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Alameda County
Environmental Health

Mr. Jerry Wickham
Hazardous Materials Specialist
Alameda County Health Care Services Agency
Environmental Health Services
Environmental Protection
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502

RE: Eagle Gas Station
4301 San Leandro Street
Oakland, California 94601

LOP StID# 2118
Fuel Leak Case No. RO0000096
USTCF Claim No. 014551
Clearwater Group Project # ZP046M

Dear Mr. Wickham,

As the legally authorized representative of the above-referenced project location, I have reviewed the *Quarterly Groundwater Monitoring Report – Third Quarter 2008* prepared by my consultant of record, Clearwater Group. I declare, under penalty of perjury, that the information and/or recommendations contained in this report are true and correct to the best of my knowledge.

Sincerely,

Muhammad Jamil
Mr. Muhammad Jamil

Date: 11-7-08

CLEARWATER
GROUP
Environmental Services

November 4, 2008

Mr. Jerry Wickham, PG, CEG, CHG
Hazardous Materials Specialist
Alameda County Environmental Health Services
Environmental Protection Division
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

Re: ***Quarterly Groundwater Monitoring Report – Third Quarter 2008***
Eagle Gas Station
4301 San Leandro Street
Oakland, California 94601

LOP Site ID# 2118
USTCF Claim No. 014551
ACEH Case No. RO# 0000096
Clearwater Project No. ZP046M

Dear Mr. Wickham:

Clearwater Group (Clearwater) has prepared this *Quarterly Groundwater Monitoring Report – Third Quarter 2008*, for the Eagle Gas Station site. This report presents the groundwater monitoring activities and associated results for the groundwater monitoring performed on September 17 and 18, 2008. This report also presents the results of the analyses of a sample of free product collected from well IS-5 during the previous quarterly groundwater monitoring event (Second Quarter of 2008) and Clearwater's recommended changes of sampling procedure for future groundwater monitoring events.

SITE DESCRIPTION

The site is located in the southern portion of the City of Oakland, Alameda County, California, at the southern corner of the intersection of San Leandro Street and High Street. The site is located approximately 1,100 feet northeast of Interstate Highway 880 and approximately 500 feet southeast of the 42nd Avenue overcrossing (**Figure 1**). The site is bounded by commercial property to the southeast and southwest, by High Street to the northwest, and by San Leandro Street to the northeast (**Figure 2**). The site is operated as a gas station and convenience store. A site investigation history is provided as **Attachment A**.

229 Tewksbury Avenue ◆ Point Richmond, California 94801 ◆ Telephone: 510-307-9943 ◆ Fax: 510-232-2823

THIRD QUARTER 2008 GROUNDWATER MONITORING EVENT

The Third Quarter 2008 groundwater monitoring event was performed on September 17 and 18, 2008. The monitoring event included measuring the depths to groundwater, well purging and sampling, and laboratory analysis of groundwater samples. Well construction details for all groundwater monitoring wells are included as **Table 1**.

Groundwater Gauging, Purging, and Sampling

On September 17, 2008, the depth to groundwater in all 20 wells was measured (**Table 2**). An electronic water-level indicator accurate to within 1/100 foot was used to measure the depth to groundwater from the top of each well casing. All the wells were visually checked for the presence of light non-aqueous phase liquid (LNAPL) during well purging.

Per the Alameda County Environmental Health Services (ACEH) letter dated September 4, 2008 (**Attachment B**), only the following wells were sampled; MW-1, MW-1D, MW-2, MW-3, MW-4, MW-4D, MW-5, MW-5D, MW-7, MW-7D, MW-8, IS-4, IS-5, and EW-2. Prior to groundwater sampling, these wells were purged of approximately three well volumes using a disposable polyethylene bailer until the temperature, conductivity, and pH measurements of the purge water stabilized, in accordance with Clearwater's *Groundwater Monitoring and Sampling Field Procedures* (**Attachment C**). Depth-to-water and well purging data were recorded on Well Gauging/Purging Calculations and Purge Data Sheets (**Attachment D**). Following recovery of the water levels to at least 80% of their static levels, groundwater samples were collected from these wells. A new disposable polyethylene bailer was used for each well. The samples were labeled, documented on a chain-of-custody form, and placed on ice in a chilled cooler for transport to the laboratory. The purge water and rinseate were pumped into an internal tank in the sampling van and removed from the site for disposal at InStrat, Rio Vista, California, a licensed treatment, storage, and disposal facility.

Laboratory Analysis

The groundwater samples were analyzed by Kiff Analytical LLC (Kiff), of Davis, California. Kiff is a State of California, Department of Health Services-certified laboratory. The samples were analyzed by Environmental Protection Agency (EPA) Method 8260B for total petroleum hydrocarbons as gasoline (TPH-g); benzene, toluene, ethylbenzene, and total xylenes (BTEX); and five oxygenates including methyl tertiary butyl ether (MTBE), di-isopropyl ether (DIPE), ethyl tertiary butyl ether (ETBE), tertiary amyl methyl ether (TAME), and tert-butanol (TBA). The samples were also analyzed for total petroleum hydrocarbons as diesel (TPH-d) by EPA Method 8015. The Kiff analytical report (#64876), including the chain-of-custody forms, is included in **Attachment E**.

On September 29, 2008, Clearwater staff uploaded the electronic laboratory report (EDF) to Geotracker, the State of California website that provides online public access to environmental data. The depth-to-water data spreadsheet GEO_WELL was uploaded to Geotracker on the same day. Confirmations of the electronic submittals of these groundwater and laboratory data to the website are included **(Attachment F)**. Upon the completion and certification of this report, it will be scanned into PDF format and uploaded to the Geotracker website per the January 1, 2005, GEO_REPORT requirement.

GROUNDWATER MONITORING RESULTS

Observations During Groundwater Sampling

During well purging, apparent petroleum odors were detected emanating from monitoring wells MW-1, MW-2, MW-7D, MW-8, IS-1, and IS-5. Sheens were observed in the groundwater samples collected from monitoring wells MW-1, MW-8, EW-2, and IS-5. Strong odor and free product were noted on the groundwater samples collected from wells IS-5 (approximately 1 inch thick) and MW-8 (trace of product). No sheen was identified in the groundwater samples collected from monitoring wells MW-1D, MW-3, MW-4D, MW-5, MW-5D, IS-4, or EW-2. No sheen was detected in monitoring wells MW-1D, MW-3, MW-4D, MW-5, MW-7, MW-7D, IS-6, or EW-1. Groundwater purged from wells MW-4, MW-8, and IS-2 had high turbidity; groundwater in the remaining wells had moderate to low turbidity. The color of the water ranged from brown to gray to tan. **Attachment D** presents the observations made during groundwater sampling.

Groundwater Elevation and Flow Direction

On September 17, 2008, the shallow-zone groundwater elevations ranged from a low of 7.22 feet above mean sea level (AMSL) in well MW-2 to a high of 12.11 feet AMSL in well IS-2 (**Table 2**). The shallow-zone groundwater elevation contour map (**Figure 3**) shows highly variable groundwater flow directions and gradients (i) and an apparent groundwater mound. The steepest gradient is near the northern corner of this site. Three representative flow directions and gradients are shown on **Figure 3**. On the southwest side of the site, the gradient is toward the south at 0.11, along the east edge of the site the gradient is 0.11 toward the east, and at the north corner, the gradient is 0.50 toward the north.

The depth to groundwater data collected on September 17, 2008, was reviewed by Clearwater. The depth to groundwater reading for well MW-5D appeared to be unreasonable compared with the depth to groundwater reading from the other deep wells (MW-1D, MW-4D, and MW-7D) and previous readings of the site depth to groundwater. Clearwater re-measured the depth to groundwater in the four deep wells on September 22, 2008. The depth to groundwater readings from September 22, 2008, were selected as being more representative of site groundwater conditions and were used to prepare the Deep Zone Groundwater Elevation Contour map (**Figure 4**) presented in this quarterly groundwater monitoring report.

The groundwater elevations in the deep-zone monitoring wells (MW-1D, MW-4D, MW-5D, and MW-7D) ranged from a low of 3.97 feet AMSL (MW-7D) to a high of 4.30 feet AMSL (MW-1D). The groundwater flow direction and gradient for the deep zone was determined from the four deep-zone wells (MW-1D, MW-4D, MW-5D, and MW-7D). **Figure 4** shows three representative gradients: the gradient along the axis of the groundwater depression is toward the north at 0.008, and two representative flow directions and gradients for groundwater flowing into the groundwater depression from the east and west are at 0.012 and 0.008, respectively. With the installation of additional groundwater monitoring wells screened within the deep-zone, the determinations of groundwater flow direction and gradient could change significantly.

The apparent groundwater flow direction and gradient in the shallow zone (**Figure 3**) is different from the groundwater flow direction and gradient in the deep zone (**Figure 4**). At each pair of shallow-zone and deep-zone wells (MW-1/MW-1D, MW-4/MW-4D, MW-5/MW-5D, and MW-7/MW-7D), the groundwater elevation was higher in the shallow-zone well. The differences ranged from 3.49 feet (wells MW-7/MW-7D) to 7.84 feet (wells MW-5/MW-5D). The shallow-zone wells are all screened from 10 feet to 25 feet bgs, and the deep-zone wells are screened from 35 feet to 45 feet bgs (**Table 1**).

Groundwater Sample Analytical Results: Shallow-Zone Wells

Consistent with historical data, the primary constituents of concern (COCs) at the site are TPH-g, TPH-d, benzene, MTBE, and TBA. The groundwater sample analytical results are summarized in **Table 3**. The shallow-zone wells sampled using the reduced sampling schedule were MW-1, MW-2, MW-3, MW-4, MW-5, MW-7, MW-8, IS-4, IS-5, and EW-2. TPH-g concentrations were reported above the laboratory method-reporting limit (MRL) in samples collected from shallow-zone monitoring wells MW-1 (430 μg/L), MW-2 (410 μg/L), IS-4 (2,600 μg/L), and IS-5 (680,000 μg/L). However, the modified MRLs for samples with interfering TPH-g concentrations ranged from a low of <300 μg/L (MW-7D) to a high of <40,000 μg/L (MW-4). **Figure 5** presents the TPH-g concentrations in groundwater for the shallow zone.

The detected concentrations of diesel-range hydrocarbons (TPH-d) in the samples collected from shallow-zone wells ranged from a low of 110 μg/L (MW-3) to a high of 10,000,000 μg/L (IS-5). TPH-d was reported above the MRLs in all the shallow-zone monitoring wells that were sampled.

Benzene concentrations reported above the MRLs ranged from a low of 7.5 μg/L (MW-2) to a high of 3,600 μg/L (IS-3). Benzene concentrations were not reported above the MRLs in samples collected from monitoring wells MW-1 (<1.50 μg/L), MW-3 (<9.0 μg/L), MW-5 (<150 μg/L), MW-7 (<90 μg/L), and MW-8 (<250 μg/L). **Figure 6** presents the benzene concentrations in groundwater for the shallow zone.

MTBE concentrations were reported above the MRLs in all the samples collected from the shallow-zone wells and ranged from a low of 86 μg/L (MW-1) to 220,000 μg/L (MW-4). **Figure 7** presents the MTBE concentration in groundwater for the shallow zone.

TBA concentrations were reported above the MRLs from all the samples collected from the shallow-zone wells and ranged from 4,100 μg/L (MW-1) to 520,000 μg/L (MW-5). **Figure 8** presents the TBA concentration in groundwater for the shallow zone.

Groundwater Sample Analytical Results: Deep-Zone Wells

TPH-d was reported in samples collected from deep-zone monitoring wells MW-4D (72 µg/L), MW-5D (65 µg/L), and MW-7D (52 µg/L). TPH-d was not detected above the MRL (50 µg/L) for well MW-1D.

TPH-g was not detected in any of the groundwater samples at MRLs ranging from 50 µg/L (MW-1D, MW-4D, and MW-5D) to 300 µg/L (MW-7D).

None of the BTEX components was detected in any of the samples collected from the deep-zone wells, at MRLs ranging from 0.50 µg/L (MW-1D and MW-5D) to 3.0 µg/L (MW-7D).

MTBE was detected in all of the deep-zone wells, at concentrations ranged from 1.1 µg/L (MW-5D) to 1,300 µg/L (MW-7D).

TBA concentrations ranged from below the MRL of 5.0 µg/L (MW-1D, MW-4D, and MW-5D) to 24 µg/L (MW-7D). **Figure 9** presents the groundwater sample analytical results for the deep zone.

FINDINGS AND CONCLUSIONS

The mounded groundwater elevation contour pattern observed in the shallow zone during this quarterly monitoring event (**Figure 3**) is consistent with historical shallow-zone groundwater elevation contour patterns observed since February 2006 (First Quarter 2006). A groundwater mound appears to be located near the two dispenser islands.

The groundwater elevation contour pattern within the deep zone (**Figure 4**) was determined from data collected from deep-zone wells MW-1D, MW-4D, MW-5D, and MW-7D on September 22, 2008. The deep-zone groundwater elevation contours indicate a partial elongated groundwater depression, which appears to discharge due north, at a gradient of 0.008.

The groundwater sample analytical results indicate that the site groundwater continues to be significantly impacted by TPH-g, TPH-d, benzene, MTBE, and TBA. TBA levels have generally increased over time as MTBE levels have decreased. The high TBA concentrations are likely due to the biodegradation of MTBE. TBA concentrations in the samples from wells MW-5, MW-8, IS-4, and IS-5 have been generally increasing over time as MTBE concentrations in these wells have been generally decreasing (**Table 3**).

ANALYSIS OF 2008 FREE PRODUCT SAMPLE COLLECTED FROM WELL IS-5

A sample of free product (free phase petroleum hydrocarbons) was collected from well IS-5 during the previous quarterly groundwater monitoring event (Second Quarter of 2008). This sample, named IS-5 Free Product, was sent under Chain-of-Custody documentation to Friedman & Bruya, Inc., in Seattle, Washington. Friedman & Bruya, Inc. analyzed the sample for

Paraffins, Isoparaffins, Aromatics, Naphthenes, and Olefins (PIANO) by Capillary Gas Chromatography (GC) using a Flame Ionization Detector (FID). The PIANO analytical results were reported in percent by weight. The sample was also analyzed for Organic Lead Speciation and Manganese by EPA Method 8082 modified, and for Total Organic Lead and Total Organic Manganese by EPA Method 200.8. A copy of the Friedman & Bruya, Inc. report (#807083) is presented in **Attachment G**. An EDF has been requested from Friedman & Bruya, Inc. Clearwater will upload the EDF to Geotracker when it is received.

The PIANO analysis identified 45.47% of the total identified compounds by weight, of which 45.38% by weight were hydrocarbon compounds. Of the hydrocarbons compounds, 3.10% were paraffins, 13.77% were isoparaffins, 23.86% were aromatics, 4.28% were naphthenes, and 0.37% were olefins.

The following quotation is from the Friedman & Bruya report: "The gas chromatography trace using the flame ionization detector (FID) showed the presence of low to medium boiling compounds. The majority of material present in this sample is indicative of gasoline. This sample may also contain a middle distillate such as diesel fuel. The GC/FID trace showed the presence of peaks, at varying levels, that are indicative of C3-benzenes and methylnaphthalenes. These compounds are characteristic of the constituents commonly found in gasoline. The relative abundance of the volatile and semivolatile constituents present indicates that substantial degradation has occurred to the gasoline. It should also be noted that an irregular pattern of peaks is present above *n*-C_{14} on the GC/FID trace. The presence of these peaks indicates that a low level of a middle distillate such as diesel fuel may also be present in the sample."

The sample did not contain detectable concentrations of tetramethyl lead, trimethyethyl lead, dimethyldiethyl lead, or methycyclopentadienyl manganese tricarbonyl (at a MRL of 1 μg/g; microgram per gram); however, it did contain 20 μg/g of methyltriethyl lead and 180 μg/g of tetraethyl lead. The sample contained 128 mg/kg of Organic Lead and was non-detect for Organic Manganese, at an MRL of 5 mg/kg.

The results of the free product analyses of sample IS-5 Free Product will be compared with any future detections of free product, and possibly used for source determination of potential onsite or offsite petroleum hydrocarbon sources.

CHANGE OF SAMPLING PROCEDURE FOR FUTURE QUARTERLY GROUNDWATER MONITORING EVENTS

Clearwater recommends upgrading its well purging and groundwater sampling procedures to the EPA-recommended low-flow purging protocol, beginning with the next quarterly groundwater monitoring event (Fourth Quarter of 2008). **Attachments H** and **I** present EPA guidance regarding the use of low-flow groundwater sampling.

FUTURE WORK

Clearwater has received ACEH approval of its *2008 Soil and Groundwater Investigation and Pilot Test Work Plan*, dated July 2, 2008. Currently, Clearwater has acquired access agreements for two off-site locations and is in the process of implementing the investigative actions in the approved work plan. The results obtained from this investigation will be presented in a separate report.

RECOMMENDATIONS

Clearwater has performed extensive on-site groundwater sampling during quarterly groundwater monitoring events beginning in the Third Quarter of 2000 through this quarterly groundwater monitoring event (**Table 1**). Based on a recent USTCF request, and in order save time and available funds, Clearwater recommends further reducing the number of wells sampled during the quarterly groundwater events to only three wells: IS-5, MW-4 and MW-8 (**Figure 2**). During each quarterly groundwater monitoring event, all of the wells would continue to be checked for the presence of free product and sheen, along with collecting depth to water measurements. All of the wells would be sampled once per year, in the third quarter, and analyzed for all constituents, or as needed related to future remediation system operation and monitoring.

Two shallow-zone groundwater monitoring wells and three deep-zone groundwater monitoring wells are slated to be installed as part of the ACEH approved tasks in the *2008 Soil and Groundwater Investigation and Pilot Test Work Plan.* The wells will be installed to investigate off-site groundwater conditions and to further define the hydrology of the deep-zone groundwater. These will be sampled quarterly for one year. After one year the results from these wells will be evaluated to determine if a trend has been established and whether these wells may be put on a reduced sampling schedule.

CERTIFICATION

This report was prepared under the supervision of a Professional Geologist registered in the State of California. All statements, conclusions, and recommendations are based solely upon published results from previous consultants, field observations by Clearwater staff, and laboratory analyses performed by a State-of-California-certified laboratory related to the work performed by Clearwater. Information and interpretation presented herein are for the sole use of the client and regulatory agency. A third party should not rely upon the information and interpretation contained in this document.

The service provided by Clearwater has been conducted in a manner consistent with the level of care and skill ordinarily exercised by members of this profession currently practicing under similar conditions in the area of the site. No other warranty, expressed or implied, is made.

LICENSED PROFESSIONALS

In-house licensed professionals direct all projects. These professionals, including geologists and engineers, shall be guided by the highest standards of ethics, honesty, integrity, fairness, personal honor, and professional conduct. To the fullest extent possible, the licensed professional shall protect the public health and welfare and property in carrying out their professional duties. In the course of normal business, recommendations by the in-house professional may include the use of equipment, services, or products in which the Company has an interest. Therefore, the Company is making full disclosure of potential or perceived conflicts of interest to all parties.

Sincerely,
CLEARWATER GROUP

ROBERT L. NELSON
No. 2087

Robert L. Nelson

Robert L. Nelson, P.G. #6270, C.E.G. #2087
Senior Geologist

JAMES ALAN JACOBS
NO. 88

James A. Jacobs, P.G. #4815, C.HG. #88
Chief Hydrogeologist

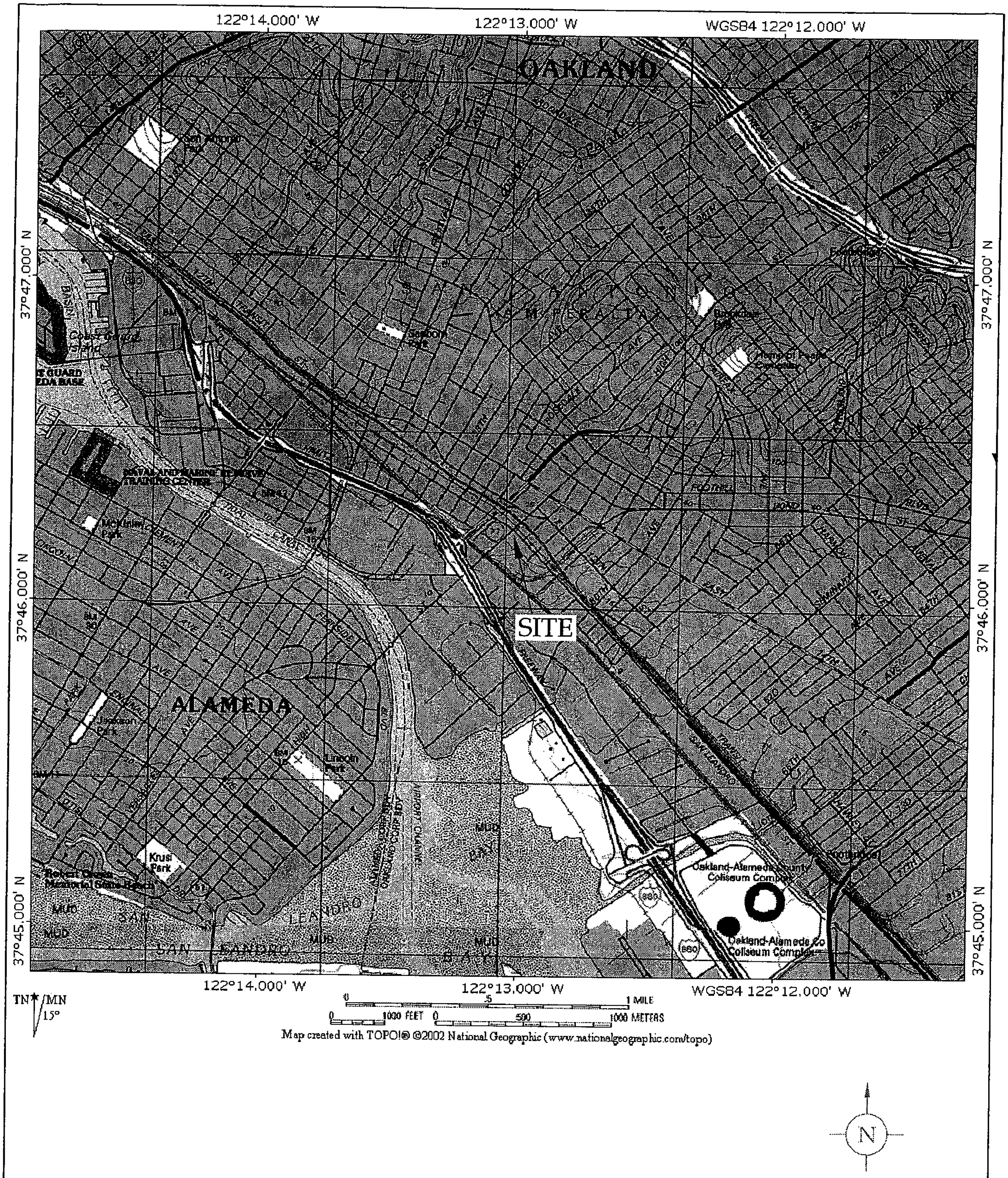
cc: Mr. Muhammad Jamil, 40092 Davis Street, Fremont, CA 94538

FIGURES:

TABLES:

ATTACHMENTS:

FIGURES

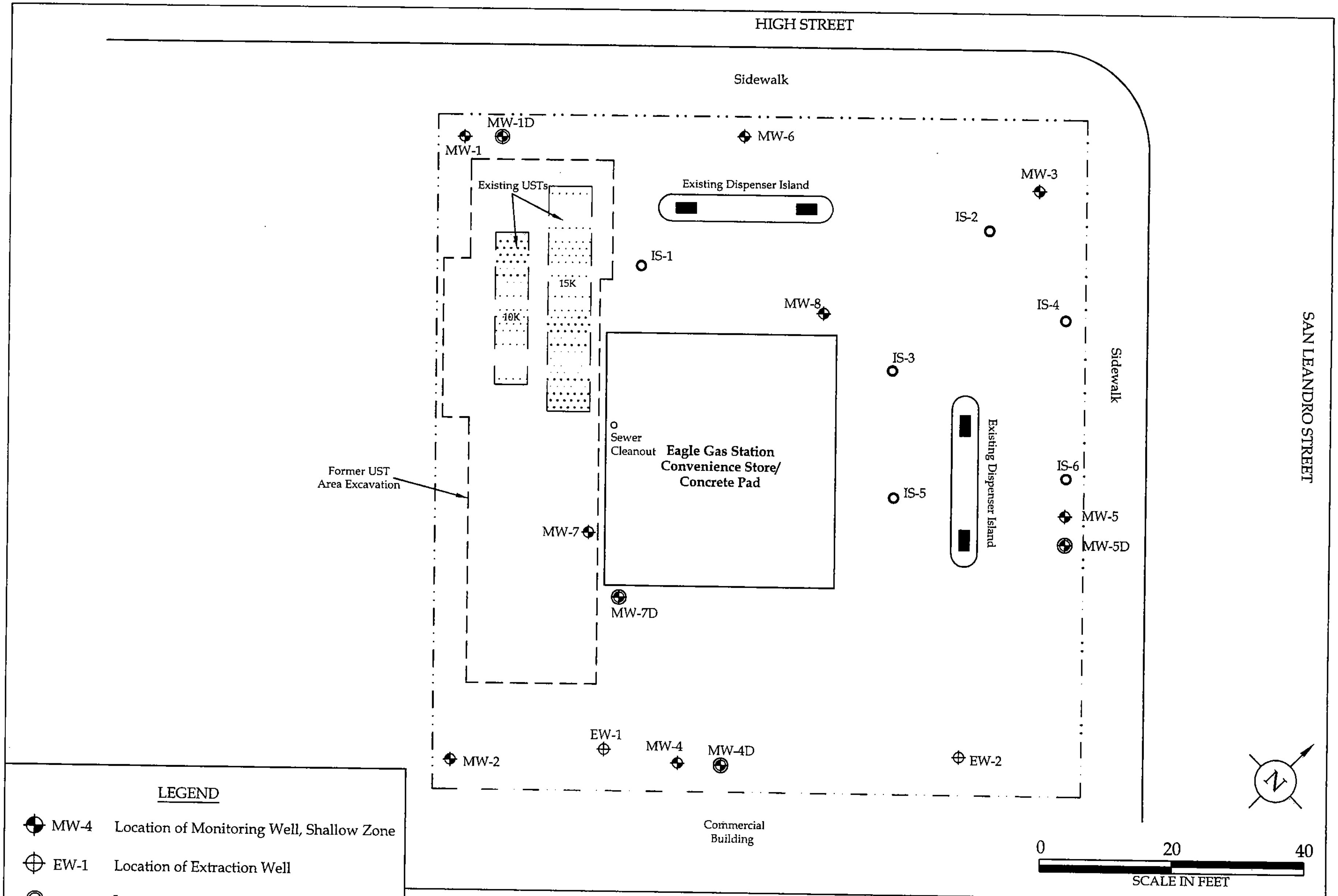


Map created with TOPO!® ©2002 National Geographic (www.nationalgeographic.com/topo)

SITE VICINITY MAP
Eagle Gas
4301 San Leandro Street
Oakland, California

CLEARWATER GROUP

Project No.	Figure Date	Figure
ZP046	**1/08**	**1**



LEGEND

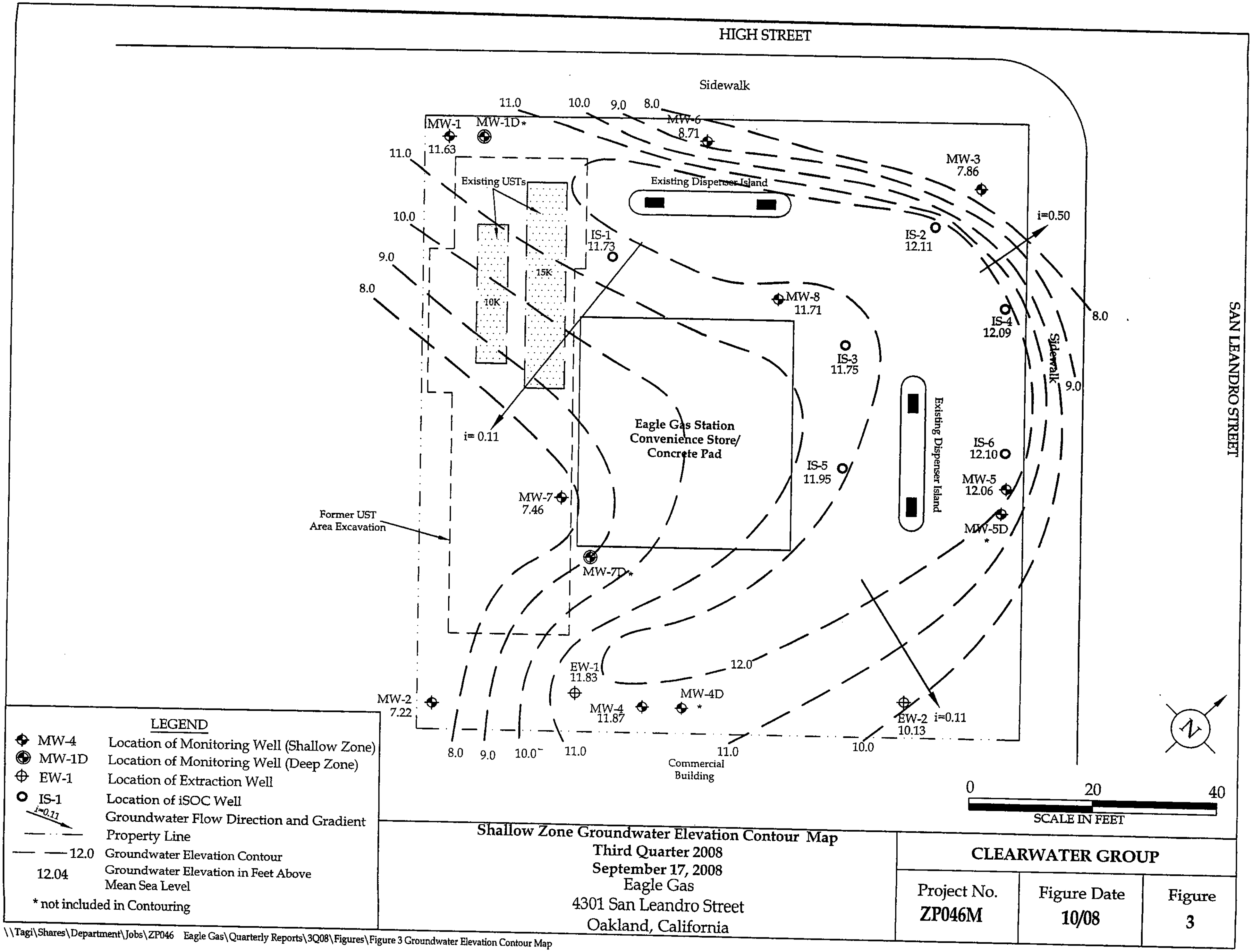
MW-4	Location of Monitoring Well, Shallow Zone
EW-1	Location of Extraction Well
IS-1	Location of iSOC Well
MW-1D	Location of Monitoring Well (Deep Zone)
— —	Property Line

Site Plan

Eagle Gas
4301 San Leandro Street
Oakland, California

CLEARWATER GROUP

Project No.	Figure Date	Figure
ZP046	**1/08**	**2**



LEGEND

MW-4	Location of Monitoring Well (Shallow Zone)
MW-1D	Location of Monitoring Well (Deep Zone)
EW-1	Location of Extraction Well
IS-1	Location of iSOC Well
i=0.11	Groundwater Flow Direction and Gradient
— · —	Property Line
— — 12.0	Groundwater Elevation Contour
12.04	Groundwater Elevation in Feet Above Mean Sea Level

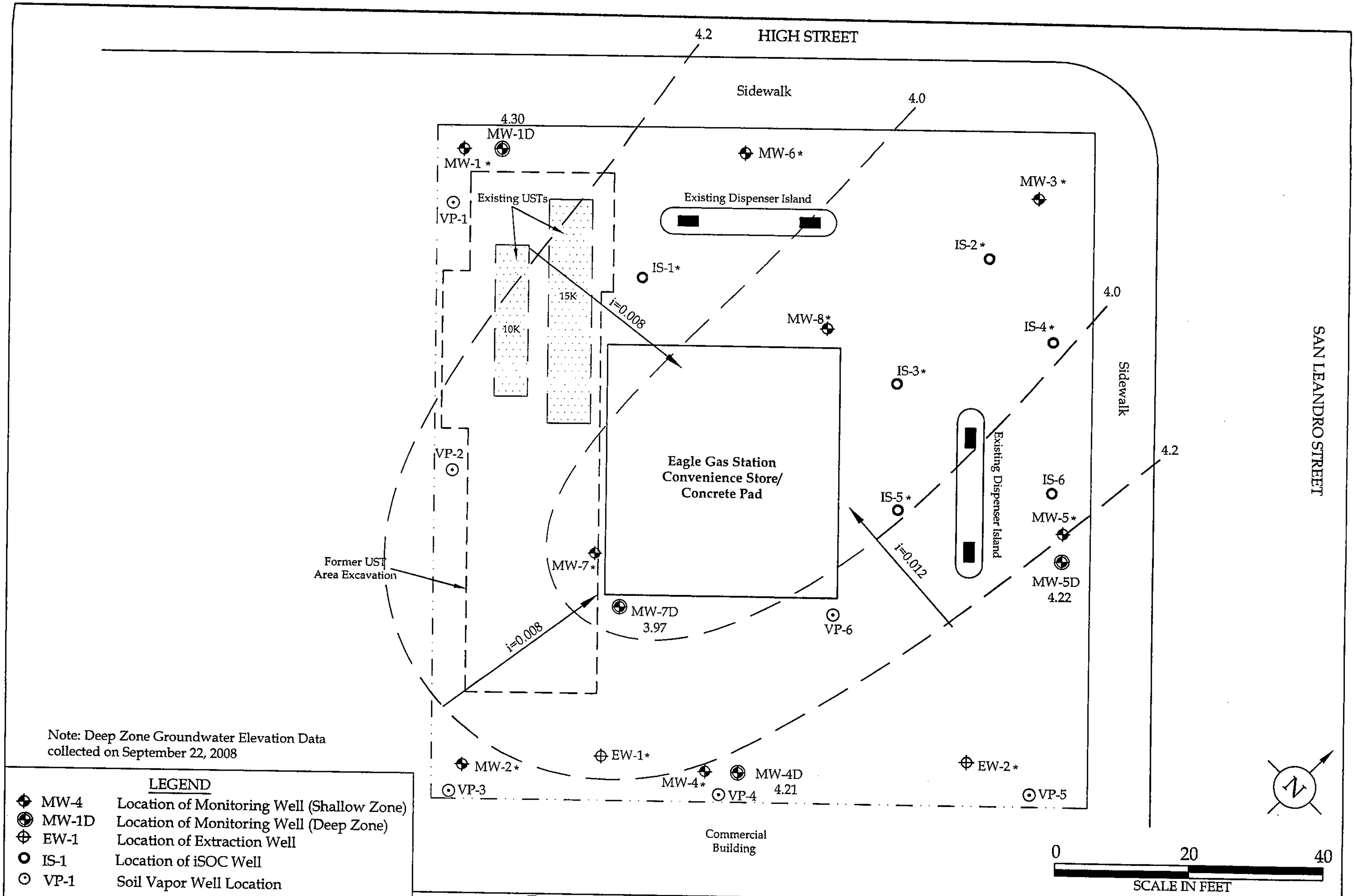
* not included in Contouring

Shallow Zone Groundwater Elevation Contour Map
Third Quarter 2008
September 17, 2008
Eagle Gas
4301 San Leandro Street
Oakland, California

CLEARWATER GROUP

Project No.	Figure Date	Figure
ZP046M	10/08	3

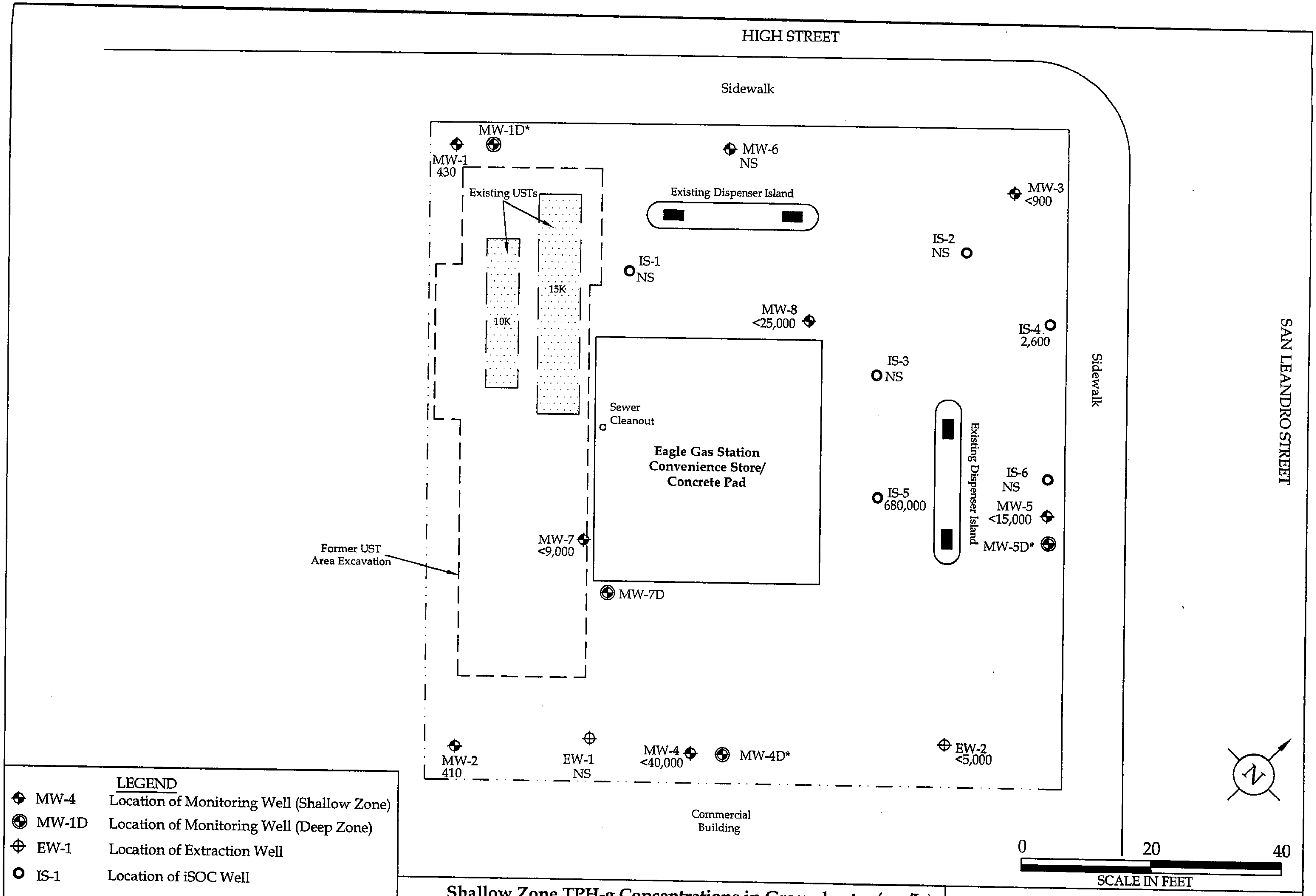
\\Tagi\Shares\Department\Jobs\ZP046 Eagle Gas\Quarterly Reports\3Q08\Figures\Figure 3 Groundwater Elevation Contour Map



Deep Zone Groundwater Elevation Contour Map
Third Quarter 2008
September 22, 2008
Eagle Gas
4301 San Leandro Street
Oakland, California

CLEARWATER GROUP		
Project No. **ZP046M**	Figure Date **10/08**	Figure **4**

\\Tagi\Shares\Department\Jobs\ZP046 Eagle Gas\Quarterly Reports\3Q08\Figures\Fig 4 Groundwater Elevation Contour Map



LEGEND

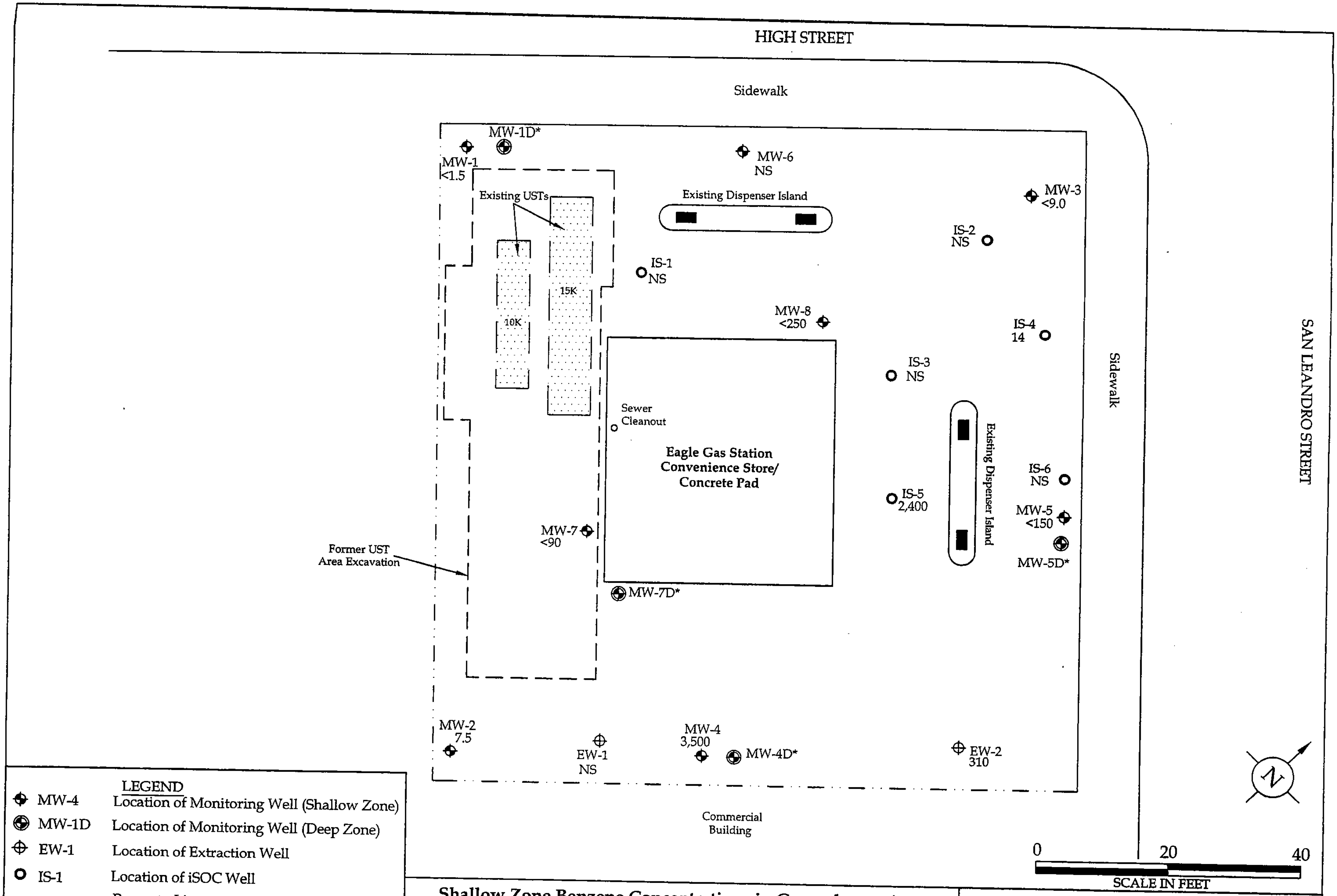
⊕	MW-4	Location of Monitoring Well (Shallow Zone)
●	MW-1D	Location of Monitoring Well (Deep Zone)
⊕	EW-1	Location of Extraction Well
○	IS-1	Location of iSOC Well
— · · —		Property Line
	2,700	TPH-g Concentration in µg/L
	NS	Not Sampled
	*	Deep Zone Well, Result not shown

Shallow Zone TPH-g Concentrations in Groundwater (µg/L)
Third Quarter 2008 Groundwater Monitoring Event
Eagle Gas
4301 San Leandro Street
Oakland, California

CLEARWATER GROUP

Project No.	Figure Date	Figure
ZP046M	**10/08**	**5**

\\Tagi\Shares\Department\Jobs\ZP046 Eagle Gas\Quarterly Reports\3Q08\Figures\Fig 5 TPH-g Concentration groundwater (ug/L), Shallow Zone



LEGEND

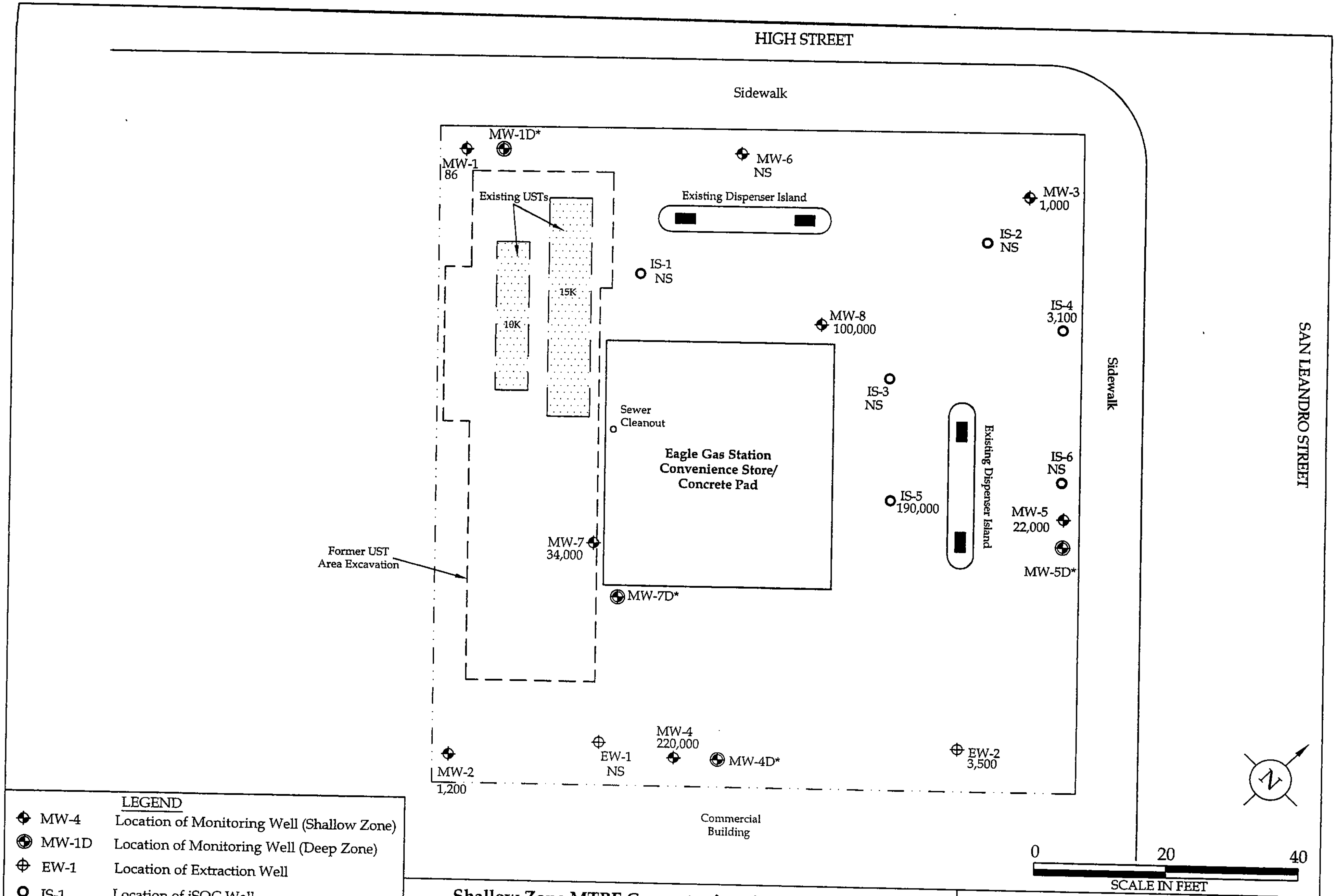
⊕	MW-4	Location of Monitoring Well (Shallow Zone)
⊛	MW-1D	Location of Monitoring Well (Deep Zone)
⌖	EW-1	Location of Extraction Well
○	IS-1	Location of iSOC Well
— · —		Property Line
550		Benzene Concentration in µg/L
NS		Not Sampled
*		Deep Zone Well, Result not shown

Shallow Zone Benzene Concentrations in Groundwater (µg/L)
Third Quarter 2008 Groundwater Monitoring Event
Eagle Gas
4301 San Leandro Street
Oakland, California

CLEARWATER GROUP

Project No.	Figure Date	Figure
ZP046M	**10/08**	**6**

\\Tagi\Shares\Department\Jobs\ZP046 Eagle Gas\Quarterly Reports\3Q08\Figures\Fig 6 Benzene Concentration groundwater (ug/L), Shallow Zone



LEGEND

⊕ MW-4	Location of Monitoring Well (Shallow Zone)
⊕ MW-1D	Location of Monitoring Well (Deep Zone)
⊕ EW-1	Location of Extraction Well
○ IS-1	Location of iSOC Well
— · · —	Property Line
110,000	MTBE Concentration in µg/L
NS	Not Sampled
*	Deep Zone Well, Result not shown

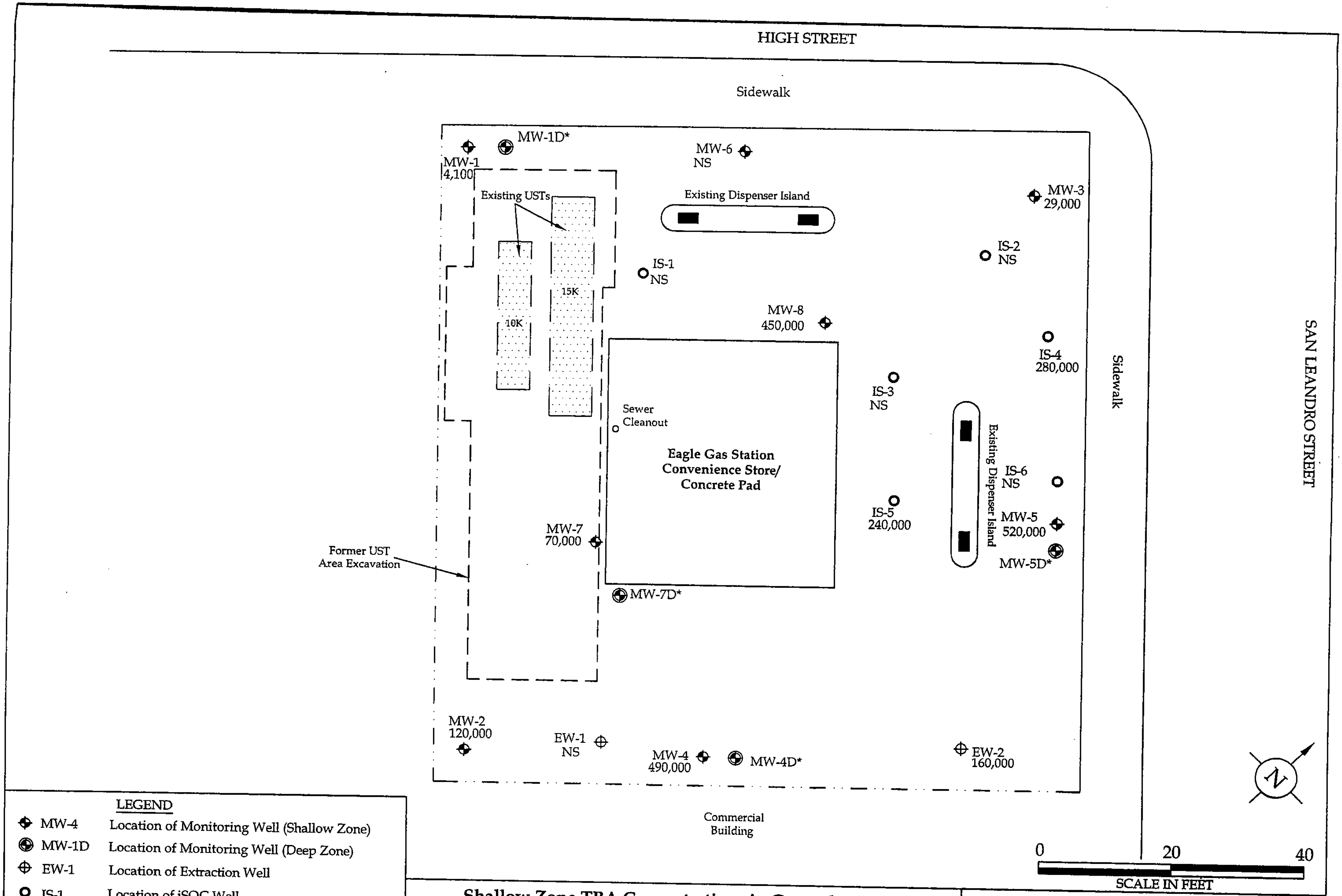
Shallow Zone MTBE Concentrations in Groundwater (µg/L)
Third Quarter 2008 Groundwater Monitoring Event

Eagle Gas
4301 San Leandro Street
Oakland, California

CLEARWATER GROUP

Project No.	Figure Date	Figure
ZP046M	**10/08**	**7**

\\Tagi\Shares\Department\Jobs\ZP046 Eagle Gas\Quarterly Reports\3Q08\Figures\Fig 7 MTBE Concentration Groundwater (ug/L), Shallow Zone



LEGEND

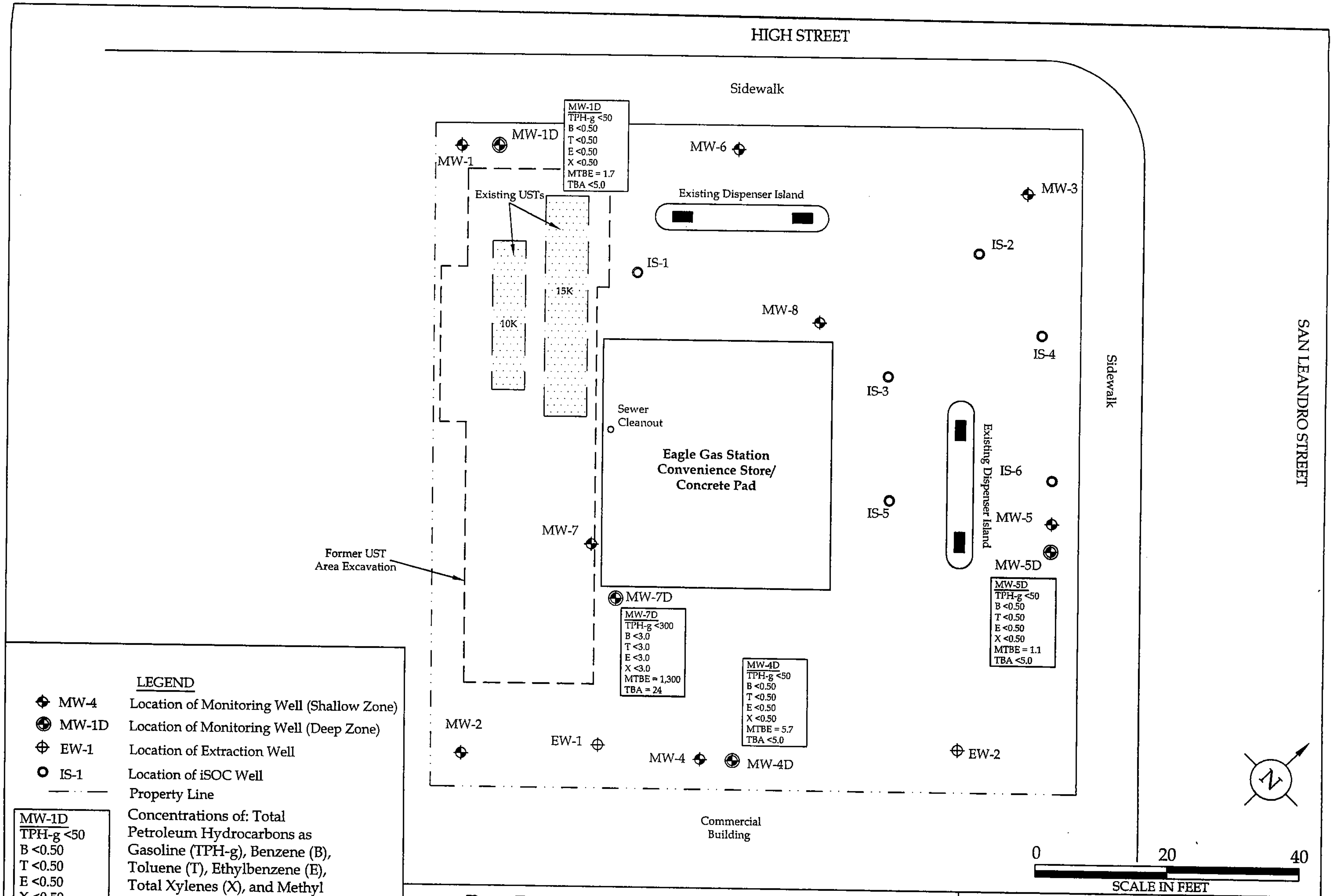
⊕	MW-4	Location of Monitoring Well (Shallow Zone)
●	MW-1D	Location of Monitoring Well (Deep Zone)
⊕	EW-1	Location of Extraction Well
○	IS-1	Location of iSOC Well
— · · —		Property Line
	65,000	TBA Concentration in μg/L
	NS	Not Sampled
	*	Deep Zone Well, Result not shown

Shallow Zone TBA Concentrations in Groundwater (μg/L)
Third Quarter 2008 Groundwater Monitoring Event
Eagle Gas
4301 San Leandro Street
Oakland, California

CLEARWATER GROUP

Project No.	Figure Date	Figure
ZP046M	**10/08**	**8**

\\Tagi\Shares\Department\Jobs\ZP046 Eagle Gas\Quarterly Reports\3Q08\Figures\Fig 8 TBA Concentration groundwater (ug/L), Shallow Zone



LEGEND

◆ MW-4	Location of Monitoring Well (Shallow Zone)
● MW-1D	Location of Monitoring Well (Deep Zone)
⊕ EW-1	Location of Extraction Well
○ IS-1	Location of iSOC Well
— · · —	Property Line
MW-1D TPH-g <50 B <0.50 T <0.50 E <0.50 X <0.50 MTBE = 2.8 TBA <5.0	Concentrations of: Total Petroleum Hydrocarbons as Gasoline (TPH-g), Benzene (B), Toluene (T), Ethylbenzene (E), Total Xylenes (X), and Methyl Tertiary Butyl Ether (MTBE), Tertiary Butyl Alcohol (TBA). All concentrations reported in micrograms per liter (µg/L).

Deep Zone Groundwater Sample Analytical Result (µg/L)
Third Quarter 2008 Groundwater Monitoring Event
Eagle Gas
4301 San Leandro Street
Oakland, California

CLEARWATER GROUP

Project No.	Figure Date	Figure
ZP046M	**10/08**	**9**

\\Tagi\Shares\Department\Jobs\ZP046 Eagle Gas\Quarterly Reports\3Q08\Figures\Fig 9 Deep-Zone Dissolved Phase Analytical Concentrations

TABLES

TABLE 1
WELL CONSTRUCTION DATA
Eagle Gas

4301 San Leandro Street
Oakland, California
Clearwater Group Project No. ZP046

Well I.D.	Date Installed	Installed by	Borehole Diameter (inches)	Casing Diameter (inches)	Depth of Borehole (feet bgs)	Cement (feet bgs)	Bentonite Seal (feet bgs)	Filter Pack (feet bgs)	Filter Pack Material	Screened Interval (feet bgs)	Slot Size (inches)
MW-1	9/26/2000	Western Hazmat	8	2	25	0-5	5-7	7-25	#2/12 sand	10-25	0.01
MW-1D	10/4/2007	Gregg Drilling	8	2	45	0-31	31-33	33-45	#2/12 sand	35-45	0.01
MW-2	9/26/2000	Western Hazmat	8	2	25	0-5	5-7	7-25	#2/12 sand	10-25	0.01
MW-3	9/26/2000	Western Hazmat	8	2	25	0-5	5-7	7-25	#2/12 sand	10-25	0.01
MW-4	12/19/2005	HEW Drilling	8	2	25	0-5	5-8	8-25	#3 sand	10-25	0.02
MW-4D	12/19/2005	HEW Drilling	8	2	45	0-30	30-33	33-45	#3 sand	35-45	0.02
MW-5	12/15/2005	HEW Drilling	8	2	25	0-5	5-8	8-25	#3 sand	10-25	0.02
MW-5D	12/15/2005	HEW Drilling	8	2	45	0-30	30-33	33-45	#3 sand	35-45	0.02
MW-6	12/20/2005	HEW Drilling	8	2	25	0-5	5-8	8-25	#3 sand	10-25	0.02
MW-7	12/19/2005	HEW Drilling	8	2	25	0-5	5-8	8-25	#3 sand	10-25	0.02
MW-7D	10/4/2007	Gregg Drilling	8	2	45	0-31	31-33	33-45	#2/12 sand	35-45	0.01
MW-8	12/21/2005	HEW Drilling	8	2	25	0-5	5-8	8-25	#3 sand	10-25	0.02
IS-1	12/20/2005	HEW Drilling	8	2	25	0-3	3-6	6-25	#3 sand	10-25	0.02
IS-2	12/20/2005	HEW Drilling	8	2	25	0-3	3-6	6-25	#3 sand	10-25	0.02
IS-3	12/21/2005	HEW Drilling	8	2	25	0-3	3-6	6-25	#3 sand	10-25	0.02
IS-4	12/20/2005	HEW Drilling	8	2	25	0-3	3-6	6-25	#3 sand	10-25	0.02
IS-5	12/21/2005	HEW Drilling	8	2	25	0-3	3-6	6-25	#3 sand	10-25	0.02
IS-6	12/20/2005	HEW Drilling	8	2	25	0-3	3-6	6-25	#3 sand	10-25	0.02
EW-1	12/16/2005	HEW Drilling	8	4	25	0-3	3-6	6-25	#3 sand	10-25	0.02
EW-2	12/16/2005	HEW Drilling	8	4	25	0-3	3-6	6-25	#3 sand	10-25	0.02

Note: All depths and intervals are below ground surface (bgs)

TABLE 2
GROUNDWATER ELEVATIONS
Eagle Gas
4301 San Leandro Street
Oakland, California

Well Name	**Measurement Date**	**TOC in feet AMSL**	**DTW in feet BTOC**	**GWE in feet AMSL**
MW-1	10/3/2000	18.37	8.96	9.41
	10/27/2000	18.37	7.27	11.10
	1/26/2001	18.37	7.60	10.77
	5/8/2001	18.37	7.50	10.87
	8/3/2001	18.37	7.09	11.28
	7/1/2003	18.37	7.59	10.78
	10/1/2003	18.37	8.36	10.01
	2/13/2004	18.37	8.80	9.57
	5/17/2004	18.37	10.92	7.45
	8/6/2004	18.37	7.76	10.61
	11/12/2004	18.37	9.25	9.12
	2/15/2005	18.37	10.12	8.25
	5/9/2005	18.37	9.58	8.79
	8/8/2005	20.08	10.09	9.99
	11/16/2005	20.08	9.81	10.27
	2/22/2006	20.08	9.58	10.50
	5/16/2006	20.08	6.89	13.19
	8/23/2006	20.08	9.21	10.87
	11/13/2006	20.08	8.55	11.53
	2/13/2007	20.08	7.11	12.97
	5/15/2007	20.08	6.63	13.45
	8/15/2007	20.08	9.61	10.47
	11/13/2007	20.08	13.63	6.45
	2/19/2008	20.08	6.13	13.95
	6/25/2008	20.08	6.72	13.36
	9/17/2008	**20.08**	**8.45**	**11.63**
MW-1D	11/13/2007	19.98	15.61	4.37
	11/27/2007	19.98	15.52	4.46
	2/19/2008	19.98	13.81	6.17
	6/25/2008	19.98	14.43	5.55
	9/17/2008	**19.98**	**15.77**	**4.21**
	9/22/2008	**19.98**	**15.68**	**4.3**
MW-2	10/3/2000	20.28	20.26	0.02
	10/27/2000	20.28	13.88	6.40
	1/26/2001	20.28	12.10	8.18
	5/8/2001	20.28	12.05	8.23
	8/3/2001	20.28	13.30	6.98
	7/1/2003	20.28	14.98	5.30
	10/1/2003	20.28	15.99	4.29
	2/13/2004	20.28	13.88	6.40
	5/17/2004	20.38	14.68	5.70
	8/6/2004	20.38	15.36	5.02
	11/12/2004	20.38	15.49	4.89
	2/15/2005	20.38	14.16	6.22
	5/9/2005	20.38	13.62	6.76
	8/8/2005	22.05	13.36	8.69

TABLE 2
GROUNDWATER ELEVATIONS
Eagle Gas

4301 San Leandro Street
Oakland, California

Well Name	Measurement Date	TOC in feet AMSL	DTW in feet BTOC	GWE in feet AMSL
MW-2	11/16/2005	22.05	14.51	7.54
cont'd	2/22/2006	22.05	12.69	9.36
	5/16/2006	22.05	12.01	10.04
	8/23/2006	21.98	11.33	10.65
	11/13/2006	21.98	13.64	8.34
	2/13/2007	21.98	12.78	9.20
	5/16/2007	21.98	13.17	8.81
	8/16/2007	21.98	13.48	8.50
	11/16/2007	21.98	14.11	7.87
	2/19/2008	21.98	14.02	7.96
	6/25/2008	21.98	14.63	7.35
	9/17/2008	**21.98**	**14.76**	**7.22**
MW-3	10/3/2000	18.98	NA	NA
	10/27/2000	18.98	18.75	0.23
	1/26/2001	18.98	13.38	5.60
	5/8/2001	18.98	11.82	7.16
	8/3/2001	18.98	13.44	5.54
	7/1/2003	18.98	12.67	6.31
	10/1/2003	18.98	14.04	4.94
	2/13/2004	18.98	12.20	6.78
	5/17/2004	18.98	11.87	7.11
	8/6/2004	18.98	13.07	5.91
	11/12/2004	18.98	12.83	6.15
	2/15/2005	18.98	11.95	7.03
	5/9/2005	18.98	10.51	8.47
	8/8/2005	20.73	10.98	9.75
	11/16/2005	20.73	12.89	7.84
	2/22/2006	20.73	10.31	10.42
	5/16/2006	20.73	9.03	11.70
	8/23/2006	20.68	10.81	9.87
	11/13/2006	20.68	12.29	8.39
	2/13/2007	20.68	11.23	9.45
	5/15/2007	20.68	10.39	10.29
	8/15/2007	20.68	11.81	8.87
	11/14/2007	20.68	12.26	8.42
	2/19/2008	20.68	10.72	9.96
	6/25/2008	20.68	11.30	9.38
	9/17/2008	**20.68**	**12.82**	**7.86**
MW-4	2/22/2006	21.63	7.87	13.76
	5/16/2006	21.63	8.04	13.59
	8/23/2006	21.53	9.77	11.76
	11/13/2006	21.53	8.78	12.75
	2/13/2007	21.53	7.56	13.97
	5/16/2007	21.53	7.97	13.56
	8/16/2007	21.53	9.03	12.50

TABLE 2
GROUNDWATER ELEVATIONS
Eagle Gas
4301 San Leandro Street
Oakland, California

Well Name	Measurement Date	TOC in feet AMSL	DTW in feet BTOC	GWE in feet AMSL
MW-4	11/16/2007	21.53	8.52	13.01
cont'd	2/19/2008	21.53	7.51	14.02
	6/25/2008	21.53	8.10	13.43
	9/17/2008	**21.53**	**9.66**	**11.87**
MW-4D	2/21/2006	21.54	15.58	5.96
	5/16/2006	21.54	13.23	8.31
	8/23/2006	21.44	15.33	6.11
	11/13/2006	21.44	16.23	5.21
	2/13/2007	21.44	15.73	5.71
	5/15/2007	21.44	15.38	6.06
	8/15/2007	21.44	16.42	5.02
	11/13/2007	21.44	17.21	4.23
	11/27/2007	21.44	15.85	5.59
	2/29/2008	21.44	15.41	6.03
	6/25/2008	21.44	16.01	5.43
	9/17/2008	**21.44**	**17.36**	**4.08**
	9/2/2008	**21.44**	**17.23**	**4.21**
MW-5	2/21/2006	20.48	6.63	13.85
	5/16/2006	20.48	6.62	13.86
	8/23/2006	20.41	7.62	12.79
	11/13/2006	20.41	7.31	13.10
	2/13/2007	20.41	6.54	13.87
	5/16/2007	20.41	6.79	13.62
	8/16/2007	20.41	7.99	12.42
	11/16/2007	20.41	7.51	12.90
	2/19/2008	20.41	8.41	12.00
	6/25/2008	20.41	9.00	11.41
	9/17/2008	**20.41**	**8.35**	**12.06**
MW-5D	2/21/2006	20.32	13.68	6.64
	5/16/2006	20.32	12.72	7.60
	8/23/2006	20.22	14.48	5.74
	11/13/2006	20.22	14.98	5.24
	2/13/2007	20.22	14.48	5.74
	5/15/2007	20.22	14.13	6.09
	8/15/2007	20.22	15.21	5.01
	11/13/2007	20.22	15.94	4.28
	11/27/2007	20.22	15.85	4.37
	2/19/2008	20.22	14.17	6.05
	6/25/2008	20.22	14.77	5.45
	9/17/2008	**20.22**	**6.11**	**14.11**
	9/22/2008	**20.22**	**16**	**4.22**
MW-6	2/22/2006	20.45	9.88	10.57
	5/16/2006	20.45	9.35	11.10
	8/23/2006	20.47	10.48	9.99
	11/13/2006	20.47	10.86	9.61

TABLE 2
GROUNDWATER ELEVATIONS
Eagle Gas
4301 San Leandro Street
Oakland, California

Well Name	Measurement Date	TOC in feet AMSL	DTW in feet BTOC	GWE in feet AMSL
MW-6	2/13/2007	20.47	10.31	10.16
cont'd	5/15/2007	20.47	10.35	10.12
	8/15/2007	20.47	10.74	9.73
	11/14/2007	20.47	10.91	9.56
	2/19/2008	20.47	9.82	10.65
	6/25/2008	20.47	10.43	10.04
	9/17/2008	**20.47**	**11.76**	**8.71**
MW-7	2/22/2006	21.13	11.72	9.41
	5/16/2006	21.13	8.72	12.41
	8/23/2006	21.14	11.34	9.80
	11/13/2006	21.14	12.53	8.61
	2/13/2007	21.14	11.83	9.31
	5/15/2007	21.14	10.99	10.15
	8/15/2007	21.14	12.41	8.73
	11/14/2007	21.14	13.41	7.73
	2/19/2008	21.14	9.51	11.63
	6/25/2008	21.14	10.03	11.11
	9/17/2008	**21.14**	**13.68**	**7.46**
MW-7D	11/13/2007	21.36	19.21	2.15
	11/27/2007	21.36	17.02	4.34
	2/19/2008	21.36	15.78	5.58
	6/25/2008	21.36	16.36	5.00
	9/17/2008	**21.36**	**17.24**	**4.12**
	9/22/2208	**21.36**	**17.39**	**3.97**
MW-8	2/22/2006	21.03	7.28	13.75
	5/16/2006	21.03	7.48	13.55
	8/23/2006	20.95	8.19	12.76
	11/13/2006	20.95	8.15	12.80
	2/13/2007	20.95	6.58	14.37
	5/16/2007	20.95	7.24	13.71
	8/16/2007	20.95	8.61	12.34
	11/16/2007	20.95	8.21	12.74
	2/19/2008	20.95	7.01	13.94
	6/25/2008	20.95	7.59	13.36
	9/17/2008	**20.95**	**9.24**	**11.71**
IS-1	2/22/2006	20.57	6.91	13.66
	5/16/2006	20.57	7.01	13.56
	8/23/2006	20.58	7.82	12.76
	11/13/2006	20.58	8.21	12.37
	2/13/2007	20.58	6.14	14.44
	5/15/2007	20.58	7.04	13.54
	8/15/2007	20.58	8.06	12.52

TABLE 2
GROUNDWATER ELEVATIONS
Eagle Gas
4301 San Leandro Street
Oakland, California

Well Name	**Measurement Date**	**TOC in feet AMSL**	**DTW in feet BTOC**	**GWE in feet AMSL**
IS-1	11/13/2007	20.58	7.61	12.97
cont'd	2/19/2008	20.58	6.42	14.16
	6/25/2008	20.58	7.04	13.54
	9/17/2008	**20.58**	**8.85**	**11.73**
IS-2	2/22/2006	20.87	6.92	13.95
	5/16/2006	20.87	6.99	13.88
	8/23/2006	20.78	7.91	12.87
	11/13/2006	20.78	8.23	12.55
	2/13/2007	20.78	6.76	14.02
	5/15/2007	20.78	6.87	13.91
	8/15/2007	20.78	8.08	12.70
	11/14/2007	20.78	7.69	13.09
	2/19/2008	20.78	6.63	14.15
	6/25/2008	20.78	7.21	13.57
	9/17/2008	**20.78**	**8.67**	**12.11**
IS-3	2/22/2006	20.99	7.32	13.67
	5/16/2006	20.99	7.86	13.13
	8/23/2006	20.87	8.19	12.68
	11/13/2006	20.87	8.03	12.84
	2/13/2007	20.87	7.03	13.84
	5/16/2007	20.87	7.17	13.70
	8/15/2007	20.87	8.43	12.44
	11/14/2007	20.87	7.93	12.94
	2/19/2008	20.87	6.01	14.86
	6/25/2008	20.87	6.59	14.28
	9/17/2008	**20.87**	**9.12**	**11.75**
IS-4	2/22/2006	20.79	6.95	13.84
	5/16/2006	20.79	7.17	13.62
	8/23/2006	20.68	7.83	12.85
	11/13/2006	20.68	8.46	12.22
	2/13/2007	20.68	9.02	11.66
	5/15/2007	20.68	6.99	13.69
	8/15/2007	20.68	8.05	12.63
	11/14/2007	20.68	6.38	14.30
	2/19/2008	20.68	6.11	14.57
	6/25/2008	20.68	6.70	13.98
	9/17/2008	**20.68**	**8.59**	**12.09**
IS-5	2/22/2006	21.02	7.17	13.85
	5/16/2006	21.02	6.81	14.21
	8/23/2006	20.91	8.12	12.79
	11/13/2006	20.91	8.41	12.50
	2/13/2007	20.91	6.78	14.13
	5/16/2007	20.91	7.15	13.76
	8/15/2007	20.91	8.32	12.59
	11/16/2007	20.91	7.71	13.20

TABLE 2
GROUNDWATER ELEVATIONS
Eagle Gas
4301 San Leandro Street
Oakland, California

Well Name	Measurement Date	TOC in feet AMSL	DTW in feet BTOC	GWE in feet AMSL
IS-5	2/19/2008	20.91	7.35	13.56
cont'd	6/25/2008	20.91	7.93	12.98
	9/17/2008	**20.91**	**8.96**	**11.95**
IS-6	2/22/2006	20.56	6.89	13.67
	5/16/2006	20.56	6.44	14.12
	8/23/2006	20.47	7.69	12.78
	11/13/2006	20.47	7.72	12.75
	2/13/2007	20.47	6.12	14.35
	5/16/2007	20.47	6.67	13.80
	8/15/2007	20.47	7.91	12.56
	11/14/2007	20.47	7.22	13.25
	2/19/2008	20.47	6.49	13.98
	6/25/2008	20.47	7.07	13.40
	9/17/2008	**20.47**	**8.37**	**12.10**
EW-1	2/22/2006	21.74	8.06	13.68
	5/16/2006	21.74	7.97	13.77
	8/23/2006	21.65	9.61	12.04
	11/13/2006	21.65	8.78	12.87
	2/13/2007	21.65	6.31	15.34
	5/16/2007	21.65	8.13	13.52
	8/16/2007	21.65	8.71	12.94
	11/16/2007	21.65	8.70	12.95
	2/19/2008	21.65	7.71	13.94
	6/25/2008	21.65	8.30	13.35
	9/17/2008	**21.65**	**9.82**	**11.83**
EW-2	2/22/2006	20.46	7.31	13.15
	5/16/2006	20.46	7.25	13.21
	8/23/2006	20.37	8.31	12.06
	11/13/2006	20.37	8.18	12.19
	2/13/2007	20.37	7.15	13.22
	5/16/2007	20.37	7.74	12.63
	8/16/2007	20.37	9.45	10.92
	11/16/2007	20.37	9.64	10.73
	2/19/2008	20.37	7.91	12.46
	6/25/2008	20.37	8.50	11.87
	9/17/2008	**20.37**	**10.24**	**10.13**

Notes:

TOC	Top-of-well casing referenced to arbitrary datum prior to third Quarter 2005. Wells re-surveyed on March 28, 2005.
DTW	Depth to water
AMSL	Above mean sea level
BTOC	Below top of casing
GWE	Groundwater elevation measured in feet above mean sea level
NA	Not Available

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas

4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
MW-1	10/3/2000	**460**	93,000	<500	<500	<500	<500	130,000	<10,000	<10,000	<10,000	<2,000	---	---	---	---
	10/27/2000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	1/26/2001	**1,600***	**51,000**	**270**	<100	<100	<100	**77,000**	<5,000	<5,000	<5,000	<20,000	---	---	---	---
	5/8/2001	**470***	**36,000***	<100	<100	<100	<100	**15,000**	<5,000	<5,000	<5,000	<20,000	---	---	---	---
	8/3/2001	**2,200***	**19,000***	<50	**59**	<50	<50	**96,000**	<5,000	<5,000	<5,000	<20,000	---	---	---	---
	7/1/2003	**3,000**	<25,000	<250	<250	<250	<250	**170,000**	<250	<250	**980**	**8,700**	---	---	---	---
	10/1/2003	**2,600**	<20,000	<200	<200	<200	<200	**69,000**	<200	<200	**270**	**15,000**	---	---	---	---
	2/13/2004	**1,800**	<10,000	<100	<100	<100	<100	**85,000**	<100	<100	**390**	**79,000**	---	---	---	---
	5/17/2004	**5,400**	<15,000	<150	<150	<150	<150	**60,000**	<150	<150	**260**	**160,000**	---	---	---	---
	8/6/2004	**510**	<10,000	<100	<100	<100	<100	**26,000**	<100	<100	**100**	**250,000**	---	---	---	---
	11/12/2004	**3,500**	<5,000	<50	<50	<50	<50	**25,000**	<50	<50	**150**	**160,000**	---	---	---	---
	2/15/2005	**2,900**	<5,000	<50	<50	<50	<50	**12,000**	<50	<50	**70**	**160,000**	---	---	---	---
	5/9/2005	**1,700**	<5,000	<50	<50	<50	<50	**11,000**	<50	<50	**53**	**200,000**	---	---	---	---
	8/8/2005	**2,000**	<5,000	<50	<50	<50	<50	**8,500**	<50	<50	<50	**250,000**	---	---	---	---
	11/16/2005	**3,600**	<5,000	<50	<50	<50	<50	**3,800**	<50	<50	<50	**140,000**	<5,000	<500	<50	<50
	2/22/2006	**2,600**	<5,000	<50	<50	<50	<50	**5,800**	<50	<50	<50	**120,000**	<5,000	<500	<50	<50
	5/16/2006	**4,700**	<5,000	<50	<50	<50	<50	**3,700**	<50	<50	<50	**150,000**	<5,000	<500	<50	<50
	8/23/2006	**2,000**	<5,000	<50	<50	<50	<50	**3,700**	<50	<50	<50	**110,000**	<5,000	<500	<50	<50
	11/13/2006	**NA**	<4,000	<40	<40	<40	<40	**2,000**	<40	<40	<40	**79,000**	NA	NA	NA	NA
	2/13/2007	**900**	<2,500	<25	<25	<25	<25	**3,700**	<25	<25	**25**	**63,000**	NA	NA	NA	NA
	5/15/2007	**3,000**	<2,500	<25	<25	<25	<25	**1,100**	<25	<25	<25	**52,000**	NA	NA	NA	NA
	8/15/2007	**1,000**	<1,000	<10	<10	<10	<10	**230**	<10	<10	<10	**34,000**	NA	NA	NA	NA
	11/13/2007	**170**	<150	<1.5	<1.5	<1.5	<1.5	**630**	<1.5	<1.5	**3.1**	**200**	NA	NA	NA	NA
	2/19/2008	**1,800**	**240**	<1.5	<1.5	**1.7**	**18**	**53**	<1.5	<1.5	<1.5	**2,500**	NA	NA	NA	NA
	6/25/2008	**1,300**	**640**	<0.50	<0.50	<0.50	<0.50	**77**	<0.50	<0.50	**0.6**	**3,800**	NA	NA	NA	NA
	9/17/2008	**2,300**	**430**	<1.5	<1.5	<1.5	<1.5	**86**	<1.5	<1.5	<1.5	**4,100**	NA	NA	NA	NA
MW-1D	11/13/2007	**140**	**71**	<0.50	<0.50	<0.50	<0.50	**600**	<0.50	<0.50	**3.4**	**550**	<50	<5.0	<0.50	<0.50
	11/27/2007	**No groundwater samples collected**														
	2/19/2008	**180**	<50	<0.50	<0.50	<0.50	<0.50	**1.5**	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	6/25/2008	<50	<50	<0.50	<0.50	<0.50	<0.50	**2.8**	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	9/17/2008	<50	<50	<0.50	<0.50	<0.50	<0.50	**1.7**	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas
4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
MW-2	10/3/2000	**210**	**250,000**	<1,250	<1,250	<1,250	<1,250	**400,000**	<25,000	<25,000	<25,000	<100,000	---	---	---	---
	10/27/2000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	1/26/2001	**6,000***	**740,000**	**3,800**	<500	**940**	**1,600**	**1,000,000**	<50,000	<50,000	<50,000	<200,000	---	---	---	---
	5/8/2001	**2,100***	**140,000**	**2,800**	<250	**780**	**640**	**840,000**	<50,000	<50,000	<50,000	<200,000	---	---	---	---
	8/3/2001	**2,600***	**42,000***	**1,100**	**63**	**230**	**130**	**880,000**	<25,000	<25,000	<25,000	<100,000	---	---	---	---
	7/1/2003	**2,200**	<200,000	<2,000	<2,000	<2,000	<2,000	**790,000**	<2,000	<2,000	**3,400**	<20,000	---	---	---	---
	10/1/2003	**870**	<100,000	<1,000	<1,000	<1,000	<1,000	**620,000**	<1,000	<1,000	**2,700**	<20,000	---	---	---	---
	2/13/2004	**1,200**	<20,000	**860**	<200	**260**	<200	**710,000**	<200	<200	**2,000**	<25,000	---	---	---	---
	5/17/2004	**2,500**	<50000	**860**	<500	<500	<500	**760,000**	<500	<500	**2,500**	**13,000J**	---	---	---	---
	8/6/2004	**2,500**	<50000	**590**	<500	<500	<500	**810,000**	<500	<500	**3,600**	**17,000J**	---	---	---	---
	11/12/2004	**500**	<150,000	<1500	<1500	<1500	<1500	**700,000**	<1500	<1500	**2,800**	**25,000J**	---	---	---	---
	2/15/2005	**990**	<150,000	<1,500	<1,500	<1,500	<1,500	**630,000**	<1,500	<1,500	**2,600**	**32,000**	---	---	---	---
	5/9/2005	**1,100**	<150,000	<1,500	<1,500	<1,500	<1,500	**570,000**	<1,500	<1,500	**2,300**	**32,000**	---	---	---	---
	8/8/2005	**770**	<150,000	<1,500	<1,500	<1,500	<1,500	**770,000**	<1,500	<1,500	**2,200**	**85,000**	---	---	---	---
	11/16/2005	**890**	<70,000	<700	<700	<700	<700	**430,000**	<700	<700	**2,100**	**130,000**	<100,000	<7,000	<700	<700
	2/22/2006	<1,500	<70,000	**800**	<700	<700	<700	**400,000**	<700	<700	**1,700**	**130,000**	<70,000	<7,000	<700	<700
	5/16/2006	**1,100**	<70,000	<700	<700	<700	<700	**250,000**	<700	<700	**940**	**140,000**	<70,000	<7,000	<700	<700
	8/23/2006	**660**	<40,000	<400	<400	<400	<400	**200,000**	<400	<400	**830**	**170,000**	<40,000	<4,000	<400	<400
	11/13/2006	**NA**	<40,000	<400	<400	<400	<400	**140,000**	<400	<400	**490**	**170,000**	NA	NA	NA	NA
	2/13/2007	**780**	<20,000	**250**	<200	<200	<200	**100,000**	<200	<200	**240**	**130,000**	NA	NA	NA	NA
	5/16/2007	**800**	<7,000	**150**	<70	<70	<70	**44,000**	<70	<70	**120**	**130,000**	NA	NA	NA	NA
	8/16/2007	**610**	<5,000	**100**	<50	<50	<50	**21,000**	<50	<50	$<80^{++}$	**100,000**	NA	NA	NA	NA
	11/16/2007	**480**	<4,000	**140**	<40	<40	<40	**10,000**	<40	<40	<40	**100,000**	NA	NA	NA	NA
	2/19/2008	**2,600**	**1,400**	**88**	**0.96**	**4.4**	**4.4**	**5,000**	<0.50	**4.6**	**14**	**76,000**	NA	NA	NA	NA
	6/25/2008	**340**	<4,000	<40	<40	<40	<40	**1,300**	<40	<40	<40	**98,000**	NA	NA	NA	NA
	9/18/2008	**370**	**410**	**7.5**	<0.50	**1.8**	**2.7**	**1,200**	<0.50	**4.9**	**2.3**	**120,000**	NA	NA	NA	NA

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas
4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
MW-3	10/3/2000	**120**	**83,000**	<500	<500	<500	<500	**33,000**	<2,500	<2,500	<2,500	<10,000	---	---	---	---
	10/27/2000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	1/26/2001	**900***	**230,000**	**930**	<500	<500	<500	**330,000**	<25,000	<25,000	<25,000	<100,000	---	---	---	---
	5/8/2001	**1,100***	**95,000**	**840**	<250	<250	<250	**390,000**	<12,500	<12,500	<12,500	<50,000	---	---	---	---
	8/3/2001	**290***	**30,000***	<50	**51**	<50	<50	**270,000**	<12,500	<12,500	<12,500	<50,000	---	---	---	---
	7/1/2003	**620**	<50,000	<500	<500	<500	<500	**230,000**	<500	<500	**1,800**	<5,000	---	---	---	---
	10/1/2003	**370**	<20,000	<200	<200	<200	<200	**120,000**	<200	<200	**1,200**	<5,000	---	---	---	---
	2/13/2004	**430**	<20,000	**280**	<200	<200	<200	**210,000**	<200	<200	**1,200**	<5,000	---	---	---	---
	5/17/2004	**920**	<25,000	<250	<250	<250	<250	**150,000**	<250	<250	**1,100**	**5,600J**	---	---	---	---
	8/6/2004	**78**	<20,000	<200	<200	<200	<200	**110,000**	<200	<200	**760**	<2,500	---	---	---	---
	11/12/2004	**120**	<20,000	<200	<200	<200	<200	**100,000**	<200	<200	**660**	**6,000**	---	---	---	---
	2/15/2005	**130**	<25,000	<250	<250	<250	<250	**110,000**	<250	<250	**760**	**12,000**	---	---	---	---
	5/9/2005	**320**	<15,000	<150	<150	<150	<150	**97,000**	<150	<150	**780**	**30,000**	---	---	---	---
	8/8/2005	**180**	<15,000	<150	<150	<150	<150	**75,000**	<150	<150	**500**	**44,000**	---	---	---	---
	11/16/2005	<200	<5,000	<50	<50	<50	<50	**37,000**	<50	<50	**190**	**38,000**	<5,000	<500	<50	<50
	2/22/2006	<600	<5,000	**88**	<50	<50	<50	**57,000**	<50	<50	**420**	**65,000**	<9,000	<500	<50	<50
	5/16/2006	<600^	<9,000	**110**	<90	<90	<90	**42,000**	<90	<90	**340**	**68,000**	<9,000	<900	<90	<90
	8/23/2006	<200^	<4,000	<40	<40	<40	<40	**18,000**	<40	<40	**120**	**60,000**	<4,000	<400	<40	<40
	11/13/2006	NA	<2,000	<20	<20	<20	<20	**6,100**	<20	<20	**30**	**54,000**	NA	NA	NA	NA
	2/13/2007	<200^	<4,000	**52**	<40	<40	<40	**13,000**	<40	<40	**82**	**65,000**	NA	NA	NA	NA
	5/15/2007	<300^	<4,000	**67**	<40	<40	<40	**12,000**	<40	<40	**77**	**71,000**	NA	NA	NA	NA
	8/15/2007	<200^	<4,000	**42**	<40	<40	<40	**4,500**	<40	<40	<40	**64,000**	NA	NA	NA	NA
	11/14/2007	<100	<2,000	**27**	<20	<20	<20	**3,300**	25	<20	<20	**49,000**	NA	NA	NA	NA
	2/19/2008	<300	<2,000	**64**	<20	<20	<20	**3,500**	<20	<20	**31**	**52,000**	NA	NA	NA	NA
	6/25/2008	**140**	<2,000	<20	<20	<20	<20	**1,100**	<20	<20	<20	**54,000**	NA	NA	NA	NA
	9/18/2008	**110**	<900	<9.0	<9.0	<9.0	<9.0	**1,000**	**19**	**<9.0**	**<9.0**	**29,000**	NA	NA	NA	NA

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas
4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
MW-4	2/22/2006	<8,000	<150,000	**3,200**	**2,000**	**1,600**	**3,800**	**770,000**	<1,500	<1,500	**3,300**	**59,000**	<150,000	<15,000	<1,500	<1,500
	5/16/2006	**3,800**	<70,000	**2,100**	<700	**930**	**1,500**	**410,000**	<700	<700	**2,500**	**110,000**	<70,000	<7,000	<700	<700
	8/23/2006	**8,400**	**89,000**	**4,500**	<700	**2,100**	**2,800**	**870,000**	<700	<700	**4,000**	**89,000**	<70,000	<7,000	<700	<700
	11/13/2006	NA	<150,000	**3,700**	<1,500	<1,500	**2,400**	**950,000**	<1,500	<1,500	**4,000**	**110,000**	NA	NA	NA	NA
	2/13/2007	**2,000**	<150,000	**2,000**	<1,500	<1,500	<1,500	**640,000**	<1,500	<1,500	**2,900**	**130,000**	NA	NA	NA	NA
	5/16/2007	**1,900 ^^**	<70,000	**3,200**	<700	**1,000**	**940**	**430,000**	<700	<700	**2,300**	**160,000**	NA	NA	NA	NA
	8/16/2007	**4,400**	<150,000	**2,400**	<1,500	<1,500	<1,500	**630,000**	<1,500	<1,500	**4,300**	**130,000**	NA	NA	NA	NA
	11/16/2007	**2,200**	<70,000	**4,900**	<700	**1,000**	<700	**620,000**	<700	<700	**3,600**	**150,000**	NA	NA	NA	NA
	2/19/2008	**3,200**	<70,000	**3,900**	<700	**1,400**	<1,500	**350,000**	<700	<700	**2,100**	**130,000**	<70,000	<7,000	NA	NA
	6/25/2008	**13,000**	<70,000	**4,000**	<700	<700	<700	**360,000**	<700	<700	**2,300**	**330,000**	NA	NA	NA	NA
	9/18/2008	**7,600**	<40,000	**3,500**	<400	<400	<400	**220,000**	<400	<400	**1,400**	**490,000**	NA	NA	NA	NA
MW-4D	2/21/2006	<50	<90	<0.90	<0.90	<0.90	<0.90	**440**	<0.90	<0.90	**2**	<5.0	<90	<9.0	<0.90	<0.90
	5/16/2006	<50	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	<50	<5.0	<0.50	<0.50
	8/23/2006	<50	<50	<0.50	<0.50	<0.50	<0.50	**1**	<0.50	<0.50	<0.50	<5.0	**93**	**8**	<0.50	<0.50
	11/13/2006	NA	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	2/13/2007	<50	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	5/15/2007	<50	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	8/15/2007	**130 ^^**	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	11/13/2007	<50	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	11/27/2007	**No groundwater samples collected**														
	2/29/2008	**170**	<50	<0.50	<0.50	<0.50	<1.0	**0.64**	<0.50	<0.50	<0.50	<5.0	<50	<5.0	NA	NA
	6/25/2008	<50	<50	<0.50	<0.50	<0.50	<0.50	**7.9**	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	9/17/2008	**72**	<50	<0.50	<0.50	<0.50	<0.50	**5.7**	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA

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Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
MW-5	2/21/2006	<3,000	<10,000	**460**	<100	**170**	<100	**480,000**	<100	<100	**3,000**	**95,000**	<90,000	<1,000	<100	<100
	5/16/2006	**1,600**	<90,000	<900	<900	<900	<900	**480,000**	<900	<900	**2,300**	**130,000**	<90,000	<9,000	<900	<900
	8/23/2006	**1,400**	<90,000	<900	<900	<900	<900	**510,000**	<900	<900	**2,400**	**270,000**	<90,000	<9,000	<900	<900
	11/13/2006	NA	<90,000	<900	<900	<900	<900	**430,000**	<900	<900	**2,200**	**350,000**	NA	NA	NA	NA
	2/13/2007	**1,000**	<50,000	<500	<500	<500	<500	**260,000**	<500	<500	**740**	**350,000**	NA	NA	NA	NA
	5/16/2007	**2,200** ^^	<15,000	**650**	<150	<150	<150	**73,000**	<150	<150	**610**	**240,000**	NA	NA	NA	NA
	8/16/2007	**950**	<25,000	<250	<250	<250	<250	**130,000**	<250	<250	**550**	**620,000**	NA	NA	NA	NA
	11/16/2007	**800**	<15,000	<150	<150	<150	<150	**92,000**	<150	<150	**250**	**300,000**	NA	NA	NA	NA
	2/19/2008	**3,400**	<15000	**160**	<150	<150	<150	**38,000**	<150	<150	<150	**480,000**	NA	NA	NA	NA
	6/25/2008	**850**	<15,000	<150	<150	<150	<150	**33,000**	<150	<150	<150	**520,000**	NA	NA	NA	NA
	9/17/2008	**900**	<15,000	<150	<150	<150	<150	**22,000**	<150	<150	<150	**520,000**	NA	NA	NA	NA
MW-5D	2/21/2006	<50	<50	<0.50	<0.50	<0.50	<0.50	**8**	<0.50	<0.50	<0.50	**6**	<50	<5.0	<0.50	<0.50
	5/16/2006	<50	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	<50	<5.0	<0.50	<0.50
	8/23/2006	<50	<50	<0.50	<0.50	<0.50	<0.50	**56**	<0.50	<0.50	<0.50	<5.0	**120**	**6**	<0.50	<0.50
	11/13/2006	NA	<50	<0.50	<0.50	<0.50	<0.50	**81**	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	2/13/2007	<50	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	5/15/2007	<50	<50	<0.50	<0.50	<0.50	<0.50	**1.1**	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	8/15/2007	**330** ^^	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	11/13/2007	**3,700**	**51**	<0.50	<0.50	<0.50	<0.50	**3.1**	<0.50	<0.50	<0.50	<0.50	NA	NA	NA	NA
	11/27/2007	**No groundwater samples collected**														
	2/19/2008	**12,000**	<50	<0.50	<0.50	<0.50	<0.50	**190**	<0.50	<0.50	**0.83**	**36**	NA	NA	NA	NA
	6/25/2008	**74**	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA
	9/17/2008	**65**	<50	<0.50	<0.50	<0.50	<0.50	**1.1**	<0.50	<0.50	<0.50	<5.0	NA	NA	NA	NA

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas
4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
MW-6	2/22/2006	**2,900**	<10,000	**620**	<100	<100	<100	**50,000**	<100	<100	**210**	**24,000**	<10,000	<1,000	<100	<100
	5/16/2006	**3,200**	<9,000	**1,500**	<90	<90	<90	**50,000**	<90	<90	**280**	**27,000**	<10,000	<900	<90	<90
	8/23/2006	**3,400**	<9,000	**1,600**	<90	<90	<90	**39,000**	<90	<90	**190**	**55,000**	<9,000^{++}	<900	<90	<90
	11/13/2006	**NA**	<5,000	**1,200**	<50	<50	<50	**17,000**	<50	<50	**66**	**71,000**	NA	NA	NA	NA
	2/13/2007	**2,400**	**4,900**	**1,800**	<25	<25	<25	**14,000**	<25	<25	**65**	**55,000**	NA	NA	NA	NA
	5/15/2007	**2,600**	**4,900**	**1,900**	**21**	<20	<20	**12,000**	<20	<20	**55**	**60,000**	NA	NA	NA	NA
	8/15/2007	**2,900**	**4,000**	**1,300**	<20	<20	<20	**7,000**	<20	<20	**32**	**69,000**	NA	NA	NA	NA
	11/14/2007	**2,400**	**5,400**	**2,000**	<20	<20	<20	**3,300**	<20	<20	<20	**63,000**	NA	NA	NA	NA
	2/19/2008	**2,300**	**2,000**	**660**	**6.7**	<1.5	**4.6**	**280**	<1.5	<1.5	**1.7**	**4,500**	NA	NA	NA	NA
	6/25/2008	**2,500**	**2,700**	**880**	<20	<20	<20	**1,400**	<20	<20	<20	**74,000**	NA	NA	NA	NA
	9/17/2008	**No groundwater samples collected, per ACEH**														

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas

4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
MW-7	2/22/2006	**400**	<10,000	<100	<100	<100	<100	**88,000**	<100	<100	**430**	**90,000**	<10,000	<1,000	<100	<100
	5/16/2006	**340**	<5,000	<50	<50	<50	<50	**28,000**	<50	<50	**120**	**47,000**	<5,000	<500	<50	<50
	8/23/2006	**280**	<9,000	<90	<90	<90	<90	**62,000**	<90	<90	**280**	**160,000**	<18,000^{++}	<900	<90	<90
	11/13/2006	NA	<9,000	<90	<90	<90	<90	**49,000**	<90	<90	**280**	**130,000**	NA	NA	NA	NA
	2/13/2007	**210**	<7,000	<70	<70	<70	<70	**33,000**	<70	<70	**170**	**130,000**	NA	NA	NA	NA
	5/15/2007	**250**	<5,000	<50	<50	<50	<50	**36,000**	<50	<50	**190**	**140,000**	NA	NA	NA	NA
	8/15/2007	**390**	<9,000	<90	<90	<90	<90	**37,000**	<90	<90	**170**	**160,000**	NA	NA	NA	NA
	11/14/2007	**310**	<9,000	<90	<90	<90	<90	**45,000**	<90	<90	**220**	**150,000**	NA	NA	NA	NA
	2/19/2008	**190**	<500	<5.0	<5.0	<5.0	<5.0	**3,000**	<5.0	<5.0	**15**	**13,000**	NA	NA	NA	NA
	6/25/2008	**240**	<4,000	<40	<40	<40	<40	**21,000**	<40	<40	**99**	**100,000**	NA	NA	NA	NA
	9/17/2008	**230**	<9,000	<90	<90	<90	<90	**34,000**	<90	<90	**180**	**70,000**	NA	NA	NA	NA
MW-7D	11/13/2007	**760**	<150	<1.5	<1.5	<1.5	<1.5	760	<1.5	<1.5	5.3	7.7J	<150	**31**	<1.5	<1.5
	11/27/2007	No groundwater samples collected														
	2/19/2008	**280**	<150	<1.5	<1.5	<1.5	**2.4**	**1,000**	<1.5	<1.5	**7.5**	**17J**	NA	NA	NA	NA
	6/25/2008	**92**	<100	<1.0	<1.0	<1.0	<1.0	**690**	<1.0	<1.0	**5.9**	**63**	NA	NA	NA	NA
	9/17/2008	**52**	<300	<3.0	<3.0	<3.0	<3.0	**1,300**	<3.0	<3.0	**10**	**24J**	NA	NA	NA	NA

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas
4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
MW-8	2/22/2006	**6,800**	<10,000	**1,200**	<100	**270**	**220**	**400,000**	<100	<100	**2,100**	**63,000**	<300,000	<1,000	<100	<100
	5/16/2006	**3,800**	<90,000	**1,600**	<900	<900	<900	**620,000**	<900	<900	**3,000**	**46,000**	<90,000	<9,000	<900	<900
	8/23/2006	**17,000**	<90,000	**940**	<900	<900	<900	**340,000**	<900	<900	**1,200**	**74,000**	<90,000	<9,000	<900	<900
	11/13/2006	NA	<25,000	**490**	<250	<250	<250	**120,000**	<250	<250	**360**	**130,000**	NA	NA	NA	NA
	2/13/2007	**4,100**	<90,000	**1,700**	<900	<900	<900	**410,000**	<900	<900	**1,700**	**160,000**	NA	NA	NA	NA
	5/16/2007	**3,300**	<50,000	**650**	<500	<500	<500	**190,000**	<500	<500	**750**	**170,000**	NA	NA	NA	NA
	8/16/2007	**4,400**	<25,000	**420**	<250	<250	<250	**150,000**	<250	<250	**460**	**210,000**	NA	NA	NA	NA
	11/16/2007	**89,000**	<25,000	<250	<250	<250	<250	**120,000**	<250	<250	<250	**250,000**	NA	NA	NA	NA
	2/19/2008	**120,000**	<10000	**650**	<100	<100	**160**	**56,000**	<100	<100	**210**	**260,000**	NA	NA	NA	NA
	6/25/2008	**3,200**	<15,000	**210**	<150	<150	<150	**70,000**	<150	<150	**190**	**320,000**	NA	NA	NA	NA
	9/18/2008	**8,300**	<25,000	<250	<250	<250	<250	**100,000**	<250	<250	<250	**450,000**	NA	NA	NA	NA

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas

4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
IS-1	2/22/2006	**4,400**	<5,000	**160**	<50	<50	<50	**21,000**	<50	<50	**64**	**130,000**	<5,000	<500	<50	<50
	5/16/2006	**3,800**	<5,000	**150**	<50	<50	<50	**24,000**	<50	<50	**58**	**130,000**	<5,000	<500	<50	<50
	8/23/2006	**3,800**	<5,000	**65**	<50	<50	<50	**5,800**	<50	<50	<50	**110,000**	<5,000	<500	<50	<50
	11/13/2006	NA	<5,000	<50	<50	<50	<50	**1,000**	<50	<50	<50	**100,000**	NA	NA	NA	NA
	2/13/2007	**1,800**	<4,000	<40	<40	<40	<40	**3,600**	<40	<40	<40	**110,000**	NA	NA	NA	NA
	5/15/2007	**2,000**	<4,000	**49**	<40	<40	<40	**2,800**	<40	<40	<40	**98,000**	NA	NA	NA	NA
	8/15/2007	**2,700**	<4,000	<40	<40	<40	<40	**4,200**	<40	<40	<40	**90,000**	NA	NA	NA	NA
	11/13/2007	**1,400**	<700	<7.0	<7.0	<7.0	<7.0	**470**	<7.0	<7.0	<7.0	25,000	NA	NA	NA	NA
	2/19/2008	**1,800**	**410**	**2.0**	<0.50	<0.50	<0.50	**1,000**	<0.50	**1.8**	**2.7**	80,000	NA	NA	NA	NA
	6/25/2008	**2,500**	<4,000	<40	<40	<40	<40	**3,300**	<40	<40	<40	**94,000**	NA	NA	NA	NA
	9/17/2008	**No groundwater samples collected, per ACEH**														

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GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas
4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
IS-2	2/22/2006	<4,000	**8,600**	**1,200**	<9.0	**240**	**17**	**190,000**	<9.0	**9**	**1,700**	**29,000**	<150,000	<90	<9.0	<9.0
	5/16/2006	<3,000^	<15,000	**500**	<150	<150	<150	**130,000**	<150	<150	**880**	**24,000**	<15,000	<1,500	<150	<150
	8/23/2006	**2,700**	<40,000	**490**	<400	<400	<400	**150,000**	<400	<400	**1,200**	**39,000**	<40,000^{++}	<4,000	<400	<400
	11/13/2006	NA	<40,000	<400	<400	<400	<400	**160,000**	<400	<400	**990**	**120,000**	NA	NA	NA	NA
	2/13/2007	<1,500^	<5,000	**230**	<50	<50	<50	**28,000**	<50	<50	**250**	**72,000**	NA	NA	NA	NA
	5/15/2007	<3,000^	<7,000	**690**	<70	**120**	<70	**35,000**	<70	<70	**370**	**32,000**	NA	NA	NA	NA
	8/15/2007	<3,000^	<7,000	**500**	<70	<70	<70	**20,000**	<70	<70	**160**	**160,000**	NA	NA	NA	NA
	11/14/2007	<4,000	**15,000**	**1,100**	<70	**240**	<70	**29,000**	<70	<70	**380**	**25,000**	NA	NA	NA	NA
	2/19/2008	<3000	**5,300**	**550**	**5.0**	**32**	**7.6**	**7,400**	<0.50	**3.2**	**94**	**65,000**	NA	NA	NA	NA
	6/25/2008	**4,300**	**5,500**	**440**	<40	<40	<40	**3,100**	<40	<40	<40	**110,000**	NA	NA	NA	NA
	9/18/2008	**No groundwater samples collected, per ACEH**														
IS-3	2/22/2006	<4,000	**29,000**	**2,700**	**820**	**1,100**	**2,900**	**750,000**	<100	<100	**3,400**	**40,000**	<80,000	<1,000	<100	<100
	5/16/2006	**8,000**	<20,000	**1,110**	<200	**450**	<200	**300,000**	<200	<200	**1,600**	**65,000**	<20,000	<2,000	<200	<200
	8/23/2006	**4,800**	<50,000	**2,900**	<500	**1,100**	**660**	**970,000**	<500	<500	**3,900**	**54,000**	<50,000	<5,000	<500	<500
	11/13/2006	NA	<200,000	**2,800**	<2,000	<2,000	<2,000	**1,100,000**	<2,000	<2,000	**4,500**	**65,000**	NA	NA	NA	NA
	2/13/2007	<3,000	<150,000	**3,200**	<1,500	<1,500	<1,500	**600,000**	<1,500	<1,500	**3,300**	**49,000**	NA	NA	NA	NA
	5/16/2007	<4,000^	<150,000	**2,900**	<1,500	<1,500	<1,500	**630,000**	<1,500	<1,500	**3,400**	**88,000**	NA	NA	NA	NA
	8/15/2007	<3,000^	<150,000	**2,800**	<1,500	<1,500	<1,500	**960,000**	<1,500	<1,500	**4,300**	**98,000**	NA	NA	NA	NA
	11/14/2007	**1,900**	<150,000	**2,600**	<1,500	<1,500	<1,500	**880,000**	**2,000**	<1,500	**3,600**	**130,000**	NA	NA	NA	NA
	2/19/2008	**1,200**	**2,700**	**660**	**4.8**	**160**	<150	**32,000**	**0.63**	**1.8**	**200**	**3,600**	NA	NA	NA	NA
	6/25/2008	**3,500**	<150,000	**3,600**	<1,500	<1,500	<1,500	**840,000**	<1,500	<1,500	**4,000**	**200,000**	NA	NA	NA	NA
	9/17/2008	**No groundwater samples collected, per ACEH**														
IS-4	2/22/2006	**3,100**	**11,000**	**790**	<100	**120**	<100	**280,000**	<100	<100	**2,400**	**51,000**	<10,000	<1,000	<100	<100
	5/16/2006	**5,600**	<15,000	**610**	<150	<150	<150	**220,000**	<150	<150	**1,700**	**53,000**	<15,000	<1,500	<150	<150
	8/23/2006	**4,300**	**6,100**	**280**	<40	<40	<40	**270,000**	<40	<40	**1,600**	**100,000**	<80,000^{++}	<400	<40	<40
	11/13/2006	NA	<50,000	<500	<500	<500	<500	**230,000**	<500	<500	**1,100**	**220,000**	NA	NA	NA	NA
	2/13/2007	**1,500**	<25,000	**380**	<250	<250	<250	**160,000**	<250	<250	**570**	**250,000**	NA	NA	NA	NA
	5/15/2007	**1,700**	<25,000	<250	<250	<250	<250	**150,000**	<250	<250	**820**	**260,000**	NA	NA	NA	NA
	8/15/2007	**1,000**	<15,000	<150	<150	<150	<150	**85,000**	<150	<150	**360**	**280,000**	NA	NA	NA	NA

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Eagle Gas
4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
	11/14/2007	**760**	<9,000	<90	<90	<90	<90	**45,000**	<90	<90	**220**	**110,000**	NA	NA	NA	NA
	2/19/2008	**1,100**	**980**	**39**	**0.94**	**3.1**	**1.2**	**870**	<0.50	**3.4**	**7.6**	**42,000**	NA	NA	NA	NA
	6/25/2008	**4,000**	<9,000	<90	<90	<90	<90	**6,300**	<90	<90	<90	**300,000**	NA	NA	NA	NA
	9/18/2008	<1,500	**2,600**	**14**	**0.96**	**2.6**	**1.9**	**3,100**	<1.0	**9.1**	**8.4**	**280,000**	NA	NA	NA	NA
IS-5	2/22/2006	**35,000**	**66,000**	**4,100**	<250	**3,100**	**7,700**	**420,000**	<250	<250	**4,600**	**40,000**	<25,000	<2,500	<250	<250
	5/16/2006	**11000+**	**33,000**	**2,800**	<200	**1,700**	**1,900**	**350,000**	<200	<200	**3,400**	**29,000**	<20,000	<2,000	<200	<200
	8/23/2006	**11,000**	**71,000**	**5,200**	<500	**6,200**	**4,500**	**350,000**	<500	<500	**3,900**	**32,000**	<50,000	<5,000	<500	<500
	11/13/2006	NA	<50,000	**930**	<500	<500	<500	**440,000**	<500	<500	**2,800**	**89,000**	NA	NA	NA	NA
	2/13/2007	<5,000	<50,000	**3,600**	<500	**2,200**	**3,800**	**240,000**	<500	<500	**3,600**	**28,000**	NA	NA	NA	NA
	5/16/2007	<5,000^	<50,000	**4,500**	<500	<500	<500	**200,000**	<500	<500	**2,700**	**24,000**	NA	NA	NA	NA
	8/15/2007	<10,000^	<50,000	**4,300**	<500	**2,100**	**990**	**310,000**	<500	<500	**3,400**	**48,000**	NA	NA	NA	NA
	11/16/2007	<5,000	<50,000	**2,100**	<500	**1,900**	**3,600**	**260,000**	<500	<500	**2,600**	**55,000**	NA	NA	NA	NA
	2/19/2008	<18,000	**73,000**	**5,200**	**67**	**2,800**	**5,300**	**110,000**	**1.9**	**8.3**	**2,500**	**250,000**	NA	NA	NA	NA
	6/25/2008	**27,000**	<50,000	**3,400**	<500	**740**	**1,300**	**180,000**	<500	<500	**2,600**	**94,000**	NA	NA	NA	NA
	9/18/2008	**10,000,000**	**680,000**	**2,400**	**50**	**18,000**	**27,000**	**190,000**	<10	**13**	**2,200**	**240,00**	NA	NA	NA	NA
IS-6	2/22/2006	**3,000**	**11,000**	**1,000**	<100	**560**	**180**	**130,000**	<100	<100	**1,400**	**210,000**	<15,000	<1,000	<100	<100
	5/16/2006	**3,300**	<20,000	**1,300**	<200	730	<200	**96,000**	<200	<200	**1,300**	**260,000**	<25,000	<2,500	<200	<200
	8/23/2006	**2,900**	<20,000	**580**	<200	<200	<200	**54,000**	<200	<200	**500**	**370,000**	<20,000	<2,000	<200	<200
	11/13/2006	NA	<9,000	**220**	<90	<90	<90	**20,000**	<90	<90	**170**	**260,000**	NA	NA	NA	NA
	2/13/2007	**1,600**	<9,000	**360**	<90	<90	<90	**28,000**	<90	<90	**210**	**310,000**	NA	NA	NA	NA
	5/16/2007	**1,700**	9,100	**1,400**	<70	300	<70	**21,000**	<70	<70	**240**	**240,000**	NA	NA	NA	NA
	8/15/2007	**1,700**	<9,000	**560**	<90	<90	<90	**8,000**	<90	<90	**100**	**220,000**	NA	NA	NA	NA
	11/14/2007	**880**	<5,000	**200**	<50	<50	<50	**3,700**	<50	<50	**<50**	**190,000**	NA	NA	NA	NA
	2/19/2008	**1,200**	**3,500**	**360**	**2.3**	**41**	**1.6**	**6,100**	**0.66**	**8.6**	**55**	**220,000**	NA	NA	NA	NA
	6/25/2008	**1,900**	<7,000	**200**	<70	<70	<70	**1,600**	<70	<70	<70	**250,000**	NA	NA	NA	NA
	9/17/2008	**No groundwater samples collected, per ACEH**														

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas
4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
EW-1	2/22/2006	**3,200**	<150,000	**3,100**	<1,500	<1,500	<1,500	**700,000**	<1,500	<1,500	**5,100**	**59,000**	<150,000	<15,000	<1,500	<1,500
	5/16/2006	**1,600**	<100,000	**2,000**	<1,000	<1,000	<1,000	**630,000**	<1,000	<1,000	**4,700**	**57,000**	<100,000	<10,000	<1,000	<1,000
	8/23/2006	**2,600**	<150,000	**2,200**	<1,500	<1,500	<1,500	**1,000,000**	<1,500	<1,500	**5,200**	**79,000**	<150,000	<15,000	<1,500	<1,500
	11/13/2006	NA	<100,000	<1,000	<1,000	<1,000	<1,000	**610,000**	<1,000	<1,000	**4,000**	**110,000**	NA	NA	NA	NA
	2/13/2007	**840**	<70,000	**1,200**	<700	<700	<700	**530,000**	<700	<700	**2,500**	**100,000**	NA	NA	NA	NA
	5/16/2007	**1,500**	<70,000	**1,700**	<700	<700	<700	**990,000**	<700	<700	**3,900**	**150,000**	NA	NA	NA	NA
	8/16/2007	**1,400**	<80,000	**1,900**	<800	<800	<800	**680,000**	<800	<800	**3,400**	**210,000**	NA	NA	NA	NA
	11/16/2007	**860**	<70,000	<700	<700	<700	<700	**440,000**	<700	<700	**1,700**	**280,000**	NA	NA	NA	NA
	2/19/2008	**800**	<25000	**340**	**1.5**	<250	<250	**300,000**	<5.0	**26**	**1,200**	**340,000**	NA	NA	NA	NA
	6/25/2008	**1,200**	<40,000	**580**	<400	<400	<400	**260,000**	<400	<400	**1,100**	**450,000**	NA	NA	NA	NA
	9/17/2008	**No groundwater samples collected, per ACEH**														

TABLE 3
GROUNDWATER SAMPLE ANALYTICAL RESULTS
Eagle Gas
4301 San Leandro Street
Oakland, California

Sample Name	Sample Date	TPH-d (µg/L)	TPH-g (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	DIPE (µg/L)	ETBE (µg/L)	TAME (µg/L)	TBA (µg/L)	Methanol (µg/L)	Ethanol (µg/L)	DCA (µg/L)	EDB (µg/L)
ESL (µg/L)		**640**	**500**	**46**	**130**	**290**	**100**	**1,800**	--	--	--	**18,000**	--	**50,000**	**200**	**150**
EW-2	2/22/2006	<3,000	**10,000**	**1,800**	<100	**700**	**670**	**120,000**	<100	<100	**1,200**	**36,000**	<80,000	<1,000	<100	<100
	5/16/2006	<3,000^	<25,000	**2,400**	<250	**1,110**	**880**	**180,000**	<250	<250	**1,400**	**45,000**	<25,000	<2,500	<250	<250
	8/23/2006	<2,000	<25,000	**1,600**	<250	**520**	<250	**120,000**	<250	<250	**930**	**35,000**	<25,000	<2,500	<250	<250
	11/13/2006	NA	<10,000	**610**	<100	**170**	<100	**60,000**	<100	<100	**380**	**25,000**	NA	NA	NA	NA
	2/13/2007	<2,000	<15,000	**1,100**	<150	**230**	<150	**81,000**	<150	<150	**700**	**49,000**	NA	NA	NA	NA
	5/16/2007	<3,000^	**9,900**	**1,700**	<50	**460**	**170**	**96,000**	<50	<50	**870**	**65,000**	NA	NA	NA	NA
	8/16/2007	<2,000^	<15,000	**1,300**	<150	**250**	<150	**100,000**	<150	<150	**700**	**75,000**	NA	NA	NA	NA
	11/16/2007	<1,500	**8,100**	**820**	**5.5**	**190**	**91**	**30000**	<0.50	**4.6**	**230**	**47000**	NA	NA	NA	NA
	2/19/2008	<2000	**11,000**	**1,500**	<50	**610**	**300**	**78,000**	<50	<50	**590**	**130,000**	NA	NA	NA	NA
	6/25/2008	**1,600**	<5,000	**730**	<50	<50	<50	**11,000**	<50	<50	**120**	**130,000**	NA	NA	NA	NA
	9/18/2008	**1,300**	<5,000	**310**	<50	<50	<50	**3,500**	<50	<50	<50	**160,00**	NA	NA	NA	NA

Notes:

NA	Not analyzed.
TPH-d	Total petroleum hydrocarbons as diesel by EPA Method 8015 (modified)
TPH-g	Total petroleum hydrocarbons as gasoline by EPA Method 8260B
BTEX	Benzene, toluene, ethylbenzene, total xylenes by EPA Method 8260B
MTBE	Methyl tertiary butyl ether by EPA Method 8260B
DIPE	Di-isopropyl ether by EPA Method 8260B
ETBE	Ethyl tertiary butyl ether by EPA Method 8260B
TAME	Tertiary amyl methyl ether by EPA Method 8260B
TBA	Tertiary butyl alcohol by EPA Method 8260B
DCA	1,2-Dichloroethane
EDB	1,2-Dibromoethane
ESL	Environmental Screening Levels for deep soils and groundwater that are not a current or potential source of drinking water; San Francisco Bay Regional Water Quality Control Board, February 2005
ACEH	Alameda County Environmental Health Department
(µg/L)	Micrograms per liter
#	See Well Gauging/Purging Calculation Data Sheets for date of depth to groundwater measurement
<50	Not detected in concentrations above indicated laboratory reporting limit.
J	Estimated quantity because the MTBE-to-TBA ratio is greater than 20 to 1.
---	No samples collected, no data available
--	Not provided
*	Laboratory note: "Results within quantitation range; chromatographic pattern not typical of fuel."
^	The method reporting limit for TPH-d is increased due to interference from gasoline-range hydrocarbons.
^^	Petroleum hydrocarbons reported as TPH-d do not exhibit a typical Diesel chromatogram pattern; they have a lower boiling point than typical Diesel fuel.
++	The method reporting limit has been increased due to the presence of an interfering compound.

ATTACHMENTS

ATTACHMENT A

Site Investigation History

Site Investigation History

Eagle Gas Station
4301 San Leandro Street
Oakland, California 94601
LOP Site ID# 2118
USTCF Claim No. 014551
Clearwater Project No. ZP046M

On April 21 and 22, 1999, Clearwater (formerly Artesian Environmental) oversaw the removal of five underground storage tanks (USTs) consisting of two 6,000-gallon gasoline tanks, two 4,000-gallon diesel tanks, and one 300-gallon used-oil tank from the site. Strong petroleum hydrocarbon odors were reportedly observed emanating from the excavation pit of the USTs. Five soil samples and three groundwater samples were collected from the UST excavation for confirmation sampling after completion of the UST excavation. Field observations and laboratory analysis indicated that an unauthorized release of petroleum hydrocarbons had occurred. The former UST excavation is shown in **Figure 2** of the Second Quarter 2008 Quarterly Monitoring Report and was defined by driven steel shoring installed to protect the on-site and off-site buildings prior to the field activities.

In a letter dated May 10, 1999, Alameda County Environmental Health Services (ACEH) staff recommended that the soil at the site be remediated by over-excavation and that "as much groundwater as possible" be pumped from the excavation. Approximately 800 tons of petroleum hydrocarbon-impacted soil were excavated and disposed of as Class II non-hazardous waste, and approximately 1,000 gallons of petroleum hydrocarbon-impacted groundwater were pumped and removed from the site. Groundwater did not recharge quickly after the initial pumping. Existing on-site and off-site structures and associated shoring limited the amount of soil that could be safely excavated. Soil samples collected from the excavation walls and product-piping trenches indicated that residual concentrations of petroleum hydrocarbons and methyl-tert-butyl-ether (MTBE) remained.

On August 4 and 5, 1999, approximately 100 linear feet of product piping were removed. Vent piping from between the former USTs and the southern corner of the on-site building was also removed. All piping was cut up and disposed of as scrap metal. On August 5, 1999, six confirmation soil samples were collected along the piping trench approximately 3 feet below ground surface (bgs). In addition, one soil sample was collected from each of the four former fuel dispensers. Laboratory analytical results indicated that petroleum hydrocarbon impacts remained along the piping trenches.

On September 26, 2000, West Hazmat of Rancho Cordova, California, used a CME 75 drill rig to advance three borings to approximately 25 feet bgs and collect soil samples. The three borings were completed as groundwater-monitoring wells **(Figure 2)** using clean, flush-threaded, 2-inch diameter polyvinyl chloride (PVC) for the well casing. The construction data for these three wells are presented in **Table 1**.

On October 3 and 10, 2000, Clearwater surveyed the top-of-the-casing (TOC) elevation of each of the wells relative to an arbitrary datum and developed the wells for monitoring purposes. Initial groundwater samples collected from these wells contained 83,000 micrograms per liter (µg/L) to 250,000 µg/L total petroleum hydrocarbon as gasoline (TPH-g) and 33,000 µg/L to 400,000 µg/L MTBE.

On August 3, 2001, Clearwater submitted its *Groundwater Monitoring Report—Second Quarter 2001* and *Sensitive Receptor Survey and Workplan for Continuing Investigation.* It was determined, at that time, that there were no major ecological receptors, permanent surface waters, or domestic-use wells within a 2,000-foot radius of the site. The proposed scope of the workplan included the installation of eight groundwater-monitoring wells around the site to delineate the MTBE plume in groundwater. In response to Clearwater's workplan, ACEH staff, in correspondence dated October 18, 2001, recommended postponing the installation of the additional off-site wells. Instead, ACEH staff requested that further characterization of subsurface soils and groundwater on the subject site be completed prior to the installation of any off-site wells.

Quarterly monitoring was suspended after the Third Quarter 2001 event on August 3, 2001. Quarterly monitoring resumed in July 2003 and has since continued. The historical groundwater elevation and analytical results are listed in **Table 2.**

On January 9, 2004, after completing the review of the *Third Quarter 2003 Groundwater Monitoring Report*, ACEH staff requested a workplan that included additional on-site and off-site subsurface investigations to address the extent of groundwater impacts on the site. Clearwater submitted its *Interim Remedial Action Plan* (IRAP), as requested by ACEH staff, on January 14, 2004.

ACEH staff provided review comments for the IRAP and the *First Quarter 2005 Groundwater Monitoring Report* in a letter dated May 26, 2005. Pursuant to the ACEH request described in this letter, Clearwater submitted a *Soil and Groundwater Investigation Workplan* on August 10, 2005. In review letters dated September 21, 2005, and November 1, 2005, ACEH approved the implementation of a modified IRAP proposed in Clearwater's June 13, 2005, letter entitled *Recommendations for Interim Remedial Actions* and the August 10, 2005, *Soil and Groundwater Investigation Workplan.* On the basis of the recommendations made in the above-mentioned documents and correspondences, Clearwater installed 15 additional on-site wells between December 15 and December 20, 2005, and conducted Geoprobe® soil sampling from December 6 to December 9, 2005, and from March 29 to April 2, 2006. In order to monitor the extent of groundwater impacts and the magnitude of vertical migration of contaminants in deeper groundwater, two deep-zone monitoring wells (MW-4D and MW-5D) were installed. These wells were screened between 35 and 45 feet bgs. The construction data for these new wells are presented in **Table 1**. All the wells were surveyed by Clearwater using a global positioning system (GPS) and laser level on March 16 and 28, 2006.

On the basis of apparent on-site groundwater mounding and unusually steep on-site groundwater gradients, ACEH staff requested a check of the groundwater elevation data. Each well's horizontal position was originally determined using a GPS survey in 2005. Clearwater field-checked the well locations of all the groundwater monitoring wells on August 18, 2006, using a 100-foot-long cloth tape. The horizontal distances between wells were measured, and the well positions were triangulated from these measurements. Several well locations were adjusted slightly on the base map; the revised base map with the resurveyed well locations is shown on **Figure 2** and has been used throughout reports generated since that time.

The TOC elevations of all the wells were remeasured on September 12, 2006, using a survey level and survey staff, accurate to within 1/100th of a foot. The TOC elevation for well MW-1 (northwest corner of site) was the starting datum, and the TOC elevation for all the other wells was calculated as the relative difference from MW-1's TOC elevation. The surveyed TOC elevations were compared with the previously used TOC elevations, which were determined using a laser level. The relative difference in TOC elevation for each well was determined. The maximum vertical difference was found to be 0.12 foot for well IS-3. **Table 2** presents the original elevation values up to May 9, 2005, followed by the resurveyed TOC elevations after that date. The overall groundwater gradient pattern did not significantly change after completion of the monitoring well resurvey.

Sampling analysis for *Escherichia coli* (*E. coli*), total coliform, and water treatment byproducts as residual chlorine was performed in November 2006 on groundwater samples obtained from wells IS-5, MW-8, and MW-7 in an attempt to identify whether on-site groundwater mounding could be caused by water and/or sewer line leaks; both *E. coli* and total coliform were present in IS-5 and MW-8, and water treatment byproducts were present in IS-5, MW-8, and MW-7. Leak testing was performed, and both a crack and an off-set in the sewer line were identified to exist near well IS-1. The sampling results for the *E. coli*, total coliform, and water treatment byproducts were reported in the *Quarterly Groundwater Monitoring Report - Fourth Quarter 2006*, and the sewer line leak test results were reported in the *Quarterly Groundwater Monitoring Report - First Quarter 2007.*

On May 30, 2006, Clearwater submitted its *Soil and Groundwater Investigation Report* to the ACEH, which included an updated Site Conceptual Model for the site. In response to the report, ACEH requested a Workplan to present proposed additional on- and off-site investigations. ACEH staff also provided Technical Comments to be addressed in the Workplan. Clearwater's *Response to Comments* was sent to ACEH on July 7, 2006.

ACEH responded with an August 11, 2006, letter with revised Technical Comments to be incorporated into the Workplan. Clearwater submitted its *Revised Workplan* to the ACEH on December 19, 2006. ACEH responded in a letter dated January 4, 2007, with Technical

Comments, which were to be addressed and incorporated during the field investigation. Submittal of an additional, revised, Workplan was not requested by ACEH staff.

A *Bioremediation Feasibility Study Report* (Feasibility Report) was submitted July 9, 2007. The Feasibility Report concluded that the bioremediation parameters suggest an environment that is generally anaerobic and reducing. It appears that the general lack of sufficient oxygen and essential nutrients is limiting the degradation of the petroleum hydrocarbons.

Clearwater submitted its *2007 Soil and Groundwater Investigation Report* (2007 Report) to the ACEH on December 5, 2007. The scope of work presented in the 2007 Report included an inspection of the on-site sanitary sewer lateral, driving and sampling of 15 off-site soil borings, driving of 2 cone-penetrometer test (CPT) borings, installation of additional on-site "deep-zone" groundwater monitoring wells MW-1D and MW-7D, installation and sampling of 6 shallow soil vapor wells, surveying of 8 well and 15 boring locations using a GPS, and collection of soil samples for a persulfate bench test.

The 2007 Report included a revised Site Conceptual Model (SCM). In the new SCM, the depth of the contact between the clayey gravel layer and the underlying soil has been revised. The site lithology can be conceptually divided into an upper, shallow zone and a lower, deep zone. The shallow-zone is generally more clay-rich and the deep zone is generally coarser grained. The separation between the two zones varies from 25 to 30 feet bgs. The groundwater within the shallow-zone is highly contaminated, whereas the groundwater within the deep zone is relatively less contaminated. Grab groundwater samples collected from off-site borings indicate that the groundwater contamination within both zones extends offsite and that the extent of contamination has not been defined in either zone.

Clearwater generated the groundwater elevation contour diagrams for the 2007 Report using the same depth-to-water data used for this Fourth Quarter 2007 Groundwater Monitoring Event. With this data set the groundwater elevation contour diagram for the shallow zone was consistent with previously reported quarterly groundwater elevation contour diagrams. The groundwater elevation contour diagrams for the deep zone were generated on November 13, 2007, using data from wells MW-1D, MW-4D, MW-5D, and MW-7D. Because the deep zone groundwater elevation contour pattern did not conform with the shallow zone groundwater elevation pattern, the depths to groundwater of deep zone wells were measured a second time November 27, 2007. Both sets of measurements indicated a partial groundwater depression, with a groundwater flow direction toward the north.

Clearwater submitted its *2008 Soil and Groundwater Investigation Work Plan* (2008 Work Plan) to the ACEH on July 2, 2008. The 2008 Work Plan proposed conducting an offsite passive soil vapor survey, installing additional groundwater monitoring wells, determining whether the 42nd Avenue freeway on-ramp is a groundwater discharge area, and performing a high-vacuum dual phase extraction pilot test. The ACEH approved the 2008 Work Plan in a letter dated September

4, 2008. However, the ACEH did not concur with the proposed passive soil vapor sampling survey.

To date, two access agreements have been acquired to allow the installation of groundwater monitoring wells on adjacent and nearby properties. The finalized design and location of the on-site High Vacuum Dual Phase Extraction test and observation wells will be submitted to the ACEH for review in the near future.

ATTACHMENT B

Alameda County Environmental Health Services Letter, September 4, 2008

ALAMEDA COUNTY
HEALTH CARE SERVICES
AGENCY
DAVID J. KEARS, Agency Director

ENVIRONMENTAL HEALTH SERVICES
ENVIRONMENTAL PROTECTION
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577
(510) 567-6700
FAX (510) 337-9335

September 4, 2008

Ms. Farah Naz c/o
Mr. Muhammad Jamil
40092 Davis Street
Fremont, CA 94538

Subject: Fuel Leak Case No. RO0000096 and Geotracker Global ID T0600143649, Eagle Gas, 4301 San Leandro Street, Oakland, CA 94601

Dear Ms. Naz:

Alameda County Environmental Health (ACEH) staff has reviewed the fuel leak case file for the above-referenced site including the recently submitted document entitled, "*2008 Soil and Groundwater Investigation Work Plan*," dated July 2, 2008 and received by ACEH on July 17, 2008. The Work Plan proposes:

- conducting an off-site passive soil vapor survey;
- installing off-site wells and one on-site well;
- determining whether the 42nd Avenue freeway on-ramp is a groundwater discharge area;
- performing a high-vacuum dual phase extraction (DPE) pilot test.

The proposed scope of work is generally acceptable with the exception of the proposed off-site passive soil vapor survey. As discussed in technical comment 1, we do not concur with the implementation of the proposed passive soil vapor survey. Well installation, determining whether the 42nd Avenue freeway on-ramp is a groundwater discharge area, and the DPE pilot test may be implemented provided that the technical comments below are addressed and incorporated during field implementation of the proposed activities. We request that you address the following technical comments, perform the proposed work, and send us the reports described below.

TECHNICAL COMMENTS

1. **Proposed Passive Soil Vapor Sampling (Gore Sorber®) Survey.** The proposed passive soil vapor sampling (Gore Sorber®) survey is proposed largely within areas where soil and groundwater sampling was previously conducted. The purpose of many of the proposed lines of passive soil vapor samples appears to be corroboration of previous soil and groundwater sampling results. Since the soil and grab groundwater sample data provide much more direct evidence of contamination than the proposed passive soil vapor sampling survey, corroboration of the soil and grab groundwater sample data does not appear to add significant value to the investigation. Therefore, we do not concur with the proposed passive soil vapor sampling (Gore Sorber®) survey. If you choose to implement the passive soil vapor survey, we recommend that the State Water Resources Control Board UST Cleanup Fund not reimburse you for the costs.

2. **Proposed Monitoring Wells.** The proposed locations for monitoring wells MW-3D, MW-9, MW-9D, MW-10, and MW-10D are acceptable. Pilot soil borings that are continuously sampled for logging purposes or CPT borings are to be used to select filter pack and screen intervals for the wells. In order to prevent the potential for cross-contamination, filter packs and screen intervals must not extend between shallow first-encountered groundwater and lower permeable intervals. In no case shall the filter pack or screen interval for the shallow wells extend below a depth of 25 feet bgs. The deeper wells shall be installed within the lower permeable unit typically encountered at depths of approximately 35 to 45 feet bgs and must not have screen intervals longer than 10 feet. Please present documentation of the well installation in the DPE Pilot Test Report below. Groundwater sampling results are to be incorporated into the quarterly groundwater monitoring reports requested below.

3. **Groundwater Monitoring Program.** The proposed elimination of quarterly groundwater sampling of wells MW-6, IS-1, IS-2, IS-3, IS-6, and EW-1 is approved. Please submit future groundwater monitoring results in the reports requested below.

4. **Dual-Phase Extraction Pilot Test.** The proposal to install one extraction well and three observation wells to conduct a DPE pilot test is generally acceptable and may be implemented. We concur with the proposal to install one extraction well and three observation wells for the proposed dual-phase extraction (DPE) pilot test. Targeting the clayey gravel layer for the DPE pilot testing is acceptable. However, our previous January 10, 2008 requested further discussion of the rationale for installation of the screen interval for the extraction well as shallow as 3.5 feet bgs. Review of historical soil analytical data indicates that most of the mass of contamination appears to be in the zone of seasonal water table fluctuations between depths of approximately 8 to 14 feet bgs. We request that the top of the screen interval for the DPE extraction and observation wells be no shallower than 5 feet bgs. If you disagree with this request and wish to proceed with installation of extraction and observation wells with well screens as shallow as 3.5 feet bgs, you must provide further justification including a discussion of the shallow contamination that is being targeted, how the potential for short circuiting with the surface will be addressed, and any additional steps that will be taken to assure the integrity of the surface seal. Please present results from the DPE pilot test in the Well Installation and DPE Pilot Test Report requested below.

5. **Sewer System Leaks.** As discussed in Appendix H of the 2007 Soil and Groundwater Investigation Report, two leaks were found in the sewer line from the station building. Please report on progress in repairing the leaks in the reports requested below.

6. **Potential Discharge to 42nd Avenue.** Please present the drawings of the 42nd Avenue On-ramp and your plans for evaluating whether contaminated groundwater from the site is discharging to this area in the Well Installation and DPE Pilot Test Report requested below.

TECHNICAL REPORT REQUEST

Please submit technical reports to Alameda County Environmental Health (Attention: Jerry Wickham), according to the following schedule:

- **November 5, 2008** – Third Quarter 2008 Groundwater Monitoring Report

- **January 11, 2009** – Well Installation and DPE Pilot Test Report
- **February 5, 2009** – Fourth Quarter 2008 Groundwater Monitoring Report
- **May 5, 2009** – First Quarter 2009 Groundwater Monitoring Report
- **August 5, 2009** – Second Quarter 2009 Groundwater Monitoring Report

These reports are being requested pursuant to California Health and Safety Code Section 25296.10. 23 CCR Sections 2652 through 2654, and 2721 through 2728 outline the responsibilities of a responsible party in response to an unauthorized release from a petroleum UST system, and require your compliance with this request.

ELECTRONIC SUBMITTAL OF REPORTS

ACEH's Environmental Cleanup Oversight Programs (LOP and SLIC) require submission of reports in electronic form. The electronic copy replaces paper copies and is expected to be used for all public information requests, regulatory review, and compliance/enforcement activities. Instructions for submission of electronic documents to the Alameda County Environmental Cleanup Oversight Program FTP site are provided on the attached "Electronic Report Upload Instructions." Submission of reports to the Alameda County FTP site is an addition to existing requirements for electronic submittal of information to the State Water Resources Control Board (SWRCB) Geotracker website. In September 2004, the SWRCB adopted regulations that require electronic submittal of information for all groundwater cleanup programs. For several years, responsible parties for cleanup of leaks from underground storage tanks (USTs) have been required to submit groundwater analytical data, surveyed locations of monitoring wells, and other data to the Geotracker database over the Internet. Beginning July 1, 2005, these same reporting requirements were added to Spills, Leaks, Investigations, and Cleanup (SLIC) sites. Beginning July 1, 2005, electronic submittal of a complete copy of all reports for all sites is required in Geotracker (in PDF format). Please visit the SWRCB website for more information on these requirements (http://www.swrcb.ca.gov/ust/cleanup/electronic_reporting).

PERJURY STATEMENT

All work plans, technical reports, or technical documents submitted to ACEH must be accompanied by a cover letter from the responsible party that states, at a minimum, the following: "I declare, under penalty of perjury, that the information and/or recommendations contained in the attached document or report is true and correct to the best of my knowledge." This letter must be signed by an officer or legally authorized representative of your company. Please include a cover letter satisfying these requirements with all future reports and technical documents submitted for this fuel leak case.

PROFESSIONAL CERTIFICATION & CONCLUSIONS/RECOMMENDATIONS

The California Business and Professions Code (Sections 6735, 6835, and 7835.1) requires that work plans and technical or implementation reports containing geologic or engineering evaluations and/or judgments be performed under the direction of an appropriately registered or certified professional. For your submittal to be considered a valid technical report, you are to present site specific data, data interpretations, and recommendations prepared by an appropriately licensed professional and include the professional registration stamp, signature, and statement of professional certification. Please ensure all that all technical reports submitted for this fuel leak case meet this requirement.

UNDERGROUND STORAGE TANK CLEANUP FUND

Please note that delays in investigation, later reports, or enforcement actions may result in your becoming ineligible to receive grant money from the state's Underground Storage Tank Cleanup Fund (Senate Bill 2004) to reimburse you for the cost of cleanup.

AGENCY OVERSIGHT

If it appears as though significant delays are occurring or reports are not submitted as requested, we will consider referring your case to the Regional Board or other appropriate agency, including the County District Attorney, for possible enforcement actions. California Health and Safety Code, Section 25299.76 authorizes enforcement including administrative action or monetary penalties of up to $10,000 per day for each day of violation.

If you have any questions, please call me at (510) 567-6791 or send me an electronic mail message at jerry.wickham@acgov.org.

Sincerely,

Jerry Wickham

Jerry Wickham, California PG 3766, CEG 1177, and CHG 297
Senior Hazardous Materials Specialist

Enclosure: ACEH Electronic Report Upload (ftp) Instructions

cc: Leroy Griffin, Oakland Fire Department, 250 Frank H. Ogawa Plaza, Ste. 3341, Oakland, CA 94612-2032

Robert Nelson, Clearwater Group, 229 Tewksbury Avenue, Point Richmond, CA 94801

Donna Drogos, ACEH
Jerry Wickham, ACEH
File

Alameda County Environmental Cleanup Oversight Programs (LOP and SLIC)	**ISSUE DATE:** July 5, 2005 **REVISION DATE:** December 16, 2005 **PREVIOUS REVISIONS:** October 31, 2005
SECTION: Miscellaneous Administrative Topics & Procedures	**SUBJECT:** Electronic Report Upload (ftp) Instructions

Effective **January 31, 2006**, the Alameda County Environmental Cleanup Oversight Programs (LOP and SLIC) require submission of all reports in electronic form to the county's ftp site. Paper copies of reports will no longer be accepted. The electronic copy replaces the paper copy and will be used for all public information requests, regulatory review, and compliance/enforcement activities.

REQUIREMENTS

- Entire report including cover letter must be submitted to the ftp site as a **single portable document format (PDF) with no password protection.** (Please do not submit reports as attachments to electronic mail.)
- It is **preferable** that reports be converted to PDF format from their original format, (e.g., Microsoft Word) rather than scanned.
- Signature pages and perjury statements **must** be included and have either original or electronic signature.
- **Do not password protect the document.** Once indexed and inserted into the correct electronic case file, the document will be secured in compliance with the County's current security standards and a password. **Documents with password protection will not be accepted.**
- Each page in the PDF document should be rotated in the direction that will make it easiest to read on a computer monitor.
- Reports must be named and saved using the following naming convention:
  RO#_Report Name_Year-Month-Date (e.g., RO#5555_WorkPlan_2005-06-14)

Additional Recommendations

- A separate copy of the tables in the document should be submitted by e-mail to your Caseworker in **Excel** format. These are for use by assigned Caseworker only.

Submission Instructions

1) Obtain User Name and Password:
   a) Contact the Alameda County Environmental Health Department to obtain a User Name and Password to upload files to the ftp site.
      i) Send an e-mail to dehloptoxic@acgov.org
      or
      ii) Send a fax on company letterhead to (510) 337-9335, to the attention of Alicia Lam-Finneke.
   b) In the subject line of your request, be sure to include **"ftp PASSWORD REQUEST"** and in the body of your request, include the **Contact Information, Site Addresses,** and the **Case Numbers (RO# available in Geotracker) you will be posting for.**

2) Upload Files to the ftp Site
   a) Using Internet Explorer (IE4+), go to ftp://alcoftp1.acgov.org
      (i) Note: Netscape and Firefox browsers will not open the FTP site.
   b) Click on File, then on Login As.
   c) Enter your User Name and Password. (Note: Both are Case Sensitive.)
   d) Open "My Computer" on your computer and navigate to the file(s) you wish to upload to the ftp site.
   e) With both "My Computer" and the ftp site open in separate windows, drag and drop the file(s) from "My Computer" to the ftp window.

3) Send E-mail Notifications to the Environmental Cleanup Oversight Programs
   a) Send email to dehloptoxic@acgov.org notify us that you have placed a report on our ftp site.
   b) Copy your Caseworker on the e-mail. Your Caseworker's e-mail address is the entire first name then a period and entire last name at acgov.org. (e.g., firstname.lastname@acgov.org)
   c) The subject line of the e-mail must start with the RO# followed by **Report Upload.** (e.g., Subject: RO1234 Report Upload)

ATTACHMENT C

Groundwater Monitoring and Sampling Field Procedures

CLEARWATER GROUP

Groundwater Monitoring and Sampling Field Procedures

Groundwater Monitoring

Prior to beginning purging tasks or sampling, a decontamination area is established. Decontamination procedures consist of scrubbing downhole equipment in an Alconox® solution wash (wash solution is pumped through any purging pumps used), and rinsing in a first rinse of potable water and a second rinse of potable water or deionized water if the latter is required. Any non-dedicated downhole equipment is decontaminated prior to use.

Prior to gauging, purging, and sampling a well, caps for all on-site wells are opened to allow atmospheric pressure to equalize the water levels if local groundwater is under confined or semi-confined conditions. The static water level is measured to the nearest 0.01± foot with an electronic water sounder. Depth to bottom is measured during each monitoring event, at the request of the project manager, and during Clearwater's first visit to a site. The water sounder and tape will be decontaminated between each well. Floating separate-phase hydrocarbons (SPH) where suspected or observed will be collected using a clear, open-ended product bailer, and the thickness is measured to the nearest 0.01 feet in the bailer. SPH may alternatively be measured with an electronic interface probe. Any monitoring well containing a measurable thickness of SPH before or during purging is not additionally purged, and no sample is collected from that well. Wells containing hydrocarbon sheen are sampled, unless otherwise specified by the project manager. Field observations of well integrity, water level, and floating product thicknesses are noted on the Well Gauging/Purging Calculations Data Sheet.

Well Purging

Each monitoring well to be sampled is purged using either a PVC bailer or a submersible pump. Physical parameters (pH, temperature, and conductivity) of the purge water are monitored during purging activities to assess if the water sample collected is representative of the aquifer. If required, parameters such as dissolved oxygen, turbidity, salinity, etc. are also measured. Samples are considered representative if parameter stability is achieved. Stability is defined as a change of less than 0.25 pH units, less than 10% change in conductivity in micro mhos, and less than 1.0 degree centigrade (1.8 degrees Fahrenheit) change in temperature. Parameters are measured in a discrete sample decanted from the bailer separately from the rest of the purge water. Parameters are measured at least four times during purging: initially, and at purging volume intervals of one casing volume. Purging continues until three well casing volumes have been removed or until the well completely dewaters. Wells that dewater or demonstrate a slow recharge rate may be sampled after fewer than three well volumes have been removed. Well purging information is recorded on the Purge Data Sheet. All meters used to measure parameters are calibrated daily. Investigation-derived wastes (purge and rinseate water) are handled in one of three ways: 1) Purge and rinseate water is sealed, labeled, and stored on site in D.O.T.-approved 55-gallon drums. After being chemically profiled, the water is removed to an appropriate disposal facility. 2) Purge and rinseate water is collected into a 250-gallon portable holding tank and transported to the Clearwater equipment yard in Point Richmond, CA. At the yard, the investigation-derived waste is then transferred to 55-gallon drums pending disposal at an appropriate disposal facility, or 3) Purge and rinseate water is collected in a 250-gallon portable holding tank and transported to the appropriate disposal facility. The applicable method will be indicated in the field log sheets and the corresponding technical report.

Groundwater Sample Collection

Groundwater samples are collected immediately after purging, with the following exception: If the purging rate exceeds well recharge rate, samples are collected when the well has recharged to at least 80% of its static water level. If recharge is extremely slow, the well is allowed to recharge for at least two hours, if practicable, or until sufficient volume for sampling has accumulated. The well is sampled within 24 hours of purging or is re-purged. Samples are collected using polyethylene bailers, either disposable or dedicated to the well. Samples being analyzed for compounds most sensitive to volatilization are collected first. Water samples are placed in appropriate laboratory-supplied containers (glass or plastic ware depending on the analysis), labeled, documented on a chain-of-custody form and placed on ice in a chilled cooler for transport to a state-certified analytical laboratory. Analytical detection limits match or surpass standards required by relevant local or regional guidelines.

Quality Assurance Procedures

To prevent contamination or cross contamination of the samples, Clearwater personnel adhere to the following procedures in the field:

- A new, clean pair of latex gloves is put on prior to sampling each well.
- Wells are gauged and purged and groundwater samples are collected in the expected order of increasing degree of contamination based on historical analytical results.
- All purging equipment is thoroughly decontaminated between each well, using the procedures previously described at the beginning of this section.
- During sample collection for volatile organic analysis, the amount of air passing through the sample is minimized. This helps prevent the air from stripping the volatiles from the water. Sample bottles are filled by slowly running the liquid being sampled down the inside wall of the bottle until there is a convex meniscus over the mouth of the bottle. The lid is carefully screwed onto the bottle such that no air bubbles are present within the bottle. If a bubble is present, the cap is removed and additional liquid is added to the sample container. After resealing the sample container, if bubbles still are present inside, the sample container is discarded and the procedure is repeated with a new container.

Laboratory and field handling procedures may be monitored, if required by the client or regulators, by including quality control (QC) samples for analysis with the groundwater samples. Examples of different types of QC samples are as follows:

- Trip blanks are prepared at the analytical laboratory by laboratory personnel to check field handling procedures. Trip blanks are transported to the project site in the same manner as the laboratory-supplied sample containers to be filled. They are not opened and are returned to the laboratory with the samples collected. Trip blanks are analyzed for purgeable organic compounds.
- Equipment blanks are prepared in the field to determine if decontamination of field sampling equipment has been effective. The sampling equipment used to collect the groundwater samples is rinsed with distilled water that is then decanted into laboratory-supplied containers. The equipment blanks are transported to the laboratory and are analyzed for the same chemical constituents as the samples collected at the site.
- Duplicates are collected at the same time standard groundwater samples are collected; they are analyzed for the same compounds in order to verify the reproducibility of laboratory data. They are usually collected from only one well per sampling event. The duplicate is assigned an identification number that will not associate it with the source well.

Generally, trip blanks and field blanks verify field handling and transportation procedures. Duplicates verify laboratory procedures. The configuration of QC samples is determined by Clearwater depending on site conditions and regulatory requirements.

ATTACHMENT D

Well Gauging/Purging Calculation Data Sheets and Purge Date Sheets

CLEARWATER GROUP

229 Tewksbury Avenue,
Point Richmond, CA 94801
Tel: (510) 307-9943 Fax: (510) 232-2823

WELL GAUGING/PURGING CALCULATIONS DATA SHEET

Date: 9-17-08

Job No.: ZP046M

Location: 4301 San Leandro St, Oakland, CA.

Tech(s): Eric V Austin / Diego Fumes

Drums on Site @ TOA/TOD

Soil: 0 Water: 0

Total number of DRUMS used for this event

Soil: 0 Water: 3

Well No.	Diameter (in)	DTB (ft)	DTW (ft)	ST (ft)	CV (gal)	PV (gal)	SPL (ft)	Notes
Mw-5D	2 inch	42.50	6.11	36.39	5.82	17.46	—	
Mw-4D	2 inch	42.13	17.36	24.77	3.96	11.88	—	
Mw-1D	2 inch	43.50	15.77	27.73	4.44	13.20	—	
Mw-1	2 inch	24.53	8.45	16.08	2.57	7.71	—	
IS-1	2 inch	24.86	8.85					DTW only
Mw-7D	2 inch	28.30	17.24	11.06	1.77	5.31	—	
Mw-7	2 inch	25.90	13.68	12.22	1.96	5.88	—	
Mw-3	2 inch	23.00	12.82	10.18	1.63	4.89	—	

Explanation:

DTB = Depth to Bottom
DTW = Depth to Water
ST = Saturated Thickness (DTB-DTW) must be > 1 foot
CV = Casing Volume (ST x cf)
PV = Purge Volume (standard 3 x CV, well development 10 x CV)
SPL = Thickness of Separate Phase Liquid

Conversion Factors (cf)

2-inch diameter well cf = 0.16 gal/ft
4-inch diameter well cf = 0.65 gal/ft
6-inch diameter well cf = 1.44 gal.ft

Well No.	Diameter (in)	DTB (ft)	DTW (ft)	ST (ft)	CV (gal)	PV (gal)	SPL (ft)	Notes
Mw-6	2 inch	25.30	11.76	→				DTW-Only
TS-2	2 inch	25.32	8.67	→				DTW-Only
TS-4	2 inch	24.90	8.59	16.31	2.61	7.83	—	
TS-6	2 inch	25.35	8.37	→				DTW-only
TS-3	2 inch	24.25	9.12	→				DTW-only
TS-5	2 inch	14.30	8.96	5.34	0.85	2.55	1 inch of	Product (oily
Ew-2	4 inch	25.20	10.24	14.96	9.72	29.16	—	
Mw-2	2 inch	24.59	14.76	9.83	1.57	4.71	—	
Mw-4	2 inch	24.51	9.66	14.85	2.38	7.14	—	
Ew-1	4 inch	25.09	9.82	→				DTW-only
Mw-5	2 inch	25.51	8.35	17.16	2.75	8.25	—	
Mw-8	2 inch	24.60	9.24	15.36	2.46	7.38	Small Amount	of oil

133.35

15 gallons Decon H2O

148 gallons

xplanation:

TB = Depth to Bottom
TW = Depth to Water
T = Saturated Thickness (DTB-DTW) must be > 1 foot
V = Casing Volume (ST x cf)
V = Purge Volume (standard 3 x CV, well development 10 x CV)
PL = Thickness of Separate Phase Liquid

Conversion Factors (cf)

2-inch diameter well cf = 0.16 gal/ft
4-inch diameter well cf = 0.65 gal/ft
6-inch diameter well cf = 1.44 gal.ft

PURGE DATA SHEET

No.: 2PC46M **Location:** 4301 San Leandro St **Date:** 9/17/08 **Sheet** 1 **of** 7

Tech: Eric V. Austin
Diego Funes

WELL #	TIME	VOL. (gal.)	ORP	CND (µ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe_T
w-5D	9:30	5.00	112.8	678	65.77	5.34	7.34		
purge	9:45	10.00	131.5	686	65.92	5.61	6.89		
ne 17.40	10:00	17.00	139.1	692	65.95	6.25	6.89		

Sample for: 5oxys/TBA

[✓ TPHg] [✓ TPHd] 8260

[✓ BTEX] [✓ MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Brown, Moderate, Poor, No sheen & No Odor

POST DEPTH TO WATER: NA

SAMPLE TIME: 10:15

WELL #	TIME	VOL. (gal.)	ORP	CND (µ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe_T
w-4d	10:30	4.00	146.5	693	64.68	6.23	7.49		
purge	10:45	8.00	150.9	702	65.18	6.10	6.94		
e 11.88	11.00	12.00	149.2	700	65.16	6.01	7.44		

Sample for: 5oxys/TBA

[✓ TPHg TPHd] 8260

[✓ BTEX MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Tan, Low, Poor, No sheen & No odor

POST DEPTH TO WATER: NA

SAMPLE TIME: 11:15

Clearwater Group, Inc. - 229 Tewksbury Avenue, Point Richmond, California 94801
Phone : (510) 307-9943 Fax : (510) 232-2823

H:/Department/World/Purge Data Sheet Updated 06.xls

PURGE DATA SHEET

Job No.: ZPOY611 Location: 4301 San Leandro St. Oakland, CA Sheet 2 of 7

Date: 9-17-08 Tech: Eric Wallsted / Diego Funes

WELL #	TIME	VOL. (gal.)	ORP	CND (μ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe_T
Mw-1D	11:20	5.00	153.5	705	67.18	5.95	7.49		
Calc. purge	11:30	10.00	153.6	702	67.07	6.20	7.52		
volume 13.20	11:40	13.00	154.8	702	67.15	6.11	7.44		

Sample for: 5oxy/TBA

[✓ TPHg TPHd] 8260

[✓ BTEX MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Brown, Moderate, OK, No sheen, & No Odor

POST DEPTH TO WATER: NA

SAMPLE TIME: 12:00

Job No.:

Location:

Date:

Tech:

WELL #	TIME	VOL. (gal.)	ORP	CND (μ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe_T
Mw-1	12:15	2.00	9.5	715	68.72	3.21	7.43		
Calc. purge	12:25	5.00	6.2	714	69.35	2.98	7.16		
volume 7.71	12:40	8.00	-3.7	706	68.56	1.99	6.98		

Sample for: 5oxy/TBA

[✓ TPHg TPHd] 8260

[✓ BTEX MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Lt. Gray, Low, OK, Has sheen & Has Odor

POST DEPTH TO WATER: NA

SAMPLE TIME: 13:00

PURGE DATA SHEET

No.: ZP046M **Location:** 430 San Leandro St. Oakland, CA **Date:** 9-1708 Sheet 3 of 7

Tech: Eric Austin
Diego Funes

WELL #	**TIME**	**VOL. (gal.)**	**ORP**	**CND (µ/cm)**	**TMP (°F)**	**DO (mg/L)**	**pH**	**Fe^{2+}**	**Fe_T**
w-7d	12:55	1.00	-0.8	838	66.64	2.85	7.45		
purge	13:05	3.00	1.9	842	66.70	2.72	7.39		
ne 5.31	13:15	5.00	28.7	858	66.29	3.27	7.07		

Sample for: 5oxys/TBA

[✓ TPHg] [✓ TPHd] 8260

[✓ BTEX] [✓ MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Tan, low, OK, No sheen - slight Odor

POST DEPTH TO WATER: NA SAMPLE TIME: 13:30

WELL #	**TIME**	**VOL. (gal.)**	**ORP**	**CND (µ/cm)**	**TMP (°F)**	**DO (mg/L)**	**pH**	**Fe^{2+}**	**Fe_T**
w-7	13:25	2.00	40.9	1329	68.81	2.57	6.62		
ourge	13:35	4.00	37.9	1369	68.54	2.37	6.77		
e 5.88	13:45	6.00	32.4	1359	68.29	2.83	7.41		

Sample for: 5oxys/TBA

[✓ TPHg] [✓ TPHd] 8260

[✓ BTEX] [✓ MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Clear, low, OK, No sheen & No Odor

POST DEPTH TO WATER: NA SAMPLE TIME: 14:00

Clearwater Group, Inc. - 229 Tewksbury Avenue, Point Richmond, California 94801
Phone : (510) 307-9943 Fax : (510) 232-2823

PURGE DATA SHEET

Job No.: 2P046M **Location:** 4301 San Leandro St, Oakland, CA **Date:** 9/18/08 **Sheet** 4 of 7

Tech: Eric V. Austin Diego Evans

WELL #	TIME	VOL. (gal.)	ORP	CND (μ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe$_T$
MW-3	8:10	1.00	113.1	746	69.30	3.80	7.50		
Calc. purge	8:20	3.00	112.9	772	69.62	3.37	7.18		
volume 4.89	8:30	5.00	102.0	772	68.34	3.12	7.19		

Sample for: 5oxys/TBA

~~TPHg~~ [✓ TPHd] 8260

[✓ BTEX MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Lt. Gray, Low, Poor, No sheen & No Odor

POST DEPTH TO WATER: NA SAMPLE TIME: 8:45

Job No.: **Location:** **Date:** **Tech:**

WELL #	TIME	VOL. (gal.)	ORP	CND (μ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe$_T$
FS-4	8:40	2.00	9.6	1031	69.18	4.60	6.84		
Calc. purge	8:50	5.00	-8.1	1068	70.68	2.83	6.77		
volume 7.83	9:00	8.00	-11.1	988	67.45	2.43	6.82		

Sample for: 5oxys/TBA

~~TPHg~~ [✓ TPHd] 8260

[✓ BTEX MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Gray, Low, OK, No sheen & No Odor

POST DEPTH TO WATER: NA SAMPLE TIME: 9:15

PURGE DATA SHEET

No.: ZPO10M Location: 4301 San Leandro St. Oakland, CA Date: 9/18/08

Sheet 5 of 7

Tech: Eric V. Anglin
Diego Tamez

WELL #	TIME	VOL. (gal.)	ORP	CND (µ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe$_T$
S-5	9:20	1.00	-20.4	1044	66.28	5.10	6.73		
purge	9:25	2.00	-37.7	1081	67.01	1.91	6.62		
ne 2.55	9:30	3.00	-39.3	1087	67.08	1.80	6.61		

Sample for: 5oxys/TBA

[✓ TPHg] [✓ TPHd] 8260

[✓ BTEX] [✓ MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Dk Gray, High, Poor, Has sheen, odor & Product about 1inch of Oily

POST DEPTH TO WATER: NA SAMPLE TIME: 9:45

WELL #	TIME	VOL. (gal.)	ORP	CND (µ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe$_T$
Ew-2	9:49	10.00	-27.7	925	65.52	3.88	6.71		
purge	10:29	20.00	-15.8	883	64.67	6.29	6.70		
e 29.16	11:17	29.00	-8.6	879	62.74	4.99	6.73		

Sample for: 5oxys/TBA

[✓ TPHg TPHd] 8260

[✓ BTEX MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Gray, Moderate, very Poor, slight sheen, No Odor

POST DEPTH TO WATER: NA SAMPLE TIME: 11:30

Clearwater Group, Inc. - 229 Tewksbury Avenue, Point Richmond, California 94801
Phone : (510) 307-9943 Fax : (510) 232-2823

H:/Department/World/Purge Data Sheet Updated 06.xls

PURGE DATA SHEET

Job No.: ZP046m **Location:** 4301 San Leandro St. Oakland, Ca. **Sheet** 6 **of** 7

Date: 9-18-08 **Tech:** Eric V. Austin Diego Funes

WELL #	TIME	VOL. (gal.)	ORP	CND (µ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe_T
Mw-2	11:42	1.00	4.7	783	64.52	5.10	6.77		
Calc. purge	11:50	3.00	-8.3	795	64.10	4.73	6.70		
volume 4.71	11:58	5.00	-12.7	795	64.01	3.95	6.74		

Sample for: 5oxys/TBA

[✓ TPHg] [✓ TPHd] 8260

[✓ BTEX] [✓ MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Lt. Gray, Low, OK, No sheen & Has Odor

POST DEPTH TO WATER: NA

SAMPLE TIME: 12:15

Job No.: **Location:**

Date: **Tech:**

WELL #	TIME	VOL. (gal.)	ORP	CND (µ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe_T
Mw-4	12:13	2.00	-41.5	1147	67.10	4.96	6.74		
Calc. purge	12:20	4.00	-55.5	1189	66.48	2.21	6.75		
volume 7.14	12:30	7.00	-67.1	1193	66.32	0.76	6.67		

Sample for: 5oxys, /TBA

[✓ TPHg] [✓ TPHd] 8260

[✓ BTEX] [✓ MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor DK Gray, High, OK, No sheen & Has Oder

POST DEPTH TO WATER: NA

SAMPLE TIME: 12:45

PURGE DATA SHEET

No.: ZP046M Location: 4301 San Leandro St. Oakland, CA Date: 9-18-08 Sheet 7 of 7

Tech: Eric V. Austin Diego Torres

WELL #	TIME	VOL. (gal.)	ORP	CND (µ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe$_T$	
w-5	12:55	2.00	-64.2	1128	72.50	4.76	6.61			Sample for: 5oxys, TBA
purge	13:06	5.00	-65.8	1131	72.48	4.40	6.60			[✓ TPHg] [✓ TPHd] 8260
ne 8.25	13:14	8.00	-47.2	1112	71.12	3.71	6.64			[✓ BTEX] [✓ MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer]

COMMENTS: color, turbidity, recharge, sheen, odor Gray, Moderate, OK, No sheen & No odor

POST DEPTH TO WATER: NA SAMPLE TIME: 13:30

WELL #	TIME	VOL. (gal.)	ORP	CND (µ/cm)	TMP (°F)	DO (mg/L)	pH	Fe^{2+}	Fe$_T$	
w-8	13:50	2.00	-30.3	1229	67.46	4.44	6.75			Sample for: 5oxys/TBA
purge	14:00	5.00	-36.7	1234	67.52	3.68	6.68			[✓ TPHg] [✓ TPHd] 8260
ne 7.38	14:09	7.00	-40.3	1241	67.48	3.31	6.62			[✓ BTEX] [✓ MTBE] Metals

Purging Method: PVC Bailer / Pump / [✓ Disp. Bailer] Small amount of oil Product -

COMMENTS: color, turbidity, recharge, sheen, odor Lt Gray, low —, OK, Has shee, Stong Odor

POST DEPTH TO WATER: NA SAMPLE TIME: 14:30

Clearwater Group, Inc. - 229 Tewksbury Avenue, Point Richmond, California 94801
Phone : (510) 307-9943 Fax : (510) 232-2823

H:/Department/World/Purge Data Sheet Updated 06.xls *updated on 9/23/2008 by ht*

CLEARWATER
GROUP

229 Tewksbury Avenue,
Point Richmond, CA 94801
Tel: (510) 307-9943 Fax: (510) 232-2823

WELL GAUGING/PURGING CALCULATIONS
DATA SHEET

Date: 9-22-2008

Job No.: ZB046M 3Q08

Location: Eagle Gas 4301 San Leandro Ave, Oak

Tech(s): Robert L. Nelson

Drums on Site @ TOA/TOD

Soil:

Water:

Total number of DRUMS used for this event

Soil:

Water:

Well No.	Diameter (in)	DTB (ft)	DTW (ft)	ST (ft)	CV (gal)	PV (gal)	SPL (ft)	Notes Time
MW-1D	2"		15.68					1554
MW-4D	2"		17.23					1600
MW5D	2"		16.00					1607
MW-7D	2"		17.39					1610

RLN 9-22-2008

Explanation:
DTB = Depth to Bottom
DTW = Depth to Water
ST = Saturated Thickness (DTB-DTW) must be > 1 foot
CV = Casing Volume (ST x cf)
PV = Purge Volume (standard 3 x CV, well development 10 x CV)
SPL = Thickness of Separate Phase Liquid

Conversion Factors (cf)
2-inch diameter well cf = 0.16 gal/ft
4-inch diameter well cf = 0.65 gal/ft
6-inch diameter well cf = 1.44 gal.ft

H:/Department/World/Well Gauging Spread Sheet Updated 06.xls

ATTACHMENT E

Kiff analytical Report #64876 with Chain-of-Custody Documents

KIFF
Analytical LLC

Report Number : 64876
Date : 09/26/2008

Rob Nelson
Clearwater Group, Inc.
229 Tewksbury Avenue
Point Richmond, CA 94801

Subject : 14 Water Samples
Project Name : NAZ Eagle Gas
Project Number : ZP046M

Dear Mr. Nelson,

Chemical analysis of the samples referenced above has been completed. Summaries of the data are contained on the following pages. Sample(s) were received under documented chain-of-custody. US EPA protocols for sample storage and preservation were followed.

Kiff Analytical is certified by the State of California (# 2236). If you have any questions regarding procedures or results, please call me at 530-297-4800.

Sincerely,

Joel Kiff

KIFF
Analytical LLC

Report Number : 64876
Date : 09/26/2008

Subject :	14 Water Samples
Project Name :	NAZ Eagle Gas
Project Number :	ZP046M

Case Narrative

The Method Reporting Limit for Diisopropyl ether has been increased due to the presence of an interfering compound for sample IS-4.

Tert-Butanol results for sample MW-7d may be biased slightly high and are flagged with a 'J'. A fraction of MtBE (typically less than 1%) converts to Tert-Butanol during the analysis of water samples. We consider this conversion effect to be mathematically significant in samples that contain MtBE/Tert-Butanol in ratios of over 20:1.

Matrix Spike/Matrix Spike Duplicate results associated with sample EW-2 for the analyte Tert-Butanol were affected by the analyte concentrations already present in the un-spiked sample.

Matrix Spike/Matrix Spike Duplicate results associated with samples MW-5 and MW-8 for the analyte Methyl-t-butyl ether were affected by the analyte concentrations already present in the un-spiked sample.

KIFF Analytical LLC

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-5d**
Matrix : Water
Lab Number : 64876-01
Sample Date :09/17/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Toluene	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Ethylbenzene	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Total Xylenes	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Methyl-t-butyl ether (MTBE)	**1.1**	0.50	ug/L	EPA 8260B	09/22/2008
Diisopropyl ether (DIPE)	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Ethyl-t-butyl ether (ETBE)	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Tert-amyl methyl ether (TAME)	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Tert-Butanol	**< 5.0**	5.0	ug/L	EPA 8260B	09/22/2008
TPH as Gasoline	**< 50**	50	ug/L	EPA 8260B	09/22/2008
1,2-Dichloroethane-d4 (Surr)	101		% Recovery	EPA 8260B	09/22/2008
Toluene - d8 (Surr)	99.7		% Recovery	EPA 8260B	09/22/2008
TPH as Diesel	**65**	50	ug/L	M EPA 8015	09/25/2008
Octacosane (Diesel Surrogate)	101		% Recovery	M EPA 8015	09/25/2008

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-4d**
Matrix : Water
Lab Number : 64876-02
Sample Date :09/17/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Toluene	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Ethylbenzene	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Total Xylenes	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Methyl-t-butyl ether (MTBE)	**5.7**	0.50	ug/L	EPA 8260B	09/22/2008
Diisopropyl ether (DIPE)	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Ethyl-t-butyl ether (ETBE)	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Tert-amyl methyl ether (TAME)	**< 0.50**	0.50	ug/L	EPA 8260B	09/22/2008
Tert-Butanol	**< 5.0**	5.0	ug/L	EPA 8260B	09/22/2008
TPH as Gasoline	**< 50**	50	ug/L	EPA 8260B	09/22/2008
1,2-Dichloroethane-d4 (Surr)	102		% Recovery	EPA 8260B	09/22/2008
Toluene - d8 (Surr)	100		% Recovery	EPA 8260B	09/22/2008
TPH as Diesel	**72**	50	ug/L	M EPA 8015	09/25/2008
(Note: Discrete peaks in Diesel range, atypical for Diesel Fuel.)					
Octacosane (Diesel Surrogate)	117		% Recovery	M EPA 8015	09/25/2008

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-1d**
Matrix : Water
Lab Number : 64876-03
Sample Date :09/17/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**< 0.50**	0.50	ug/L	EPA 8260B	09/23/2008
Toluene	**< 0.50**	0.50	ug/L	EPA 8260B	09/23/2008
Ethylbenzene	**< 0.50**	0.50	ug/L	EPA 8260B	09/23/2008
Total Xylenes	**< 0.50**	0.50	ug/L	EPA 8260B	09/23/2008
Methyl-t-butyl ether (MTBE)	**1.7**	0.50	ug/L	EPA 8260B	09/23/2008
Diisopropyl ether (DIPE)	**< 0.50**	0.50	ug/L	EPA 8260B	09/23/2008
Ethyl-t-butyl ether (ETBE)	**< 0.50**	0.50	ug/L	EPA 8260B	09/23/2008
Tert-amyl methyl ether (TAME)	**< 0.50**	0.50	ug/L	EPA 8260B	09/23/2008
Tert-Butanol	**< 5.0**	5.0	ug/L	EPA 8260B	09/23/2008
TPH as Gasoline	**< 50**	50	ug/L	EPA 8260B	09/23/2008
1,2-Dichloroethane-d4 (Surr)	101		% Recovery	EPA 8260B	09/23/2008
Toluene - d8 (Surr)	97.4		% Recovery	EPA 8260B	09/23/2008
TPH as Diesel	**< 50**	50	ug/L	M EPA 8015	09/25/2008
Octacosane (Diesel Surrogate)	102		% Recovery	M EPA 8015	09/25/2008

KIFF
Analytical LLC

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-1**
Sample Date :09/17/2008

Matrix : Water

Lab Number : 64876-04

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**< 1.5**	1.5	ug/L	EPA 8260B	09/25/2008
Toluene	**< 1.5**	1.5	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	**< 1.5**	1.5	ug/L	EPA 8260B	09/25/2008
Total Xylenes	**< 1.5**	1.5	ug/L	EPA 8260B	09/25/2008
Methyl-t-butyl ether (MTBE)	**86**	1.5	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	**< 1.5**	1.5	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	**< 1.5**	1.5	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	**< 1.5**	1.5	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	**4100**	7.0	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	**430**	150	ug/L	EPA 8260B	09/25/2008
1,2-Dichloroethane-d4 (Surr)	106		% Recovery	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	106		% Recovery	EPA 8260B	09/25/2008
TPH as Diesel	**2300**	50	ug/L	M EPA 8015	09/25/2008
Octacosane (Diesel Surrogate)	103		% Recovery	M EPA 8015	09/25/2008

KIFF Analytical LLC

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-7d**
Matrix : Water
Lab Number : 64876-05
Sample Date :09/17/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**< 3.0**	3.0	ug/L	EPA 8260B	09/25/2008
Toluene	**< 3.0**	3.0	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	**< 3.0**	3.0	ug/L	EPA 8260B	09/25/2008
Total Xylenes	**< 3.0**	3.0	ug/L	EPA 8260B	09/25/2008
Methyl-t-butyl ether (MTBE)	**1300**	3.0	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	**< 3.0**	3.0	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	**< 3.0**	3.0	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	**10**	3.0	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	**24 J**	15	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	**< 300**	300	ug/L	EPA 8260B	09/25/2008
1,2-Dichloroethane-d4 (Surr)	104		% Recovery	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	112		% Recovery	EPA 8260B	09/25/2008
TPH as Diesel	**52**	50	ug/L	M EPA 8015	09/23/2008
Octacosane (Diesel Surrogate)	99.6		% Recovery	M EPA 8015	09/23/2008

Report Number : 64876

Date : 09/26/2008

Project Name : **NAZ Eagle Gas**

Project Number : **ZP046M**

Sample : **MW-7**

Matrix : Water

Lab Number : 64876-06

Sample Date :09/17/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**< 90**	90	ug/L	EPA 8260B	09/25/2008
Toluene	**< 90**	90	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	**< 90**	90	ug/L	EPA 8260B	09/25/2008
Total Xylenes	**< 90**	90	ug/L	EPA 8260B	09/25/2008
Methyl-t-butyl ether (MTBE)	**34000**	90	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	**< 90**	90	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	**< 90**	90	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	**180**	90	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	**70000**	500	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	**< 9000**	9000	ug/L	EPA 8260B	09/25/2008
1,2-Dichloroethane-d4 (Surr)	103		% Recovery	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	112		% Recovery	EPA 8260B	09/25/2008
TPH as Diesel	**230**	50	ug/L	M EPA 8015	09/24/2008
Octacosane (Diesel Surrogate)	103		% Recovery	M EPA 8015	09/24/2008

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-3**
Matrix : Water
Lab Number : 64876-07
Sample Date :09/18/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**< 9.0**	9.0	ug/L	EPA 8260B	09/26/2008
Toluene	**< 9.0**	9.0	ug/L	EPA 8260B	09/26/2008
Ethylbenzene	**< 9.0**	9.0	ug/L	EPA 8260B	09/26/2008
Total Xylenes	**< 9.0**	9.0	ug/L	EPA 8260B	09/26/2008
Methyl-t-butyl ether (MTBE)	**1000**	9.0	ug/L	EPA 8260B	09/26/2008
Diisopropyl ether (DIPE)	**19**	9.0	ug/L	EPA 8260B	09/26/2008
Ethyl-t-butyl ether (ETBE)	**< 9.0**	9.0	ug/L	EPA 8260B	09/26/2008
Tert-amyl methyl ether (TAME)	**< 9.0**	9.0	ug/L	EPA 8260B	09/26/2008
Tert-Butanol	**29000**	50	ug/L	EPA 8260B	09/26/2008
TPH as Gasoline	**< 900**	900	ug/L	EPA 8260B	09/26/2008
1,2-Dichloroethane-d4 (Surr)	99.8		% Recovery	EPA 8260B	09/26/2008
Toluene - d8 (Surr)	102		% Recovery	EPA 8260B	09/26/2008
TPH as Diesel	**110**	50	ug/L	M EPA 8015	09/23/2008
Octacosane (Diesel Surrogate)	102		% Recovery	M EPA 8015	09/23/2008

Report Number : 64876

Date : 09/26/2008

Project Name : **NAZ Eagle Gas**

Project Number : **ZP046M**

Sample : **IS-4**

Matrix : Water

Lab Number : 64876-08

Sample Date :09/18/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**14**	0.50	ug/L	EPA 8260B	09/22/2008
Toluene	**0.96**	0.50	ug/L	EPA 8260B	09/22/2008
Ethylbenzene	**2.6**	0.50	ug/L	EPA 8260B	09/22/2008
Total Xylenes	**1.9**	0.50	ug/L	EPA 8260B	09/22/2008
Methyl-t-butyl ether (MTBE)	**3100**	250	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	**< 1.0**	1.0	ug/L	EPA 8260B	09/22/2008
Ethyl-t-butyl ether (ETBE)	**9.1**	0.50	ug/L	EPA 8260B	09/22/2008
Tert-amyl methyl ether (TAME)	**8.4**	0.50	ug/L	EPA 8260B	09/22/2008
Tert-Butanol	**280000**	1500	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	**2600**	50	ug/L	EPA 8260B	09/22/2008
1,2-Dichloroethane-d4 (Surr)	97.8		% Recovery	EPA 8260B	09/22/2008
Toluene - d8 (Surr)	96.0		% Recovery	EPA 8260B	09/22/2008
TPH as Diesel	**< 1500**	1500	ug/L	M EPA 8015	09/23/2008
(Note: MRL increased due to interference from Gasoline-range hydrocarbons.)					
Octacosane (Diesel Surrogate)	108		% Recovery	M EPA 8015	09/23/2008

KIFF Analytical LLC

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **IS-5**
Matrix : Water
Lab Number : 64876-09
Sample Date :09/18/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**2400**	10	ug/L	EPA 8260B	09/25/2008
Toluene	**50**	10	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	**18000**	150	ug/L	EPA 8260B	09/26/2008
Total Xylenes	**27000**	150	ug/L	EPA 8260B	09/26/2008
Methyl-t-butyl ether (MTBE)	**190000**	500	ug/L	EPA 8260B	09/26/2008
Diisopropyl ether (DIPE)	**< 10**	10	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	**13**	10	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	**2200**	10	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	**240000**	700	ug/L	EPA 8260B	09/26/2008
TPH as Gasoline	**680000**	15000	ug/L	EPA 8260B	09/26/2008
1,2-Dichloroethane-d4 (Surr)	104		% Recovery	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	102		% Recovery	EPA 8260B	09/25/2008
TPH as Diesel	**< 10,000,000**	10000000	ug/L	M EPA 8015	09/26/2008

(Note: MRL increased due to interference from Gasoline-range hydrocarbons.)

Octacosane (Diesel Surrogate)	Diluted Out		% Recovery	M EPA 8015	09/26/2008

KIFF Analytical LLC

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **EW-2**
Matrix : Water
Lab Number : 64876-10
Sample Date :09/18/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**310**	50	ug/L	EPA 8260B	09/25/2008
Toluene	**< 50**	50	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	**< 50**	50	ug/L	EPA 8260B	09/25/2008
Total Xylenes	**< 50**	50	ug/L	EPA 8260B	09/25/2008
Methyl-t-butyl ether (MTBE)	**3500**	50	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	**< 50**	50	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	**< 50**	50	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	**< 50**	50	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	**160000**	250	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	**< 5000**	5000	ug/L	EPA 8260B	09/25/2008
1,2-Dichloroethane-d4 (Surr)	98.6		% Recovery	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	97.9		% Recovery	EPA 8260B	09/25/2008
TPH as Diesel	**1300**	50	ug/L	M EPA 8015	09/23/2008
Octacosane (Diesel Surrogate)	85.9		% Recovery	M EPA 8015	09/23/2008

KIFF
Analytical LLC

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-2**
Matrix : Water
Lab Number : 64876-11
Sample Date :09/18/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**7.5**	0.50	ug/L	EPA 8260B	09/23/2008
Toluene	**< 0.50**	0.50	ug/L	EPA 8260B	09/23/2008
Ethylbenzene	**1.8**	0.50	ug/L	EPA 8260B	09/23/2008
Total Xylenes	**2.7**	0.50	ug/L	EPA 8260B	09/23/2008
Methyl-t-butyl ether (MTBE)	**1200**	50	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	**< 0.50**	0.50	ug/L	EPA 8260B	09/23/2008
Ethyl-t-butyl ether (ETBE)	**4.9**	0.50	ug/L	EPA 8260B	09/23/2008
Tert-amyl methyl ether (TAME)	**2.3**	0.50	ug/L	EPA 8260B	09/23/2008
Tert-Butanol	**120000**	250	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	**410**	50	ug/L	EPA 8260B	09/23/2008
1,2-Dichloroethane-d4 (Surr)	99.5		% Recovery	EPA 8260B	09/23/2008
Toluene - d8 (Surr)	97.6		% Recovery	EPA 8260B	09/23/2008
TPH as Diesel	**370**	50	ug/L	M EPA 8015	09/24/2008
Octacosane (Diesel Surrogate)	104		% Recovery	M EPA 8015	09/24/2008

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-4** Matrix : Water Lab Number : 64876-12
Sample Date :09/18/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**3500**	400	ug/L	EPA 8260B	09/25/2008
Toluene	**< 400**	400	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	**< 400**	400	ug/L	EPA 8260B	09/25/2008
Total Xylenes	**< 400**	400	ug/L	EPA 8260B	09/25/2008
Methyl-t-butyl ether (MTBE)	**220000**	1500	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	**< 400**	400	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	**< 400**	400	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	**1400**	400	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	**490000**	2000	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	**< 40000**	40000	ug/L	EPA 8260B	09/25/2008
1,2-Dichloroethane-d4 (Surr)	98.5		% Recovery	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	103		% Recovery	EPA 8260B	09/25/2008
TPH as Diesel	**7600**	50	ug/L	M EPA 8015	09/23/2008
Octacosane (Diesel Surrogate)	80.7		% Recovery	M EPA 8015	09/23/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-5**
Matrix : Water
Lab Number : 64876-13
Sample Date :09/18/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**< 150**	150	ug/L	EPA 8260B	09/26/2008
Toluene	**< 150**	150	ug/L	EPA 8260B	09/26/2008
Ethylbenzene	**< 150**	150	ug/L	EPA 8260B	09/26/2008
Total Xylenes	**< 150**	150	ug/L	EPA 8260B	09/26/2008
Methyl-t-butyl ether (MTBE)	**22000**	150	ug/L	EPA 8260B	09/26/2008
Diisopropyl ether (DIPE)	**< 150**	150	ug/L	EPA 8260B	09/26/2008
Ethyl-t-butyl ether (ETBE)	**< 150**	150	ug/L	EPA 8260B	09/26/2008
Tert-amyl methyl ether (TAME)	**< 150**	150	ug/L	EPA 8260B	09/26/2008
Tert-Butanol	**520000**	1500	ug/L	EPA 8260B	09/26/2008
TPH as Gasoline	**< 15000**	15000	ug/L	EPA 8260B	09/26/2008
1,2-Dichloroethane-d4 (Surr)	96.5		% Recovery	EPA 8260B	09/26/2008
Toluene - d8 (Surr)	98.9		% Recovery	EPA 8260B	09/26/2008
TPH as Diesel	**900**	50	ug/L	M EPA 8015	09/24/2008
Octacosane (Diesel Surrogate)	109		% Recovery	M EPA 8015	09/24/2008

Report Number : 64876
Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Sample : **MW-8**
Matrix : Water
Lab Number : 64876-14
Sample Date :09/18/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	**< 250**	250	ug/L	EPA 8260B	09/26/2008
Toluene	**< 250**	250	ug/L	EPA 8260B	09/26/2008
Ethylbenzene	**< 250**	250	ug/L	EPA 8260B	09/26/2008
Total Xylenes	**< 250**	250	ug/L	EPA 8260B	09/26/2008
Methyl-t-butyl ether (MTBE)	**100000**	250	ug/L	EPA 8260B	09/26/2008
Diisopropyl ether (DIPE)	**< 250**	250	ug/L	EPA 8260B	09/26/2008
Ethyl-t-butyl ether (ETBE)	**< 250**	250	ug/L	EPA 8260B	09/26/2008
Tert-amyl methyl ether (TAME)	**< 250**	250	ug/L	EPA 8260B	09/26/2008
Tert-Butanol	**450000**	1500	ug/L	EPA 8260B	09/26/2008
TPH as Gasoline	**< 25000**	25000	ug/L	EPA 8260B	09/26/2008
1,2-Dichloroethane-d4 (Surr)	101		% Recovery	EPA 8260B	09/26/2008
Toluene - d8 (Surr)	100		% Recovery	EPA 8260B	09/26/2008
TPH as Diesel	**8300**	50	ug/L	M EPA 8015	09/24/2008
Octacosane (Diesel Surrogate)	98.7		% Recovery	M EPA 8015	09/24/2008

Report Number : 64876

Date : 09/26/2008

QC Report : Method Blank Data

Project Name : **NAZ Eagle Gas**

Project Number : **ZP046M**

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
TPH as Diesel	< 50	50	ug/L	M EPA 8015	09/23/2008
Octacosane (Diesel Surrogate)	97.6		%	M EPA 8015	09/23/2008
TPH as Diesel	< 50	50	ug/L	M EPA 8015	09/24/2008
Octacosane (Diesel Surrogate)	102		%	M EPA 8015	09/24/2008
TPH as Diesel	< 50	50	ug/L	M EPA 8015	09/25/2008
Octacosane (Diesel Surrogate)	83.8		%	M EPA 8015	09/25/2008
Methyl-t-butyl ether (MTBE)	< 0.50	0.50	ug/L	EPA 8260B	09/24/2008
Tert-Butanol	< 5.0	5.0	ug/L	EPA 8260B	09/24/2008
Benzene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Toluene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Total Xylenes	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Methyl-t-butyl ether (MTBE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	< 5.0	5.0	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	< 50	50	ug/L	EPA 8260B	09/25/2008
1,2-Dichloroethane-d4 (Surr)	96.2		%	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	103		%	EPA 8260B	09/25/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Methyl-t-butyl ether (MTBE)	< 0.50	0.50	ug/L	EPA 8260B	09/26/2008
Tert-Butanol	< 5.0	5.0	ug/L	EPA 8260B	09/26/2008
Benzene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Toluene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Total Xylenes	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Methyl-t-butyl ether (MTBE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	< 5.0	5.0	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	< 50	50	ug/L	EPA 8260B	09/25/2008
1,2-Dichloroethane-d4 (Surr)	98.4		%	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	99.0		%	EPA 8260B	09/25/2008
Benzene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Toluene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Total Xylenes	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Methyl-t-butyl ether (MTBE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	< 5.0	5.0	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	< 50	50	ug/L	EPA 8260B	09/25/2008
1,2-Dichloroethane-d4 (Surr)	97.5		%	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	98.8		%	EPA 8260B	09/25/2008

Report Number : 64876

Date : 09/26/2008

QC Report : Method Blank Data

Project Name : **NAZ Eagle Gas**

Project Number : **ZP046M**

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	< 0.50	0.50	ug/L	EPA 8260B	09/23/2008
Ethylbenzene	< 0.50	0.50	ug/L	EPA 8260B	09/23/2008
Toluene	< 0.50	0.50	ug/L	EPA 8260B	09/23/2008
Total Xylenes	< 0.50	0.50	ug/L	EPA 8260B	09/23/2008
Diisopropyl ether (DIPE)	< 0.50	0.50	ug/L	EPA 8260B	09/23/2008
Ethyl-t-butyl ether (ETBE)	< 0.50	0.50	ug/L	EPA 8260B	09/23/2008
Methyl-t-butyl ether (MTBE)	< 0.50	0.50	ug/L	EPA 8260B	09/23/2008
Tert-Butanol	< 5.0	5.0	ug/L	EPA 8260B	09/23/2008
Tert-amyl methyl ether (TAME)	< 0.50	0.50	ug/L	EPA 8260B	09/23/2008
TPH as Gasoline	< 50	50	ug/L	EPA 8260B	09/23/2008
1,2-Dichloroethane-d4 (Surr)	103		%	EPA 8260B	09/23/2008
Toluene - d8 (Surr)	99.1		%	EPA 8260B	09/23/2008
Benzene	< 0.50	0.50	ug/L	EPA 8260B	09/24/2008
Ethylbenzene	< 0.50	0.50	ug/L	EPA 8260B	09/24/2008
Toluene	< 0.50	0.50	ug/L	EPA 8260B	09/24/2008
Total Xylenes	< 0.50	0.50	ug/L	EPA 8260B	09/24/2008
Diisopropyl ether (DIPE)	< 0.50	0.50	ug/L	EPA 8260B	09/24/2008
Ethyl-t-butyl ether (ETBE)	< 0.50	0.50	ug/L	EPA 8260B	09/24/2008
Methyl-t-butyl ether (MTBE)	< 0.50	0.50	ug/L	EPA 8260B	09/24/2008
Tert-Butanol	< 5.0	5.0	ug/L	EPA 8260B	09/24/2008
Tert-amyl methyl ether (TAME)	< 0.50	0.50	ug/L	EPA 8260B	09/24/2008
TPH as Gasoline	< 50	50	ug/L	EPA 8260B	09/24/2008
1,2-Dichloroethane-d4 (Surr)	106		%	EPA 8260B	09/24/2008
Toluene - d8 (Surr)	108		%	EPA 8260B	09/24/2008

Parameter	Measured Value	Method Reporting Limit	Units	Analysis Method	Date Analyzed
Benzene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Ethylbenzene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Toluene	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Total Xylenes	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Diisopropyl ether (DIPE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Ethyl-t-butyl ether (ETBE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Methyl-t-butyl ether (MTBE)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
Tert-Butanol	< 5.0	5.0	ug/L	EPA 8260B	09/25/2008
Tert-amyl methyl ether (TAME)	< 0.50	0.50	ug/L	EPA 8260B	09/25/2008
TPH as Gasoline	< 50	50	ug/L	EPA 8260B	09/25/2008
1,2-Dichloroethane-d4 (Surr)	108		%	EPA 8260B	09/25/2008
Toluene - d8 (Surr)	109		%	EPA 8260B	09/25/2008
Benzene	< 0.50	0.50	ug/L	EPA 8260B	09/22/2008
Ethylbenzene	< 0.50	0.50	ug/L	EPA 8260B	09/22/2008
Toluene	< 0.50	0.50	ug/L	EPA 8260B	09/22/2008
Total Xylenes	< 0.50	0.50	ug/L	EPA 8260B	09/22/2008
Diisopropyl ether (DIPE)	< 0.50	0.50	ug/L	EPA 8260B	09/22/2008
Ethyl-t-butyl ether (ETBE)	< 0.50	0.50	ug/L	EPA 8260B	09/22/2008
Methyl-t-butyl ether (MTBE)	< 0.50	0.50	ug/L	EPA 8260B	09/22/2008
Tert-Butanol	< 5.0	5.0	ug/L	EPA 8260B	09/22/2008
Tert-amyl methyl ether (TAME)	< 0.50	0.50	ug/L	EPA 8260B	09/22/2008
TPH as Gasoline	< 50	50	ug/L	EPA 8260B	09/22/2008
1,2-Dichloroethane-d4 (Surr)	101		%	EPA 8260B	09/22/2008
Toluene - d8 (Surr)	99.2		%	EPA 8260B	09/22/2008

Report Number : 64876

QC Report : Matrix Spike/ Matrix Spike Duplicate

Date : 09/26/2008

Project Name : **NAZ Eagle Gas**
Project Number : **ZP046M**

Parameter	Spiked Sample	Sample Value	Spike Level	Spike Dup. Level	Spiked Sample Value	Duplicate Spiked Sample Value	Units	Analysis Method	Date Analyzed	Spiked Sample Percent Recov.	Duplicate Spiked Sample Percent Recov.	Relative Percent Diff.	Spiked Sample Percent Recov. Limit	Relative Percent Diff. Limit
TPH as Diesel	BLANK	<50	1000	1000	993	960	ug/L	M EPA 8015	9/23/08	99.3	96.0	3.41	70-130	25
TPH as Diesel	BLANK	<50	1000	1000	972	959	ug/L	M EPA 8015	9/24/08	97.2	95.9	1.32	70-130	25
TPH as Diesel	BLANK	<50	1000	1000	929	939	ug/L	M EPA 8015	9/25/08	92.9	93.9	1.15	70-130	25
Methyl-t-butyl ether	64915-02	26	40.0	40.1	58.3	60.2	ug/L	EPA 8260B	9/24/08	79.6	84.0	5.40	70-130	25
Tert-Butanol	64915-02	53	200	200	254	250	ug/L	EPA 8260B	9/24/08	101	98.6	2.29	70-130	25
Benzene	64942-01	14	39.9	40.0	51.7	52.3	ug/L	EPA 8260B	9/25/08	93.0	94.3	1.38	70-130	25
Methyl-t-butyl ether	64942-01	<0.50	39.8	40.0	35.9	38.6	ug/L	EPA 8260B	9/25/08	90.2	96.5	6.79	70-130	25
Tert-Butanol	64942-01	<5.0	199	200	212	212	ug/L	EPA 8260B	9/25/08	107	106	0.620	70-130	25
Toluene	64942-01	22	39.3	39.5	59.8	60.4	ug/L	EPA 8260B	9/25/08	95.2	96.3	1.14	70-130	25
Benzene	64942-10	1.2	40.1	40.1	41.0	39.7	ug/L	EPA 8260B	9/25/08	99.4	96.0	3.47	70-130	25
Methyl-t-butyl ether	64942-10	12	40.1	40.1	47.9	46.1	ug/L	EPA 8260B	9/25/08	88.8	84.6	4.94	70-130	25
Tert-Butanol	64942-10	1500	200	200	1650	1600	ug/L	EPA 8260B	9/25/08	72.0	47.9	40.2	70-130	25
Toluene	64942-10	3.2	39.5	39.5	41.6	40.4	ug/L	EPA 8260B	9/25/08	97.2	93.9	3.39	70-130	25
Benzene	64966-07	<0.50	40.1	40.1	40.2	40.4	ug/L	EPA 8260B	9/25/08	100	101	0.683	70-130	25
Methyl-t-butyl ether	64966-07	200	40.1	40.1	227	244	ug/L	EPA 8260B	9/25/08	57.2	100	54.9	70-130	25
Tert-Butanol	64966-07	74	200	200	271	287	ug/L	EPA 8260B	9/25/08	98.7	107	7.93	70-130	25

Report Number : 64876

QC Report : Matrix Spike/ Matrix Spike Duplicate

Date : 09/26/2008

Project Name : **NAZ Eagle Gas**

Project Number : **ZP046M**

Parameter	Spiked Sample	Sample Value	Spike Level	Spike Dup. Level	Spiked Sample Value	Duplicate Spiked Sample Value	Units	Analysis Method	Date Analyzed	Spiked Sample Percent Recov.	Duplicate Spiked Sample Percent Recov.	Relative Percent Diff.	Spiked Sample Percent Recov. Limit	Relative Percent Diff. Limit
Toluene	64966-07	<0.50	39.5	39.5	38.9	39.4	ug/L	EPA 8260B	9/25/08	98.5	99.8	1.29	70-130	25
Benzene	64876-03	<0.50	40.1	40.1	41.2	40.3	ug/L	EPA 8260B	9/23/08	103	100	2.08	70-130	25
Methyl-t-butyl ether	64876-03	1.7	40.1	40.1	44.5	44.3	ug/L	EPA 8260B	9/23/08	107	106	0.303	70-130	25
Tert-Butanol	64876-03	<5.0	200	200	190	199	ug/L	EPA 8260B	9/23/08	95.3	99.7	4.52	70-130	25
Toluene	64876-03	<0.50	39.5	39.5	40.8	40.1	ug/L	EPA 8260B	9/23/08	103	101	1.58	70-130	25
Benzene	64933-02	<0.50	40.1	40.1	40.0	39.1	ug/L	EPA 8260B	9/24/08	99.6	97.4	2.18	70-130	25
Methyl-t-butyl ether	64933-02	<0.50	40.1	40.1	37.7	37.3	ug/L	EPA 8260B	9/24/08	94.0	93.0	1.02	70-130	25
Tert-Butanol	64933-02	<5.0	200	200	206	205	ug/L	EPA 8260B	9/24/08	103	102	0.761	70-130	25
Toluene	64933-02	<0.50	39.5	39.5	42.4	42.3	ug/L	EPA 8260B	9/24/08	107	107	0.218	70-130	25
Benzene	64942-07	<0.50	40.1	40.1	39.5	38.6	ug/L	EPA 8260B	9/25/08	98.5	96.3	2.30	70-130	25
Methyl-t-butyl ether	64942-07	<0.50	40.1	40.1	39.8	39.4	ug/L	EPA 8260B	9/25/08	99.4	98.3	1.17	70-130	25
Tert-Butanol	64942-07	<5.0	200	200	207	205	ug/L	EPA 8260B	9/25/08	104	102	0.924	70-130	25
Toluene	64942-07	<0.50	39.5	39.5	44.1	42.8	ug/L	EPA 8260B	9/25/08	112	108	2.87	70-130	25
Benzene	64874-10	<0.50	40.1	40.1	39.8	38.9	ug/L	EPA 8260B	9/22/08	99.3	97.0	2.40	70-130	25
Methyl-t-butyl ether	64874-10	<0.50	40.1	40.1	39.7	38.9	ug/L	EPA 8260B	9/22/08	99.0	97.0	1.98	70-130	25
Tert-Butanol	64874-10	<5.0	200	200	195	201	ug/L	EPA 8260B	9/22/08	97.3	101	3.43	70-130	25
Toluene	64874-10	<0.50	39.5	39.5	39.7	38.5	ug/L	EPA 8260B	9/22/08	100	97.3	3.12	70-130	25

Report Number : 64876

Date : 09/26/2008

QC Report : Matrix Spike/ Matrix Spike Duplicate

Project Name : **NAZ Eagle Gas**

Project Number : **ZP046M**

Parameter	Spiked Sample	Sample Value	Spike Level	Spike Dup. Level	Spiked Sample Value	Duplicate Spiked Sample Value	Units	Analysis Method	Date Analyzed	Spiked Sample Percent Recov.	Duplicate Spiked Sample Percent Recov.	Relative Percent Diff.	Spiked Sample Percent Recov. Limit	Relative Percent Diff. Limit
Methyl-t-butyl ether	64971-06	0.72	39.8	39.4	41.0	41.7	ug/L	EPA 8260B	9/26/08	101	104	2.71	70-130	25
Tert-Butanol	64971-06	<5.0	198	196	208	204	ug/L	EPA 8260B	9/26/08	105	104	0.948	70-130	25

Report Number : 64876

Date : 09/26/2008

QC Report : Laboratory Control Sample (LCS)

Project Name : **NAZ Eagle Gas**

Project Number : **ZP046M**

Parameter	Spike Level	Units	Analysis Method	Date Analyzed	LCS Percent Recov.	LCS Percent Recov. Limit
Methyl-t-butyl ether	40.1	ug/L	EPA 8260B	9/24/08	86.8	70-130
Tert-Butanol	200	ug/L	EPA 8260B	9/24/08	101	70-130
Benzene	40.1	ug/L	EPA 8260B	9/25/08	98.6	70-130
Methyl-t-butyl ether	40.1	ug/L	EPA 8260B	9/25/08	92.9	70-130
Tert-Butanol	200	ug/L	EPA 8260B	9/25/08	105	70-130
Toluene	39.5	ug/L	EPA 8260B	9/25/08	104	70-130
Methyl-t-butyl ether	40.1	ug/L	EPA 8260B	9/26/08	96.2	70-130
Tert-Butanol	200	ug/L	EPA 8260B	9/26/08	98.9	70-130
Benzene	40.1	ug/L	EPA 8260B	9/25/08	107	70-130
Methyl-t-butyl ether	40.2	ug/L	EPA 8260B	9/25/08	91.8	70-130
Tert-Butanol	200	ug/L	EPA 8260B	9/25/08	110	70-130
Toluene	40.1	ug/L	EPA 8260B	9/25/08	106	70-130
Benzene	40.1	ug/L	EPA 8260B	9/25/08	106	70-130
Methyl-t-butyl ether	40.2	ug/L	EPA 8260B	9/25/08	88.8	70-130
Tert-Butanol	200	ug/L	EPA 8260B	9/25/08	107	70-130
Toluene	40.1	ug/L	EPA 8260B	9/25/08	105	70-130

Report Number : 64876

QC Report : Laboratory Control Sample (LCS)

Date : 09/26/2008

Project Name : **NAZ Eagle Gas**

Project Number : **ZP046M**

Parameter	Spike Level	Units	Analysis Method	Date Analyzed	LCS Percent Recov.	LCS Percent Recov. Limit
Benzene	40.2	ug/L	EPA 8260B	9/23/08	100	70-130
Methyl-t-butyl ether	40.3	ug/L	EPA 8260B	9/23/08	104	70-130
Tert-Butanol	201	ug/L	EPA 8260B	9/23/08	96.7	70-130
Toluene	40.2	ug/L	EPA 8260B	9/23/08	101	70-130
Benzene	40.3	ug/L	EPA 8260B	9/24/08	98.8	70-130
Methyl-t-butyl ether	40.3	ug/L	EPA 8260B	9/24/08	98.8	70-130
Tert-Butanol	201	ug/L	EPA 8260B	9/24/08	102	70-130
Toluene	39.7	ug/L	EPA 8260B	9/24/08	109	70-130
Benzene	39.9	ug/L	EPA 8260B	9/25/08	97.3	70-130
Methyl-t-butyl ether	39.9	ug/L	EPA 8260B	9/25/08	96.6	70-130
Tert-Butanol	199	ug/L	EPA 8260B	9/25/08	100	70-130
Toluene	39.4	ug/L	EPA 8260B	9/25/08	110	70-130
Benzene	40.2	ug/L	EPA 8260B	9/22/08	97.3	70-130
Methyl-t-butyl ether	40.2	ug/L	EPA 8260B	9/22/08	96.2	70-130
Tert-Butanol	200	ug/L	EPA 8260B	9/22/08	98.0	70-130
Toluene	39.6	ug/L	EPA 8260B	9/22/08	100	70-130

KIFF Analytical LLC

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Davis, CA 95616
Lab: 530.297.4800
Fax: 530.297.4802

SRG # / Lab No. 64876

Page 1 of 2

Chain-of-Custody Record and Analysis Request

Project Contact (Hardcopy or PDF To): Rob Nelson

California EDF Report? ☑ Yes ☐ No

Company / Address: 229 Tewksbury Ave Clearwater Group Pt. Richmond, CA

Sampling Company Log Code: CWGO

Phone #: 510-307-9943

Fax #: 510-232-2823

Global ID: T0605300219

Project #: ZP046M

P.O. #:

EDF Deliverable To (Email Address): sliao@clearwatergroup.com

Project Name: NAZ Eagle Gas

Sampler Signature: Eric

Project Address: 4301 San Leandro St. Oakland, CA

Sample Designation	Sampling Date	Sampling Time	Container: 40 ml VOA	Sleeve	Poly	Glass	Tedlar		Preservative: HCl	HNO_3	None			Matrix: Water	Soil	Air		Analysis Request: MTBE (EPA 8260B) per EPA 8021 level @ 5.0 ppb	MTBE (EPA 8260B) @ 0.5 ppb	BTEX (EPA 8260B)	TPH Gas (EPA 8260B)	5 Oxygenates (EPA 8260B)	7 Oxygenates (EPA 8260B)	Lead Scav. (1,2 DCA & 1,2 EDB-EPA 8260B)	Volatile Halocarbons (EPA 8260B)	Volatile Organics Full List (EPA 8260B)	Volatile Organics (EPA 524.2 Drinking Water)	TPH as Diesel (EPA 8015M)	TPH as Motor Oil (EPA 8015M)	Total Lead (EPA 6010)	W.E.T. Lead (STLC)	TBA			TAT: ☐ 12 hr ☐ 24 hr ☐ 48 hr ☐ 72 hr ☒ 1 wk	For Lab Use Only
MW-5d	9-17-08	1015	6						6					6					X	X	X	X						X				X			X	01
MW-4d	↓	1115	↓						↓					↓					↓	↓	↓	↓						↓				↓			↓	02
MW-1d	↓	1200	↓						↓					↓					↓	↓	↓	↓						↓				↓			↓	03
MW-1	↓	1300	↓						↓					↓					↓	↓	↓	↓						↓				↓			↓	04
MW-7d	↓	13:30	↓						↓					↓					↓	↓	↓	↓						↓				↓			↓	05
MW-7	↓	14:00	↓						↓					↓					↓	↓	↓	↓						↓				↓			↓	06

Relinquished by:	Date	Time	Received by:
Eric V. Austin	9/18/08	~~515~~ 1600 EVA	
Relinquished by:	Date	Time	Received by:
Relinquished by:	Date	Time	Received by Laboratory:
	091908	1136	Kiff Analytical

Remarks:

Bill to:

For Lab Use Only: Sample Receipt

Temp °C	Initials	Date	Time	Therm. ID #	Coolant Present
1.2	TJB	091908	1640	IR-1	[✓ Yes] / No

Distribution: White - Lab; Pink - Originator
Rev: 051805

KIFF Analytical LLC

2795 2nd Street, Suite 300
Davis, CA 95616
Lab: 530.297.4800
Fax: 530.297.4802

SRG # / Lab No. 64876

Page 2 of 2

Chain-of-Custody Record and Analysis Request

Project Contact (Hardcopy or PDF To): Rob Nelson

California EDF Report? ☒ Yes ☐ No

Company / Address: 229 Tewksbury Ave, Pt. Richmond, CA; Clearwater group

Sampling Company Log Code: CWGO

Phone #: 510-307-9943

Fax #: 510-232-2823

Global ID: T0605300219

Project #: ZP046M

P.O. #:

EDF Deliverable To (Email Address): [illegible]@Clearwatergroup.com

Project Name: NAZ Eagle Gas

Sampler Signature: Eric V Austin

Project Address: 4301 San Leandro St, Oakland, CA.

TAT: ☐ 12 hr ☐ 24 hr ☐ 48 hr ☐ 72 hr ☒ 1 wk

Sample Designation	Date	Time	40 ml VOA	Sleeve	Poly	Glass	Tedlar		HCl	HNO_3	None			Water	Soil	Air	
MW-3	9-18-08	8:45	6						6					6			
IS-4		9:15															
IS-5		945															
EW-2		11:30															
MW-2		12:15															
MW-4		1245															
MW-5		1330															
MW-8	↓	1430	↓						↓					↓			

Sample Designation	MTBE (EPA 8260B) per EPA 8021 level @ 5.0 ppb	MTBE (EPA 8260B) @ 0.5 ppb	BTEX (EPA 8260B)	TPH Gas (EPA 8260B)	5 Oxygenates (EPA 8260B)	7 Oxygenates (EPA 8260B)	Lead Scav.(1,2 DCA & 1,2 EDB-EPA 8260B)	Volatile Halocarbons (EPA 8260B)	Volatile Organics Full List (EPA 8260B)	Volatile Organics (EPA 524.2 Drinking Water)	TPH as Diesel (EPA 8015M)	TPH as Motor Oil (EPA 8015M)	Total Lead (EPA 6010)	W.E.T. Lead (STLC)	TBA			TAT	For Lab Use Only
MW-3		X	X	X	X						X				X			X	07
IS-4																			08
IS-5																			09
EW-2																			10
MW-2																			11
MW-4																			12
MW-5																			13
MW-8		↓	↓	↓	↓						↓				↓			↓	14

Relinquished by:	Date	Time	Received by:
Eric V Austin	9/18/08	1600	EV.
	091908	1136	Received by Laboratory: Kiff Analytical

Remarks:

Bill to:

For Lab Use Only: Sample Receipt

Temp °C	Initials	Date	Time	Therm. ID #	Coolant Present
					Yes / No

Distribution: White - Lab; Pink - Originator
Rev: 051805

ATTACHMENT F

Geotracker Confirmation Pages

STATE WATER RESOURCES CONTROL BOARD

GEOTRACKER ESI

UPLOADING A GEO_WELL FILE

SUCCESS

Processing is complete. No errors were found!
Your file has been successfully submitted!

Submittal Type:	GEO_WELL
Submittal Title:	Groundwater Monitoring 3Q08
Facility Global ID:	T0600143649
Facility Name:	EAGLE GAS
File Name:	GEO_WELL.zip
Organization Name:	Clearwater Group
Username:	CLEARWATERGROUP
IP Address:	209.76.203.27
Submittal Date/Time:	9/29/2008 12:54:43 PM
Confirmation Number:	1266331553

ZP046M

STATE WATER RESOURCES CONTROL BOARD

GEOTRACKER ESI

UPLOADING A EDF FILE

SUCCESS

Processing is complete. No errors were found!
Your file has been successfully submitted!

Submittal Type: GWM_R
Submittal Title: Groundwater Monitoring 3Q08 (64876)
Facility Global ID: T0600143649
Facility Name: EAGLE GAS
File Name: EDF_NAZEagleGas_64876.ZIP
Organization Name: Clearwater Group
Username: CLEARWATERGROUP
IP Address: 209.76.203.27
Submittal Date/Time: 9/29/2008 1:26:36 PM
Confirmation Number: 6501236438

VIEW QC REPORT

VIEW DETECTIONS REPORT

ZP046M

ATTACHMENT G

Friedman & Bruya, Inc. Report #807083

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083
Date Extracted: 07/11/08
Date Analyzed: 07/11/08

RESULTS FROM THE ANALYSIS OF THE PRODUCT SAMPLE FOR FORENSIC EVALUATION BY CAPILLARY GAS CHROMATOGRAPHY USING A FLAME IONIZATION DETECTOR (FID)

Sample ID	GC Characterization
IS-5 Free Product	The GC trace using the flame ionization detector (FID) showed the presence of low to medium boiling compounds. The majority of material present in this sample is indicative of gasoline. This sample may also contain a middle distillate such as diesel fuel. The low boiling compounds appear as a ragged pattern of peaks eluting from n-C_7 to n-C_{13} showing a maximum near n-C_{10}. This correlates with a temperature range of approximately 100°C to 240°C with a maximum near 170 °C. Within this range, the GC/FID trace showed the presence of peaks, at varying levels, that are indicative of C3-benzenes and methylnaphthalenes. These compounds are characteristic of the constituents commonly found in gasoline. The relative abundance of the volatile and semivolatile constituents present indicates that substantial degradation has occurred to the gasoline. It should also be noted that an irregular pattern of peaks is present above n-C_{14} on the GC/FID trace. The presence of these peaks indicates that a low level of a middle distillate such as diesel fuel may also be present in the sample. The large peak seen near 25 minutes on the GC/FID trace is pentacosane, added as a quality assurance check for this GC analysis.

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083
Date Analyzed: 07/11/08

RESULTS FROM THE ANALYSIS OF THE PRODUCT SAMPLE FOR PARAFFINS, ISOPARAFFINS, OLEFINS, NAPHTHENES, AND AROMATICS

Results Reported as % by Weight

Client ID IS-5 Free Product
Laboratory ID 807083-01

Compound	Weight Percent
Propane	<0.01
Methanol	<0.01
Isobutane	<0.01
2-Methyl-1-propene	<0.01
Ethanol	<0.01
n-Butane	<0.01
t-2-Butene	<0.01
c-2-Butene	<0.01
Isopropanol	<0.01
3-Methyl-1-butene	<0.01
Isopentane	0.15
tert-Butanol	<0.01
1-Pentene	<0.01
2-Methyl-1-butene	0.01
n-Propanol	<0.01
n-Pentane	0.07
t-2-Pentene	0.01
c-2-Pentene	<0.01
2-Methyl-2-butene	0.01
MTBE	0.07
sec-Butanol	<0.01
4-Methyl-1-pentene	<0.01
Isobutanol	<0.01
2,3-Dimethylbutane	0.20
Cyclopentane	0.03
2-Methylpentane	0.40
DIPE	<0.01
3-Methylpentane	0.31
1-Hexene	<0.01
ETBE	<0.01
n-Hexane	0.33

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083
Date Analyzed: 07/11/08

RESULTS FROM THE ANALYSIS OF THE PRODUCT SAMPLE FOR PARAFFINS, ISOPARAFFINS, OLEFINS, NAPHTHENES, AND AROMATICS

Results Reported as % by Weight

Client ID	IS-5 Free Product
Laboratory ID	807083-01

Compound	Weight Percent
t-2-Hexene	0.03
2-Methyl-1-pentene	0.02
2-Methyl-2-pentene	0.02
c-2-Hexene	0.01
2,2-Dimethylpentane	0.03
2,4-Dimethylpentane	0.44
Methylcyclopentane	0.62
2,2,3-Trimethylbutane	0.02
Benzene	0.06
1-Methylcyclopentene	0.03
TAME	0.01
3,3-Dimethylpentane	0.06
Cyclohexane	0.32
2-Methylhexane	0.56
2,3-Dimethylpentane	0.97
1,1-Dimethylcyclopentane	0.05
3-Methylhexane	0.68
c-1,3-Dimethylcyclopentane	0.31
3-Ethylpentane	0.08
Isooctane	1.86
t-1,2-Dimethylcyclopentane	0.28
1-Heptene	<0.01
n-Heptane	0.58
t-3-Heptene	0.01
c-3-Heptene	<0.01
t-2-Heptene	0.01
c-2-Heptene	0.01
2,2-Dimethylhexane	0.05
2,5-Dimethylhexane	0.54
Methylcyclohexane	0.59
2,4-Dimethylhexane	0.51
Ethylcyclopentane	0.43

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083
Date Analyzed: 07/11/08

RESULTS FROM THE ANALYSIS OF THE PRODUCT SAMPLE FOR PARAFFINS, ISOPARAFFINS, OLEFINS, NAPHTHENES, AND AROMATICS
Results Reported as % by Weight

Client ID	IS-5 Free Product
Laboratory ID	807083-01

Compound	Weight Percent
t-1,c-2,4-Trimethylcyclopentane	0.28
t-1,c-2,3-Trimethylcyclopentane	0.25
2,3,4-Trimethylpentane	1.39
Toluene	0.01
2,3-Dimethylhexane	1.76
2-Methylheptane	0.52
3-Methylheptane	0.72
4-Methylheptane	0.25
3-Ethylhexane	0.14
1-Octene	<0.01
1,2,3-Trimethylcyclopentane	0.10
t-1,2-Dimethylcyclohexane	0.47
n-Octane	0.53
1-Ethyl-1-methylcyclopentane	0.12
c-2-Octene	0.06
c-1,2-Dimethylcyclohexane	0.16
Isopropylcyclopentane	0.04
2,5-Dimethylheptane	0.26
3,5-Dimethylheptane	0.07
n-Propylcyclopentane	0.10
Ethylbenzene	1.86
2,3-Dimethylheptane	0.19
3,4-Dimethylheptane	<0.01
2-Methyloctane	0.31
m-Xylene	0.79
p-Xylene	1.74
3-Methyloctane	0.46
1-Nonene	<0.01
3,3-Diethylpentane	<0.01
t-3-Nonene	0.05
c3-Nonene	0.06
o-Xylene	0.11

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083
Date Analyzed: 07/11/08

RESULTS FROM THE ANALYSIS OF THE PRODUCT SAMPLE FOR PARAFFINS, ISOPARAFFINS, OLEFINS, NAPHTHENES, AND AROMATICS

Results Reported as % by Weight

Client ID	IS-5 Free Product
Laboratory ID	807083-01

Compound	Weight Percent
n-Nonane	0.40
Isobutylcyclopentane	0.02
t-2-Nonene	0.03
c-2-Nonene	<0.01
Isopropylbenzene	0.32
3,3-Dimethyloctane	0.15
n-Butylcyclopentane	0.09
n-Propylbenzene	1.00
2,3-Dimethyloctane	0.10
1-Methyl-3-ethylbenzene	0.05
1-Methyl-4-ethylbenzene	1.37
2-Methylnonane	0.22
3-Ethyloctane	0.10
3-Methylnonane	0.26
1,3,5-Trimethylbenzene	0.91
1-Methyl-2-ethylbenzene	0.92
1,2,4-Trimethylbenzene	2.96
tert-Butylbenzene	<0.01
n-Decane	0.18
Isobutylbenzene	0.17
Isopropylcyclohexane	<0.01
sec-Butylbenzene	0.23
1-Methyl-3-isopropylbenzene	0.13
Isobutylcyclohexane	<0.01
1-Methyl-4-isopropylbenzene	0.17
1,2,3-Trimethylbenzene	1.20
Indan	0.87
1-Methyl-3-n-propylbenzene	0.25
1-Methyl-4-n-propylbenzene	0.63
n-Butylbenzene	0.50
1,3-Dimethyl-5-ethylbenzene	0.63
1,2-Diethylbenzene	0.11

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083
Date Analyzed: 07/11/08

RESULTS FROM THE ANALYSIS OF THE PRODUCT SAMPLE FOR PARAFFINS, ISOPARAFFINS, OLEFINS, NAPHTHENES, AND AROMATICS

Results Reported as % by Weight

Client ID	IS-5 Free Product
Laboratory ID	807083-01

Compound	Weight Percent
1-Methyl-2-n-propylbenzene	0.34
1,4-Dimethyl-2-ethylbenzene	0.72
1,2-Dimethyl-4-ethylbenzene	1.21
1,3-Dimethyl-2-ethylbenzene	0.32
1,2-Dimethyl-3-ethylbenzene	0.23
n-Undecane	0.32
1,2,4,5-Tetramethylbenzene	0.79
2-Methylbutylbenzene	0.05
n-Pentylbenzene	0.14
Methylindan	0.57
1-tert-Butyl-3,5-dimethylbenzene	<0.01
1-tert-Butyl-4-ethylbenzene	<0.01
n-Dodecane	0.25
1,3,5-Triethylbenzene	<0.01
1,2,4-Triethylbenzene	<0.01
Naphthalene	1.03
n-Hexylbenzene	0.15
2-Methylnaphthalene	0.84
n-Tridecane	0.32
1-Methylnaphthalene	0.47
n-Tetradecane	0.12
n-Pentadecane	<0.01

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083
Date Analyzed: 07/11/08

RESULTS FROM THE ANALYSIS OF THE PRODUCT SAMPLE FOR PARAFFINS, ISOPARAFFINS, OLEFINS, NAPHTHENES, AND AROMATICS

Results Reported as % by Weight

Client ID	IS-5 Free Product
Laboratory ID	807083-01

PIANO SUMMARY	Weight Percent
Total Identified Compounds	45.47
Oxygenated Compounds	0.08
Hydrocarbon Compounds	45.38
Unidentified Compounds	54.53
Total	100

	Paraffins	Isoparaffins	Aromatics	Naphthenes	Olefins	Total
C3	<0.01					<0.01
C4	<0.01	<0.01			<0.01	<0.01
C5	0.07	0.15		0.03	0.03	0.28
C6	0.33	0.91	0.06	0.95	0.11	2.37
C7	0.58	2.84	0.01	1.66	0.04	5.13
C8	0.53	7.74	4.50	1.52	0.06	14.34
C9	0.40	1.30	9.59	0.12	0.13	11.54
C10	0.18	0.83	8.05	<0.01		9.06
C11	0.32		1.50			1.83
C12	0.25		0.15			0.40
C13	0.32					0.32
C14	0.12					0.12
C15	<0.01					<0.01
Total	3.10	13.77	23.86	4.28	0.37	45.38

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083
Date Extracted: 07/11/08
Date Analyzed: 07/11/08

RESULTS FROM THE ANALYSIS OF PRODUCT SAMPLES FOR ORGANIC LEAD SPECIATION AND MANGANESE BY METHOD 8082 MODIFIED

Results Reported as μg/g (ppm)

Sample ID Laboratory ID	TML	TMEL	DMDEL	MTEL	TEL	MMT	Surrogate (% Rec.) (Limit 50-150)
IS-5 Free Product 807083-01	<1	<1	<1	20	180	<1	144
Method Blank	<1	<1	<1	<1	<1	<1	136

TML	Tetramethyl Lead
TMEL	Trimethylethyl Lead
DMDEL	Dimethyldiethyl Lead
MTEL	Methyltriethyl Lead
TEL	Tetraethyl Lead
MMT	Methylcyclopentadienyl Manganese Tricarbonyl

Analysis For Total Organic Lead and Manganese By EPA Method 200.8

Client ID:	IS-5 Free Product	Client:	Clearwater Group, Inc.
Date Received:	07/08/08	Project:	NAZ Eagle Gas, F&BI 807083
Date Extracted:	07/17/08	Lab ID:	807083-01
Date Analyzed:	07/17/08	Data File:	807083-01.026
Matrix:	Product	Instrument:	ICPMS1
Units:	mg/kg (ppm)	Operator:	hr

Analyte:	Concentration mg/kg (ppm)
Organic Lead	128
Organic Manganese	<5

Analysis For Total Organic Lead and Manganese By EPA Method 200.8

Client ID:	Method Blank	Client:	Clearwater Group, Inc.
Date Received:	07/08/08	Project:	NAZ Eagle Gas, F&BI 807083
Date Extracted:	07/17/08	Lab ID:	I8-290 mb
Date Analyzed:	07/17/08	Data File:	I8-290 mb.023
Matrix:	Product	Instrument:	ICPMS1
Units:	mg/kg (ppm)	Operator:	hr

Analyte:	Concentration mg/kg (ppm)
Organic Lead	<1
Organic Manganese	<1

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083

QUALITY ASSURANCE RESULTS FROM THE ANALYSIS OF PRODUCT SAMPLES FOR ORGANIC LEAD AND MANGANESE BY EPA METHOD 8082 MODIFIED

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Percent Recovery LCSD	Acceptance Criteria	RPD (Limit 20)
Tetramethyl lead	μg/g (ppm)	25	107	113	70-130	5
Tetraethyl lead	μg/g (ppm)	25	86	91	70-130	6
MMT	μg/g (ppm)	25	96	101	70-130	5

Date of Report: 07/23/08
Date Received: 07/08/08
Project: NAZ Eagle Gas, F&BI 807083

QUALITY ASSURANCE RESULTS FOR THE ANALYSIS OF PRODUCT SAMPLES FOR ORGANIC LEAD AND MANGANESE USING EPA METHOD 200.8

Laboratory Code: Laboratory Control Sample

Analyte	Reporting Units	Spike Level	Percent Recovery LCS	Percent Recovery LCSD	Acceptance Criteria	RPD (Limit 20)
Organic Lead	mg/kg (ppm)	70.75	86	87	70-130	1
Organic Manganese	mg/kg (ppm)	12.5	107	111	70-130	4

Data Qualifiers & Definitions

a - The analyte was detected at a level less than five times the reporting limit. The RPD results may not provide reliable information on the variability of the analysis.

A1 – More than one compound of similar molecule structure was identified with equal probablility.

b - The analyte was spiked at a level that was less than five times that present in the sample. Matrix spike recoveries may not be meaningful.

ca - The calibration results for this range fell outside of acceptance criteria. The value reported is an estimate.

c - The presence of the analyte indicated may be due to carryover from previous sample injections.

d - The sample was diluted. Detection limits may be raised due to dilution.

ds - The sample was diluted. Detection limits are raised due to dilution and surrogate recoveries may not be meaningful.

dv - Insufficient sample was available to achieve normal reporting limits and limits are raised accordingly.

fb - The analyte indicated was found in the method blank. The result should be considered an estimate.

fc – The compound is a common laboratory and field contaminant.

hr - The sample and duplicate were reextracted and reanalyzed. RPD results were still outside of control limits. The variability is attributed to sample inhomogeneity.

ht - The sample was extracted outside of holding time. Results should be considered estimates.

ip - Recovery fell outside of normal control limits. Compounds in the sample matrix interfered with the quantitation of the analyte.

j – The result is below normal reporting limits. The value reported is an estimate.

J - The internal standard associated with the analyte is out of control limits. The reported concentration is an estimate.

jl - The analyte result in the laboratory control sample is out of control limits. The reported concentration should be considered an estimate.

jr - The rpd result in laboratory control sample associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

js - The surrogate associated with the analyte is out of control limits. The reported concentration should be considered an estimate.

lc - The presence of the compound indicated is likely due to laboratory contamination.

L - The reported concentration was generated from a library search.

nm - The analyte was not detected in one or more of the duplicate analyses. Therefore, calculation of the RPD is not applicable.

pc – The sample was received in a container not approved by the method. The value reported should be considered an estimate.

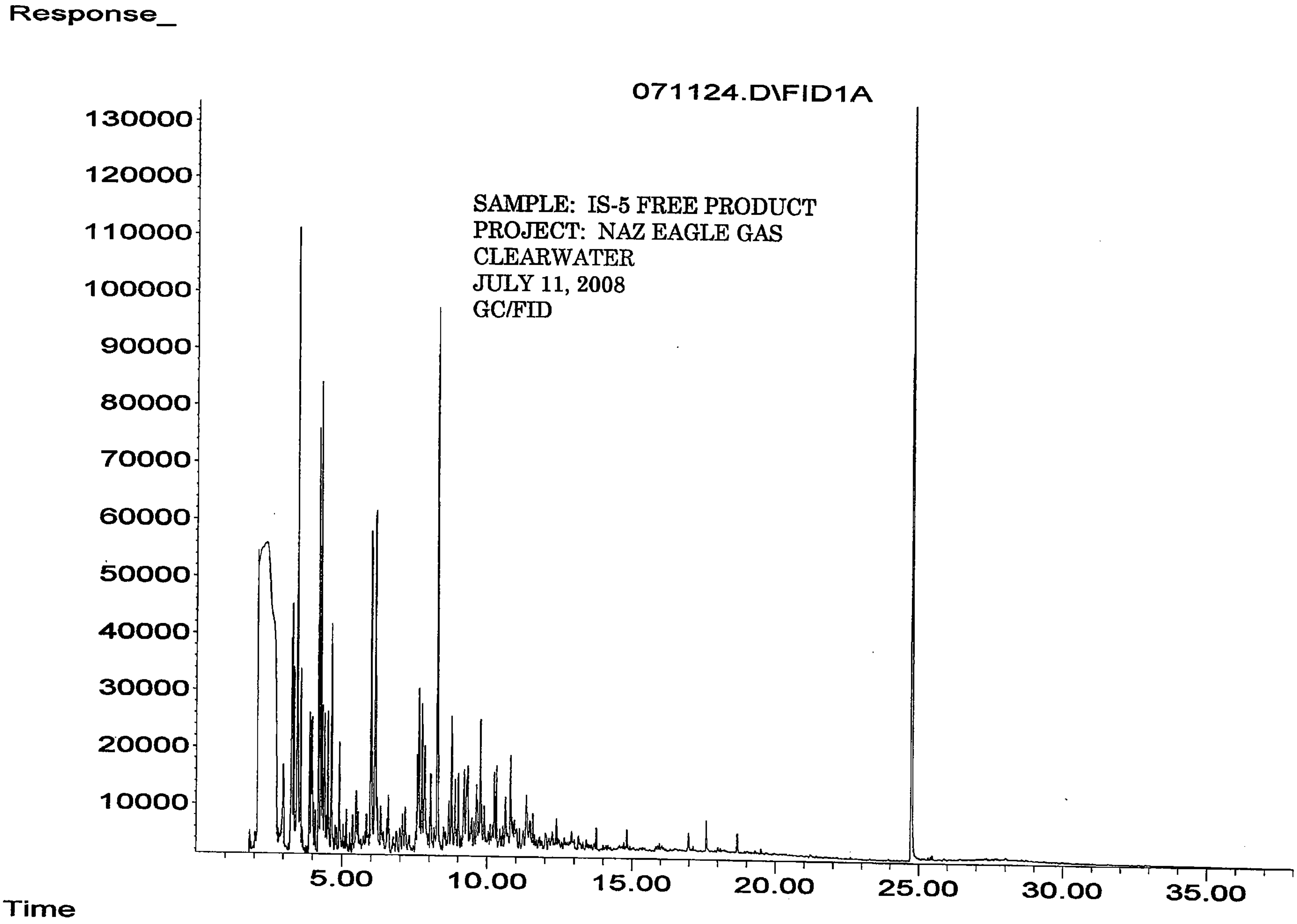
pr – The sample was received with incorrect preservation. The value reported should be considered an estimate.

ve - The value reported exceeded the calibration range established for the analyte. The reported concentration should be considered an estimate.

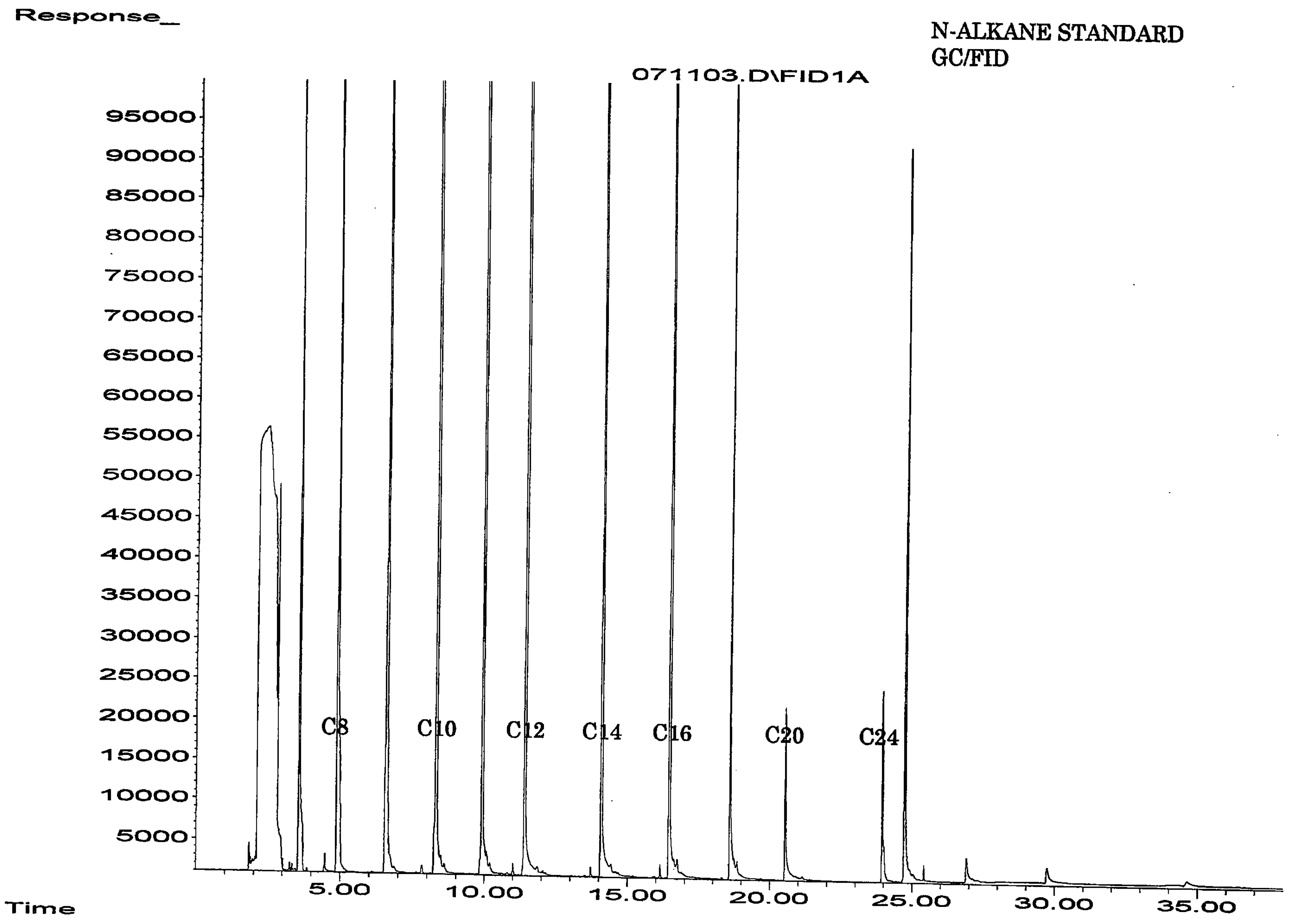
vo - The value reported fell outside the control limits established for this analyte.

x - The pattern of peaks present is not indicative of diesel.

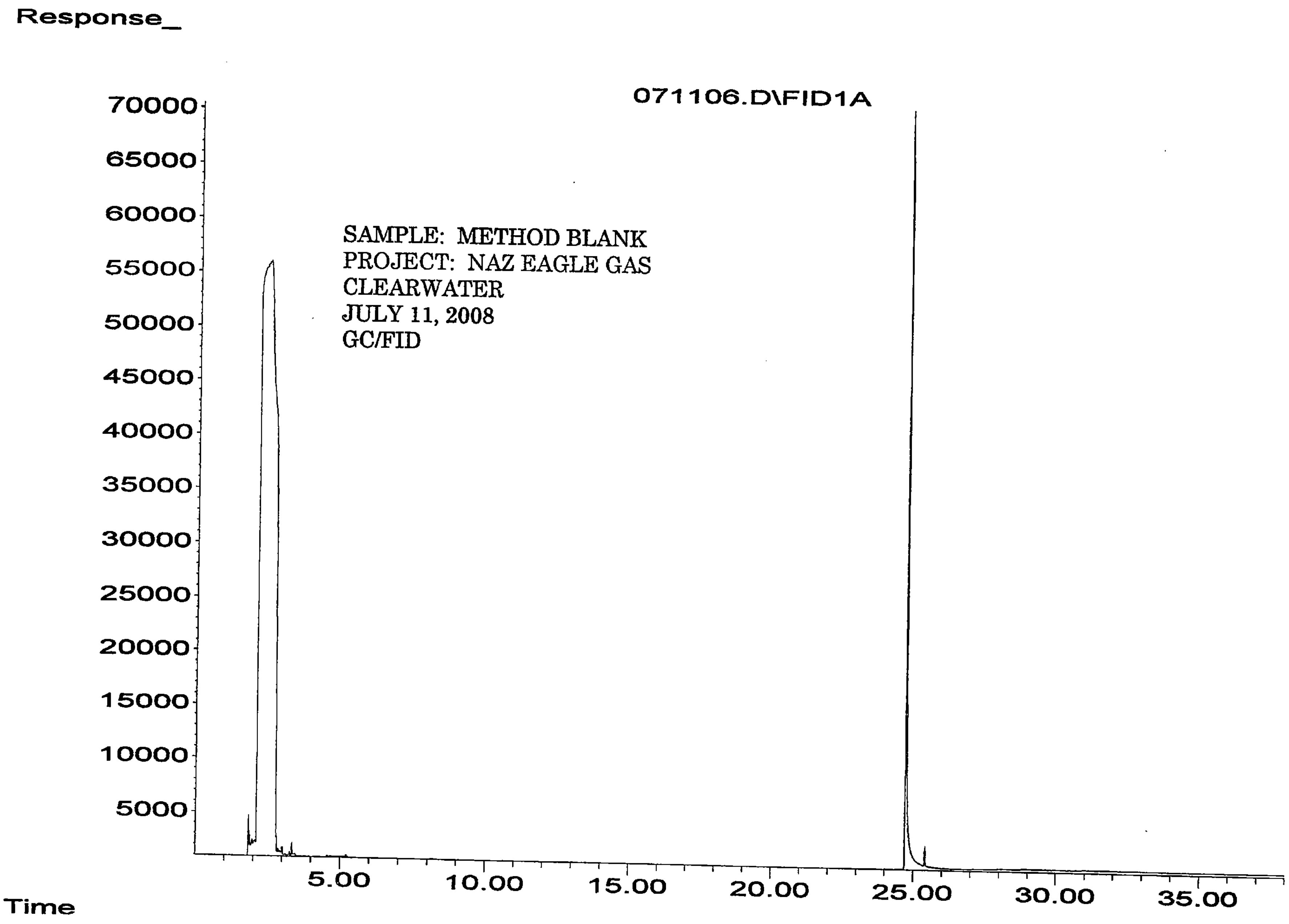
y - The pattern of peaks present is not indicative of motor oil.



SAMPLE: IS-5 FREE PRODUCT
PROJECT: NAZ EAGLE GAS
CLEARWATER
JULY 11, 2008
GC/FID



N-ALKANE STANDARD
GC/FID


SAMPLE: METHOD BLANK
PROJECT: NAZ EAGLE GAS
CLEARWATER
JULY 11, 2008
GC/FID

807083

CHAIN OF CUSTODY

MP 07-08-08

A02

SAMPLERS: (Signature) Erin V

PROJECT NAME: NAZ Eagle Gas

JOB NUMBER: ZP0462

DESCRIPTION: Free Product Sample, well IS-5

ADDRESS: 4501 San Leandro Street, Oakland CA

ANALYSIS REQUESTED

CROSS REFERENCE NUMBER Lab ID	DATE	TIME	SOIL	WATER		STATION LOCATION	TOTAL PETROLEUM HYDROCARBONS	BTX & E	VOC - EPA 8240	TOTAL OIL & GREASE	TETRAETHYL LEAD	HFS	PIANO	Organic Lead	REMARKS
01	6-27-2008	0945		X		IS-5 Free Product						X	X	X	

RELINQUISHED BY: (Signature) Erin V	DATE 7/7/08 TIME 1300	RECEIVED BY: (Signature) M	DATE 7-8-08 TIME 10:00 Am
RELINQUISHED BY: (Signature)	DATE TIME	RECEIVED BY: (Signature)	DATE TIME
RELINQUISHED BY: (Signature)	DATE TIME	RECEIVED BY: (Signature)	DATE TIME
RELINQUISHED BY: (Signature)	DATE TIME	RECEIVED FOR LABORATORY BY: (Signature)	DATE TIME

Samples received at 2 °C

ATTACHMENT H

Standard Operating Procedure for Low-Stress (Low Flow)/ Minimal Drawdown Groundwater Sample Collection

STANDARD OPERATING PROCEDURE FOR LOW-STRESS (Low Flow) / MINIMAL DRAWDOWN GROUND-WATER SAMPLE COLLECTION

INTRODUCTION

The collection of "representative" water samples from wells is neither straightforward nor easily accomplished. Ground-water sample collection can be a source of variability through differences in sample personnel and their individual sampling procedures, the equipment used, and ambient temporal variability in subsurface and environmental conditions. Many site inspections and remedial investigations require the sampling at ground-water monitoring wells within a defined criterion of data confidence or data quality, which necessitates that the personnel collecting the samples are trained and aware of proper sample-collection procedures.

The purpose of this standard operating procedure (SOP) is to provide a method which minimize the amount of impact the purging process has on the ground water chemistry during sample collection and to minimize the volume of water that is being purged and disposed. This will take place by placing the pump intake within the screen interval and by keeping the drawdown at a minimal level (0.33 feet) (Puls and Barcelona, 1996) until the water quality parameters have stabilized and sample collection is complete. The flow rate at which the pump will be operating will be depended upon both hydraulic conductivity of the aquifer and the drawdown with the goal of minimizing the drawdown. The flow rate from the pump during purging and sampling will be at a rate that will not compromise the integrity of the analyte that is being sampled. This sampling procedure may or may not provide a discrete ground water sample at the location of the pump intake. The flow of ground-water to the pump intake will be dependent on the distribution of the hydraulic conductivity (K) of the aquifer within the screen interval. In order to minimize the drawdown in the monitoring well a low-flow rate must be utilized. Low-flow refers to the velocity with which water enters the pump intake from the surrounding formation in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface, which can be affected by flow regulators or restrictions (Puls and Barcelona, 1996). This SOP was developed by the Superfund/RCRA Ground Water Forum and draws from an USEPA's Ground Water Issue Paper, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedure, by Robert W. Puls and Michael J. Barcelona. Also, available USEPA Regional SOPs regarding Low-Stress(Low Flow)Purging and Sampling were used for this SOP.

SCOPE AND APPLICATION

This SOP should be used primarily at monitoring wells which have a screen or an open interval with a length of ten feet or less and can accept a sampling device which minimizes the disturbance to the aquifer or the water column in the well casing. The screen or open interval should have been optimally located to intercept an existing contaminant plume(s) or along flowpaths of potential contaminant releases. Knowledge of the contaminant distribution within the screen interval is highly recommended and is essential for the success of this sampling procedure. The ground-water samples which are collected using this procedure are acceptable for the analyses of ground-water contaminants which may be found at Superfund and RCRA contamination sites. The analytes may be volatile, semi-volatile organic compounds, pesticides, PCBs, metals and other inorganic compounds. The screened interval should be located within the contaminant plume(s) and the pump intake should be placed at or near the known source of the contamination within the screened interval. It is critical to place the pump intake in the exact location or depth for each sampling event. This argues for the use of dedicated, permanently installed sampling devices whenever possible. If this is not possible then the placement of the pump intake should be positioned with a calibrated sampling pump hose sounded with a weighted-tape or using a pre-measured hose. The pump intake should not be placed near the bottom of the screened interval to avoid disturbing any sediment that may have settled at the bottom of the well.

Water-quality indicator parameters and water levels must be measured during purging, prior to sample collection. Stabilization of the water quality parameters as well as monitoring water levels are a prerequisite to sample collection. The water-quality indicator parameters which are recommended include the following: specific electrical conductance, dissolved oxygen, turbidity, oxidation-reduction potential, pH, and temperature. The latter two parameters are useful data, but are generally insensitive as purging parameters. Oxidation-reduction potential may not always be appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidation conditions, and for fate and transport issues. Also, when samples are collected for metals, semi-volatile organic compounds, and pesticides every effort must be made to reduce turbidity to 10 NTUs or less (not just the stabilization of turbidity) prior to the collection of the water sample. In addition to the measurement of the above parameters, depth to water must be measured during purging (U.S. Environmental Protection Agency, 1995).

Proper well construction, development and maintenance are essential for any ground-water sampling procedure. Prior to conducting the field work, information on the construction of the well and well development should be obtained and that information factored into the site specific sampling procedure. The attached Sampling Checklist is an example of the type of information that is useful.

Stabilization of the water-quality indicator parameters is the criterion for sample collection. But if stabilization is not occurring and the procedure has been strictly followed, then sample collection can take place once three (minimum) to six (maximum) casing volumes have been removed (Schuller et al., 1981 and U.S. Environmental Protection Agency., 1986; Wilde et al., 1998; Gibs and Imbrigiotta., 1990). The specific information on what took place during purging must be recorded in the field notebook or in the ground-water sampling log.

This SOP is not to be used where non-aqueous phase liquids (immiscible fluids) are present in the monitoring well.

EQUIPMENT

- Depth-to-water measuring device - An electronic water-level indicator or steel tape and chalk, with marked intervals of

0.01 foot. Interface probe for determination of liquid products (NAPL) presence, if needed.

- Steel tape and weight - Used for measuring total depth of well. Lead weight should not be used.
- Sampling pump - Submersible or bladder pumps with adjustable rate controls are preferred. Pumps are to be constructed of inert materials, such as stainless steel and teflon®. Pump types that are acceptable include gear and helical driven, centrifugal (low-flow type) and air-activated piston. Adjustable rate, peristaltic pump can be used when the depth to water is 20 feet or less.
- Tubing - Teflon® or Teflon® lined polyethylene tubing is preferred when sampling for organic compounds. Polyethylene tubing can be used when sampling inorganics.
- Power Source - If a combustion type (gasoline or diesel-driven) generator is used, it must be placed downwind of the sampling area.
- Flow measurement supplies - flow meter, graduated cylinder and a stop watch.
- Multi-Parameter meter with flow-through-cell - This can be one instrument or more contained in a flow-through cell. The water-quality indicator parameters which must be monitored are pH, ORP/EH, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Turbidity readings must be collected before the flow cell because of the potential for sediment buildup which can bias the turbidity measurements. Calibration fluids for all instruments should be NIST-traceable and there should be enough for daily calibration through-out the sampling event. The inlet of the flow cell must be located near the bottom of the flow cell and the outlet near the top. The size of the flow cell should be kept to a minimum and a closed cell is preferred. The flow cell must not contain any air or gas bubbles when monitoring for the water-quality indicator parameters.
- Decontamination Supplies - Including a reliable and documented source of distilled water and any solvents (if used). Pressure sprayers, buckets or decontamination tubes for pumps, brushes and non-phosphate soap will also be needed.
- Sample bottles, sample preservation supplies, sample tags or labels and chain of custody forms.
- Approved Field Sampling and Quality Assurance Project Plan.
- Well construction data, field and water quality data from the previous sampling event.
- Well keys and map of well locations.

- Field notebook, ground-water sampling logs and calculator. A suggested field data sheet (ground-water sampling record or ground-water sampling log) are provided in the attachment.
- Filtration equipment, if needed. An in-line disposable filter is recommended.
- Polyethylene sheeting which will be placed on ground around the well head.
- Personal protective equipment specified in the site Health and Safety Plan.
- Air monitoring equipment as specified in the Site Health and Safety Plan.
- Tool box - All needed tools for all site equipment used.
- A 55-gallon drum or container to contain the purged water.

Materials of construction of the sampling equipment (bladders, pumps, tubing, and other equipment that comes in contact with the sample) should be limited to stainless steel, Teflon®, glass and other inert material. This will reduce the chance of the sampling materials to alter the ground-water where concentrations of the site contaminants are expected to be near the detection limits. The sample tubing diameter thickness should be maximized and the tubing length should be minimized so that the loss of contaminants into and through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of material makes the appropriate selection of sample tubing material critical for trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998).

PURGING AND SAMPLING PROCEDURES

The following describes the purging and sampling procedures for the Low-Stress (Low Flow)/ Minimal Drawdown method for the collection of ground-water samples. These procedures also describe steps for dedicated and non-dedicated systems.

<u>Pre-Sampling Activities</u> (Non-dedicated and dedicated system)

1. Sampling locations must begin at the monitoring well with the least contamination, generally up-gradient or furthest from the site or suspected source. Then proceed systematically to the monitoring wells with the most contaminated ground water.

2. Check and record the condition of the monitoring well for damage or evidence of tampering. Lay out polyethylene sheeting around the well to minimize the likelihood of contamination of sampling/purging equipment from the soil. Place monitoring, purging and sampling equipment on the sheeting.

3. Unlock well head. Record location, time, date and appropriate information in a field logbook or on the ground-water sampling log (See attached ground-water sampling record and ground-water sampling log as examples).

4. Remove inner casing cap.

5. Monitor the headspace of the monitoring well at the rim of the casing for volatile organic compounds (VOC) with a Photo-ionization detector (PID) or Flame ionization detector (FID), and record in the logbook. If the existing monitoring well has a history of positive readings of the headspace, then the sampling must be conducted in accordance with the Health and Safety Plan.

6. Measure the depth to water (water level must be measured to nearest 0.01 feet) relative to a reference measuring point on the well casing with an electronic water level indicator or steel tape and record in logbook or ground-water sampling log. If no reference point is found, measure relative to the top of the inner casing, then mark that reference point and note that location in the field logbook. Record information on depth to ground water in the field logbook or ground water sampling log. Measure the depth to water a second time to confirm initial measurement; measurement should agree within 0.01 feet or re-measure.

7. Check the available well information or field information for the total depth of the monitoring well. Use the information from the depth of water in step six and the total depth of the monitoring well to calculate the volume of the water in the monitoring well or the volume of one casing. Record information in field logbook or ground-water sampling log.

Purging and Sampling Activities

8A. Non-dedicated system - Place the pump and support equipment at the wellhead and slowly lower the pump and tubing down into the monitoring well until the location of the pump intake is set at a pre-determined location within the screen interval. The placement of the pump intake should be positioned with a calibrated sampling pump hose, sounded with a weighted-tape, or using a pre-measured hose. Refer to the available monitoring well information to determine the depth and length of the screen interval. Measure the depth of the pump intake while lowering the pump into location. Record pump location in field logbook or groundwater sampling log.

8B. Dedicated system - Pump has already been installed, refer to the available monitoring well information and record the depth of the pump intake in the field logbook or ground-water sampling log.

9. Non-dedicated system and dedicated system - Measure the water level (water level must be measured to nearest 0.01 feet) and record information on the ground-water sampling log, leave water level indicator probe in the monitoring well.

10. Non-dedicated and dedicated system - Connect the discharge line from the pump to a flow-through cell. A "T" connection is needed prior to the flow cell to allow for the collection of water for the turbidity measurements. The discharge line from the flow-through cell must be directed to a container to contain the purge water during the purging and sampling of the monitoring well.

11. Non-dedicated and dedicated system - Start pumping the well at a low flow rate (0.2 to 0.5 liter per minute) and slowly increase the speed. Check water level. Maintain a steady flow rate while maintaining a drawdown of less than 0.33 feet (Puls and Barcelona, 1996). If drawdown is greater than 0.33 feet lower the flow rate. 0.33 feet is a goal to help guide with the flow rate adjustment. It should be noted that this goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience (Puls and Barcelona, 1996).

12. Non-dedicated and dedicated system - Measure the discharge rate of the pump with a graduated cylinder and a stop watch. Also, measure the water level and record both flow rate and water level on the groundwater sampling log. Continue purging, monitor and record water level and pump rate every three to five minutes during purging. Pumping rates should be kept at minimal flow to

ensure minimal drawdown in the monitoring well.

13. Non-dedicated and dedicated system - During the purging, a minimum of one tubing volume (including the volume of water in the pump and flow cell) must be purged prior to recording the water-quality indicator parameters. Then monitor and record the water-quality indicator parameters every three to five minutes. The water-quality indicator field parameters are turbidity, dissolved oxygen, specific electrical conductance, pH, redox-potential and temperature. Oxidation-reduction potential may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions. Also, for the final dissolved oxygen measurement, if the readings are less than 1 milligram per liter, it should be collected and analyze with the spectrophotometric method (Wilde et al., 1998 Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). The stabilization criterion is based on three successive readings of the water quality field parameters; the following are the criteria which must be used:

Parameter	**Stabilization Criteria**	**Reference**
pH	± 0.1 pH units	Puls and Barcelona, 1996; Wilde et al.,
Specific electrical conductance (SEC)	± 3% •S/cm	Puls and Barcelona, 1996
oxidation-reduction potential (ORP)	± 10 millivolts	Puls and Barcelona 1996
turbidity	± 10 % NTUs (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996 Wilde et al., 1998
dissolved oxygen	± 0.3 milligrams per liter	Wilde et al., 1998

Once the criteria have been successfully met indicating that the water quality indicator parameters have stabilized, then sample collection can take place.

14. If a stabilized drawdown in the well can't be maintained at 0.33 feet and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is shut off. Under no circumstances should the well be

pumped dry. Begin pumping at a lower flow rate, if the water draws-down to the top of the screened interval again turn pump off and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging then sampling can proceed next time the pump is turned on. This information should be noted in the field notebook or ground-water sampling log with a recommendation for a different purging and sampling procedure.

15. Non-dedicated and dedicated system - Maintain the same pumping rate or reduce slightly for sampling (0.2 to 0.5 liter per minute) in order to minimize disturbance of the water column. Samples should be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. Disconnect the pump's tubing from the flow-through-cell so that the samples are collected from the pump's discharge tubing. For samples collected for dissolved gases or Volatile Organic Compounds (VOCs) analyses, the pump's tubing needs to be completely full of ground water to prevent the ground water from being aerated as the ground water flows through the tubing. The sequence of the samples is immaterial unless filtered (dissolved) samples are collected and they must be collected last (Puls and Barcelona, 1996). All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container. When filling the VOC samples a meniscus must be formed over the mouth of the vial to eliminate the formation of air bubbles and head space prior to capping. In the event that the ground water is turbid,(greater then 10 NTUs), a filtered metal (dissolved) sample also should be collected.

If filtered metal sample is to be collected, then an in-line filter is fitted at the end of the discharge tubing and the sample is collected after the filter. The in-line filter must be pre-rinsed following manufacturer's recommendations and if there are no recommendations for rinsing, a minimum of 0.5 to 1 liter of ground water from the monitoring well must pass through the filter prior to sampling.

16A. Non-dedicated system - Remove the pump from the monitoring well. Decontaminate the pump and dispose of the tubing if it is non-dedicated.

16B Dedicated system - Disconnect the tubing that extends from the plate at the wellhead (or cap) and discard after use.

17. Non-dedicated system - Before locking the monitoring well, measure and record the well depth (to 0.1 feet).
Measure the total depth a second time to confirm initial measurement; measurement should agree within 0.01 feet or re-measure.

18. Non-dedicated and dedicated system - Close and lock the well.

DECONTAMINATION PROCEDURES

Decontamination procedures for the water level meter and the water quality field parameter sensors.
The electronic water level indicator probe/steel tape and the water-quality field parameter sensors will be decontaminated by the following procedures:
1. The water level meter will be hand washed with phosphate free detergent and a scrubber, then thoroughly rinsed with distilled water.

2. Water quality field parameter sensors and flow-through cell will be rinsed with distilled water between sampling locations. No other decontamination procedures are necessary or recommended for these probes since they are sensitive. After the sampling event, the flow cell and sensors must be cleaned and maintained per the manufacturer's requirements.

Decontamination Procedure for the Sampling Pump

Upon completion of the ground water sample collection the sampling pump must be properly decontaminated between monitoring wells. The pump and discharge line including support cable and electrical wires which were in contact with the ground water in the well casing must be decontaminated by the following procedure:

1. The outside of the pump, tubing, support cable and electrical wires must be pressured sprayed with soapy water, tap water and distilled water. Spray outside of tubing and pump until water is flowing off of tubing after each rinse. Use bristle brush to help remove visible dirt and contaminants.
2. Place the sampling pump in a bucket or in a short PVC casing (4-in. diameter) with one end capped. The pump placed in this device must be completely submerged in the water. A small amount of phosphate free detergent must be added to the potable water

(tap water).

3. Remove the pump from the bucket or 4-in. casing and scrub the outside of the pump housing and cable.

4. Place pump and discharge line back in the 4-in. casing or bucket, start pump and re-circulate this soapy water for 2 minutes (wash).

5. Re-direct discharge line to a 55-gallon drum, continue to add 5 gallons of potable water (tap water)or until soapy water is no longer visible.

6. Turn pump off and place pump into a second bucket or 4-in. Casing which contains tap water, continue to add 5-gallons of tap water (rinse).

7. Turn pump off and place pump into a third bucket or 4-in. casing which contains distilled/deionized water, continue to add three to five gallons of distilled/deionized water (final rinse).

8. If a hydrophobic contaminant is present (such as separate phase, high levels of PCB's, etc.) An additional decon step, or steps, may be added. For example, an organic solvent, such as reagent-grade isopropanol alcool may be added as a first spraying/bucket prior to the soapy water rinse/bucket.

FIELD QUALITY CONTROL

Quality control (QC) samples must be collected to verify that sample collection and handling procedures were performed adequately and that they have not compromised the quality of the ground water samples. The appropriate EPA program guidance must be consulted in preparing the field QC sample requirements for the site-specific Quality Assurance Project Plan (QAPP).

There are five primary areas of concern for quality assurance (QA) in the collection of representative ground-water samples:

1. Obtaining a ground-water sample that is representative of the aquifer or zone of interest in the aquifer. Verification is based on the field log documenting that the field water-quality parameters stabilized during the purging of the well, prior to sample collection.
2. Ensuring that the purging and sampling devices are made of materials, and utilized in a manner, which will not interact with or alter the analyses.
3. Ensuring that results generated by these procedures are reproducible; therefore, the sampling scheme should incorporate co-located samples (duplicates).

4. Preventing cross-contamination. Sampling should proceed from least to most contaminated wells, if known. Field equipment blanks should be incorporated for all sampling and purging equipment, and decontamination of the equipment is therefore required.
5. Properly preserving, packaging, and shipping samples.

All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The chain of custody procedures for the QC samples will be identical to the field ground water samples. The following are quality control samples which must be collected during the sampling event:

Sample Type	Frequency
Field duplicates	1 per 20 samples
Matrix spike	1 per 20 samples
Matrix spike duplicate	1 per 20 samples
Equipment blank	Per Regional requirements or policy
Trip blank (VOCs)	1 per sample cooler
Temperature blank	1 per sample cooler

HEALTH AND SAFETY CONSIDERATIONS

Depending on the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. The site Health and Safety Plan should be reviewed with specific emphasis placed on the protection program planned for the sampling tasks. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the liquid and vapor phase through the use of appropriate personal protective equipment.

Depending on the type of contaminants expected or determined in previous sampling efforts, the following safe work practices will be employed:

Particulate or metals contaminants

1. Avoid skin contact with, and incidental ingestion of, purge water.
2. Use protective gloves and splash protection.

Volatile organic contaminants

1. Avoid breathing constituents venting from well.
2. Pre-survey the well head space with an appropriate device as specified in the Site Health and Safety Plan.
3. If monitoring results indicate elevated organic constituents, sampling activities may be conducted in level C protection. At a minimum, skin protection will be afforded by disposable protective clothing, such as Tyvek®.

General, common practices should include avoiding skin contact with water from preserved sample bottles, as this water will have pH less than 2 or greater than 10. Also, when filling pre-acidified VOA bottles, hydrochloric acid fumes may be released and should not be inhaled.

POST-SAMPLING ACTIVITIES

Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to:

1. Ensure that all field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
2. All sample paperwork should be processed, including copies provided to the Regional Laboratory, Sample Management Office, or other appropriate sample handling and tracking facility.
3. All field data should be complied for site records.
4. All analytical data when processed by the analytical laboratory, should be verified against field sheets to ensure all data has been returned to sampler.

REFERENCES

Gibs, J. and T.E. Imbrigiotta, 1990, Well-Purging Criteria for Sampling Purgeable Organic Compounds; Ground Water, Vol. 28, No. 1, pp 68-78.

Pohlmann, K.F. and A.J. Alduino, 1992, Ground-Water Issue Paper: Potential Sources of Error in Ground-Water Sampling at Hazardous Waste Sites, EPA/540/S-92/019.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal

Drawdown) Ground-Water Sampling Procedure, EPA/540/S-95/504, 12 pp.

Schuller, R.M., J.P. Gibb and R.A Griffin, 1981, Recommended Sampling Procedures for Monitoring Wells; Ground Water Monitoring Review, Spring 1981, pp. 42-46.

Parker, L.V. and T.A. Ranney, 1998, Sampling Trace-Level Organic Solutes with Polymeric Tubing: Part 2, Dynamic Studies; Ground Water Monitoring and Remediation, Vol. 18, No. 1, pp. 148-155.

U.S. Environmental Protection Agency, 1986, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document; OSWER-9950.1, U.S. Government Printing Office, Washington, D.C., 208 pp., appendices.

U.S. Environmental Protection Agency, 1995, Ground Water Sampling - A Workshop Summary, Texas, November 30-December 2, 1993, EPA/600/R-94/205, 146 pp.

U.S. Environmental Protection Agency Region 1, 1996, Low Stress (low flow) Purging and Sampling Produre For the collection of Ground water Samples From Monitoring Wells, SOP#: GW 0001, July 30, 1996.

U.S. Environmental Protection Agency Region 2, 1998, Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, GW Sampling SOP Final, March 16, 1998.

Wilde, F.D., D.B. Radtke, J.Gibs and R.T. Iwatsubo, eds., 1998, National Field Manual for the Collection of Water-Quality Data; U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Handbooks for Water-Resources Investigations, variously paginated.

Wilkin, R.T., M.S. McNeil, C.J. Adair and J.T. Wilson, 2001, Field Measurement of Dissolved Oxygen: A Comparison of Methods, Ground Water Monitoring and Remediation, Vol. 21, No. 4, pp. 124-132.

SAMPLING CHECKLIST

Well Identification:____________________________

Map of Site Included: Y or N
Wells Clearly Identified w/ Roads: Y or N
Well Construction Diagram Attached: Y or N

Well Construction:

Diameter of Borehole:_________ Diameter of Casing:____________
Casing Material:______________ Screen Material:________________

Screen Length:______________ Total Depth:_______________

Approximate Depth to Water:______________
Maximum Well Development Pumping Rate:__________________
Date of Last Well Development:______________

Previous Sampling Information:

Was the Well Sampled Previously: Y or N
(If Sampled, Fill Out Table Below)

Table of Previous Sampling Information				
Parameter	Previously Sampled	Number of Times Sampled	Maximum Concentration	Notes (include previous purge rates)

Ground-Water Sampling Log

Site Name: **Well #:** **Date:**

Well Depth(Ft-BTOC[1]): **Screen Interval**(Ft):

Well Dia.: **Casing Material:** **Sampling Device:**

Pump placement(Ft from TOC[2]):

Measuring Point: **Water level (static)**(Ft):

ATTACHMENT I

Low Flow Groundwater Sampling Procedures

United States
Environmental Protection
Agency

Office of
Research and
Development

Office of Solid Waste
and Emergency
Response

EPA/540/S-95/504
April 1996

EPA Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

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I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

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chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

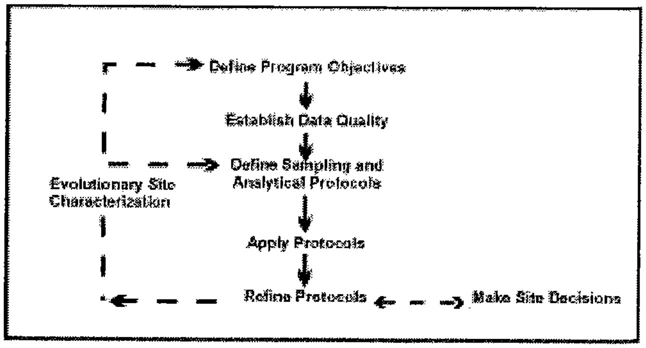

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action.*

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g. , pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:

- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

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VIII. References

Backhus, D,A., J.N. Ryan, D.M. Groher, J.K. McFarlane, and P.M. Gschwend. 1993. Sampling Colloids and Colloid-Associated Contaminants in Ground Water. *Ground Water*, 31(3):466-479.

Barcelona, M.J., J.A. Helfrich, E.E. Garske, and J.P. Gibb. 1984. A laboratory evaluation of groundwater sampling mechanisms. *Ground Water Monitoring Review*, 4(2):32-41.

Barcelona, M.J. and J.A. Helfrich. 1986. Well construction and purging effects on ground-water samples. *Environ. Sci. Technol.,* 20(11):1179-1184.

Barcelona, M.J., H.A. Wehrmann, and M.D. Varljen. 1994. Reproducible well purging procedures and VOC stabilization criteria for ground-water sampling. *Ground Water*, 32(1):12-22.

Buddemeier, R.W. and J.R. Hunt. 1988. Transport of Colloidal Contaminants in Ground Water: Radionuclide Migration at the Nevada Test Site. *Applied Geochemistry*, 3: 535-548.

Danielsson, L.G. 1982. On the Use of Filters for Distinguishing Between Dissolved and Particulate Fractions in Natural Waters. *Water Research*, 16:179.

Enfield, C.G. and G. Bengtsson. 1988. Macromolecular Transport of Hydrophobic Contaminants in Aqueous Environments. *Ground Water,* 26(1): 64-70.

Gschwend, P.M. and M.D. Reynolds. 1987. Monodisperse Ferrous Phosphate Colloids in an Anoxic Groundwater Plume, *J. of Contaminant Hydrol.,* 1: 309-327.

Herzog, B., J. Pennino, and G. Nielsen. 1991. Ground-Water Sampling. In **Practical Handbook of Ground-Water Monitoring** (D.M. Nielsen, ed.). Lewis Publ., Chelsea, MI, pp. 449-499.

Horowitz, A.J., K.A. Elrick, and M.R. Colberg. 1992. The effect of membrane filtration artifacts on dissolved trace element concentrations. *Water Res.,* 26(6):753-763.

Laxen, D.P.H. and I.M. Chandler. 1982. Comparison of Filtration Techniques for Size Distribution in Freshwaters. *Analytical Chemistry*, 54(8):1350.

McCarthy, J.F. and J.M. Zachara. 1989. Subsurface Transport of Contaminants, *Environ. Sci. Technol.*, 5(23):496-502.

McCarthy, J.F. and C. Degueldre. 1993. Sampling and Characterization of Colloids and Ground Water for Studying Their Role in Contaminant Transport. In: Environmental Particles (J. Buffle and H.P. van Leeuwen, eds.), Lewis Publ., Chelsea, MI, pp. 247-315.

Parker, L.V. 1994. The Effects of Ground Water Sampling Devices on Water Quality: A Literature Review. *Ground Water Monitoring and Remediation*, 14(2):130-141.

Penrose, W.R., W.L. Polzer, E.H. Essington, D.M. Nelson, and K.A. Orlandini. 1990. Mobility of Plutonium and Americium through a Shallow Aquifer in a Semiarid Region, *Environ. Sci. Technol.*, 24:228-234.

Puls, R.W. and M.J. Barcelona. 1989. Filtration of Ground Water Samples for Metals Analyses. *Hazardous Waste and Hazardous Materials,* 6(4):385-393.

Puls, R.W., J.H. Eychaner, and R.M. Powell. 1990. Colloidal-Facilitated Transport of Inorganic Contaminants in Ground Water: Part I. Sampling Considerations. EPA/600/M-90/023, NTIS PB 91-168419.

Puls, R.W. 1990. Colloidal Considerations in Groundwater Sampling and Contaminant Transport Predictions. *Nuclear Safety*, 31(1):58-65.

Puls, R.W. and R.M. Powell. 1992. Acquisition of Representative Ground Water Quality Samples for Metals. *Ground Water Monitoring Review,* 12(3):167-176.

Puls, R.W., D.A. Clark, B.Bledsoe, R.M. Powell, and C.J. Paul. 1992. Metals in Ground Water: Sampling Artifacts and Reproducibility. *Hazardous Waste and Hazardous Materials,* 9(2): 149-162.

Puls, R.W. and C.J. Paul. 1995. Low-Flow Purging and Sampling of Ground-Water Monitoring Wells with Dedicated Systems. *Ground Water Monitoring and Remediation,* 15(1):116-123.

Ryan, J.N. and P.M. Gschwend. 1990. Colloid Mobilization in Two Atlantic Coastal Plain Aquifers. *Water Resour. Res.*, 26: 307-322.

Thurnblad, T. 1994. Ground Water Sampling Guidance: Development of Sampling Plans, Sampling Protocols, and Sampling Reports. Minnesota Pollution Control Agency.

U. S. EPA. 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste, Washington, DC EPA/530/R-93/001, NTIS PB 93-139350.

U. S. EPA. 1995. Ground Water Sampling Workshop -- A Workshop Summary, Dallas, TX, November 30 - December 2, 1993. EPA/600/R-94/205, NTIS PB 95-193249, 126 pp.

U. S. EPA. 1982. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846. Office of Solid Waste and Emergency Response, Washington, D.C.

Figure 2. **Ground Water Sampling Log**

Project ________________ **Site** ________________ **Well No.** ______________ **Date** ___________________________
Well Depth _____________ **Screen Length** __________ **Well Diameter** __________ **Casing Type** ____________
Sampling Device ________________ **Tubing type** _______________________ **Water Level** ___________________
Measuring Point ____________________ **Other Infor** ____
____
Sampling Personnel ____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc			Notes

Type of Samples Collected

____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi\ r^3$

Figure 3. **Ground Water Sampling Log** (with automatic data logging for most water quality parameters)

Project ______________ **Site** ______________ **Well No.** ____________ **Date** ________________________
Well Depth ___________ **Screen Length** _________ **Well Diameter** ________ **Casing Type** __________
Sampling Device ______________ **Tubing type** ____________________ **Water Level** ________________
Measuring Point _________________ **Other Infor** ____

Sampling Personnel ____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

Type of Samples Collected

____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$