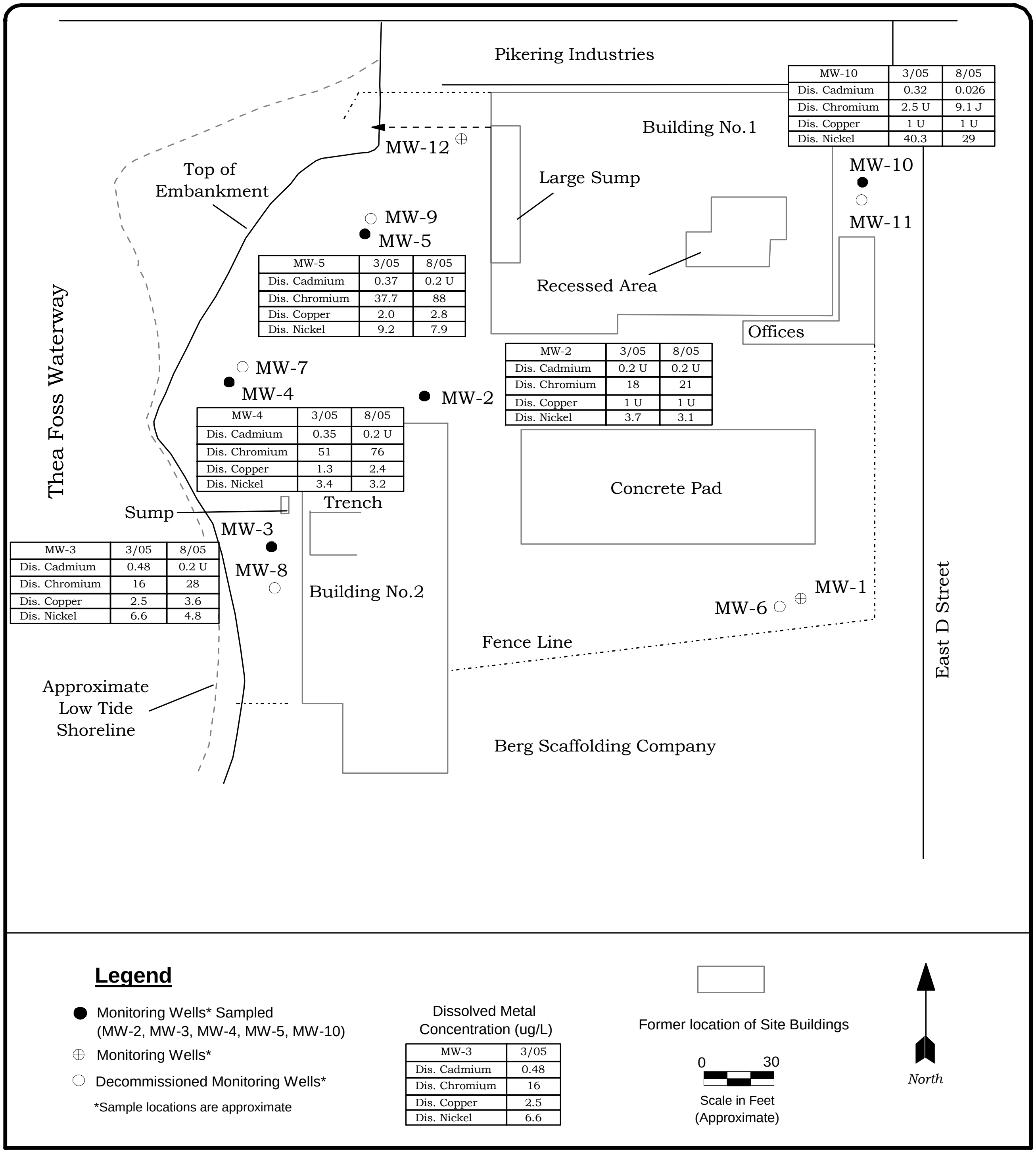
Well MW-10 was also sampled for VOCs. During both sample rounds MW-10 was purged dry and allowed six hours to recover before sampling.

Table 4: Summary of VOC Results (ug/L) for March and August, 2005

Well	Chloroethane		1,1-Dichloroethane		Cis-1,2-Dichloroethene	
	3/05	8/05	3/05	8/05	3/05	8/05
MW-10	16	8.8	7.2	0.41 J	0.87 J	0.81 J

J – Analyte was positively identified. The associated numerical result is an estimate.

Chloroethane, 1,1-dichloroethane, and cis-1,2-dichloroethene were detected during both sample rounds. These volatile organics were also detected in this well in 2004 at similar concentrations. 1,1-Trichloroethane and benzene were also detected in March, and 2-butanone and trichloroethene in August, all at concentrations near, or below, the reporting limits. A summary of VOC data is presented in the Appendix.



MW-10	3/05	8/05
Dis. Cadmium	0.32	0.026
Dis. Chromium	2.5 U	9.1 J
Dis. Copper	1 U	1 U
Dis. Nickel	40.3	29

MW-5	3/05	8/05
Dis. Cadmium	0.37	0.2 U
Dis. Chromium	37.7	88
Dis. Copper	2.0	2.8
Dis. Nickel	9.2	7.9

MW-2	3/05	8/05
Dis. Cadmium	0.2 U	0.2 U
Dis. Chromium	18	21
Dis. Copper	1 U	1 U
Dis. Nickel	3.7	3.1

MW-4	3/05	8/05
Dis. Cadmium	0.35	0.2 U
Dis. Chromium	51	76
Dis. Copper	1.3	2.4
Dis. Nickel	3.4	3.2

MW-3	3/05	8/05
Dis. Cadmium	0.48	0.2 U
Dis. Chromium	16	28
Dis. Copper	2.5	3.6
Dis. Nickel	6.6	4.8

- ● Monitoring Wells* Sampled (MW-2, MW-3, MW-4, MW-5, MW-10)
- ⊕ Monitoring Wells*
- ○ Decommissioned Monitoring Wells*

*Sample locations are approximate

Dissolved Metal Concentration (ug/L)

MW-3	3/05
Dis. Cadmium	0.48
Dis. Chromium	16
Dis. Copper	2.5
Dis. Nickel	6.6

Figure 5: American Plating Dissolved Metal Concentrations

Discussion

Dissolved cadmium, chromium, copper, and nickel were detected in groundwater at the site in March and August, 2005. Table 5 is a comparison of the 2005 results to cleanup levels established for this site. Due to the proximity of the site to the waterway, the groundwater cleanup levels were developed based on protection of human contact with surface water (MTCA Method B surface water levels) and on protection of marine organisms (WAC 173-201A). The surface water criterion for cyanide (1 ug/L for acute exposure) is based on the weak acid dissociable (WAD) cyanide.

Table 5: Comparison of 2005 Groundwater Results to Surface-Water Based Cleanup Levels

Parameter	Cleanup Level (ug/L)	MW-2	MW-3	MW-4	MW-5	MW-10
Dissolved Metals						
Cadmium	9.3	0.2 U	0.2 U-0.48	0.2 U-0.35	0.2 U-0.37	0.026-0.32
Chromium	--	18-21	16-28	51-76	37.7-88	2.5 U-9.1 J
Copper	3.1	1 U	2.5-**3.6**	1.3-2.4	2.0-2.8	1 U
Nickel	8.2	3.1-3.7	4.8-6.6	3.2-3.4	7.9-**9.2**	**29-40.3**
Cyanide	1 (WAD)	5 U-10 U	5 U-10 U	5 U-10 U	5 U-10 U	5 U-10 U
Vinyl Chloride	3.7	--	--	--	--	2 U

U – Analyte was not detected at, or above, the reported value.
J – Analyte was positively identified. The associated numerical result is an estimate.
Bold – Concentration exceeded established cleanup level.

Dissolved nickel concentrations exceeded the cleanup criterion of 8.2 ug/L in wells MW-5 and MW-10. In March, the nickel concentration in MW-5 was 9.2 ug/L. Nickel concentrations in MW-10 were 40.3 ug/L and 29 ug/L in March and August, respectively.

The criterion for dissolved copper of 3.1 ug/L was slightly exceeded in MW-3 with a concentration of 3.6 ug/L in August.

In 2004, dissolved chromium concentrations exceeded the state surface water quality standards for protection of aquatic organisms in marine waters for acute exposure to hexavalent chromium of 50 ug/L (WAC 173-201A). Since it was not possible to determine which form of chromium, trivalent or hexavalent, was present, samples were collected and analyzed for hexavalent chromium in August 2005. As stated previously, dissolved hexavalent chromium was not detected in any of the samples. Therefore, it is assumed that the less toxic and immobile trivalent chromium was present.

WAD cyanide was not detected in any of the wells during this monitoring. However, the available reporting limit of 5 to 10 ug/L does not meet the cleanup level of 1 ug/L for WAD cyanide established for this site.

Recommendation

Because dissolved nickel exceeded the established groundwater cleanup standard during both monitoring rounds, groundwater monitoring should continue.

References

Ecology, 2003. Manchester Environmental Laboratory - Laboratory Users' Manual. 7th Edition. Washington State Department of Ecology, Manchester, WA.

Hart, Crowser, 2001. Summary of Data and Potential Cleanup Actions, American Plating Site, Tacoma, Washington. February 13, 2001.

Marti, Pamela, 2004. Quality Assurance Project Plan: American Plating Post-Interim Action Monitoring. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-105. www.ecy.wa.gov/biblio/0403105.html.

Marti, Pamela, 2004. American Plating Post-Interim Action Monitoring Results, February and August, 2004. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-052. www.ecy.wa.gov/biblio/0403052.html.

PRC, 1995. Final Report for Resource Conservation and Recovery Act Comprehensive Groundwater Monitoring Evaluation, American Plating Company, Inc. (Lewis R. Jones), Tacoma, Washington. January 5, 1995.

SAIC, 1994. Final RCRA Facility Assessment Preliminary Assessment Report, American Plating, Inc., Tacoma, Washington. WAD 08335 0231. July 1994.

SAIC, 2003. Final Interim Action Plan, American Plating Site, Tacoma, Washington. April 25, 2003.

SM, 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association, Washington, D.C.

U.S. EPA, 1996. Test Methods for Evaluating Solid Waste, SW-846. Office of Emergency Response, U.S. Environmental Protection Agency, Washington D.C.

U.S. EPA, 2000. EPA 821/R-99-013 Method OIA-1677: Available Cyanide by Flow Injection and Ligand Exchange and Amperometry. January 2000. NTIS/PB99-132011 or www.epa.gov/ost/methods/.

Appendix. Historical Data

Table A-1: Dissolved Metals Results (ug/L) from May 1988 to August 2005

Well ID	LR Jones				EPA	LR Jones		PRC	Ecology			
	5/88	8/88	11/88	2/89	2/89	3/89	12/93	9/94	2/04	8/04	3/05	8/05
MW-2												
Cadmium	4 U	--	--	--	5 U	--	0.5 U	2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	10 U	--	--	--	10 U	--	10 U	5 U	**8.2**	**30.2**	**18**	**21**
Copper	20 U	--	--	--	25 U	--	10 U	3 U	1 U	1 U	1 U	1 U
Nickel	20 U	--	--	--	17 U	--	10 U	**19 P**	**4.3**	**4.4**	**3.7**	**3.1**
Cyanide	10 U	**20**	**20**	**20**	5 U	**10**	**9**	**13**	10 U	10 U	10 U	5 U
MW-3												
Cadmium	4 U	--	--	--	5 U	--	0.2 U	--	0.2 U	0.2 U	**0.48**	0.2 U
Chromium	10 U	--	--	--	10 U	--	10 U	--	**12.2***	**24***	**16**	**28**
Copper	20 U	--	--	--	25 U	--	10 U	--	**1.4***	**2.7**	**2.5**	**3.6**
Nickel	**20**	--	--	--	17 U	--	10 U	--	**8.6***	**5.8**	**6.6**	**4.8**
Cyanide	10 U	10 U	10	10 U	5 U	**10**	**27**	--	0.01 U	0.01 U	10 U	5 U
MW-4												
Cadmium	4 U	--	--	--	5 U	--	0.5 U	10 U	0.2 U	0.2 U	**0.35**	0.2 U
Chromium	10 U	--	--	--	10 U	--	10 U	25 U	**20**	**54.9**	**51**	**76**
Copper	20 U	--	--	--	25 U	--	10 U	15 U	1 U	**2.1**	**1.3**	**2.4**
Nickel	20 U	--	--	--	17 U	--	10 U	50 U	**4.9**	**4.9**	**3.4**	**3.2**
Cyanide	10 U	**30**	**30**	**20**	5 U	**10**	**9**	**15**	0.01 U	0.01 U	10 U	5 U
MW-5												
Cadmium	4 U	--	--	--	5 U	--	0.4 U	--	0.2 U	0.2 U	**0.37**	0.2 U
Chromium	10 U	--	--	--	10 U	--	10 U	--	**30.9**	**71**	**37.7**	**88**
Copper	20 U	--	--	--	**41.9**	--	10 U	--	1 U	**1.5**	**2.0**	**2.8**
Nickel	20 U	--	--	--	17 U	--	**28**	--	**14.8**	**11.8**	**9.2**	**7.9**
Cyanide	10 U	10 U	10	10 U	5 U	10 U	5 U	--	0.01 U	0.01 U	10 U	5 U
MW-10												
Cadmium	--	--	--	--	--	--	0.5 U	--	--	0.2 U	**0.32**	**0.026**
Chromium	--	--	--	--	--	--	10 U	--	--	**25.5**	2.5 U	**9.1 J**
Copper	--	--	--	--	--	--	10 U	--	--	1 U	1 U	1 U
Nickel	--	--	--	--	--	--	**110**	--	--	**62.2**	**40.3**	**29**
Cyanide	--	--	--	--	--	**40**	**24**	--	0.01 U	0.01 U	10 U	5 U

-- = not sampled.
U = Analyte was not detected at, or above, the reported value.
P = Analyte was detected but at a concentration between the instrument detection limit and the quantitation limit.
* = Average concentration of duplicate samples.
Bold = Analyte was detected.

Table A-2: VOC Results (ug/L) from Well MW-10 from May 1989 to August 2005

MW-10	LR Jones		PRC	Ecology			
	3/89	1/94	9/94	2/04	8/04	3/05	8/05
Benzene	---	**1.5**	**1.8**	10 U	**0.33 J**	**0.22 J**	1 U
2-Butanone	---	---	1 U	20 U	**1.8 NJ**	2 U	**1.3 J**
Chloroethane	**18**	**150 D6**	**178**	12 U	**15**	**16**	**8.8**
Chloroform	**3**	0.2 U	1 U	10 U	1 U	1 U	1 U
Chloromethane	**2.1**	2 U	**0.13 J**	20 U	2 U	2 U	5 UJ
1,1-Dichloroethane	**170 D4**	**140 D6**	**10**	**27**	**0.49 J**	**7.2**	**0.41 J**
1,2-Dichloroethane	**1.6**	**0.2**	1 U	10 U	**0.3 NJ**	1 U	1 U
1,1-Dichloroethene	**4**	**1**	1 U	10 U	1 U	1 U	1 U
Cis-1,2-Dichloroethene	**430 D4**	**8.2**	**2.3**	10 U	**0.93 J**	**0.87 J**	**0.81 J**
Trans-1,2-Dichloroethene	**1.3**	0.2 U	1 U	10 U	1 U	2 U	1 U
1,2-Dichloropropane	0.2 U	**1.3**	**0.34 J**	10 U	1 U	1 U	1 U
Ethylbenzene	---	**0.5**	**0.56 J**	10 U	1 UJ	1 U	1 U
Propylbenzene	---	---	**0.19 J**	10 UJ	1 UJ	2 U	2 U
Tetrahydrofuran	---	---	---	20 U	**1.4**	2 U	2 U
Toluene	---	0.5 U	**0.29 J**	10 U	1 UJ	1 U	1 U
1,1,1-Trichloroethane	**41 D4**	0.2 U	1 U	**10**	1 UJ	**1 J**	2 U
Trichloroethene	**8.6**	**0.7**	**0.89 J**	10 U	**0.46 NJ**	1 U	**0.62 J**
1,2,4-Trimethylbenzene	---	---	**2.5**	10 UJ	1 UJ	1 U	1 U
1,3,5-Trimethylbenzene	---	---	**0.42 J**	10 UJ	1 UJ	1 U	1 U
Vinyl chloride	**190 D4**	**6.1**	**1**	20 U	**0.94 NJ**	2 U	2 U
Xylene	---	**0.6**	**2 J**	20 U	2 UJ	4 U	2 U

--- = not analyzed.
U = Analyte was not detected at or above the reported value.
D = The detection limit was elevated due to matrix interference.
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 = There is evidence that the analyte is present. The associated numerical result is an estimate.
Bold = Analyte was detected.