



MACTEC

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Alameda County
OCT 30 2003
Environmental Health

October 17, 2003

Project 53087 Task 007

Mr. Jeff Christoff
Blue Print Service Company
149 Second Street
San Francisco, California 94105

Quarterly Groundwater Remediation and Monitoring Report
April through July 1, 2003
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California

Dear Mr. Christoff:

MACTEC Engineering and Consulting, Inc., (formerly Harding ESE) presents this quarterly status letter-report on the groundwater monitoring and remedial activities at the BPS Reprographic Services (BPS) facility located at 1700 Jefferson Street in Oakland, California (Plate 1). This letter-report covers the period from April 1 through July 1, 2003, and was prepared to satisfy the quarterly groundwater monitoring requirements of the Alameda County Department of Health Care Services (ACHCS). Additionally, this letter-report presents the results of a statistical comparison of groundwater data collected pre and post purge. The Second Quarter 2003 sampling event did not occur until July 1, 2003 due to delivery of monitoring equipment to the incorrect address.

BACKGROUND

Three underground gasoline storage tanks were removed from the property in 1987 and a preliminary soil and groundwater investigation indicated that a release of fuel into the subsurface had occurred. Three groundwater-monitoring wells (MW-1, MW-2, and MW-3) were installed on the property to evaluate the distribution of petroleum hydrocarbons in the groundwater and to determine the direction of groundwater flow. Free phase hydrocarbon (FPH) was found in MW-1. Groundwater level measurements indicated that the local groundwater gradient was in a north to northwest direction.

In November 1987, monitoring well MW-2 was abandoned to facilitate the construction of the present BPS facility and, in January 1988, two additional wells, MW-1A and MW-4, were installed as groundwater extraction wells. MACTEC also installed one offsite monitoring well, MW-5, in

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August 1988 and a second offsite well, MW-6, in April 1996. The monitoring well locations are shown on Plate 1.

In 1992, a groundwater extraction system was constructed at the site to remove FPH from the groundwater surface. Groundwater was extracted from MW-1A and MW-4 and passed through an oil-water separator that removed the FPH. The water was then drawn into a 3,000-gallon bioreactor tank for treatment by hydrocarbon reducing microbes. Air and nutrients were supplied to the water within the bioreactor to facilitate microbial growth. The treated water from the bioreactor was pumped in batches of approximately 500 gallons through three granular activated carbon vessels before discharge under a wastewater discharge permit from the East Bay Utility District to the sanitary sewer. The treatment system processed approximately 1,385,490 gallons of groundwater and an estimated 5,062 pounds of FPH were recovered.

By 1999, the oil-water separator was no longer recovering FPH and FPH was no longer present in any of the groundwater monitoring wells. Dissolved hydrocarbon concentrations were decreasing and MACTEC requested approval from The County to terminate groundwater extraction and to modify the remediation technique to *in situ*-bioremediation using an oxygen-releasing compound (ORC™). ORC™ is manufactured and distributed by Regensis, Inc.; its purpose is to increase the concentration of dissolved oxygen (DO) in the groundwater and to augment the ability of naturally occurring microbial organisms in the groundwater to biodegrade the dissolved petroleum hydrocarbons. The County approved this plan in a letter dated September 28, 1999, following the submittal of an ORC™ calculation sheet and a Groundwater Monitoring Plan, dated September 23, 1999.

MACTEC implemented the *in situ* remediation technique by placing ORC™ in treatment wells: MW-1A, MW-3, MW-4, and MW-5 on September 29, 1999. The ORC™ is contained in fabric "socks" which release oxygen over time until the compound's oxygen releasing potential is depleted. MACTEC installed five socks in each treatment well at the approximate depth of the well's screened interval. As described in the Groundwater Monitoring Plan, the ORC™ socks are removed from the treatment wells two weeks before each quarterly groundwater monitoring event, then replaced after sampling is complete.

The Groundwater Monitoring Plan outlined procedures for groundwater sampling using a non-purge method approved by the Regional Water Quality Control Board in a letter dated January 31, 1997. The first quarter that the new Groundwater Monitoring Plan was implemented, sampling included duplicate sampling using both the purge and non-purge methods (see MACTEC's quarterly report, dated October 25, 1999).

During the Fourth Quarter 2002 groundwater monitoring event MACTEC removed the ORC™ socks from the treatment wells per a request from the ACHCS in a September 27, 2002 letter to BPS. The ACHCS suggested that contaminant concentrations may not be accurate due to the presence of the

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ORC™ socks and requested the socks be removed and DO allowed to return to back ground levels. Additionally, the ACHCS suggested in the same letter that the ORC™ socks appear to be ineffective as contaminant concentrations continue to be high in MW-1 and MW-5.

During the ORC™ socks removal effort from MW-5 it was discovered that the socks were stuck. ORC™ socks can become stuck in monitoring wells when the well casing has become disturbed or bent. This can typically be caused by even minor seismic occurrences in the area of the well. The ORC™ socks remained stuck in MW-5 despite three removal attempts including attempts incorporating an industrial winch and tripod. An ORC™ sock removal effort was performed on September 17, 2003 utilizing a drill rig. The socks were successfully removed with no damage to the monitoring well.

SECOND QUARTER 2003 GROUNDWATER SAMPLING AND ANALYSIS

On July 1, 2003, MACTEC conducted the quarterly groundwater monitoring of MW-1, MW-3, and MW-6 (Plate 1) using the purge and sample method as described in the September 27, 2002 ACHCS letter. Prior to sampling, MACTEC measured the depth to groundwater from the top of casing (TOC) of wells MW-1, MW-3 and MW-6 using an electronic water level indicator. These measurements are displayed on Plate 2 and tabulated in Table 2.

Monitoring well samples were collected according to methods described in the September 27, 2002 ACHCS letter and typical well purging protocol as described in *Ground-Water Sampling Preparations and Purging Methods at Water-Supply Wells and Monitoring Wells* dated September 1999 by Jacob Gibs and F.D. Wilde. This document was provided as a reference for groundwater monitoring procedures by the ACHCS case worker.

Immediately after sample collection, MACTEC labeled and stored the samples in a cooler with ice. The groundwater samples were kept chilled until submitted to Sequoia Analytical Laboratory (Sequoia), a California state-certified laboratory (CA ELAP Certificate #2374), under chain-of-custody protocol for the following analyses:

- Total petroleum hydrocarbons as gasoline (TPHg) in accordance with EPA Method 8015 modified.
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX) in accordance with EPA Method 8020.
- Methyl tertiary butyl ether (MTBE) in accordance with EPA Method 8020 with confirmation of detections by EPA Method 8260.
- Ethylene Dichloride (EDC) by EPA Method 8260.

The analytical results for TPH-g, BTEX and MTBE are displayed on Plates 3 and 4. Historical groundwater elevations are shown graphically on Plate 5. Historical analytical results for TPH-g, BTEX

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and MTBE are shown on Table 3. Analytical results for groundwater samples collected pre-purge are presented on Table 4a. Analytical results for groundwater samples collected post-purge are presented on Table 4b. Analytical results for samples collected pre and post purge during the First Quarter 2003 groundwater monitoring event are displayed on Table 4c. Historical analytical results for Tert-amyl methyl ether (TAME), Tert-butyl alcohol (TBA), Di-isopropyl ether (DIPE), Ethylene Dibromide (EDB), Ethyl tert Butyl Ether (ETBE) and EDC are displayed on Table 5. The certified analytical reports (CARs) are presented in the Appendix A.

PRE AND POST PURGE STATISTICAL ANALYSIS

The ACHCS September 27, 2002 letter requested a statistical analysis comparing pre-and post purge groundwater sample results and parameters to determine if there is a significant difference. Post purge groundwater parameters as well as samples were collected during the First and Second Quarter 2003 Monitoring events for comparison against existing pre-purge data.

Data from sixteen groundwater sampling events collected prior to purging of the wells was available for comparison to post purge data collected during the First and Second Quarter 2003 sampling events. This data is displayed on Tables 1 and 4a.

Analytical results from MW-1, -3, -5, and -6 were evaluated. Post-purge data from MW-5 was not available due to ORC™ socks stuck in the well as described above. In order to make statistical comparisons, all values less than or equal to analyte detection limits were set equal to the detection limit. Ethylbenzene has not been detected in any groundwater samples collected from MW-6 and therefore, no statistical analysis was conducted for this analyte in that well.

Data for all wells were evaluated for normality and log normality using the Shapiro-Wilks test. A description of the Shapiro-Wilks test is included with this report under Appendix C. To test for log normality, the Shapiro-Wilks test was applied to natural log transformed data. The p-values for these test results are included in the Statistical Summary Tables 6 and 7. If the post-purge data was neither normal nor log normal, box and whisker plots were constructed to compare the pre- and post-purge data.

An upper tolerance limit [UTL (USEPA, 1989)] was calculated to determine if the chemical post-purge results were equivalent to historic and contemporaneous pre-purge analytical results. This method is applicable to normally and log normally distributed data. The UTL is calculated as shown below:

$$\text{UTL} = \text{mean} + K * \text{standard deviation}$$

gamma = 0.95, coverage = 0.95 (95% of future points will fall below UTL 95% of the time)

Two sets of post-purge data were available for the groundwater parameters. If the pre-purge data were normally distributed, then the t-test was used to compare the pre- and post-purge data. A description of the t-test is included with this report under Appendix D. Alternatively, if the data were log normally distributed, then the Mann-Whitney test was run to compare the two groups. A description of the Mann-Whitney test is included with this report under Attachment E. If the pre-purge parameter data was neither normal nor log normal, then the UTL method was used to compare the maximum parameter datum to the 95th percentile UTL of the pre-purge data.

Chemical Concentration Statistical Analysis

The results of the chemical concentrations in groundwater statistical analysis are summarized in Table 6. For all analytes detected in MW-1 and MW-3 the post-purge analytical results were less than the calculated 95th percentile UTL for the pre-purge data, indicating no statistical difference. For MW-6 the post-purge results for Total Xylenes and TPH-g were also less than the applicable calculated 95th percentile UTL for the pre-purge data. Ethlybenzene has not been detected in any groundwater samples collected from MW-6 and therefore, no statistical analysis was conducted for this analyte in that well. Pre-purge results for Benzene, MTBE, and Toluene in MW-6 were neither normal nor log normal. The box plots for these analytes are presented in Plates 6, 7, and 8, respectively. Comparison of the post-purge results for these three analytes to the applicable box plots reveals that all the results for Benzene and Toluene are less than the 75th percentile UTL of the respective pre-purge result. The post-purge results for MTBE are less than the 25th percentile UTL of the pre-purge results.

Groundwater Parameter Statistical Analysis

Results of the groundwater parameter statistical analysis are summarized in Table 7. None of the pre- and post-purge parameter results were statistically different. However, the Mann-Whitney Test results suggested that the pre- and post-purge DO values in MW-6 were significantly different. Due to the small number of data points (N) in the post-purge group, additional analysis was performed. The results indicated the maximum post-purge DO value was less than the 95th percentile UTL of the natural log transformed data. Also, the natural log of the maximum value of the post-purge data is approximately in the 90-95th percentile of the pre-purge data based upon comparison to the box plot (Plate 9). Based upon these analyses it is concluded that the pre- and post-purge DO results for MW-6 are not significantly or statistically different.

DISCUSSION

Groundwater Monitoring Data

As shown in Table 2 and on Plate 5, the groundwater surface elevation increased an average of 0.25 feet across the site as compared to last quarter's measurements. Using the groundwater elevations from MW-1, MW-3 and MW-6 as measured on July 1, 2003, groundwater contours were created and are shown on

Plate 2. Based on the groundwater elevations, the groundwater gradient is approximately 0.006 ft/ft. The direction of flow appears to be West to Northwest.

Table 3 displays a summary of historical groundwater sample results through September 29, 1999, when the typical purge and sample protocol was terminated. Plate 3 presents the sample results from this quarter's sampling event. Table 4a and Plate 4 display historical groundwater sample results since instituting *in situ* bioremediation using ORC™ socks and a non-purge sampling protocol. As of December 2002 *in situ* bioremediation using ORC™ socks was suspended. As of July 1, 2003 the data displayed on Table 4a and Plate 4 were collected by the purge and sample protocol described in the previous section.

As shown on Plate 3 and Table 4a, concentrations of TPH-g, BTEX and MTBE remained within the range of historical values (including historical concentrations monitored prior to September 1999) for all the wells sampled. However, TPH-g and BTEX concentrations in MW-1 were the highest monitored since the no purge sampling protocol was instituted in September 1999. TPH-g ranged from non-detectable with a detection limit of 0.05 mg/l (MW-6) to 61 mg/l (MW-1). Benzene ranged from non-detectable with a detection limit of 0.05 ug/l (MW-6) to 7,700 ug/l (MW-1). Toluene ranged from non-detectable with a detection limit of 0.05 ug/l (MW-6) to 11,000 ug/l (MW-1). Ethylbenzene ranged from non-detectable with a detection limit of 0.05 ug/l (MW-6) to 1,200 ug/l (MW-1). Total Xylenes ranged from non-detectable with a detection limit of 0.05 ug/l (MW-6) to 6,700 ug/l (MW-1). MTBE was not detected in samples from any of the groundwater monitoring wells this quarter with detection limits ranging from 2.5 ug/l (MW-6) to 250 ug/L (MW-1). A laboratory provided trip blank consisting of organic free water was transported to and from the Site with the samples described above. The trip blank was analyzed for TPH-g, BTEX and MTBE with the groundwater samples using EPA Method 8015M/8020M. The CARS reported no analytes of concern were present in the trip blank equal to or above their respective detection limits.

Historical analytical results for TAME, TBA, DIPE, EDB, ETBE and EDC are displayed on Table 5. As described in the ACHCS September 27, 2002 letter to BPS these analyses were performed per ACHCS request during the Fourth Quarter 2002 monitoring event. None of these analytes were detected in any of the groundwater samples collected from MW-1, MW-3, MW-5 and MW-6 except for EDC. EDC was detected in the samples collected from MW-1 at a concentration of 370 ug/L and MW-5 at a concentration of 220 ug/l. As a result of this detection of EDC an analysis was performed for EDC in the groundwater sample from MW-1 during the Second Quarter 2003 event. EDC was detected in this sample at a concentration of 400 ug/L. As described above MW-5 could not be sampled this quarter due to obstruction by the stuck ORCs.

As described above, the ORC™ socks were removed from all treatment wells during the Fourth Quarter 2002 monitoring event per ACHCS request (except MW-5, ORC™ socks removed from this well

September 17, 2003). The ORC™ socks were removed to allow the DO concentrations in each well to return to background levels. Prior to sampling during the Second Quarter 2003 event, DO was monitored in each well. The DO concentrations monitored in wells MW-1, MW-3 and MW-6 were significantly greater than typical DO concentrations monitored in these wells (Table 1) with or without ORC™ socks and suggest equipment malfunction. Temperature values collected from the same wells using the same equipment were higher than normal and also suggest equipment malfunction. Although it can be reasonably assumed that DO levels have returned to background levels due to the length of time ORC™ socks have been absent from the wells, DO will continue to be monitored during future quarterly events to confirm DO has returned to background levels.

The ACHCS letter of September 27, 2002 suggests that the presence of ORC™ socks may effect contaminant concentrations in wells containing them. The letter asks if contaminant concentrations will rebound after ORC™ socks have been removed from the wells longer than two weeks. As described above, ORC™ socks were removed from all wells containing them during the Fourth Quarter Monitoring Event in 2002 and not replaced. Groundwater has been sampled post purge during the subsequent First and Second Quarter Monitoring Events in 2003. There continues to be a slight increasing trend of BTEX concentrations in MW-3 over the last four events beginning in June of 2002 compared to analytical results from two years previous. However, as MW-3 was being used as a treatment well up until the 4th Quarter 2002 event, the presence of ORC™ socks appears unrelated to this trend. TPH-g and BTEX concentrations in MW-1 were significantly higher this monitoring event compared to data collected during the previous three years. Well MW-1 will continue to be monitored during the upcoming quarterly events and TPH-g and BTEX concentrations evaluated for increased values. The impact ORC™ socks had on contaminant concentrations in the treatment wells will continue to be evaluated as the data becomes available.

Pre and Post Purge Statistical Analysis Results

Based upon the available evidence, the post-purge results of the April and July 2003 groundwater monitoring events are equivalent to the historical and contemporaneous pre-purge analytical and groundwater parameter results.

RECOMMENDATIONS

MACTEC recommends continued quarterly monitoring utilizing the procedures outlined in the ACHCS September 27, 2002 letter. MACTEC recommends analysis of the ORC™ socks effectiveness as prescribed by the ACHCS before continuing their use at the site. Based upon the results of the pre and post purge groundwater data, MACTEC recommends continuing pre-purge groundwater monitoring with ACHCS approval.

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The workplan requested in the ACHCS September 27, 2002 letter is currently being created and will contain responses to the remaining comments in the ACHCS letter that have not been addressed by this or previous quarterly reports.

MACTEC recommends that Blue Print Services send a copy of this report to the following address:

Mr. Don Hwang
Alameda County
Environmental Health Services
1131 Harbor Bay Parkway, Suite 250
Alameda, California, 94502-6577

While under contract to BPS, MACTEC will continue to provide quarterly groundwater monitoring and reporting as required by The County.

If you have any questions, please contact the undersigned at (415) 278-2118.

Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.



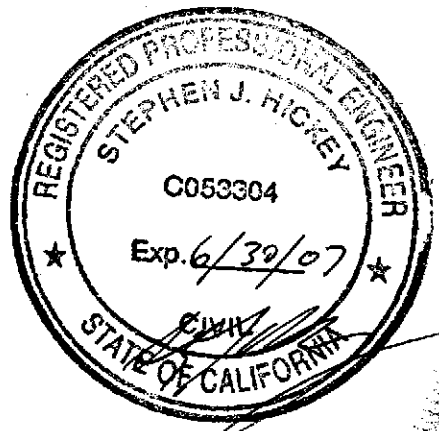
David S. Nanstad
Project Engineer



Steven Hickey
Senior Engineer

DSN SF0main/Cityblue/2q03

4 copies submitted



- Attachments:
- Table 1 – Groundwater Parameters
 - Table 2 – Groundwater Elevation Data
 - Table 3 – Historical Groundwater Monitoring Analytical Results - Using Purge Method
 - Table 4a – Groundwater Monitoring Analytical Results – Non-Purge Method
 - Table 4b – Groundwater Monitoring Analytical Results – Comparison of Non-Purge and Purge Methods
 - Table 4c – Groundwater Monitoring Analytical Results 1Q03 – Comparison of Non-Purge and Purge Methods
 - Table 5 – Groundwater Monitoring Analytical Results – EPA Method 8260
 - Table 6 – Chemical Concentration Data Statistical Summary
 - Table 7 – Groundwater Parameter Statistical Summary
 - Plate 1 – Site Map
 - Plate 2 – Groundwater Contours, First Quarter 2003
 - Plate 3 – TPH-g, BTEX and MTBE Concentrations in Groundwater, First Quarter 2003
 - Plate 4 – BTEX and DO Results
 - Plate 5 – Groundwater Elevation Data
 - Plate 6 – Box and Whisker Plot, Pre and Post Purge Analytical Data for MW-6 - Benzene
 - Plate 7 - Box and Whisker Plot, Pre and Post Purge Analytical Data for MW-6 - MTBE
 - Plate 8 - Box and Whisker Plot, Pre and Post Purge Analytical Data for MW-6 - Toluene
 - Plate 9 – Box and Whisker Plot, Pre and Post Purge Groundwater Parameter Data for MW-6 – Dissolved Oxygen
-
- Appendix A – Laboratory Reports
 - Appendix B – Groundwater Sampling Forms
 - Table B1. Sample Location/Sample Description Cross-Reference
 - Appendix C – Shapiro-Wilks Test for Normality Description
 - Appendix D – t-Test Description
 - Appendix E – Mann-Whitney Test Description

- References:
- USEPA, 1989. "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities", April 1989, EPA-RCRA-89

**Table 1. Groundwater Parameters
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California**

Dissolved Oxygen (mg/L)	MW-1	MW-3	MW-5	MW-6
9/29/1999	2.90	1.70	0.40	1.80
11/5/1999	4.00	10.30	4.00	2.80
11/22/1999	1.80	2.40	2.00	3.20
1/28/2000	2.90	8.40	3.60	2.20
2/11/2000	2.50	2.30	1.80	3.50
5/12/2000	2.00	7.40	2.40	1.70
5/30/2000	1.90	2.60	1.80	3.20
9/1/2000	2.90	3.40	2.30	2.70
9/15/2000	2.00	1.80	2.20	3.80
11/9/2000	NA	5.00	5.30	NA
11/17/2000	3.10	4.20	3.40	6.00
3/15/2001	2.00	7.00	1.40	2.10
4/2/2001	1.00	0.78	2.00	0.99
6/1/2001	0.22	0.24	6.62	0.32
6/28/2001	0.32	0.56	0.53	0.71
8/16/2001	0.48	6.52	1.61	0.78
8/30/2001	0.33	0.40	0.23	0.46
12/14/2001	0.03	3.76	2.22	0.16
12/26/2001	0.16	0.28	0.19	0.21
4/10/2002	0.55	0.63	0.20	0.37
4/23/2002	0.30	0.35	0.90	0.45
6/3/2002	0.38	5.16	4.32	0.65
6/14/2002	0.29	0.34	0.38	0.31
8/5/2002	0.33	0.28	0.40	0.39
8/14/2002	0.34	0.28	0.42	0.63
12/6/2002	1.00	0.90	NA	0.62
12/27/2002	0.94	0.96	NA	1.24
4/1/2003 ^b	0.30	1.06	*NA	NA ¹
7/1/2003 ^{ab}	7.65	7.70	NA	7.2
REDOX (mvolts)				
5/30/2000	-322	197	-128	203
9/15/2000	-269	3	-89	206
11/17/2000	64	178	296	230
4/2/2001	-194	26	-36	102
6/28/2001	-310	-283	-360	107
8/30/2001	NA	NA	NA	NA
12/26/2001	12	11	11	11
4/23/2002	3	62	-299	158
6/14/2002	0	245	-215	254
8/20/2002	-294	-315	-238	228
12/27/2002	-315	-357	NA	-12
4/1/2003 ^b	-82	-75	NA	172
7/1/2003 ^b	212	230	NA	227
Temperature (deg F)				
9/29/1999	67.0	72.6	67.7	73.8
11/22/1999	66.4	62.9	65.0	69.8
2/11/2000	61.3	63.2	62.0	68.5
5/30/2000	77.7	74.8	76.3	76.2
9/15/2000	64.4	64.3	64.7	67.0
11/17/2000	54.5	58.1	68.1	65.9
4/2/2001	63.5	64.9	66.2	66.4
6/28/2001	73.0	71.2	74.7	74.3
8/30/2001	74.8	77.6	78.3	78.7
12/26/2001	65.7	65.8	65.8	65.1
4/23/2002	64.4	69.8	37.1	71.6
6/14/2002	66.7	67.5	66.7	68.0
8/20/2002	64.6	67.6	66.2	68.0
12/27/2002	41.7	42.5	NA	41.7
4/1/2003 ^b	64.6	67.6	NA	68.0
7/1/2003 ^{ab}	79.4	80.3	NA	81.9

**Table 1. Groundwater Parameters
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California**

pH	MW-1	MW-3	MW-5	MW-6
9/29/1999	8.39	8.53	8.43	8.44
11/22/1999	6.86	8.42	6.84	6.79
2/11/2000	6.80	6.94	6.83	6.72
5/30/2000	7.02	7.35	7.54	7.56
9/15/2000	7.06	7.54	6.76	6.62
11/17/2000	7.37	7.69	7.12	7.34
4/2/2001	6.98	6.61	7.07	6.96
6/28/2001	6.90	6.74	6.78	6.83
8/30/2001	7.85	7.91	7.9	8.41
12/26/2001	6.23	6.91	7.11	6.72
4/23/2002	6.90	6.95	6.94	6.86
6/14/2002	7.05	7.24	7.08	6.89
8/20/2002	NA	6.89	NA	6.91
12/27/2002	6.33	6.41	NA	6.49
4/1/2003 ^b	6.90	7.08	NA	6.70
7/1/2003 ^b	7.42	7.59	NA	7.68
Specific Conductance (µS/cm)				
9/29/1999	976	880	1,577	966
11/22/1999	1,004	1,500	1,352	1,038
2/11/2000	992	1,327	1,275	1,149
5/30/2000	845	1,020	758	924
9/15/2000	800	917	989	1,009
11/17/2000	785	970	742	886
4/2/2001	725	365	839	821
6/28/2001	1080	704	876	1021
8/30/2001	924	1015	975	931
12/26/2001	848	496	333	891
4/23/2002	922	601	848	977
6/14/2002	932	767	810	961
8/20/2002	1015	809	891	985
12/27/2002	956	791	NA	903
4/1/2003 ^b	1128	800	NA	1021
7/1/2003 ^b	1020	690	NA	970

Note:

Baseline dissolved oxygen measurement taken on 09/29/99, prior to initial installation of oxygen releasing compound

mg/l = milligrams per liter

mvolts = millivolts

deg F = degrees Fahrenheit

µS/cm = micro-ohms per centimeter

NA = Not Available

l = indicates data not available due to equipment malfunction

a = indicates dissolved oxygen and temperature readings collected on this date above typical range and should be considered suspect

b = indicates this data collected post purge

**Table 2. Groundwater Elevation Data
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California**

Date Sampled	MW-1 TOC Elev. 32.36		MW-3 TOC Elev. 31.77		MW-5 TOC Elev. 30.56		MW-6 TOC Elev. 31.26		Average Change Since Preceding Quarter
	Water Level	Water Elevation	Water Level	Water Elevation	Water Level	Water Elevation	Water Level	Water Elevation	
3/6/1996	NM	--	24.79	6.98	23.53	7.03	NA	--	
6/11/1996	FP	--	25.60	6.17	23.78	6.78	25.16	6.10	-0.53
9/19/1996	FP	--	26.09	5.68	24.48	6.08	25.76	5.50	-0.60
12/23/1996	FP	--	FP	--	24.83	5.73	25.88	5.38	-0.23
3/27/1997	FP	--	FP	--	23.82	6.74	24.78	6.48	1.06
6/4/1997	26.41	5.95	25.11	6.66	23.92	6.64	24.60	6.66	0.04
9/26/1997	26.80	5.56	25.41	6.36	24.29	6.27	24.80	6.46	-0.32
12/22/1997	26.00	6.36	24.91	6.86	24.02	6.54	24.71	6.55	0.42
3/31/1998	26.06	6.30	24.05	7.72	22.78	7.78	23.75	7.51	0.75
6/18/1998	25.60	6.76	23.71	8.06	22.51	8.05	23.22	8.04	0.40
8/28/1998	25.45	6.91	23.70	8.07	22.74	7.82	22.23	9.03	0.23
12/2/1998	24.92	7.44	23.60	8.17	23.16	7.40	23.72	7.54	-0.32
3/10/1999	24.90	7.46	22.65	9.12	22.82	7.74	23.54	7.72	0.37
6/30/1999	25.53	6.83	23.07	8.70	22.41	8.15	23.04	8.22	-0.04
9/29/1999	24.23	8.13	23.03	8.74	22.81	7.75	23.42	7.84	0.14
11/22/1999	24.33	8.03	23.68	8.09	22.88	7.68	23.64	7.62	-0.26
2/11/2000	24.38	7.98	23.74	8.03	22.74	7.82	23.67	7.59	0.00
5/30/2000	23.57	8.79	22.97	8.80	21.73	8.83	22.82	8.44	0.86
9/15/2000	23.85	8.51	23.12	8.65	22.14	8.42	23.10	8.16	-0.28
11/16/2000	24.14	8.22	23.40	8.37	22.39	8.17	23.41	7.85	-0.28
4/2/2001	23.40	8.96	23.40	8.37	22.07	8.49	23.33	7.93	0.29
6/28/2001	23.58	8.78	23.17	8.60	22.15	8.41	23.15	8.11	0.04
8/30/2001	24.00	8.36	23.35	8.42	22.35	8.21	23.35	7.91	-0.25
12/26/2001	24.18	8.18	23.54	8.23	22.49	8.07	23.27	7.99	-0.11
4/23/2002	NA	NA	22.89	8.88	21.07	9.49	22.89	8.37	0.82
6/14/2002	23.41	8.95	22.85	8.92	21.80	8.76	22.81	8.45	-0.20
8/20/2002	23.85	8.51	23.11	8.66	22.14	8.42	23.15	8.11	-0.31
12/27/2002	24.10	8.26	23.34	8.43	*NA	*NA	23.41	7.85	-0.24
4/1/2003	23.75	8.61	22.90	8.87	*NA	*NA	23.16	8.10	0.35
7/1/2003	23.50	8.86	22.80	8.97	*NA	*NA	22.75	8.51	0.25

TOC Elev. = top of casing elevation
 NM = not monitored
 FP = free product
 -- = no data collected
 NA = not available
 * This data not available due to ORC socks stuck in well

Table 3. Historical Groundwater Monitoring Analytical Results - Using Purge Method
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California

Parameter	Date Sampled																												
	8/1/1991	9/30/1992	3/30/1993	1/13/1994	4/13/1994	6/29/1994	12/8/1994	4/3/1995	6/27/1995	9/19/1995	12/13/1995	3/6/1996	6/11/1996	9/19/1996	12/23/1996	3/27/1997	6/4/1997	9/26/1997	12/23/1997	3/31/1998	6/18/1998	9/22/1998	12/2/1998	3/10/1999	6/30/1999	9/23/1999			
TPH_g (mg/L)	FP	FP	FP	FP	FP	FP	FP	NA	NA	NA	NA	NA	FP	FP	FP	FP	68	59	41	44	33	26	26	26	18	21			
MW-1	350	FP	FP	FP	FP	FP	95	190	67	53	62	200	140	100	FP	66	54	73	66	51	50	15	41	10	18	NA			
MW-1A	74	FP	FP	FP	FP	FP	39	4,600	51	20	4.2	19	7	16	6	FP	32	32	16	17	3.2	16	17	3.2	9.6	7.9	5.0		
MW-3	86	FP	FP	FP	FP	FP	58	16	92	35	13	14	11	110	260	95	FP	37	24	41	48	NA	25	48	10	11	8.8	NA	
MW-4	120	51	74	80	63	64	59	51	41	50	45	51	48	48	45	44	35	36	39	48	17	16	15	23	23	7.7	11		
MW-5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	
MW-6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	FP	FP	FP	FP	2,200	6,000	6,800	8,300	1,100	8,600	9,200	8,200	7,000	9,200	NA	NA	
Benzene (µg/L)	17,000	FP	FP	FP	FP	FP	17,000	16,000	13,000	11,000	11,000	8,900	9,900	14,000	18,000	16,000	FP	12,000	11,000	10,000	10,000	9,100	11,000	1,100	8,500	2,300	6,400	NA	
MW-1	1,600	FP	FP	FP	FP	FP	3,200	1,500	1,100	270	70	220	120	170	45	FP	FP	8,500	610	640	690	180	84	39	86	31	120	NA	
MW-1A	1,500	FP	FP	FP	FP	FP	1,500	1,700	1,200	1,300	2,200	2,600	6,800	9,900	FP	2,600	2,600	2,900	6,000	2,000	9,700	1,700	2,300	1,800	1,800	NA	NA	NA	
MW-3	20,000	13,000	16,000	19,000	14,000	29,000	13,000	15,000	12,000	1,600	13,000	15,000	12,000	12,000	12,000	11,000	8,900	7,900	13,000	10,000	9,500	5,400	8,400	14,000	5,200	9,600	NA	NA	
MW-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
MW-5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	FP	FP	FP	FP	14,000	4,500	3,600	3,000	3,700	3,800	2,300	4,300	3,900	3,800	10,000	NA	
MW-6	31,000	FP	FP	FP	FP	FP	31,000	21,000	13,000	9,900	9,200	11,000	22,000	28,000	22,000	FP	15,000	17,900	16,000	16,000	11,000	15,000	830	11,800	1,900	7,800	NA	NA	
Toluene (µg/L)	4,600	FP	FP	FP	FP	FP	2,900	4,200	2,300	550	140	480	170	270	30	FP	FP	15,000	6,000	5,300	3,800	1,500	1,100	85	540	330	340	NA	
MW-1	6,200	FP	FP	FP	FP	FP	3,500	790	4,100	3,400	1,600	2,100	470	3,600	19,000	19,000	FP	6,900	3,200	5,800	11,000	NA	460	11,000	610	2,100	3,800	NA	
MW-1A	14,000	5,900	5,000	8,200	3,500	5,400	3,800	2,200	2,100	2,700	2,100	2,800	2,800	2,900	4,500	2,200	1,100	560	270	500	400	310	160	120	300	270	710	NA	
MW-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
MW-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	FP	FP	FP	FP	1,500	1,600	1,400	1,100	550	730	820	870	870	950	1,200	NA	
MW-5	3,900	FP	FP	FP	FP	FP	2,100	1,500	1,400	910	500	710	790	2,700	2,800	2,100	FP	1,400	1,000	1,400	1,400	1,100	870	31	720	1,600	660	NA	
MW-6	870	FP	FP	FP	FP	FP	580	6,000	580	190	68	140	49	68	15	FP	FP	2,400	930	800	870	490	430	25	250	200	230	NA	
Biphenylene (µg/L)	1,900	1,400	1,800	1,400	1,500	2,800	1,800	2,800	1,400	2,000	16,000	2,800	2,800	2,300	2,700	1,900	1,500	1,500	1,900	2,000	420	1,100	1,500	1,800	1,100	1,100	1,100	NA	
MW-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
MW-1A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	FP	FP	FP	FP	11,000	8,600	6,600	4,300	3,000	2,100	2,800	3,500	2,500	5,500	NA	NA	
MW-3	22,000	FP	FP	FP	FP	FP	14,000	12,000	11,000	9,800	6,300	6,800	5,300	22,000	19,900	14,000	FP	100	7,200	8,500	12,000	6,800	5,800	3,000	6,700	2,300	4,100	NA	
MW-4	4,300	FP	FP	FP	FP	FP	4,300	95,000	4,800	1,700	590	1,700	440	1,500	300	FP	FP	16,000	5,900	5,900	5,200	3,700	3,800	360	2,300	1,800	1,300	NA	
MW-5	7,300	FP	FP	FP	FP	FP	3,200	3,400	5,400	5,800	1,800	2,100	1,800	10,000	28,000	13,000	FP	5,500	3,500	4,800	8,200	NA	6,400	5,900	2,300	1,500	2,700	NA	
MW-6	4,900	2,600	2,700	2,700	2,100	4,500	2,900	4,500	1,600	2,100	1,900	2,400	2,700	4,000	6,500	2,800	1,700	1,300	1,700	2,200	850	900	840	1,100	690	1,100	NA		
MTBE (µg/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-1A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TPH_g = total petroleum hydrocarbons as gasoline
MTBE = methyl tert-butyl ether
(µg/L) micrograms per liter
(mg/L) milligrams per liter

ND = Not detected above the reporting limit in parenthesis
NA = Not analyzed
FP = From Product - well not sampled
-- Well did not exist at date indicated

Table 4a. Groundwater Monitoring Analytical Results – Non-Purge Method Through 4Q02
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California

	9/29/1999	11/22/1999	2/11/2000	5/30/2000	9/15/2000	11/16/2000	4/2/2001	6/28/2001	8/30/2001	12/26/2001	4/24/2002	6/14/2002	8/20/2002	12/27/2002	4/1/2003
TPHg (mg/L)															
MW-1	14	24	19	19	20	18	19	39	31	34	35	35	26	28	16
MW-3	4.1	3.1	0.54	0.49	1.5	1.3	0.17	4.9	3.1	0.95	300	4.6	4.9	4	5.9
MW-5	10	30	23	19	24	1.8	15	3.6	34	1.9	9.4	1.7	3.2	*6.2	NA ⁴
MW-6	ND<0.5	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	0.066	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05
Benzene (µg/L)															
MW-1	6,200	4,900	4,100	5,700	4,100	3,500	4,700	5,200	5,600	5,300	4,900	5400	4100	4,500	4500
MW-3	180	6.5	8.3	11	28	20	9	150	42	8	11	130	330	110	370
MW-5	14,000	11,000	12,000	9,900	3,800	470	7,400	300	8,300	300	2,300	110	320	*2200	NA ⁴
MW-6	ND<0.3	ND<0.3	ND<0.3	ND<0.3	ND<0.3	ND<0.30	ND<0.30	ND<0.50	ND<0.50	3.6	ND<0.50	ND<0.50	ND<0.50	ND<0.5	ND<0.5
Toluene (µg/L)															
MW-1	5,900	5,000	4,800	8,400	5,700	4,300	5,200	4,200	5,100	5,200	6,000	6,800	4700	5,000	6000
MW-3	340	33	20	5.6	14	34	6.2	240	48	5.2	4.8	470	170	280	150
MW-5	470	3,400	4,500	6,900	3,000	220	3,000	11	3,000	110	130	ND<2.5	8.6	*140	NA ⁴
MW-6	ND<0.3	ND<0.3	ND<0.3	ND<0.3	ND<0.3	ND<0.30	ND<0.30	2.9	ND<0.50	3.6	ND<0.50	ND<0.50	ND<0.50	ND<0.05	ND<0.05
Ethylbenzene (µg/L)															
MW-1	620	730	530	730	540	640	570	660	560	630	740	870	620	660	680
MW-3	130	27	2.4	0.45	2.6	25	1.4	38	26	1.1	0.72	91	40	57	44
MW-5	1,100	1,500	1,200	1,200	460	39	1000	16	1,400	55	300	7.2	22	*160	NA ⁴
MW-6	ND<0.3	ND<0.3	ND<0.3	ND<0.3	ND<0.3	ND<0.30	ND<0.30	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.50	ND<0.5	ND<0.5
Total Xylenes (µg/L)															
MW-1	3,500	3,500	2,800	3,500	2,700	3,200	2,600	3,900	2,500	2,400	3,100	3500	2700	3,000	3100
MW-3	580	260	28	17	160	28	8.1	160	210	7	1.4	390	150	260	230
MW-5	600	2,500	1,300	2,600	1,200	100	2,200	15	2,600	120	270	ND<2.5	19	*250	NA ⁴
MW-6	ND<0.6	ND<0.6	ND<0.6	ND<0.6	ND<0.6	ND<0.60	ND<0.30	2.7	ND<0.50	8.7	ND<0.50	ND<0.50	ND<0.50	ND<0.5	ND<0.5
MTBE (µg/L) (BPA Method 8020)															
MW-1	ND<250	ND<100	6.6	ND<5.0 ¹	ND<12 ^{1,2}	ND<40 ^{1,2}	50 ¹	8.5 ¹	ND<100 ^{1,2}	ND<120	ND<120	ND<250	ND<120	ND<120	ND<120
MW-3	14	ND<1.0	31	ND<5.0 ¹	ND<5 ¹	ND<5 ¹	77 ¹	ND<2 ¹	ND<1.2 ¹	ND<0.50 ¹	ND<0.50 ¹	ND<0.50 ¹	ND<5 ¹	19	ND<1.0 ¹
MW-5	ND<100	ND<100	6.6	ND<200	ND<10 ^{1,2}	ND<5 ¹	ND<50 ¹	4.4 ¹	ND<50 ¹	ND<10 ¹	ND<50	ND<0.50 ¹	ND<0.50 ¹	*ND(25)	NA ⁴
MW-6	ND<1.0	ND<1.0	ND<1.0	ND<1.0	ND<1.0	ND<1.0	5 ^{1,3}	17 ¹	ND<2.5	ND<2.5	ND<2.5	ND<2.5	ND<2.5	ND<2.5	ND<2.5
Ethylene Dichloride (µg/L) (BPA Method 8260)															
MW-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	370	ND<120
MW-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND<12	NA
MW-5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	220	NA ⁴
MW-6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND<0.5	NA

* = Fourth Quarter 2002 analytical data for MW-5 collected on January 3, 2003

mg/l = milligrams per liter

µg/l = micrograms per liter

ND = Not detected above the reporting limit following the less than sign

NA = Not Applicable

MTBE = methyl t-butyl ether

1 Result of MTBE confirmation by BPA Method 8260.

2 Reporting limits elevated due to matrix interference.

3 Detection limit = 5 µg/L, backup sample analyzed after hold time had a result of ND<5 µg/L

4 Data from April 1, 2003 sampling event not available due to ORC sock obstruction in well (see report for details)

5 Table 4b displays post purge sample analytical results

**Table 4b. Groundwater Monitoring Analytical Results - Samples Collected Post Purge
Beginning 1Q03
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California**

TPHg (mg/L)	4/1/2003	7/1/2003
MW-1	23	61
MW-3	6.6	12
² MW-5	NA ⁴	NA ⁴
MW-6	ND<0.05	ND<0.05
Benzene (µg/L)		
MW-1	5100	7,700
MW-3	240	200
² MW-5	NA ⁴	NA ⁴
MW-6	ND<0.5	ND<0.5
Toluene (µg/L)		
MW-1	6900	11,000
MW-3	200	460
² MW-5	NA ⁴	NA ⁴
MW-6	ND<0.05	ND<0.05
Ethylbenzene (µg/L)		
MW-1	840	1200
MW-3	63	130
² MW-5	NA ⁴	NA ⁴
MW-6	ND<0.5	ND<0.5
Xylenes (µg/L)		
MW-1	4100	6700
MW-3	220	390
² MW-5	NA ⁴	NA ⁴
MW-6	ND<0.5	ND<2.5
MTBE (µg/L) (EPA Method 8020)		
MW-1	ND<120	ND<250
MW-3	ND<2.5	ND<5 ¹
² MW-5	NA ⁴	NA ⁴
MW-6	ND<2.5	ND<2.5
Ethylene Dichloride (µg/L) (EPA Method 8260)		
MW-1	ND<120	400
MW-3	NA	NA
² MW-5	NA	NA
MW-6	NA	NA

mg/l = milligrams per liter

µg/l = micrograms per liter

ND = Not detected above the reporting limit following the less than sign

NA = Not Available

MTBE = methyl t-butyl ether

¹ Result of MTBE confirmation by EPA Method 8260.

² Data not available from April 1 and July 1, 2003 sampling events due to ORC socks stuck in well

**Table 4c. Groundwater Monitoring Analytical Results 1Q03 – Comparison of Non-Purge and Purge Methods
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California**

	Pre-Purge 4/1/2003	Post-Purge 4/1/2003
TPHg (mg/L)		
MW-1	16	23
MW-3	5.9	6.6
*MW-5	NA ²	NA ²
MW-6	ND<0.05	ND<0.05
Benzene (µg/L)		
MW-1	4500	5100
MW-3	370	240
*MW-5	NA ²	NA ²
MW-6	ND<0.5	ND<0.5
Toluene (µg/L)		
MW-1	6000	6900
MW-3	150	200
*MW-5	NA ²	NA ²
MW-6	ND<0.05	ND<0.05
Ethylbenzene (µg/L)		
MW-1	680	840
MW-3	44	63
*MW-5	NA ²	NA ²
MW-6	ND<0.5	ND<0.5
Xylenes (µg/L)		
MW-1	3100	4100
MW-3	230	220
*MW-5	NA ²	NA ²
MW-6	ND<0.5	ND<0.5
MTBE (µg/L) (EPA Method 8020)		
MW-1	ND<120	ND<120
MW-3	ND<1.0 ¹	ND<2.5 ¹
*MW-5	NA ²	NA ²
MW-6	ND<2.5	ND<2.5
Ethylene Dichloride (µg/L) (EPA Method 8260)		
MW-1	ND<120	ND<120
MW-3	NA	NA
*MW-5	NA	NA
MW-6	NA	NA

mg/l = milligrams per liter

µg/l = micrograms per liter

ND = Not detected above the reporting limit following the less than sign

NA = Not Available

MTBE = methyl t-butyl ether

¹ Result of MTBE confirmation by EPA Method 8260.

² Data not available from April 1, 2003 sampling date due to ORC socks stuck in well

* = Analytical data collected for MW-5 on January 3, 2003

Table 5. Groundwater Monitoring Analytical Results
EPA Method 8260
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California

	¹ 12/27/2002	² 4/1/2003	² 7/1/2003
tert Amyl Methyl Ether (µg/L)			
MW-1	ND<250	NA	NA
MW-3	ND<25	NA	NA
*MW-5	ND<100	NA	NA
MW-6	ND<1	NA	NA
Ethyl tert Butyl Ether (µg/L)			
MW-1	ND<250	NA	NA
MW-3	ND<25	NA	NA
*MW-5	ND<100	NA	NA
MW-6	ND<1	NA	NA
Di-isopropyl Ether (µg/L)			
MW-1	ND<250	NA	NA
MW-3	ND<25	NA	NA
*MW-5	ND<100	NA	NA
MW-6	ND<1	NA	NA
tert Butyl Alcohol (µg/L)			
MW-1	ND<5000	NA	NA
MW-3	ND<500	NA	NA
*MW-5	ND<2000	NA	NA
MW-6	ND<20	NA	NA
Ethylene Dibromide (µg/L)			
MW-1	ND<120	NA	NA
MW-3	ND<12	NA	NA
*MW-5	ND<50	NA	NA
MW-6	ND<0.5	NA	NA
Ethylene Dichloride (µg/L)			
MW-1	370	ND<120	400
MW-3	ND<12	NA	NA
*MW-5	220	NA	NA
MW-6	ND<0.5	NA	NA

µg/l = micrograms per liter

ND = Not detected above the reporting limit

NA = Not Available/MW-1 is the only well currently sampled for

Ethylene Dichloride (see report for details)

* = Analytical data collected for MW-5 on January 3, 2003

1 = Samples on this date collected pre-purge

2 = Analytical results displayed here are from samples collected post-purge (see table 4b)

Table 6. Chemical Concentration Statistical Summary
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California

Analyte	Well	Count	Hits	FOD	Min	Max	Avg	StDev	LnAvg	LnStDev	Normal	S-W Sig	LogNormal	S-W Sig	Basis	Post-Purge Result	Ln Post-Purge Result	95% UTL	<95 UTL	ln 95% UTL	< Ln 95 UTL	Pre-Post-Purge Values Significantly Different?	Notes	
																								YES
Benzene	MW-1	16	16	100%	3500	7700	5025	1006	8.510	0.190	Y	0.936	Y	0.798	Norm	5100	8.537	7581	YES	8.969	YES	NO	No Post-Purge Results UTL assumes norm or Inorm. See Box Plot	
	MW-3	16	16	100%	6.5	370	100.88	118.43	3.750	1.480	n	--	Y	0.081	LnNorm	240	5.481	400	YES	7.484	YES	NO		
	MW-5	14	14	100%	110	14000	5171.4	5063.7	7.650	1.700	Y	0.038	Y	0.052	LnNorm	NA	--	--	--	--	--	--		NO
Benzene	MW-6	16	1	6%	3.6	3.6	0.61	0.8	-0.790	0.610	n	--	n	--	--	ND<0.5	-0.693	3	--	0.749	--	--	--	
Ethylbenzene	MW-1	16	16	100%	530	1200	686.25	162.31	6.510	0.200	Y	0.359	Y	0.588	LnNorm	840	6.733	1096	YES	7.015	YES	NO	No Post-Purge Results	
	MW-3	16	16	100%	0.45	130	38.54	43.86	2.520	1.970	n	--	Y	0.094	LnNorm	63	4.143	149	YES	7.480	YES	NO		
	MW-5	14	14	100%	7.2	1500	604.23	589.74	5.350	1.910	Y	0.014	Y	0.047	LnNorm	NA	--	--	--	--	--	--		NO
MTBE	MW-1	16	3	19%	6.6	50	104.51	85.3	4.090	1.330	Y	0.033	Y	0.037	LnNorm	ND<120	4.787	320	no	7.446	YES	NO	No Post-Purge Results UTL assumes norm or Inorm. See Box Plot	
	MW-3	16	4	25%	14	77	10.79	19.52	1.260	1.540	n	--	Y	0.418	LnNorm	ND<2.5	0.916	60	no	5.145	YES	NO		
	MW-5	14	2	14%	4.4	6.6	43.71	56.81	2.890	1.870	n	--	Y	0.341	LnNorm	NA	--	--	--	--	--	--		NO
	MW-6	16	2	13%	5	17	3	3.86	0.740	0.760	n	--	n	--	--	ND<2.5	0.916	13	--	2.657	--	--		NO
Toluene	MW-1	16	16	100%	4200	11000	5831.3	1720.4	8.640	0.250	Y	0.029	n	0.278	Norm	6900	8.839	10172	YES	9.271	YES	NO	No Post-Purge Results UTL assumes norm or Inorm. See Box Plot	
	MW-3	16	16	100%	4.8	470	142.55	166.48	3.920	1.720	n	--	Y	0.138	LnNorm	200	5.298	583	YES	8.260	YES	NO		
	MW-5	14	13	93%	6.6	6900	1778	2192.3	5.790	2.600	n	--	Y	0.123	LnNorm	NA	--	--	--	--	--	--		NO
	MW-6	16	2	13%	2.9	3.6	0.67	1.03	-1.110	1.210	n	--	n	--	--	ND<0.05	-2.996	3	--	1.943	--	--		NO
Total Xylenes	MW-1	16	16	100%	2400	6700	3293.8	1005.6	8.070	0.240	Y	0.426	Y	0.462	LnNorm	4100	8.318	5831	YES	8.676	YES	NO	No Post-Purge Results	
	MW-3	16	16	100%	1.4	590	179.97	169.36	4.330	1.770	Y	0.030	Y	0.189	LnNorm	220	5.394	607	YES	8.796	YES	NO		
	MW-5	14	13	93%	15	2600	984.04	1063.5	5.840	2.220	n	--	n	0.095	--	NA	--	--	--	--	--	--		NO
	MW-6	16	2	13%	2.7	8.7	1.3	2.1	-0.270	0.980	n	--	Y	--	LnNorm	ND<0.5	-0.693	7	no	1.900	YES	NO		
TPHg	MW-1	16	16	100%	14	61	27.38	11.67	3.230	0.390	Y	0.359	Y	0.417	LnNorm	23	3.135	57	YES	4.214	YES	NO	No Post-Purge Results	
	MW-3	16	16	100%	0.17	300	21.97	74.2	1.080	1.660	n	--	Y	0.021	LnNorm	6.6	1.867	209	YES	5.268	YES	NO		
	MW-5	14	14	100%	1.7	34	13.06	11.16	2.100	1.190	Y	0.086	Y	0.207	LnNorm	NA	--	--	--	--	--	--		NO
	MW-6	16	1	6%	0.07	0.07	0.08	0.11	-2.840	0.580	n	--	Y	--	LnNorm	ND<0.05	-2.996	0	no	-1.377	YES	NO		

Calculations of tolerance limits are based on equation and table (pg 5-22 and table B-5) in "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities", April 1989, EPA-RCRA-89.

Equation : UTL = mean + K*standard deviation (for gamma = 0.95, coverage = 0.85) (95% of future points will fall below UTL 95% of the time)

Notes: "-" Not calculated because of insufficient or no data.

Table 7. Groundwater Parameter Statistical Summary
BPS Reprographic Services Facility 1700 Jefferson Street
Oakland, California

Parameter	Well	Pre-Purge Data							Ln			Post-Purge Data							Units	t-test or Mann-Whitney	Pre- Post-Purge Values Significantly Different?		
		Count	Min	Max	Avg	StDev	LnAvg	LnStDev	Normal	S-W Sig	Basis	Count	Min	Max	Avg	StDev	LnAvg	LnStDev					
DO	MW-1	28	0.03	7.02	1.52	1.56	-0.19	1.25	n	--	Y	0.199	LnNorm	2	0.3	7.65	3.98	5.20	0.42	2.29	mg/L	ns	NO
DO	MW-3	29	0.24	10.3	3.02	2.90	0.47	1.24	n	--	Y	0.04	LnNorm	2	1.06	7.7	4.38	4.70	1.05	1.4	mg/L	ns	NO
DO	MW-5	25	0.19	6.62	2.02	1.71	0.26	1.08	n	--	--	--	--	--	--	--	--	--	--	--	mg/L	NA	--
DO	MW-6	28	0.16	12.7	2.25	2.85	0.18	1.15	n	--	Y	0.579	LnNorm	2	7.23	17.7	12.5	7.40	2.43	0.63	mg/L	Significant ^A	NO ^A
pH	MW-1	15	6.23	8.39	7.07	0.54	1.95	0.07	Y	0.297	Y	0.171	Norm	2	6.9	7.42	7.16	0.37	1.97	0.05	--	ns	NO
pH	MW-3	16	6.41	8.53	7.3	0.62	1.98	0.08	Y	0.33	Y	0.204	Norm	2	7.08	7.59	7.34	0.36	1.99	0.05	--	ns	NO
pH	MW-5	12	6.76	8.43	7.2	0.51	1.97	0.07	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	--
pH	MW-6	16	6.49	8.44	7.12	0.62	1.96	0.08	n	--	n	--	--	2	6.7	7.68	7.19	0.69	1.97	0.1	--	ns	NO
Specific Conductance	MW-1	12	725	1080	903	104	6.86	0.1	n	--	Y	0.05	LnNorm	2	1020	1128	1074	76.37	6.98	0.07	uS/cm	ns	NO
Specific Conductance	MW-3	12	496	1734	890	326	8.98	0.6	n	--	Y	0.087	LnNorm	2	690	800	745	77.78	6.61	0.1	uS/cm	--	NO
Specific Conductance	MW-5	9	333	3361	1574	1075	7.12	0.77	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	--
Specific Conductance	MW-6	12	891	2491	1412	659	7.15	0.43	n	--	n	--	--	2	970	1021	996	36.06	6.9	0.04	uS/cm	ns	NO
Temp	MW-1	16	41.7	65.3	66.6	11.2	4.17	0.15	Y	0.937	Y	0.887	Norm	2	64.6	79.41	72.01	10.48	4.27	0.15	°F	ns	NO
Temp	MW-3	16	42.5	80.3	66.9	8.69	4.19	0.14	Y	0.064	Y	0.828	LnNorm	2	67.64	80.35	73.99	8.99	4.3	0.12	°F	ns	NO
Temp	MW-5	13	37.1	78.3	66.1	9.98	4.18	0.18	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	--
Temp	MW-6	16	41.7	78.7	68.8	8.41	4.23	0.15	n	--	n	--	--	2	68	81.93	74.97	9.85	4.31	0.13	°F	ns	NO
Turbidity	MW-1	5	11.8	248	68.2	101	3.52	1.22	Y	0.305	n	--	Norm	2	157.0	526	342	261	5.68	0.85	NTU	ns	NO
Turbidity	MW-3	5	11.2	396	123	162	4.02	1.46	Y	0.465	Y	0.07	Norm	2	120.0	286	203	117	5.22	0.61	NTU	ns	NO
Turbidity	MW-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	--
Turbidity	MW-6	5	11.8	1000	309	441	4.17	2.2	Y	0.013	Y	0.041	Norm	2	590.0	1000	795	290	6.64	0.37	NTU	ns	NO

Notes:

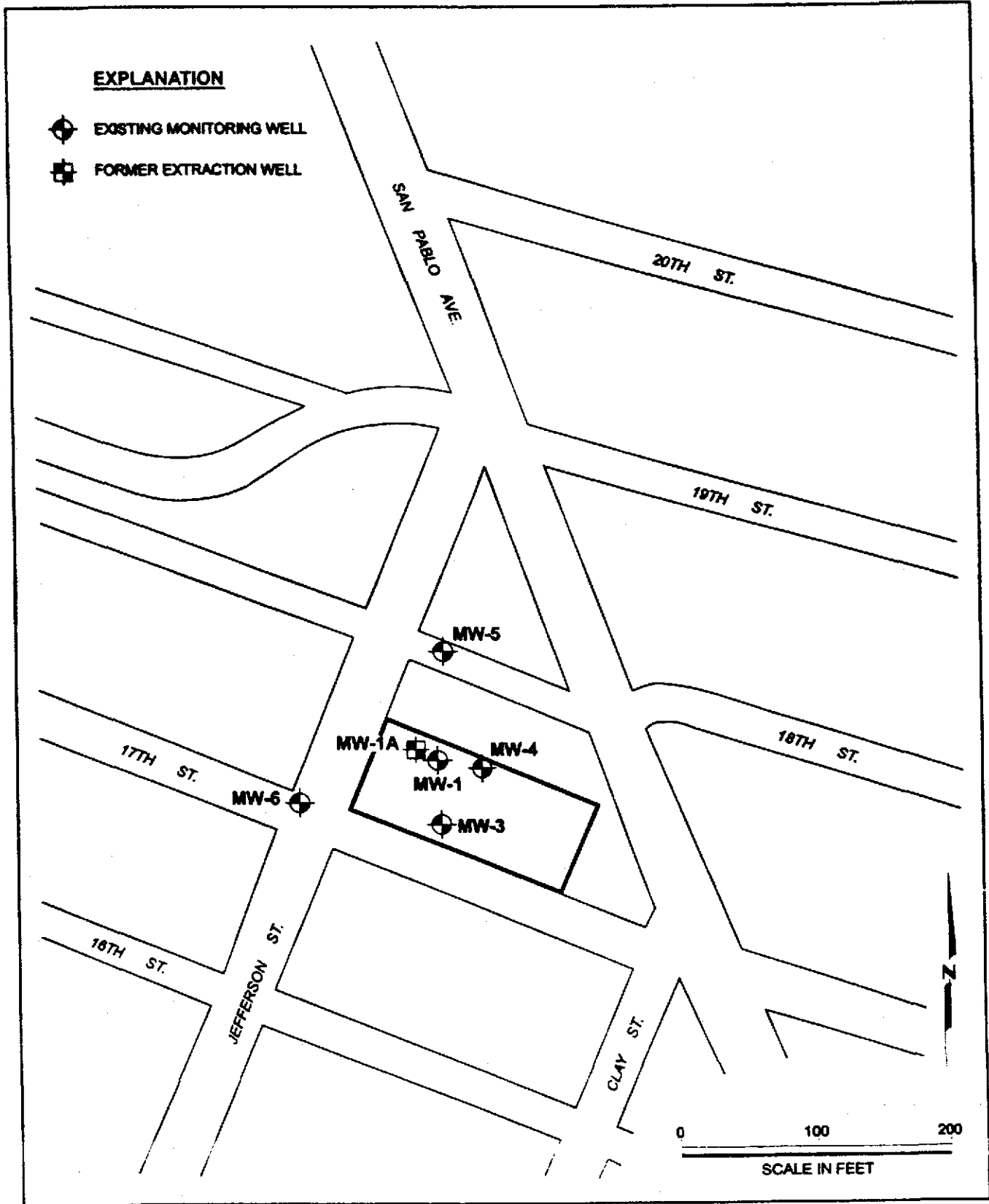
-- Not calculated because of insufficient or no data.

A. For Mann-Whitney test, p=0.034.

Shapiro-Wilk (S-W) for lognormal transformed pre-purge data significant at p=0.579; Data is assumed Lognormally distributed.
 Ln 95% UTL for Pre-purge data is 3.04. Post-purge ln(max)=2.87, which is less than the Ln 95% UTL

EXPLANATION

-  EXISTING MONITORING WELL
-  FORMER EXTRACTION WELL



MACTEC

Site Map
Second Quarter 2003
1700 Jefferson Street
BPS Reprographic Services Facility
Oakland, California

PLATE

1

DRAWN
CN

PROJECT NUMBER
53087 007

APPROVED

DATE
8/03

REVISED DATE

EXPLANATION



EXISTING MONITORING WELL



FORMER EXTRACTION WELL

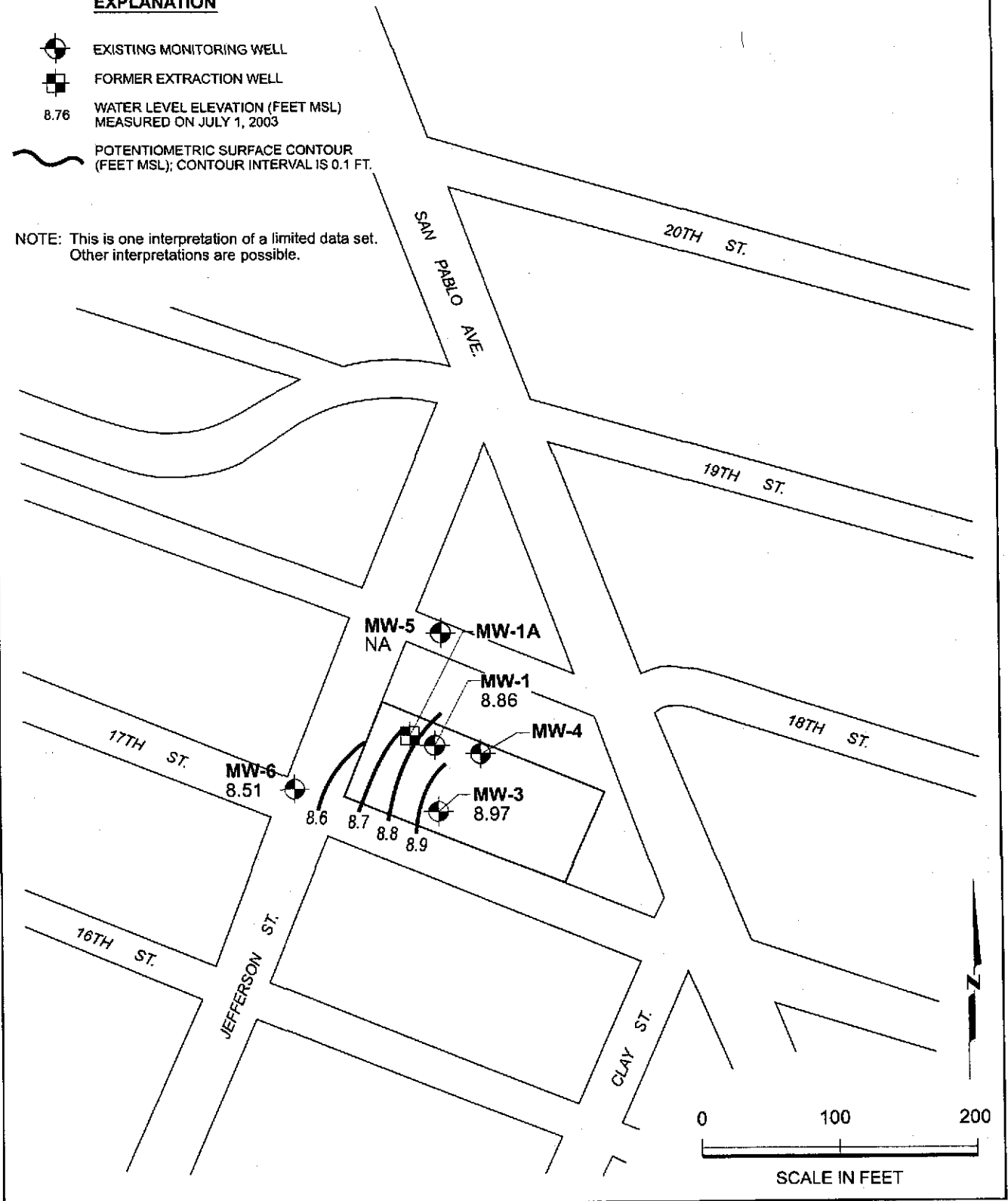
8.76

WATER LEVEL ELEVATION (FEET MSL)
MEASURED ON JULY 1, 2003



POTENTIOMETRIC SURFACE CONTOUR
(FEET MSL); CONTOUR INTERVAL IS 0.1 FT.

NOTE: This is one interpretation of a limited data set.
Other interpretations are possible.



MACTEC

Groundwater Contours
Second Quarter 2003
1700 Jefferson Street
BPS Reprographic Services Facility
Oakland, California

PLATE

2

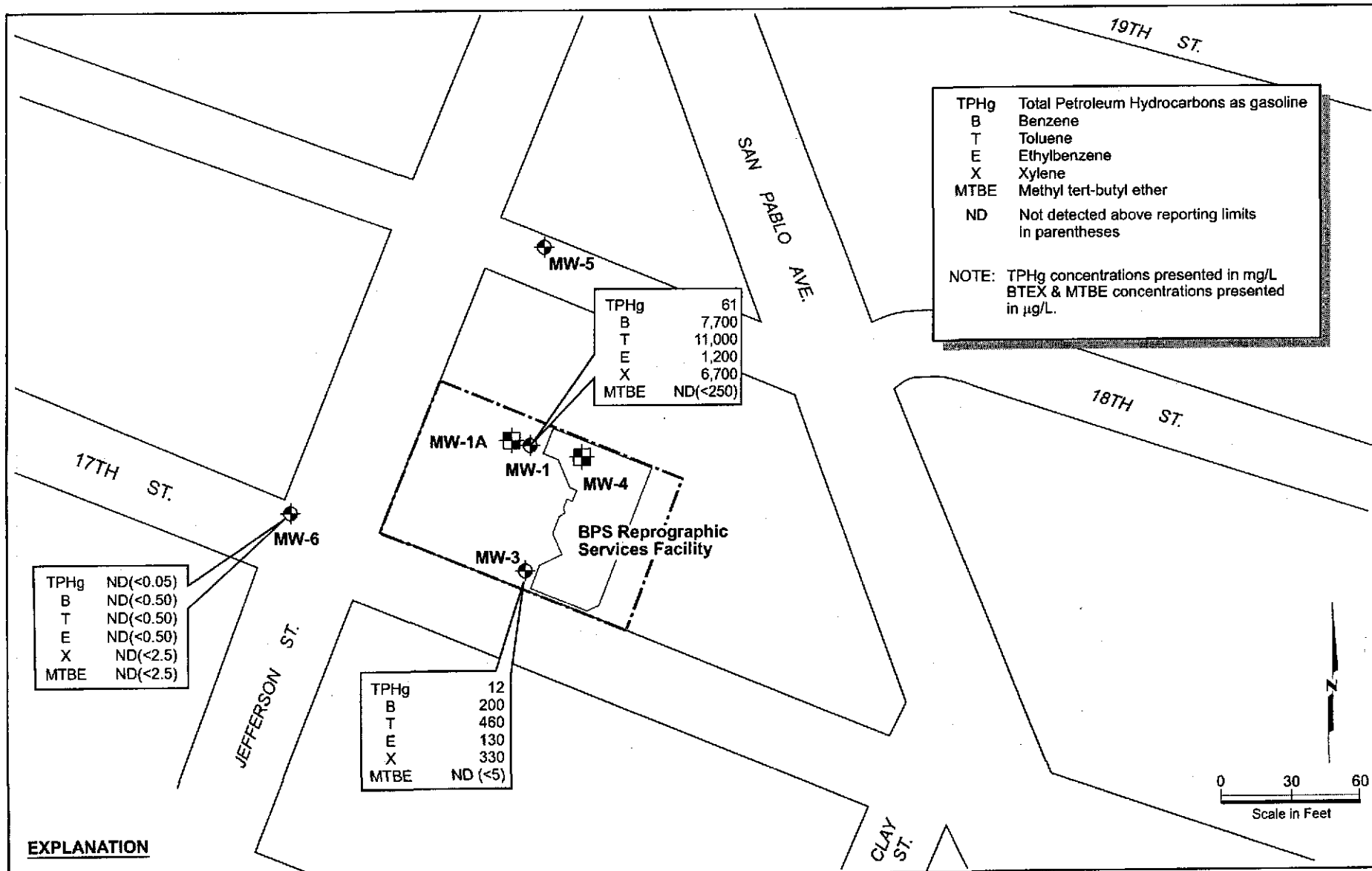
DRAWN
CN

PROJECT NUMBER
53087 007

APPROVED

DATE
6/03

REVISED DATE



TPHg Total Petroleum Hydrocarbons as gasoline
 B Benzene
 T Toluene
 E Ethylbenzene
 X Xylene
 MTBE Methyl tert-butyl ether
 ND Not detected above reporting limits in parentheses

NOTE: TPHg concentrations presented in mg/L
 BTEX & MTBE concentrations presented in µg/L.

TPHg	61
B	7,700
T	11,000
E	1,200
X	6,700
MTBE	ND(<250)

TPHg	ND(<0.05)
B	ND(<0.50)
T	ND(<0.50)
E	ND(<0.50)
X	ND(<2.5)
MTBE	ND(<2.5)

TPHg	12
B	200
T	460
E	130
X	330
MTBE	ND (<5)

EXPLANATION

- SITE BOUNDARY
- ⊕ MONITORING WELL
- ⊞ FORMER EXTRACTION WELL
- mg/L MILIGRAMS PER LITER
- µg/L MICROGRAMS PER LITER

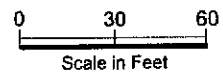


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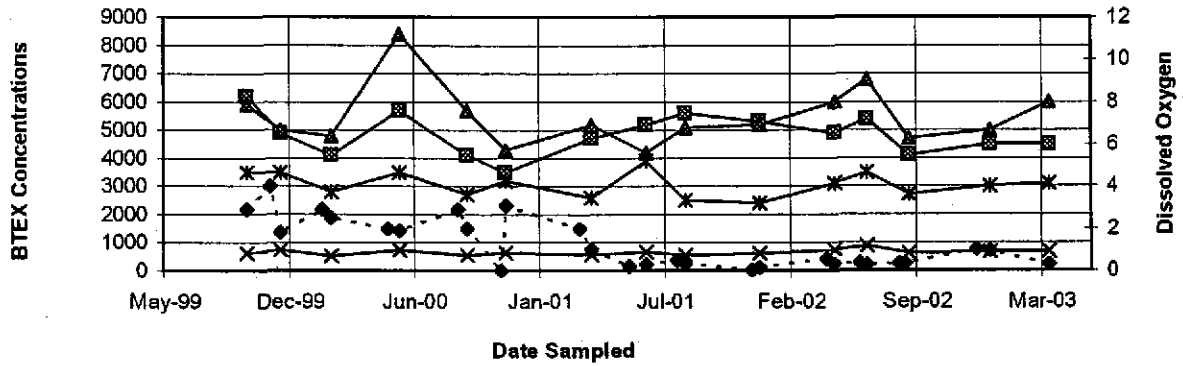
TPHg, BTEX, and MTBE Concentrations in Groundwater PLATE
 Second Quarter 2003
 1700 Jefferson Street
 BPS Reprographic Services Facility
 Oakland, California

3

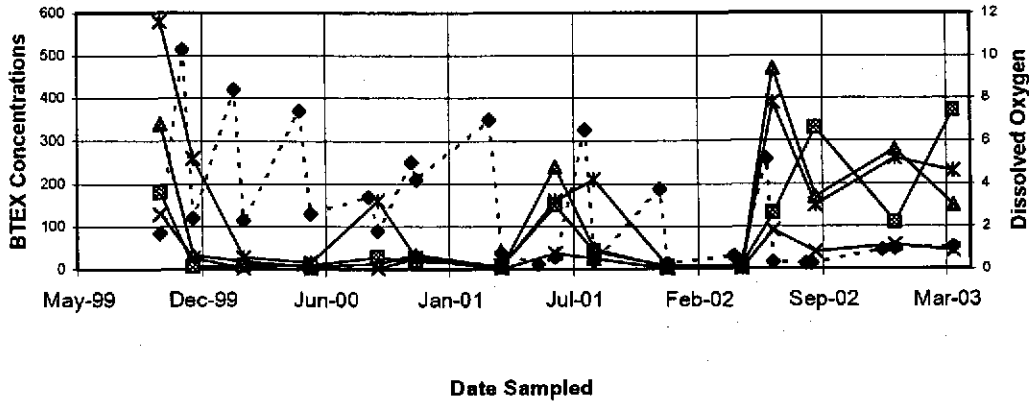
DRAWN CN	PROJECT NUMBER 53087 007	APPROVED	DATE 8/03	REVISED DATE
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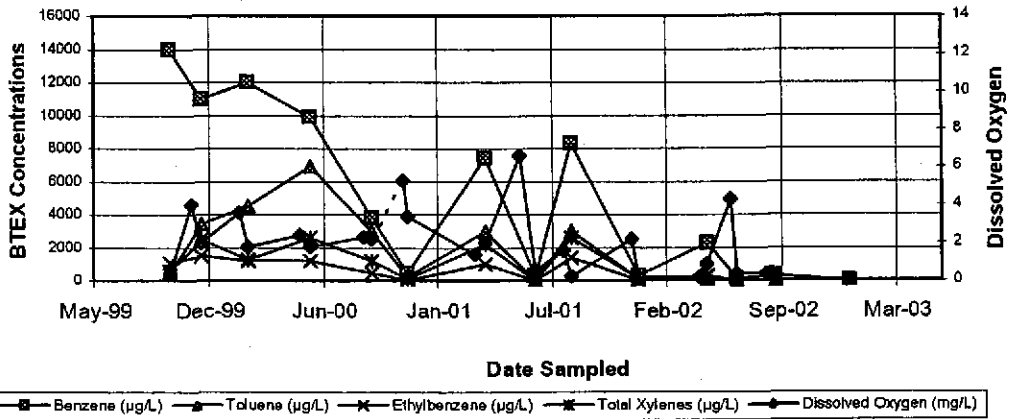
MW-1



MW-3



MW-5



Benzene (µg/L)
 Toluene (µg/L)
 Ethylbenzene (µg/L)
 Total Xylenes (µg/L)
 Dissolved Oxygen (mg/L)



MACTEC

Historical BTEX and DO Results
 Second Quarter 2003
 BPS Reprographic Services Facility
 1700 Jefferson Street
 Oakland, California

Plate

4

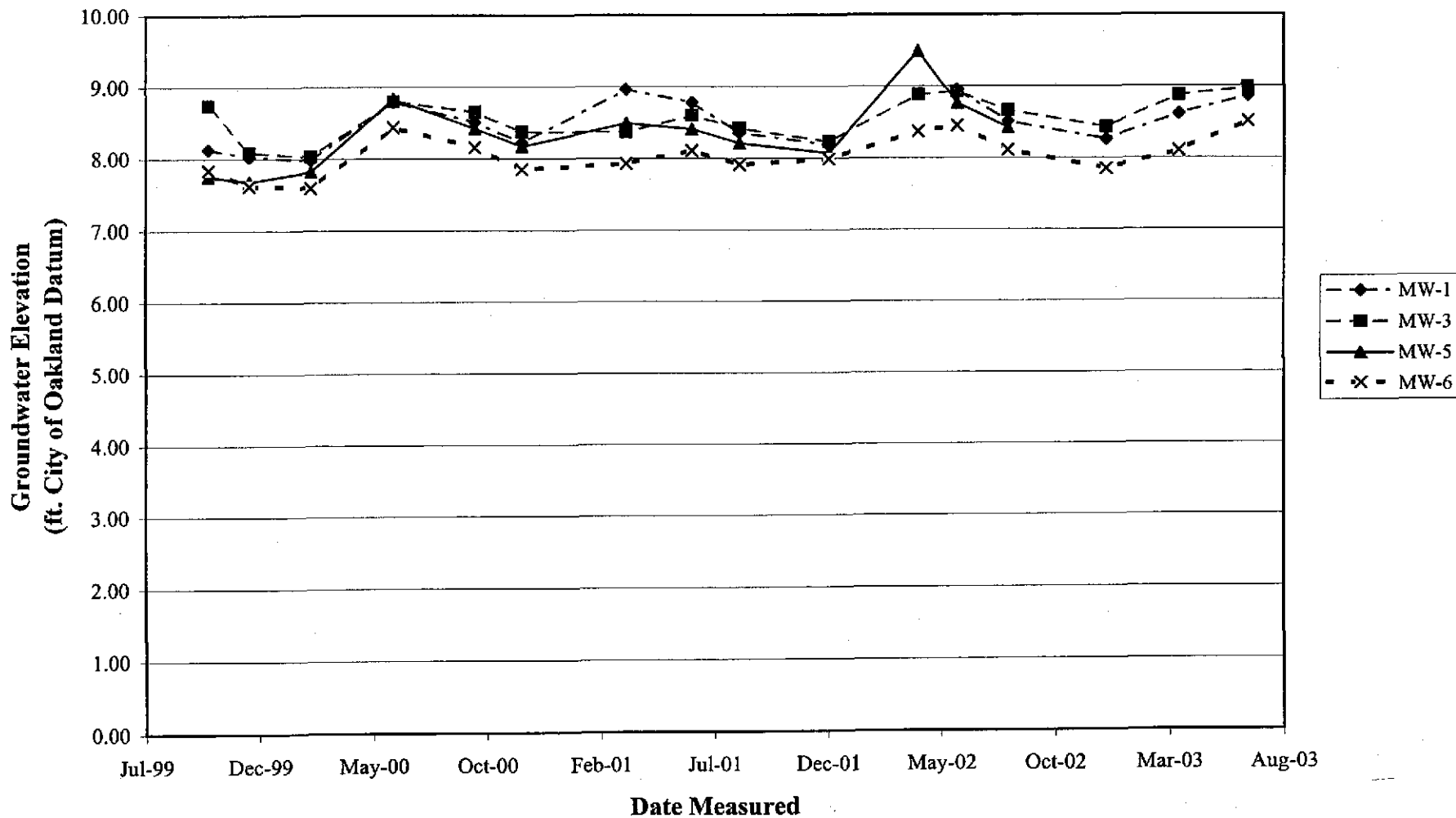
Drawn by
DSN

JOB NUMBER
53087.007

APPROVED

DATE
10/13/2003

REVISION DATE



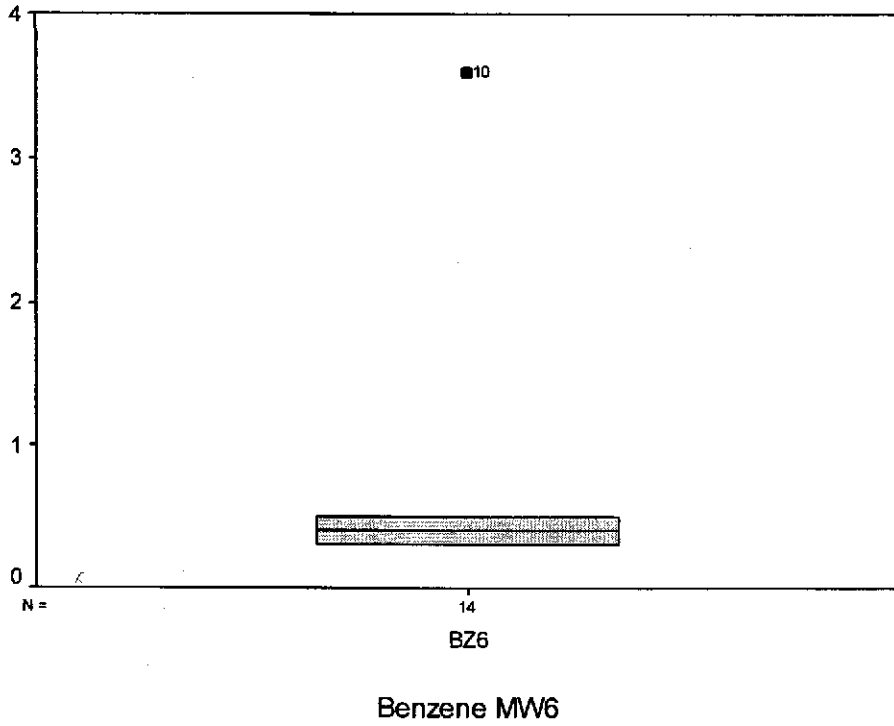
Groundwater Elevation Data
 Second Quarter 2003
 BPS Reprographic Services Facility
 1700 Jefferson Steet
 Oakland, California

Plate

5

DRAWN DSN	JOB NUMBER 53087.007	APPROVED	DATE 7/28/2003	REVISION DATE
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**Plate 6. Box and Whisker Plot
Pre-Post Purge Analytical Data
for MW-6 - Benzene
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California**



**Plate 7. Box and Whisker Plot
Pre-Post Purge Analytical Data
for MW-6 - MTBE
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California**

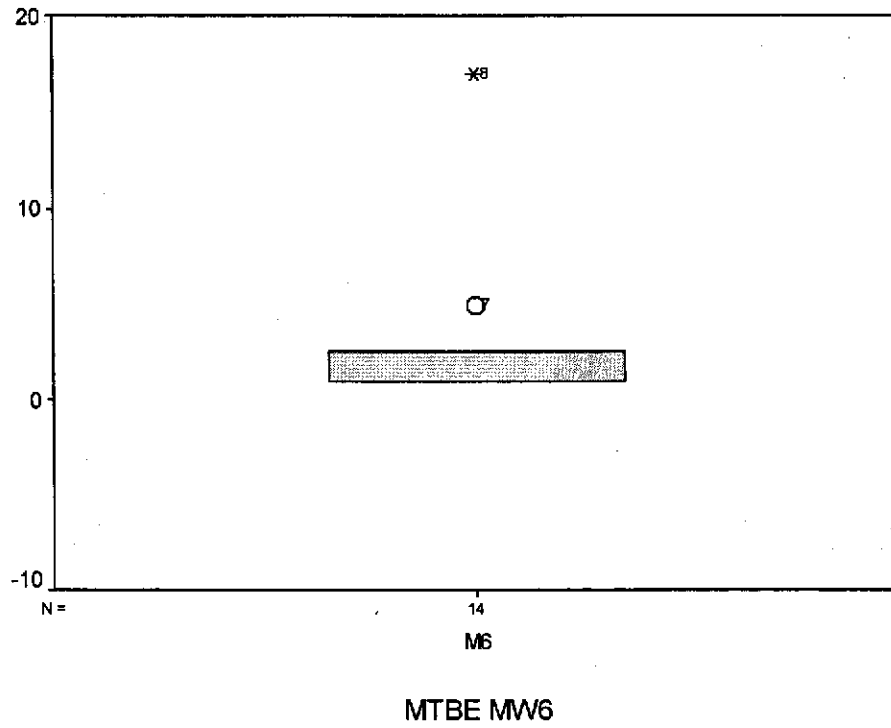


Plate 8. Box and Whisker Plot
Pre and Post Purge Analytical Data for MW-6 - Toluene
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California

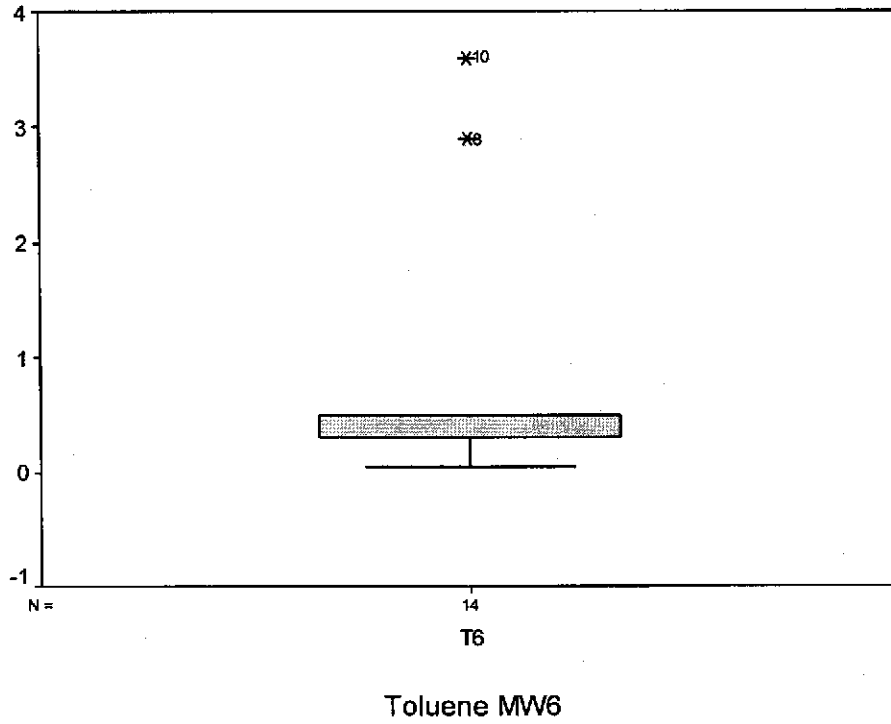
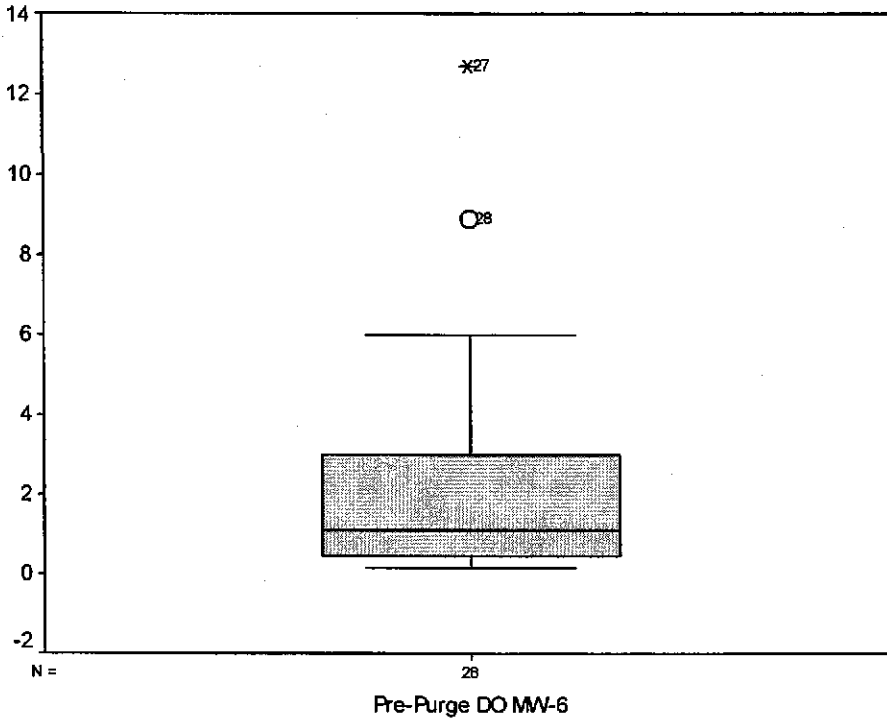


Plate 9. Box and Whisker Plot
Pre-Post Purge Groundwater Parameter Data
for MW-6 - Dissolved Oxygen
BPS Services Reproduction Facility
1700 Jefferson Street
Oakland, California



APPENDIX A
LABORATORY REPORTS



**Sequoia
Analytical**

1455 McDowell Blvd, North Ste D
Petaluma, CA 94954
(707) 792-1865
FAX (707) 792-0342
www.sequoialabs.com

17 July, 2003

David Nanstad
Harding ESE / Oakland
600 Grand Avenue, Suite 300
Oakland, CA 94610

RE: BPS Services
Work Order: P307062

Enclosed are the results of analyses for samples received by the laboratory on 07/02/03 17:30. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Stacy P. Hoch
Dept Manager - Client Services

CA ELAP Certificate #2374



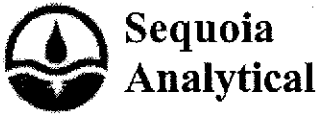
Harding ESE / Oakland
600 Grand Avenue, Suite 300
Oakland CA, 94610

Project: BPS Services
Project Number: 53087.007
Project Manager: David Nanstad

P307062
Reported:
07/17/03 18:17

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
53087-4	P307062-01	Water	07/01/03 13:55	07/02/03 17:30
53087-2	P307062-02	Water	07/01/03 15:30	07/02/03 17:30
53087-1	P307062-03	Water	07/01/03 17:10	07/02/03 17:30
53087-T	P307062-04	Water	07/01/03 17:30	07/02/03 17:30



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Harding ESE / Oakland
 600 Grand Avenue, Suite 300
 Oakland CA, 94610

Project: BPS Services
 Project Number: 53087.007
 Project Manager: David Nanstad

P307062
 Reported:
 07/17/03 18:17

Total Petroleum Hydrocarbons as Gasoline and BTEX by EPA 8015B/8021B
Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
53087-4 (P307062-01) Water Sampled: 07/01/03 13:55 Received: 07/02/03 17:30									
Gasoline Range Organics	ND	50	ug/l	1	3070139	07/08/03	07/08/03	EPA 8015B/8021B	
Benzene	ND	0.50	"	"	"	"	"	"	
Toluene	ND	0.50	"	"	"	"	"	"	
Ethylbenzene	ND	0.50	"	"	"	"	"	"	
Xylenes (total)	ND	0.50	"	"	"	"	"	"	
Methyl tert-butyl ether	ND	2.5	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		98 %	65-135	"	"	"	"	"	
Surrogate: 4-Bromofluorobenzene		97 %	65-135	"	"	"	"	"	
53087-2 (P307062-02) Water Sampled: 07/01/03 15:30 Received: 07/02/03 17:30									
Gasoline Range Organics	12000	250	ug/l	5	3070139	07/08/03	07/08/03	EPA 8015B/8021B	
Benzene	200	2.5	"	"	"	"	"	"	
Toluene	460	2.5	"	"	"	"	"	"	
Ethylbenzene	130	2.5	"	"	"	"	"	"	
Xylenes (total)	390	2.5	"	"	"	"	"	"	
Methyl tert-butyl ether	89	12	"	"	"	"	"	"	QR-04
Surrogate: a,a,a-Trifluorotoluene		101 %	65-135	"	"	"	"	"	
Surrogate: 4-Bromofluorobenzene		101 %	65-135	"	"	"	"	"	
53087-1 (P307062-03) Water Sampled: 07/01/03 17:10 Received: 07/02/03 17:30									
Gasoline Range Organics	61000	5000	ug/l	100	3070139	07/08/03	07/08/03	EPA 8015B/8021B	
Benzene	7700	50	"	"	"	"	"	"	
Toluene	11000	50	"	"	"	"	"	"	
Ethylbenzene	1200	50	"	"	"	"	"	"	
Xylenes (total)	6700	50	"	"	"	"	"	"	
Methyl tert-butyl ether	ND	250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		103 %	65-135	"	"	"	"	"	
Surrogate: 4-Bromofluorobenzene		97 %	65-135	"	"	"	"	"	

Sequoia Analytical - Petaluma

The results in this report apply to the samples analyzed in accordance with the chain of custody document. Unless otherwise stated, results are reported on a wet weight basis. This analytical report must be reproduced in its entirety.



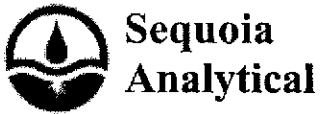
Harding ESE / Oakland
600 Grand Avenue, Suite 300
Oakland CA, 94610

Project: BPS Services
Project Number: 53087.007
Project Manager: David Nanstad

P307062
Reported:
07/17/03 18:17

Total Petroleum Hydrocarbons as Gasoline and BTEX by EPA 8015B/8021B
Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
53087-T (P307062-04) Water Sampled: 07/01/03 17:30 Received: 07/02/03 17:30									
Gasoline Range Organics	ND	50	ug/l	1	3070139	07/08/03	07/08/03	EPA 8015B/8021B	
Benzene	ND	0.50	"	"	"	"	"	"	
Toluene	ND	0.50	"	"	"	"	"	"	
Ethylbenzene	ND	0.50	"	"	"	"	"	"	
Xylenes (total)	ND	0.50	"	"	"	"	"	"	
Methyl tert-butyl ether	ND	2.5	"	"	"	"	"	"	
Surrogate: <i>a,a,a</i> -Trifluorotoluene		99 %		65-135	"	"	"	"	
Surrogate: 4-Bromofluorobenzene		95 %		65-135	"	"	"	"	



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Harding ESE / Oakland
 600 Grand Avenue, Suite 300
 Oakland CA, 94610

Project: BPS Services
 Project Number: 53087.007
 Project Manager: David Nanstad

P307062
 Reported:
 07/17/03 18:17

Volatile Organic Compounds by EPA Method 8260B
Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
53087-2 (P307062-02) Water									R-05
Sampled: 07/01/03 15:30 Received: 07/02/03 17:30									
Methyl tert-butyl ether	ND	5.0	ug/l	10	3070247	07/11/03	07/12/03	EPA 8260B	
Surrogate: Dibromofluoromethane		101 %	84-122		"	"	"	"	
53087-1 (P307062-03) Water									
Sampled: 07/01/03 17:10 Received: 07/02/03 17:30									
1,2-Dichloroethane	400	12	ug/l	25	3070255	07/14/03	07/14/03	EPA 8260B	
Surrogate: Dibromofluoromethane		99 %	84-122		"	"	"	"	
Surrogate: 1,2-Dichloroethane-d4		96 %	74-135		"	"	"	"	
Surrogate: Toluene-d8		102 %	84-119		"	"	"	"	

Harding ESE / Oakland
 600 Grand Avenue, Suite 300
 Oakland CA, 94610

 Project: BPS Services
 Project Number: 53087.007
 Project Manager: David Nanstad

 P307062
 Reported:
 07/17/03 18:17

Total Petroleum Hydrocarbons as Gasoline and BTEX by EPA 8015B/8021B - Quality Control
Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch 3070139 - EPA 5030, waters
Blank (3070139-BLK1)

Prepared & Analyzed: 07/08/03

Gasoline Range Organics	ND	50	ug/l							
Benzene	ND	0.50	"							
Toluene	ND	0.50	"							
Ethylbenzene	ND	0.50	"							
Xylenes (total)	ND	0.50	"							
Methyl tert-butyl ether	ND	2.5	"							
<i>Surrogate: a,a,a-Trifluorotoluene</i>	292		"	300		97	65-135			
<i>Surrogate: 4-Bromofluorobenzene</i>	303		"	300		101	65-135			

Laboratory Control Sample (3070139-BS1)

Prepared & Analyzed: 07/08/03

Gasoline Range Organics	2600	50	ug/l	2750		95	65-135			
Benzene	43.0	0.50	"	40.0		108	65-135			
Toluene	224	0.50	"	186		120	65-135			
Ethylbenzene	45.6	0.50	"	47.0		97	65-135			
Xylenes (total)	239	0.50	"	210		114	65-135			
Methyl tert-butyl ether	64.9	2.5	"	62.0		105	65-135			
<i>Surrogate: a,a,a-Trifluorotoluene</i>	331		"	300		110	65-135			
<i>Surrogate: 4-Bromofluorobenzene</i>	315		"	300		105	65-135			

Matrix Spike (3070139-MS1)

Source: P307062-01

Prepared & Analyzed: 07/08/03

Gasoline Range Organics	2300	50	ug/l	2750	24	83	65-135			
Benzene	41.6	0.50	"	40.0	ND	104	65-135			
Toluene	221	0.50	"	186	0.35	119	65-135			
Ethylbenzene	46.3	0.50	"	47.0	ND	99	65-135			
Xylenes (total)	234	0.50	"	210	ND	111	65-135			
Methyl tert-butyl ether	64.9	2.5	"	62.0	1.2	103	65-135			
<i>Surrogate: a,a,a-Trifluorotoluene</i>	341		"	300		114	65-135			
<i>Surrogate: 4-Bromofluorobenzene</i>	290		"	300		97	65-135			



1455 McDowell Blvd, North Ste D
 Petaluma, CA 94954
 (707) 792-1865
 FAX (707) 792-0342
 www.sequoialabs.com

Harding ESE / Oakland
 600 Grand Avenue, Suite 300
 Oakland CA, 94610

Project: BPS Services
 Project Number: 53087.007
 Project Manager: David Nanstad

P307062
 Reported:
 07/17/03 18:17

Total Petroleum Hydrocarbons as Gasoline and BTEX by EPA 8015B/8021B - Quality Control
Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch 3070139 - EPA 5030, waters

Matrix Spike Dup (3070139-MSD1)

Source: P307062-01

Prepared & Analyzed: 07/08/03

Gasoline Range Organics	2560	50	ug/l	2750	24	92	65-135	11	20	
Benzene	40.1	0.50	"	40.0	ND	100	65-135	4	20	
Toluene	220	0.50	"	186	0.35	118	65-135	0.5	20	
Ethylbenzene	45.4	0.50	"	47.0	ND	97	65-135	2	20	
Xylenes (total)	235	0.50	"	210	ND	112	65-135	0.4	20	
Methyl tert-butyl ether	61.8	2.5	"	62.0	1.2	98	65-135	5	20	
Surrogate: <i>a,a,a</i> -Trifluorotoluene	336		"	300		112	65-135			
Surrogate: 4-Bromofluorobenzene	315		"	300		105	65-135			

Sequoia Analytical - Petaluma

The results in this report apply to the samples analyzed in accordance with the chain of custody document. Unless otherwise stated, results are reported on a wet weight basis. This analytical report must be reproduced in its entirety.



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Harding ESE / Oakland
 600 Grand Avenue, Suite 300
 Oakland CA, 94610

Project: BPS Services
 Project Number: 53087.007
 Project Manager: David Nanstad

P307062
 Reported:
 07/17/03 18:17

Volatile Organic Compounds by EPA Method 8260B - Quality Control
Sequoia Analytical - Petaluma

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch 3070247 - EPA 5030 waters

Blank (3070247-BLK1)

Prepared & Analyzed: 07/11/03

Methyl tert-butyl ether	ND	0.50	ug/l							
Surrogate: Dibromofluoromethane	4.51		"	4.50		100	84-122			

Laboratory Control Sample (3070247-BS1)

Prepared & Analyzed: 07/11/03

Methyl tert-butyl ether	5.06	0.50	ug/l	5.00		101	77-123			
Surrogate: Dibromofluoromethane	4.53		"	4.50		101	84-122			

Laboratory Control Sample Dup (3070247-BSD1)

Prepared & Analyzed: 07/11/03

Methyl tert-butyl ether	5.10	0.50	ug/l	5.00		102	77-123	0.8	20	
Surrogate: Dibromofluoromethane	4.50		"	4.50		100	84-122			

Batch 3070255 - EPA 5030 waters

Blank (3070255-BLK1)

Prepared & Analyzed: 07/14/03

Tert-amyl methyl ether	ND	1.0	ug/l							
Tert-butyl alcohol	ND	20	"							
Di-isopropyl ether	ND	1.0	"							
1,2-Dichloroethane	ND	0.50	"							
Ethyl tert-butyl ether	ND	1.0	"							
Methyl tert-butyl ether	ND	0.50	"							
Surrogate: Dibromofluoromethane	4.59		"	4.50		102	84-122			
Surrogate: 1,2-Dichloroethane-d4	4.70		"	4.50		104	74-135			
Surrogate: Toluene-d8	4.67		"	4.50		104	84-119			

Laboratory Control Sample (3070255-BS1)

Prepared & Analyzed: 07/14/03

Tert-amyl methyl ether	4.89	1.0	ug/l	5.00		98	70-116			
Tert-butyl alcohol	85.4	20	"	100		85	62-142			
Di-isopropyl ether	4.99	1.0	"	5.00		100	71-121			
1,2-Dichloroethane	5.29	0.50	"	5.00		106	79-126			
Ethyl tert-butyl ether	4.91	1.0	"	5.00		98	71-110			
Methyl tert-butyl ether	4.91	0.50	"	5.00		98	77-123			
Surrogate: Dibromofluoromethane	4.55		"	4.50		101	84-122			
Surrogate: 1,2-Dichloroethane-d4	4.50		"	4.50		100	74-135			
Surrogate: Toluene-d8	4.65		"	4.50		103	84-119			

Sequoia Analytical - Petaluma

The results in this report apply to the samples analyzed in accordance with the chain of custody document. Unless otherwise stated, results are reported on a wet weight basis. This analytical report must be reproduced in its entirety.



Harding ESE / Oakland 600 Grand Avenue, Suite 300 Oakland CA, 94610	Project: BPS Services Project Number: 53087.007 Project Manager: David Nanstad	P307062 Reported: 07/17/03 18:17
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**Volatile Organic Compounds by EPA Method 8260B - Quality Control
Sequoia Analytical - Petaluma**

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch 3070255 - EPA 5030 waters

Laboratory Control Sample Dup (3070255-BSD1)

Prepared & Analyzed: 07/14/03

Tert-amyl methyl ether	5.11	1.0	ug/l	5.00		102	70-116	4	20	
Tert-butyl alcohol	87.2	20	"	100		87	62-142	2	20	
Di-isopropyl ether	4.98	1.0	"	5.00		100	71-121	0.2	20	
1,2-Dichloroethane	5.39	0.50	"	5.00		108	79-126	2	20	
Ethyl tert-butyl ether	4.94	1.0	"	5.00		99	71-110	0.6	20	
Methyl tert-butyl ether	5.04	0.50	"	5.00		101	77-123	3	20	
<i>Surrogate: Dibromofluoromethane</i>	4.56		"	4.50		101	84-122			
<i>Surrogate: 1,2-Dichloroethane-d4</i>	4.58		"	4.50		102	74-135			
<i>Surrogate: Toluene-d8</i>	4.66		"	4.50		104	84-119			

Harding ESE / Oakland
600 Grand Avenue, Suite 300
Oakland CA, 94610

Project: BPS Services
Project Number: 53087.007
Project Manager: David Nanstad

P307062
Reported:
07/17/03 18:17

Notes and Definitions

- QR-04 Primary and confirmation results varied by greater than 40% RPD. The results may still be useful for their intended purpose.
- R-05 The sample was diluted due to the presence of high levels of non-target analytes resulting in elevated reporting limits.
- DET Analyte DETECTED
- ND Analyte NOT DETECTED at or above the reporting limit
- NR Not Reported
- dry Sample results reported on a dry weight basis
- RPD Relative Percent Difference



Harding ESE
 A MACTEC COMPANY
 600 Grand Ave, Suite 300
 Oakland, CA 94610
 (510) 451-1001

CHAIN OF CUSTODY FORM

Seq. No.: N^o 011014
 Lab: SEQUOIA

Samplers: M. PETERSON

Job Number: 53087 007
 Name/Location: BPS SERVICES
 Project Manager: DAVID NANSTAD
 Recorder: [Signature] (Signature Required)

MATRIX			#CONTAINERS & PRESERV.				SAMPLE NUMBER				DATE				STATION DESCRIPTION	
Water	Soil	Air	Unpres	H2SO4	HNO3	HCL	XX	SEQ	YR	MO	DAY	TIME	DEPTH			
X						6		53087-4	03	07	01	1355	P807062-01			
X						6		53087-2	03	07	01	1530	2			
X						6		53087-1	03	07	01	1710	3			
X						2		53087-T	03	07	01	1730	4			

STATION DESCRIPTION	
P807062-01	
2	
3	
4	

ANALYSIS REQUESTED							
Gasoline Range Organics 8015B	Diesel Range Organics 8015B	BTEX plus MTBE 8020	CCR Title 22 Metals (17)	EPA 8021B	EPA 8260B	EPA 8270C	ETHYLENE DICHLORIDE 8260
X	X	X			X	X	X
X	X	X			X	X	X
X	X	X			X	X	X
X	X	X			X	X	X

COOLER CUSTODY SEALS INTACT
 NOT INTACT
 COOLER TEMPERATURE 30 °C

ADDITIONAL INFORMATION		
SAMPLE NUMBER		TURNAROUND TIME/REMARKS
YR	SEQ	
		DETECTIONS OF MTBE CONFIRMED USING EPA 8260
		STD T.A.C.

CHAIN OF CUSTODY RECORD			
Relinquished By: (signature)	Michael Peterson	MACTEC	7/2/03 1130
Received By: (signature)	Steve Korbay	MACTEC	7/2/03 1140
Relinquished By: (signature)	Steve Korbay	MACTEC	7/2/03 1730
Received By: (signature)	GAIL HERRMANN	SEQUOIA	7/2/03 1730
Relinquished By: (signature)		(Company)	Date/Time
Received By: (signature)		(Company)	Date/Time
Received By: (signature)		(Company)	Date/Time

Method of Shipment:

APPENDIX B

GROUNDWATER SAMPLING FORMS

Table B1. Sample Location/Sample Description Cross-Reference
BPS Reprographic Services Facility
1700 Jefferson Street
Oakland, California

Well/Sample Number	Client Sample ID
MW-1	53087-1
MW-3	53087-2
MW-6	53087-4
Field Blank	53087-T

Job Number: 53087 007

Name/Location: BPS SERVICES

Project Manager: DWID NANSAD

Samplers: M. PETERSON

Recorder: [Signature]
(Signature Required)

MATRIX			#CONTAINERS & PRESERV.				SAMPLE NUMBER				DATE			
Water	Soil	Air	Unpres	H ₂ SO ₄	HNO ₃	HCL	YR	SEQ	YR	MO	DAY	TIME	DEPTH	
X						6	53087	-4	03	07	01	1355	MW-6	
X						6	53087	-2	03	07	01	1530	MN-3	
X						6	53087	-1	03	07	01	1710	MW-1	
X						2	53087	-T	03	07	01	1730	TRIP BLANK	

STATION DESCRIPTION		DEPTH
MW-6		
MN-3		
MW-1		
TRIP BLANK		

ANALYSIS REQUESTED						
Gasoline Range Organics 8015B	Dieisel Range Organics 8015B	BTEX plus MTBE 8020	CCR Title 22 Metals (17)	EPA 8021B	EPA 8260B	EPA 8270C
X	X	X			X	X
X	X	X			X	X
X	X	X			X	X
X	X	X			X	X

ADDITIONAL INFORMATION											
SAMPLE NUMBER						TURNAROUND TIME/REMARKS					
YR	SEQ										
						DETECTIONS OF MTBE CONFIRMED USING EPA 8260					
						STD T.A.T.					

CHAIN OF CUSTODY RECORD			
Relinquished By: (signature)	Michael Peterson	MACTEC	7/2/03 1130
Received By: (signature)			
Relinquished By: (signature)			
Received By: (signature)			
Relinquished By: (signature)			
Received By: (signature)			
Relinquished By: (signature)			
Received By: (signature)			
Method of Shipment:			



Harding Lawson Associates
Engineering and
Environmental Services

GROUND WATER SAMPLING FORM

Well No. MW-1
Well Type: Monitor Extraction Other
Well Material: PVC St. Steel Other
Date 7-1-03 Time 1620
Sampled by MBP

Job Name BPS SERVICES
Job Number 53087 007
Recorded by [Signature]

Casing Diameter (D in inches):
 2-inch 4-inch 6-inch Other
Total Depth of Casing (TD in feet BTOC): 31.67
Water Level Depth (WL in feet BTOC): 23.50
Number of Well Volumes to be purged (# Vols)
 3 4 5 10 Other

Bailor - Type: PVC
 Submersible Centrifugal Bladder; Pump No.:
 Other - Type:
 Near Bottom Near Top Other
Depth in feet (BTOC): _____ Screen Interval in Feet (BTOC) from _____ to _____

$(31.67 - 23.50) \times 4^2 \times 3 \times 0.0408 = 18.00$ gallons
TD (feet) WL (feet) D (inches) # Vols Calculated Purge Volume

1620 Start 1700 Stop 40 min Elapsed Initial _____ gpm Final _____ gpm 18 gallons

Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T °C / °F	Other	Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T °C / °F	Other
0	7.53	1035	35.14	702/143.6/139	18	7.42	1020	26.34	7.65/212.3/157
4	7.50	1001	31.71	7.53/202.5/160					
8	7.48	1020	29.49	7.46/207.3/148					
12	7.47	1018	28.60	7.29/208.3/142					
16	7.46	1025	28.46	7.26/209.6/130					

Observations During Purging (Well Condition, Turbidity, Color, Odor): BLACK COLOR, ODOR
Discharge Water Disposal: Sanitary Sewer Storm Sewer Other SERVICES

Bailor - Type: POLY Same As Above
 Submersible Centrifugal Bladder; Pump No.: Grab - Type:
 Other - Type:

Sample Series: _____

Sample No.	Volume/Cont.	Analysis Requested	Preservatives	Lab	Comments
53087-1	6 DORS	VARIOUS	HCL	SEQUOIA	

Duplicate Samples		Blank Samples		Other Samples	
Original Sample No.	Duplicate Sample No.	Type	Sample No.	Type	Sample No.
				TRIP BLANK	53087-T



Harding Lawson Associates
Engineering and
Environmental Services

GROUND WATER SAMPLING FORM

Job Name BPS SERVICES
Job Number 53087 007
Recorded by NL
(Signature)

Well No. MW-3
Well Type: Monitor Extraction Other
Well Material: PVC St. Steel Other
Date 7-1-03 Time 1415
Sampled by MBP
(Initials)

Casing Diameter (D in inches):
 2-inch 4-inch 6-inch Other
Total Depth of Casing (TD in feet BTOC): 31.15
Water Level Depth (WL in feet BTOC): 22.80
Number of Well Volumes to be purged (# Vols)
 3 4 5 10 Other

Bailer - Type: PVC
 Submersible Centrifugal Bladder; Pump No.:
 Other - Type:

Near Bottom Near Top Other
Depth in feet (BTOC): _____ Screen Interval in Feet (BTOC) from _____ to _____

$$\left(\frac{31.15 - 22.80}{\text{TD (feet)}} \right) \times \frac{4^2}{\text{D (inches)}} \times \frac{3}{\text{\# Vols}} \times 0.0408 = 16.35 \text{ gallons}$$

Calculated Purge Volume

1415 Start 1530 Stop 1:15 Elapsed Initial _____ gpm Final _____ gpm 18.00 gallons

Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T <input type="checkbox"/> °C <input type="checkbox"/> °F	OC/Redox/Temp. Other	Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T <input type="checkbox"/> °C <input type="checkbox"/> °F	Other
0	7.67	716	26.82	6.89/2745/396	18	7.59	690	26.86	7.7/2307/120
4	7.64	656	22.69	7.11/252/720					
8	7.59	680	21.63	7.41/2485/317					
12	7.63	696	24.52	7.8/240/502					
16	7.62	663	25.12	7.26/2363/198					

Observations During Purging (Well Condition, Turbidity, Color, Odor):
Discharge Water Disposal: Sanitary Sewer Storm Sewer Other

Bailer - Type: POLY Same As Above
 Submersible Centrifugal Bladder; Pump No.: Grab - Type:
 Other - Type:

Sample Series: _____

Sample No.	Volume/Cont.	Analysis Requested	Preservatives	Lab	Comments
53087-2	6 GALS	VARIOUS	MLL	SEQUOIA	

Duplicate Samples		Blank Samples		Other Samples	
Original Sample No.	Duplicate Sample No.	Type	Sample No.	Type	Sample No.



Harding Lawson Associates
Engineering and
Environmental Services

GROUND WATER SAMPLING FORM

Job Name BPS SERVICES
Job Number 53087 007
Recorded by [Signature]

Well No. MW-6
Well Type: Monitor Extraction Other
Well Material: PVC St. Steel Other
Date 7/1/03 Time 1230
Sampled by MGP

Casing Diameter (D in inches):
 2-inch 4-inch 6-inch Other
Total Depth of Casing (TD in feet BTOC): 32.58
Water Level Depth (WL in feet BTOC): 22.75
Number of Well Volumes to be purged (# Vols)
 3 4 5 10 Other

Bailer - Type: PVC
 Submersible Centrifugal Bladder; Pump No.:
 Other - Type:

Near Bottom Near Top Other
Depth in feet (BTOC): from _____ to _____
Screen Interval in Feet (BTOC) from _____ to _____

$$\left(\frac{32.58 - 22.75}{\text{TD (feet)}} \right) \times \frac{2}{\text{D (inches)}} \times \frac{3}{\text{\# Vols}} \times 0.0408 = \frac{4.81}{\text{Calculated Purge Volume}} \text{ gallons}$$

1230 Start 1400 Stop 1500 Elapsed Initial _____ gpm Final _____ gpm _____ gallons

Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T <input type="checkbox"/> °C <input type="checkbox"/> °F	DO, Redox, Turb, Other	Minutes Since Pumping Began	pH	Cond. (µmhos/cm)	T <input type="checkbox"/> °C <input type="checkbox"/> °F	Other
0	7.77	1054	25.38	8.9/230.3/504	5	7.68	970	27.74	7.23/222/1000
1	7.60	977	23.56	8.26/237/1000					
2	7.72	982	25.98	7.94/231.8/1000					
3	7.68	980	26.38	7.53/231.2/1000					
4	7.69	970	26.16	7.35/230.6/1000					

Observations During Purging (Well Condition, Turbidity, Color, Odor):
Discharge Water Disposal: Sanitary Sewer Storm Sewer Other

Bailer - Type: Poly Same As Above
 Submersible Centrifugal Bladder; Pump No.: Grab - Type:
 Other - Type:

Sample Series: _____

Sample No.	Volume/Cont.	Analysis Requested	Preservatives	Lab	Comments
53087-4	6 VOLS	VARIOUS	HCL	SEQUOLA	

Duplicate Samples		Blank Samples		Other Samples	
Original Sample No.	Duplicate Sample No.	Type	Sample No.	Type	Sample No.

Project: BPS SERVICES Job No.: 53087 007
 Subject: FIELD INVESTIGATION DAILY REPORT Date: 6/27/03
 Equipment Range: _____ Company: _____ To: _____
 Equipment Hours: _____ P.E. Time from: _____ to: _____ By: MICHAEL PETERSON

(outside service and expense record must be attached for any outside costs)

6/27/03

(10)

FM: DAVID NANSTAD FIELD: M. PETERSON

1030 CONVERSATION RE: SAMPLING SCHEDULE W/ T.M.

1100 ORDER BOTTLE SET FROM SEBASTIA

CONFIRM WITH GAIL HELMAN THAT EDC IS ANALYZED VIA EPA 8210B. PETRA DONS (40M) ORDERED FOR TEST 6 DONS SA SAMPLE WILL BE COLLECTED TO PREPARE SAMPLE IN ACCORDANCE WITH INSTRUCTIONS PROVIDED. GAIL NOT FAMILIAR WITH BOTTLE SET FOR THIS JOB.

200 SECURE TRUCK FOR SAMPLING. DRIVE TO ADJANTA TO STEAM. CLEAN PUMPING EQUIPMENT, PICKUP PAPERWORK, EQUIPMENT & SUPPLIES NECESSARY FOR TRAFFIC SAFETY, WASTEWATER CONTAINMENT AND SAMPLING.

300 @ OAKLAND OFFICE UNLOAD TRUCK EQUIP & SUPPLIES INTO WAREHOUSE. PREPARE PAPERWORK FOR SAMPLING EFFORT TO BEGIN ON MONDAY JUNE 30.

MARUE BOWSER TO DROP OFF METERS KIT FOR TAKING PARAMETER READINGS PH, COND., TEMP, TURB, DO, P&H BY MONDAY A.M.

700 END OF DAY

Attachments:

Initial MP

Project: BPS SERVICES Job No.: 53087 007
 Subject: FIELD INVESTIGATION DAILY REPORT Date: 6/20/63
 Equipment Rental: _____ Company: _____ To: _____
 Equipment Hours: _____ F.E. Time from: _____ to: _____ By: MICHAEL PETERSON

(outside service and expense record must be attached for any outside costs)

7:00 AM: 53087 007 TM: DAVID NANSBRO FIELD: MIKE PETERSON
 9:00 (C) OAKLAND OFFICE. LOAN EQUIP & SUPPLIES.
 ARRANGE FOR TRAFFIC COORDINATION ASSISTANCE WITH
 MARIE BOWLER. CALL LEAVE MSG W/ TM.
 GET ICE & DOUBLE BAG.
 10:30 (C) SITE SURVEY SITUATION. TRAFFIC HALTAINS
 POSSIBLE ENCRoACHMENT PERMIT REQUIRED. LEAVE
 MSG W/ TM. NOTIFY THAT WILL BE SAMPLING
 IN THE AREA.
 11:30 (C) MW-6 PROCEED W/ SAMPLING. DO READ METERS MISSING
 DTW: 22.75 3 vols = 9.81 gal. SET UP TRAFFIC SAFETY
 11:50 BEGIN PURGE. REMOVE TUBING FROM WELL.
 MEASURE: PH, CONDUCTIVITY, TEMP, TURBIDITY.
 12:55 FINISH PURGE OF WELL MW-6
 1:30 TAKE SAMPLE 53087-4
 6 LBS W/ HCL PRESERVATIVE.
 3:20 CONTACT STUVE KORBAN RE: DO/READ METERS
 MARIE BOWLER STATES METERS NOT PRESENT AT FHL
 DIFFICULTY LOCATING ANY DO READS
 4:30 CONTACT TM RE SAMPLING W/OUT DO/READ PARAMETERS
 DO READ NECESSARY. SAMPLING POSTPONED UNTIL METERS
 ARRIVE ON TUESDAY A.M.
 5:30 END OF DAY

Attachments:

Initial MSP

Project: BPS SERVICES Job No.: 53087 007
 Subject: FIELD INVESTIGATION DAILY REPORT Date: 7/1/85
 Equipment Rental: _____ Company: _____ To: _____
 Equipment Hours: _____ P.E. Time from: _____ to: _____ By: MICHAEL HILF

(outside service and expense record must be attached for any outside costs)

0900 (C) OFFICE IN OAKLAND. PICK UP METER CABLE. METER NOT IN PACKAGE. PHONE EQUI. CO. METER SENT DELIVERED TO WRONG LOCATION. REPLACEMENT DO. RATER COURIERED OUT TO OAKLAND.

1230 (C) MW-6
 DW: 22.75'
 WK: SUNNY WARM.
 FINISH PURGE (C) 1400 ^{UP} 1350

1355 SAMPLE TAKEN # 53087-4

1415 (C) MW-3
 DW: 22.80'
 1525 FINISH PURGE (C) 18 gals
 1530 SAMPLE TAKEN # 53087-2

1600 (C) MW-5
 DW: (C) CRC SOCKS STUCK IN WELL
 WK: SUNNY, HOT

1610 (C) MW-1A REMOVE ALL SOCKS IN WELL FOR ANALYSIS
 DW: 22 1/2"

1615 (C) MW-1
 DW: 23.5'

1620 BEGIN PURGE OF 18 gals / FINISH (C) 1700
 1710 SAMPLE TAKEN # 53087-1

Attachments:

Initial

MHP

Project: BPS SERVICES Job No.: 53087 007
 Subject: FIELD INVESTIGATION DAILY REPORT Date: 7/2/03
 Equipment No.: _____ Company: _____ To: _____
 Equipment Hours: _____ E. Time from: _____ to: _____ By: ASB

(outside service and expense record must be attached for any outside costs)

1730 TRIP BLANK LABELS
 # 53087-T

NOTIFIED BY MANAGER DAVID @ BPS THAT
 WASTEWATER DRUMS MOVED OUTSIDE OF LOCKED
 ENCLOSURE. ENCLOSURE NOW OWNED BY DENVER
 LOCATED NEXT DOOR.

1740 DISPOSAL OF WASTEWATER INTO SEALED AND
 LABELED 55 GALLON STEEL DRUM. PICKUP
 SCHEDULED FOR THURSDAY, JULY 3, 2003

1745 @ MW-4 - ACCESS OBSTRUCTED THEN CLEARED W/HELP FROM BPS
 ATW: 24.04'
 REMOVE ORC ROCKS IN WELL FOR DISPOSAL

1800 BENTAL EQUIPMENT SECURED IN PREPARATION FOR
 RETURN ON 7/2/03 IN A.M.
 FRESH ICE OBTAINED AND SAMPLES RE-PACKED FOR
 TRANSPORT TO MOUNTAIN ON 7/2/03

1830 END OF DAY

Attachments:

Initial WBP

APPENDIX C

SHAPIRO-WILK TEST FOR NORMALITY

The Shapiro-Wilk Test For Normality

The Shapiro-Wilk test, proposed in (Shapiro, 1965), calculates a W statistic that tests whether a random sample, x_1, x_2, \dots, x_n comes from (specifically) a normal distribution. Small values of W are evidence of departure from normality and percentage points for the W statistic, obtained via Monte Carlo simulations, were reproduced by Pearson and Hartley (1972, Table 16). This test has done very well in comparison studies with other goodness of fit tests.

The W statistic is calculated as follows:

$$W = \frac{\left(\sum_{i=1}^n a_i x_{(i)} \right)^2}{\sum_{i=1}^n (x_i - \bar{x})^2}$$

where the $x_{(i)}$ are the ordered sample values ($x_{(1)}$ is the smallest) and the a_i are constants generated from the means, variances and covariances of the order statistics of a sample of size n from a normal distribution (see Pearson and Hartley (1972, Table 15).

Pearson, A. V., and Hartley, H. O. (1972). *Biometrika Tables for Statisticians, Vol 2*, Cambridge, England, Cambridge University Press.

Shapiro, S. S. and Wilk, M. B. (1965). "An analysis of variance test for normality (complete samples)", *Biometrika*, 52, 3 and 4, pages 591-611.

t-Test

Student" (real name: W. S. Gossett [1876-1937]) developed statistical methods to solve problems stemming from his employment in a brewery. Student's *t*-test deals with the problems associated with inference based on "small" samples: the calculated mean (\bar{X}_{avg}) and standard deviation (σ) may by chance deviate from the "real" mean and standard deviation (i.e., what you'd measure if you had many more data items: a "large" sample).

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$df = (n_1 + n_2) - 2$$

Using *df* and the value calculated for *t*, the *t*-test statistic is looked up in a standard table (for Example Gilbert, table A2), at a given confidence level. The 95th confidence level was used in the values reported in the text.

Gilbert, R.O., 1987. *Statistical Methods for Environmental Pollution Monitoring*. Van Nostrand Reinhold. ISBN 0-442-23050-8.

Mann - Whitney test

This test is a non-parametric alternative to the two-sample Student t -test. It also goes by the names Wilcoxon test and the U -test. The Mann-Whitney test is performed by combining the two data sets we want to compare, sort them into ascending order, and assign each point a rank: smallest value is given rank = 1; the largest observation is ranked $n_1 + n_2$. Should some of the observations be identical, one assigns the average rank to all these values. E.g., if the 7th and 8th sorted values are identical, we assign to each the rank 7.5. The idea here is that if the samples consist of random drawings from the same population one would expect the ranks for both samples to be scattered more-or-less uniformly through the sequence.

After arranging the data, we add up the ranks for each data set into *rank sums* which we denote W_1 and W_2 . The sum of $W_1 + W_2$ must obviously equal the sum of the first $(n_1 + n_2)$ integers which is

$$\frac{1}{2}(n_1 + n_2)(n_1 + n_2 + 1) \quad (1)$$

Many early rank sum tests were based on W_1 or W_2 but now it is customary to use the statistic U defined as

$$U_1 = n_1 n_2 + \frac{1}{2} n_1 (n_1 + 1) - W_1 \quad (1)$$

or

$$U_2 = n_1 n_2 + \frac{1}{2} n_2 (n_2 + 1) - W_2 \quad (3)$$

or simply U , the smallest of U_1 and U_2 . This statistic takes on values from 0 to $n_1 \cdot n_2$ and its sampling distribution is symmetrical about $n_1 n_2 / 2$. The test, then, consists of comparing the calculated U statistic to a critical U_α value given the sample sizes and desired level of significance α .

Taken from:

http://www.higp.hawaii.edu/~cecily/courses/gg313/DA_book/node60.html