GW - 14

MONITORING REPORTS

DATE:

1999 - 1995

1999 Annual Groundwater Monitoring and Sampling and Remediation System Performance Report
Navajo Refining Company – Lea Refinery
Lea County, New Mexico

JANUARY 12, 2000

Prepared For:

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1999 Annual Groundwater Monitoring and Sampling and Remediation System Performance Report
Navajo Refining Company - Lea Refinery
Lea County, New Mexico

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1.0 EXECUTIVE SUMMARY

TRW Inc. (TRW), was retained by Navajo Refining Company (Navajo) to perform groundwater sampling and monitoring of the remediation system at the Lea Refinery located in Lovington, New Mexico. This 1999 annual report documents the four quarterly sampling events performed by TRW at the Navajo Lea Refinery on February 16, 1999; April 21, 1998; August 16, 1999; and November 23, 1999. The report also contains the historical groundwater elevation and analytical data for the life of the project that began in September 1995. This monitoring and sampling program was conducted in accordance with the guidelines specified by Mr. Bill Olson of the New Mexico Oil Conservation Division (OCD) in his letters dated November 21, 1996 and March 26, 1998.

Based on the sampling and monitoring data to date, the following conclusions relevant to groundwater conditions and remediation system performance at the Lea Refinery are evident:

- Benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations in upgradient monitoring wells MW-2 and MW-4 have remained at levels below the laboratory detection limits and below New Mexico Water Quality Control Commission (WQCC) standards.

- BTEX concentrations in downgradient wells MW-5, MW-6, MW-8, and MW-10 have also remained at levels near or below the laboratory detection limits and below WQCC standards.

- Benzene concentrations in MW-9 fluctuate over time but have declined from a high of 1.69 mg/L in April 1996 to its lowest levels of below laboratory detection limits during the first, third, and fourth quarter sampling events during 1999. This significant decrease has been attributed to the successful operation of the air sparge/vapor extraction (AS/VE) system.

- BTEX concentrations in downgradient well MW-3 have also remained at levels near or below the laboratory detection limit and below WQCC standards, with the exception of the November 23, 1999, sampling event. It is suspected that the BTEX increase during this fourth quarter sampling event represents the downgradient movement of a limited slug of contaminants that was observed in upgradient well MW-9 during the August 14, 1997. The next two quarterly sampling events should reveal that the slug has passed the area of MW-3 and that BTEX concentrations are attenuating toward levels below WQCC standards.

- A boron concentration of 0.84 mg/L in MW-8 slightly exceeded the WQCC standard of 0.75 mg/L. The source of boron is unknown.

- Chloride concentrations in MW-3 (580 mg/L) and MW-9 (420 mg/L) exceeded the WQCC standard of 250 mg/L. These choride levels are consistent with the supposition that a limited and attenuating slug of contaminants has migrated downgradient from MW-9 to MW-3.

- Fluoride concentrations varied from 0.92 mg/L in MW-3 to 2.6 mg/L in MW-8. Fluoride levels in monitoring wells MW6, MW-8, and MW-9 are equal to or slightly exceed the WQCC standard of 1.6 mg/L. Since fluoride is not a constituent for the refinery processes on site, its presence is likely due to natural conditions as it is a common natural occurrence in groundwater (1989, USGS Water-Supply Paper 2254, pg. 120-123).

- Monitoring well MW-6 had a vanadium concentration of 0.35 mg/L, which exceeds the WQCC standard of 0.05 mg/L. Since vanadium is not a constituent for the refinery processes on site, this anomaly is most likely due to its natural occurrence.

- The WQCC standard for TDS (1,000 mg/L) was exceeded in MW-3 (1,300 mg/L) and MW-9 (1,100 mg/L). As suggested by increased levels of BTEX and chlorides in MW-3, these TDS levels are consistent with the supposition that a limited and attenuating slug of contaminants has migrated downgradient from MW-9 to MW-3. Background TDS concentrations in Lea County typically range from 500 mg/L to 3,000 mg/L.

- Based on the analytical results of the VE exhaust and measured flow rates, the VE system has recovered an estimated 19,514 kilograms (8,870 LB) of total volatile hydrocarbons (TVHC) since the startup of the system on October 2, 1996.

- Approximately 167.8 gallons of free product has been recovered since installation of the Xitech product recovery system in recovery well RW-1 on January 21, 1998.

- Product recovery rates appear to decreasing due to the declining volume of free product in the free product plume as evidenced by the decreasing product thickness trend in MW-1 and MW-7. Free product thickness in MW-1 and MW-7 have fluctuated since October 1996, but have generally declined to the present thickness of 0.82 feet and 0.14 feet, respectively.

- During 1999, groundwater temperatures within the hydrocarbon plume (MW-1, MW-6, and MW-7) have stabilized to an average of 13°F above those outside of the plume. This reflects an approximate decrease of approximately 12°F from 1997 temperatures. A dye trace test and ground temperature survey conducted in early 1999 did not reveal a source for the elevated groundwater temperatures.

Based on the sampling and monitoring data to date, the following recommendations are suggested for the remediation system and monitoring operations at the Lea Refinery.

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- Continue product recovery operations since the present system has been effective in recovering 167.8 gallons of free product from RW-1.

- Although the free product recovery system is performing as designed, free product and elevated groundwater temperatures remain present near recovery well RW-1; therefore BTEX levels may indeed increase in the downgradient wells during subsequent sampling events. This situation can be closely monitored by continuing the quarterly sampling program. The air sparge/vapor extraction system should be restarted if BTEX concentrations in monitoring wells MW-6 and MW-9 rebound to levels above WQCC standards.

- Continue the sampling and monitoring program on a quarterly basis. The next sampling event is scheduled during the first quarter of 2000.

2.0 CHRONOLOGY OF EVENTS

August 1995	Navajo discovered a pipe leak at a sewer junction box near the API separator system.
September 1995	Navajo initiated an investigation to determine the horizontal and vertical extent of the hydrocarbon release from the sewer junction box. The investigation included the installation and sampling of nine soil borings (B-1 through B-9) and seven monitoring wells (MW-1 through MW-7).
October 25, 1995	Navajo retained Geoscience Consultants, Ltd. (GCL) to design, install, and maintain a remediation system at the Lea Refinery.
December 12, 1995	GCL submitted the remediation work plan to Navajo. The work plan addressed the remediation and additional investigation plans for the hydrocarbon-impacted groundwater at the Lea Refinery.
December 14, 1995	Navajo submitted the remediation work plan to the OCD.
February 9, 1996	Navajo submitted the revised remediation work plan to the OCD.
March 18, 1996	The OCD approved the remediation work plan for Lea Refinery.
April 1996	GCL installed a groundwater recovery well (RW-1), eight AS/VE wells (AS-1 through AS-8), and three additional monitoring wells (MW-8, MW-9, and MW-10).
April 23, 1996	GCL conducted the second quarter 1996 sampling event at Lea Refinery.
October 1, 1996	GCL completed the installation of the remediation system at the Lea Refinery and the system began operation.
October 11, 1996	GCL submitted the *Soil and Groundwater Investigation and Remediation Work Plan* to the OCD.
November 19, 1996	GCL conducted the fourth quarter 1996 sampling event at Lea Refinery.
November 21, 1996	The OCD approved the remediation work plan.
January 20, 1997	BDM International, Inc. (formerly GCL) conducted the first quarter 1997 sampling event at Lea Refinery.
April 16, 1997	BDM International, Inc. (BDM) conducted the second quarter 1997 sampling event at Lea Refinery.

August 14, 1997 BDM conducted the third quarter 1997 sampling event at Lea Refinery.

October 28, 1997	BDM conducted the fourth quarter 1997 sampling event at Lea Refinery.

January 21, 1998	TRW (formerly BDM) conducted the first quarter 1998 sampling event at Lea Refinery.
April 23, 1998	TRW conducted the second quarter 1998 sampling event at Lea Refinery.
August 4, 1998	TRW conducted the third quarter 1998 sampling event at Lea Refinery.
October 28, 1998	TRW conducted the fourth quarter 1998 sampling event at Lea Refinery.
December 14, 1998	Dye tracer test was performed by placing approximately 2½ pounds (lbs.) of yellow-green dye into the oily water side of the API sump to assist in identifying the source for the elevated groundwater temperatures observed on site.
January 18, 1999	Approximately 2 lbs. of red dye was placed on the clean water side of the API sump.
Dec 1998 - Feb 1999	Weekly inspection of groundwater samples did not reveal presence of dye that might indicate the API sump as a potential source for elevated groundwater temperatures observed in RW-1, MW-1, MW-6, and MW-7.
February 16, 1999	TRW conducted the first quarter 1999 sampling event at Lea Refinery.
February 19, 1999	A ground temperature survey did not reveal any anomalous ground temperatures to indicate a probable source for elevated groundwater temperatures observed in RW-1, MW-1, MW-6, and MW-7.
April 21, 1999	TRW conducted the second quarter 1999 sampling event at Lea Refinery.

August 16, 1999TRW conducted the third quarter 1999 sampling event at Lea Refinery.

August 16, 1999TRW shut down the air sparge/vapor extraction system indefinitely.

November 23, 1999	TRW conducted the fourth quarter 1999 sampling event at Lea Refinery.

3.0 PROCEDURES

The following sampling frequency and remediation schedule was followed to document the groundwater quality conditions and remediation system performance in accordance with the remediation work plan and the OCD letters dated November 21, 1996 and March 26, 1998:

Monthly

- Air injection rates/volumes
- Vapor extraction rates/volumes
- Free product recovery rates from RW-1
- Free product thickness in monitoring wells MW-1 and MW-7 using a Heron Model H0.1L oil/water interface probe

Quarterly

- Vapor extraction sample for BTEX (EPA Method 8021B) and total volatile hydrocarbon (TVHC) analysis (EPA Method 8015-gas range)
- Groundwater samples from MW-3, MW-6, MW-8, MW-9, and MW-10 for BTEX analysis (EPA Method 8021B)
- Dissolved oxygen and temperature for monitoring wells MW-3, MW-6, MW-8, MW-9, and MW-10 using a Hanna Model 9143 DO meter
- Conductivity and pH for monitoring wells MW-3, MW-6, MW-8, MW-9, and MW-10 using a Hydac Model 910 pH/conductivity meter
- Depth to groundwater in monitoring wells MW-1 through MW-10
- Monthly parameters noted above

Annually

- Groundwater samples from MW-2, MW-3, MW-4, MW-5, MW-6, MW-8, MW-9, and MW-10 for BTEX, chloride, fluoride, iron, manganese, nitrate, sulfate, and TDS analysis
- Dissolved oxygen, pH, conductivity, and temperature for monitoring wells MW-1 through MW-10
- Quarterly parameters noted above

Prior to sampling, the on-site monitoring wells (MW-1 through MW-10) were gauged for depth to groundwater and free product thickness using the oil/water interface probe. Immediately prior to collecting groundwater samples, each monitoring well was purged of a minimum of three well casing volumes. The monitoring wells were purged during each sampling event using clean, decontaminated PVC bailers. A summary of purging and sampling methods is provided in Table 1. Groundwater samples were obtained using a new, decontaminated, disposable bailer for each well after purging. Groundwater parameters, including pH, conductivity, temperature, and dissolved oxygen (DO) were measured using a Hydac Model 910 pH/conductivity meter and a Hanna Model 9143 DO/temperature meter.

The first set of water samples were transferred into air-tight, septum-sealed, 40 milliliter glass, volatile organic analysis sample vials with zero head space for analysis of BTEX using EPA Method 8021B. A duplicate sample of MW-9 was collected during each sampling event for BTEX analysis. During the annual sampling event on November 23, 1999, a second and third set of water samples was transferred into appropriately preserved containers for analysis of major ions and WQCC metals. Chain-of-custody (COC) forms documenting sample identification numbers, collection times, and delivery times to the laboratory were completed for each set of samples. The water samples were placed in an ice-filled cooler immediately after collection and shipped to Trace Analysis, Inc. of Lubbock, Texas for laboratory analysis.

Table 1

Summary of Purging and Sampling Methods

Monitoring Well No.	Sample Date	Sample Event	Purge Method	Purge Volume (gallons)	Sampling Method	Groundwater Analytes
MW-2	11/23/99	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX, WQCC Metals, Ions
MW-3	02/16/99	First Quarter	Hand bailer	8	Disposable bailer	BTEX
	04/21/99	Second Quarter	Hand bailer	8	Disposable bailer	BTEX
	08/16/99	Third Quarter	Hand bailer	6	Disposable bailer	BTEX
	11/23/99	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX, WQCC Metals, Ions
MW-4	11/23/99	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX
MW-5	11/23/99	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX
MW-6	02/16/99	First Quarter	Hand bailer	2	Disposable bailer	BTEX
	04/21/99	Second Quarter	Hand bailer	2	Disposable bailer	BTEX
	08/16/99	Third Quarter	Hand bailer	3	Disposable bailer	BTEX
	11/23/99	Fourth Quarter	Hand bailer	2	Disposable bailer	BTEX, WQCC Metals, Ions
MW-8	02/16/99	First Quarter	Hand bailer	8	Disposable bailer	BTEX
	04/21/99	Second Quarter	Hand bailer	8	Disposable bailer	BTEX
	08/16/99	Third Quarter	Hand bailer	7	Disposable bailer	BTEX
	11/23/99	Fourth Quarter	Hand bailer	5	Disposable bailer	BTEX, WQCC Metals, Ions
MW-9	02/16/99	First Quarter	Hand bailer	8	Disposable bailer	BTEX
	04/21/99	Second Quarter	Hand bailer	8	Disposable bailer	BTEX
	08/16/99	Third Quarter	Hand bailer	6	Disposable bailer	BTEX
	11/23/99	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX, WQCC Metals, Ions
MW-10	02/16/99	First Quarter	Hand bailer	8	Disposable bailer	BTEX
	04/21/99	Second Quarter	Hand bailer	8	Disposable bailer	BTEX
	08/16/99	Third Quarter	Hand bailer	6	Disposable bailer	BTEX
	11/23/99	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX, WQCC Metals, Ions

BTEX - benzene, toluene, ethylbenzene, xylenes (EPA Method 8021B)
WQCC Metals - arsenic (As), boron (B), barium (Ba), iron (Fe), manganese (Mn), and vanadium (V).
Ions - chloride (Cl), fluoride (F), nitrate (NO_3), sulfate (SO_4), and total dissolved solids (TDS), .
Monitoring wells MW-1 and MW-7 were not sampled due to presence of phase-separated hydrocarbons.

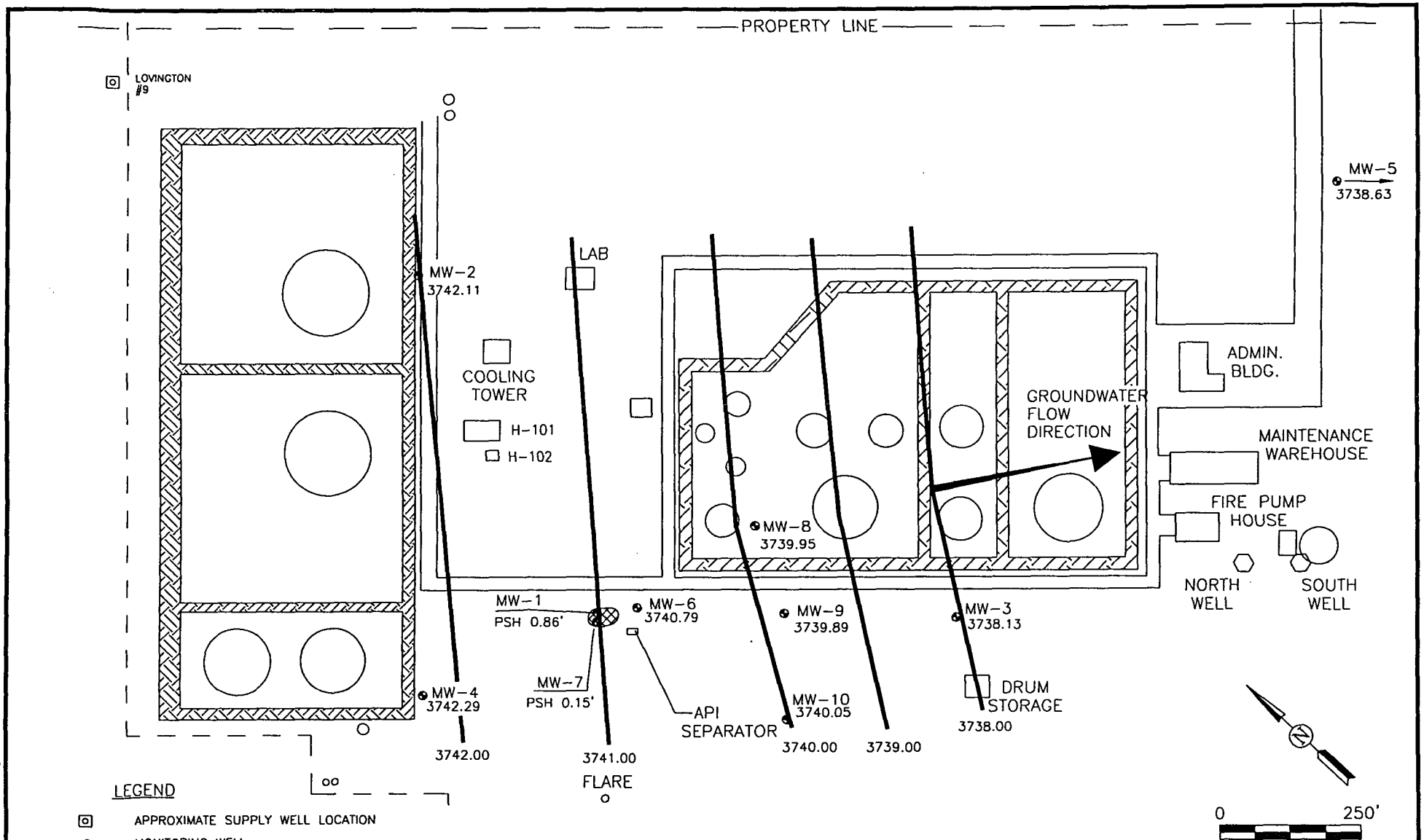
4.0 WATER TABLE ELEVATIONS, HYDRAULIC GRADIENT AND FLOW DIRECTION

Based on the gauging data collected between September 10, 1995 and November 23, 1999, the groundwater conditions at the Lea Refinery are characterized below.

- The depth to the water table across the site varies from approximately 75 to 98 feet below ground surface.
- The hydraulic gradient is approximately 0.0044 feet/foot.
- The direction of groundwater flow is to the southeast.
- The water table elevations have been declining at the rate of approximately 1.35 feet per year for the past 4 years.

The direction of groundwater flow and hydraulic gradient has remained consistent for the past four years. Groundwater elevation maps depicting the water table elevation and direction of groundwater flow using the gauging data obtained during the four 1999 sampling events are presented in Figure 1a (February 16, 1999), Figure 1b (April 21, 1999), Figure 1c (August 16, 1999), and Figure 1d (November 23, 1999). Gauging data for monitoring wells MW-1 and MW-7 were not incorporated into the water table elevation maps due to the presence of free product in these wells.

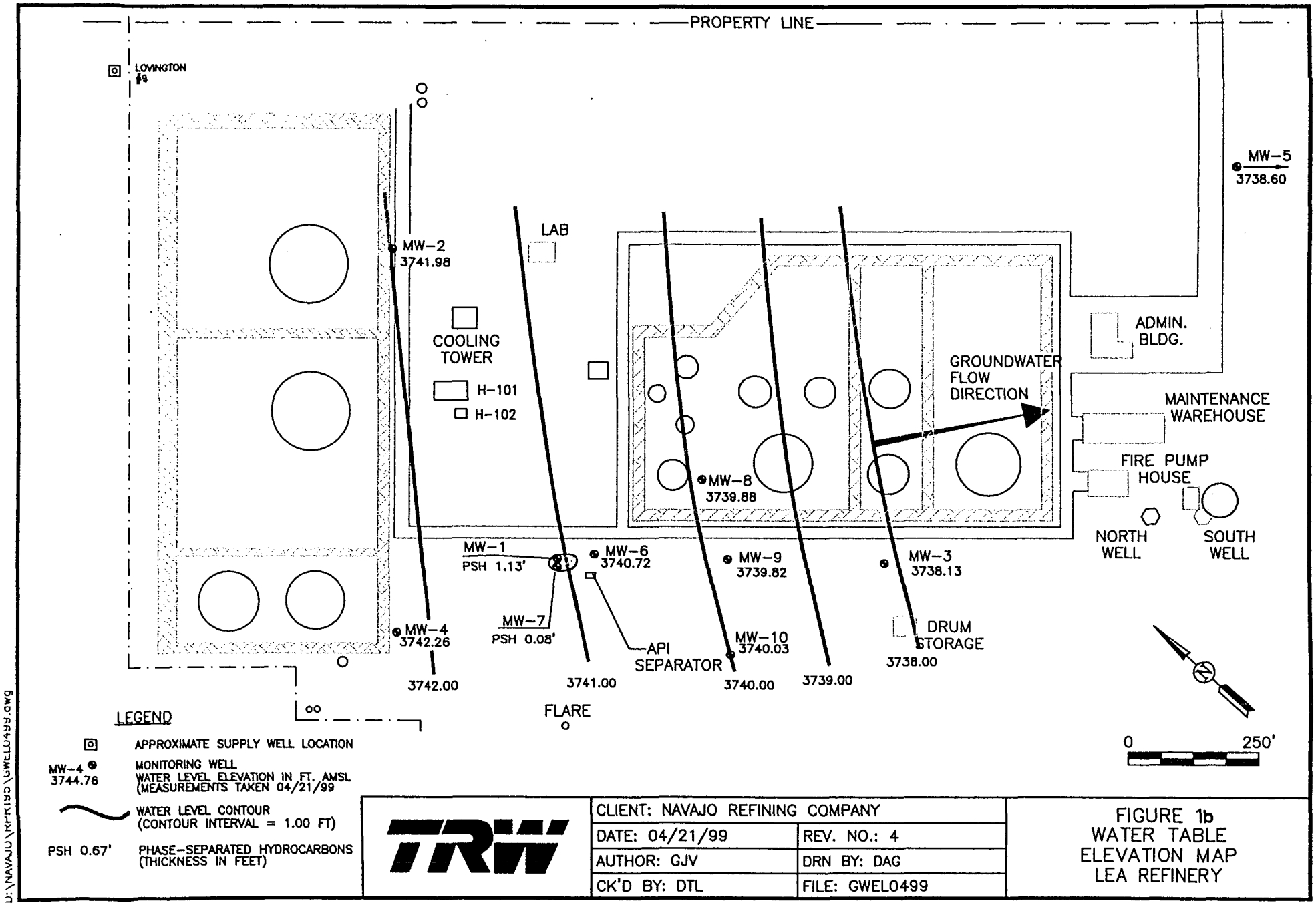
Figure 2 depicts the water table elevation changes over time in monitoring wells MW-1 through MW-10. Historical groundwater elevations and depth to water measurements are summarized in Table 2.



CLIENT: NAVAJO REFINING COMPANY	
DATE: 02/16/99	REV. NO.: 4
AUTHOR: GJV	DRN BY: DAG
CK'D BY: DTL	FILE: GWEL0299

FIGURE 1a
WATER TABLE ELEVATION MAP
LEA REFINERY

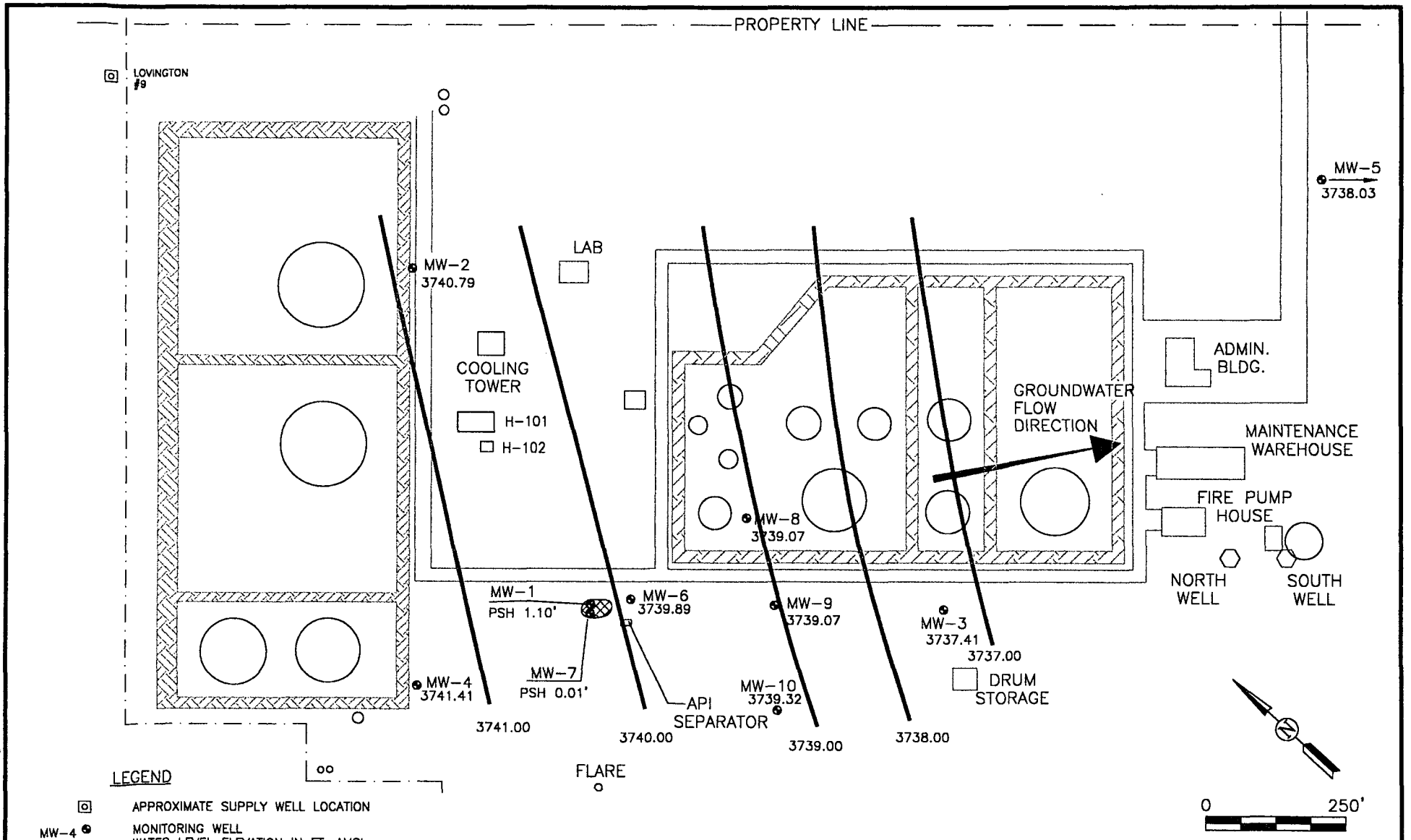
D:\NAVAJO\RPRT95\GWEL0299.dwg



TRW	CLIENT: NAVAJO REFINING COMPANY	
	DATE: 04/21/99	REV. NO.: 4
	AUTHOR: GJV	DRN BY: DAG
	CK'D BY: DTL	FILE: GWEL0499

FIGURE 1b
WATER TABLE
ELEVATION MAP
LEA REFINERY

D:\NAVAJO\APRIL99\GWELL499.dwg



CLIENT: NAVAJO REFINING COMPANY	
DATE: 08/16/99	REV. NO.: 4
AUTHOR: GJV	DRN BY: DAG
CK'D BY: DTL	FILE: GWEL0899

FIGURE 1c
WATER TABLE ELEVATION MAP
LEA REFINERY

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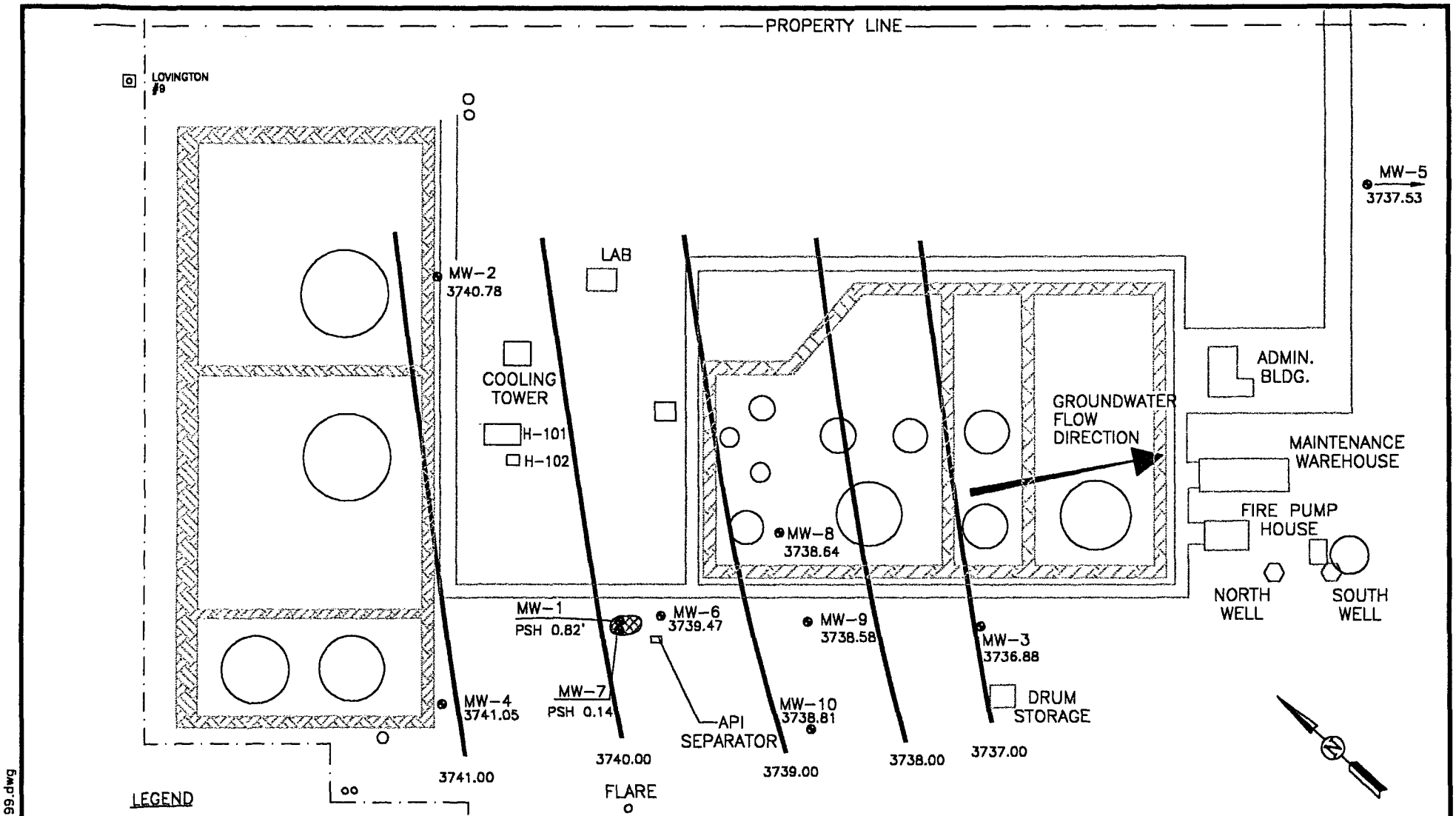


CLIENT: NAVAJO REFINING COMPANY	
DATE: 11/23/99	REV. NO.: 4
AUTHOR: GJV	DRN BY: DAG
CK'D BY: DTL	FILE: GWEL1199

FIGURE 1d
WATER TABLE ELEVATION MAP
LEA REFINERY

D:\NAVAJO\RPRT95\GWEL1199.dwg

FIGURE 2

WATER TABLE ELEVATION VERSUS TIME

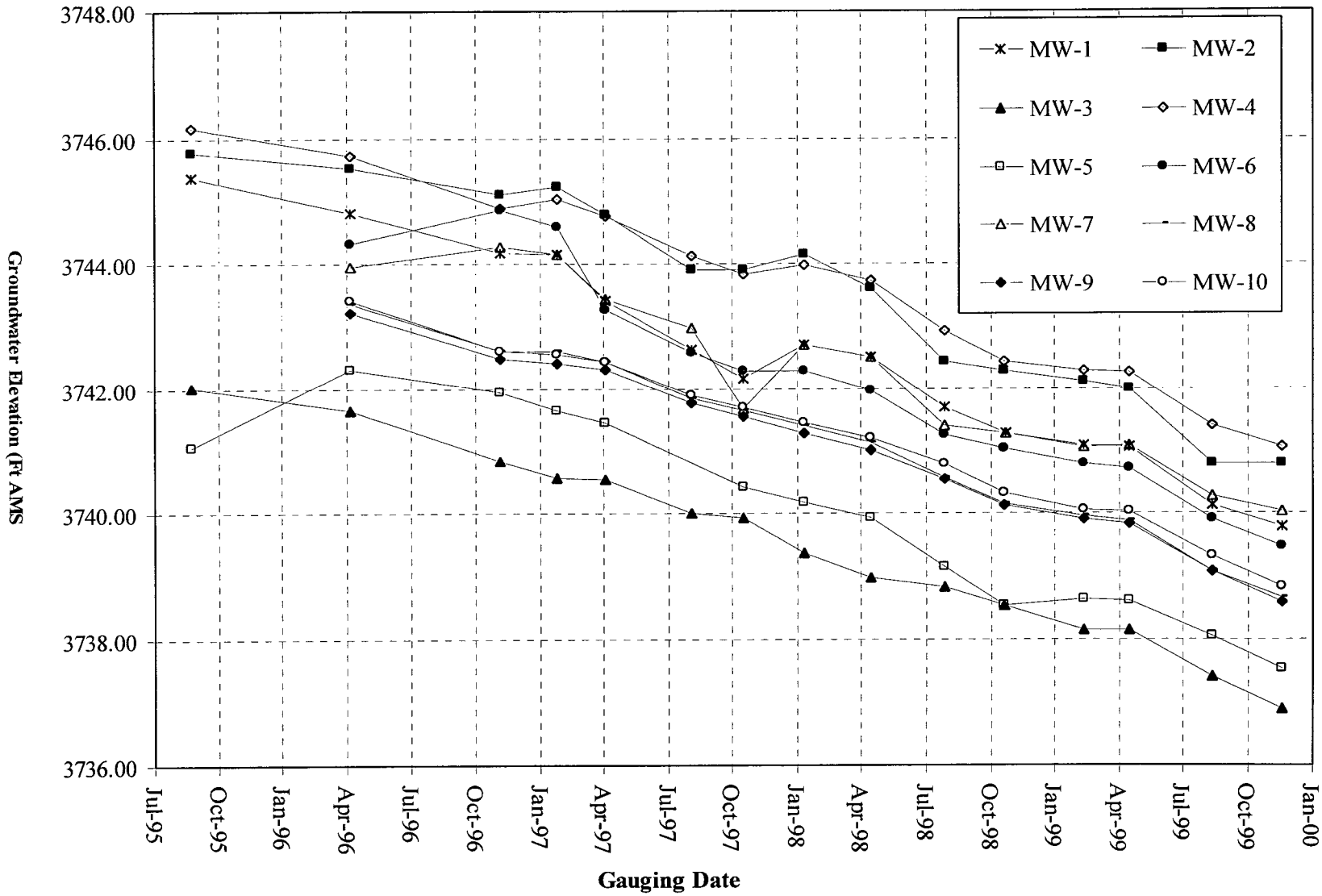


Table 2
Summary of Groundwater Elevations

Monitoring Well	Date Gauged	Relative Ground Surface Elevation (feet)	Relative Top of Casing Elevation (feet)*	Depth to Groundwater Below Top of Casing (feet)	Relative Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-1	09/10/95	3835.90	3835.67	95.89	3745.38	6.44
	04/22/96	3835.90	3835.67	96.49	3744.82	6.48
	11/19/96	3835.90	3835.67	93.57	3744.16	2.37
	02/07/97	3835.90	3835.67	93.39	3744.15	2.15
	04/16/97	3835.90	3835.67	95.49	3743.40	3.70
	08/14/97	3835.90	3835.67	96.23	3742.62	3.66
	10/28/97	3835.90	3835.67	96.88	3742.15	3.86
	01/20/98	3835.90	3835.67	95.07	3742.70	2.41
	04/23/98	3835.90	3835.67	94.75	3742.49	1.81
	08/04/98	3835.90	3835.67	97.13	3741.69	3.62
	10/29/98	3835.90	3835.67	94.98	3741.27	0.67
	02/16/99	3835.90	3835.67	95.35	3741.07	0.86
	04/21/99	3835.90	3835.67	95.60	3741.05	1.13
	08/16/99	3835.90	3835.67	96.50	3740.13	1.10
	11/23/99	3835.90	3835.67	96.60	3739.78	0.82
MW-2	09/10/95	3835.14	3834.94	89.18	3745.76	0.00
	04/22/96	3835.14	3834.94	89.42	3745.52	0.00
	11/19/96	3835.14	3834.94	89.83	3745.11	0.00
	02/07/97	3835.14	3834.94	89.71	3745.23	0.00
	04/16/97	3835.14	3834.94	90.16	3744.78	0.00
	08/14/97	3835.14	3834.94	91.05	3743.89	0.00
	10/28/97	3835.14	3834.94	91.05	3743.89	0.00
	01/20/98	3835.14	3834.94	90.79	3744.15	0.00
	04/23/98	3835.14	3834.94	91.33	3743.61	0.00
	08/04/98	3835.14	3834.94	92.51	3742.43	0.00
	10/28/98	3835.14	3834.94	92.67	3742.27	0.00
	02/16/99	3835.14	3834.94	92.83	3742.11	0.00
	04/21/99	3835.14	3834.94	92.96	3741.98	0.00
	08/16/99	3835.14	3834.94	94.15	3740.79	0.00
	11/23/99	3835.14	3834.94	94.16	3740.78	0.00
MW-3	09/10/95	3829.83	3829.55	87.53	3742.02	0.00
	04/22/96	3829.83	3829.55	87.90	3741.65	0.00
	11/19/96	3829.83	3829.55	88.72	3740.83	0.00
	02/07/97	3829.83	3829.55	88.98	3740.57	0.00
	04/16/97	3829.83	3829.55	89.00	3740.55	0.00
	08/14/97	3829.83	3829.55	89.56	3739.99	0.00
	10/28/97	3829.83	3829.55	89.62	3739.93	0.00
	01/20/98	3829.83	3829.55	90.18	3739.37	0.00
	04/23/98	3829.83	3829.55	90.58	3738.97	0.00
	08/04/98	3829.83	3829.55	90.72	3738.83	0.00
	10/28/98	3829.83	3829.55	91.03	3738.52	0.00
	02/16/99	3829.83	3829.55	91.42	3738.13	0.00
	04/21/99	3829.83	3829.55	91.42	3738.13	0.00
	08/16/99	3829.83	3829.55	92.14	3737.41	0.00
	11/23/99	3829.83	3829.55	92.67	3736.88	0.00
MW-4	09/10/95	3837.85	3837.56	91.40	3746.16	0.00
	04/22/96	3837.85	3837.56	91.84	3745.72	0.00
	11/19/96	3837.85	3837.56	92.67	3744.89	0.00
	02/07/97	3837.85	3837.56	92.54	3745.02	0.00
	04/16/97	3837.85	3837.56	92.80	3744.76	0.00
	08/14/97	3837.85	3837.56	93.43	3744.13	0.00
	10/28/97	3837.85	3837.56	93.73	3743.83	0.00
	01/20/98	3837.85	3837.56	93.59	3743.97	0.00
	04/23/98	3837.85	3837.56	93.84	3743.72	0.00
	08/04/98	3837.85	3837.56	94.65	3742.91	0.00
	10/28/98	3837.85	3837.56	95.14	3742.42	0.00
	02/16/99	3837.85	3837.56	95.27	3742.29	0.00
	04/21/99	3837.85	3837.56	95.30	3742.26	0.00
	08/16/99	3837.85	3837.56	96.15	3741.41	0.00
	11/23/99	3837.85	3837.56	96.51	3741.05	0.00

Table 2 (Continued)
Summary of Groundwater Elevations

Monitoring Well	Date Gauged	Ground Surface Elevation (feet)	Top of Casing Elevation (feet)*	Depth to Groundwater Below Top of Casing (feet)	Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-5	09/10/95	3813.87	3816.88	75.82	3741.06	0.00
	04/22/96	3813.87	3816.88	74.58	3742.30	0.00
	11/19/96	3813.87	3816.88	74.95	3741.93	0.00
	02/07/97	3813.87	3816.88	75.23	3741.65	0.00
	04/16/97	3813.87	3816.88	75.43	3741.45	0.00
	10/28/97	3813.87	3816.88	76.47	3740.41	0.00
	01/20/98	3813.87	3816.88	76.71	3740.17	0.00
	04/23/98	3813.87	3816.88	76.95	3739.93	0.00
	08/04/98	3813.87	3816.88	77.74	3739.14	0.00
	10/28/98	3813.87	3816.88	78.36	3738.52	0.00
	02/16/99	3813.87	3816.88	78.25	3738.63	0.00
	04/21/99	3813.87	3816.88	78.28	3738.60	0.00
	08/16/99	3813.87	3816.88	78.85	3738.03	0.00
	11/23/99	3813.87	3816.88	79.35	3737.53	0.00
MW-6	04/22/96	3835.70	3835.50	91.18	3744.32	0.00
	11/19/96	3835.70	3835.50	90.64	3744.86	0.00
	02/07/97	3835.70	3835.50	90.91	3744.59	0.00
	04/16/97	3835.70	3835.50	92.23	3743.27	0.00
	08/14/97	3835.70	3835.50	92.93	3742.57	0.00
	10/28/97	3835.70	3835.50	93.23	3742.27	0.00
	01/20/98	3835.70	3835.50	93.23	3742.27	0.00
	04/23/98	3835.70	3835.50	93.54	3741.96	0.00
	08/04/98	3835.70	3835.50	94.25	3741.25	0.00
	10/28/98	3835.70	3835.50	94.48	3741.02	0.00
	02/16/99	3835.70	3835.50	94.71	3740.79	0.00
	04/21/99	3835.70	3835.50	94.78	3740.72	0.00
	08/16/99	3835.70	3835.50	95.61	3739.89	0.00
	11/23/99	3835.70	3835.50	96.03	3739.47	0.00
MW-7	04/22/96	3836.07	3835.84	96.56	3743.95	5.37
	11/19/96	3836.07	3835.84	93.13	3744.27	1.79
	02/07/97	3836.07	3835.84	93.05	3744.14	1.55
	04/16/97	3836.07	3835.84	95.57	3743.45	3.65
	08/14/97	3836.07	3835.84	96.30	3742.98	3.95
	10/28/97	3836.07	3835.84	96.38	3741.66	2.53
	01/20/98	3836.07	3835.84	94.82	3742.69	1.92
	04/23/98	3836.07	3835.84	94.68	3742.50	1.54
	08/04/98	3836.07	3835.84	96.49	3741.40	2.36
	10/29/98	3836.07	3835.84	95.49	3741.28	1.07
	02/16/99	3836.07	3835.84	94.91	3741.06	0.15
	04/21/99	3836.07	3835.84	94.83	3741.08	0.08
	08/16/99	3836.07	3835.84	95.59	3740.26	0.01
	11/23/99	3836.07	3835.84	95.94	3740.02	0.14
MW-8	04/22/96	3834.42	3838.09	94.73	3743.36	0.00
	11/19/96	3834.42	3838.09	95.50	3742.59	0.00
	02/07/97	3834.42	3838.09	95.50	3742.59	0.00
	04/16/97	3834.42	3838.09	95.66	3742.43	0.00
	08/14/97	3834.42	3838.09	96.25	3741.84	0.00
	10/28/97	3834.42	3838.09	96.45	3741.64	0.00
	01/20/98	3834.42	3838.09	96.68	3741.41	0.00
	04/23/98	3834.42	3838.09	96.97	3741.12	0.00
	08/04/98	3834.42	3838.09	97.52	3740.57	0.00
	10/28/98	3834.42	3838.09	97.94	3740.15	0.00
	02/16/99	3834.42	3838.09	98.14	3739.95	0.00
	04/21/99	3834.42	3838.09	98.21	3739.88	0.00
	08/16/99	3834.42	3838.09	99.02	3739.07	0.00
	11/23/99	3834.42	3838.09	99.45	3738.64	0.00

Table 2 (Continued)
Summary of Groundwater Elevations
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Gauged	Ground Surface Elevation (feet)	Top of Casing Elevation (feet)*	Depth to Groundwater Below Top of Casing (feet)	Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-9	04/22/96	3833.06	3832.82	89.60	3743.22	0.00
	11/19/96	3833.06	3832.82	90.34	3742.48	0.00
	02/07/97	3833.06	3832.82	90.41	3742.41	0.00
	04/16/97	3833.06	3832.82	90.52	3742.30	0.00
	08/14/97	3833.06	3832.82	91.06	3741.76	0.00
	10/28/97	3833.06	3832.82	91.27	3741.55	0.00
	01/20/98	3833.06	3832.82	91.54	3741.28	0.00
	04/23/98	3833.06	3832.82	91.82	3741.00	0.00
	08/04/98	3833.06	3832.82	92.29	3740.53	0.00
	10/28/98	3833.06	3832.82	92.70	3740.12	0.00
	02/16/99	3833.06	3832.82	92.93	3739.89	0.00
	04/21/99	3833.06	3832.82	93.00	3739.82	0.00
	08/16/99	3833.06	3832.82	93.75	3739.07	0.00
	11/23/99	3833.06	3832.82	94.24	3738.58	0.00
MW-10	04/22/96	3831.34	3831.10	87.68	3743.42	0.00
	11/19/96	3831.34	3831.10	88.51	3742.59	0.00
	02/07/97	3831.34	3831.10	88.54	3742.56	0.00
	04/16/97	3831.34	3831.10	88.68	3742.42	0.00
	08/14/97	3831.34	3831.10	89.21	3741.89	0.00
	10/28/97	3831.34	3831.10	89.40	3741.70	0.00
	01/20/98	3831.34	3831.10	89.64	3741.46	0.00
	04/23/98	3831.34	3831.10	89.90	3741.20	0.00
	08/04/98	3831.34	3831.10	90.32	3740.78	0.00
	10/28/98	3831.34	3831.10	90.78	3740.32	0.00
	02/16/99	3831.34	3831.10	91.05	3740.05	0.00
	04/21/99	3831.34	3831.10	91.07	3740.03	0.00
	08/16/99	3831.34	3831.10	91.78	3739.32	0.00
	11/23/99	3831.34	3831.10	92.29	3738.81	0.00

Monitoring wells Monitoring wells MW-1 through MW-7 were installed in September 1995.
Monitoring wells MW-8, MW-9 and MW-10 were installed in March and April 1996.
* Elevations surveyed by John W. West Engineering Company of Hobbs, New Mexico. The top of the monitoring well casings were marked on the north side to provide consistent reference points for future gauging operations.
** Groundwater elevations were corrected for product, if present (SG=0.87)
Groundwater flow is to the southeast with a hydraulic gradient of approximately 0.004 feet/foot.

5.0 GROUNDWATER QUALITY CONDITIONS

5.1 Distribution of Hydrocarbons in Groundwater

A historical listing of BTEX concentrations obtained from the on-site monitoring wells is summarized in Table 3. Hydrocarbon concentration maps depicting the BTEX concentrations for the four 1998 sampling events are presented in Figure 3a (February 16, 1999), Figure 3b (April 21, 1999), Figure 3c (August 16, 1999), and Figure 3d (November 23, 1999). Figures 4a and 4b depict BTEX concentrations versus time in groundwater from May 1995 to November 23, 1999 for monitoring wells MW-6 and MW-9, respectively.

Based on the analytical data for samples collected by TRW during the four 1999 sampling events, the distribution of hydrocarbons at the Lea Refinery is described below.

- BTEX concentrations in upgradient monitoring wells MW-2 and MW-4 have remained at levels below the laboratory detection limit and below WQCC standards.

- BTEX concentrations in downgradient wells MW-5, MW-6, MW-8, and MW-10 have also remained at levels near or below the laboratory detection limit and below WQCC standards.

- Benzene concentrations in MW-9 fluctuate over time but have declined from a high of 1.69 mg/L in April 1996 to its lowest levels of below laboratory detection limits during the first, third, and fourth quarter sampling events during 1999. This significant decrease has been attributed to the successful operation of the AS/VE system.

- BTEX concentrations in downgradient well MW-3 have also remained at levels near or below the laboratory detection limit and below WQCC standards, with the exception of the November 23, 1999, sampling event. It is suspected that the BTEX increase during this fourth quarter sampling event represents the downgradient movement of a limited slug of contaminants that was observed in upgradient well MW-9 during the August 14, 1997. The next two quarterly sampling events should reveal that the slug has passed the area of MW-3 and that BTEX concentrations are attenuating toward levels below WQCC standards.

- Monitoring wells MW-1 and MW-7 were not sampled due to the continued presence of free product.

Table 3
BTEX Concentrations In Groundwater

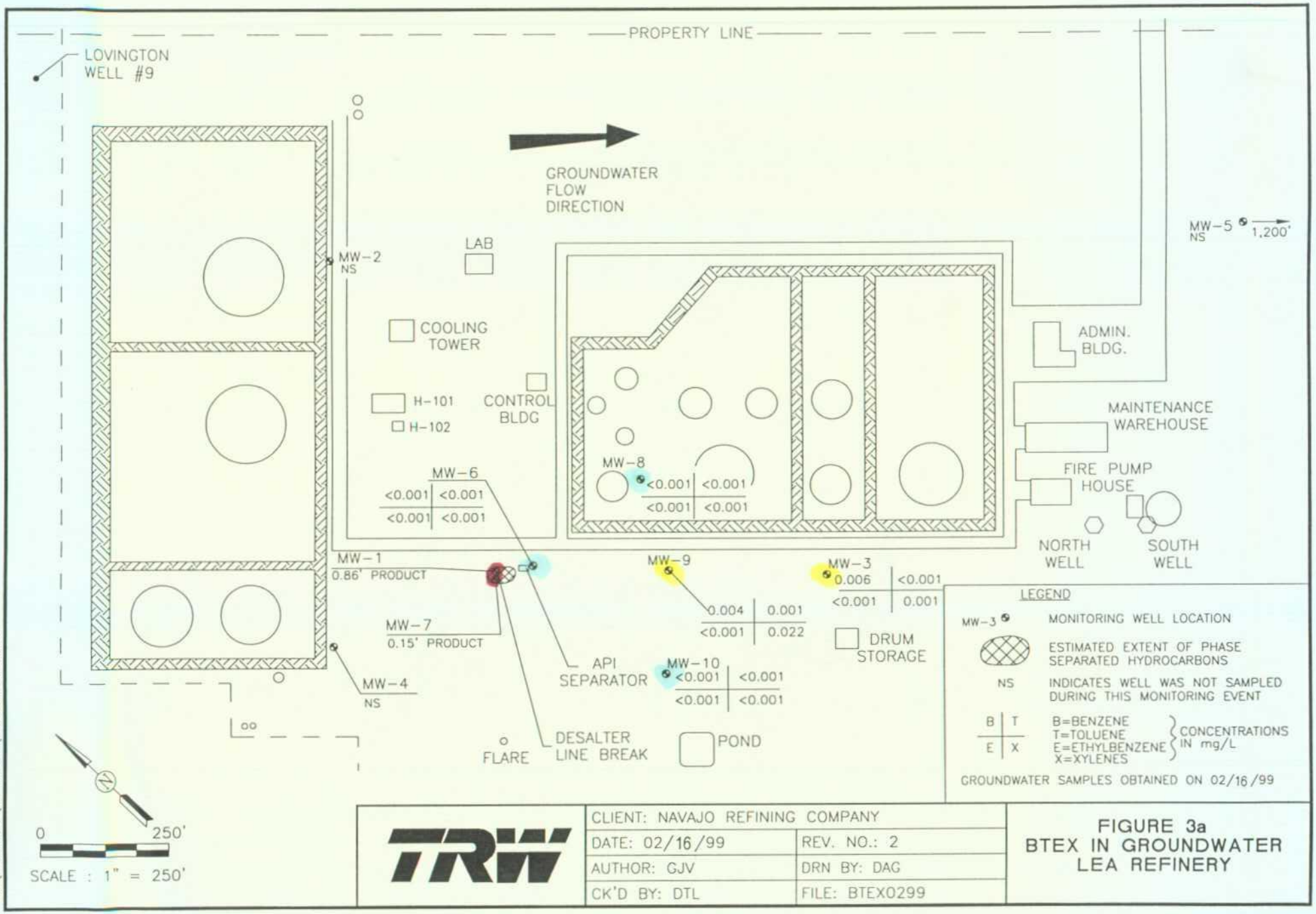
Monitoring Well	Date Sampled	Benzene (mg/l)	Toluene (mg/l)	Ethylbenzene (mg/l)	Xylenes (mg/l)
MW-2	09/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	04/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	08/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/98	< 0.001	< 0.001	< 0.001	< 0.001
	11/23/99	< 0.005	< 0.005	< 0.005	< 0.005
MW-3	09/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	04/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
	01/20/97	< 0.001	< 0.001	< 0.001	< 0.001
	04/16/97	< 0.001	< 0.001	< 0.001	< 0.001
	08/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
	01/21/98	< 0.001	< 0.001	< 0.001	< 0.001
	04/23/98	< 0.005	< 0.005	< 0.005	0.008
	04/23/98	< 0.005	< 0.005	< 0.005	0.008
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
	02/16/99	0.006	< 0.001	0.001	< 0.001
	04/21/99	< 0.005	< 0.005	< 0.005	< 0.005
	08/16/99	< 0.001	< 0.001	< 0.001	< 0.001
	11/23/99	**0.314**	< 0.005	0.005	0.102
MW-4	09/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	04/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	08/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
	11/23/99	< 0.005	< 0.005	< 0.005	< 0.005
MW-5	09/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	04/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	08/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/98	< 0.001	< 0.001	< 0.001	< 0.001
	11/23/99	< 0.005	< 0.005	< 0.005	< 0.005
MW-6	09/10/95	**1.741**	0.021	**0.962**	**0.972**
	04/23/96	**1.150**	< 0.001	0.599	0.462
	11/19/96	0.002	< 0.001	0.011	0.002
	01/20/97	0.004	< 0.001	0.003	0.007
	04/16/97	<0.001	< 0.001	< 0.001	<0.001
	08/14/97	<0.001	< 0.001	< 0.001	<0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
	01/21/98	< 0.001	< 0.001	< 0.001	< 0.001
	04/23/98	< 0.001	< 0.001	< 0.001	< 0.001
	08/04/98	< 0.001	< 0.001	< 0.001	< 0.001
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
	02/16/99	< 0.001	< 0.001	< 0.001	< 0.001
	04/21/99	< 0.001	< 0.001	< 0.001	< 0.001
	08/16/99	< 0.001	< 0.001	< 0.001	< 0.001
	11/23/99	< 0.005	< 0.005	< 0.005	< 0.005

Monitoring Wells MW-1 and MW-7 not sampled for BTEX due to presence of phase-separated hydrocarbons.
Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) unless specified otherwise.
1 Analyses performed by American Environmental Network, In. (Albuquerque, NM).
2 Duplicate analysis
Samples analyzed for BTEX using EPA Method 8020 (9/10/95 and 11/19/96) and 8260 (4/23/96).
New Mexico Water Quality Control Commission (WQCC) standards are listed as specified in Section 3-103.

Table 3 (Continued)
BTEX Concentrations In Groundwater

Monitoring Well	Date Sampled	Benzene (mg/l)	Toluene (mg/l)	Ethylbenzene (mg/l)	Xylenes (mg/l)
MW-8	04/23/96	0.002	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
	01/20/97	< 0.001	< 0.001	< 0.001	< 0.001
	04/16/97	< 0.001	< 0.001	< 0.001	< 0.001
	08/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
	01/21/98	< 0.001	< 0.001	< 0.001	< 0.001
	04/23/98	< 0.001	< 0.001	< 0.001	< 0.001
	08/04/98	< 0.001	< 0.001	< 0.001	< 0.001
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
	02/16/99	< 0.001	< 0.001	< 0.001	< 0.001
	04/21/99	< 0.005	< 0.005	< 0.005	< 0.005
	08/16/99	< 0.001	< 0.001	< 0.001	< 0.001
	11/23/99	< 0.005	< 0.005	< 0.005	< 0.005
MW-9	04/23/96	**1.690**	< 0.010	< 0.010	0.019
	11/19/96	**0.679**	< 0.005	< 0.005	< 0.005
	01/20/97	**0.340**	< 0.001	0.002	0.003
	04/16/97	**0.347**	<0.002	<0.002	0.007
	08/14/97	**1.680**	<0.010	<0.010	<0.010
	10/28/97	**0.516**	<0.010	<0.010	<0.010
	10/28/97[2]	**0.474**	<0.010	<0.010	<0.010
	01/21/98	**0.146**	0.005	< 0.001	0.002
	1/21/98[2]	**0.125**	0.004	< 0.001	< 0.001
	4/23/98[2]	**0.013**	< 0.001	< 0.001	< 0.001
	4/23/98[2]	**0.012**	< 0.001	< 0.001	< 0.001
	08/04/98	**0.010**	< 0.001	< 0.001	< 0.001
	8/4/98[2]	0.007	< 0.001	< 0.001	< 0.001
	10/29/98	0.007	0.006	< 0.001	0.002
	10/29/98[2]	0.006	0.004	0.002	0.002
	02/16/99	< 0.001	0.004	0.001	0.022
	2/16/99[2]	< 0.001	0.004	0.002	0.008
	04/21/99	0.008	0.002	< 0.001	0.005
	4/21/99[2]	0.006	0.001	< 0.001	0.004
	08/16/99	< 0.001	< 0.001	< 0.001	0.002
	11/23/99	< 0.005	< 0.005	< 0.005	< 0.005
MW-10	04/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
	01/20/97	< 0.001	< 0.001	< 0.001	< 0.001
	04/16/97	< 0.001	< 0.001	< 0.001	< 0.001
	08/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
	01/21/98	< 0.001	< 0.001	< 0.001	< 0.001
	04/23/98	< 0.001	< 0.001	< 0.001	< 0.001
	08/04/98	< 0.001	< 0.001	< 0.001	< 0.001
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
	02/16/99	< 0.001	< 0.001	< 0.001	< 0.001
	04/21/99	< 0.005	< 0.005	< 0.005	< 0.005
	08/16/99	< 0.001	< 0.001	< 0.001	< 0.001
	11/22/99	< 0.005	< 0.005	< 0.005	< 0.005
WQCC Standards (mg/l)		0.010	0.75	0.75	0.62

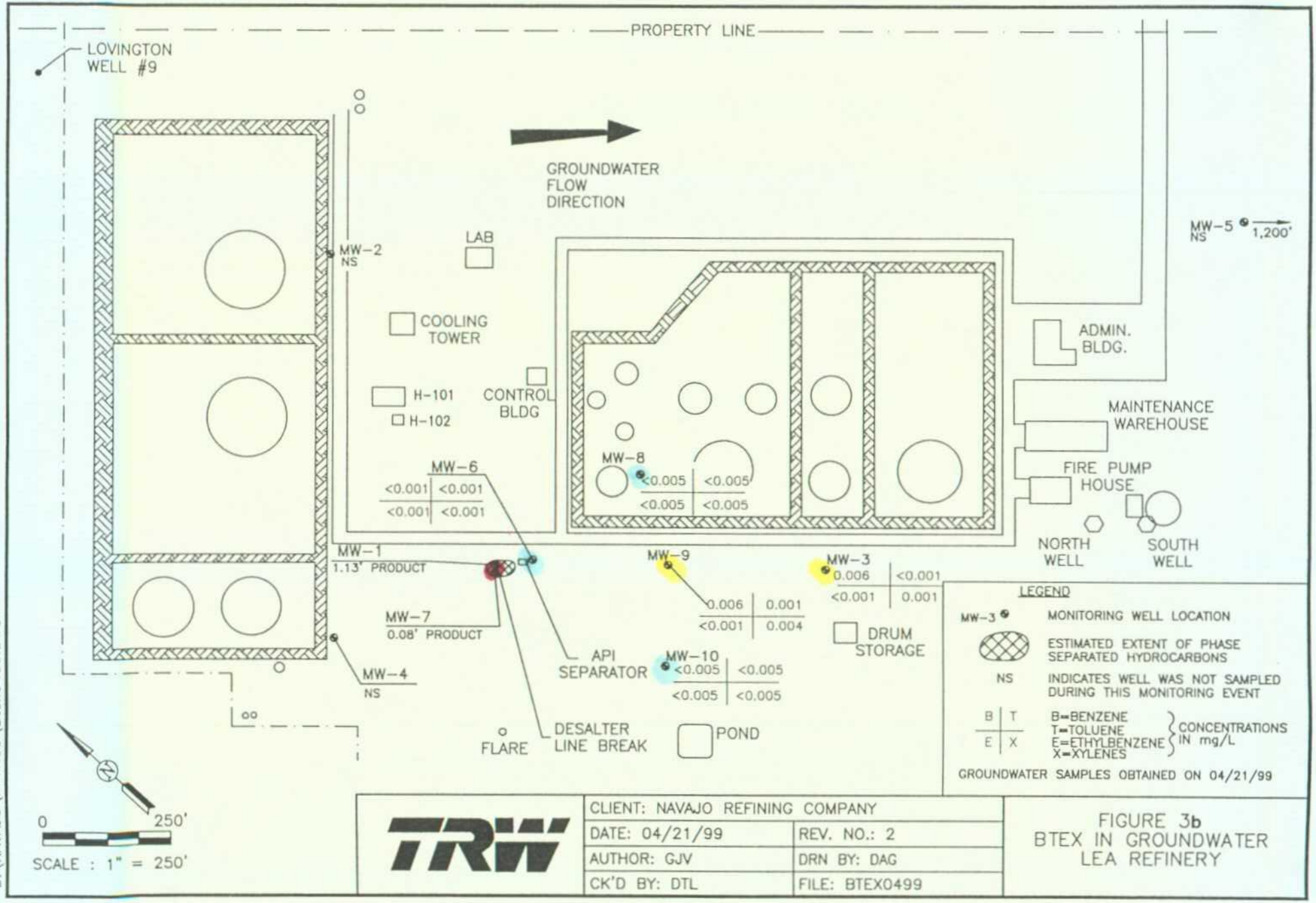
Monitoring Wells MW-1 and MW-7 not sampled for BTEX due to presence of phase-separated hydrocarbons.
Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) unless specified otherwise.
1 Analyses performed by American Environmental Network, In. (Albuquerque, NM).
2 Duplicate analysis
Samples analyzed for BTEX using EPA Method 8020 (9/10/95 and 11/19/96) and 8260 (4/23/96).
New Mexico Water Quality Control Commission (WQCC) standards are listed as specified in Section 3-103.

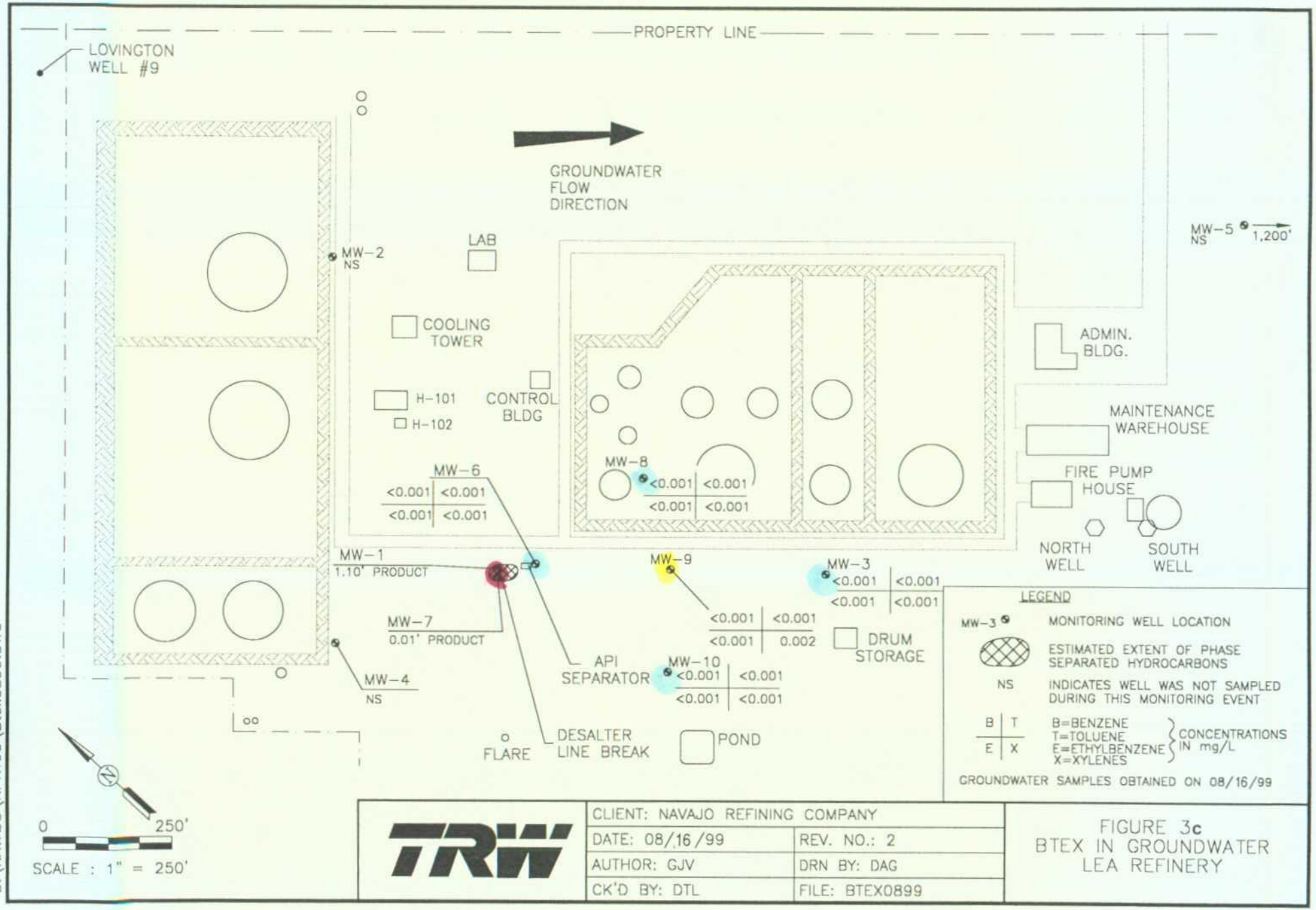


TRW

CLIENT: NAVAJO REFINING COMPANY	
DATE: 02/16/99	REV. NO.: 2
AUTHOR: GJV	DRN BY: DAG
CK'D BY: DTL	FILE: BTEX0299

FIGURE 3a
BTEX IN GROUNDWATER
LEA REFINERY


PROPERTY LINE
LOVINGTON WELL #9
GROUNDWATER FLOW DIRECTION
MW-2 NS
LAB
COOLING TOWER
H-101
H-102
CONTROL BLDG
MW-5 NS
1,200'
ADMIN. BLDG.
MAINTENANCE WAREHOUSE
FIRE PUMP HOUSE
NORTH WELL
SOUTH WELL
MW-6
<0.001 <0.001
<0.001 <0.001
MW-8
<0.005 <0.005
<0.005 <0.005
MW-1
1.13' PRODUCT
MW-7
0.08' PRODUCT
MW-4 NS
MW-9
0.006 0.001
<0.001 0.004
MW-3
0.006 <0.001
<0.001 0.001
DRUM STORAGE
API SEPARATOR
MW-10
<0.005 <0.005
<0.005 <0.005
FLARE
DESALTER LINE BREAK
POND
LEGEND
MW-3 MONITORING WELL LOCATION
ESTIMATED EXTENT OF PHASE SEPARATED HYDROCARBONS
NS INDICATES WELL WAS NOT SAMPLED DURING THIS MONITORING EVENT
B T
E X
B=BENZENE
T=TOLUENE
E=ETHYLBENZENE
X=XYLENES
CONCENTRATIONS IN mg/L
GROUNDWATER SAMPLES OBTAINED ON 04/21/99
0 250'
SCALE : 1" = 250'
TRW
CLIENT: NAVAJO REFINING COMPANY
DATE: 04/21/99
REV. NO.: 2
AUTHOR: GJV
DRN BY: DAG
CK'D BY: DTL
FILE: BTEX0499
FIGURE 3b
BTEX IN GROUNDWATER
LEA REFINERY
D:\NAVAJO\RPK195\Btex0499.DWG



CLIENT: NAVAJO REFINING COMPANY	
DATE: 08/16/99	REV. NO.: 2
AUTHOR: GJV	DRN BY: DAG
CK'D BY: DTL	FILE: BTEX0899

FIGURE 3c
BTEX IN GROUNDWATER
LEA REFINERY

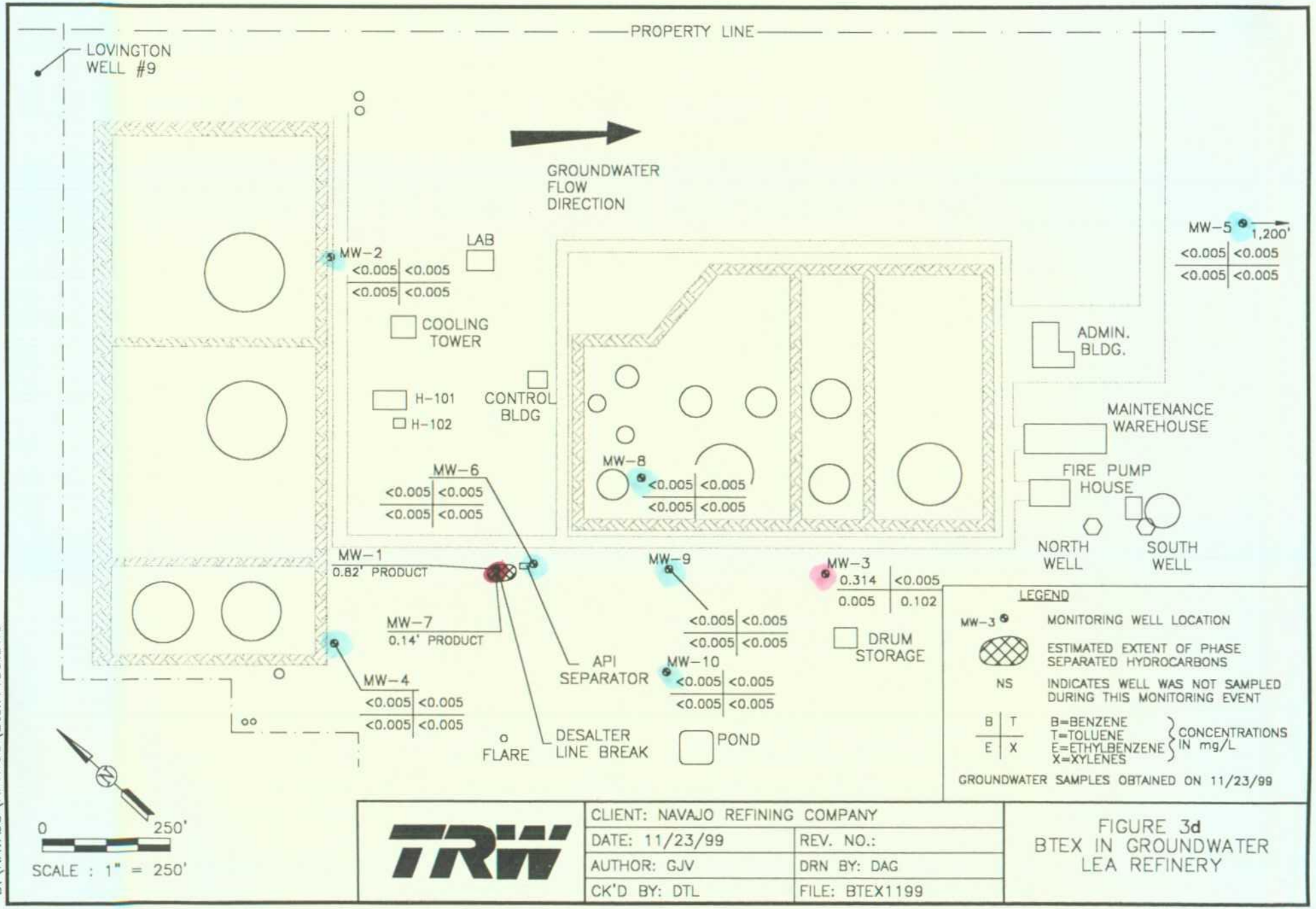

PROPERTY LINE
LOVINGTON WELL #9
GROUNDWATER FLOW DIRECTION
LAB
MW-2
<0.005 <0.005
<0.005 <0.005
COOLING TOWER
H-101
H-102
CONTROL BLDG
MW-5
1,200'
<0.005 <0.005
<0.005 <0.005
ADMIN. BLDG.
MAINTENANCE WAREHOUSE
FIRE PUMP HOUSE
NORTH WELL
SOUTH WELL
MW-8
<0.005 <0.005
<0.005 <0.005
MW-6
<0.005 <0.005
<0.005 <0.005
MW-1
0.82' PRODUCT
MW-7
0.14' PRODUCT
MW-4
<0.005 <0.005
<0.005 <0.005
API SEPARATOR
DESALTER LINE BREAK
FLARE
MW-9
<0.005 <0.005
<0.005 <0.005
MW-10
<0.005 <0.005
<0.005 <0.005
POND
MW-3
0.314 <0.005
0.005 0.102
DRUM STORAGE
LEGEND
MW-3 MONITORING WELL LOCATION
ESTIMATED EXTENT OF PHASE SEPARATED HYDROCARBONS
NS INDICATES WELL WAS NOT SAMPLED DURING THIS MONITORING EVENT
B T E X
B=BENZENE
T=TOLUENE
E=ETHYLBENZENE
X=XYLENES
CONCENTRATIONS IN mg/L
GROUNDWATER SAMPLES OBTAINED ON 11/23/99
0 250'
SCALE : 1" = 250'
TRW
CLIENT: NAVAJO REFINING COMPANY
DATE: 11/23/99 REV. NO.:
AUTHOR: GJV DRN BY: DAG
CK'D BY: DTL FILE: BTEX1199
FIGURE 3d
BTEX IN GROUNDWATER
LEA REFINERY
D:\NAVAJO\RPRT95\Btex1199.DWG

FIGURE 4a

BTEX CONCENTRATION VERSUS TIME (MW-6)

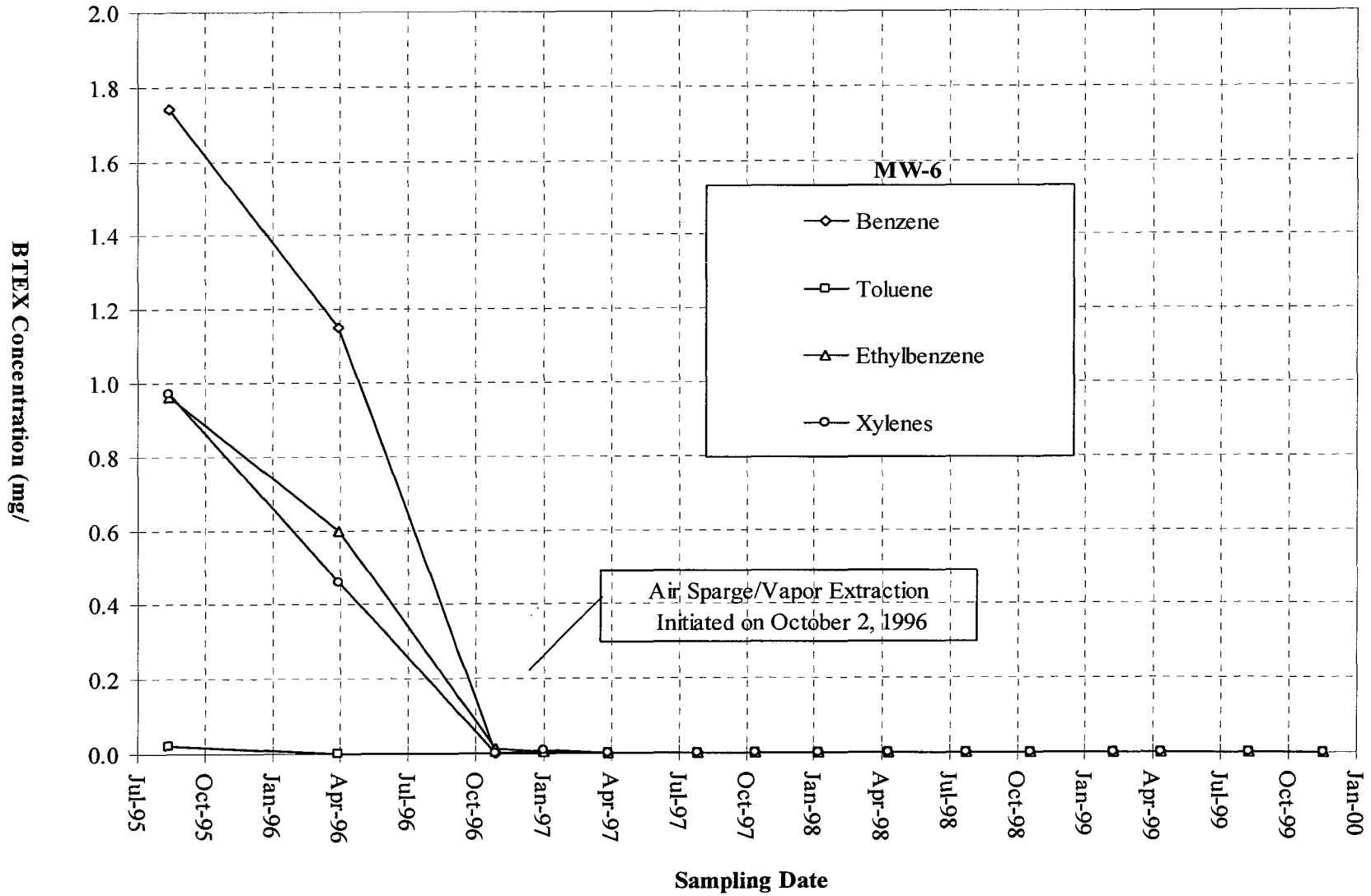
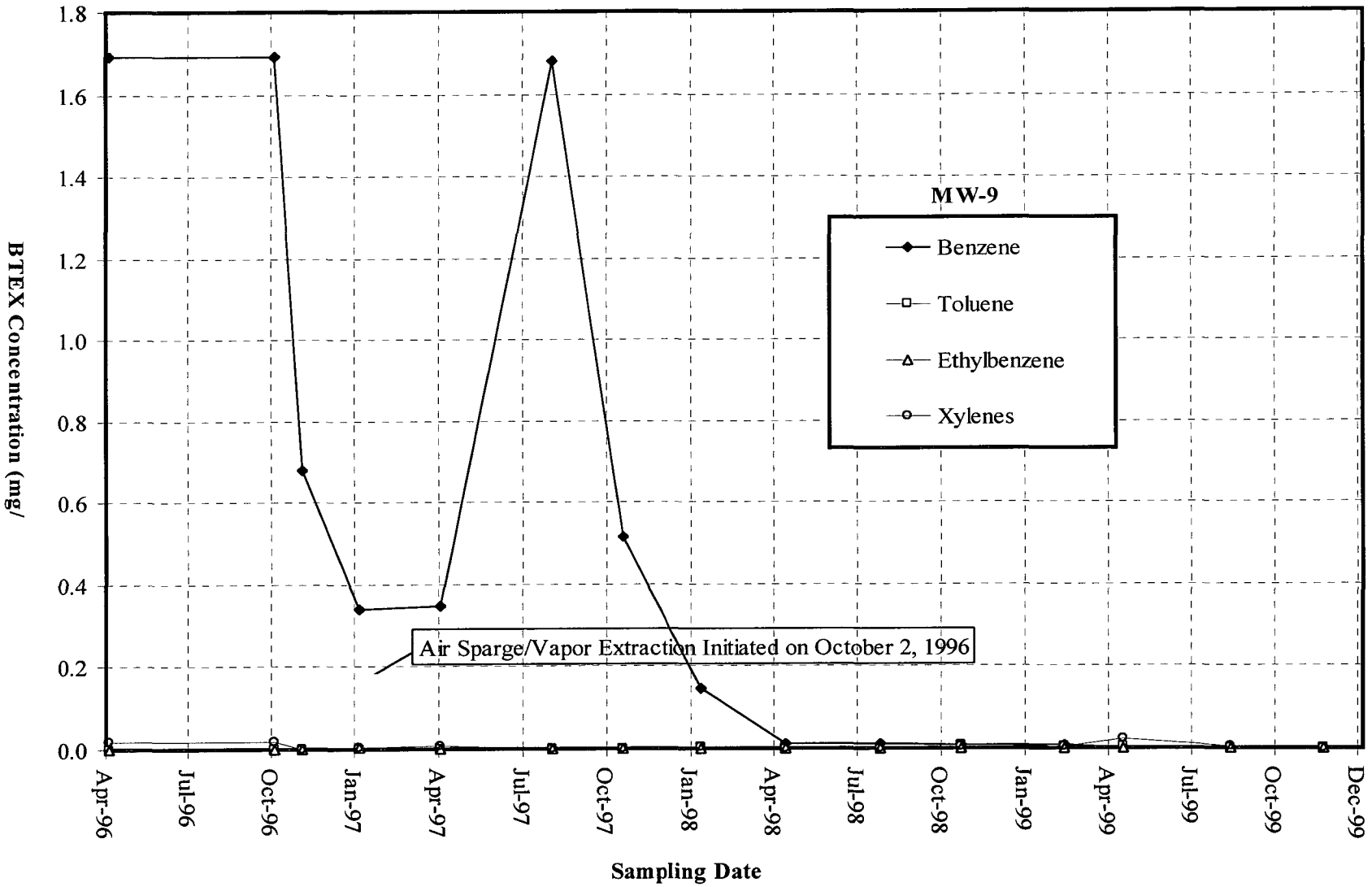


FIGURE 4b

BTEX CONCENTRATION VERSUS TIME (MW-9)



5.2 Distribution of Dissolved Metals and Major Ions in Groundwater

Historical groundwater sample analytical results for metals and major ions are presented in Table 4. The WQCC standards, if established, are also listed in the tables for comparison. Constituents with concentrations above the WQCC standards are highlighted in boldface type. The laboratory reports and chain-of-custody documentation are included in Appendix A.

Based on the analytical data for samples collected by TRW on November 23, 1999, all monitoring wells at Lea Refinery had metal and major ion concentrations below WQCC standards with the exception of the following:

- A boron concentration of 0.84 mg/L in MW-8 slightly exceeded the WQCC standard of 0.75 mg/L. The source of boron is unknown.

- Chloride concentrations in MW-3 (580 mg/L) and MW-9 (420 mg/L) exceeded the WQCC standard of 250 mg/L. These choride levels are consistent with the supposition that a limited and attenuating slug of contaminants has migrated downgradient from MW-9 to MW-3.

- Fluoride concentrations varied from 0.92 mg/L in MW-3 to 2.6 mg/L in MW-8. Fluoride levels in monitoring wells MW6, MW-8, and MW-9 are equal to or slightly exceed the WQCC standard of 1.6 mg/L. Since fluoride is not a constituent for the refinery processes on site, its presence is likely due to natural conditions as it is a common natural occurrence in groundwater (1989, USGS Water-Supply Paper 2254, pg. 120-123).

- Monitoring well MW-6 had a vanadium concentration of 0.35 mg/L, which exceeds the WQCC standard of 0.05 mg/L. Since vanadium is not a constituent for the refinery processes on site, this anomaly is most likely due to its natural occurrence.

- The WQCC standard for TDS (1,000 mg/L) was exceeded in MW-3 (1,300 mg/L) and MW-9 (1,100 mg/L). As suggested by increased levels of BTEX and chlorides in MW-3, these TDS levels are consistent with the supposition that a limited and attenuating slug of contaminants has migrated downgradient from MW-9 to MW-3. Background TDS concentrations in Lea County typically range from 500 mg/L to 3,000 mg/L.

Table 4
Summary of Metals and Major Ion Analytical Results

Monitoring Well	Date Sampled	Arsenic (As)	Barium (Ba)	Boron (B)	Chloride (Cl)	Fluoride (F)	Iron (Fe)	Manganese (Mn)	Nitrate (NO_3-N)	Sulfate (SO_4)	Total Dissolved Solids (TDS)	Vanadium (V)
MW-1	09/08/95	---	1.2	---	**509**	1.2	---	---	<0.15	<5	**1275**	---
MW-2	09/08/95	**0.3**	0.12	0.25	61	1.2	0.16	0.07	1.65	105	523	<0.05
	08/14/97	<0.1	<0.2	<0.2	140	1.2	0.28	<0.01	NS	89	650	<0.05
	10/28/98	<0.05	<0.20	0.2	170	**2.4**	0.19	<0.02	4.7	120	540	<0.05
	11/23/99	<0.05	<0.20	0.21	79	1.5	<0.05	<0.05	1.99	64	470	<0.05
MW-3	09/08/95	<0.2	0.1	0.15	35	1	0.48	<0.01	2.54	93	454	<0.05
	08/14/97	<0.1	<0.2	<0.2	73	0.87	0.24	<0.01	NS	90	470	<0.05
	10/29/98	<0.05	<0.20	0.22	99	**1.6**	0.23	0.12	6.1	110	650	<0.05
	11/23/99	<0.05	<0.20	0.23	**580**	0.92	<0.05	<0.05	0.702	110	**1300**	<0.05
MW-4	09/08/95	**0.2**	0.11	0.16	23	1	0.46	0.04	1.19	88	438	<0.05
	08/14/97	<0.1	<0.2	<0.2	49	1.1	0.14	<0.01	NS	95	400	<0.05
	10/29/98	<0.05	<0.20	<0.20	28	**2.1**	<0.05	<0.02	4.5	90	390	<0.05
	11/23/99	<0.05	<0.20	<0.20	24	1.5	<0.05	<0.05	2.11	95	370	<0.05
MW-5	09/08/95	**0.5**	<0.03	0.26	198	0.7	0.32	0.05	1.49	119	853	<0.05
	08/14/97	<0.1	<0.2	<0.2	**250**	0.5	0.75	<0.01	NS	150	**1000**	<0.05
	10/28/98	<0.05	<0.20	0.26	**280**	1.3	0.15	<0.02	4.1	120	920	<0.05
	11/23/99	<0.05	<0.20	0.25	230	0.93	<0.05	<0.05	1.79	130	810	<0.05
MW-6	04/23/96	<0.01	0.8	0.21	**798**	**1.65**	0.29	**1.7**	<0.1	13	**1786**	<0.01
	08/14/97	<0.1	0.3	<0.2	**480**	**3.4**	0.76	**0.32**	NS	100	980	**0.23**
	10/29/98	<0.05	<0.20	<0.20	53	**3.2**	0.06	<0.02	66	86	690	<0.05
	11/23/99	<0.05	<0.20	<0.20	160	**1.6**	0.07	<0.05	0.378	78	670	**0.35**
MW-8	04/23/96	<0.01	0.2	<0.03	185	1.2	<0.05	**0.27**	0.2	49	**1004**	0.02
	08/14/97	<0.1	<0.2	<0.2	**960**	0.88	0.21	0.04	NS	120	**1800**	<0.05
	10/29/98	<0.05	<0.20	0.34	**310**	**2.1**	0.05	<0.02	10	170	**1000**	<0.05
	11/23/99	<0.05	<0.20	**0.84**	160	**2.6**	<0.05	<0.05	5.37	100	740	<0.05
MW-9	04/23/96	<0.01	0.7	**0.83**	**1190**	0.5	0.11	0.19	<0.1	9	**2658**	0.02
	08/14/97	<0.1	0.8	<0.2	**6500**	0.8	0.47	**0.51**	NS	38	**2300**	<0.05
	10/28/97	---	---	---	**1200**	---	---	---	<0.01	27	---	---
	10/29/98	<0.05	**1.4**	0.49	**880**	**2.3**	<0.05	0.12	<10	48	**1700**	**0.48**
	11/23/99	<0.05	<0.20	0.25	**420**	**2.2**	<0.05	<0.05	0.347	130	**1100**	<0.05
MW-10	04/23/96	<0.01	<0.2	0.11	29	1	0.16	0.02	0.13	31	443	0.03
	08/14/97	<0.1	<0.2	<0.2	42	1.1	0.38	<0.01	NS	110	480	<0.05
	10/29/98	<0.05	0.84	0.25	32	**2.0**	<0.05	<0.02	4.6	110	480	<0.05
	11/23/99	<0.05	<0.20	<0.20	49	1.3	<0.05	<0.05	2.72	96	490	<0.05
WQCC Standards (mg/l)		0.1	1	0.75	250	1.6	1	0.2	10	600	1000	0.05

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 160.1, 200.7, 340.2, 375.4, 353.3, 4500 C1-B,and 310.1.
New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in Section 3-103.
MW-1 and MW-7 not analyzed due to presence of free product.
Values in **boldface** type indicate concentrations exceed WQCC groundwater standards.

A-Projects/Navajo/NRC-99DATA.XLS

6.0 REMEDIATION SYSTEM PERFORMANCE

6.1 Air Sparge/ Vapor Extraction System

The installation of the air sparge/vapor extraction (AS/VE) system was completed on September 25, 1996. The AS/VE system was started on October 2, 1996 and remained in continuous operation until August 16, 1999 with a few minor exceptions, such as during periodic maintenance activities, weather related upsets and a plant turnaround in which the remediation system was shut down between September 8, 1997 and October 7, 1997. The AS/VE system maintained a 95 percent system-on time performance from January 1, 1999 to August 16, 1999 when the system was shut down indefinitely. A map showing the layout of the remediation system is illustrated in Figure 5.

To monitor the performance of the AS/VE system, quarterly air samples of the VE exhaust were obtained and analyzed for BTEX (EPA Method 8021B) and TVHC (EPA Method 8015 gas range). The samples were obtained at the exhaust port in the remediation trailer prior to conveyance into the refinery boiler system. Total BTEX concentrations have decreased from a high of 429 milligrams per cubic meter (mg/m^3) in February 1997, to <1 mg/m^3 in August 1999. Similarly, TVHC concentrations have decreased from 9,740 mg/m^3 in January 1997, to <100 mg/m^3 in August 1999. Based on the analytical results of the VE exhaust and measured flow rates, the system has recovered an estimated 19,514 kilograms (8,870 lb.) of TVHC since the startup of the system on October 2, 1996. The AS/VE system performance data is summarized in Table 5. A graph of TVHC and BTEX versus time is depicted in Figure 6.

Between October 2, 1996 and April 16, 1997, the BTEX concentrations in downgradient monitoring wells MW-6 and MW-9 decreased significantly (Figures 4a and 4b). The reduced BTEX levels in these two wells, which are located within the boundaries of the hydrocarbon plume, is attributed to the successful performance of the AS/VE system. The benzene concentration in MW-6 declined from 1.150 mg/L on April 23, 1996 to less than 0.001 mg/L during the last eleven sampling events. Monitoring well MW-9, is located approximately 160 feet downgradient (southeast) from the nearest AS/VE well (AS-1) and has shown a 100 percent decrease in benzene levels since the initial sampling event on April 23, 1996. Benzene concentrations in MW-9 have declined from a high of 1.69 mg/L in April 1996 to its lowest level of less than 0.001 mg/L on February 16, 1999. The benzene concentration increased slightly during the April 21, 1999 sampling event (0.008 mg/L), however they have decreased below the laboratory detection limits during the August 18, 1999 and November 23, 1999 sampling events. The significant decrease in BTEX concentrations has been attributed to the successful operation of the AS/VE system.

On August 16, 1999, the decision was made to shut down the AS/VE system indefinitely for the following reasons:

- The AS/VE system has performed well in the past 3 years and has reduced BTEX levels to near or below detection limits in downgradients wells MW-6 and MW-9. The most recent BTEX and TVHC concentrations of the vapor extraction exhaust are also below detection limits.
- Plant turnaround from September 19th through October 1st required AS/VE system shutdown.
- Continued AS/VE operations will require repair of the system (replacement of regenerative blower and possibly cleaning/acidizing/unplugging of vapor extraction wells) because of significantly reduced extraction rates.

Restart of the AS/VE system will be necessary if BTEX concentrations in monitoring wells MW-6 and MW-9 rebound to levels above WQCC standards. Although the free product recovery system is performing as designed, free product and elevated groundwater temperatures remain present near recovery well RW-1; therefore BTEX levels may indeed increase in the downgradient wells during subsequent sampling events. This situation can be closely monitored by continuing the quarterly sampling program.

6.2 Product Recovery System

On January 21, 1998, the total fluids recovery system, which consisted of a 3/4 horsepower submersible pump in recovery well RW-1, was replaced with a product only recovery system. This upgrade was conducted to increase efficiency of recovering free product and to provide a more accurate accounting of product recovery volumes. The product recovery system consists of the following components:

- Xitech Model ADJ 1000 Smart Skimmer with polyethylene tubing
- Xitech Model 2500 ES Electronic Timer
- 55-gallon plastic drum for product recovery containment with automatic shutoff sensor.

The product recovery pump in RW-1 is pneumatically operated. Air is supplied from an existing instrument air supply line. The control box is powered by a 115-volt supply. Currently, the control box is set to pump for a duration of 30 minutes 6 times per day. Product is pumped into a plastic 55-gallon drum located adjacent to the recovery well. An automatic shutoff sensor is installed on the drum which has a steel secondary containment vessel and is inspected daily by Navajo personnel. Passive skimmers were placed in MW-1 and MW-7 on October 29, 1998 to assist in product recovery.

A summary of the meter readings, cumulative volumes recovered and flow rates is listed in Table 6. Through the first quarter of 1998, 699,033 gallons of total fluids (groundwater and free product) have been removed from recovery well RW-1 by the submersible pump system. Approximately 167.8 gallons of free product has been recovered between January 21, 1998 and November 23, 1999.

Performance of the total fluids and free product recovery system is also evaluated based on the product thickness measured in monitoring wells MW-1 and MW-7. Based on the November 23, 1999 monitoring data, product thickness in MW-1 and MW-7 were 0.82 feet and 0.14 feet, respectively. A graph of product recovery volumes and product thickness versus time is depicted in Figure 7. Product recovery rates appear to be stabilizing to low rates due to the declining volume of free product in the free product plume as evidenced by the decreasing product thickness trend in MW-1 and MW-7.

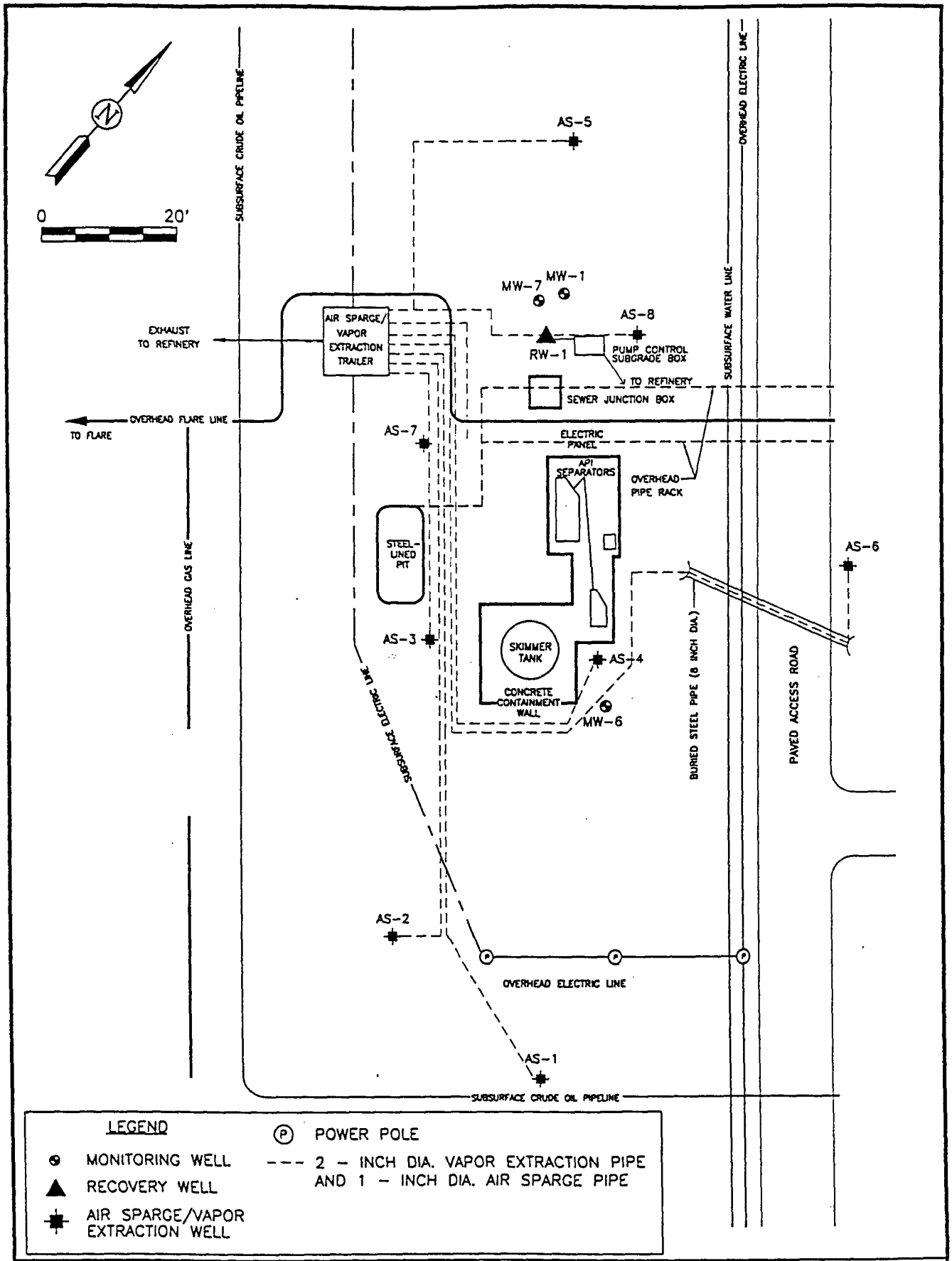
6.3 Groundwater Temperatures

Since April 1996, temperatures have been measured in the on site monitoring wells. A graph of temperature versus time for selected monitoring wells is presented in Figure 8. From this graph it is evident that the monitoring wells within the hydrocarbon plume (MW-1, MW-6 and MW-7) have elevated groundwater temperatures (approximately 25°F above background groundwater temperatures of about 70°F) until the third quarter of 1997. Groundwater temperatures within the hydrocarbon plume average

approximately 83°F and have stabilized to an average 13°F above those outside of the plume. This reflects a decrease of approximately 12°F from temperatures in early 1997. The overall decline in groundwater temperatures within the hydrocarbon plume is most likely attributable to the re-routing of the refinery sewer discharge water that now bypasses an older section of line between the desalter unit and the API separator. The discharge line was re-routed on December 30, 1997.

Since groundwater temperatures remain above background temperatures a continual source of high temperature water from the surface is suspected. On December 14, 1998, a dye tracer test was performed by placing approximately 2½ pounds (lbs.) of yellow-green dye into the oily water side of the API sump to assist in identifying the source for the elevated temperatures. The purpose of the dye tracer test was to determine if the sump was leaking based on the possible appearance of the dye in monitoring wells MW-6 or MW-7. On January 18, 1999, approximately 2 lbs. of red dye was placed on the clean water side of the API. Samples were periodically collected (approximately at weekly intervals for one month after introduction of each dye) from the monitoring wells and observed visually for presence of the dye. Although no trace of the yellow-green or red dyes have been detected since introduction of the dyes, it can not necessarily be stated that neither of the API sumps are not leaking based on the results of the dye tracer tests.

Since the dye trace test was inconclusive, a ground temperature survey was performed by Robert Duncan (Navajo), on the evening of February 19, 1999. An infrared temperature camera (Agema Model No. 470) was used to measure ground temperatures. The survey was conducted around the area north and east of the API separator system. The temperature survey did not reveal any anomalous temperatures that would indicate a probable source for the elevated temperatures observed in on site monitoring wells RW-1, MW-1, MW-6, and MW-7.



BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 12/04/97	REV. NO.: 2
AUTHOR: GJV	DRAWN BY: DAG
CK'D BY: MWS	FILE: LEA6.DWG

FIGURE 5
REMEDIATION SYSTEM
LEA REFINERY

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Table 5
Air Sparging/Vapor Extraction System Performance
Navajo Refining Company - Lea Refinery

Date	VE System Flow Rates			VE Exhaust Analytical Results						Hydrocarbon Recovery Performance						
	Vacuum	Flow	Flow	TVHC	B	T	E	X	BTEX	System-On	TVHC	B	T	E	X	BTEX
	Inches H2O	(ft^3/min)	(m^3/day)	(mg/m^3)						(Days in Period)	(kg)					
10/02/96	38	173	7061	9,450	107	67	34	45	253	15	1001	11	7	4	5	27
10/17/96	40	170	6919	7,030	56	81	53	89	279	33	1605	13	18	12	20	64
11/19/96	38	173	7061	12,100	74	154	123	184	535	28	2392	15	30	24	36	106
12/20/96	38	173	7061	10,600	53	123	95	136	407	28	2096	10	24	19	27	80
01/20/97	42	166	6777	9,740	34	116	108	136	394	27	1782	6	21	20	25	72
02/19/97	44	163	6635	8,990	41	120	113	155	429	28	1670	8	22	21	29	80
03/20/97	41	168	6848	7,940	29	76	83	125	313	28	1522	6	15	16	24	60
04/18/97	42	166	6777	6,760	26	48	69	78	221	17	779	3	6	8	9	25
05/16/97	24	197	8054	3,080	9	18	26	33	86	27	670	2	4	6	7	19
06/12/97	24	197	8054	3,950	16	22	28	46	112	40	1273	5	7	9	15	36
07/22/97	33	182	7415	7,100	20	43	59	91	213	28	1474	4	9	12	19	44
08/19/97	33	182	7415	2,960	9	12	11	16	48	20	439	1	2	2	2	7
09/08/97	33	182	7415	2,960	9	12	11	16	48	29	637	2	3	2	3	10
10/07/97	21	203	8267	2,960	9	12	11	16	48	0	0	0	0	0	0	0
10/28/97	30	187	7628	3,430	14	13	30	47	104	21	549	2	2	5	8	17
01/22/98	23	199	8125	200	10	1	20	20	40	86	140	7	1	14	14	28
02/11/98	60	135	5499	4,200	19	22	44	67	152	20	462	2	2	5	7	17
04/23/98	62	131	5357	1,990	8	6	18	32	64	56	597	2	2	5	10	19
08/04/98	63	130	5287	30	0	8	8	14	30	103	16	0	4	4	8	16
10/28/98	63	130	5287	126	4	2	7	9	22	85	57	2	1	3	4	10
02/16/99	68	121	4932	374	0	5	3	0	8	111	205	0	3	2	0	4
05/14/99	68	121	4932	348	3	0	2	3	8	87	149	1	0	1	1	3
08/16/99	64	128	5216	<100	<1	<1	<1	<1	<1	94	0	0	0	0	0	0
08/16/99	0	0	0	System shutdown indefinitely						0	0	0	0	0	0	0
										Total Recovery	19514	103	183	193	273	745

Vacuum readings were obtained at regenerative blower unit (EG&G Model DR707).

Flow rates determined from blower manufacturer's performance curve (corrected for altitude of 3,800 feet above mean sea level).

System shut down for some periods due to plant turnaround and repairs.

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 8015 (TVHC) and 8020 (BTEX).

Samples were collected from the exhaust port in remediation trailer prior to conveyance into refinery boiler system.

FIGURE 6

SOIL VAPOR CONCENTRATIONS VERSUS TIME

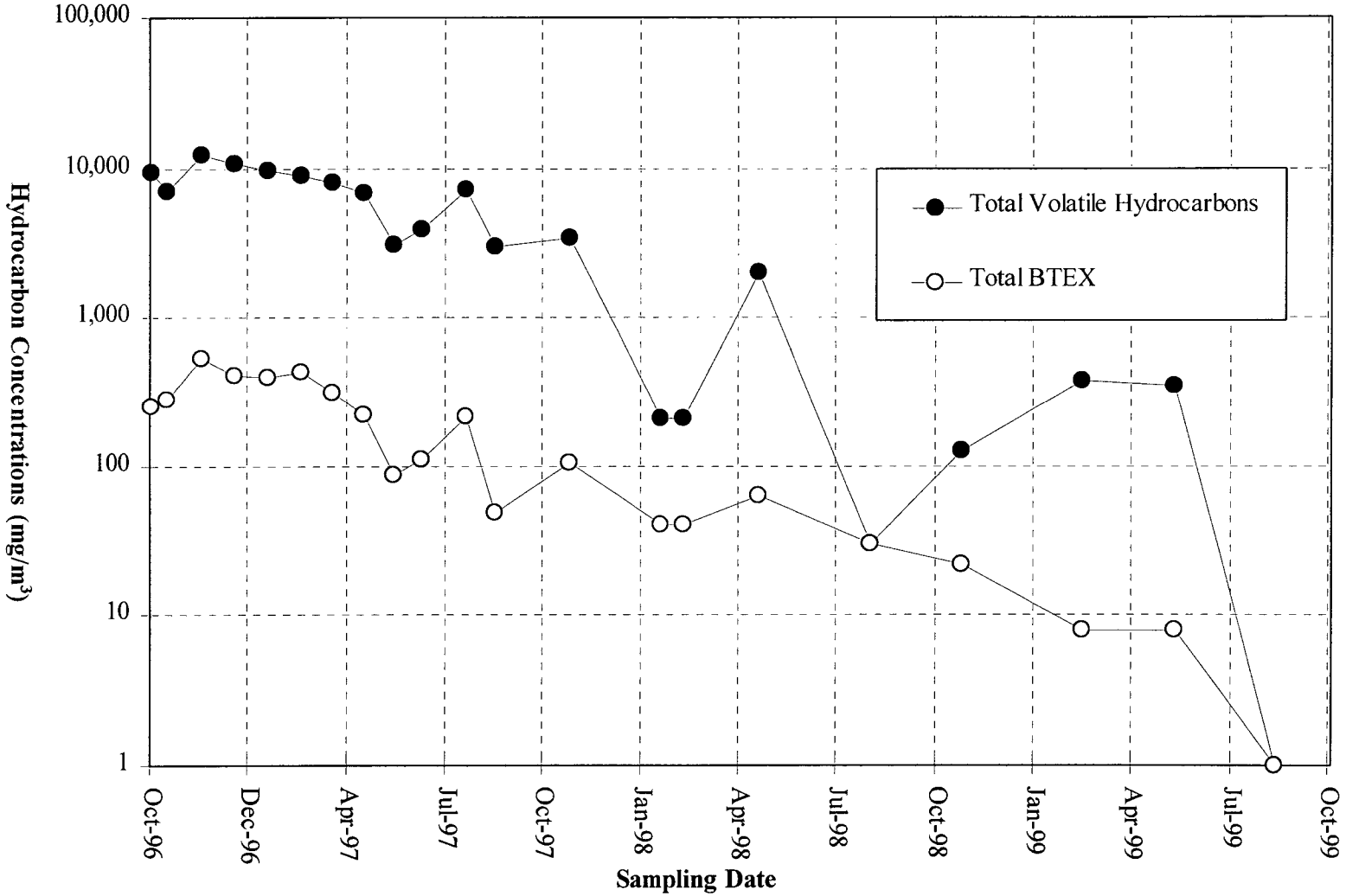


Table 6

Total Fluids and Product Recovery Volumes

Navajo Refining Company - Lea Refinery

Date	Recovery Method	Cumulative Total Fluids Recovered (gallons)	Product Recovered (gallons)	Cumulative Product Recovered (gallons)
12/28/97	Sub. Pump	699,033	Unknown*	Unknown*
01/21/98	PRS	N/A	0.5	0.5
01/27/98	PRS	N/A	2	2.5
02/11/98	Bail	N/A	1.1	3.6
02/24/98	PRS	N/A	1.5	5.1
03/13/98	PRS	N/A	2.6	7.7
03/23/98	PRS	N/A	10.6	18.3
04/10/98	PRS	N/A	15.8	34.1
04/22/98	PRS	N/A	0.5	34.6
05/06/98	PRS	N/A	7.5	42.1
06/23/98	PRS	N/A	19.5	61.6
08/04/98	PRS	N/A	5.5	67.1
09/18/98	PRS	N/A	44.2	111.3
10/29/98	PRS	N/A	15.5	126.8
11/18/98	PRS	N/A	6.6	133.4
02/16/99	PRS	N/A	10.7	144.1
04/21/99	PRS	N/A	4.4	148.5
09/14/99	PRS	N/A	11.8	160.3
10/26/99	PRS	N/A	4.3	164.5
11/23/99	PRS	N/A	1.6	166.2
12/21/99	PRS	N/A	1.7	167.8
Total Measured Volume of Product Recovered:				**167.8**

Product recovery methods used:

- Sub. Pump: 3/4 HP Grundfos submersible pump during total fluids recovery (10/1/96 - 12/28/97)
- Bail: Use of powered bailing unit by water well contractor for well cleanout.
- PRS: Product Recovery System (Xitech ADJ 1000 Smart Skimmer)

* Product recovery volume is unknown during total fluids recovery operation (10/1/96 - 12/28/97) because free product metering device was not available (699,033 gallons of total fluids recovered).

FIGURE 7

PRODUCT RECOVERY VOLUMES

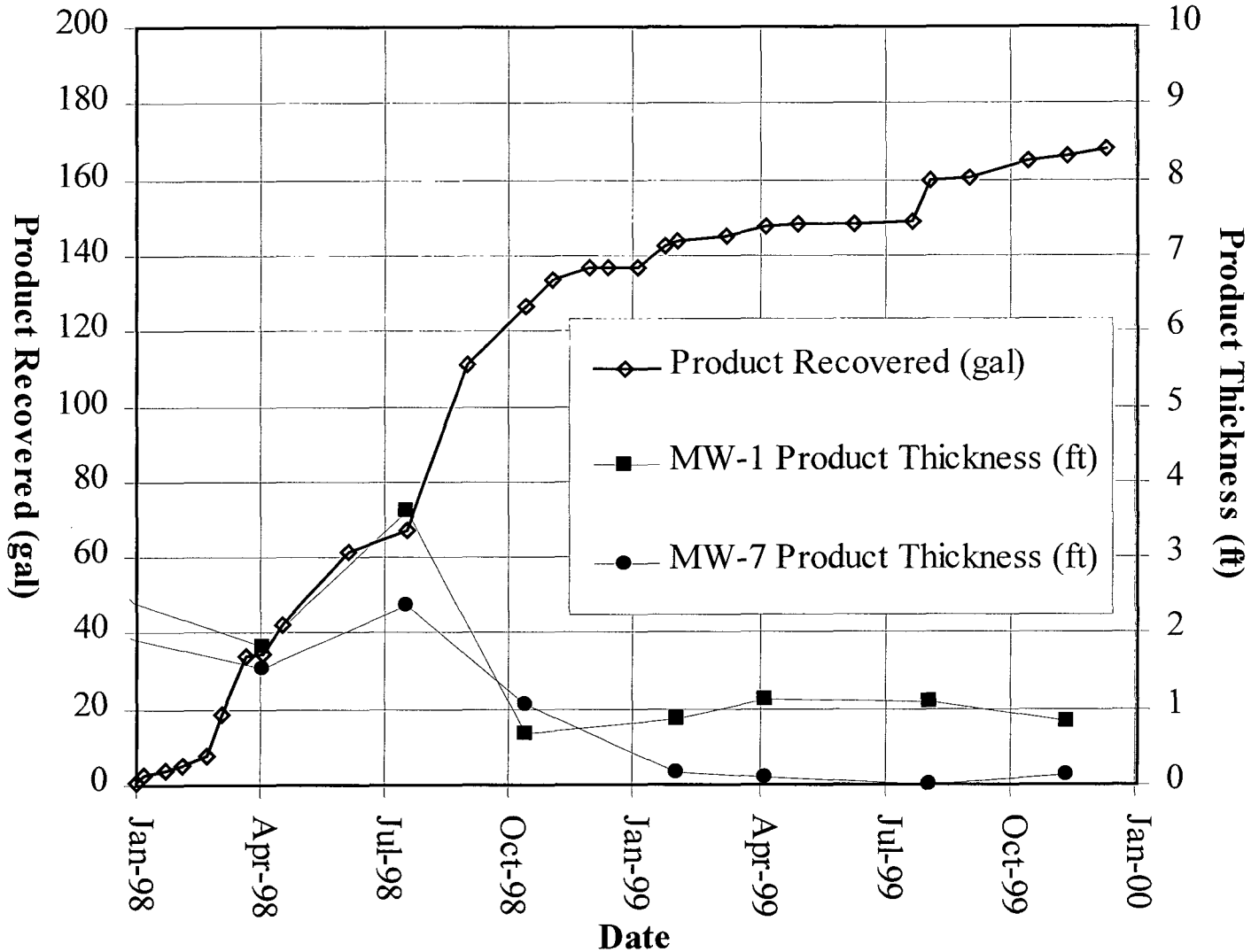
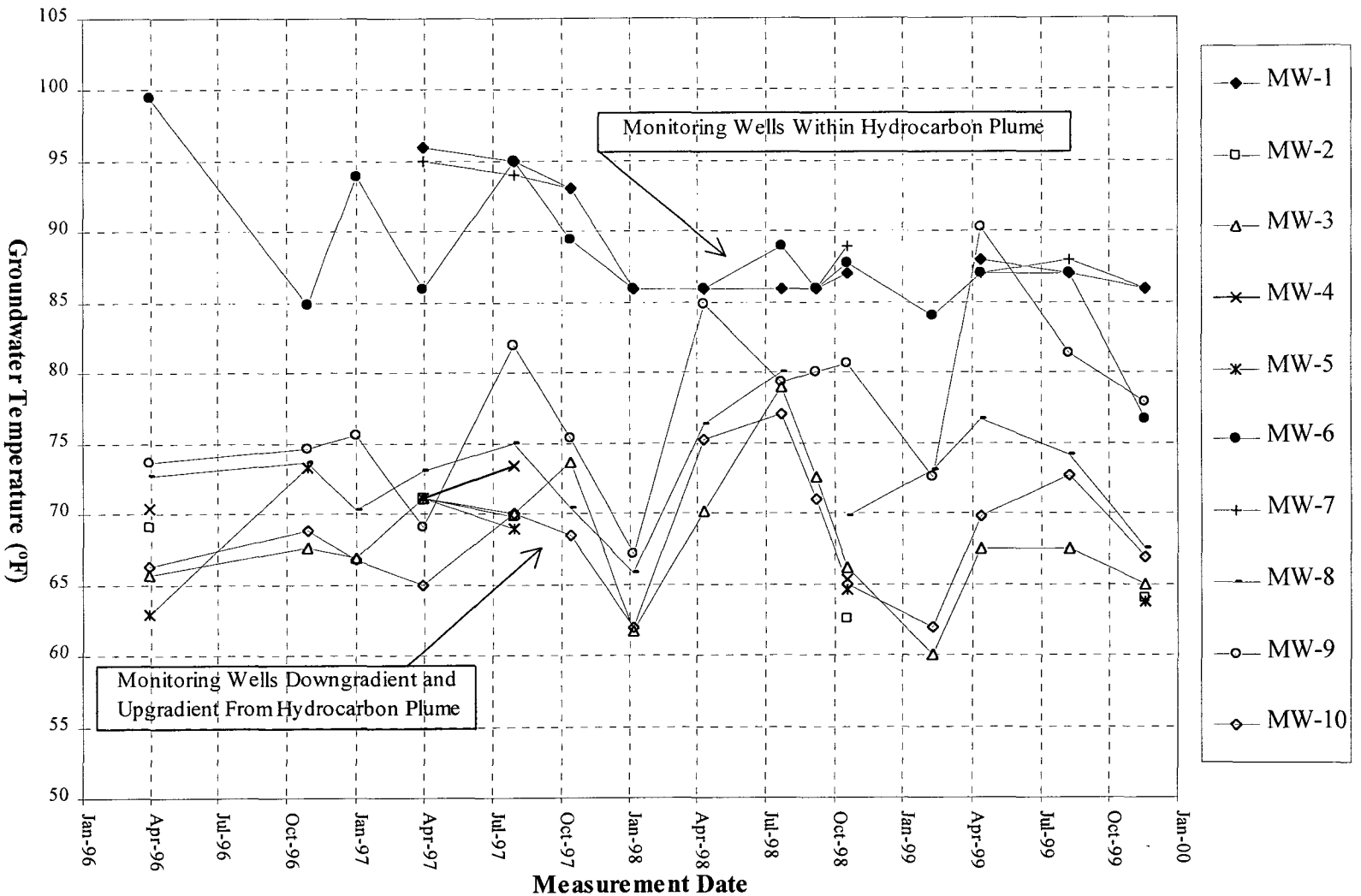


FIGURE 8

GROUNDWATER TEMPERATURES



7.0 CONCLUSIONS

Conclusions relevant to groundwater conditions and the remediation performance at the Lea Refinery are presented below.

- BTEX concentrations in upgradient monitoring wells MW-2 and MW-4 have remained at levels below the laboratory detection limit and below WQCC standards.

- BTEX concentrations in downgradient wells MW-5, MW-6, MW-8, and MW-10 have also remained at levels near or below the laboratory detection limit and below WQCC standards.

- Benzene concentrations in MW-9 fluctuate over time but have declined from a high of 1.69 mg/L in April 1996 to its lowest levels of below laboratory detection limits during the first, third, and fourth quarter sampling events during 1999. This significant decrease has been attributed to the successful operation of the AS/VE system.

- BTEX concentrations in downgradient well MW-3 have also remained at levels near or below the laboratory detection limit and below WQCC standards, with the exception of the November 23, 1999, sampling event. It is suspected that the BTEX increase during this fourth quarter sampling event represents the downgradient movement of a limited slug of contaminants that was observed in upgradient well MW-9 during the August 14, 1997. The next two quarterly sampling events should reveal that the slug has passed the area of MW-3 and that BTEX concentrations are attenuating toward levels below WQCC standards.

- A boron concentration of 0.84 mg/L in MW-8 slightly exceeded the WQCC standard of 0.75 mg/L. The source of boron is unknown.

- Chloride concentrations in MW-3 (580 mg/L) and MW-9 (420 mg/L) exceeded the WQCC standard of 250 mg/L. These choride levels are consistent with the supposition that a limited and attenuating slug of contaminants has migrated downgradient from MW-9 to MW-3.

- Fluoride concentrations varied from 0.92 mg/L in MW-3 to 2.6 mg/L in MW-8. Fluoride levels in monitoring wells MW6, MW-8, and MW-9 are equal to or slightly exceed the WQCC standard of 1.6 mg/L. Since fluoride is not a constituent for the refinery processes on site, its presence is likely due to natural conditions as it is a common natural occurrence in groundwater (1989, USGS Water-Supply Paper 2254, pg. 120-123).

- Monitoring well MW-6 had a vanadium concentration of 0.35 mg/L, which exceeds the WQCC standard of 0.05 mg/L. Since vanadium is not a constituent for the refinery processes on site, this anomaly is most likely due to its natural occurrence.

- The WQCC standard for TDS (1,000 mg/L) was exceeded in MW-3 (1,300 mg/L) and MW-9 (1,100 mg/L). As suggested by increased levels of BTEX and chlorides in MW-3, these TDS levels are consistent with the supposition that a limited and attenuating slug of contaminants has migrated downgradient from MW-9 to MW-3. Background TDS concentrations in Lea County typically range from 500 mg/L to 3,000 mg/L.

- Based on the analytical results of the VE exhaust and measured flow rates, the VE system has recovered an estimated 19,514 kilograms (8,870 lb.) of TVHC since the startup of the system on October 2, 1996.

- Approximately 167.8 gallons of free product has been recovered since installation of the Xitech product recovery system in recovery well RW-1 on January 21, 1998.

- Product recovery rates appear to be decreasing due to the declining volume of free product in the free product plume as evidenced by the decreasing product thickness trend in MW-1 and MW-7. Free product thickness in MW-1 and MW-7 have fluctuated since October 1996, but have generally declined to the present thickness of 0.82 feet and 0.14 feet, respectively.

- During 1999, groundwater temperatures within the hydrocarbon plume (MW-1, MW-6, and MW-7) have stabilized to an average of 13°F above those outside of the plume. This reflects an approximate decrease of approximately 12°F from 1997 temperatures. A dye trace test and ground temperature survey conducted in early 1999 did not reveal a source for the elevated groundwater temperatures.

8.0 RECOMMENDATIONS

The following recommendations are proposed for the remediation system and monitoring operations at the Lea Refinery.

- Continue product recovery operations since the present system has been effective in recovering 167.8 gallons of free product from RW-1.

- Although the free product recovery system is performing as designed, free product and elevated groundwater temperatures remain present near recovery well RW-1; therefore BTEX levels may indeed increase in the downgradient wells during subsequent sampling events. This situation can be closely monitored by continuing the quarterly sampling program. The air sparge/vapor extraction system should be restarted if BTEX concentrations in monitoring wells MW-6 and MW-9 rebound to levels above WQCC standards.

- Continue the sampling and monitoring program on a quarterly basis. The next sampling event is scheduled during the first quarter of 2000.

APPENDIX A

LABORATORY ANALYTICAL REPORTS AND CHAIN-OF-CUSTODY DOCUMENTATION

TRACEANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

Analytical and Quality Control Report

Gil Van Deventer
TRW
415 West Wall Suite 1818
Midland, TX 79701

Report Date: 12/8/99

Project Number: P/2292/PC
Project Name: Navajo-Lea Refinery
Project Location: Lea Refinery

Order ID Number: 99112902

Enclosed are the Analytical Results and Quality Control Data Reports for the following samples submitted to TraceAnalysis, Inc. for analysis:

Sample Number	Sample Description	Matrix	Date Taken	Time Taken	Date Received
136331	MW-5	Water	11/23/99	7:55	11/26/99
136332	MW-2	Water	11/23/99	10:44	11/26/99
136333	MW-4	Water	11/23/99	11:50	11/26/99
136334	MW-10	Water	11/23/99	12:20	11/26/99
136335	MW-3	Water	11/23/99	13:30	11/26/99
136336	MW-8	Water	11/23/99	14:40	11/26/99
136337	MW-9	Water	11/23/99	15:50	11/26/99
136338	Duplicate	Water	11/23/99	16:20	11/26/99
136339	MW-6	Water	11/23/99	17:00	11/26/99
136340	Trip Blank	Water	11/23/99	-	11/26/99

These results represent only the samples received in the laboratory. The Quality Control Report is generated on a batch basis. All information contained in this report is for the analytical batch(es) in which your sample(s) were analyzed.

This report consists of a total of 4 pages and shall not be reproduced except in its entirety, without written approval of TraceAnalysis, Inc.

Dr. Blair Leftwich, Director

Analytical Results Report

Sample Number: 136331
Description: MW-5

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Ion Chromatography (IC) (mg/L)										
CL		230	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
Fluoride		0.93	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.1
Nitrate-N		1.79	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.2
Sulfate		130	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
TDS (mg/L)										
Total Dissolved Solids		810	1	E 160.1	11/30/99	12/3/99	JS	PB03308	QC04356	10

Sample Number: 136332
Description: MW-2

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Ion Chromatography (IC) (mg/L)										
CL		79	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
Fluoride		1.5	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.1
Nitrate-N		1.99	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.2
Sulfate		64	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
TDS (mg/L)										
Total Dissolved Solids		470	1	E 160.1	11/30/99	12/3/99	JS	PB03308	QC04356	10

Sample Number: 136333
Description: MW-4

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Ion Chromatography (IC) (mg/L)										
CL		24	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
Fluoride		1.5	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.1
Nitrate-N		2.11	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.2
Sulfate		95	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
TDS (mg/L)										
Total Dissolved Solids		370	1	E 160.1	11/30/99	12/3/99	JS	PB03308	QC04356	10

Sample Number: 136334
Description: MW-10

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Ion Chromatography (IC) (mg/L)										
CL		49	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
Fluoride		1.3	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.1
Nitrate-N		2.72	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.2
Sulfate		96	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
TDS (mg/L)										
Total Dissolved Solids		490	1	E 160.1	11/30/99	12/3/99	JS	PB03308	QC04356	10

Sample Number: 136335
Description: MW-3

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Ion Chromatography (IC) (mg/L)										
CL		580	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
Fluoride		0.92	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.1
Nitrate-N		0.702	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.2
Sulfate		110	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
TDS (mg/L)										
Total Dissolved Solids		1300	1	E 160.1	11/30/99	12/3/99	JS	PB03308	QC04356	10

Sample Number: 136336
Description: MW-8

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Ion Chromatography (IC) (mg/L)										
CL		160	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
Fluoride		2.6	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.1
Nitrate-N		5.37	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.2
Sulfate		100	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
TDS (mg/L)										
Total Dissolved Solids		740	1	E 160.1	11/30/99	12/3/99	JS	PB03308	QC04356	10

Sample Number: 136337
Description: MW-9

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Ion Chromatography (IC) (mg/L)										
CL		420	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
Fluoride		2.2	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.1
Nitrate-N		0.347	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.2
Sulfate		130	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
TDS (mg/L)										
Total Dissolved Solids		1100	1	E 160.1	11/30/99	12/3/99	JS	PB03308	QC04356	10

Sample Number: 136339
Description: MW-6

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Ion Chromatography (IC) (mg/L)										
CL		160	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5
Fluoride		1.6	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.1
Nitrate-N		0.378	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.2
Sulfate		78	1	E 300.0	12/1/99	12/3/99	JS	PB03337	QC04356	0.5

TDS (mg/L)									
Total Dissolved Solids	670	1	E 160.1	11/30/99	12/3/99	JS	PB03307	QC04356	10

TRW Inc.
Energy & Environmental Systems
415 West Wall St. Suite. 1818
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No 13464

Chain of Custody

Date 11/24/99 Page 1 of 1

Lab Name: Trace Analysis
Address: 6701 Aberdeen
Lubbock, Tx 79424
Telephone: 800/378-1296

Samplers (SIGNATURES)
John Fergeson

Sample Identification	Matrix	Date	Time	BTEX (EPA 8021B)	MTBE (EPA 8021B)	SVOC (EPA 8270)	PAH (EPA 8270)	VOC (EPA 8260)	TPH (EPA 418.1)	TPH (TX-1005)	TPH (TX-1006)	GRO (EPA 8015G)	DRO (EPA 8015D)	TDS (EPA 160.1)	Anions/Cations Cl, F, NO3, SO4, TDS	Total Metals	TCLP Metals	Metals As, B, Ba, Fe, Mn, V						Number of Containers
MW-5	Water	11/23/99	0755	✓											✓			✓			136331			5
MW-2	Water	11/23/99	1044	✓											✓			✓					32	5
MW-4	Water	11/23/99	1150	✓											✓			✓					33	5
MW-10	Water	11/23/99	1220	✓											✓			✓					34	5
MW-3	Water	11/23/99	1330	✓											✓			✓					35	5
MW-8	Water	11/23/99	1440	✓											✓			✓					36	5
MW-9	Water	11/23/99	1550	✓											✓			✓					37	5
Duplicate	Water	11/23/99	1620	✓																			38	2
MW-6	Water	11/23/99	1700	✓											✓			✓					39	5
493A 493B TRIP Blank	Water			✓																			40	2

Analysis Request

Project Information	Sample Receipt
Project Name: Navajo Refining	Total Containers:
Project Location: Len Refinery	COC Seals:
Project Manager: Gil Van Deventer	Rec'd Good Cond/Cold:
Cost Center No.: P162631C	Conforms to Records:
Shipping ID No.:	Lab No.:
P O No.:	

Special Instructions/Comments: Metals Filtered In Field
Maximum Detection Limits (mg/L)
As (0.05), B (0.2), Ba (0.2), Fe (0.05), Mn (0.02), V (0.05)

Relinquished By: (1)	Relinquished By: (2)	Relinquished By: (3)
John Fergeson 1500		
(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
John Fergeson 11/24/99		
(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
TRW Inc		
(Company)	(Company)	(Company)
Received By: (1)	**Received By: (2)**	**Received By: (3)**
		Nell Green 9:00pm 9:30 MD
(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
		Nell Green 11-24-99
(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
		Trace Analysis
(Company)	(Company)	(Company)

Distribution: White, Canary-Laboratory / Pink-TRW

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TRACEANALYSIS, INC.

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E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
TRW
Attention: Gil Van DeVenter
415 West Wall, Suite 1818
Midland, TX 79701

December 08, 1999
Receiving Date: 11/24/99
Sample Type: Water
Cost Center No: P/6263/1C
Project Location: Lea Refinery
COC #13464

Sampling Date: 11/23/99
Sample Condition: Intact & Cool
Sample Received by: NG
Project Name: Navajo Refining

TOTAL METALS (mg/L)

TA#	Field Code	As	Ba	B	Fe	Mn	V
T136331	MW-5	<0.05	<0.20	0.25	<0.05	<0.02	<0.05
T136332	MW-2	<0.05	<0.20	0.21	<0.05	<0.02	<0.05
T136333	MW-4	<0.05	<0.20	<0.20	<0.05	<0.02	<0.05
T136334	MW-10	<0.05	<0.20	<0.20	<0.05	<0.02	<0.05
T136335	MW-3	<0.05	<0.20	0.23	<0.05	0.12	<0.05
T136336	MW-8	<0.05	<0.20	0.84	<0.05	<0.02	<0.05
T136337	MW-9	<0.05	<0.20	0.25	<0.05	0.12	<0.05
T136339	MW-6	0.14	<0.20	<0.20	0.07	<0.02	0.35
ICV		0.99	0.99	0.99	0.99	0.99	0.98
CCV		1.01	1.02	1.02	1.02	1.02	1.01
Reporting Limit		0.05	0.20	0.20	0.05	0.02	0.05
RPD		1	1	1	2	1	1
% Extraction Accuracy		105	102	107	102	102	100
% Instrument Accuracy		100	101	101	101	101	100
EXTRACTION DATE		12/03/99	12/03/99	12/03/99	12/03/99	12/03/99	12/03/99
ANALYSIS DATE		12/06/99	12/06/99	12/06/99	12/06/99	12/06/99	12/06/99

CHEMIST: RR
METHODS: EPA SW 846-3050, 6010B, 7471A.
TOTAL METALS SPIKE: 2.0 mg/L As, Ba, B, Fe, Mn and V.
TOTAL METALS CV: 1.0 mg/L As, Ba, B, Fe, Mn and V.

Director, Dr. Blair Leftwich

12-8-99
Date

TRACE ANALYSIS, INC.

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E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
TRW
Attention: Gil Van DeVenter
415 West Wall, Suite 1818
Midland, TX 79701

December 21, 1999
Receiving Date: 11/24/99
Sample Type: Water
Cost Center No: P/6263/1C
Project Location: Lea Refinery
COC# 13464

Prep Date: 11/29/99
Analysis Date: 11/29/99
Sampling Date: 11/23/99
Sample Condition: Intact & Cool
Sample Received by: NG
Project Name: Navajo Refining

TA#	FIELD CODE	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
T136331	MW-5	<0.005	<0.005	<0.005	<0.005	<0.005
T136332	MW-2	<0.005	<0.005	<0.005	<0.005	<0.005
T136333	MW-4	<0.005	<0.005	<0.005	<0.005	<0.005
T136334	MW-10	<0.005	<0.005	<0.005	<0.005	<0.005
T136335	MW-3	0.314	<0.005	0.005	0.102	0.421
T136336	MW-8	<0.005	<0.005	<0.005	<0.005	<0.005
T136337	MW-9	<0.005	<0.005	<0.005	<0.005	<0.005
T136338	Duplicate	<0.005	<0.005	<0.005	<0.005	<0.005
T136339	MW-6	<0.005	<0.005	<0.005	<0.005	<0.005
T136340	693A/693B Trip Blank	<0.005	<0.005	<0.005	<0.005	<0.005
QC	Quality Control	0.091	0.089	0.088	0.254	
REPORTING LIMIT		0.005	0.005	0.005	0.005	
RPD		2	5	4	3	
% Extraction Accuracy		90	88	87	85	
% Instrument Accuracy		91	89	88	85	

METHODS: EPA SW 846-8021B, 5035.
CHEMIST: RC
BTEX SPIKE: 0.100 mg/L BTEX.
BTEX QC: 0.100 mg/L BTEX.

Director, Dr. Blair Leftwich

12-21-99
Date

TRACEANALYSIS, INC.

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E-Mail: lab@traceanalysis.com

Analytical and Quality Control Report

Gil Van Deventer
TRW
415 West Wall Suite 1818
Midland, TX 79701

Report Date: 8/30/99

Project Number: P/2292/PC
Project Name: Navajo-Lea Refinery
Project Location: Lea Refinery

Order ID Number: 99082113

Enclosed are the Analytical Results and Quality Control Data Reports for the following samples submitted to TraceAnalysis, Inc. for analysis:

Sample Number	Sample Description	Matrix	Date Taken	Time Taken	Date Received
130476	MW-3	Water	8/19/99	15:00	8/21/99
130477	MW-10	Water	8/19/99	15:20	8/21/99
130478	MW-8	Water	8/19/99	15:40	8/21/99
130479	MW-6	Water	8/19/99	16:00	8/21/99
130480	MW-9	Water	8/19/99	16:20	8/21/99
130481	Duplicate	Water	8/19/99	16:40	8/21/99

These results represent only the samples received in the laboratory. The Quality Control Report is generated on a batch basis. All information contained in this report is for the analytical batch(es) in which your sample(s) were analyzed.

This report consists of a total of 7 pages and shall not be reproduced except in its entirety, without written approval of TraceAnalysis, Inc.

Dr. Blair Leftwich, Director

Analytical Results Report

Sample Number: 130476
Description: MW-3

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001
Toluene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001
Ethylbenzene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001
M,P,O-Xylene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001
Total BTEX (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001

Surrogate	Result	Dilution	Spike Amount	% Rec.	% Rec. Limit	Analyst	Prep Batch #	QC Batch #
TFT (mg/L)	0.094	1	0.1	94	72 - 128	RC	PB02066	QC02571
4-BFB (mg/L)	0.085	1	0.1	85	72 - 128	RC	PB02066	QC02571

Sample Number: 130477
Description: MW-10

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001
Toluene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001
Ethylbenzene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001
M,P,O-Xylene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001
Total BTEX (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02571	0.001

Surrogate	Result	Dilution	Spike Amount	% Rec.	% Rec. Limit	Analyst	Prep Batch #	QC Batch #
TFT (mg/L)	0.089	1	0.1	89	72 - 128	RC	PB02066	QC02571
4-BFB (mg/L)	0.079	1	0.1	79	72 - 128	RC	PB02066	QC02571

Sample Number: 130478
Description: MW-8

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001
Toluene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001
Ethylbenzene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001
M,P,O-Xylene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001
Total BTEX (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001

Surrogate	Result	Dilution	Spike Amount	% Rec.	% Rec. Limit	Analyst	Prep Batch #	QC Batch #
TFT (mg/L)	0.082	1	0.1	82	72 - 128	RC	PB02066	QC02572
4-BFB (mg/L)	0.072	1	0.1	72	72 - 128	RC	PB02066	QC02572

Sample Number: 130479
Description: MW-6

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001
Toluene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001
Ethylbenzene (mg/L)		<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001

M,P,O-Xylene (mg/L)	<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001
Total BTEX (mg/L)	<0.001	1	S 8021B	8/24/99	8/24/99	RC	PB02066	QC02572	0.001

Surrogate	Result	Dilution	Spike Amount	% Rec.	% Rec. Limit	Analyst	Prep Batch #	QC Batch #
TFT (mg/L)	0.112	1	0.1	112	72 - 128	RC	PB02066	QC02572
4-BFB (mg/L)	0.094	1	0.1	94	72 - 128	RC	PB02066	QC02572

Sample Number: 130480
Description: MW-9

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene (mg/L)		<0.001	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001
Toluene (mg/L)		<0.001	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001
Ethylbenzene (mg/L)		<0.001	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001
M,P,O-Xylene (mg/L)		0.002	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001
Total BTEX (mg/L)		0.002	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001

Surrogate	Result	Dilution	Spike Amount	% Rec.	% Rec. Limit	Analyst	Prep Batch #	QC Batch #
TFT (mg/L)	0.096	1	0.1	96	72 - 128	RC	PB02092	QC02607
4-BFB (mg/L)	0.096	1	0.1	96	72 - 128	RC	PB02092	QC02607

Sample Number: 130481
Description: Duplicate (MW-9)

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene (mg/L)		<0.001	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001
Toluene (mg/L)		<0.001	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001
Ethylbenzene (mg/L)		<0.001	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001
M,P,O-Xylene (mg/L)		0.002	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001
Total BTEX (mg/L)		0.002	1	S 8021B	8/26/99	8/26/99	RC	PB02092	QC02607	0.001

Surrogate	Result	Dilution	Spike Amount	% Rec.	% Rec. Limit	Analyst	Prep Batch #	QC Batch #
TFT (mg/L)	0.087	1	0.1	87	72 - 128	RC	PB02092	QC02607
4-BFB (mg/L)	0.085	1	0.1	85	72 - 128	RC	PB02092	QC02607

Quality Control Report
Method Blanks

Param	Flag	Blank Result	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #
Benzene (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02571
Toluene (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02571
Ethylbenzene (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02571
M,P,O-Xylene (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02571
Total BTEX (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02571
Benzene (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02572
Toluene (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02572
Ethylbenzene (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02572
M,P,O-Xylene (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02572
Total BTEX (mg/L)		<0.001	0.001	8/24/99	PB02066	QC02572
Benzene (mg/L)		<0.001	0.001	8/26/99	PB02092	QC02607
Toluene (mg/L)		<0.001	0.001	8/26/99	PB02092	QC02607
Ethylbenzene (mg/L)		<0.001	0.001	8/26/99	PB02092	QC02607
M,P,O-Xylene (mg/L)		<0.001	0.001	8/26/99	PB02092	QC02607
Total BTEX (mg/L)		<0.001	0.001	8/26/99	PB02092	QC02607

Quality Control Report
Lab Control Spikes and Duplicate Spike

	Param	Blank Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
LCS	MTBE (mg/L)	<0.001	1	0.1	0.101	101		80 - 120	0 - 20	QC02571
LCS	Benzene (mg/L)	<0.001	1	0.1	0.088	88		80 - 120	0 - 20	QC02571
LCS	Toluene (mg/L)	<0.001	1	0.1	0.087	87		80 - 120	0 - 20	QC02571
LCS	Ethylbenzene (mg/L)	<0.001	1	0.1	0.085	85		80 - 120	0 - 20	QC02571
LCS	M,P,O-Xylene (mg/L)	<0.001	1	0.3	0.246	82		80 - 120	0 - 20	QC02571

Standard	Surrogate	Dil.	Spike Amount	Result	% Rec.	% Rec. Limit	QC Batch #
LCS	TFT (mg/L)	1	0.1	0.092	92	72 - 128	QC02571
LCS	4-BFB (mg/L)	1	0.1	0.09	90	72 - 128	QC02571

LCSD	MTBE (mg/L)	<0.001	1	0.1	0.102	102	1	80 - 120	0 - 20	QC02571
LCSD	Benzene (mg/L)	<0.001	1	0.1	0.089	89	1	80 - 120	0 - 20	QC02571
LCSD	Toluene (mg/L)	<0.001	1	0.1	0.087	87	0	80 - 120	0 - 20	QC02571
LCSD	Ethylbenzene (mg/L)	<0.001	1	0.1	0.086	86	1	80 - 120	0 - 20	QC02571
LCSD	M,P,O-Xylene (mg/L)	<0.001	1	0.3	0.247	82	0	80 - 120	0 - 20	QC02571

Standard	Surrogate	Dil.	Spike Amount	Result	% Rec.	% Rec. Limit	QC Batch #
LCSD	TFT (mg/L)	1	0.1	0.096	96	72 - 128	QC02571
LCSD	4-BFB (mg/L)	1	0.1	0.094	94	72 - 128	QC02571

	Param	Blank Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
LCS	MTBE (mg/L)	<0.001	1	0.1	0.101	101		80 - 120	0 - 20	QC02572
LCS	Benzene (mg/L)	<0.001	1	0.1	0.088	88		80 - 120	0 - 20	QC02572
LCS	Toluene (mg/L)	<0.001	1	0.1	0.087	87		80 - 120	0 - 20	QC02572
LCS	Ethylbenzene (mg/L)	<0.001	1	0.1	0.085	85		80 - 120	0 - 20	QC02572
LCS	M,P,O-Xylene (mg/L)	<0.001	1	0.3	0.246	82		80 - 120	0 - 20	QC02572

Standard	Surrogate	Dil.	Spike Amount	Result	% Rec.	% Rec. Limit	QC Batch #
LCS	TFT (mg/L)	1	0.1	0.092	92	72 - 128	QC02572
LCS	4-BFB (mg/L)	1	0.1	0.09	90	72 - 128	QC02572

LCSD	MTBE (mg/L)	<0.001	1	0.1	0.102	102	1	80 - 120	0 - 20	QC02572
LCSD	Benzene (mg/L)	<0.001	1	0.1	0.089	89	1	80 - 120	0 - 20	QC02572
LCSD	Toluene (mg/L)	<0.001	1	0.1	0.087	87	0	80 - 120	0 - 20	QC02572
LCSD	Ethylbenzene (mg/L)	<0.001	1	0.1	0.086	86	1	80 - 120	0 - 20	QC02572
LCSD	M,P,O-Xylene (mg/L)	<0.001	1	0.3	0.247	82	0	80 - 120	0 - 20	QC02572

Standard	Surrogate	Dil.	Spike Amount	Result	% Rec.	% Rec. Limit	QC Batch #
LCSD	TFT (mg/L)	1	0.1	0.096	96	72 - 128	QC02572
LCSD	4-BFB (mg/L)	1	0.1	0.094	94	72 - 128	QC02572

	Param	Blank Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
LCS	MTBE (mg/L)	<0.001	1	0.1	0.085	85		80 - 120	0 - 20	QC02607
LCS	Benzene (mg/L)	<0.001	1	0.1	0.082	82		80 - 120	0 - 20	QC02607
LCS	Toluene (mg/L)	<0.001	1	0.1	0.081	81		80 - 120	0 - 20	QC02607
LCS	Ethylbenzene (mg/L)	<0.001	1	0.1	0.08	80		80 - 120	0 - 20	QC02607
LCS	M,P,O-Xylene (mg/L)	<0.001	1	0.3	0.243	81		80 - 120	0 - 20	QC02607

Standard	Surrogate	Dil.	Spike Amount	Result	% Rec.	% Rec. Limit	QC Batch #
LCS	TFT (mg/L)	1	0.1	0.096	96	72 - 128	QC02607
LCS	4-BFB (mg/L)	1	0.1	0.097	97	72 - 128	QC02607

LCSD	MTBE (mg/L)	<0.001	1	0.1	0.101	101	17	80 - 120	0 - 20	QC02607
LCSD	Benzene (mg/L)	<0.001	1	0.1	0.096	96	16	80 - 120	0 - 20	QC02607
LCSD	Toluene (mg/L)	<0.001	1	0.1	0.095	95	16	80 - 120	0 - 20	QC02607
LCSD	Ethylbenzene (mg/L)	<0.001	1	0.1	0.094	94	17	80 - 120	0 - 20	QC02607
LCSD	M,P,O-Xylene (mg/L)	<0.001	1	0.3	0.275	92	18	80 - 120	0 - 20	QC02607

Standard	Surrogate	Dil.	Spike Amount	Result	% Rec.	% Rec. Limit	QC Batch #
LCSD	TFT (mg/L)	1	0.1	0.098	98	72 - 128	QC02607
LCSD	4-BFB (mg/L)	1	0.1	0.101	101	72 - 128	QC02607

Quality Control Report
Continuing Calibration Verification Standard

Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	Benzene (mg/L)		0.1	0.09	90	80 - 120	8/24/99	QC02571
ICV	Toluene (mg/L)		0.1	0.089	89	80 - 120	8/24/99	QC02571
ICV	Ethylbenzene (mg/L)		0.1	0.087	87	80 - 120	8/24/99	QC02571
ICV	M,P,O-Xylene (mg/L)		0.3	0.254	85	80 - 120	8/24/99	QC02571
CCV (1	Benzene (mg/L)		0.1	0.097	97	80 - 120	8/24/99	QC02571
CCV (1	Toluene (mg/L)		0.1	0.096	96	80 - 120	8/24/99	QC02571
CCV (1	Ethylbenzene (mg/L)		0.1	0.094	94	80 - 120	8/24/99	QC02571
CCV (1	M,P,O-Xylene (mg/L)		0.3	0.275	92	80 - 120	8/24/99	QC02571

Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	Benzene (mg/L)		0.1	0.097	97	80 - 120	8/24/99	QC02572
ICV	Toluene (mg/L)		0.1	0.096	96	80 - 120	8/24/99	QC02572
ICV	Ethylbenzene (mg/L)		0.1	0.094	94	80 - 120	8/24/99	QC02572
ICV	M,P,O-Xylene (mg/L)		0.3	0.275	92	80 - 120	8/24/99	QC02572
CCV (1	Benzene (mg/L)		0.1	0.098	98	80 - 120	8/24/99	QC02572
CCV (1	Toluene (mg/L)		0.1	0.097	97	80 - 120	8/24/99	QC02572
CCV (1	Ethylbenzene (mg/L)		0.1	0.095	95	80 - 120	8/24/99	QC02572
CCV (1	M,P,O-Xylene (mg/L)		0.3	0.281	94	80 - 120	8/24/99	QC02572

Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	Benzene (mg/L)		0.1	0.11	110	80 - 120	8/26/99	QC02607
ICV	Toluene (mg/L)		0.1	0.112	112	80 - 120	8/26/99	QC02607
ICV	Ethylbenzene (mg/L)		0.1	0.104	104	80 - 120	8/26/99	QC02607
ICV	M,P,O-Xylene (mg/L)		0.3	0.312	104	80 - 120	8/26/99	QC02607
CCV (1	Benzene (mg/L)		0.1	0.101	101	80 - 120	8/26/99	QC02607
CCV (1	Toluene (mg/L)		0.1	0.1	100	80 - 120	8/26/99	QC02607
CCV (1	Ethylbenzene (mg/L)		0.1	0.1	100	80 - 120	8/26/99	QC02607
CCV (1	M,P,O-Xylene (mg/L)		0.3	0.293	98	80 - 120	8/26/99	QC02607

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9908113

№ 13440

Chain of Custody

Date 8/20/99 Page 1 of 1

Lab Name: Trace Analysis Inc
Address: 6701 Aberdeen, Suite 9
Lubbock, Texas 79424
Telephone: 806-794-1296

Samplers (SIGNATURES)

John Ferguson

Analysis Request

Sample Identification	Matrix	Date	Time	BTEX (EPA 8021B)	MTBE (EPA 8021B)	SVOC (EPA 8270)	PAH (EPA 8270)	VOC (EPA 8260)	TPH (EPA 418.1)	TPH (TX-1005)	TPH (TX-1006)	GRO (EPA 8015G)	DRO (EPA 8015D)	TDS (EPA 160.1)	Anions/Cations	Total Metals	TCLP Metals							Number of Containers
990819 1500 (MW-3)	Water	8/19/99	1500	√																1304	76			2
990819 1520 (MW-10)	Water	8/19/99	1520	√																4	77			2
990819 1540 (MW-5)	Water	8/19/99	1540	√																4	78			2
990819 1600 (MW-6)	Water	8/19/99	1600	√																4	79			2
990819 1620 (MW-9)	Water	8/19/99	~~1640~~ 1630	√																4	80			2
990819 1640 (Duplicate)	Water	8/19/99	1640	√																4	81			2

Project Information	Sample Receipt
Project Name: Navajo Refining	Total Containers:
Project Location: Lea Refinery	COC Seals:
Project Manager: Gil Van Deventer	Rec'd Good Cond/Cold:
Cost Center No.: P/2292/9C	Conforms to Records:
Shipping ID No.:	Lab No.:
P O No.:	

Special Instructions/Comments: CARRIER: TNM&O #902218 2731 TEMP: 5

Relinquished By: (1)	Relinquished By: (2)	Relinquished By: (3)
John Ferguson 1530 (Signature) (Time)	(Signature) (Time)	(Signature) (Time)
John Ferguson 8/20/99 (Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
TRW Inc, EE+S (Company)	(Company)	(Company)
Received By: (1)	**Received By: (2)**	**Received By: (3)**
12:38 (Signature) (Time)	(Signature) (Time)	(Signature) (Time)
D. Taylor 8/20/99 (Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
Trace Analysis (Company)	(Company)	(Company)

Distribution: White, Canary-Laboratory / Pink-TRW

TRACEANALYSIS, INC.

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Analytical and Quality Control Report

Gil Van Deventer
TRW
415 West Wall Suite 1818
Midland, TX 79701

Report Date: 8/30/99

Project Number: P/2292/9C
Project Name: Navajo
Project Location: Lea Refinery

Order ID Number: 99082021

Enclosed are the Analytical Results and Quality Control Data Reports for the following samples submitted to TraceAnalysis, Inc. for analysis:

Sample Number	Sample Description	Matrix	Date Taken	Time Taken	Date Received
130405	VE Exhaust	Air	8/16/99	13:00	8/20/99

These results represent only the samples received in the laboratory. The Quality Control Report is generated on a batch basis. All information contained in this report is for the analytical batch(es) in which your sample(s) were analyzed.

This report consists of a total of 4 pages and shall not be reproduced except in its entirety, without written approval of TraceAnalysis, Inc.

Dr. Blair Leftwich, Director

Analytical Results Report

Sample Number: 130405
Description: VE Exhaust

Param	Flag	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene (mg/m3)		<1	1000	S 8021B	8/26/99	8/26/99	RC	PB02088	QC02605	0.001
Toluene (mg/m3)		<1	1000	S 8021B	8/26/99	8/26/99	RC	PB02088	QC02605	0.001
Ethylbenzene (mg/m3)		<1	1000	S 8021B	8/26/99	8/26/99	RC	PB02088	QC02605	0.001
M,P,O-Xylene (mg/m3)		<1	1000	S 8021B	8/26/99	8/26/99	RC	PB02088	QC02605	0.001
Total BTEX (mg/m3)		<1	1000	S 8021B	8/26/99	8/26/99	RC	PB02088	QC02605	0.001
GRO (mg/m3)		<100	1	8015B	8/26/99	8/26/99	RC	PB02089	QC02606	0.1

Quality Control Report
Method Blanks

Param	Flag	Blank Result	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #
Benzene (mg/m3)		<0.001	0.001	8/26/99	PB02088	QC02605
Toluene (mg/m3)		<0.001	0.001	8/26/99	PB02088	QC02605
Ethylbenzene (mg/m3)		<0.001	0.001	8/26/99	PB02088	QC02605
M,P,O-Xylene (mg/m3)		<0.001	0.001	8/26/99	PB02088	QC02605
Total BTEX (mg/m3)		<0.001	0.001	8/26/99	PB02088	QC02605

Param	Flag	Blank Result	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #
GRO (mg/m3)		<100	0.1	8/26/99	PB02089	QC02606

Quality Control Report
Lab Control Spikes and Duplicate Spike

	Param	Blank Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
LCS	MTBE (mg/m3)	<0.001	1	0.1	0.095	95		80 - 120	0 - 20	QC02605
LCS	Benzene (mg/m3)	<0.001	1	0.1	0.091	91		80 - 120	0 - 20	QC02605
LCS	Toluene (mg/m3)	<0.001	1	0.1	0.09	90		80 - 120	0 - 20	QC02605
LCS	Ethylbenzene (mg/m3)	<0.001	1	0.1	0.089	89		80 - 120	0 - 20	QC02605
LCS	M,P,O-Xylene (mg/m3)	<0.001	1	0.3	0.262	87		80 - 120	0 - 20	QC02605

Standard	Surrogate	Dil.	Spike Amount	Result	% Rec.	% Rec. Limit	QC Batch #
LCS	TFT (mg/L)	1	0.1	0.095	95	72 - 128	QC02605
LCS	4-BFB (mg/L)	1	0.1	0.093	93	72 - 128	QC02605

LCSD	MTBE (mg/m3)	<0.001	1	0.1	0.1	100	5	80 - 120	0 - 20	QC02605
LCSD	Benzene (mg/m3)	<0.001	1	0.1	0.096	96	5	80 - 120	0 - 20	QC02605
LCSD	Toluene (mg/m3)	<0.001	1	0.1	0.095	95	5	80 - 120	0 - 20	QC02605
LCSD	Ethylbenzene (mg/m3)	<0.001	1	0.1	0.094	94	5	80 - 120	0 - 20	QC02605
LCSD	M,P,O-Xylene (mg/m3)	<0.001	1	0.3	0.279	93	6	80 - 120	0 - 20	QC02605

Standard	Surrogate	Dil.	Spike Amount	Result	% Rec.	% Rec. Limit	QC Batch #
LCSD	TFT (mg/L)	1	0.1	0.096	96	72 - 128	QC02605
LCSD	4-BFB (mg/L)	1	0.1	0.097	97	72 - 128	QC02605

	Param	Blank Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
LCS	GRO (mg/m3)	<100	1	1	0.972	97		80 - 120	0 - 20	QC02606
LCSD	GRO (mg/m3)	<100	1	1	1.03	103	6	80 - 120	0 - 20	QC02606

Quality Control Report
Continuing Calibration Verification Standard

Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	Benzene (mg/m3)		0.1	0.097	97	80 - 120	8/26/99	QC02605
ICV	Toluene (mg/m3)		0.1	0.097	97	80 - 120	8/26/99	QC02605
ICV	Ethylbenzene (mg/m3)		0.1	0.096	96	80 - 120	8/26/99	QC02605
ICV	M,P,O-Xylene (mg/m3)		0.3	0.287	96	80 - 120	8/26/99	QC02605
CCV (1	Benzene (mg/m3)		0.1	0.104	104	80 - 120	8/26/99	QC02605
CCV (1	Toluene (mg/m3)		0.1	0.102	102	80 - 120	8/26/99	QC02605
CCV (1	Ethylbenzene (mg/m3)		0.1	0.103	103	80 - 120	8/26/99	QC02605
CCV (1	M,P,O-Xylene (mg/m3)		0.3	0.302	101	80 - 120	8/26/99	QC02605

Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	GRO (mg/m3)		1	0.862	86	80 - 120	8/26/99	QC02606
CCV (1	GRO (mg/m3)		1	1.14	114	80 - 120	8/26/99	QC02606

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№ 13438

Chain of Custody

Date 8-16-99 Page 1 of 1

Lab Name: Trace Analysis Inc
Address: 6701 Aberdeen Av, Ste 9
Lubbock, Tx 79424
Telephone: 806/794-1296

Samplers (SIGNATURES)

Sample Identification	Matrix	Date	Time	BTEX (EPA 8021B)	MTBE (EPA 8021B)	SVOC (EPA 8270)	PAH (EPA 8270)	VOC (EPA 8260)	TPH (EPA 418.1)	TPH (TX-1005)	TPH (TX-1006)	GRO (EPA 8015G)	DRO (EPA 8015D)	TDS (EPA 160.1)	Anions/Cations	Total Metals	TCLP Metals								Number of Containers
MW-3	Water	8-16-99	1515	✓																					2
MW-10	Water	8-16-99	1500	✓																					2
MW-6	Water	8-16-99	1620	✓																					2
Duplicate	Water	8-16-99	1530	✓																					2
MW-8	Water	8-16-99	1640	✓																					2
MW-9	Water	8-16-99	1700	✓																					2
VE Exhaust 130405	Air	8-16-99	1300	✓								✓													2
Trip Blank	Water			✓																					2

Analysis Request

Project Information	Sample Receipt
Project Name: Navajo	Total Containers:
Project Location: Lea Refinery	COC Seals:
Project Manager: Gil Van Deventer	Rec'd Good Cond/Cold:
Cost Center No.: P/2292/9C	Conforms to Records:
Shipping ID No.:	Lab No.:
P O No.:	

Special Instructions/Comments:
all water samples rec'd broken
Bil will re-sample
Site resampled on 8/19/99 SMV

Relinquished By: (1)	Relinquished By: (2)	Relinquished By: (3)
G Van Deventer 8-18-99		
(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
Gil Van Deventer 3:45 p		
(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
TRW Inc.		
(Company)	(Company)	(Company)
Received By: (1)	**Received By: (2)**	**Received By: (3)**
		Vicki Windham 10:00 a
(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
		Vicki Windham 8-20-99
(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
		Trace Analysis
(Company)	(Company)	(Company)

TNMO 902-228-247-8 rec'd air

Distribution: White, Canary-Laboratory / Pink-TRW

TRACEANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

Analytical and Quality Control Report

Dale Littlejohn
TRW
415 West Wall Suite 1818
Midland, TX 79701

Report Date: 5/6/99

Project Number: PO #4500009585
Project Name: Navajo-Lea Refinery
Project Location: N/A

Order ID Number: 99042313

Enclosed are the Analytical Results and Quality Control Data Reports for the following samples submitted to TraceAnalysis, Inc. for analysis:

Sample Number	Sample Description	Matrix	Date Taken	Time Taken	Date Received
123362	9904210955 MW-3	Water	4/21/99	9:55	4/23/99
123363	9904211050 MW-10	Water	4/21/99	10:50	4/23/99
123364	9904211130 MW-8	Water	4/21/99	11:30	4/23/99
123365	9904211150 MW-9	Water	4/21/99	11:50	4/23/99
123366	9904211230 Duplicate	Water	4/21/99	12:30	4/23/99
123367	9904211250 MW-6	Water	4/21/99	12:50	4/23/99
123368	600A Trip Blank	Water	4/21/99	-	4/23/99

These results represent only the samples received in the laboratory. The Quality Control Report is generated on a batch basis. All information contained in this report is for the analytical batch(es) in which your sample(s) were analyzed.

This report consists of a total of 5 pages and shall not be reproduced except in its entirety, without written approval of TraceAnalysis, Inc.

Dr. Blair Leftwich, Director

Analytical Results Report

Sample Number: 123362
Description: 9904210955 MW-3

Param	Flag	Result	Units	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
Toluene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
Ethylbenzene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
M,P,O-Xylene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
Total BTEX		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001

Sample Number: 123363
Description: 9904211050 MW-10

Param	Flag	Result	Units	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
Toluene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
Ethylbenzene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
M,P,O-Xylene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
Total BTEX		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001

Sample Number: 123364
Description: 9904211130 MW-8

Param	Flag	Result	Units	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
Toluene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
Ethylbenzene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
M,P,O-Xylene		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001
Total BTEX		<0.005	mg/L	5	S 8021B	5/3/99	5/3/99	RC	PB00584	QC00696	0.001

Sample Number: 123365
Description: 9904211150 MW-9

Param	Flag	Result	Units	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene		0.008	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
Toluene		0.002	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
Ethylbenzene		<0.001	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
M,P,O-Xylene		0.005	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
Total BTEX		0.015	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001

Sample Number: 123366
Description: 9904211230 Duplicate (MW-9)

Param	Flag	Result	Units	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene		0.006	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
Toluene		0.001	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
Ethylbenzene		<0.001	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
M,P,O-Xylene		0.004	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
Total BTEX		0.011	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001

Sample Number: 123367
Description: 9904211250 MW-6

Param	Flag	Result	Units	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene		<0.001	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
Toluene		<0.001	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
Ethylbenzene		<0.001	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
M,P,O-Xylene		<0.001	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001
Total BTEX		<0.001	mg/L	1	S 8021B	4/28/99	4/28/99	RC	PB00527	QC00628	0.001

Sample Number: 123368
Description: 600A Trip Blank

Param	Flag	Result	Units	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Benzene		<0.001	mg/L	1	S 8021B	5/4/99	5/4/99	RC	PB00602	QC00724	0.001
Toluene		<0.001	mg/L	1	S 8021B	5/4/99	5/4/99	RC	PB00602	QC00724	0.001
Ethylbenzene		<0.001	mg/L	1	S 8021B	5/4/99	5/4/99	RC	PB00602	QC00724	0.001
M,P,O-Xylene		<0.001	mg/L	1	S 8021B	5/4/99	5/4/99	RC	PB00602	QC00724	0.001
Total BTEX		<0.001	mg/L	1	S 8021B	5/4/99	5/4/99	RC	PB00602	QC00724	0.001

Quality Control Report
Method Blanks

Param	Flag	Blank Result	Units	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #
Benzene		<0.001	mg/L	0.001	4/28/99	PB00527	QC00628
Toluene		<0.001	mg/L	0.001	4/28/99	PB00527	QC00628
Ethylbenzene		<0.001	mg/L	0.001	4/28/99	PB00527	QC00628
M,P,O-Xylene		<0.001	mg/L	0.001	4/28/99	PB00527	QC00628
Total BTEX		<0.001	mg/L	0.001	4/28/99	PB00527	QC00628
MTBE		<0.001	mg/L	0.001	5/3/99	PB00584	QC00696
Benzene		<0.001	mg/L	0.001	5/3/99	PB00584	QC00696
Toluene		<0.001	mg/L	0.001	5/3/99	PB00584	QC00696
Ethylbenzene		<0.001	mg/L	0.001	5/3/99	PB00584	QC00696
M,P,O-Xylene		<0.001	mg/L	0.001	5/3/99	PB00584	QC00696
Total BTEX		<0.001	mg/L	0.001	5/3/99	PB00584	QC00696
MTBE		<0.001	mg/L	0.001	5/4/99	PB00602	QC00724
Benzene		<0.001	mg/L	0.001	5/4/99	PB00602	QC00724
Toluene		<0.001	mg/L	0.001	5/4/99	PB00602	QC00724
Ethylbenzene		<0.001	mg/L	0.001	5/4/99	PB00602	QC00724
M,P,O-Xylene		<0.001	mg/L	0.001	5/4/99	PB00602	QC00724
Total BTEX		<0.001	mg/L	0.001	5/4/99	PB00602	QC00724

Quality Control Report
Lab Control Spikes and Duplicate Spike

Standard	Param	Units	Blank Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
LCS	MTBE	mg/L	<0.001	1	0.1	0.099	99		80-120	0 - 20	QC00696
LCS	Benzene	mg/L	<0.001	1	0.1	0.098	98		80-120	0 - 20	QC00696
LCS	Toluene	mg/L	<0.001	1	0.1	0.104	104		80-120	0 - 20	QC00696
LCS	Ethylbenzene	mg/L	<0.001	1	0.1	0.097	97		80-120	0 - 20	QC00696
LCS	M,P,O-Xylene	mg/L	<0.001	1	0.3	0.276	92		80-120	0 - 20	QC00696
LCSD	MTBE	mg/L	<0.001	1	0.1	0.095	95	4	80-120	0 - 20	QC00696
LCSD	Benzene	mg/L	<0.001	1	0.1	0.096	96	2	80-120	0 - 20	QC00696
LCSD	Toluene	mg/L	<0.001	1	0.1	0.103	103	1	80-120	0 - 20	QC00696
LCSD	Ethylbenzene	mg/L	<0.001	1	0.1	0.096	96	1	80-120	0 - 20	QC00696
LCSD	M,P,O-Xylene	mg/L	<0.001	1	0.3	0.273	91	1	80-120	0 - 20	QC00696

Standard	Param	Units	Blank Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
LCS	MTBE	mg/L	<0.001	1	0.1	0.108	108		80-120	0 - 20	QC00724
LCS	Benzene	mg/L	<0.001	1	0.1	0.102	102		80-120	0 - 20	QC00724
LCS	Toluene	mg/L	<0.001	1	0.1	0.103	103		80-120	0 - 20	QC00724
LCS	Ethylbenzene	mg/L	<0.001	1	0.1	0.101	101		80-120	0 - 20	QC00724
LCS	M,P,O-Xylene	mg/L	<0.001	1	0.3	0.308	103		80-120	0 - 20	QC00724
LCSD	MTBE	mg/L	<0.001	1	0.1	0.110	110	2	80-120	0 - 20	QC00724
LCSD	Benzene	mg/L	<0.001	1	0.1	0.106	106	4	80-120	0 - 20	QC00724
LCSD	Toluene	mg/L	<0.001	1	0.1	0.105	105	2	80-120	0 - 20	QC00724
LCSD	Ethylbenzene	mg/L	<0.001	1	0.1	0.104	104	3	80-120	0 - 20	QC00724
LCSD	M,P,O-Xylene	mg/L	<0.001	1	0.3	0.316	105	3	80-120	0 - 20	QC00724

Quality Control Report
Continuing Calibration Verification Standard

Standard	Param	Flag	CCVs TRUE Conc.	Units	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	MTBE		0.1	mg/L	0.098	98	80 - 120	5/3/99	QC00696
ICV	Benzene		0.1	mg/L	0.094	94	80 - 120	5/3/99	QC00696
ICV	Toluene		0.1	mg/L	0.099	99	80 - 120	5/3/99	QC00696
ICV	Ethylbenzene		0.1	mg/L	0.094	94	80 - 120	5/3/99	QC00696
ICV	M,P,O-Xylene		0.3	mg/L	0.264	88	80 - 120	5/3/99	QC00696
CCV (1)	MTBE		0.1	mg/L	0.094	94	80 - 120	5/3/99	QC00696
CCV (1)	Benzene		0.1	mg/L	0.092	92	80 - 120	5/3/99	QC00696
CCV (1)	Toluene		0.1	mg/L	0.096	96	80 - 120	5/3/99	QC00696
CCV (1)	Ethylbenzene		0.1	mg/L	0.090	90	80 - 120	5/3/99	QC00696
CCV (1)	M,P,O-Xylene		0.3	mg/L	0.254	85	80 - 120	5/3/99	QC00696

Standard	Param	Flag	CCVs TRUE Conc.	Units	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	MTBE		0.1	mg/L	0.109	109	80 - 120	5/4/99	QC00724
ICV	Benzene		0.1	mg/L	0.104	104	80 - 120	5/4/99	QC00724
ICV	Toluene		0.1	mg/L	0.104	104	80 - 120	5/4/99	QC00724
ICV	Ethylbenzene		0.1	mg/L	0.104	104	80 - 120	5/4/99	QC00724
ICV	M,P,O-Xylene		0.3	mg/L	0.311	104	80 - 120	5/4/99	QC00724
CCV (1)	MTBE		0.1	mg/L	0.102	102	80 - 120	5/4/99	QC00724
CCV (1)	Benzene		0.1	mg/L	0.103	103	80 - 120	5/4/99	QC00724
CCV (1)	Toluene		0.1	mg/L	0.103	103	80 - 120	5/4/99	QC00724
CCV (1)	Ethylbenzene		0.1	mg/L	0.104	104	80 - 120	5/4/99	QC00724
CCV (1)	M,P,O-Xylene		0.3	mg/L	0.310	103	80 - 120	5/4/99	QC00724

9904[redacted]315

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

13296

Chain of Custody

Date 4/22/99 Page 1 Of 1

Lab Name Trace Analysis Inc.
Address 6701 Aberdeen Ave.
Lubbock, TX 79424
Telephone (800) 378-1296

Samplers (SIGNATURES) Joh Ferguson

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles ~~602/8020~~ 8021 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 GRO/TVHC	TCLP - Vol., Semi-Vol. Herbicides, Pesticides	TCLP - Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)						Number of Containers
9904210955	Water	MW-3		✓					123362																					2
9904211050	Water	MW-10		✓					63																					2
9904211130	Water	MW-8		✓					64																					2
9904211150	Water	MW-9		✓					65																					2
990421 1230	Water	Duplicate		✓					66																					2
990421 1250	Water	MW-6		✓					67																					2
990421 1345	Air	VE Exhaust		✓					123369				✓	Lab lost sample due to janitors throwing out																2
600A	Water	Trip Blank		✓					68																					2

Project Information
Project Navajo - Lea Refining
Project Director G. Van Deventer
Charge Code No. P/2292/9C
Shipping ID. No.
Via: Greyhound

Sample Receipt
Total No. of Containers
Chain of Custody Seals
Rec'd Good Condition/Cold
Conforms to Record
Lab No.

Special Instructions/Comments: P.O. #4500009585

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
(Signature) Joh Ferguson (Time) 1045	(Signature) Helen Shelton (Time) 6:45PM	(Signature) (Time)
(Printed Name) John Ferguson (Date) 4/22/99	(Printed Name) HELEN SHELTON (Date) 4/22/99	(Printed Name) (Date)
(Company) TRW Inc	(Company) TRACE ANALYSIS	(Company)
Received By 1.	**Received By 2.**	**Received By (Laboratory) 3.**
(Signature) Helen Shelton (Time) 10:50AM	(Signature) (Time)	(Signature) Vicki Windham (Time) 10:00 Am
(Printed Name) HELEN SHELTON (Date) 4/22/99	(Printed Name) (Date)	(Printed Name) Vicki Windham (Date) 4-23-99
(Company) TRACE ANALYSIS	(Company)	(Laboratory) TraceAnalysis

5/7

notified Gil 4/28 no air will re-sample

16 samples - HS

1" Rus 1503 PL11/99A

Distribution: White, Canary-Laboratory • Pink, BDM

TRACE ANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
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E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
TRW
Attention Gil Van Deventer
415 West Wall Suite 1818
Midland Tx 79701

Lab Receiving # : 9902000292
Sampling Date: 2/16/99
Sample Condition: Intact and Cool
Sample Received By: VW

Date: Feb 22, 1999
Date Rec: 2/18/99
Project: P/2292/PC
Proj Name: Navajo-Lea Refinery
Proj Loc: N/A

TA#	Field Code	MATRIX	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
119125	MW-6	Water	<0.001	<0.001	<0.001	<0.001	<0.001
119126	MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001
119127	MW-9	Water	<0.001	0.004	0.001	0.022	0.027
119128	Duplicate (MW-9)	Water	<0.001	0.004	0.002	0.008	0.014
119129	Trip Blank	Water	<0.001	<0.001	<0.001	<0.001	<0.001
Method Blank			<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	
QC			0.100	0.099	0.099	0.288	
RPD			0	0	0	2	
% Extraction Accuracy			92	93	91	90	
% Instrument Accuracy			100	99	99	96	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	2/19/99	EPA 8021B	2/19/99	RC	0.100 ea	0.1 ea

Director, Dr. Blair Leftwich

2-22-99
Date

TRACE ANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
TRW
Attention Gil Van Deventer
415 West Wall Suite 1818
Midland Tx 79701

Date: Feb 19, 1999
Date Rec: 2/18/99
Project: P/2292/PC
Proj Name: Navajo-Lea Refinery
Proj Loc: N/A

Lab Receiving # : 9902000292
Sampling Date: 2/16/99
Sample Condition: Intact and Cool
Sample Received By: VW

TA#	Field Code	MATRIX	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
119123	MW-3	Water	0.006	<0.001	<0.001	0.001	0.007
119124	MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001
Method Blank			<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	
QC			0.100	0.100	0.099	0.290	
RPD			3	2	3	3	
% Extraction Accuracy			103	106	102	100	
% Instrument Accuracy			100	100	99	97	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	2/18/99	EPA 8021B	2/18/99	RC	0.100 ea	0.1 ea

BL
Director, Dr. Blair Leftwich

2-99-99
Date

292

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

13300

Chain of Custody

Date 2-16-99 Page 1 Of 1

Lab Name Trace Analysis Inc.
Address 6701 Aberdeen Ave.
Lubbock, TX 79424
Telephone (800) 378-1296
Samplers (SIGNATURES) [signature]

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
99 02 16 0940	Water	MW-3		✓					119123																				2
99 02 16 1105	Water	MW-10		✓							124																		2
99 02 16 1050	Water	MW-6		✓							125																		2
99 02 16 1402	Water	MW-8		✓							126																		2
99 02 16 1415	Water	MW-9		✓							127																		2
99 02 16 1430	Water	Duplicate		✓							128																		2
502A & 502B	Water	Trip Blank		✓							129																		2

Project Information

Project Navajo-Lea Refinery
Project Director G. VanDeventer
Charge Code No. P/2292/9C
Shipping ID. No. 159-384-460-4
Via: Greyhound

Sample Receipt

Total No. of Containers	
Chain of Custody Seals	
Rec'd Good Condition/Cold	
Conforms to Record	
Lab No.	

	1.	2.	3.
Relinquished By	[signature] 2:30pm	[signature] 6:00PM	[signature] 6:30AM
(Signature) / (Time) / (Printed Name) / (Date)	Gil Van Deventer 2-17-99	HELEN SHELTON 2/17/99	HELEN SHELTON 2/17/99
(Company)	TRW Inc	TRACE ANALYSIS	TRACE ANALYSIS
Received By	[signature] 2:30pm	[signature] 6:00	(Laboratory) [signature]
(Signature) / (Time) / (Printed Name) / (Date)	Duke Roush 2-17-99	Duke Roush	Vicki Windham 9:30am 2-18-99
(Company)	TRACE ANALYSIS	TRACE ANALYSIS	(Laboratory) TraceAnalysis

Special Instructions/Comments:

14 samples - HS
4° R.I.C 1KGDPC/C/1.ncl

Distribution: White, Canary-Laboratory • Pink, BDM

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
TRW
Attention: Gil Van Deventer
415 W. Wall, Suite 1818
Midland, TX 79701

February 26, 1999
Receiving Date: 02/17/99
Sample Type: Air
Charge Code No: P/2292/9C
Project Location: NA
COC# 13301

Prep Date: 02/24/99
Analysis Date: 02/24/99
Sampling Date: 02/16/99
Sample Condition: Intact
Sample Received by: VW
Project: Navajo - Lea Refinery

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T119028	9902161115 VE	374	<1	5	3	<1	8
T119029	9902161550 Air Supply	<100	<1	<1	<1	<1	<1
QC	Quality Control	109	94	94	92	268	
Reporting Limit		100	1	1	1	1	
Method Blank		<100	<1	<1	<1	<1	
RPD		5	2	2	0	1	
% Instrument Accuracy		109	94	94	92	89	

METHODS: EPA SW 846-8021B; 8015 Modified.
CHEMIST: CS
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich

2-26-99
Date

275

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

13301

Chain of Custody

Date 2-16-99 Page 1 Of 1

Lab Name Trace Analysis Inc.
Address 6701 Aberdeen Ave.
Lubbock, TX 79424
Telephone (800) 378-1296

Samplers (SIGNATURES)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 TVHC	TCLP - Vol., Semi-Vol. Herbicides, Pesticides	TCLP - Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
990216 1115	Air	VE		✓									✓				1	1902	8										2
990216 1550	Air	Air Supply		✓									✓				1	1902	9										2

Project Information	Sample Receipt	Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Project Navajo-Lea Refinery	Total No. of Containers	Gil Van Deventer 5:30pm (Signature) (Time)	(Signature) (Time)	(Signature) (Time)
Project Director G. VanDeventer	Chain of Custody Seals	Gil Van Deventer 2/16/99 (Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
Charge Code No. P/2292/9C	Rec'd Good Condition/Cold	TRW Inc. (Company)	(Company)	(Company)
Shipping ID. No.	Conforms to Record	Received By 1.	Received By 2.	Received By (Laboratory) 3.
Via: TNM&O	Lab No.	(Signature) (Time)	(Signature) (Time)	Vicki Winkler (Signature) (Time)
Special Instructions/Comments:		(Printed Name) (Date)	(Printed Name) (Date)	Vicki Winkler 2-17-99 (Printed Name) (Date)
		(Company)	(Company)	Trace Analysis 9:00AM (Laboratory)

Distribution: White, Canary-Laboratory • Pink, BDM

TRW028A.XLS (689)

Bus 902111430 0

2/17

~~Exodus~~ So Union
Lexington
1-27-87


690D LC

So Union Lovington Refinery

3/14/90

So Union Lovington Refinery

3/14/90

So Union Lovington Refinery

3/14/90

So Union Lexington

1-27-87

~~[illegible]~~ Sc Union
Lovington
1-27-87

1998 Annual Groundwater Monitoring and Sampling and Remediation System Performance Report Navajo Refining Company – Lea Refinery Lea County, New Mexico

NOVEMBER 24, 1998

Prepared For:

Navajo Refining Company
P. O. Box 159
Artesia, New Mexico 88211

Prepared By:

Energy & Environmental Systems
415 West Wall, Suite 1818
Midland, Texas 79701

1998 Annual Groundwater Monitoring and Sampling and Remediation System Performance Report Navajo Refining Company - Lea Refinery Lea County, New Mexico

Prepared by:

TRW Inc.
Energy & Environmental Systems
415 West Wall Street, Suite 1818
Midland, Texas 79701
(915) 682-0008
FAX (915) 682-0028

SUBMITTED BY:

Gilbert J. Van Deventer, REM
Project Manager

DATE: 11/24/98

REVIEWED BY:

Dale T. Littlejohn
Quality Assurance Officer

DATE: 12/4/98

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FIGURES

TABLES

APPENDIX

1.0 EXECUTIVE SUMMARY

BDM International, Inc., a wholly owned subsidiary of TRW Inc. (TRW), was retained by Navajo Refining Company (Navajo) to perform sampling and monitoring of the groundwater remediation system at the Lea Refinery located in Lovington, New Mexico. This 1998 annual report documents the four quarterly sampling events performed by TRW at the Navajo Lea Refinery on January 21, 1998; April 23, 1998; August 4, 1998; and October 28, 1998. The report also contains the historical groundwater elevation and analytical data for the life of the project which began in September 1995. This monitoring and sampling program was conducted in accordance with the guidelines specified by Mr. Bill Olson of the New Mexico Oil Conservation Division (OCD) in his letters dated November 21, 1996 and March 26, 1998.

Based on the sampling and monitoring data to date, the following conclusions relevant to groundwater conditions and remediation system performance at the Lea Refinery are evident:

- Benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations in upgradient monitoring wells MW-2 and MW-4 have remained at levels below the laboratory detection limit of 0.001 mg/L and below New Mexico Water Quality Control Commission (WQCC) standards.

- BTEX concentrations in downgradient wells MW-3, MW-5, MW-6, MW-8, and MW-10 have also remained at levels near or below the laboratory detection limit of 0.001 mg/L and below WQCC standards.

- Benzene concentrations in MW-9 fluctuate over time but have declined from a high of 1.69 mg/L in April 1996 to its lowest level of 0.007 mg/L on October 29, 1998. This significant decrease has been attributed to the successful operation of the AS/VE system.

- A barium concentration of 1.4 mg/L in MW-9 slightly exceeded the WQCC standard of 1 mg/L. The source of barium is unknown.

- Chloride concentrations in MW-5 (280 mg/L) and MW-9 (880 mg/L) exceeded the WQCC standard of 250 mg/L.

- Fluoride concentrations varied from 1.3 mg/L in MW-5 to 3.2 mg/L in MW-6. Fluoride levels in all monitoring wells, with the exception of MW-5, slightly exceed the WQCC standard of 1.6 mg/L. Since fluoride is not a constituent for the refinery processes on site, its presence is likely due to natural conditions as it is a common natural occurrence in groundwater (1989, USGS Water-Supply Paper 2254, pg. 120-123).

- A manganese concentration of 0.31 mg/L in MW-9 slightly exceeds the WQCC standard of 0.2 mg/L. Since manganese is a common byproduct of aerobic biodegradation of hydrocarbons, its presence in monitoring well MW-9 appears to indicate beneficial biodegradation activity.

- Monitoring well MW-9 had a vanadium concentration of 0.48 mg/L which exceeds the WQCC standard of 0.05 mg/L. Since vanadium is not a constituent for the refinery processes on site, this anomaly is most likely due to its natural occurrence.

- The WQCC standard for TDS (1,000 mg/L) was exceeded in MW-8 (1,000 mg/L) and MW-9 (1,700 mg/L). Background TDS concentrations in Lea County typically range from 500 mg/L to 3,000 mg/L.

- Based on the analytical results of the VE exhaust and measured flow rates, the VE system has recovered an estimated 19,160 kilograms (8,700 lb) of TVHC since the startup of the system on October 2, 1996.

- Approximately 133.4 gallons of free product has been removed from recovery well RW-1 since installation of the Xitech product recovery system on January 21, 1998.

- Free product thicknesses have fluctuated since October 1996, but have generally declined to the present thicknesses of 1.07 feet and 0.67 feet in MW-1 and MW-7, respectively.

- During 1998, groundwater temperatures within the hydrocarbon plume (MW-1, MW-6, and MW-7) have stabilized to an average of 17°F above those outside of the plume. This reflects an approximate decrease of approximately 8°F from 1997 temperatures.

Based on the sampling and monitoring data to date, the following recommendations are suggested for the remediation system and monitoring operations at the Lea Refinery.

- Continue product recovery operations since the present system has been effective in recovering 133.4 gallons of free product from RW-1.

- Continue air sparge and vapor extraction operations since the present system has been effective in recovering an estimated 19,160 kilograms (8,700 lb) of total volatile hydrocarbons.

- Continue the sampling and monitoring program on a quarterly basis. The next sampling event is scheduled during the first quarter of 1999.

2.0 CHRONOLOGY OF EVENTS

August 1995	Navajo discovered a pipe leak at a sewer junction box near the API separator system.
September 1995	Navajo initiated an investigation to determine the horizontal and vertical extent of the hydrocarbon release from the sewer junction box. The investigation included the installation and sampling of nine soil borings (B-1 through B-9) and seven monitoring wells (MW-1 through MW-7).
October 25, 1995	Navajo retained Geoscience Consultants, Ltd. (GCL) to design, install, and maintain a remediation system at the Lea Refinery.
December 12, 1995	GCL submitted the remediation work plan to Navajo. The work plan addressed the remediation and additional investigation plans for the hydrocarbon-impacted groundwater at the Lea Refinery.
December 14, 1995	Navajo submitted the remediation work plan to the OCD.
February 9, 1996	Navajo submitted the revised remediation work plan to the OCD.
March 18, 1996	The OCD approved the remediation work plan for Lea Refinery.
April 1996	GCL installed a groundwater recovery well (RW-1), eight AS/VE wells (AS-1 through AS-8), and three additional monitoring wells (MW-8, MW-9, and MW-10).
April 23, 1996	GCL conducted the second quarter 1996 sampling event at Lea Refinery.
October 1, 1996	GCL completed the installation of the remediation system at the Lea Refinery and the system began operation.
October 11, 1996	GCL submitted the *Soil and Groundwater Investigation and Remediation Work Plan* to the OCD.
November 19, 1996	GCL conducted the fourth quarter 1996 sampling event at Lea Refinery.
November 21, 1996	The OCD approved the remediation work plan.
January 20, 1997	BDM International, Inc. (formerly GCL) conducted the first quarter 1997 sampling event at Lea Refinery.
April 16, 1997	BDM International, Inc. (BDM) conducted the second quarter 1997 sampling event at Lea Refinery.
August 14, 1997	BDM conducted the third quarter 1997 sampling event at Lea Refinery.
October 28, 1997	BDM conducted the fourth quarter 1997 sampling event at Lea Refinery.

January 21, 1998	TRW (formerly BDM) conducted the first quarter 1998 sampling event at Lea Refinery.
April 23, 1998	TRW conducted the second quarter 1998 sampling event at Lea Refinery.
August 4, 1998	TRW conducted the third quarter 1998 sampling event at Lea Refinery.
October 28, 1998	TRW conducted the fourth quarter 1998 sampling event at Lea Refinery.

3.0 PROCEDURES

The following sampling frequency and remediation schedule was followed to document the groundwater quality conditions and remediation system performance in accordance with the remediation work plan and the OCD letter dated November 21, 1996:

Monthly

- Air injection rates/volumes
- Vapor extraction rates/volumes
- Free product recovery rates from RW-1
- Free product thickness in monitoring wells MW-1 and MW-7 using a Heron Model H0.1L oil/water interface probe

Quarterly

- Vapor extraction sample for BTEX (EPA Method 8021B) and total volatile hydrocarbon (TVHC) analysis (EPA Method 8015-gas range)
- Groundwater samples from MW-3, MW-6, MW-8, MW-9, and MW-10 for BTEX analysis (EPA Method 8021B)
- Dissolved oxygen and temperature for monitoring wells MW-3, MW-6, MW-8, MW-9, and MW-10 using a Hanna Model 9143 DO meter
- Conductivity and pH for monitoring wells MW-3, MW-6, MW-8, MW-9, and MW-10 using a Hydac Model 910 pH/conductivity meter
- Depth to groundwater in monitoring wells MW-1 through MW-10
- Monthly parameters noted above

Annually

- Groundwater samples from MW-2, MW-3, MW-4, MW-5, MW-6, MW-8, MW-9, and MW-10 for BTEX, chloride, fluoride, iron, manganese, nitrate, sulfate, and TDS analysis
- Dissolved oxygen, pH, conductivity, and temperature for monitoring wells MW-1 through MW-10
- Quarterly parameters noted above

Prior to sampling, the on-site monitoring wells (MW-1 through MW-10) were gauged for depth to groundwater and free product thickness using the oil/water interface probe. Immediately prior to collecting groundwater samples, each monitoring well was purged of a minimum of three well casing volumes. The monitoring wells were purged during each sampling event using clean, decontaminated PVC bailers, with the exception of monitoring wells MW-3 and MW-10 during the first quarter sampling event. During the first quarter sampling event, MW-3 and MW-10 were purged using a decontaminated 2-inch diameter submersible pump (Grundfos Redi-Flo2). A summary of purging and sampling methods is provided in Table 1. Groundwater samples were obtained using a new, decontaminated, disposable bailer for each well after purging. Groundwater parameters, including pH, conductivity, temperature, and dissolved oxygen (DO)

were measured using a Hydac Model 910 pH/conductivity meter and a Hanna Model 9143 DO/temperature meter.

The first set of water samples were transferred into air-tight, septum-sealed, 40 milliliter glass, volatile organic analysis sample vials with zero head space for analysis of BTEX using EPA Method 8021B. A duplicate sample of MW-9 was collected during each sampling event for BTEX analysis. During the annual sampling event on October 28-29, 1998, a second and third set of water samples were transferred into appropriately preserved containers for analysis of major ions and WQCC metals. Chain-of-custody (COC) forms documenting sample identification numbers, collection times, and delivery times to the laboratory were completed for each set of samples. The water samples were placed in an ice-filled cooler immediately after collection and shipped to Trace Analysis, Inc. of Lubbock, Texas for laboratory analysis.

Table 1

Summary of Purging and Sampling Methods

Monitoring Well No.	Sample Date	Sample Event	Purge Method	Purge Volume (gallons)	Sampling Method	Groundwater Analytes
MW-2	10/28/98	Fourth Quarter	Hand bailer	6	Disposable bailer	BTEX, WQCC Metals, Ions
MW-3	1/21/98	First Quarter	Pump	30	Disposable bailer	BTEX
	4/23/98	Second Quarter	Hand bailer	6	Disposable bailer	BTEX
	8/4/98	Third Quarter	Hand bailer	7	Disposable bailer	BTEX
	10/29/98	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX, WQCC Metals, Ions
MW-4	10/29/98	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX
MW-5	10/28/98	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX
MW-6	1/21/98	First Quarter	Hand bailer	5	Disposable bailer	BTEX
	4/23/98	Second Quarter	Hand bailer	6	Disposable bailer	BTEX
	8/4/98	Third Quarter	Hand bailer	3	Disposable bailer	BTEX
	10/29/98	Fourth Quarter	Hand bailer	4	Disposable bailer	BTEX, WQCC Metals, Ions
MW-8	1/21/98	First Quarter	Hand bailer	5	Disposable bailer	BTEX
	4/23/98	Second Quarter	Hand bailer	6	Disposable bailer	BTEX
	8/4/98	Third Quarter	Hand bailer	7	Disposable bailer	BTEX
	10/29/98	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX, WQCC Metals, Ions
MW-9	1/21/98	First Quarter	Hand bailer	5	Disposable bailer	BTEX
	4/23/98	Second Quarter	Hand bailer	6	Disposable bailer	BTEX
	8/4/98	Third Quarter	Hand bailer	7	Disposable bailer	BTEX
	10/29/98	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX, WQCC Metals, Ions
MW-10	1/21/98	First Quarter	Pump	25	Disposable bailer	BTEX
	4/23/98	Second Quarter	Hand bailer	6	Disposable bailer	BTEX
	8/4/98	Third Quarter	Hand bailer	15	Disposable bailer	BTEX
	10/29/98	Fourth Quarter	Hand bailer	8	Disposable bailer	BTEX, WQCC Metals, Ions

BTEX - benzene, toluene, ethylbenzene, xylenes (EPA Method 8020)

WQCC Metals - arsenic (As), boron (B), barium (Ba), iron (Fe), manganese (Mn), and vanadium (V).

Ions - chloride (Cl), fluoride (F), nitrate (NO_3), sulfate (SO_4), and total dissolved solids (TDS), .

NS - Not sampled due to presence of phase-separated hydrocarbons.

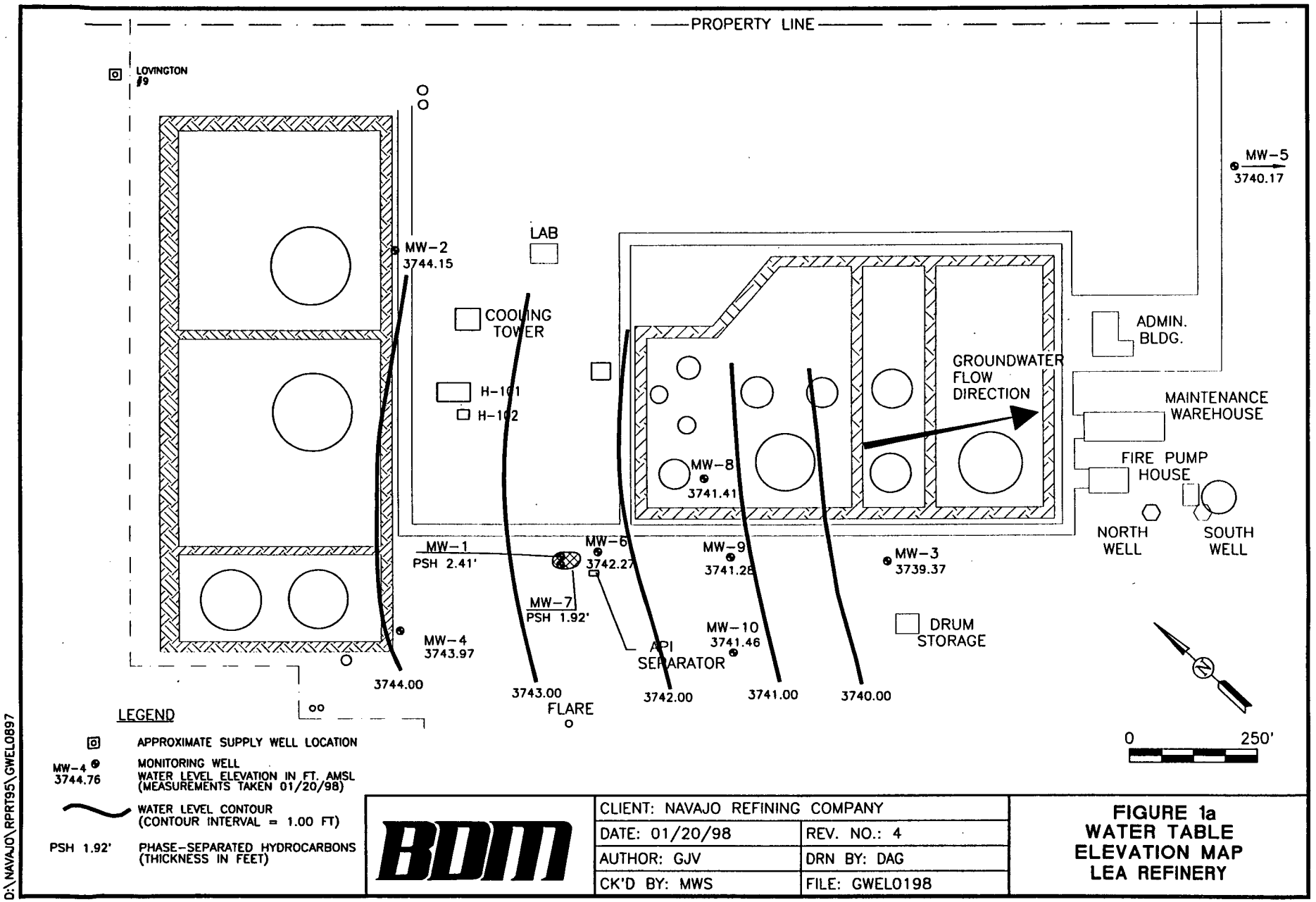
4.0 WATER TABLE ELEVATIONS, HYDRAULIC GRADIENT AND FLOW DIRECTION

Based on the gauging data collected between September 10, 1995 and October 28, 1998, the groundwater conditions at the Lea Refinery are characterized below.

- The depth to the water table across the site varies from approximately 73 to 98 feet below ground surface.
- The hydraulic gradient is approximately 0.004 feet/foot.
- The direction of groundwater flow is to the southeast.

The direction of groundwater flow and hydraulic gradient have remained consistent for the past three years. Groundwater elevation maps depicting the water table elevation and direction of groundwater flow using the gauging data obtained during the four 1998 sampling events are presented in Figure 1a (January 21, 1998), Figure 1b (April 23, 1998), Figure 1c (August 4, 1998), and Figure 1d (October 28, 1998). Gauging data for monitoring wells MW-1 and MW-7 were not incorporated into the water table elevation maps due to the presence of free product in these wells.

Figure 2 depicts the water table elevation changes over time in monitoring wells MW-1 through MW-10. Historical groundwater elevations and depth to water measurements are summarized in Table 2.

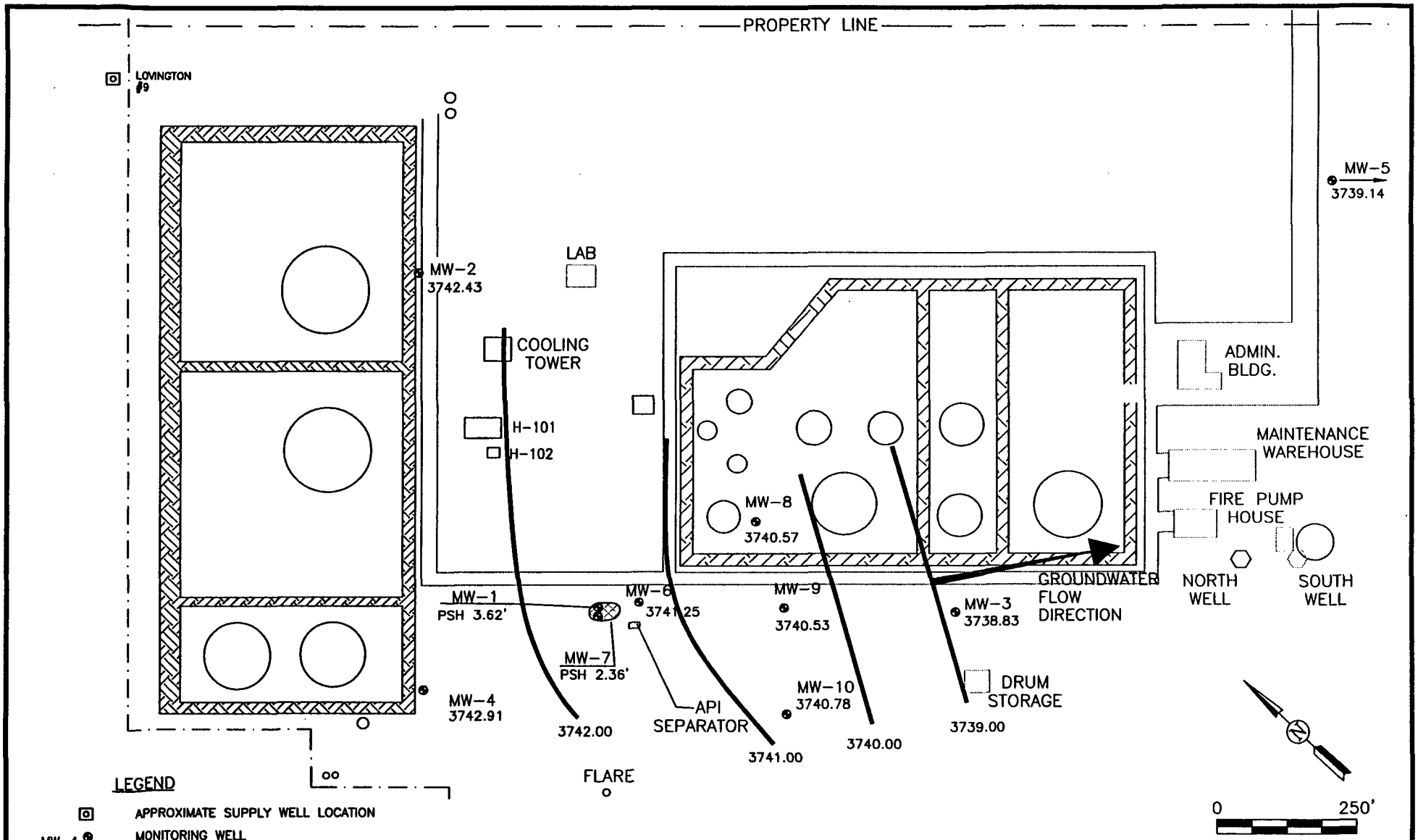


D:\NAVAJO\RPRT95\GWEL0897

BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 01/20/98	REV. NO.: 4
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: GWEL0198

FIGURE 1a
WATER TABLE ELEVATION MAP
LEA REFINERY

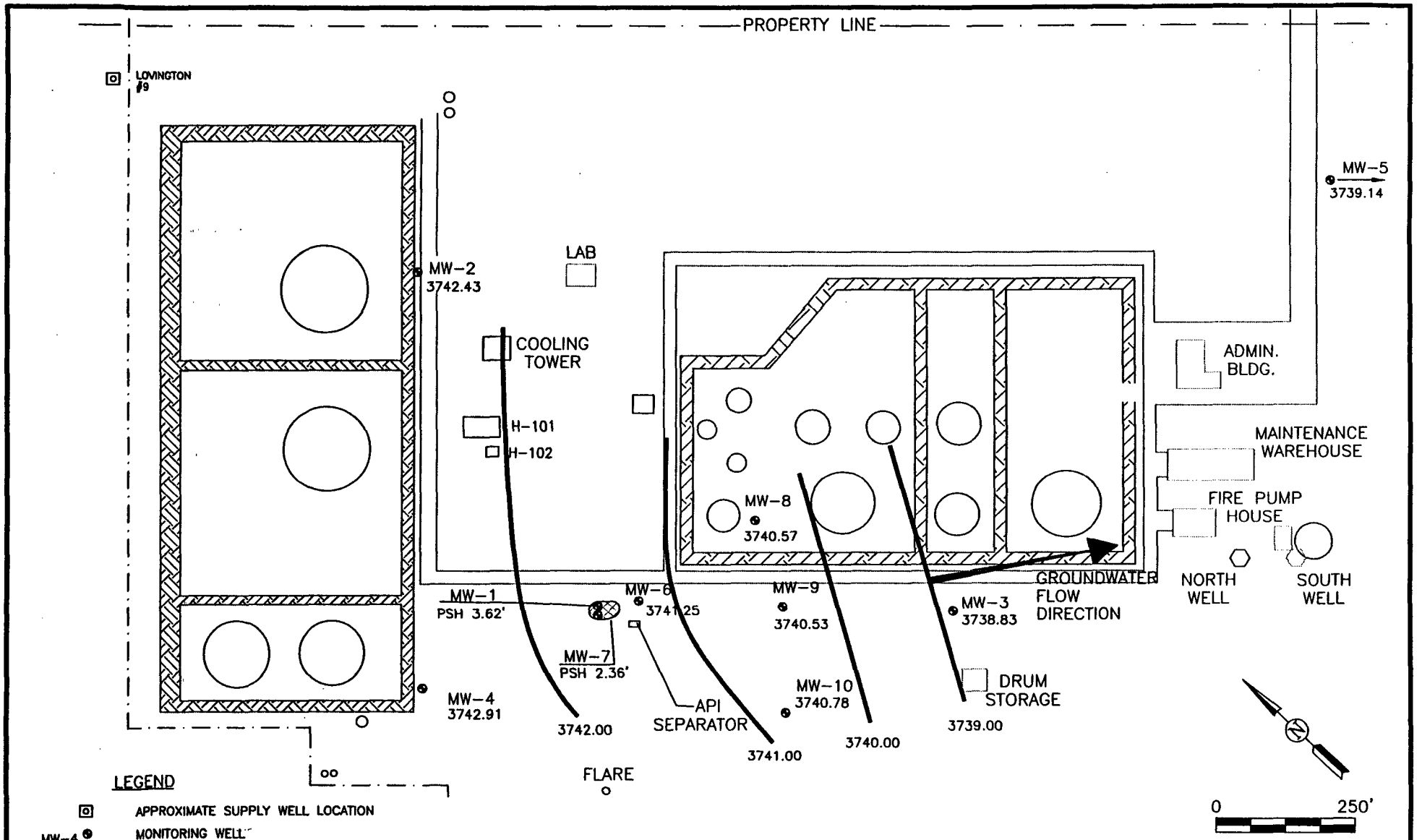


BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 08/04/98	REV. NO.: 4
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: GWEL0898

FIGURE 1c
WATER TABLE ELEVATION MAP
LEA REFINERY

D:\NAVAJO\RPRT95\GWEL0897



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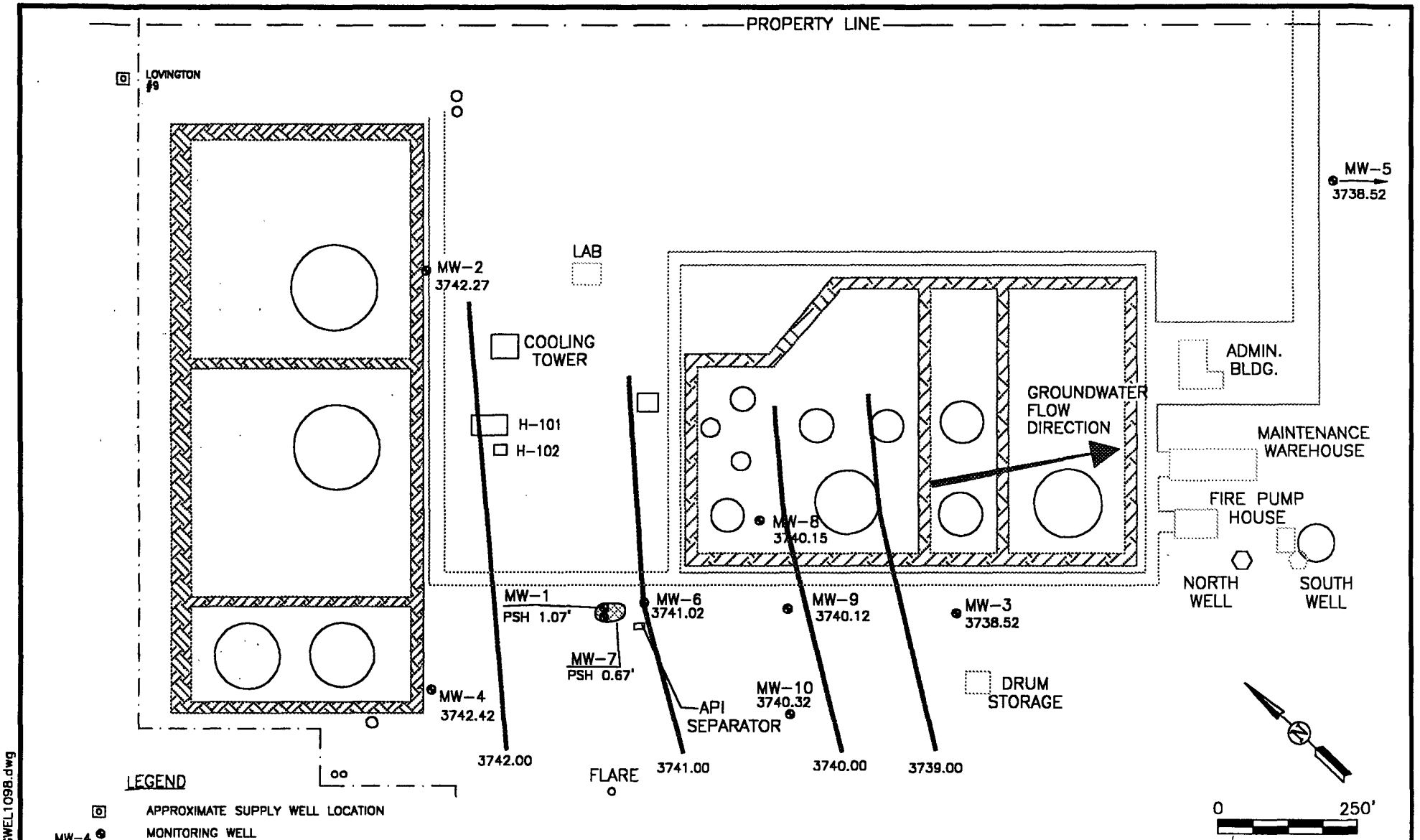
BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 08/04/98	REV. NO.: 4
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: GWEL0898

FIGURE 1c
WATER TABLE ELEVATION MAP
LEA REFINERY



BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 10/28/98	REV. NO.: 4
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: GWEL1098

FIGURE 1d
WATER TABLE ELEVATION MAP
LEA REFINERY

D:\NAVAJO\RPRT95\GWEL1098.dwg

FIGURE 2

WATER TABLE ELEVATION VERSUS TIME

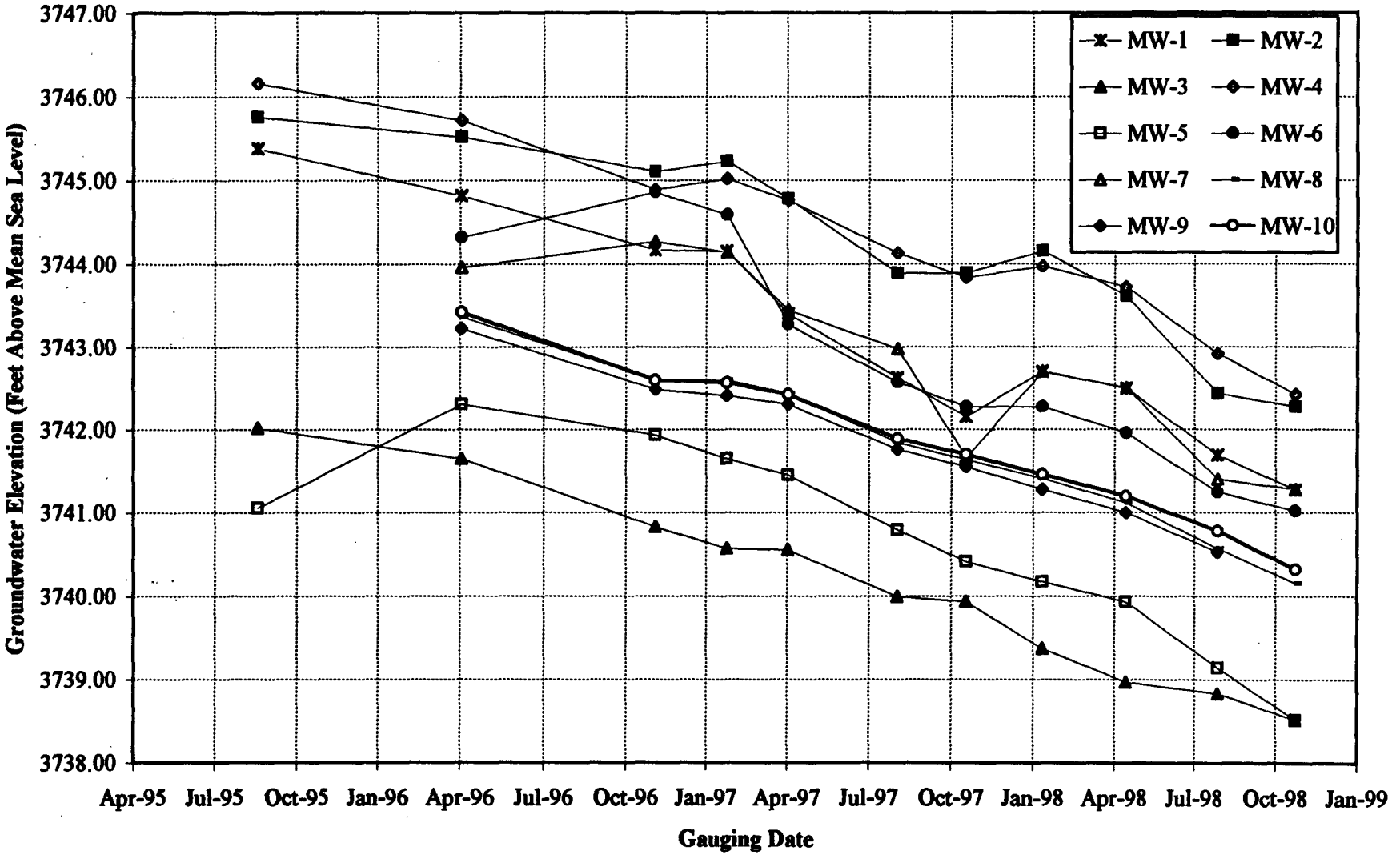


Table 2

Summary of Groundwater Elevations

Navajo Refining Company - Lea Refinery

Monitoring Well	Date Gauged	Relative Ground Surface Elevation (feet)	Relative Top of Casing Elevation (feet)*	Depth to Groundwater Below Top of Casing (feet)	Relative Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-1	9/10/95	3835.90	3835.67	95.89	3745.38	6.44
	4/22/96	3835.90	3835.67	96.49	3744.82	6.48
	11/19/96	3835.90	3835.67	93.57	3744.16	2.37
	2/7/97	3835.90	3835.67	93.39	3744.15	2.15
	4/16/97	3835.90	3835.67	95.49	3743.40	3.70
	8/14/97	3835.90	3835.67	96.23	3742.62	3.66
	10/28/97	3835.90	3835.67	96.88	3742.15	3.86
	1/20/98	3835.90	3835.67	95.07	3742.70	2.41
	4/23/98	3835.90	3835.67	94.75	3742.49	1.81
	8/4/98	3835.90	3835.67	97.13	3741.69	3.62
	10/29/98	3835.90	3835.67	94.98	3741.27	0.67
MW-2	9/10/95	3835.14	3834.94	89.18	3745.76	0.00
	4/22/96	3835.14	3834.94	89.42	3745.52	0.00
	11/19/96	3835.14	3834.94	89.83	3745.11	0.00
	2/7/97	3835.14	3834.94	89.71	3745.23	0.00
	4/16/97	3835.14	3834.94	90.16	3744.78	0.00
	8/14/97	3835.14	3834.94	91.05	3743.89	0.00
	10/28/97	3835.14	3834.94	91.05	3743.89	0.00
	1/20/98	3835.14	3834.94	90.79	3744.15	0.00
	4/23/98	3835.14	3834.94	91.33	3743.61	0.00
	8/4/98	3835.14	3834.94	92.51	3742.43	0.00
	10/28/98	3835.14	3834.94	92.67	3742.27	0.00
MW-3	9/10/95	3829.83	3829.55	87.53	3742.02	0.00
	4/22/96	3829.83	3829.55	87.90	3741.65	0.00
	11/19/96	3829.83	3829.55	88.72	3740.83	0.00
	2/7/97	3829.83	3829.55	88.98	3740.57	0.00
	4/16/97	3829.83	3829.55	89.00	3740.55	0.00
	8/14/97	3829.83	3829.55	89.56	3739.99	0.00
	10/28/97	3829.83	3829.55	89.62	3739.93	0.00
	1/20/98	3829.83	3829.55	90.18	3739.37	0.00
	4/23/98	3829.83	3829.55	90.58	3738.97	0.00
	8/4/98	3829.83	3829.55	90.72	3738.83	0.00
	10/28/98	3829.83	3829.55	91.03	3738.52	0.00
MW-4	9/10/95	3837.85	3837.56	91.40	3746.16	0.00
	4/22/96	3837.85	3837.56	91.84	3745.72	0.00
	11/19/96	3837.85	3837.56	92.67	3744.89	0.00
	2/7/97	3837.85	3837.56	92.54	3745.02	0.00
	4/16/97	3837.85	3837.56	92.80	3744.76	0.00
	8/14/97	3837.85	3837.56	93.43	3744.13	0.00
	10/28/97	3837.85	3837.56	93.73	3743.83	0.00
	1/20/98	3837.85	3837.56	93.59	3743.97	0.00
	4/23/98	3837.85	3837.56	93.84	3743.72	0.00
	8/4/98	3837.85	3837.56	94.65	3742.91	0.00
	10/28/98	3837.85	3837.56	95.14	3742.42	0.00
MW-5	9/10/95	3813.87	3816.88	75.82	3741.06	0.00
	4/22/96	3813.87	3816.88	74.58	3742.30	0.00
	11/19/96	3813.87	3816.88	74.95	3741.93	0.00
	2/7/97	3813.87	3816.88	75.23	3741.65	0.00
	4/16/97	3813.87	3816.88	75.43	3741.45	0.00
	10/28/97	3813.87	3816.88	76.47	3740.41	0.00
	1/20/98	3813.87	3816.88	76.71	3740.17	0.00
	4/23/98	3813.87	3816.88	76.95	3739.93	0.00
	8/4/98	3813.87	3816.88	77.74	3739.14	0.00
	10/28/98	3813.87	3816.88	78.36	3738.52	0.00

Monitoring wells MW-1 through MW-7 were installed in September 1995.

Monitoring wells MW-8, MW-9 and MW-10 were installed in March and April 1996.

* Elevations surveyed by John W. West Engineering Company of Hobbs, New Mexico. The top of the monitoring well casings were marked on the north side to provide consistent reference points for future gauging operations.

** Groundwater elevations were corrected for product, if present (SG=0.87)

Groundwater flow is to the southeast with a hydraulic gradient of approximately 0.004 feet/foot.

Table 2 (Continued)
Summary of Groundwater Elevations
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Gauged	Relative Ground Surface Elevation (feet)	Relative Top of Casing Elevation (feet)*	Depth to Groundwater Below Top of Casing (feet)	Relative Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-6	4/22/96	3835.70	3835.50	91.18	3744.32	0.00
	11/19/96	3835.70	3835.50	90.64	3744.86	0.00
	2/7/97	3835.70	3835.50	90.91	3744.59	0.00
	4/16/97	3835.70	3835.50	92.23	3743.27	0.00
	8/1497	3835.70	3835.50	92.93	3742.57	0.00
	10/28/97	3835.70	3835.50	93.23	3742.27	0.00
	1/20/98	3835.70	3835.50	93.23	3742.27	0.00
	4/23/98	3835.70	3835.50	93.54	3741.96	0.00
	8/4/98	3835.70	3835.50	94.25	3741.25	0.00
	10/28/98	3835.70	3835.50	94.48	3741.02	0.00
MW-7	4/22/96	3836.07	3835.84	96.56	3743.95	5.37
	11/19/96	3836.07	3835.84	93.13	3744.27	1.79
	2/7/97	3836.07	3835.84	93.05	3744.14	1.55
	4/16/97	3836.07	3835.84	95.57	3743.45	3.65
	8/14/97	3836.07	3835.84	96.30	3742.98	3.95
	10/28/97	3836.07	3835.84	96.38	3741.66	2.53
	1/20/98	3836.07	3835.84	94.82	3742.69	1.92
	4/23/98	3836.07	3835.84	94.68	3742.50	1.54
	8/4/98	3836.07	3835.84	96.49	3741.40	2.36
	10/29/98	3836.07	3835.84	95.49	3741.28	1.07
MW-8	4/22/96	3834.42	3838.09	94.73	3743.36	0.00
	11/19/96	3834.42	3838.09	95.50	3742.59	0.00
	2/7/97	3834.42	3838.09	95.50	3742.59	0.00
	4/16/97	3834.42	3838.09	95.66	3742.43	0.00
	8/14/97	3834.42	3838.09	96.25	3741.84	0.00
	10/28/97	3834.42	3838.09	96.45	3741.64	0.00
	1/20/98	3834.42	3838.09	96.68	3741.41	0.00
	4/23/98	3834.42	3838.09	96.97	3741.12	0.00
	8/4/98	3834.42	3838.09	97.52	3740.57	0.00
	10/28/98	3834.42	3838.09	97.94	3740.15	0.00
MW-9	4/22/96	3833.06	3832.82	89.60	3743.22	0.00
	11/19/96	3833.06	3832.82	90.34	3742.48	0.00
	2/7/97	3833.06	3832.82	90.41	3742.41	0.00
	4/16/97	3833.06	3832.82	90.52	3742.30	0.00
	8/14/97	3833.06	3832.82	91.06	3741.76	0.00
	10/28/97	3833.06	3832.82	91.27	3741.55	0.00
	1/20/98	3833.06	3832.82	91.54	3741.28	0.00
	4/23/98	3833.06	3832.82	91.82	3741.00	0.00
	8/4/98	3833.06	3832.82	92.29	3740.53	0.00
	10/28/98	3833.06	3832.82	92.70	3740.12	0.00
MW-10	4/22/96	3831.34	3831.10	87.68	3743.42	0.00
	11/19/96	3831.34	3831.10	88.51	3742.59	0.00
	2/7/97	3831.34	3831.10	88.54	3742.56	0.00
	4/16/97	3831.34	3831.10	88.68	3742.42	0.00
	8/14/97	3831.34	3831.10	89.21	3741.89	0.00
	10/28/97	3831.34	3831.10	89.40	3741.70	0.00
	1/20/98	3831.34	3831.10	89.64	3741.46	0.00
	4/23/98	3831.34	3831.10	89.90	3741.20	0.00
	8/4/98	3831.34	3831.10	90.32	3740.78	0.00
	10/28/98	3831.34	3831.10	90.78	3740.32	0.00

Monitoring wells MW-1 through MW-7 were installed in September 1995.

Monitoring wells MW-8, MW-9 and MW-10 were installed in March and April 1996.

* Elevations surveyed by John W. West Engineering Company of Hobbs, New Mexico. The top of the monitoring well casings were marked on the north side to provide consistent reference points for future gauging operations.

** Groundwater elevations were corrected for product, if present (SG=0.87)

Groundwater flow is to the southeast with a hydraulic gradient of approximately 0.004 feet/foot.

5.0 GROUNDWATER QUALITY CONDITIONS

5.1 Distribution of Hydrocarbons in Groundwater

A historical listing of BTEX concentrations obtained from the on-site monitoring wells is summarized in Table 3. Hydrocarbon concentration maps depicting the BTEX concentrations for the four 1998 sampling events are presented in Figure 3a (January 21, 1998), Figure 3b (April 23, 1998), Figure 3c (August 4, 1998), and Figure 3d (October 28-29, 1998). Figures 4a and 4b depict BTEX concentrations versus time in groundwater from May 1995 to October 28, 1998 for monitoring wells MW-6 and MW-9, respectively.

Based on the analytical data for samples collected by TRW during the four 1998 sampling events, the distribution of hydrocarbons at the Lea Refinery is described below.

- BTEX concentrations in upgradient monitoring wells MW-2 and MW-4 have remained at levels below the laboratory detection limit of 0.001 mg/L and below WQCC standards.

- BTEX concentrations in downgradient wells MW-3, MW-5, MW-6, MW-8, and MW-10 have also remained at levels near or below the laboratory detection limit of 0.001 mg/L and below WQCC standards.

- Benzene concentrations in MW-9 fluctuate over time but have declined from a high of 1.69 mg/L in April 1996 to its lowest level of 0.007 mg/L on October 29, 1998. This significant decrease has been attributed to the successful operation of the AS/VE system.

- Monitoring wells MW-1 and MW-7 were not sampled due to the continued presence of free product.

Table 3

BTEX Concentrations In Groundwater

Navajo Refining Company - Lea Refinery

Monitoring Well	Date Sampled	Benzene (mg/l)	Toluene (mg/l)	Ethylbenzene (mg/l)	Xylenes (mg/l)
MW-2	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	NS	NS	NS	NS
	1/20/97	NS	NS	NS	NS
	4/16/97	NS	NS	NS	NS
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	NS	NS	NS	NS
	1/21/98	NS	NS	NS	NS
	4/23/98	NS	NS	NS	NS
	8/4/98	NS	NS	NS	NS
	10/28/98	< 0.001	< 0.001	< 0.001	< 0.001
MW-3	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
	1/20/97	< 0.001	< 0.001	< 0.001	< 0.001
	4/16/97	< 0.001	< 0.001	< 0.001	< 0.001
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
	1/21/98	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/98	< 0.005	< 0.005	< 0.005	0.008
	8/4/98	< 0.001	< 0.001	< 0.001	< 0.001
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
MW-4	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	NS	NS	NS	NS
	1/20/97	NS	NS	NS	NS
	4/16/97	NS	NS	NS	NS
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	NS	NS	NS	NS
	1/21/98	NS	NS	NS	NS
	4/23/98	NS	NS	NS	NS
	8/4/98	NS	NS	NS	NS
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
MW-5	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	NS	NS	NS	NS
	1/20/97	NS	NS	NS	NS
	4/16/97	NS	NS	NS	NS
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	1/21/98	NS	NS	NS	NS
	4/23/98	NS	NS	NS	NS
	8/4/98	NS	NS	NS	NS
	10/28/98	< 0.001	< 0.001	< 0.001	< 0.001

Monitoring Wells MW-1 and MW-7 not sampled for BTEX due to presence of phase-seperated hydrocarbons.

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) unless specified otherwise.

1 Analyses performed by American Environmental Network, In. (Albuquerque, NM).

2 Duplicate analysis

NS indicates monitoring well was not sampled (annual sampling frequency).

Samples analyzed for BTEX using EPA Method 8020 (9/10/95 and 11/19/96) and 8260 (4/23/96).

New Mexico Water Quality Control Commission (WQCC) standards are listed as specified in Section 3-103.

Table 2 (Continued)
BTEX Concentrations In Groundwater
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Sampled	Benzene (mg/l)	Toluene (mg/l)	Ethylbenzene (mg/l)	Xylenes (mg/l)
MW-6	9/10/95	**1.741**	0.021	**0.962**	**0.972**
	4/23/96	**1.150**	< 0.001	0.599	0.462
	11/19/96	0.002	< 0.001	0.011	0.002
	1/20/97	0.004	< 0.001	0.003	0.007
	4/16/97	<0.001	< 0.001	< 0.001	<0.001
	8/14/97	<0.001	< 0.001	< 0.001	<0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
	1/21/98	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/98	< 0.001	< 0.001	< 0.001	< 0.001
	8/4/98	< 0.001	< 0.001	< 0.001	< 0.001
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
MW-8	4/23/96	0.002	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
	1/20/97	< 0.001	< 0.001	< 0.001	< 0.001
	4/16/97	< 0.001	< 0.001	< 0.001	< 0.001
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
	1/21/98	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/98	< 0.001	< 0.001	< 0.001	< 0.001
	8/4/98	< 0.001	< 0.001	< 0.001	< 0.001
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
MW-9	4/23/96	**1.690**	< 0.010	< 0.010	0.019
	11/19/96	**0.679**	< 0.005	< 0.005	< 0.005
	1/20/97	**0.340**	< 0.001	0.002	0.003
	4/16/97	**0.347**	<0.002	<0.002	0.007
	8/14/97	**1.680**	<0.010	<0.010	<0.010
	10/28/97	**0.516**	<0.010	<0.010	<0.010
	10/28/97[2]	**0.474**	<0.010	<0.010	<0.010
	1/21/98	**0.146**	0.005	< 0.001	0.002
	1/21/98[2]	**0.125**	0.004	< 0.001	< 0.001
	4/23/98[2]	**0.013**	< 0.001	< 0.001	< 0.001
	4/23/98[2]	**0.012**	< 0.001	< 0.001	< 0.001
	8/4/98	**0.010**	< 0.001	< 0.001	< 0.001
	8/4/98[2]	0.007	< 0.001	< 0.001	< 0.001
	10/29/98	0.007	0.006	< 0.001	0.002
	10/29/98[2]	0.006	0.004	0.002	0.002
MW-10	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
	1/20/97	< 0.001	< 0.001	< 0.001	< 0.001
	4/16/97	< 0.001	< 0.001	< 0.001	< 0.001
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
	1/21/98	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/98	< 0.001	< 0.001	< 0.001	< 0.001
	8/4/98	< 0.001	< 0.001	< 0.001	< 0.001
	10/29/98	< 0.001	< 0.001	< 0.001	< 0.001
WQCC Standards (mg/l)		0.010	0.75	0.75	0.62

Monitoring Wells MW-1 and MW-7 not sampled for BTEX due to presence of phase-separated hydrocarbons.

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) unless specified otherwise.

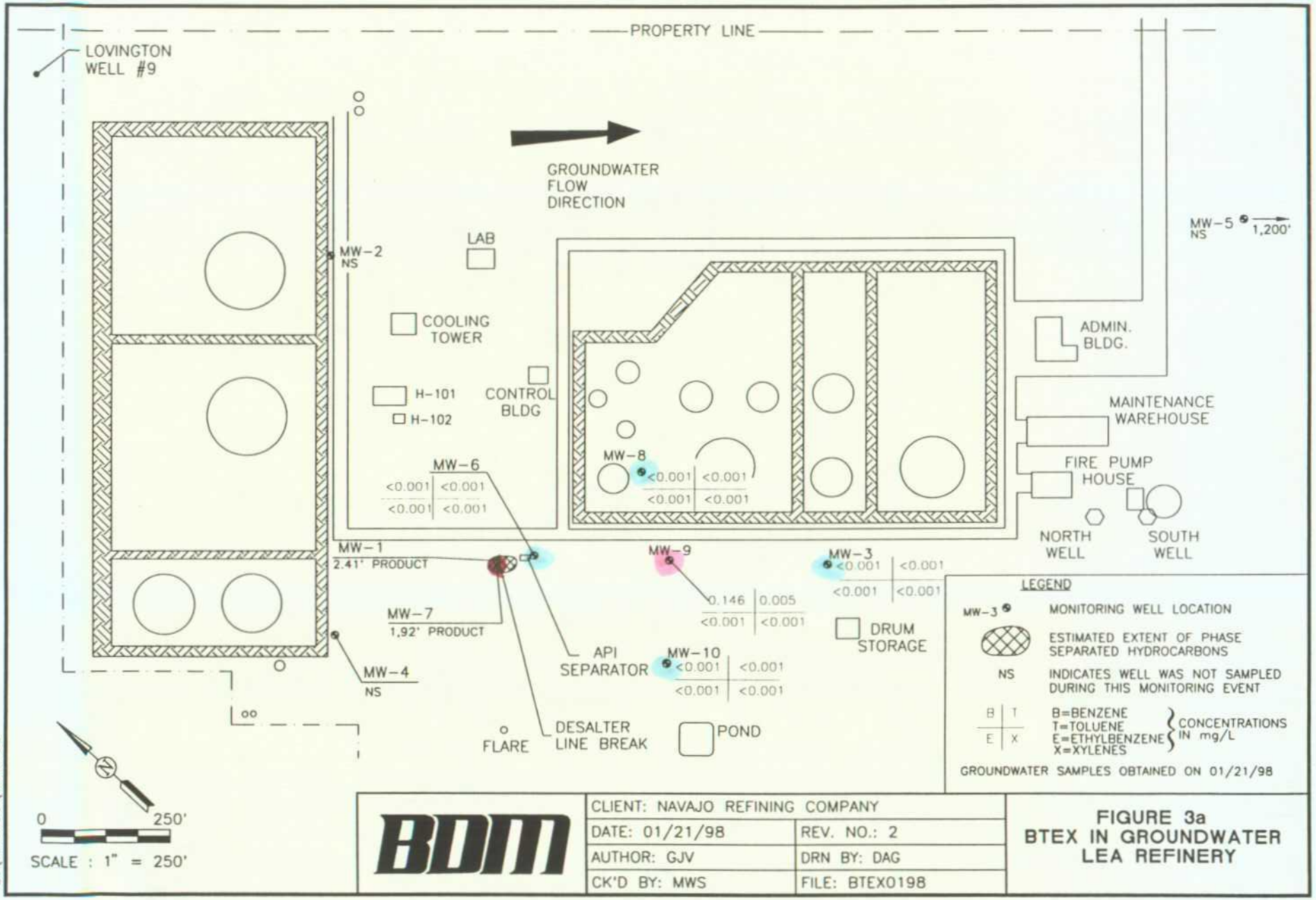
1 Analyses performed by American Environmental Network, In. (Albuquerque, NM).

2 Duplicate analysis

NS indicates monitoring well was not sampled (annual sampling frequency).

Samples analyzed for BTEX using EPA Method 8020 (9/10/95 and 11/19/96) and 8260 (4/23/96).

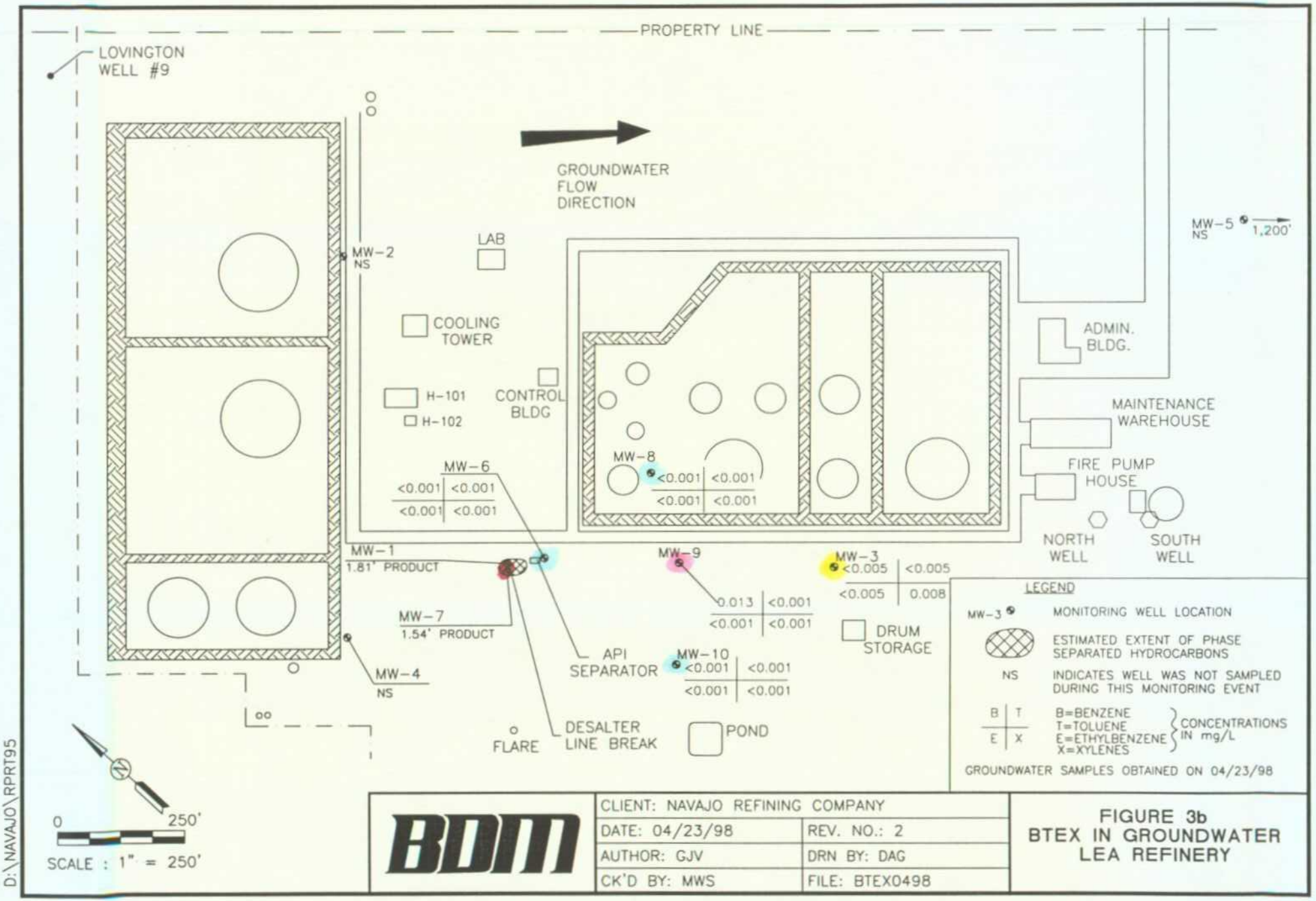
New Mexico Water Quality Control Commission (WQCC) standards are listed as specified in Section 3-103.



BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 01/21/98	REV. NO.: 2
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: BTEX0198

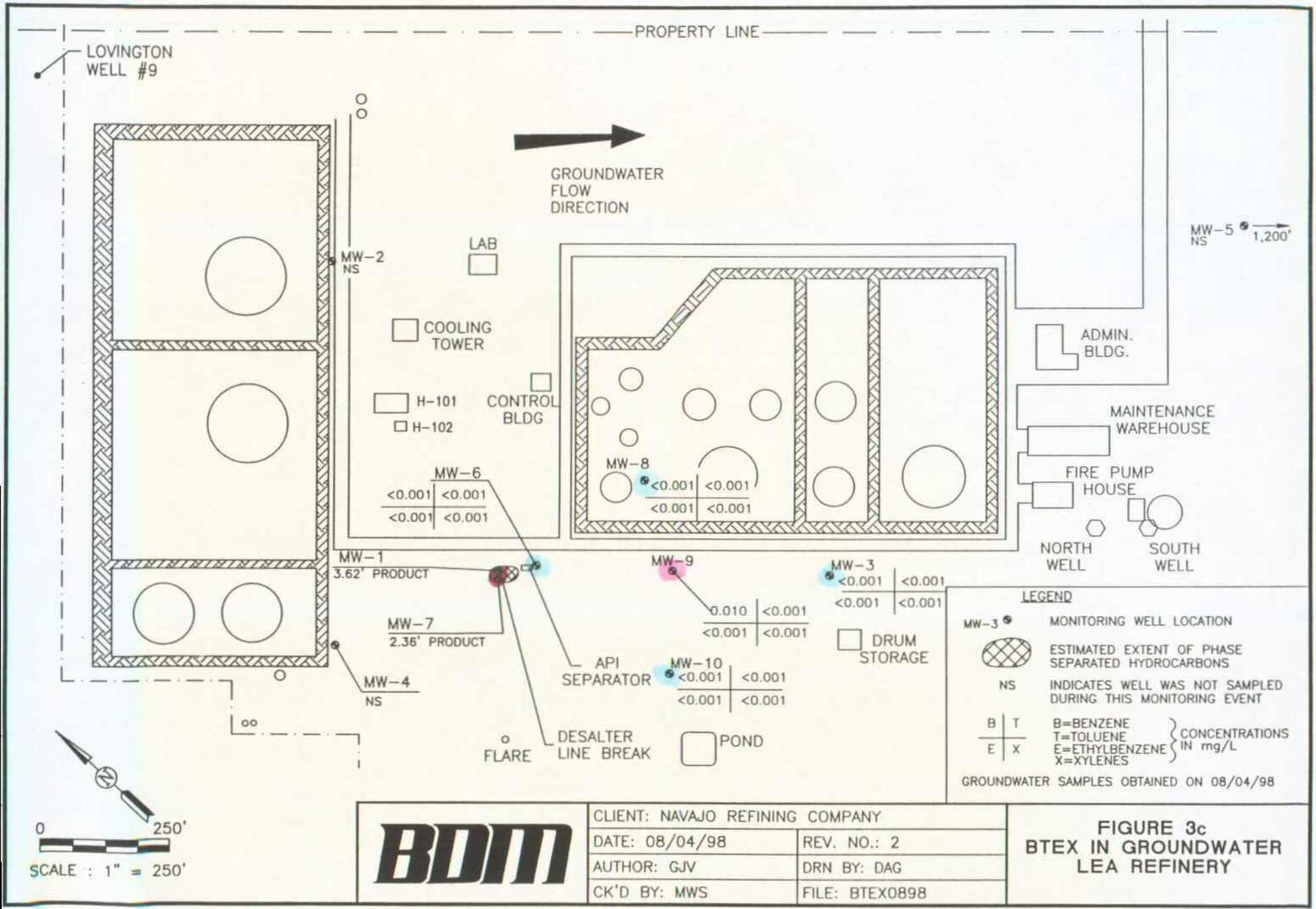
FIGURE 3a
BTEX IN GROUNDWATER
LEA REFINERY



BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 04/23/98	REV. NO.: 2
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: BTEX0498

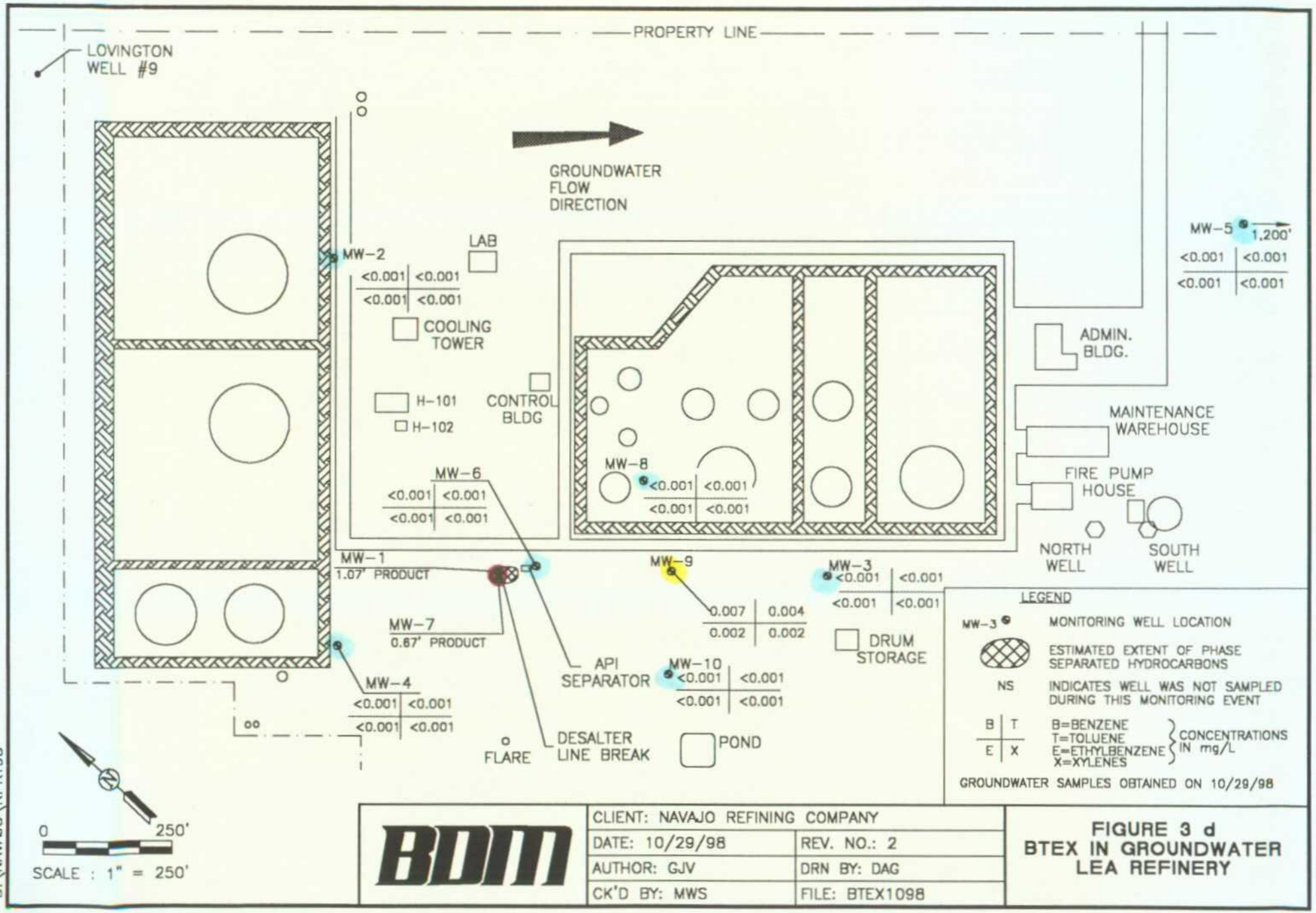
FIGURE 3b
BTEX IN GROUNDWATER
LEA REFINERY



BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 08/04/98	REV. NO.: 2
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: BTEX0898

FIGURE 3c
BTEX IN GROUNDWATER
LEA REFINERY



BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 10/29/98	REV. NO.: 2
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: BTEX1098

FIGURE 3 d
BTEX IN GROUNDWATER
LEA REFINERY

D:\NAVAJO\RPRT95

FIGURE 4a

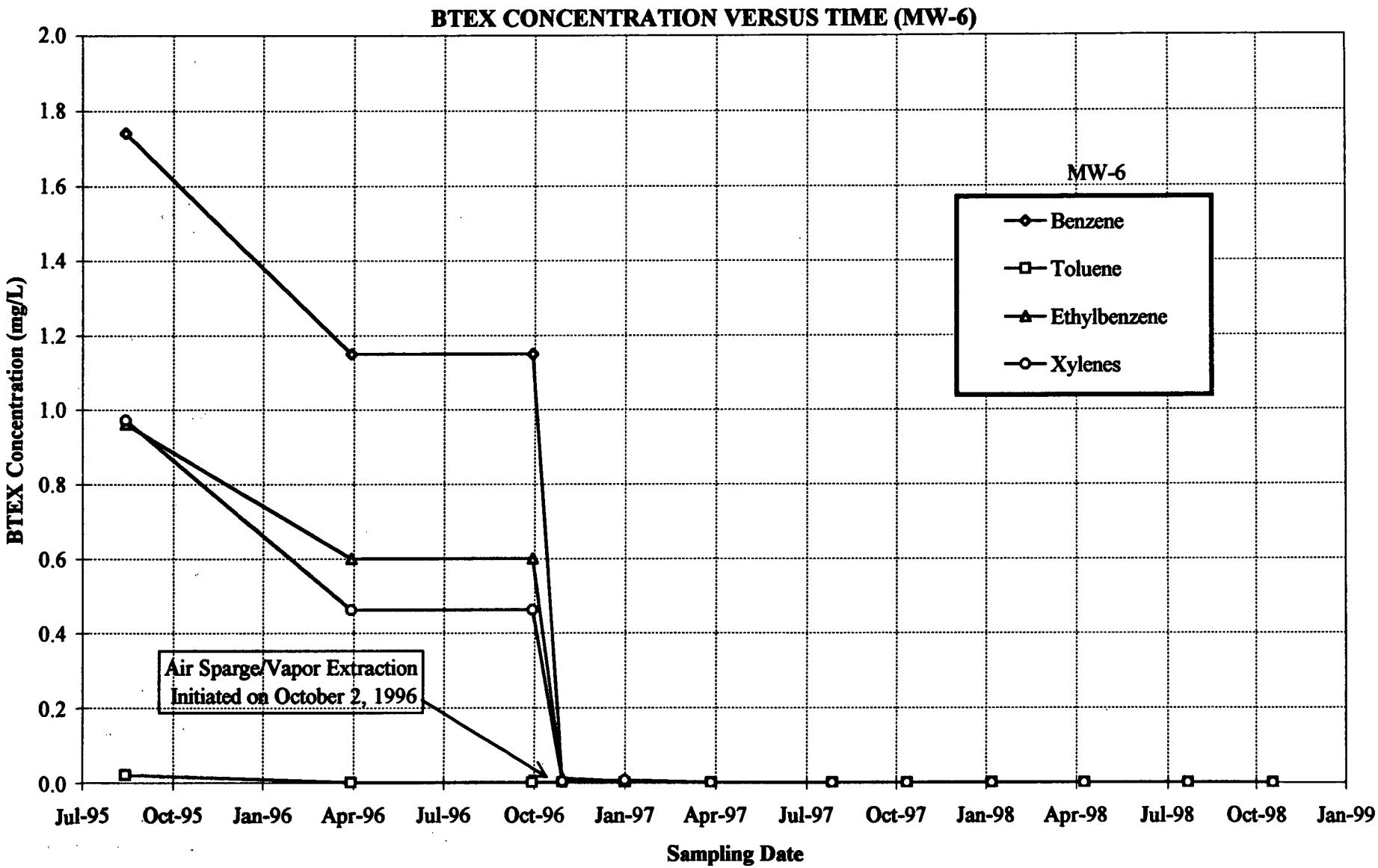

BTEX CONCENTRATION VERSUS TIME (MW-6)
BTEX Concentration (mg/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
MW-6
Benzene
Toluene
Ethylbenzene
Xylenes
Air Sparge/Vapor Extraction Initiated on October 2, 1996
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Sampling Date

FIGURE 4b

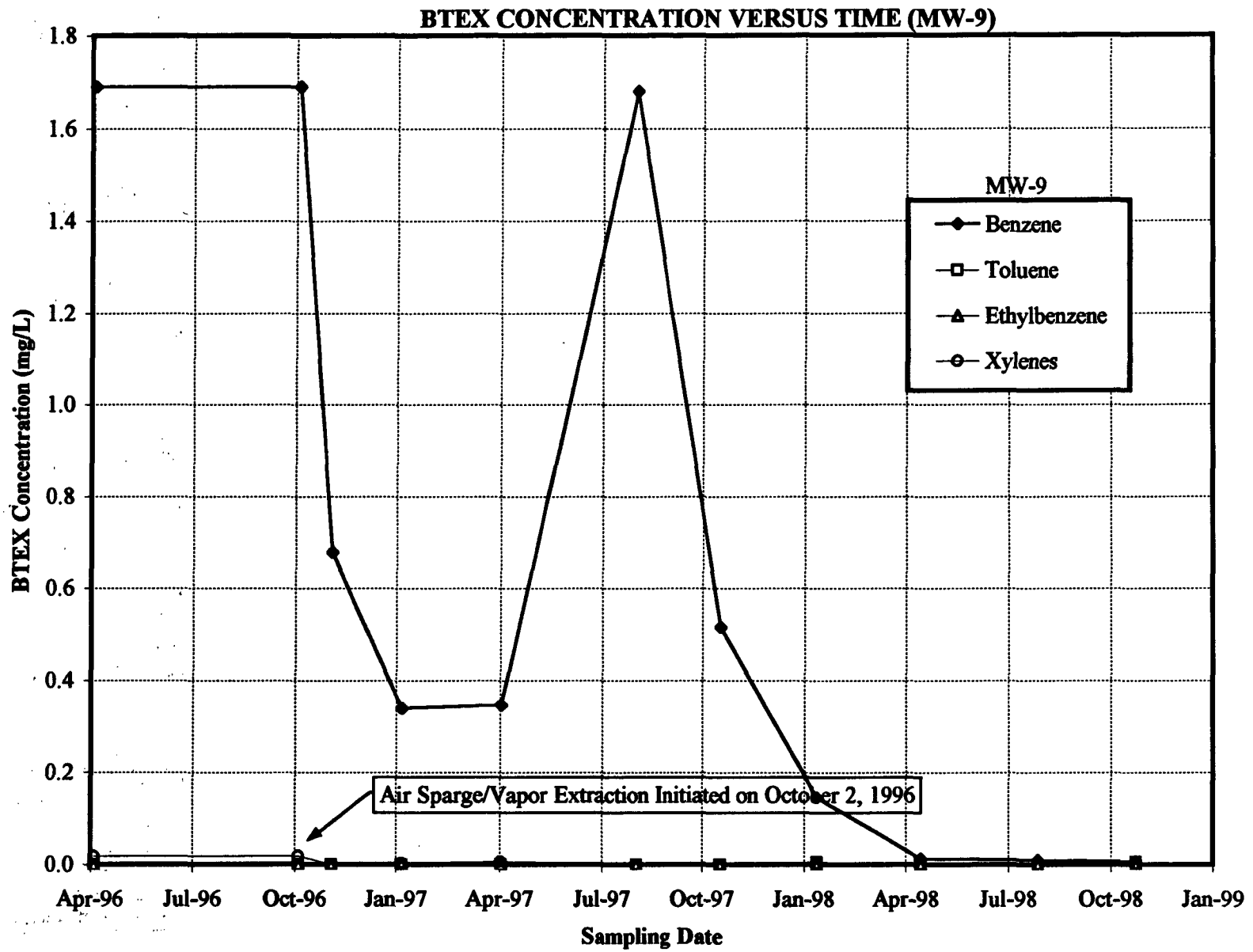

BTEX CONCENTRATION VERSUS TIME (MW-9)
BTEX Concentration (mg/L)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
MW-9
Benzene
Toluene
Ethylbenzene
Xylenes
Air Sparge/Vapor Extraction Initiated on October 2, 1996
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Sampling Date

Table 4
Summary of Metal Analytical Results
Navajo Refining-Lea Refinery

Constituent	Date Sampled	MW-1 (mg/l	MW-2 (mg/l)	MW-3 (mg/l)	MW-4 (mg/l)	MW-5 (mg/l)	MW-6 (mg/l)	MW-8 (mg/l)	MW-9 (mg/l)	MW-10 (mg/l)	WQCC Standards (mg/l)
Arsenic (As)	9/8/95	**0.5**	**0.3**	<0.2	**0.2**	**0.5**	NS	NS	NS	NS	0.1
	4/23/96	NS	NS	NS	NS	NS	<0.01	<0.01	<0.01	<0.01	
	8/14/97	NS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
	10/29/98	NS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Barium (Ba)	9/8/95	**2.12**	0.12	0.1	0.11	<0.03	NS	NS	NS	NS	1
	4/23/96	NS	NS	NS	NS	NS	0.8	0.2	0.7	<0.2	
	8/14/97	NS	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	0.8	<0.2	
	10/29/98	NS	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**1.4**	0.84	
Boron (B)	9/8/95	0.66	0.25	0.15	0.16	0.26	NS	NS	NS	NS	0.75
	4/23/96	NS	NS	NS	NS	NS	0.21	<0.03	**0.83**	0.11	
	8/14/97	NS	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
	10/29/98	NS	0.2	0.22	<0.20	0.26	<0.20	0.34	0.49	0.25	
Iron (Fe)	9/8/95	**1.38**	0.16	0.48	0.46	0.32	NS	NS	NS	NS	1
	4/23/96	NS	NS	NS	NS	NS	0.29	<0.05	0.11	0.16	
	8/14/97	NS	0.28	0.24	0.14	0.75	0.76	0.21	0.47	0.38	
	10/29/98	NS	0.19	0.23	<0.05	0.15	0.06	0.05	<0.05	<0.05	
Manganese (Mn)	9/8/95	**0.39**	0.07	<0.01	0.04	0.05	NS	NS	NS	NS	0.2
	4/23/96	NS	NS	NS	NS	NS	**1.7**	**0.27**	0.19	0.02	
	8/14/97	NS	<0.01	<0.01	<0.01	<0.01	**0.32**	0.04	**0.51**	<0.01	
	10/29/98	NS	<0.02	0.1	<0.02	<0.02	<0.02	<0.02	**0.31**	<0.02	
Vanadium (v)	9/8/95	<0.05	<0.05	<0.05	<0.05	<0.05	NS	NS	NS	NS	0.05
	4/23/96	NS	NS	NS	NS	NS	<0.01	0.02	0.02	0.03	
	8/14/98	NS	<0.05	<0.05	<0.05	<0.05	**0.23**	<0.05	<0.05	<0.05	
	10/29/98	NS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.48**	<0.05	

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 200.7, 239.2, 270.2, 272.2, 3015, 6010, and 7470.

New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in Section 3-103.

NS Indicates samples not analyzed for this constituent.

Monitoring wells MW-1 and MW-7 not analyzed due to presence of free product.

Values in **boldface** type indicate concentrations exceed WQCC groundwater standards.

NAVAO/NRC-4-98.XLS

Table 5
Summary of Major Cation and Anion Analytical Results
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Sampled	Total Dissolved Solids (TDS)	Calcium (Ca)	Fluoride (F)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Chloride (Cl)	Nitrate (NO_3-N)	Sulfate (SO_4)
MW-1	9/8/95	**1275**	NS	1.2	NS	NS	NS	349	**509**	<0.15	<5
MW-2	9/8/95	523	133	1.2	16.9	65.7	2.3	283	61	1.65	105
	8/14/97	650	130	1.2	14	52	1.9	210	140	NS	89
	10/28/98	540	NS	**2.4**	NS	NS	NS	NS	170	4.7	120
MW-3	9/8/95	454	NS	1	NS	NS	NS	223	35	2.54	93
	8/14/97	470	97	0.87	11	37	2.5	220	73	NS	90
	10/29/98	650	NS	**1.6**	NS	NS	NS	NS	99	6.1	110
MW-4	9/8/95	438	NS	1	NS	NS	NS	254	23	1.19	88
	8/14/97	400	72	1.1	7.4	27	2	170	49	NS	95
	10/29/98	390	NS	**2.1**	NS	NS	NS	NS	28	4.5	90
MW-5	9/8/95	853	196	0.7	23.6	82.4	3	230	198	1.49	119
	8/14/97	**1000**	200	0.5	18	80	2.8	300	**250**	NS	150
	10/28/98	920	NS	1.3	NS	NS	NS	NS	**280**	4.1	120
MW-6	4/23/96	**1786**	83	**1.65**	14	501	6.6	319	**798**	<0.1	13
	8/14/97	980	37	**3.4**	5.3	310	3.4	92	**480**	NS	100
	10/29/98	690	NS	**3.2**	NS	NS	NS	NS	53	66	86
MW-8	4/23/96	**1004**	105	1.2	15	171	5.8	420	185	0.2	49
	8/14/97	**1800**	320	0.88	28	230	7.5	460	**960**	NS	120
	10/29/98	**1000**	NS	**2.1**	NS	NS	NS	NS	**310**	10	170
MW-9	4/23/96	**2658**	226	0.5	44	370	9.1	340	**1190**	<0.1	9
	8/14/97	**2300**	1100	0.8	110	3300	67	230	**6500**	NS	38
	10/28/97	NA	140	NA	14	410	9.4	260	**1200**	<0.01	27
	10/29/98	**1700**	NS	**2.3**	NS	NS	NS	NS	**880**	<10	48
MW-10	4/23/96	443	70	1	9	36	2.5	190	29	0.13	31
	8/14/97	480	77	1.1	7.9	32	1.6	170	42	NS	110
	10/29/98	480	NS	**2.0**	NS	NS	NS	NS	32	4.6	110
WQCC Standards (mg/l)		1000	NA	1.6	NA	NA	NA	NA	250	10	600

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 160.1, 200.7, 340.2, 375.4, 353.3, 4500 Cl-B,and 310.1.

New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in Section 3-103.

NS Indicates samples not analyzed for this constituent.

NA Not applicable (no regulatory standard established).

MW-1 and MW-7 not analyzed due to presence of free product.

Values in **boldface** type indicate concentrations exceed WQCC groundwater standards.

A-Projects/Navajo/NRC-4-98.XLS

6.0 REMEDIATION SYSTEM PERFORMANCE

6.1 Air Sparge/ Vapor Extraction System

The installation of the air sparge/vapor extraction (AS/VE) system was completed on September 25, 1996. The AS/VE system was started on October 2, 1996 and has remained in continuous operation since that date with a few minor exceptions, such as during periodic maintenance activities, weather related upsets and a plant turnaround in which the remediation system was shut down between September 8, 1997 and October 7, 1997. The AS/VE system has maintained an 95 percent system-on time performance between January 1, 1998 and October 28, 1998. A map showing the layout of the remediation system is illustrated in Figure 5.

To monitor the performance of the AS/VE system, quarterly air samples of the VE exhaust were obtained and analyzed for BTEX (EPA Method 8021B) and TVHC (EPA Method 8015 gas range). The samples were obtained at the exhaust port in the remediation trailer prior to conveyance into the refinery boiler system. Total BTEX concentrations have decreased from a high of 429 milligrams per cubic meter (mg/m^3) in February 1997, to 22 mg/m^3 in August 1998. Similarly, TVHC concentrations have decreased from 9,740 mg/m^3 in January 1997, to 30 mg/m^3 in August 1998. Based on the analytical results of the VE exhaust and measured flow rates, the system has recovered an estimated 19,160 kilograms (8,700 lb) of TVHC since the startup of the system on October 2, 1996. The AS/VE system performance data is summarized in Table 6. A graph of TVHC and BTEX versus time is depicted in Figure 6.

Between October 2, 1996 and April 16, 1997, the BTEX concentrations in downgradient monitoring wells MW-6 and MW-9 decreased significantly (Figures 4a and 4b). The reduced BTEX levels in these two wells, which are located within the boundaries of the hydrocarbon plume, is attributed to the successful performance of the air sparge/vapor extraction system. The benzene concentration in MW-6 declined from 1.150 mg/L on April 23, 1996 to less than 0.001 mg/L during the last seven sampling events. This well is located only 10 feet south of air sparge/vapor extraction well AS-6, therefore the measured reduction in BTEX concentrations are somewhat skewed in this area. Monitoring well MW-9, is located approximately 160 feet downgradient (southeast) from the nearest air sparge/vapor extraction well (AS-1) and has shown a 99 percent decrease in benzene levels since the initial sampling event on April 23, 1996. Benzene concentrations in MW-9 fluctuate over time. With the exception of an anomalous high concentration of BTEX in August 1997, BTEX concentrations in MW-9 have declined from a high of 1.69 mg/L in April 1996 to its lowest level of 0.007 mg/L on August 4, 1998. This significant decrease has been attributed to the successful operation of the AS/VE system.

6.2 Product Recovery System

On January 21, 1998, the total fluids recovery system, which consisted of a 3/4 horsepower submersible pump in recovery well RW-1, was replaced with a product only recovery system. This upgrade was conducted to increase efficiency of recovering free product and to provide a more accurate accounting of product recovery volumes. Since the existing air sparge/vapor extraction system has proven to be very effective at removing the dissolved hydrocarbons, groundwater recovery with a submersible pump is not necessary. The product recovery system consists of the following components:

- Xitech Model ADJ 1000 Smart Skimmer with polyethylene tubing

- Xitech Model 2500 ES Electronic Timer
- 55-gallon plastic drum for product recovery containment with automatic shutoff sensor.

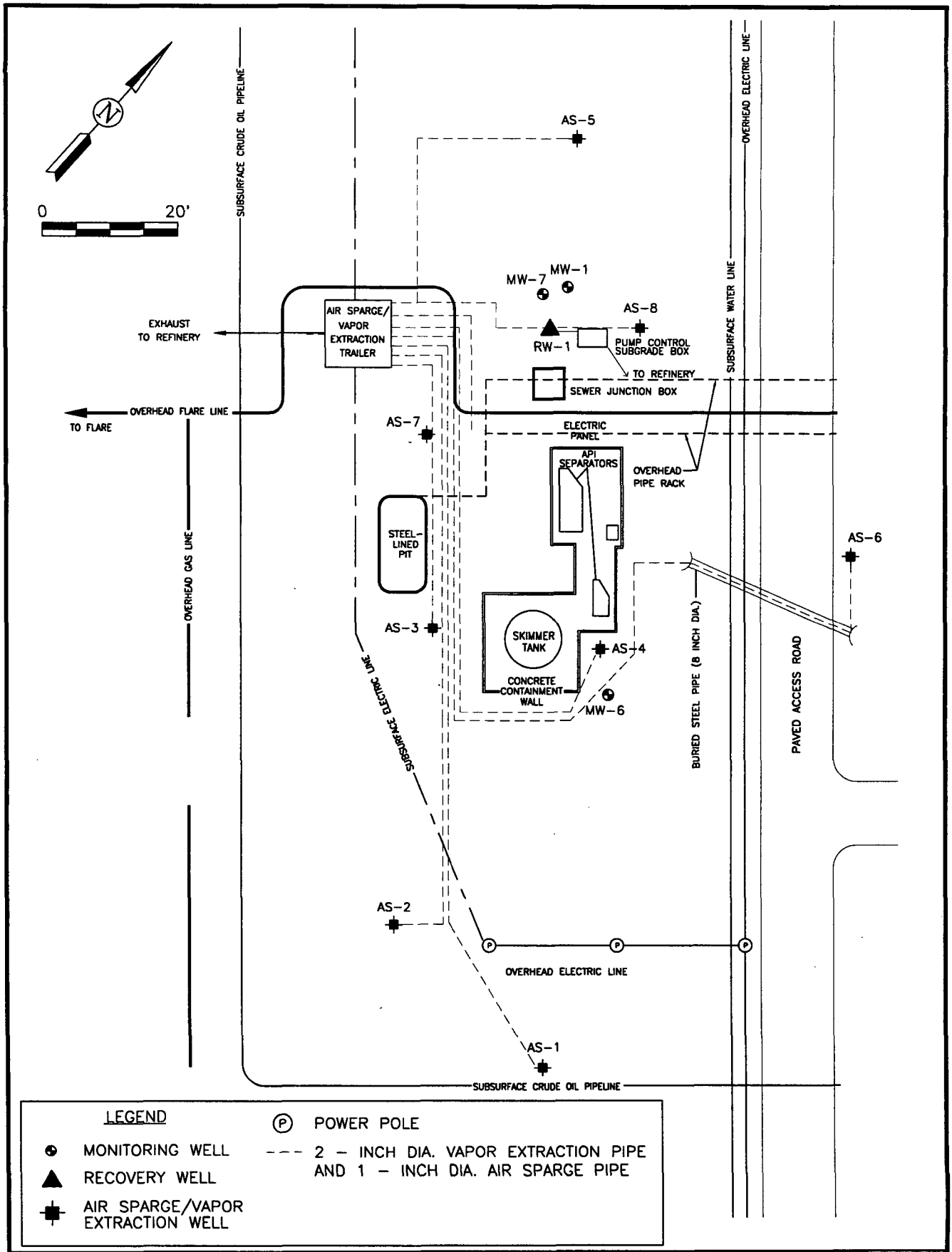
The product recovery pump is pneumatically operated. Air is supplied from an existing instrument air supply line. The control box is powered by a 115-volt supply. Currently, the control box is set to pump for a duration of 20 minutes 48 times per day. Product is pumped into a plastic 55-gallon drum located adjacent to the recovery well. An automatic shutoff sensor is installed on the drum which has a steel secondary containment vessel and is inspected daily by Navajo personnel.

A summary of the meter readings, cumulative volumes recovered and flow rates is listed in Table 4 (Attachment A). Through the first quarter of 1998, 699,033 gallons of total fluids (groundwater and free product) have been removed from recovery well RW-1 by the submersible pump system. Approximately 133.4 gallons of free product has been recovered between January 21, 1998 and November 18, 1998.

Performance of the total fluids and free product recovery system is also evaluated based on the product thickness measured in monitoring wells MW-1 and MW-7. Based on the October 29, 1998 monitoring data, product thicknesses in MW-1 and MW-7 were 1.07 feet and 0.67 feet, respectively. Passive skimmers were placed in MW-1 and MW-7 on October 29, 1998 to assist in product recovery. A graph of product recovery volumes versus time is depicted in Figure 7.

6.3 Groundwater Temperatures

Since April 1996, temperatures have been measured in the on site monitoring wells. A graph of temperature versus time for selected monitoring wells is presented in Figure 7. From this graph it is evident that the monitoring wells within the hydrocarbon plume (MW-1, MW-6 and MW-7) had elevated groundwater temperatures (approximately 25°F above background groundwater temperatures of about 70°F) until the third quarter of 1997. Groundwater temperatures within the hydrocarbon plume have stabilized to an average of 17°F above those outside of the plume. This reflects an approximate decrease of approximately 8°F from temperatures in early 1997. The overall decline in groundwater temperatures within the hydrocarbon plume is most likely attributable to the re-routing of the refinery sewer discharge water that now bypasses an older section of line between the desalter unit and the API separator. The discharge line was re-routed on December 30, 1997. Since groundwater temperatures remain above background temperatures a continual source of high temperature water from the surface is suspected. Placement of a fluorescent dye in potential source areas may assist in identifying the source for the elevated temperatures.



BDM	CLIENT: NAVAJO REFINING COMPANY	
	DATE: 12/04/97	REV. NO.: 2
	AUTHOR: GJV	DRAWN BY: DAG
	CK'D BY: MWS	FILE: LEA6.DWG

FIGURE 5
REMEDIATION SYSTEM
LEA REFINERY

D:\NAVAJO\LEA4.DWG 4-30-96

Table 6
Air Sparging/Vapor Extraction System Performance
Navajo Refining Company - Lea Refinery

Date	VE System Flow Rates			VE Exhaust Analytical Results						Hydrocarbon Recovery Performance						
	Vacuum	Flow	Flow	TVHC	B	T	E	X	BTEX	System-On	TVHC	B	T	E	X	BTEX
	Inches H2O	(ft^3/min)	(m^3/day)	(mg/m^3)						(Days in Period)	(kg)					
10/2/96	38	173	7061	9,450	107	67	34	45	253	15	1001	11	7	4	5	27
10/17/96	40	170	6919	7,030	56	81	53	89	279	33	1605	13	18	12	20	64
11/19/96	38	173	7061	12,100	74	154	123	184	535	28	2392	15	30	24	36	106
12/20/96	38	173	7061	10,600	53	123	95	136	407	28	2096	10	24	19	27	80
1/20/97	42	166	6777	9,740	34	116	108	136	394	27	1782	6	21	20	25	72
2/19/97	44	163	6635	8,990	41	120	113	155	429	28	1670	8	22	21	29	80
3/20/97	41	168	6848	7,940	29	76	83	125	313	28	1522	6	15	16	24	60
4/18/97	42	166	6777	6,760	26	48	69	78	221	17	779	3	6	8	9	25
5/16/97	24	197	8054	3,080	9	18	26	33	86	27	670	2	4	6	7	19
6/12/97	24	197	8054	3,950	16	22	28	46	112	40	1273	5	7	9	15	36
7/22/97	33	182	7415	7,100	20	43	59	91	213	28	1474	4	9	12	19	44
8/19/97	33	182	7415	2,960	9	12	11	16	48	20	439	1	2	2	2	7
9/8/97	33	182	7415	2,960	9	12	11	16	48	29	637	2	3	2	3	10
10/7/97	21	203	8267	2,960	9	12	11	16	48	0	0	0	0	0	0	0
10/28/97	30	187	7628	3,430	14	13	30	47	104	21	549	2	2	5	8	17
1/22/98	23	199	8125	200	10	1	20	20	40	86	140	7	1	14	14	28
2/11/98	60	135	5499	4,200	19	22	44	67	152	20	462	2	2	5	7	17
4/23/98	62	131	5357	1,990	8	6	18	32	64	56	597	2	2	5	10	19
8/4/98	63	130	5287	30	0	8	8	14	30	103	16	0	4	4	8	16
10/28/98	63	130	5287	126	4	2	7	9	22	85	57	2	1	3	4	10
										Total Recovery	19160	102	181	191	272	737

Vacuum readings were obtained at regenerative blower unit (EG&G Model DR707).

Flow rates determined from blower manufacturer's performance curve (corrected for altitude of 3,800 feet above mean sea level).

System shut down between 9/8/97 and 10/7/97 due to plant turnaround and repairs.

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 8015 (TVHC) and 8020 (BTEX).

Samples were collected from the exhaust port in remediation trailer prior to conveyance into refinery boiler system.

FIGURE 6

SOIL VAPOR CONCENTRATIONS VERSUS TIME

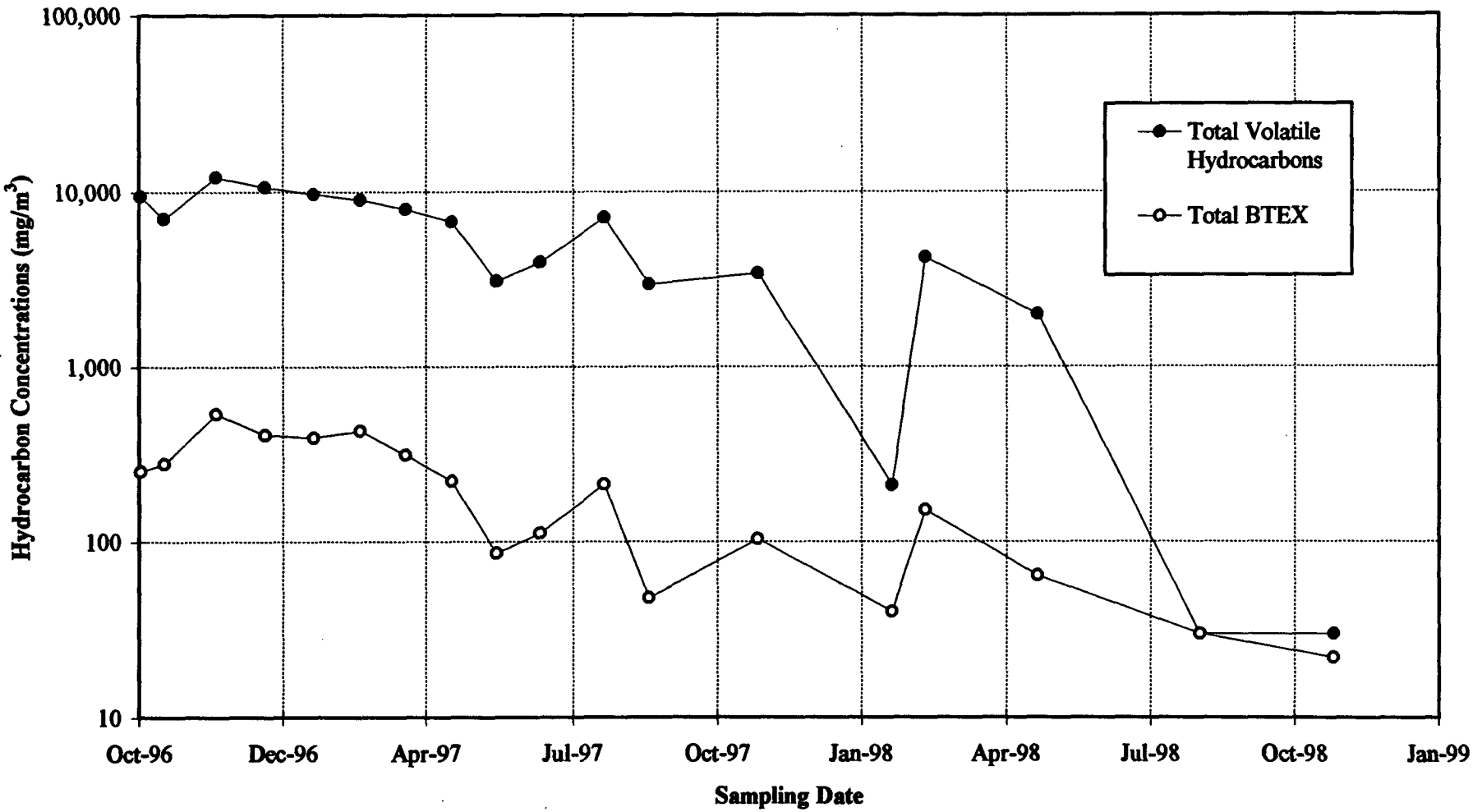


Table 7

Total Fluids and Product Recovery Volumes

Navajo Refining Company - Lea Refinery

Date	Recovery Method	Cumulative Total Fluids Recovered (gallons)	Product Recovered (gallons)	Cumulative Product Recovered (gallons)
12/28/97	Sub. Pump	699,033	Unknown*	Unknown*
1/21/98	PRS	N/A	0.5	0.5
1/27/98	PRS	N/A	2	2.5
2/11/98	Bail	N/A	1.1	3.6
2/24/98	PRS	N/A	1.5	5.1
3/13/98	PRS	N/A	2.6	7.7
3/23/98	PRS	N/A	10.6	18.3
4/10/98	PRS	N/A	15.8	34.1
4/22/98	PRS	N/A	0.5	34.6
5/6/98	PRS	N/A	7.5	42.1
6/23/98	PRS	N/A	19.5	61.6
8/4/98	PRS	N/A	5.5	67.1
9/18/98	PRS	N/A	44.2	111.3
10/29/98	PRS	N/A	15.5	126.8
11/18/98	PRS	N/A	6.6	133.4
Total Measured Volume of Product Recovered:				**133.4**

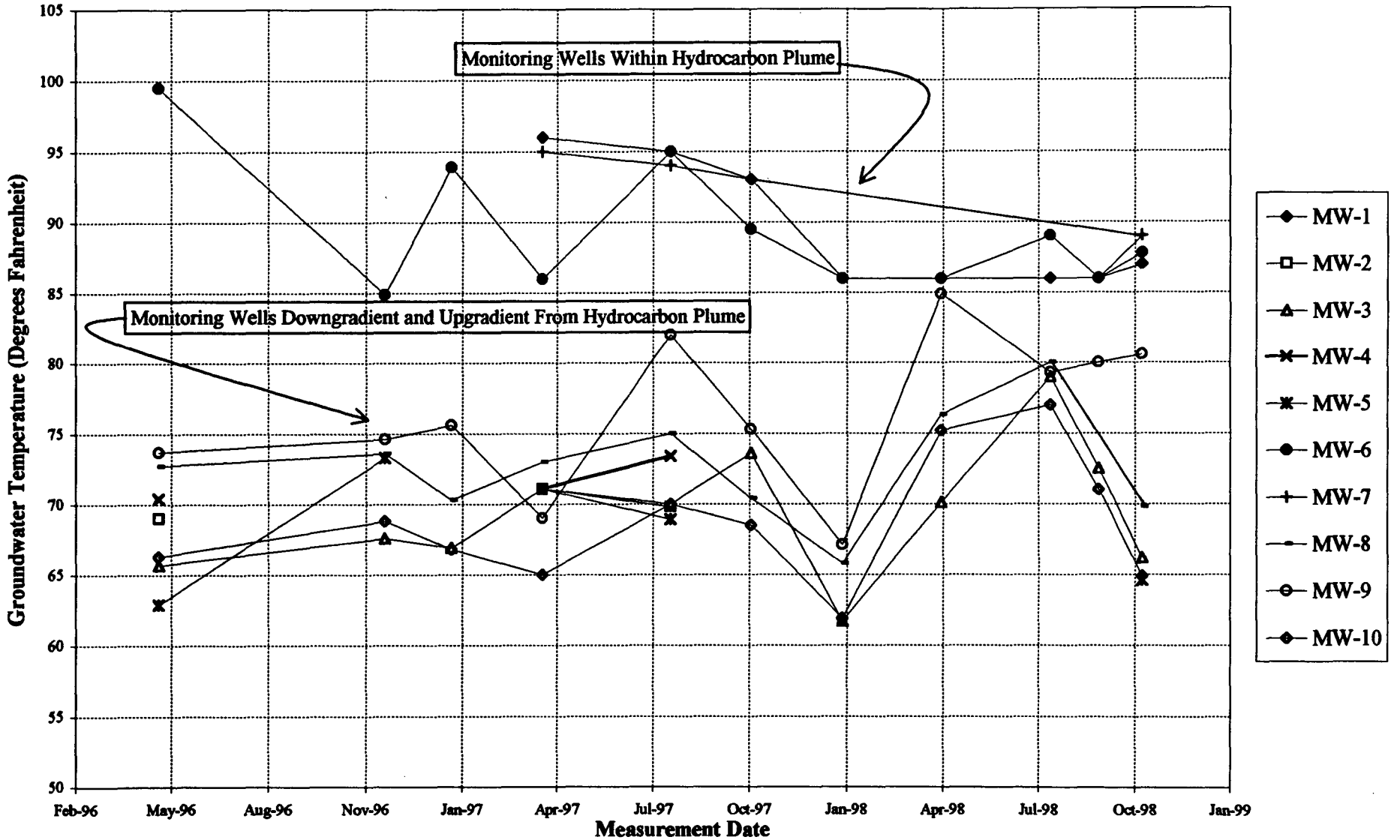
Product recovery methods used:

- Sub. Pump: 3/4 HP Grundfos submersible pump during total fluids recovery (10/1/96 - 12/28/97)
- Bail: Use of powered bailing unit by water well contractor for well cleanout.
- PRS: Product Recovery System (Xitech ADJ 1000 Smart Skimmer)

* Product recovery volume is unknown during total fluids recovery operation (10/1/96 - 12/28/97) because free product metering device was not available (699,033 gallons of total fluids recovered).

FIGURE 7

GROUNDWATER TEMPERATURES



7.0 CONCLUSIONS

Conclusions relevant to groundwater conditions and the remediation performance at the Lea Refinery are presented below.

- BTEX concentrations in upgradient monitoring wells MW-2 and MW-4 have remained at levels below the laboratory detection limit of 0.001 mg/L and below WQCC standards.

- BTEX concentrations in downgradient wells MW-3, MW-5, MW-6, MW-8, and MW-10 have also remained at levels near or below the laboratory detection limit of 0.001 mg/L and below WQCC standards.

- Benzene concentrations in MW-9 fluctuate over time but have declined from a high of 1.69 mg/L in April 1996 to its lowest level of 0.007 mg/L on October 29, 1998. This significant decrease has been attributed to the successful operation of the AS/VE system.

- A barium concentration of 1.4 mg/L in MW-9 slightly exceeded the WQCC standard of 1 mg/L. The source of barium is unknown.

- Chloride concentrations in MW-5 (280 mg/L) and MW-9 (880 mg/L) exceeded the WQCC standard of 250 mg/L.

- Fluoride concentrations varied from 1.3 mg/L in MW-5 to 3.2 mg/L in MW-6. Fluoride levels in all monitoring wells, with the exception of MW-5, slightly exceed the WQCC standard of 1.6 mg/L. Since fluoride is not a constituent for the refinery processes on site, its presence is likely due to natural conditions as it is a common natural occurrence in groundwater (1989, USGS Water-Supply Paper 2254, pg. 120-123).

- A manganese concentration of 0.31 mg/L in MW-9 slightly exceeds the WQCC standard of 0.2 mg/L. Since manganese is a common byproduct of aerobic biodegradation of hydrocarbons, its presence in monitoring well MW-9 appears to indicate beneficial biodegradation activity.

- Monitoring well MW-9 had a vanadium concentration of 0.48 mg/L which exceeds the WQCC standard of 0.05 mg/L. Since vanadium is not a constituent for the refinery processes on site, this anomaly is most likely due to its natural occurrence.

- The WQCC standard for TDS (1,000 mg/L) was exceeded in MW-8 (1,000 mg/L) and MW-9 (1,700 mg/L). Background TDS concentrations in Lea County typically range from 500 mg/L to 3,000 mg/L.

- Based on the analytical results of the VE exhaust and measured flow rates, the VE system has recovered an estimated 19,160 kilograms (8,700 lb) of TVHC since the startup of the system on October 2, 1996.

- Approximately 133.4 gallons of free product has been removed from recovery well RW-1 since installation of the Xitech product recovery system on January 21, 1998.

- Free product thicknesses have fluctuated since October 1996, but have generally declined to the present thicknesses of 1.07 feet and 0.67 feet in MW-1 and MW-7, respectively.

- During 1998, groundwater temperatures within the hydrocarbon plume (MW-1, MW-6, and MW-7) have stabilized to an average of 17°F above those outside of the plume. This reflects an approximate decrease of approximately 8°F from 1997 temperatures.

8.0 RECOMMENDATIONS

The following recommendations are proposed for the remediation system and monitoring operations at the Lea Refinery.

- Continue product recovery operations since the present system has been effective in recovering 133.4 gallons of free product from RW-1.
- Continue air sparge and vapor extraction operations since the present system has been effective in recovering an estimated 19,160 kilograms (8,700 lb) of total volatile hydrocarbons.
- Continue the sampling and monitoring program on a quarterly basis. The next sampling event is scheduled during the first quarter of 1999.

APPENDIX A

Laboratory Analytical Reports

and

Chain of Custody Documentation

11554-64

6663 / 6666

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

13261

Chain of Custody

Date 10-29-98 Page 1 Of 1

Lab Name Trace Analysis Inc
Address 6701 Aberdeen
Lubbock, Tx 79424
Telephone 800/378-1296

Samplers (SIGNATURES)

Analysis Request

	Sample Number	Matrix	Sample ID Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX 8021B	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 GRO/DRO/TVHC	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)	METALS As,B,Ba,Fe,Mn & Ions Cl,F,NO3,SO4 & TDS		Number of Containers
11554	981028 1550	Water	MW-5		✓																				✓	✓		4
55	98102818 10	Water	MW-2		✓																				✓	✓		4
56	98102908 25	Water	MW-3		✓																				✓	✓		4
57	98102908 40	Water	MW-4		✓																				✓	✓		4
58	98 10 29 1020	Water	MW-8		✓																				✓	✓		4
59	98 10 29 1030	Water	MW-10		✓																				✓	✓		4
60	98 10 29 1200	Water	DUPLICATE		✓																							2
61	98 10 29 1300	Water	MW-9		✓																				✓	✓		4
62	98 10 29 1210	Water	MW-6		✓																				✓	✓		4
63	98 10 28 1340	Air	VE Exhaust		✓									✓														2

Project Information	Sample Receipt	Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Project Navajo-Lea Refinery	Total No. of Containers	John Ferguson 1730		
Project Director G. Van Deventer	Chain of Custody Seals	(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
Charge Code No. P/2292/9C	Rec'd Good Condition/Cold	John Ferguson 10/29/98		
Shipping ID. No.	Conforms to Record	(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
Via:	Lab No.	TRW Inc - Energy & Environmental Systems	(Company)	(Company)
		Received By 1.	Received By 2.	Received By (Laboratory) 3.
		(Signature) (Time)	(Signature) (Time)	(Signature) Vicki Windham (Time)
		(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) Vicki Windham (Date) 10:00 A.M.
		(Company)	(Company)	(Laboratory) Trace Analysis 10-30-98

Special Instructions/Comments: Maximum detection limits (mg/L): As (0.05), B(0.2), Ba(0.2), Fe(0.05), Mn(0.02), V (0.05), F(0.2)

11563 Metal samples were filtered in field

63 * TRIPBLANKS 227A & 227B (BTEX 8021B) ✓

TRW#

Distribution: White, Canary-Laboratory • Pink-BDM

4° Bus 9020537614

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
TRW
Attention Gil Van Deventer
415 West Wall Suite 1818
Midland Tx 79701

Lab Receiving # : 9810000665
Date Rec: 10/30/98
Sampling Date: 10/28/9 - 10/29/98
Sample Condition: Intact and Cool
Sample Received By: VW

Date: Nov 03, 1998
Project: P/2292/PC
Proj Name: Navajo-Lea Refinery
Proj Loc: N/A

TA#	Field Code	MATRIX	MTBE (mg/L)	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
111555	9810281810 MW-2	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111556	9810290825 MW-3	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111557	9810290840 MW-4	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111558	9810291020 MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111559	9810291030 MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111560	9810291200 Duplicate	Water	0.002	0.006	0.004	0.002	0.002	0.014
111561	9810291300 MW-9	Water	0.002	0.007	0.006	<0.001	0.002	0.015
111562	9810291210 MW-6	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111563	Trip Blank	Water	0.006	<0.001	<0.001	<0.001	<0.001	<0.001
Method Blank			<0.001	<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	0.001	
QC			0.110	0.124	0.113	0.106	0.309	
RPD			2	2	1	1	1	
% Extraction Accuracy			113	128	118	108	108	
% Instrument Accuracy			110	124	113	106	103	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	11/2/98	EPA 8021B	11/2/98	CS	0.100 ea	0.1 ea

Director, Dr. Blair Leftwich

11-3-98
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
TRW
Attention Gil Van Deventer
415 West Wall Suite 1818
Midland Tx 79701

Date: Nov 04, 1998
Project: P/2292/PC
Proj Name: Navajo-Lea Refinery
Proj Loc: N/A

Lab Receiving # : 9810000665
Date Rec: 10/30/98
Sampling Date: 10/28/9
Sample Condition: Intact and Cool
Sample Received By: VW

TA#	Field Code	MATRIX	MTBE (mg/L)	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
111554	9810281550 MW-5	Water	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Method Blank			<0.001	<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	0.001	
QC			0.110	0.124	0.113	0.106	0.309	
RPD			2	2	1	1	1	
% Extraction Accuracy			113	128	118	108	108	
% Instrument Accuracy			110	124	113	106	103	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	11/2/98	EPA 8021B	11/2/98	CS	0.100 ea	0.1 ea

Director, Dr. Blair Leftwich

11-4-98
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
TRW
Attention Gil Van Deventer
415 West Wall Suite 1818
Midland Tx 79701

Date: Nov 03, 1998
Project: P/2292/EC
Proj Name: Navajo-Lea Refinery
Proj Loc: N/A

Lab Receiving # : 9810000665
Date Rec: 10/30/98
Sampling Date: 10/28/9 - 10/29/98
Sample Condition: Intact and Cool
Sample Received By: VW

TA#	Field Code	MATRIX	MTBE (mg/L)	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
111555	9810281810 MW-2	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111556	9810290825 MW-3	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111557	9810290840 MW-4	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111558	9810291020 MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111559	9810291030 MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111560	9810291200 Duplicate	Water	0.002	0.006	0.004	0.002	0.002	0.014
111561	9810291300 MW-9	Water	0.002	0.007	0.006	<0.001	0.002	0.015
111562	9810291210 MW-6	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
111563	Trip Blank	Water	0.006	<0.001	<0.001	<0.001	<0.001	<0.001
Method Blank			<0.001	<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	0.001	
QC			0.110	0.124	0.113	0.106	0.309	
RPD			2	2	1	1	1	
% Extraction Accuracy			113	128	118	108	108	
% Instrument Accuracy			110	124	113	106	103	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	11/2/98	EPA 8021B	11/2/98	CS	0.100 ea	0.1 ea

Director, Dr. Blair Leftwich

11-3-98
Date

TRACE ANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
TRW
Attention: Gil Van Deventer
415 W. Wall, Suite 1818
Midland, TX 79701

November 05, 1998
Receiving Date: 10/30/98
Sample Type: Water
Charge Code No: P/2292/9C
Project Location: NA
COC# 13261

Sampling Date: 10/29/98
Sample Condition: Intact & Cool
Sample Received by: VW
Project: Navajo - Lea Refinery

TA#	FIELD CODE	FLUORIDE (mg/L)	CHLORIDE (mg/L)	N03-N (mg/L)	S04 (mg/L)	TDS (mg/L)
T111561	9810291300 MW-9	2.3	880	<10	48	1,700
T111562	9810291210 MW-6	3.2	53	66	86	690
ICV		2.5	13	5.3	13	---
CCV		2.6	12	5.2	13	---
REPORTING LIMIT		0.1	0.5	0.2	0.5	10
RPD		0	0	1	3	0
% Extraction Accuracy		103	103	104	107	---
% Instrument Accuracy		104	104	105	105	96
PREP DATE		10/30/98	10/30/98	10/30/98	10/30/98	11/03/98
ANALYSIS DATE		10/30/98	10/30/98	10/30/98	10/30/98	11/03/98

METHODS: EPA 300.0, 160.1.
CHEMIST: FLUORIDE/CHLORIDE/N03-N/S04: JS TDS: RS
FLUORIDE SPIKE: 12.5 mg/L FLUORIDE.
CHLORIDE SPIKE: 62.5 mg/L CHLORIDE.
N03-N SPIKE: 25 mg/L N03-N.
S04 SPIKE: 62.5 mg/L S04.
FLUORIDE CV: 2.5 mg/L FLUORIDE.
CHLORIDE CV: 12.5 mg/L CHLORIDE.
N03-N CV: 5.0 mg/L N03-N.
S04 CV: 12.5 mg/L S04.

Director, Dr. Blair Leftwich

11-5-98
DATE

TRACE ANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
TRW
Attention: Gil Van Deventer
415 W. Wall, Suite 1818
Midland, TX 79701

November 05, 1998
Receiving Date: 10/30/98
Sample Type: Water
Charge Code No: P/2292/9C
Project Location: NA
COC# 13261

Sampling Date: 10/29/98
Sample Condition: Intact & Cool
Sample Received by: VW
Project: Navajo - Lea Refinery

TA#	FIELD CODE	FLUORIDE (mg/L)	CHLORIDE (mg/L)	N03-N (mg/L)	S04 (mg/L)	TDS (mg/L)
T111557	9810290840 MW-4	2.1	28	4.5	90	390
T111558	9810291020 MW-8	2.3	310	10	170	1,000
T111559	9810291030 MW-10	2.0	32	4.6	110	480
ICV		2.5	12	5.0	13	---
CCV		2.5	13	5.3	13	---
REPORTING LIMIT		0.1	0.5	0.2	0.5	10
RPD		0	0	1	2	0
% Extraction Accuracy		101	100	99	99	---
% Instrument Accuracy		104	104	104	106	96
PREP DATE		10/30/98	10/30/98	10/30/98	10/30/98	11/03/98
ANALYSIS DATE		10/30/98	10/30/98	10/30/98	10/30/98	11/03/98

METHODS: EPA 300.0, 160.1.
CHEMIST: FLUORIDE/CHLORIDE/N03-N/S04: JS TDS: RS
FLUORIDE SPIKE: 12.5 mg/L FLUORIDE.
CHLORIDE SPIKE: 62.5 mg/L CHLORIDE.
N03-N SPIKE: 25 mg/L N03-N.
S04 SPIKE: 62.5 mg/L S04.
FLUORIDE CV: 2.5 mg/L FLUORIDE.
CHLORIDE CV: 12.5 mg/L CHLORIDE.
N03-N CV: 5.0 mg/L N03-N.
S04 CV: 12.5 mg/L S04.

Director, Dr. Blair Leftwich

11-5-98
DATE

TRACE ANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
TRW
Attention: Gil Van Deventer
415 W. Wall, Suite 1818
Midland, TX 79701

November 05, 1998
Receiving Date: 10/30/98
Sample Type: Water
Charge Code No: P/2292/9C
Project Location: NA
COC# 13261

Sampling Date: 10/28-29/98
Sample Condition: Intact & Cool
Sample Received by: VW
Project: Navajo - Lea Refinery

TA#	FIELD CODE	FLUORIDE (mg/L)	CHLORIDE (mg/L)	N03-N (mg/L)	S04 (mg/L)	TDS (mg/L)
T111555	9810281810 MW-2	2.4	170	4.7	120	540
T111556	9810290825 MW-3	1.6	99	6.1	110	650
ICV		2.6	13	5.1	13	---
CCV		2.5	12	5.0	13	---
REPORTING LIMIT		0.1	0.5	0.2	0.5	10
RPD		1	0	1	0	0
% Extraction Accuracy		101	93	101	106	---
% Instrument Accuracy		104	107	103	107	96
PREP DATE		10/30/98	10/30/98	10/30/98	10/30/98	11/03/98
ANALYSIS DATE		10/30/98	10/30/98	10/30/98	10/30/98	11/03/98

METHODS: EPA 300.0, 160.1.
CHEMIST: FLUORIDE/CHLORIDE/N03-N/S04: JS TDS: RS
FLUORIDE SPIKE: 12.5 mg/L FLUORIDE.
CHLORIDE SPIKE: 62.5 mg/L CHLORIDE.
N03-N SPIKE: 25 mg/L N03-N.
S04 SPIKE: 62.5 mg/L S04.
FLUORIDE CV: 2.5 mg/L FLUORIDE.
CHLORIDE CV: 12.5 mg/L CHLORIDE.
N03-N CV: 5.0 mg/L N03-N.
S04 CV: 12.5 mg/L S04.

Director, Dr. Blair Leftwich

11-5-98
DATE

TRACEANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
TRW
Attention: Gil Van Deventer
415 W. Wall, Suite 1818
Midland, TX 79701

November 05, 1998
Receiving Date: 10/30/98
Sample Type: Water
Charge Code No: P/2292/9C
Project Location: NA
COC# 13261

Sampling Date: 10/28/98
Sample Condition: Intact & Cool
Sample Received by: VW
Project: Navajo - Lea Refinery

TA#	FIELD CODE	FLUORIDE (mg/L)	CHLORIDE (mg/L)	N03-N (mg/L)	S04 (mg/L)	TDS (mg/L)
T111554	9810281550 MW-5	1.3	280	4.1	120	920
ICV		2.6	13	5.1	13	---
CCV		2.5	12	5.0	13	---
REPORTING LIMIT		0.1	0.5	0.2	0.5	10
RPD		1	0	1	0	8
% Extraction Accuracy		101	93	101	106	---
% Instrument Accuracy		104	107	103	107	98
PREP DATE		10/30/98	10/30/98	10/30/98	10/30/98	11/02/98
ANALYSIS DATE		10/30/98	10/30/98	10/30/98	10/30/98	11/02/98

METHODS: EPA 300.0, 160.1.
CHEMIST: FLUORIDE/CHLORIDE/N03-N/S04: JS TDS: RS
FLUORIDE SPIKE: 12.5 mg/L FLUORIDE.
CHLORIDE SPIKE: 62.5 mg/L CHLORIDE.
N03-N SPIKE: 25 mg/L N03-N.
S04 SPIKE: 62.5 mg/L S04.
FLUORIDE CV: 2.5 mg/L FLUORIDE.
CHLORIDE CV: 12.5 mg/L CHLORIDE.
N03-N CV: 5.0 mg/L N03-N.
S04 CV: 12.5 mg/L S04.

BL

Director, Dr. Blair Leftwich

11-5-98

DATE

TRACE ANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
TRW
Attention: Gil Van Deventer
415 W. Wall, Suite 1818
Midland, TX 79701

November 05, 1998
Receiving Date: 10/30/98
Sample Type: Water
Charge Code No: P/2292/9C
Project Location: NA
COC# 13261

Sampling Date: 10/28-29/98
Sample Condition: Intact & Cool
Sample Received by: VW
Project: Navajo - Lea Refinery

		DISSOLVED METALS					
TA#	FIELD CODE	As (mg/L)	Ba (mg/L)	Fe (mg/L)	Mn (mg/L)	V (mg/L)	B (mg/L)
T111554	9810281550 MW-5	<0.05	<0.20	0.15	<0.02	<0.05	0.26
T111555	9810281810 MW-2	<0.05	<0.20	0.19	<0.02	<0.05	0.20
T111556	9810290825 MW-3	<0.05	<0.20	0.23	0.10	<0.05	0.22
T111557	9810290840 MW-4	<0.05	<0.20	<0.05	<0.02	<0.05	<0.20
T111558	9810291020 MW-8	<0.05	<0.20	0.05	<0.02	<0.05	0.34
T111559	9810291030 MW-10	<0.05	0.84	<0.05	<0.02	<0.05	0.25
T111561	9810291300 MW-9	<0.05	1.4	<0.05	0.31	<0.05	0.49
T111562	9810291210 MW-6	0.15	0.16	0.06	<0.02	0.48	<0.20
ICV		4.8	5.0	5.0	5.0	5.0	4.9
CCV		4.9	5.0	5.1	5.0	5.0	5.0
REPORTING LIMIT		0.05	0.20	0.05	0.02	0.05	0.20
RPD		5	0	5	10	5	10
% Extraction Accuracy		95	100	100	105	105	100
% Instrument Accuracy		96	100	100	100	100	98
PREP DATE		10/31/98	10/31/98	10/31/98	10/31/98	10/31/98	10/31/98
ANALYSIS DATE		10/31/98	10/31/98	10/31/98	10/31/98	10/31/98	10/31/98

METHODS: EPA SW 846-3005A, 6010B.
CHEMIST: RR
DISSOLVED METALS SPIKE: 2.0 mg/L As, Ba, Fe, Mn, V, B.
DISSOLVED METALS CV: 5.0 mg/L As, Ba, Fe, Mn, V, B.

Director, Dr. Blair Leftwich

11-5-98
DATE

TRACEANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
TRW
Attention: Gil VanDeventer
415 West Wall, Suite 1818
Midland, TX 79701

November 3, 1998
Receiving Date: 10/30/98
Sample Type: Air
Project Name: Navajo-Lea Refinery
Project Loc: N/A

Prep Date: 11/02/98
Analysis Date: 11/02/98
Sampling Date: 10/28/98
Sample Condition: Intact
Sample Received by: VW

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T111564	VE Exhaust	126	4	2	7	9	22
QC	Quality Control	148	124	113	106	309	
Reporting Limit		100	1	1	1	1	
RPD		0	2	1	1	1	
% Instrument Accuracy		148	124	113	106	103	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: CS
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich

11-3-98
Date

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

158/172

13240

Chain of Custody

Date 8-4-98 Page 1 Of 1

Lab Name Trace Analysis Inc
Address 6701 Aberdeen
Lubbock, TX 79424
Telephone 806/794-1296
Samplers (SIGNATURES) [signatures]

	Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 GRO/TVHC	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
04581	9808040815	Air	VE Exhaust		✓									✓	Rush		Air				NOT			In		Ice	Chest			2
04523	9808041100	Water	MW-10		✓																									2
524	9808041200	Water	Duplicate		✓																									2
525	9808041414	Water	MW-8		✓																									2
526	9808041525	Water	MW-3		✓																									2
527	9808041630	Water	MW-6		✓																									2
528	9808041510	Water	MW-9		✓																									2
529	341B	Water	Trip Blank		✓																									1

Project Information
Project Navajo - Lea Refinery
Project Director G. Van Deventer
Charge Code No. P/2292/6C
Shipping ID. No.
Via: Greyhound
Special Instructions/Comments: PO # ENG0000001

Sample Receipt
Total No. of Containers
Chain of Custody Seals
Rec'd Good Condition/Cold
Conforms to Record
Lab No.

	1.	2.	3.
Relinquished By (Signature) / (Time)	[signature] 6:30pm	Helen Shelton 6:45PM	
(Printed Name) / (Date)	Gil Van Deventer 8/7/98	HELEN SHELTON 8/7/98	
(Company)	TRW (BDM)	TRACE ANALYSIS	
Received By (Signature) / (Time)	Helen Shelton 6:30PM		Received By (Laboratory) [signature]
(Printed Name) / (Date)	HELEN SHELTON 8/7/98		James Taylor 8/8/98
(Company) / (Laboratory)	TRACE ANALYSIS		Trace Analysis

°C
Greyhound # 155-755-995-7 BDMAir81.XLS (570)

Distribution: White, Canary-Laboratory • Pink, BDM 8/18

15 samples - HS

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM International
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Date: Aug 18, 1998
Date Rec: 8/8/98
Project: N/A
Proj Name: 2292/6C-Navajo Lea Refinery
Proj Loc: N/A

Lab Receiving # : 9808000158
Sampling Date: 8/4/98
Sample Condition: Intact and Cool
Sample Received By: JT

TA#	Field Code	MATRIX	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
104523	9808041100 MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001
104524	9808041200 Duplicate	Water	0.007	<0.001	<0.001	<0.001	0.007
104525	9808041414 MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001
104526	9808041525 MW-3	Water	<0.001	<0.001	<0.001	<0.001	<0.001
104527	9808041630 MW-6	Water	<0.001	<0.001	<0.001	<0.001	<0.001
104528	9808041510 MW-9	Water	0.010	<0.001	<0.001	<0.001	0.010
104529	341B Trip Blank	Water	<0.001	<0.001	<0.001	<0.001	<0.001
Method Blank			<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	
QC			0.100	0.097	0.099	0.308	
RPD			0	0	0	0	
% Extraction Accuracy			107	104	106	113	
% Instrument Accuracy			100	97	99	103	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	8/12/98	EPA 8021B	8/12/98	JG	0.100 ea	0.1 ea

Director, Dr. Blair Leftwich

8-18-98
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM INTERNATIONAL
Attention: Gil VanDeVenter
415 W. Wall, Suite 1818
Midland, TX 79701

August 18, 1998
Receiving Date: 08/08/98
Sample Type: Air
Charge Code No: P/2292/6C
Project Location: NA
COC# 13240
PO# EN60000001

Prep Date: 08/11/98
Analysis Date: 08/11/98
Sampling Date: 08/04/98
Sample Condition: Intact
Sample Received by: JT
Project: Navajo - Lea Refinery

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T104581	9808040815 VE Exhaust	<100	<1	8	8	14	30
QC	Quality Control	960	94	97	98	286	
Reporting Limit		100	1	1	1	1	
Method Blank		<100	<1	<1	<1	<1	
RPD		0	1	1	3	3	
% Instrument Accuracy		96	94	98	98	96	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: JG
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich

8-18-98
Date

433/434

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

13138

Chain of Custody

Date 4-23-98 Page 1 Of 1

Lab Name Trace Analysis Inc
Address 6701 Aberdeen Ave
Lubbock TX 79424
Telephone 806 794 1296

Samplers (SIGNATURES) [signature]

Analysis Request

	Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 GRO	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
16833	98 04 23 1048	Water	MW-3		✓																									2
34	98 04 23 1203	Water	MW-10		✓																									2
35	98 04 23 1429	Water	MW-6		✓																									2
36	98 04 23 1530	Water	MW-9		✓																									2
37	98 04 23 1325	Water	MW-11		✓																									2
38	98 04 23 1647	Water	MW-8		✓																									2
40	98 04 23 1340	Air	VE Exhaust		✓									✓																2
39	98 04 20 1200	Water	Trip Blank		✓																									2

Project Information	
Project	Navajo - Lea Refinery
Project Director	Gil Van Deventer
Charge Code No.	2292/6C
Shipping ID. No.	901 905 1404
Via:	Greyhound

Sample Receipt	
Total No. of Containers	
Chain of Custody Seals	
Rec'd Good Condition/Cold	
Conforms to Record	
Lab No.	

Special Instructions/Comments:

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
(Signature) [signature] (Time) 1145	(Signature) (Time)	(Signature) [signature] (Time)
(Printed Name) Gil Van Deventer (Date) 4/24/98	(Printed Name) (Date)	(Printed Name) (Date)
(Company) BDM International	(Company)	(Company)

Received By 1.	Received By 2.	Received By (Laboratory) 3.
(Signature) (Time)	(Signature) (Time)	(Signature) [signature] (Time) 9:30
(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) Marty Brooks (Date) 4-25
(Company)	(Company)	(Laboratory) Trace Analysis

Distribution: White, Canary-Laboratory • Pink, BDM

11°C

Greyhound 901 905 1404

TRACE ANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
BDM International
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Lab Receiving # : 9804000433
Sampling Date: 4/23/98
Sample Condition: Intact and Cool
Sample Received By: MB

Date: Apr 30, 1998
Date Rec: 4/25/98
Project: N/A
Proj Name: Navajo Lea Refining
Proj Loc: N/A

TA#	Field Code	MATRIX	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
T96933	9804231048 MW-3	Water	<0.005	<0.005	<0.005	0.008	0.008
T96934	9804231203 MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T96935	9804231429 MW-6	Water	<0.001	<0.001	<0.001	<0.001	<0.001
Method Blank			<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	
QC			0.111	0.109	0.108	0.342	
RPD			2	0	0	3	
% Extraction Accuracy			104	104	105	109	
% Instrument Accuracy			111	109	108	114	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	4/27/98	EPA 8021B	4/27/98	JG	0.100 ea	0.1 ea

Director, Dr. Blair Leftwich

4-30-98

TRACE ANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR

BDM International
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Lab Receiving # : 9804000433
Sampling Date: 4/20/98 - 4/23/98
Sample Condition: Intact and Cool
Sample Received By: MB

Date: Apr 30, 1998
Date Rec: 4/25/98
Project: N/A
Proj Name: Navajo Lea Refining
Proj Loc: N/A

TA#	Field Code	MATRIX	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
T96936	9804231530 MW-9	Water	0.013	<0.001	<0.001	<0.001	0.013
T96937	9804231325 MW-11	Water	0.012	<0.001	<0.001	<0.001	0.012
T96938	9804121647 MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T96939	9804201200 Trip Blank	Water	<0.001	<0.001	<0.001	<0.001	<0.001
Method Blank			<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	
QC			0.102	0.101	0.101	0.296	
RPD			1	0	0	0	
% Extraction Accuracy			99	98	97	96	
% Instrument Accuracy			102	101	101	99	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	4/28/98	EPA 8021B	4/28/98	JG	0.100 ea	0.1 ea

BB

Director, Dr. Blair Leftwich

4-30-98

TRACE ANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

ANALYTICAL RESULTS FOR
BDM INTERNATIONAL
Attention: Gil VanDeVenter
415 W. Wall, Suite 1818
Midland, TX 79701

May 04, 1998
Receiving Date: 04/25/98
Sample Type: Air
Project No: 2292/6C
Project Location: Navajo-Lea Refining

Lab Receiving No: 9804000434
Prep Date: 04/28/98
Analysis Date: 04/28/98
Sampling Date: 04/23/98
Sample Condition: Intact
Sample Received by: MB

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T96940	9804231340 VE Exhaust	1,990	8.00	6.00	18.0	32.0	64.0
QC	Quality Control	943	113	112	112	350	
	Reporting Limit	100	1	1	1	1	
	Method Blank	<100	<1	<1	<1	<1	
	RPD	9	1	1	1	1	
	% Instrument Accuracy	94	113	113	113	115	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: JG
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich

5-4-98
Date

352

13120

Chain of Custody

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

Date _____ Page _____ Of _____

Lab Name Trace Analysis
Address 6701 Aberdeen
Lubbock, Tx 79424
Telephone 800-378-1298

Samplers (SIGNATURES)
John Fergeran

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	~~Aromatic Volatiles~~ 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
9801210915	Water	MW-3		✓							89715																	2
9801211015	Water	MW-10		✓							89716																	2
9801211210	Water	MW-8		✓							89717																	2
9801211600	Water	MW-9		✓							89718																	2
9801211630	Water	MW-9D		✓							89719																	2
9801211615	Water	Rinsate		✓							89720																	2
9801211700	Water	~~Trip Blank~~ MW-6		✓							89721																	2
	Water	Trip Blank		✓							89722																	2
9801211750	Air	SVE Unit		✓							89~~7~~ 89845																	2

Pc
~~Did not Req~~

Project Information		Sample Receipt	
Project	Navajo-Lea Refinery	Total No. of Containers	
Project Director	G. Van Deventer	Chain of Custody Seals	
Charge Code No.	P/2292/GC	Rec'd Good Condition/Cold	
Shipping ID. No.		Conforms to Record	
Via:		Lab No.	

Special Instructions/Comments: Bill BDM
Rush Order on MW-6

	1.	2.	3.
Relinquished By			
(Signature)	1530 (Time)		(Time)
(Printed Name)	Gil Van Deventer (Date) 1-22-98	(Date)	(Date)
(Company)	BDM		
Received By			
(Signature)	(Time)	(Time)	Vicki Windham (Time)
(Printed Name)	(Date)	(Date)	Vicki Windham 9:40 AM (Date)
(Company)			Trace Analysis 1-23-98

Bus 901 837 708 2 20

Distribution: White, Canary-Laboratory • Pink, BDM

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM INTERNATIONAL, INC.
Attention: Gil VanDeventer
415 West Wall, Suite 1818
Midland, TX 79701

January 28, 1998
Receiving Date: 01/23/98
Sample Type: Water
Charge Code: P/2292/6C
Project Location: Navajo-Lea Refinery

Prep Date: 01/23/98
Analysis Date: 01/23/98
Sampling Date: 01/21/98
Sample Condition: Intact & Cool
Sample Received by: VW
Project Name: Navajo

TA#	FIELD CODE	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
T89715	9801210915 MW-3	<0.001	<0.001	<0.001	<0.001	<0.001
T89716	9801211015 MW-10	<0.001	<0.001	<0.001	<0.001	<0.001
T89717	9801211210 MW-8	<0.001	<0.001	<0.001	<0.001	<0.001
T89718	9801211600 MW-9	0.146	0.005	<0.001	0.002	0.153
T89719	9801211630 MW-9D	0.125	0.004	<0.001	<0.001	0.129
T89720	980121615 Rinsate	<0.001	<0.001	<0.001	<0.001	<0.001
T89721	9801211700 MW-6	<0.001	<0.001	<0.001	<0.001	<0.001
T89722	Trip Blank	<0.001	<0.001	<0.001	<0.001	<0.001
QC	Quality Control	0.098	0.098	0.095	0.098	
REPORTING LIMIT		0.001	0.001	0.001	0.001	
RPD		4	5	4	3	
% Extraction Accuracy		98	97	94	97	
% Instrument Accuracy		98	98	95	98	

METHODS: EPA SW 846-8021B, 5030.
CHEMIST: JG
BTEX SPIKE AND QC: 0.100 mg/L BTEX.

Director, Dr. Blair Leftwich

1-28-98
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM INTERNATIONAL
Attention: Gil VanDeventer
415 W. Wall, Suite 1818
Midland, TX 79701

January 28, 1998
Receiving Date: 01/23/98
Sample Type: Air
Charge Code: P/2292/6C
Project Location: Lea Refinery

Prep Date: 01/26/98
Analysis Date: 01/26/98
Sampling Date: 01/21/98
Sample Condition: Intact
Sample Received by: VW
Project Name: Navajo-Lea Refinery

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T89845	9801211750 SVE Unit	210	10.0	1.0	20.0	20.0	40.0
QC	Quality Control	890	97	97	93	285	
	Reporting Limit	100	1	1	1	1	
	RPD	0	2	2	2	3	
	% Instrument Accuracy	89	98	98	94	95	

METHODS: EPA SW 846-8020 Modified, 8015 Modified.
CHEMIST: JG
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich

1-2=-98
Date

1997 Annual Groundwater Monitoring and Sampling and Remediation System Performance Report Navajo Refining Company - Lea Refinery Lea County, New Mexico

DECEMBER 11, 1997

Prepared For:

Navajo Refining Company
P. O. Box 159
Artesia, New Mexico 88211

Prepared By:

BDM International, Inc.
415 West Wall, Suite 1818
Midland, Texas 79701

1997 Annual Groundwater Monitoring and Sampling Report
Navajo - Lea Refinery
Lea County, New Mexico

Prepared by:

BDM International, Inc.
415 West Wall Street, Suite 1818
Midland, Texas 79701
(915) 682-0008
FAX (915) 682-0028

SUBMITTED BY:

Gilbert J. Van Deventer, REM
Project Manager

DATE: 12-11-97

REVIEWED BY:

for Michael W. Selke, RG
Senior Program Director

DATE: 12-11-97

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FIGURES

TABLES

APPENDICES

1.0 Executive Summary

BDM International, Inc. (BDM) was retained by Navajo Refining Company (Navajo) to perform the sampling and monitoring operations at the Lea Refinery. This 1997 annual report documents the four quarterly sampling events performed by BDM at the Navajo Lea Refinery on January 20, 1997, April 16, 1997, August 14, 1997, and October 28, 1997. The report also contains the historical groundwater elevation and analytical data since the beginning of the project in September 1995. This monitoring and sampling program was conducted in accordance with the guidelines specified by Mr. Bill Olson of the New Mexico Oil Conservation Division (OCD) as specified in his letter dated November 21, 1996.

Based on the sampling and monitoring data to date, the following conclusions relevant to groundwater conditions and remediation system performance at the Lea Refinery are evident:

- BTEX concentrations in upgradient monitoring wells MW-2 and MW-4 and downgradient wells MW-3, MW-5, MW-8, and MW-10, have remained at levels below the laboratory detection limit of 0.001 mg/l and below WQCC standards.

- The benzene concentrations in monitoring well MW-9 continue to exceed the WQCC standard of 0.010 mg/l. Although benzene levels in MW-9 fluctuate over time, they have declined from a high of 1.69 mg/l in April 1996 to a concentration of 0.516 mg/l on October 28, 1997. This significant decrease has been attributed to the successful operation of the air sparge/vapor extraction system.

- Monitoring wells MW-6 and MW-9 had manganese concentrations of 0.32 mg/l and 0.51 mg/l, respectively which slightly exceeds the WQCC standard of 0.2 mg/l.

- Monitoring well MW-6 had a vanadium concentration of 0.23 mg/l which exceeds the WQCC standard of 0.05 mg/l.

- The WQCC standard for chloride (250 mg/l) was exceeded in MW-5 (250 mg/l), MW-6 (480 mg/l), MW-8 (960 mg/l) and MW-9 (6,500 mg/l). MW-9 was re-sampled on October 28, 1997, and recorded a chloride concentration of 1,200 mg/l which is more consistent with previous determinations.

- The WQCC standard for TDS (1,000 mg/l) was exceeded in MW-5 (1000 mg/l), MW-8 (1,800 mg/l) and MW-9 (2,300 mg/l).

- Monitoring well MW-6 had a fluoride concentration of 3.4 mg/l which exceeds the WQCC standard of 1.6 mg/l.

- Based on the analytical results of the VE exhaust and measured flow rates, the VE system has recovered an estimated 17,888 kilograms (8,100 lb.) of total volatile hydrocarbons since the startup of the system on October 2, 1996.

- About 704,910 gallons of total fluids (groundwater and free product) have been removed from recovery well RW-1 since October 1, 1996.

- Free product thickness have fluctuated since October 1996 but have generally declined to the present thicknesses of 3.86 feet and 2.53 feet in MW-1 and MW-7, respectively.

- Monitoring wells within the hydrocarbon plume (MW-1, MW-6 and MW-7) have elevated groundwater temperatures (approximately 20°F to 25°F above background groundwater temperatures of about 70°F).

The following recommendations are suggested for the remediation system and monitoring operations at the Lea Refinery.

- Continue groundwater recovery operations since the present system has been effective in recovering free product and dissolved hydrocarbons (about 704,910 gallons of total fluids) from RW-1.

- Continue air sparge and vapor extraction operations since the present system has been effective in recovering an estimated 17,888 kilograms (8,100 lb.) of total volatile hydrocarbons.

- Continue the sampling and monitoring program on a quarterly basis. The next sampling event is scheduled during the first quarter of 1998.

- Since the groundwater is not adversely impacted with inorganic constituents, as reported throughout the previous two years, analysis of dissolved metals and major ions is an unnecessary expense. Further analysis of the WQCC metals and major ions should be discontinued with the exception of manganese, chloride, sulfate, nitrate, fluoride and TDS.

2.0 Chronology of Events

August 1995	Navajo discovered a pipe leak at a sewer junction box near the API separator system.
September 1995	Navajo initiated an investigation to determine the horizontal and vertical extent of the hydrocarbon release from the sewer junction box. The investigation included the installation and sampling of nine soil borings (B-1 through B-9) and seven monitoring wells (MW-1 through MW-7).
October 25, 1995	Navajo retained Geoscience Consultants Ltd (GCL) to design, install and maintain a remediation system at the Lea Refinery.
December 12, 1995	GCL submitted the remediation work plan to Navajo. The work plan addressed the remediation and additional investigation plans for the hydrocarbon-impacted groundwater at the Lea Refinery.
December 14, 1995	Navajo submitted the remediation work plan to the OCD.
February 9, 1996	Navajo submitted the revised remediation work plan to the OCD.
March 18, 1996	The OCD approved the remediation work plan for Lea Refinery.
April 1996	GCL installed a groundwater recovery well (RW-1), eight air sparge/vapor extraction wells (AS-1 through AS-8), and three additional monitoring wells (MW-8, MW-9, and MW-10).
April 23, 1996	GCL conducted the second quarter 1996 sampling event at Lea Refinery.
October 1, 1996	GCL completed the installation of the remediation system at the Lea Refinery and the system began operation.
October 11, 1996	GCL submitted the *Soil and Groundwater Investigation and Remediation Work Plan* to the OCD.
November 19, 1996	GCL conducted the fourth quarter 1996 sampling event at Lea Refinery.
November 21, 1996	The OCD approved the remediation work plan.
January 20, 1997	GCL conducted the first quarter 1997 sampling event at Lea Refinery.
April 16, 1997	BDM International, Inc. (formerly GCL) conducted the second quarter 1997 sampling event at Lea Refinery.
August 14, 1997	BDM conducted the third quarter 1997 sampling event at Lea Refinery.
October 28, 1997	BDM conducted the fourth quarter 1997 sampling event at Lea Refinery.

3.0 Procedures

In accordance with the remediation work plan and the OCD letter dated November 21, 1996, the following sampling frequency and remediation schedule was followed to document the groundwater quality conditions and remediation system performance:

Monthly

- Vapor extraction sample for benzene, toluene, ethylbenzene, and xylenes (BTEX) analysis (EPA Method 8020) and total volatile hydrocarbon (TVHC) analysis (EPA Method 8015-gas range)
- Air injection rates/volumes
- Vapor extraction rates/volumes
- Groundwater/free product recovery rates
- Free product thickness

Quarterly

- Groundwater samples from MW-3, MW-6, MW-8, MW-9, and MW-10 for BTEX analysis
- Dissolved oxygen for selected monitoring wells
- Depth to groundwater in all monitoring wells
- Free product thickness
- Groundwater/free product recovery rates
- Vapor extraction sample for BTEX and TPH analysis
- Air injection rates/volumes
- Vapor extraction rates/volumes

Annually

- Groundwater samples from MW-2, MW-3, MW-4, MW-5, MW-6, MW-8, MW-9, and MW-10 for BTEX, metals and major ions analyses
- Dissolved oxygen for selected monitoring wells
- Depth to groundwater in all monitoring wells
- Free product thickness
- Groundwater/free product recovery rates
- Vapor extraction sample for BTEX and TPH analysis
- Air injection rates/volumes
- Vapor extraction rates/volumes

Prior to sampling, the on-site monitoring wells (MW-1 through MW-10) were gauged for depth to groundwater using a Keck Model KIR-96 oil/water interface probe.

Immediately prior to collecting groundwater samples, each monitoring well was purged of a minimum of three well casing volumes. During the first and third quarter sampling events, the monitoring wells were purged using a decontaminated 2-inch diameter submersible pump (Grundfos Redi-Flo2). The monitoring wells were purged during the second and fourth quarter sampling event using clean, decontaminated PVC bailers. A summary of purging and sampling methods is provided in Table 1 below. Groundwater samples were obtained using a new, decontaminated, disposable bailer for each well after purging. Groundwater

parameters, including pH, conductivity, temperature, and dissolved oxygen (DO) were measured using a Hydac Model 910 pH/conductivity meter and a YSI Model 51B DO meter.

The first set of water samples were transferred into air-tight, septum-sealed, 40-ml glass VOA sample vials with zero head space for analysis of benzene, toluene, ethylbenzene, and xylenes (BTEX) using EPA Method 8020. A duplicate sample of MW-9 was collected during first, second, and fourth quarter sampling events for BTEX analysis. During the annual sampling event on August 14, 1997, a second and third set of water samples were transferred into appropriately preserved containers for analysis of major ions and WQCC metals. During the fourth quarter sampling event, a sample was collected from MW-9 to verify the major ion analytical results obtained during the previous third quarter sampling event. Chain-of-custody (COC) forms documenting sample identification numbers, collection times, and delivery times to the laboratories were completed for each set of samples. The water samples were placed in an ice-filled cooler immediately after collection and shipped to Trace Analysis, Inc. of Lubbock, Texas for laboratory analysis.

Table 1

Summary of Purging and Sampling Methods

Monitoring Well No.	Sample Date	Sample Event	Purge Method	Purge Volume (gallons)	Sampling Method	Groundwater Analytes
MW-2	8/14/97	3rd Quarter (Annual)	Pump	22	Disposable bailer	BTEX, WQCC Metals, Major ions
MW-3	1/20/97	1st Quarter	Pump	15	Disposable bailer	BTEX
	4/16/97	2nd Quarter	Bailer	8	Disposable bailer	BTEX
	8/14/97	3rd Quarter (Annual)	Pump	25	Disposable bailer	BTEX, WQCC metals, Major ions
	10/28/97	4th Quarter	Bailer	9	Disposable bailer	BTEX
MW-4	8/14/97	3rd Quarter (Annual)	Pump	10	Disposable bailer	BTEX, WQCC Metals, Major ions
MW-5	8/14/97	3rd Quarter (Annual)	Pump	27	Disposable bailer	BTEX, WQCC Metals, Major ions
MW-6	1/20/97	1st Quarter	Pump	15	Disposable bailer	BTEX
	4/16/97	2nd Quarter	Bailer	9	Disposable bailer	BTEX
	8/14/97	3rd Quarter (Annual)	Pump	16	Disposable bailer	BTEX, WQCC metals, Major ions
	10/28/97	4th Quarter	Bailer	9	Disposable bailer	BTEX
MW-8	1/20/97	1st Quarter	Pump	15	Disposable bailer	BTEX
	4/16/97	2nd Quarter	Bailer	8	Disposable bailer	BTEX
	8/14/97	3rd Quarter (Annual)	Pump	15	Disposable bailer	BTEX, WQCC metals, Major ions
	10/28/97	4th Quarter	Bailer	9	Disposable bailer	BTEX
MW-9	1/20/97	1st Quarter	Pump	15	Disposable bailer	BTEX
	4/16/97	2nd Quarter	Bailer	9	Disposable bailer	BTEX
	8/14/97	3rd Quarter (Annual)	Pump	20	Disposable bailer	BTEX, WQCC metals, Major ions
	10/28/97	4th Quarter	Bailer	9	Disposable bailer	BTEX
MW-10	1/20/97	1st Quarter	Pump	10	Disposable bailer	BTEX
	4/16/97	2nd Quarter	Bailer	8	Disposable bailer	BTEX
	8/14/97	3rd Quarter (Annual)	Pump	25	Disposable bailer	BTEX, WQCC metals, Major ions
	10/28/97	4th Quarter	Bailer	9	Disposable bailer	BTEX

BTEX - benzene, toluene, ethylbenzene, xylenes

WQCC Metals - Ag, Al, As, B, Ba, Be, Cd, Co, Cu, Cr, Fe, Hg, Pb, Mn, Mo, Ni, Se, U, V, and Zn

Major ions - TDS, Ca, Na, Mg, F, Cl, HCO_3, SO_4, NO_3

Monitoring wells MW-1 and MW-7 not sampled due to presence of free product.

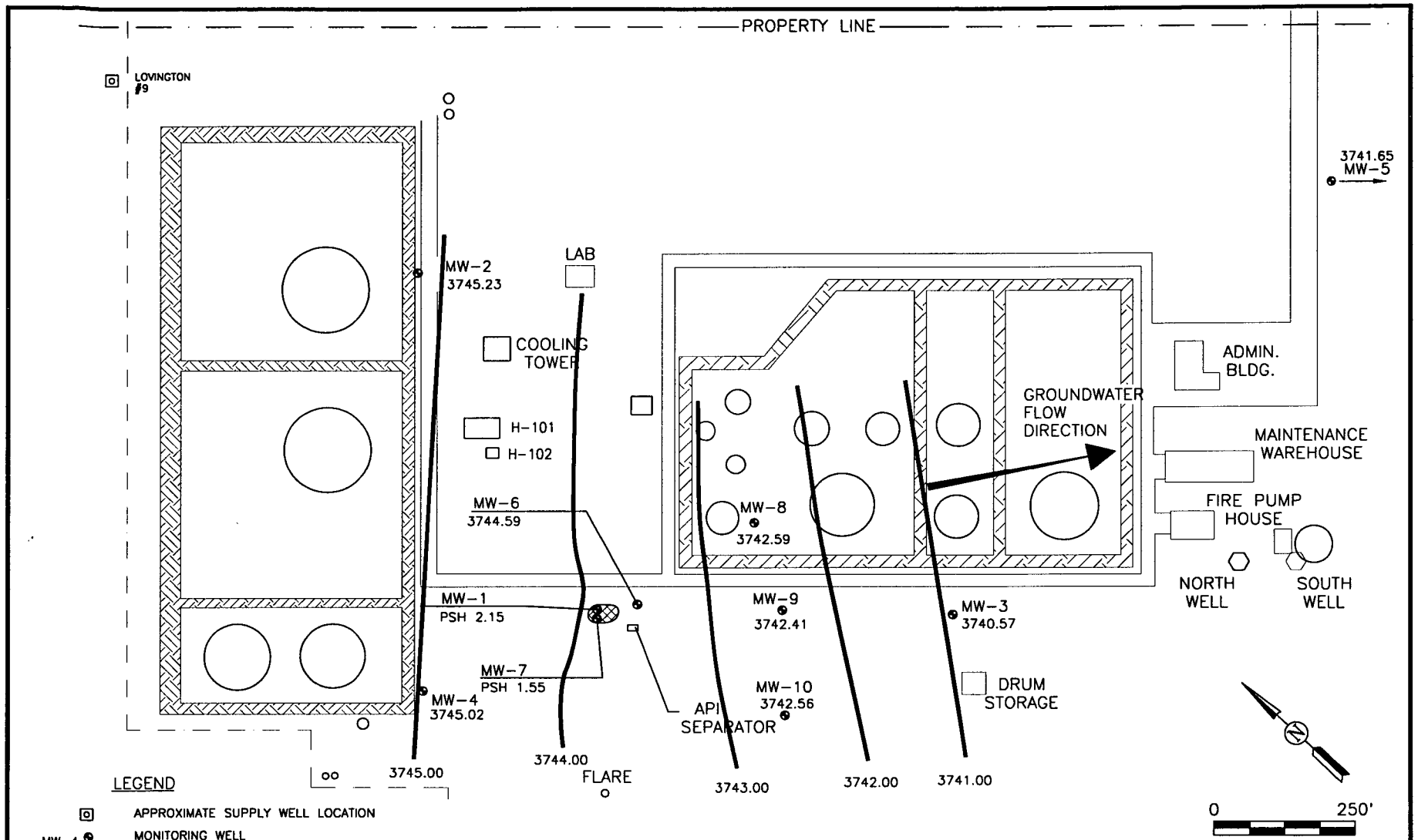
4.0 Groundwater Elevations, Hydraulic Gradient and Flow Direction

Based on the gauging data collected between September 10, 1995 and October 28, 1997 , the groundwater conditions at the Lea Refinery are characterized below.

- The depth to the water table across the site varies from approximately 72 to 97 feet below ground surface
- The hydraulic gradient is approximately 0.004 feet/foot
- The direction of groundwater flow is to the southeast

The direction of groundwater flow and hydraulic gradient have remained consistent for the past two years. Groundwater elevation maps depicting the water table elevation and direction of groundwater flow using the gauging data obtained during the four 1997 sampling events are presented in Figure 1a (February 7, 1997), Figure 1b (April 16, 1997), Figure 1c ((August 14, 1997), and Figure 1d (October 28, 1997). Gauging data for monitoring wells MW-1 and MW-7 were not incorporated into the water table elevation maps due to the presence of free product in these wells.

Figure 2 depicts the changes in groundwater elevations in monitoring wells MW-1 through MW-10 with time. Historical groundwater elevations and depth to water measurements are summarized in Table 2.

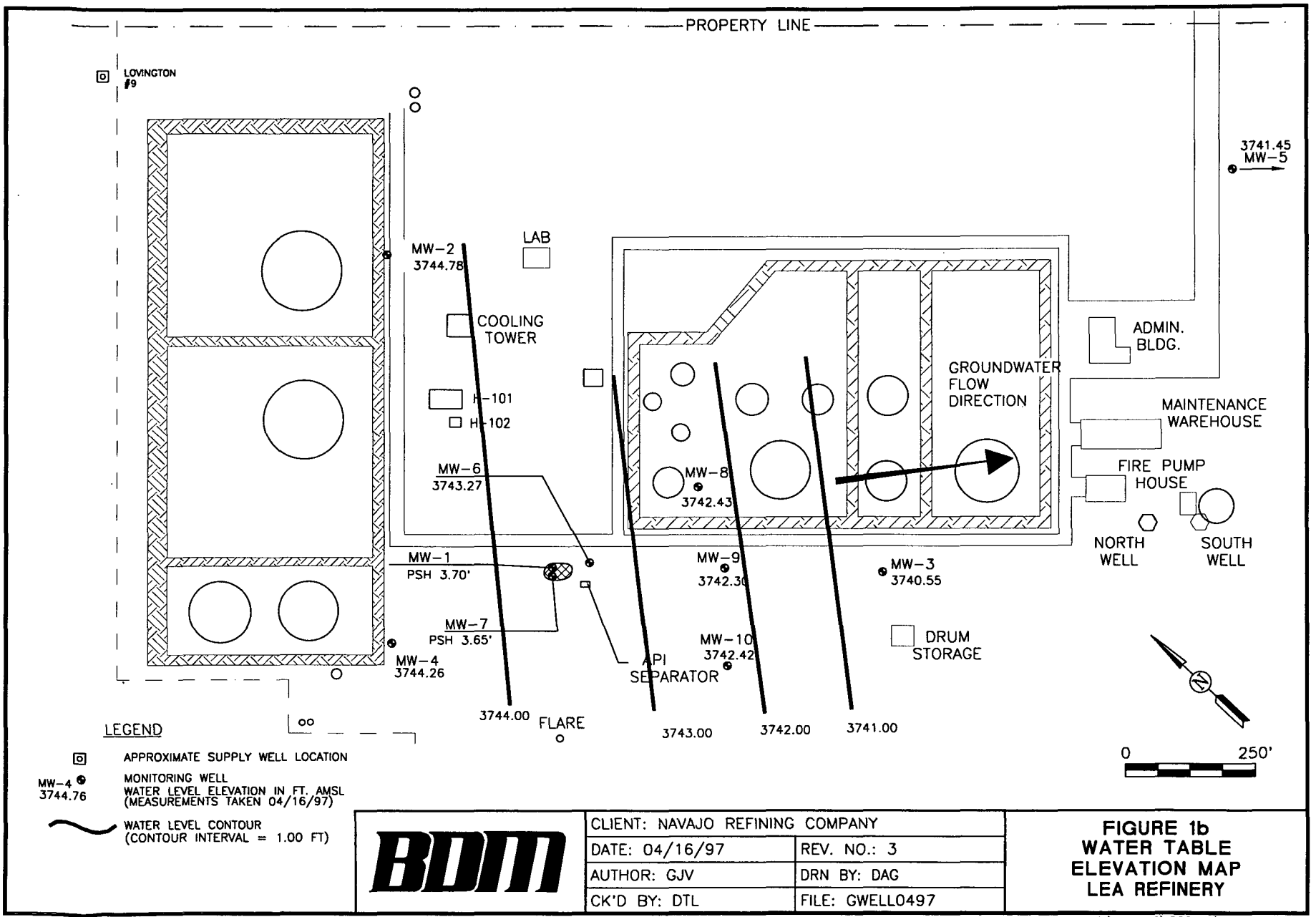


BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 02/07/97	REV. NO.: 3
AUTHOR: GJV	DRN BY: DAG
CK'D BY: DTL	FILE: GWELL0297

FIGURE 1a
WATER TABLE ELEVATION MAP
LEA REFINERY

D:\NAVAJO\RPRT95\GWEL0297

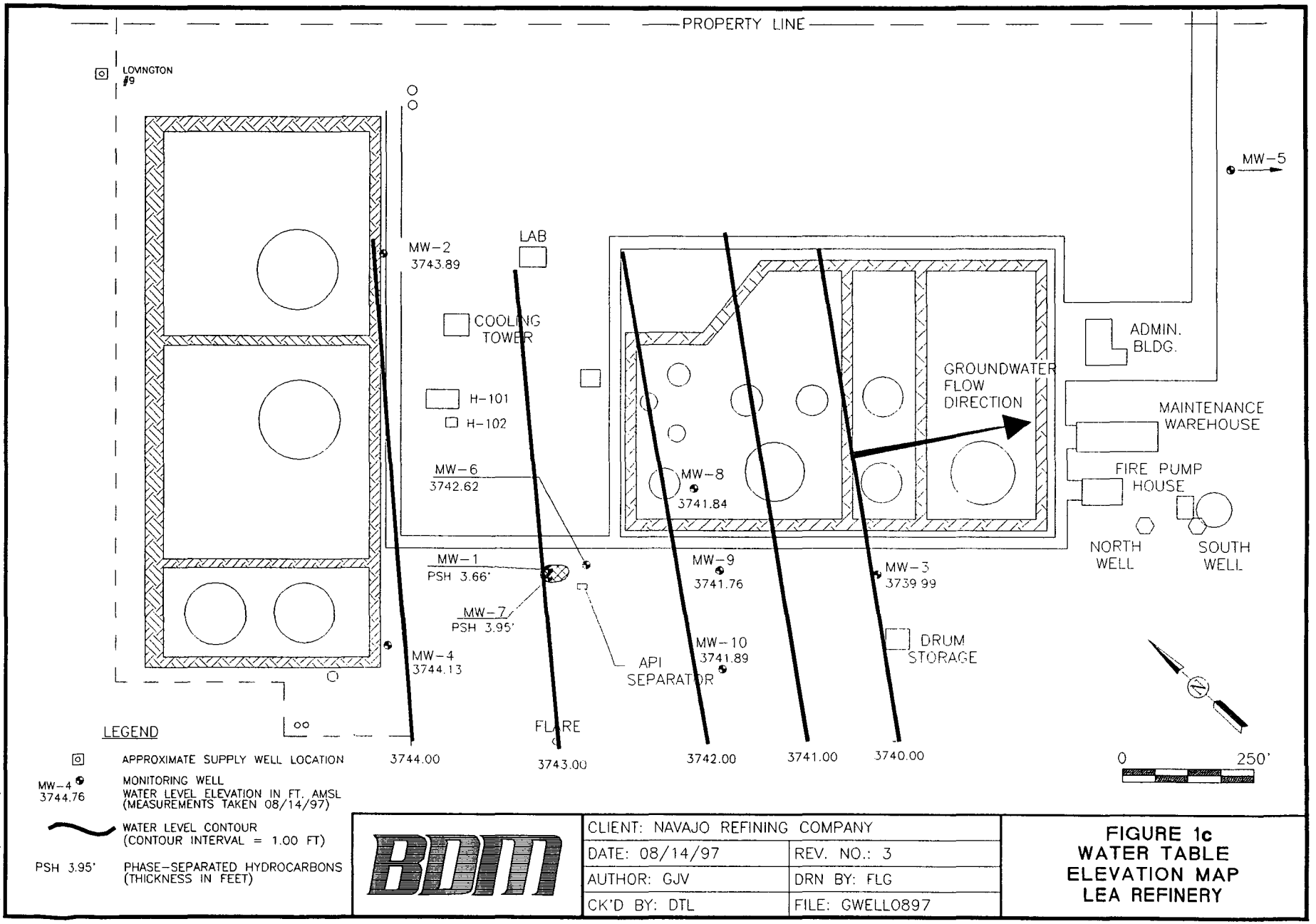


BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 04/16/97	REV. NO.: 3
AUTHOR: GJV	DRN BY: DAG
CK'D BY: DTL	FILE: GWELL0497

FIGURE 1b
WATER TABLE ELEVATION MAP
LEA REFINERY

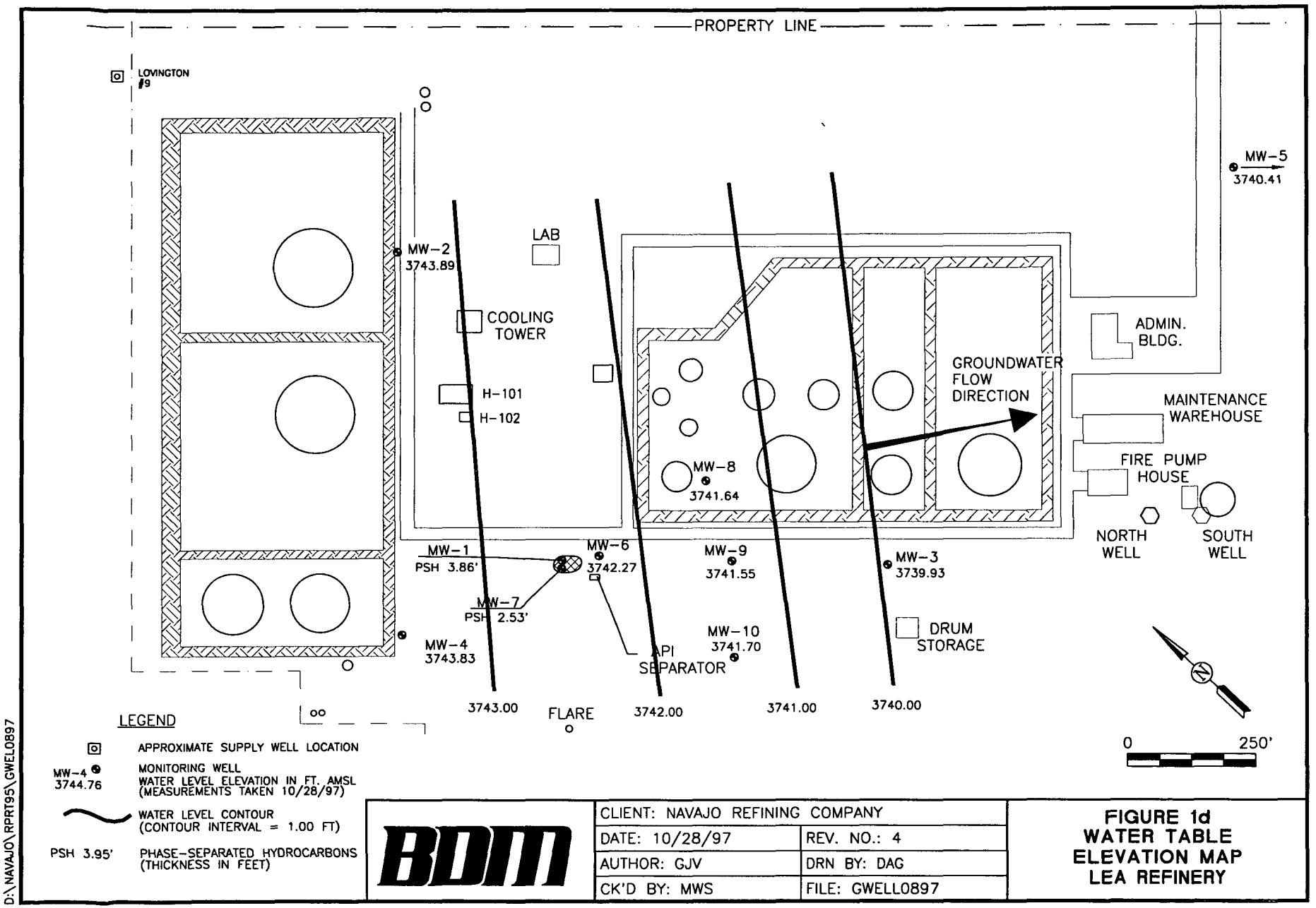
D:\NAVAJO\RPRT95\GWEL0497



D:\NAVAJO\RPRT95\GWELL0897

CLIENT: NAVAJO REFINING COMPANY	
DATE: 08/14/97	REV. NO.: 3
AUTHOR: GJV	DRN BY: FLG
CK'D BY: DTL	FILE: GWELL0897

FIGURE 1c
WATER TABLE ELEVATION MAP
LEA REFINERY



D:\NAVAJO\RPRT95\GWEL0897

BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 10/28/97	REV. NO.: 4
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: GWELL0897

FIGURE 1d
WATER TABLE ELEVATION MAP
LEA REFINERY

FIGURE 2

GROUNDWATER ELEVATION VERSUS TIME

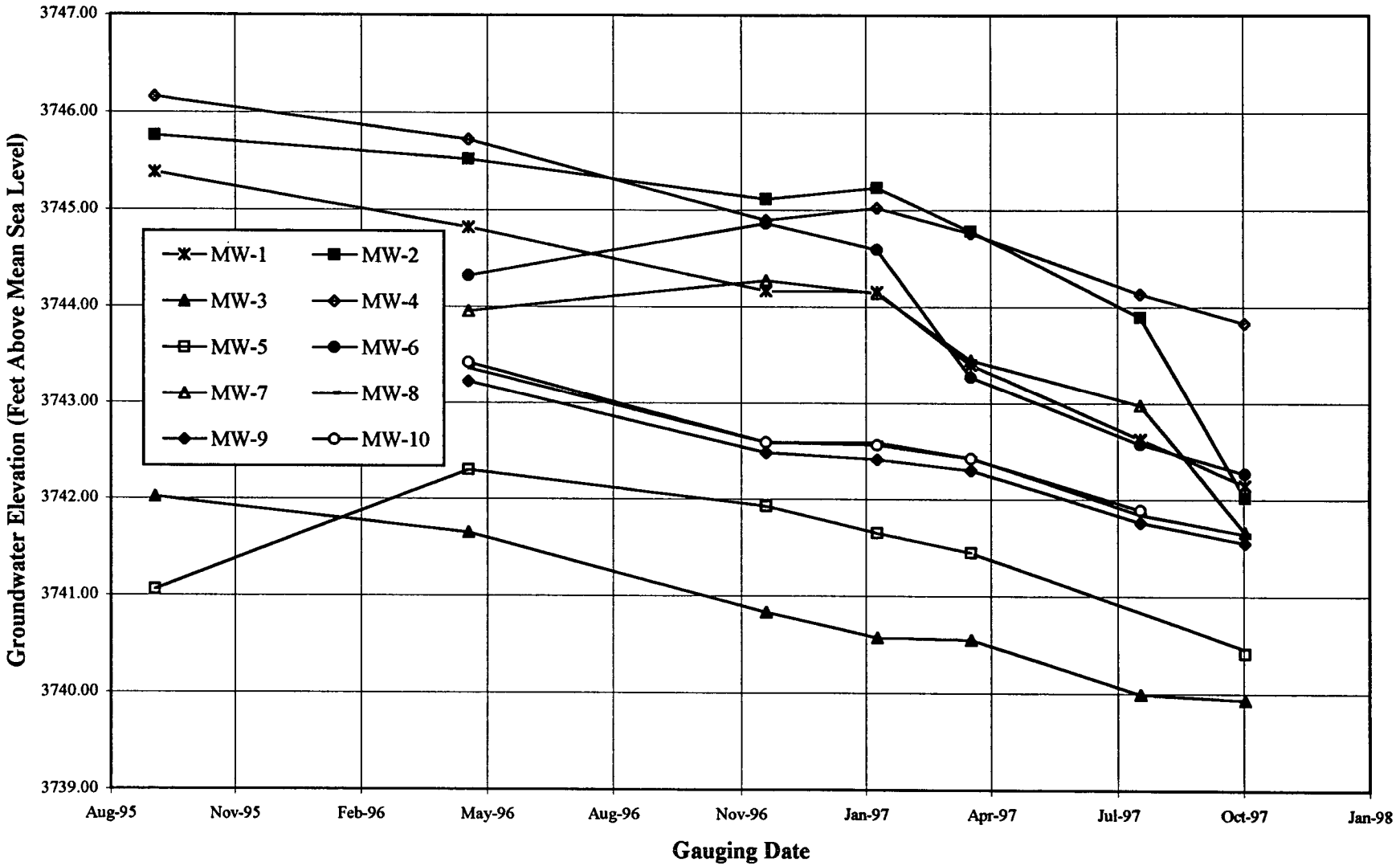


Table 2
Groundwater Elevations
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Gauged	Relative Ground Surface Elevation (feet)	Relative Top of Casing Elevation (feet)*	Depth to Groundwater Below Top of Casing (feet)	Relative Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-1	9/10/95	3835.90	3835.67	95.89	3745.38	6.44
	4/22/96	3835.90	3835.67	96.49	3744.82	6.48
	11/19/96	3835.90	3835.67	93.57	3744.16	2.37
	2/7/97	3835.90	3835.67	93.39	3744.15	2.15
	4/16/97	3835.90	3835.67	95.49	3743.40	3.70
	8/14/97	3835.90	3835.67	96.23	3742.62	3.66
	10/28/97	3835.90	3835.67	96.88	3742.15	3.86
MW-2	9/10/95	3835.14	3834.94	89.18	3745.76	0.00
	4/22/96	3835.14	3834.94	89.42	3745.52	0.00
	11/19/96	3835.14	3834.94	89.83	3745.11	0.00
	2/7/97	3835.14	3834.94	89.71	3745.23	0.00
	4/16/97	3835.14	3834.94	90.16	3744.78	0.00
	8/14/97	3835.14	3834.94	91.05	3743.89	0.00
	10/28/97	3835.14	3834.94	91.05	3743.89	0.00
MW-3	9/10/95	3829.83	3829.55	87.53	3742.02	0.00
	4/22/96	3829.83	3829.55	87.90	3741.65	0.00
	11/19/96	3829.83	3829.55	88.72	3740.83	0.00
	2/7/97	3829.83	3829.55	88.98	3740.57	0.00
	4/16/97	3829.83	3829.55	89.00	3740.55	0.00
	8/14/97	3829.83	3829.55	89.56	3739.99	0.00
	10/28/97	3829.83	3829.55	89.62	3739.93	0.00
MW-4	9/10/95	3837.85	3837.56	91.40	3746.16	0.00
	4/22/96	3837.85	3837.56	91.84	3745.72	0.00
	11/19/96	3837.85	3837.56	92.67	3744.89	0.00
	2/7/97	3837.85	3837.56	92.54	3745.02	0.00
	4/16/97	3837.85	3837.56	92.80	3744.76	0.00
	8/14/97	3837.85	3837.56	93.43	3744.13	0.00
	10/28/97	3837.85	3837.56	93.73	3743.83	0.00
MW-5	9/10/95	3813.87	3816.88	75.82	3741.06	0.00
	4/22/96	3813.87	3816.88	74.58	3742.30	0.00
	11/19/96	3813.87	3816.88	74.95	3741.93	0.00
	2/7/97	3813.87	3816.88	75.23	3741.65	0.00
	4/16/97	3813.87	3816.88	75.43	3741.45	0.00
	10/28/97	3813.87	3816.88	76.47	3740.41	0.00

Monitoring wells MW-1 through MW-7 were installed in September 1995.

Monitoring wells MW-8, MW-9 and MW-10 were installed in March and April 1996.

* Elevations surveyed by John W. West Engineering Company of Hobbs, New Mexico. The top of the monitoring well casings were marked on the north side to provide consistent reference points for future gauging operations.

** Groundwater elevations were corrected for product, if present (SG=0.87)

Groundwater flow is to the southeast with a hydraulic gradient of approximately 0.004 feet/foot.

Table 2 (Continued)
Groundwater Elevations
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Gauged	Relative Ground Surface Elevation (feet)	Relative Top of Casing Elevation (feet)*	Depth to Groundwater Below Top of Casing (feet)	Relative Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-6	4/22/96	3835.70	3835.50	91.18	3744.32	0.00
	11/19/96	3835.70	3835.50	90.64	3744.86	0.00
	2/7/97	3835.70	3835.50	90.91	3744.59	0.00
	4/16/97	3835.70	3835.50	92.23	3743.27	0.00
	8/1497	3835.70	3835.50	92.93	3742.57	0.00
	10/28/97	3835.70	3835.50	93.23	3742.27	0.00
MW-7	4/22/96	3836.07	3835.84	96.56	3743.95	5.37
	11/19/96	3836.07	3835.84	93.13	3744.27	1.79
	2/7/97	3836.07	3835.84	93.05	3744.14	1.55
	4/16/97	3836.07	3835.84	95.57	3743.45	3.65
	8/14/97	3836.07	3835.84	96.30	3742.98	3.95
	10/28/97	3836.07	3835.84	96.38	3741.66	2.53
MW-8	4/22/96	3834.42	3838.09	94.73	3743.36	0.00
	11/19/96	3834.42	3838.09	95.50	3742.59	0.00
	2/7/97	3834.42	3838.09	95.50	3742.59	0.00
	4/16/97	3834.42	3838.09	95.66	3742.43	0.00
	8/14/97	3834.42	3838.09	96.25	3741.84	0.00
	10/28/97	3834.42	3838.09	96.45	3741.64	0.00
MW-9	4/22/96	3833.06	3832.82	89.60	3743.22	0.00
	11/19/96	3833.06	3832.82	90.34	3742.48	0.00
	2/7/97	3833.06	3832.82	90.41	3742.41	0.00
	4/16/97	3833.06	3832.82	90.52	3742.30	0.00
	8/14/97	3833.06	3832.82	91.06	3741.76	0.00
	10/28/97	3833.06	3832.82	91.27	3741.55	0.00
MW-10	4/22/96	3831.34	3831.10	87.68	3743.42	0.00
	11/19/96	3831.34	3831.10	88.51	3742.59	0.00
	2/7/97	3831.34	3831.10	88.54	3742.56	0.00
	4/16/97	3831.34	3831.10	88.68	3742.42	0.00
	8/14/97	3831.34	3831.10	89.21	3741.89	0.00
	10/28/97	3831.34	3831.10	89.40	3741.70	0.00

Monitoring wells MW-1 through MW-7 were installed in September 1995.
Monitoring wells MW-8, MW-9 and MW-10 were installed in March and April 1996.
* Elevations surveyed by John W. West Engineering Company of Hobbs, New Mexico. The top of the monitoring well casings were marked on the north side to provide consistent reference points for future gauging operations.
** Groundwater elevations were corrected for product, if present (SG=0.87)
Groundwater flow is to the southeast with a hydraulic gradient of approximately 0.004 feet/foot.

5.0 Groundwater Quality Conditions

5.1 Distribution of Hydrocarbons in Groundwater

A historical listing of benzene, toluene, ethylbenzene and xylene (BTEX) concentrations obtained from the on site monitoring wells is summarized in Table 3. Hydrocarbon concentration maps depicting the BTEX concentrations for the four 1997 sampling events are presented in Figure 3a (January 20, 1997), Figure 3b (April 16, 1997), Figure 3c (August 14, 1997), and Figure 3d (October 28, 1997). Figures 4a and 4b depict BTEX concentrations versus time in groundwater from May 1995 to October 28, 1997 for monitoring wells MW-6 and MW-9, respectively.

Based on the analytical data for samples collected by BDM during the four 1997 sampling events, the distribution of hydrocarbons at the Lea Refinery is described below.

- BTEX concentrations in upgradient monitoring wells MW-2 and MW-4 have remained at levels below the laboratory detection limit of 0.001 mg/l and below WQCC standards.
- BTEX concentrations in downgradient wells MW-3, MW-5, MW-8, and MW-10 have also remained at levels below the laboratory detection limit of 0.001 mg/l and below WQCC standards.
- The benzene concentrations in monitoring well MW-9 continue to exceed the WQCC standard of 0.010 mg/l.
- Benzene concentrations in MW-9 fluctuate over time but have declined from a high of 1.69 mg/l in April 1996 to a concentration of 0.516 mg/l on October 28, 1997. This significant decrease has been attributed to the successful operation of the air sparge/vapor extraction system.
- Monitoring wells MW-1 and MW-7 were not sampled due to the continued presence of free product.

Table 3
BTEX Concentrations In Groundwater
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Sampled	Benzene (mg/l)	Toluene (mg/l)	Ethylbenzene (mg/l)	Xylenes (mg/l)
MW-2	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
MW-3	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
	1/20/97	< 0.001	< 0.001	< 0.001	< 0.001
	4/16/97	< 0.001	< 0.001	< 0.001	< 0.001
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
MW-4	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
MW-5	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
MW-6	9/10/95	**1.741**	0.021	**0.962**	**0.972**
	4/23/96	**1.150**	< 0.001	0.599	0.462
	11/19/96	0.002	< 0.001	0.011	0.002
	1/20/97	0.004	< 0.001	0.003	0.007
	4/16/97	<0.001	< 0.001	< 0.001	<0.001
	8/14/97	<0.001	< 0.001	< 0.001	<0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
MW-8	4/23/96	0.002	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
	1/20/97	< 0.001	< 0.001	< 0.001	< 0.001
	4/16/97	< 0.001	< 0.001	< 0.001	< 0.001
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
MW-9	4/23/96	**1.690**	< 0.010	< 0.010	0.019
	11/19/96	**0.679**	< 0.005	< 0.005	< 0.005
	1/20/97	**0.340**	< 0.001	0.002	0.003
	4/16/97	**0.347**	<0.002	<0.002	0.007
	8/14/97	**1.680**	<0.010	<0.010	<0.010
	10/28/97	**0.516**	<0.010	<0.010	<0.010
	10/28/97[2]	**0.474**	<0.010	<0.010	<0.010
MW-10	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
	1/20/97	< 0.001	< 0.001	< 0.001	< 0.001
	4/16/97	< 0.001	< 0.001	< 0.001	< 0.001
	8/14/97	< 0.001	< 0.001	< 0.001	< 0.001
	10/28/97	< 0.001	< 0.001	< 0.001	< 0.001
WQCC Standards (mg/l)		0.010	0.75	0.75	0.62

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) unless specified otherwise.

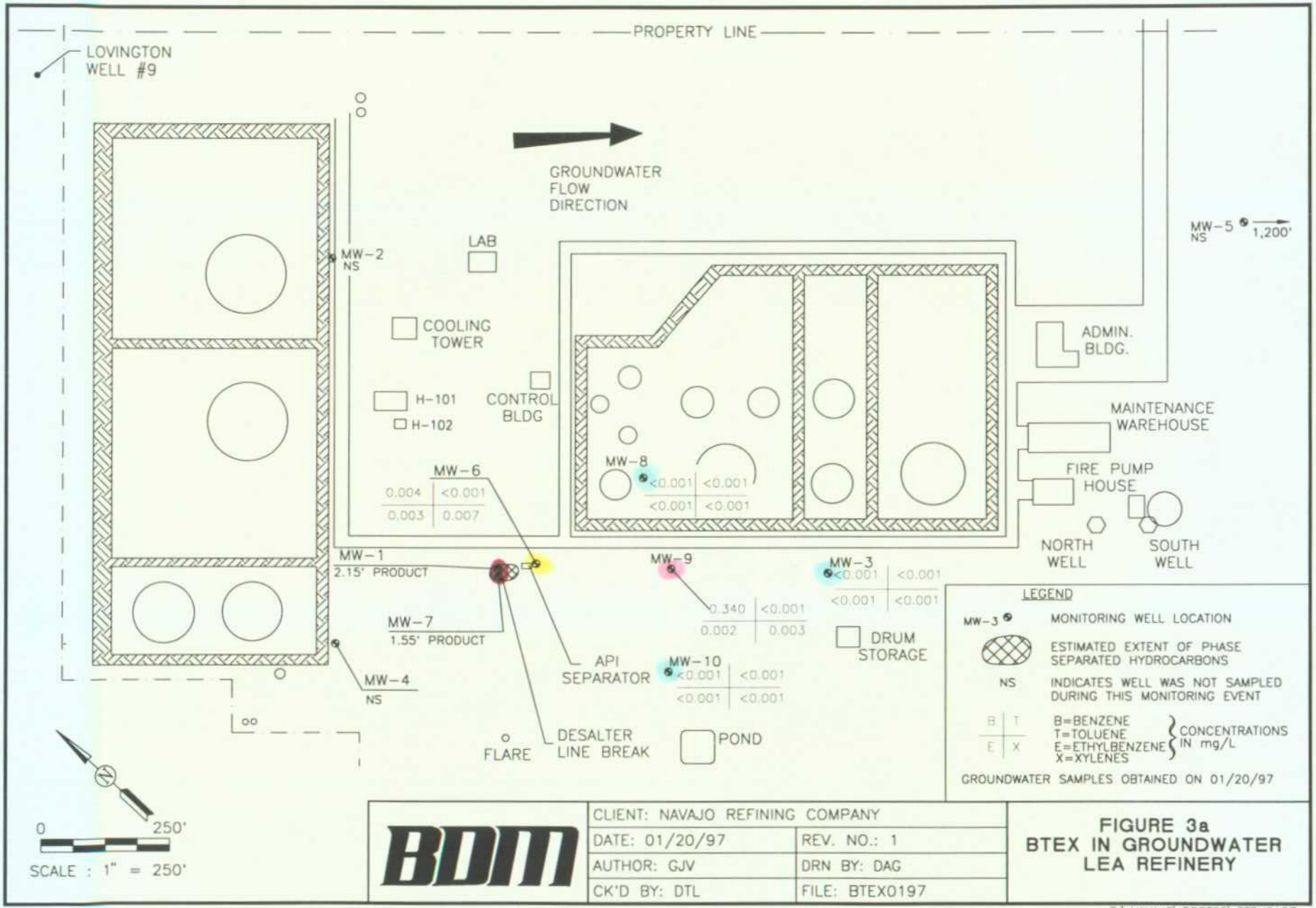
1 Analyses performed by American Environmental Network, In. (Albuquerque, NM).

2 Duplicate analysis

Samples analyzed for BTEX using EPA Method 8020 (9/10/95 and 11/19/96) and 8260 (4/23/96).

New Mexico Water Quality Control Commission (WQCC) standards are listed as specified in Section 3-103.

Monitoring Wells MW-1 and MW-7 not sampled for BTEX due to presence of phase-separated hydrocarbons.

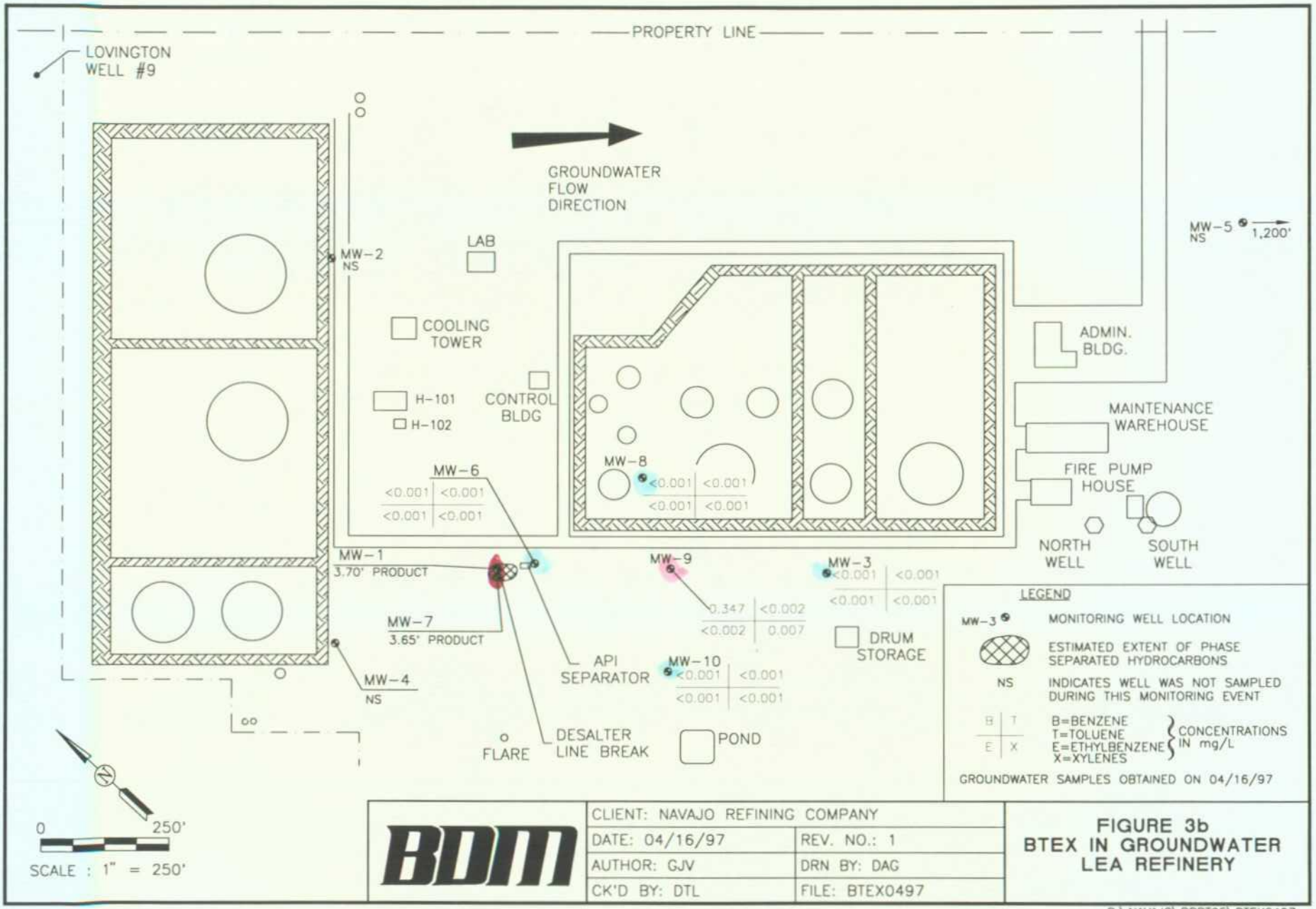


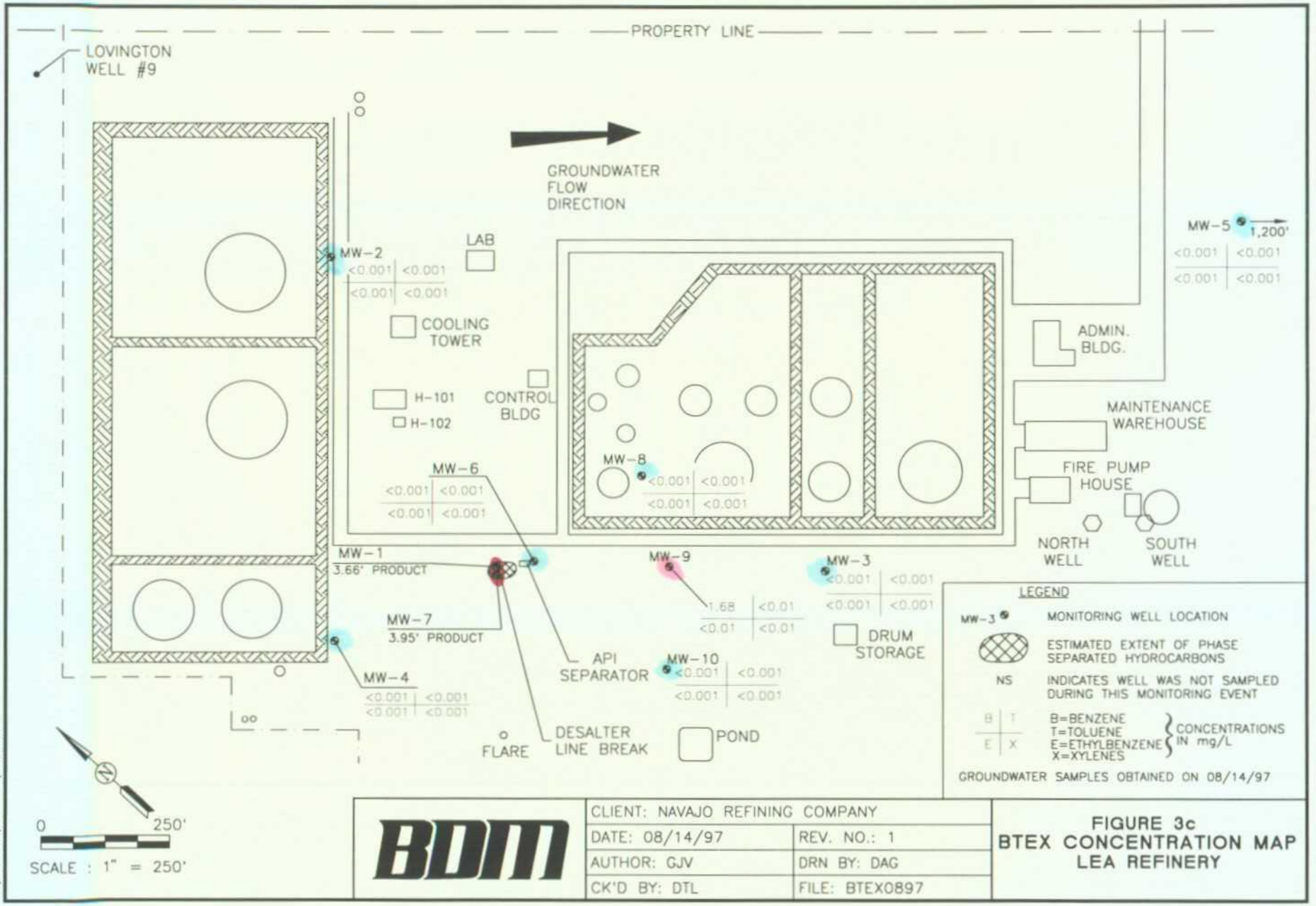
BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 01/20/97	REV. NO.: 1
AUTHOR: GJV	DRN BY: DAG
CK'D BY: DTL	FILE: BTEX0197

FIGURE 3a
BTEX IN GROUNDWATER
LEA REFINERY

D:\NAVAJO\RPRT95\BTEX0197


PROPERTY LINE
LOVINGTON WELL #9
GROUNDWATER FLOW DIRECTION
MW-2 NS
LAB
COOLING TOWER
H-101
H-102
CONTROL BLDG
MW-6 <0.001 <0.001 <0.001 <0.001
MW-8 <0.001 <0.001 <0.001 <0.001
MW-5 NS 1,200'
ADMIN. BLDG.
MAINTENANCE WAREHOUSE
FIRE PUMP HOUSE
NORTH WELL
SOUTH WELL
MW-1 3.70' PRODUCT
MW-9 0.347 <0.002 <0.002 0.007
MW-3 <0.001 <0.001 <0.001 <0.001
MW-7 3.65' PRODUCT
DRUM STORAGE
API SEPARATOR
MW-10 <0.001 <0.001 <0.001 <0.001
MW-4 NS
FLARE
DESALTER LINE BREAK
POND
LEGEND
MW-3 MONITORING WELL LOCATION
ESTIMATED EXTENT OF PHASE SEPARATED HYDROCARBONS
NS INDICATES WELL WAS NOT SAMPLED DURING THIS MONITORING EVENT
B T E X
B=BENZENE
T=TOLUENE
E=ETHYLBENZENE
X=XYLENES
CONCENTRATIONS IN mg/L
GROUNDWATER SAMPLES OBTAINED ON 04/16/97
0 250'
SCALE : 1" = 250'
BDM
CLIENT: NAVAJO REFINING COMPANY
DATE: 04/16/97
REV. NO.: 1
AUTHOR: GJV
DRN BY: DAG
CK'D BY: DTL
FILE: BTEX0497
FIGURE 3b
BTEX IN GROUNDWATER
LEA REFINERY
D:\NAVAJO\RPRT95\BTEX0497

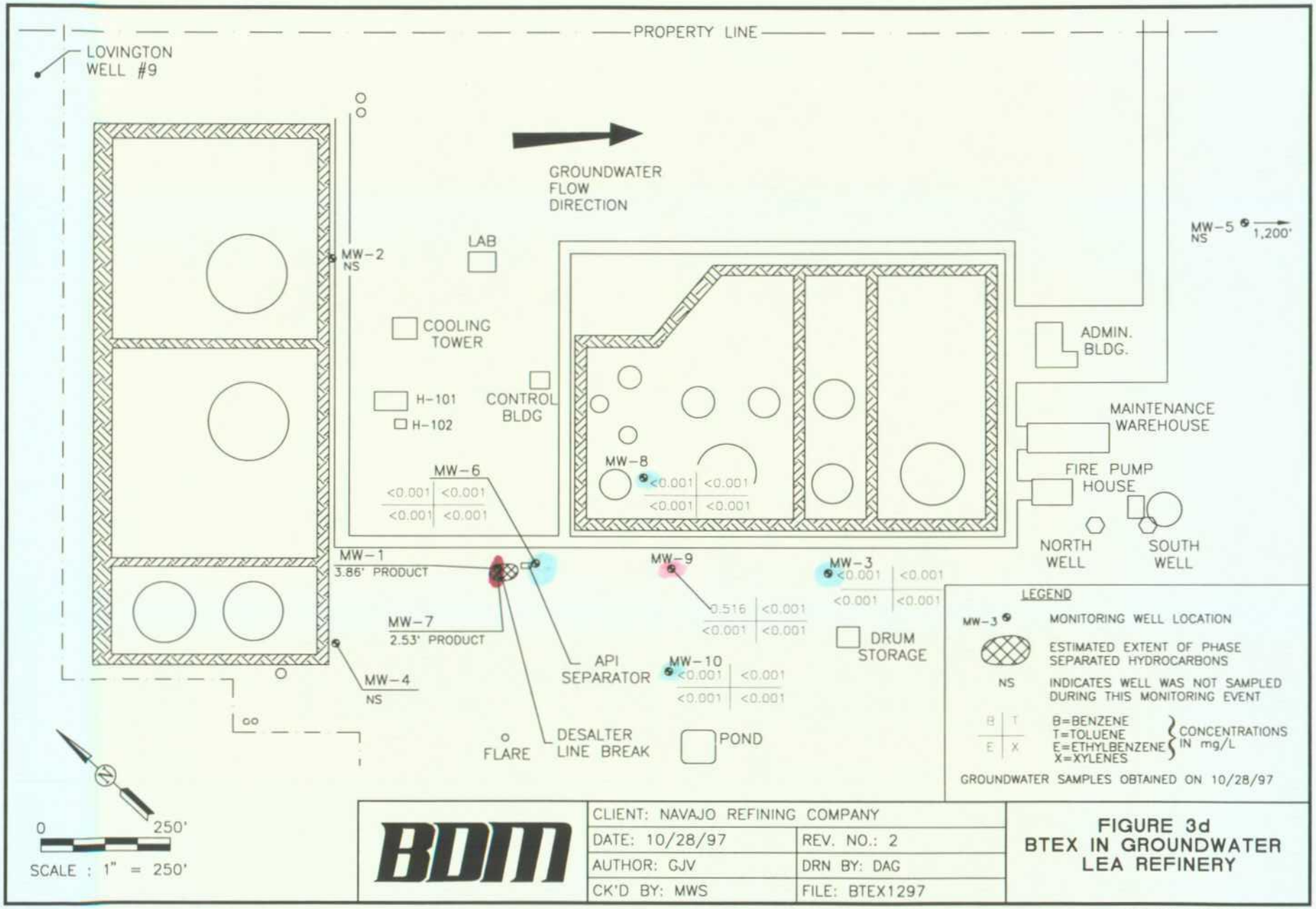


BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 08/14/97	REV. NO.: 1
AUTHOR: GJV	DRN BY: DAG
CK'D BY: DTL	FILE: BTEX0897

FIGURE 3c
BTEX CONCENTRATION MAP
LEA REFINERY

D:\NAVAJO\RPRT95\BTEX0897



BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 10/28/97	REV. NO.: 2
AUTHOR: GJV	DRN BY: DAG
CK'D BY: MWS	FILE: BTEX1297

FIGURE 3d
BTEX IN GROUNDWATER
LEA REFINERY

D:\NAVAJO\RPRT95\BTEX1297

FIGURE 4a

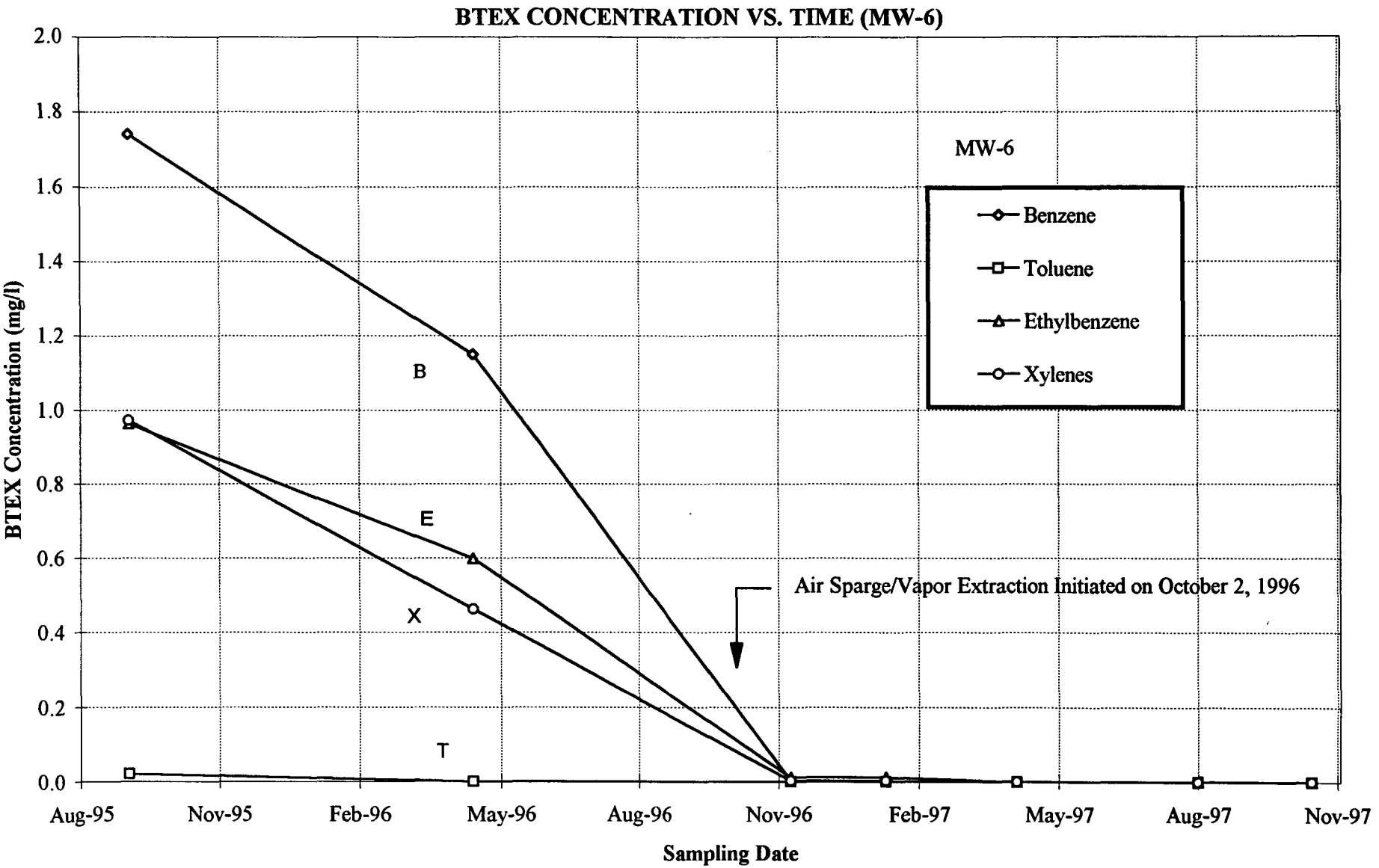
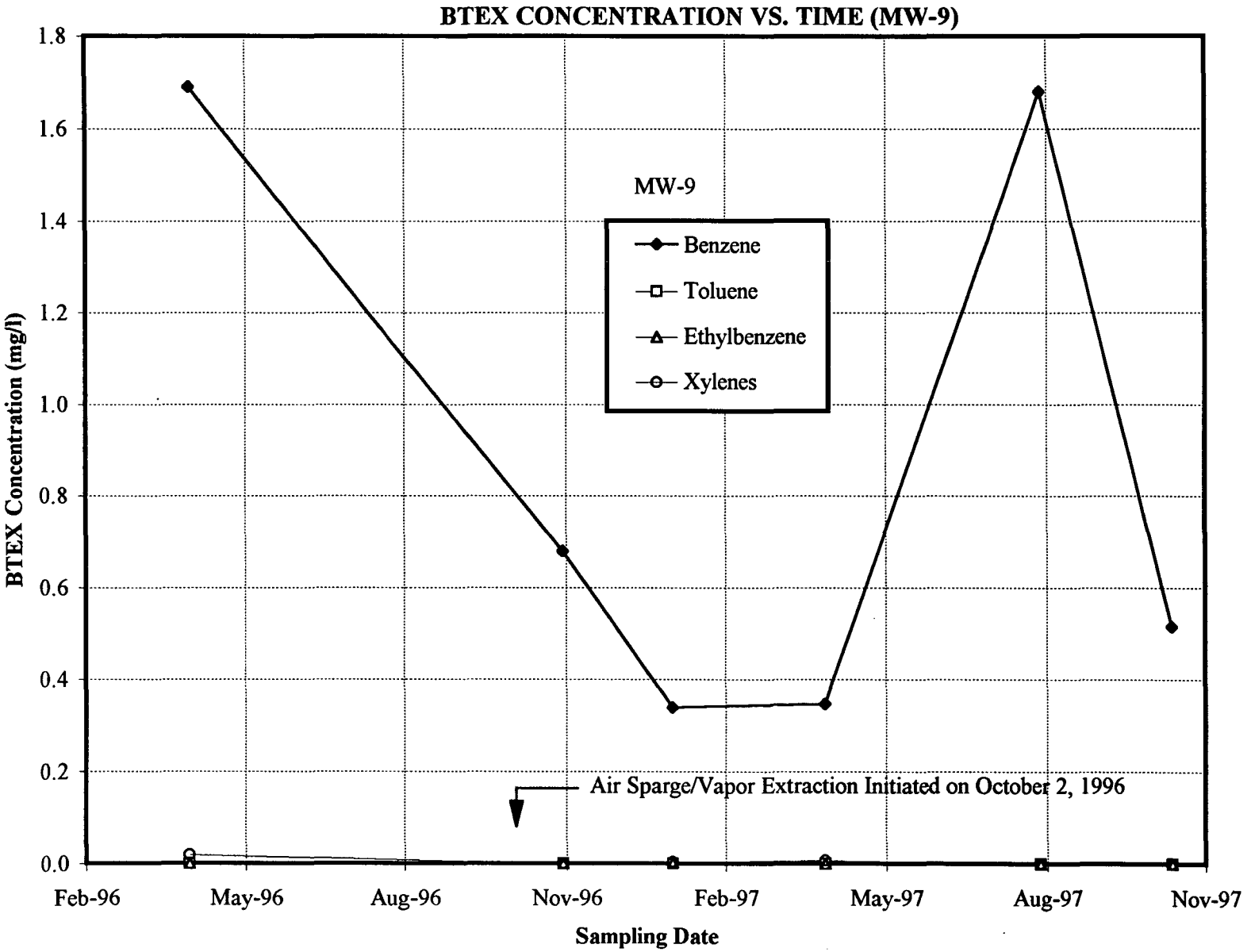

BTEX CONCENTRATION VS. TIME (MW-6)
BTEX Concentration (mg/l)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Aug-95
Nov-95
Feb-96
May-96
Aug-96
Nov-96
Feb-97
May-97
Aug-97
Nov-97
Sampling Date
MW-6
Benzene
Toluene
Ethylbenzene
Xylenes
B
E
X
T
Air Sparge/Vapor Extraction Initiated on October 2, 1996

FIGURE 4b


BTEX CONCENTRATION VS. TIME (MW-9)
BTEX Concentration (mg/l)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
MW-9
Benzene
Toluene
Ethylbenzene
Xylenes
Air Sparge/Vapor Extraction Initiated on October 2, 1996
Feb-96
May-96
Aug-96
Nov-96
Feb-97
May-97
Aug-97
Nov-97
Sampling Date

5.2 Distribution of Dissolved Metals and Major Ions in Groundwater

Historical groundwater sample analytical results for metals and major ions are presented in Tables 4 and 5, respectively. The New Mexico Water Quality Control Commission (WQCC) standards, if established, are also listed in the tables for comparison. Constituents with concentrations above the WQCC standards are highlighted in boldface type. The laboratory reports and COC documentation are included in Appendix A.

Based on the analytical data for samples collected by BDM on August 14, 1997, all monitoring wells at the Lea Refinery had metal and major ion concentrations below WQCC standards with the exception of the following:

- Monitoring wells MW-6 and MW-9 had manganese concentrations of 0.32 mg/l and 0.51 mg/l, respectively which slightly exceeds the WQCC standard of 0.2 mg/l.
- Monitoring well MW-6 had a vanadium concentration of 0.23 mg/l which exceeds the WQCC standard of 0.05 mg/l.
- The WQCC standard for chloride (250 mg/l) was exceeded in MW-5 (250 mg/l), MW-6 (480 mg/l), MW-8 (960 mg/l) and MW-9 (6,500 mg/l). MW-9 was re-sampled on October 28, 1997 and recorded a chloride concentration of 1,200 mg/l which is more consistent with previous determinations.
- The WQCC standard for TDS (1,000 mg/l) was exceeded in MW-5 (1000 mg/l), MW-8 (1,800 mg/l) and MW-9 (2,300 mg/l).
- Monitoring well MW-6 had a fluoride concentration of 3.4 mg/l which exceeds the WQCC standard of 1.6 mg/l.

Since manganese is a common byproduct of aerobic biodegradation of hydrocarbons, its presence in monitoring wells MW-6 and MW-9 indicates beneficial biodegradation activity.

The fluoride concentration of 3.4 mg/l in monitoring well MW-6 is an increase from the April 23, 1996 level of 1.65 mg/l. Fluoride is also present in upgradient monitoring wells (MW-2 and MW-4) and downgradient monitoring wells (MW-3, MW-5, MW-8, MW-9 and MW-10) at levels ranging from 0.5 mg/l to 1.2 mg/l. Since fluoride is not a constituent for the refinery processes on site, its presence is likely due to natural conditions as it is a common natural occurrence in groundwater (1989, USGS Water-Supply Paper 2254, pg. 120-123).

Because certain ion concentrations (calcium, magnesium, sodium, potassium, chloride, sulfate and TDS) were higher than normal in monitoring well MW-9 during the third quarter sampling event, MW-9 was resampled on October 28, 1997, and analyzed to verify if these ion concentrations were back to normal conditions. Indeed, the concentrations for these constituents returned to levels that were more consistent with previous determinations. The cause for the temporary elevation of calcium, magnesium, sodium, potassium, chloride, sulfate and TDS concentrations in MW-9 during the third quarter sampling event is unknown, however it may correlate to the elevated benzene concentration in this monitoring well.

Table 4
Metal Analytical Results
Navajo Refining-Lea Refinery

Constituent	Date Sampled	MW-1 (mg/l	MW-2 (mg/l)	MW-3 (mg/l)	MW-4 (mg/l)	MW-5 (mg/l)	MW-6 (mg/l)	MW-8 (mg/l)	MW-9 (mg/l)	MW-10 (mg/l)	WQCC Standards (mg/l)
Aluminum (Al)	9/8/95	1.2	0.5	1.0	0.5	1.8	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.1	0.27	0.13	0.1	5
	8/14/97	NS	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
Arsenic (As)	9/8/95	**0.5**	**0.3**	<0.2	**0.2**	**0.5**	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.01	<0.01	<0.01	<0.01	0.1
	8/14/97	NS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Barium (Ba)	9/8/95	**2.12**	0.12	0.1	0.11	<0.03	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	0.8	0.2	0.7	<0.2	1
	8/14/97	NS	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	0.8	<0.2	
Berylium (Be)	9/8/95	<0.1	<0.1	<0.1	<0.1	<0.1	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.1	<0.1	<0.1	<0.1	<0.01
	8/14/97	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Boron (B)	9/8/95	0.66	0.25	0.15	0.16	0.26	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	0.21	<0.03	**0.83**	0.11	0.75
	8/14/97	NS	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
Cadmium (Cd)	9/8/95	<0.02	<0.02	<0.02	<0.02	<0.01	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.01	<0.01	<0.01	<0.01	0.01
	8/14/97	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Chromium (Cr)	9/8/95	<0.05	<0.05	<0.05	<0.05	<0.05	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.05	<0.05	<0.05	<0.05	0.05
	8/14/97	NS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Cobalt (Co)	9/8/95	<0.03	<0.03	<0.03	<0.03	<0.03	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.01	<0.01	0.02	<0.01	0.05
	8/14/97	NS	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	
Copper (Cu)	9/8/95	<0.02	0.05	<0.02	0.04	0.05	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.01	<0.01	<0.01	<0.01	1
	8/14/97	NS	0.06	0.02	0.04	0.03	<0.02	0.03	0.02	0.06	
Iron (Fe)	9/8/95	**1.38**	0.16	0.48	0.46	0.32	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	0.29	<0.05	0.11	0.16	1
	8/14/97	NS	0.28	0.24	0.14	0.75	0.76	0.21	0.47	0.38	

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 200.7, 239.2, 270.2, 272.2, 3015, 6010, and 7470.

New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in section 3-103.

NS Indicates samples not analyzed for this constituent.

Monitoring wells MW-1 and MW-7 not analyzed due to presence of phase-separated hydrocarbons.

Values in **boldface** type indicate concentrations exceed WQCC groundwater standards.

GIL_D/2292/NAVJO97.XLS

Table 4 (Continued)
Metal Analytical Results
Navajo Refining-Lea Refinery

Constituent	Date Sampled	MW-1 (mg/l	MW-2 (mg/l)	MW-3 (mg/l)	MW-4 (mg/l)	MW-5 (mg/l)	MW-6 (mg/l)	MW-8 (mg/l)	MW-9 (mg/l)	MW-10 (mg/l)	WQCC Standards (mg/l)
Lead (Pb)	9/8/95	<0.001	<0.001	<0.001	<0.001	<0.001	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	0.05
	8/14/97	NS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Manganese (Mn)	9/8/95	**0.39**	0.07	<0.01	0.04	0.05	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	**1.7**	**0.27**	0.19	0.02	0.2
	8/14/97	NS	<0.01	<0.01	<0.01	<0.01	**0.32**	0.04	**0.51**	<0.01	
Mercury (Hg)	9/8/95	<0.001	<0.001	<0.001	<0.001	<0.001	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.001	<0.001	<0.001	<0.001	0.002
	8/14/97	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Molybdenum (Mo)	9/8/95	0.1	0.2	0.2	0.1	0.3	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.01	0.03	<0.01	<0.01	1
	8/14/97	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Nickel (Ni)	9/8/95	<0.2	<0.2	<0.2	<0.2	<0.2	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	0.04	0.06	0.05	<0.02	0.2
	8/14/97	NS	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	
Selenium (Se)	9/8/95	<0.001	<0.001	0.003	<0.001	0.003	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.001	<0.1	<0.1	<0.1	0.05
	8/14/97	NS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Silver (Ag)	9/8/95	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.01	<0.01	<0.01	<0.01	0.05
	8/14/97	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Uranium (U)	9/8/95	<0.5	<0.5	<0.5	<0.5	<0.5	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.5	<0.5	<0.5	<0.5	5
	8/14/97	NS	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Vanadium (V)	9/8/95	<0.05	<0.05	<0.05	<0.05	<0.05	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	<0.01	0.02	0.02	0.03	0.05
	8/14/97	NS	<0.05	<0.05	<0.05	<0.05	**0.23**	<0.05	<0.05	<0.05	
Zinc (Zn)	9/8/95	0.05	<0.02	0.06	0.05	0.04	NS	NS	NS	NS	
	4/23/96	NS	NS	NS	NS	NS	0.03	0.02	6.1	0.24	10
	8/14/97	NS	0.03	0.05	0.05	0.05	0.04	<0.02	<0.02	<0.02	

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 200.7, 239.2, 270.2, 272.2, 3015, 6010, and 7470.

New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in section 3-103.

NS Indicates samples not analyzed for this constituent.

Monitoring wells MW-1 and MW-7 not analyzed due to presence of phase-separated hydrocarbons.

Values in **boldface** type indicate concentrations exceed WQCC groundwater standards.

GIL_D/2292/NAVJO97.XLS

Table 5
Major Cation and Anion Analytical Results
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Sampled	Total Dissolved Solids (TDS)	Calcium (Ca)	Fluoride (F)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Chloride (Cl)	Nitrate (NO_3-N)	Sulfate (SO_4)
MW-1	9/8/95	**1275**	NS	1.2	NS	NS	NS	349	**509**	<0.15	<5
MW-2	9/8/95	523	133	1.2	16.9	65.7	2.3	283	61	1.65	105
	8/14/97	650	130	1.2	14	52	1.9	210	140	NS	89
MW-3	9/8/95	454	NS	1	NS	NS	NS	223	35	2.54	93
	8/14/97	470	97	0.87	11	37	2.5	220	73	NS	90
MW-4	9/8/95	438	NS	1	NS	NS	NS	254	23	1.19	88
	8/14/97	400	72	1.1	7.4	27	2	170	49	NS	95
MW-5	9/8/95	853	196	0.7	23.6	82.4	3	230	198	1.49	119
	8/14/97	**1000**	200	0.5	18	80	2.8	300	**250**	NS	150
MW-6	4/23/96	**1786**	83	**1.65**	14	501	6.6	319	**798**	<0.1	13
	8/14/97	980	37	**3.4**	5.3	310	3.4	92	**480**	NS	100
MW-8	4/23/96	**1004**	105	1.2	15	171	5.8	OK 420	185	0.2	49
	8/14/97	**1800**	320	0.88	28	230	7.5	460	**960**	NS	120
MW-9	4/23/96	**2658**	226	0.5	44	370	9.1	340	**1190**	<0.1	9
	8/14/97	**2300**	1100	0.8	110	3300	67	230	**6500**	NS	38
	10/28/97	NA	140	NA	14	410	9.4	260	**1200**	<0.01	27
MW-10	4/23/96	443	70	1	9	36	2.5	190	29	0.13	31
	8/14/97	480	77	1.1	7.9	32	1.6	170	42	NS	110
WQCC Standards (mg/l)		1000	NA	1.6	NA	NA	NA	NA	250	10	600

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 160.1, 200.7, 340.2, 375.4, 353.3, 4500 Cl-B,and 310.1.

New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in section 3-103.

NS Indicates samples not analyzed for this constituent.

NA Not applicable (no regulatory standard established).

MW-7 not analyzed due to presence of phase-separated hydrocarbons.

Values in **boldface** type indicate concentrations exceed WQCC groundwater standards.

GIL_D/2292/NAVJO97.XLS

6.0 Remediation System Performance

6.1 Air Sparging/ Vapor Extraction System

The installation of the air sparging/ vapor extraction (AS/VE) system was completed on September 25, 1996. The AS/VE system was started on October 2, 1996 and has remained in continuous operation since that date with a few minor exceptions, such as during periodic maintenance activities, weather related upsets and a plant turnaround in which the remediation system was shut down between September 8, 1997 and October 7, 1997. The AS/VE system has maintained an 86 percent system-on time performance between January 1, 1997 and October 28, 1997. A map showing the layout of the remediation system is illustrated in Figure 5.

To monitor the performance of the AS/VE system, monthly air samples of the VE exhaust were obtained and analyzed for BTEX (EPA Method 8020) and total volatile hydrocarbons (TVHC; EPA Method 8015 gas range). The samples were obtained at the exhaust port in the remediation trailer prior to conveyance into the refinery boiler system. Total BTEX concentrations have decreased from a high of 429 mg/m^3 in February 1997 to 48 mg/m^3 in August 1997. Similarly, TVHC concentrations have decreased from 9,740 mg/m^3 in January 1997 to 2,960 mg/m^3 in August 1997. Based on the analytical results of the VE exhaust and measured flow rates, the system has recovered an estimated 17,888 kilograms (8,100 lb.) of TVHC since the startup of the system on October 2, 1996. The AS/VE system performance data is summarized in Table 6. A graph of TVHC and BTEX versus time is depicted in Figure 6.

Between October 2, 1996 and April 16, 1997, the BTEX concentrations in downgradient monitoring wells MW-6 and MW-9 decreased significantly (Figures 4a and 4b). The reduced BTEX levels in these two wells, which are located within the boundaries of the hydrocarbon plume, is attributed to the successful performance of the air sparge/vapor extraction system. The benzene concentration in MW-6 declined from 1.150 mg/l on April 23, 1996 to less than 0.001 mg/l during the last five quarters. This well is located only 10 feet south of air sparge/vapor extraction well AS-6, therefore the measured reduction in BTEX concentrations are somewhat skewed in this area. Monitoring well MW-9, is located approximately 160 feet downgradient (southeast) from the nearest air sparge/vapor extraction well (AS-1) and has shown an 80 percent decrease in benzene levels from a concentration of 1.69 mg/l on April 23, 1996 to 0.347 mg/l on April 16, 1997. Although, the benzene concentration in MW-9 increased to original levels on the August 14, 1997 sampling event they decreased back to 0.516 mg/l during the latest sampling event on October 28, 1997.

6.2 Total Fluids Recovery

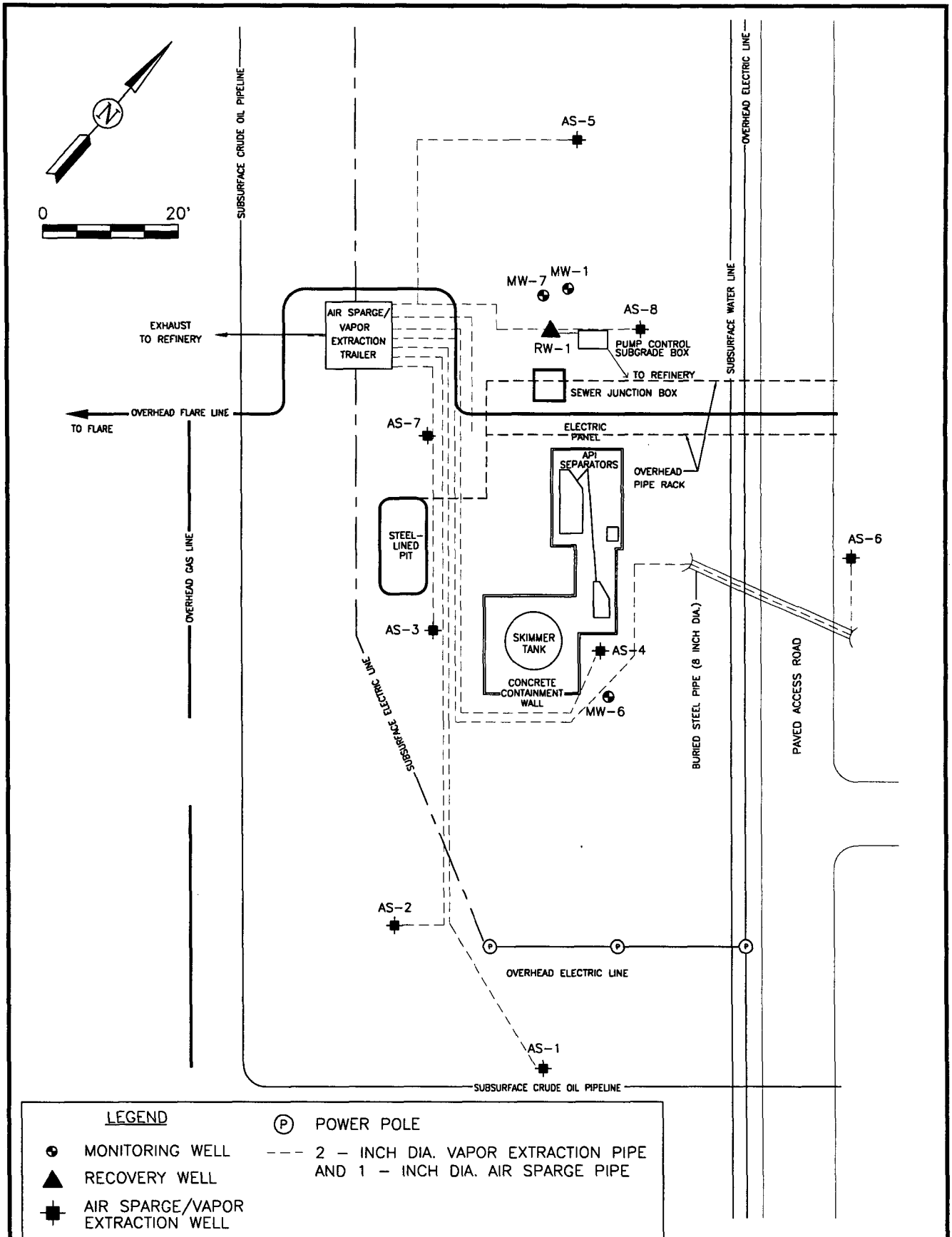
About 704,910 gallons of total fluids (groundwater and free product) have been removed from recovery well RW-1 since October 1, 1996. A summary of the meter readings, cumulative volumes recovered and flow rates is listed in Table 7. The total fluids recovery system has maintained an 87 percent system-on time performance during the period of record (January 1, 1997 through November 25, 1997). The recovery well was shut down between September 13, 1997 and October 7, 1997 during plant turnaround operations. Currently, the recovery system is pumping at an approximate rate of 1.19 gallons per minute (gpm). The submersible pump usually pumps at about 19 gpm for approximately 20 seconds and then shuts off as the fluid level reaches the pump intake. It takes approximately 4 to 5 minutes for the water table near the wellbore to recover before the pump reactivates for another pumping cycle. The total fluids are pumped to

the refinery desalter unit where the free product is recovered by an electrostatic oil/water separation process along with other refinery discharge water. The recovered water then undergoes a steam stripping process prior to be being released into the Lovington publicly owned treatment works (POTW).

Since the total fluids recovery system is not configured to measure the volumes of free product recovered, system performance is evaluated based on the product thickness measured in monitoring wells MW-1 and MW-7. Initial gauging of MW-1 and MW-7 on April 22, 1996 indicated free product thicknesses of 6.48 feet and 5.37 feet, respectively. Free product thickness have fluctuated since October 1996 but have generally declined to the present thicknesses of 3.86 feet and 2.53 feet in MW-1 and MW-7, respectively.

6.3 Groundwater Temperatures

Since April 1996, temperatures have been measured in the on site monitoring wells. A graph of temperature versus time for selected monitoring wells is presented in Figure 7. From this graph it is evident that the monitoring wells within the hydrocarbon plume (MW-1, MW-6 and MW-7) have elevated groundwater temperatures (approximately 20°F to 25°F above background groundwater temperatures of about 70°F). Wells downgradient and upgradient from the plume (MW-2, MW-3, MW-4, MW-8, MW-9 and MW-10) have groundwater temperatures at background levels. The elevated temperatures within the plume has been under investigation and various line integrity tests have been conducted, however the cause has not yet been determined.



BDM

CLIENT: NAVAJO REFINING COMPANY	
DATE: 12/04/97	REV. NO.: 2
AUTHOR: GJV	DRAWN BY: DAG
CK'D BY: MWS	FILE: LEA6.DWG

FIGURE 5
REMEDIATION SYSTEM
LEA REFINERY

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Table 6
Air Sparging/Vapor Extraction System Performance
Navajo Refining Company - Lea Refinery

Date	VE System Flow Rates			VE Exhaust Analytical Results						Hydrocarbon Recovery Performance						
	Vacuum Inches H2O	Flow (ft^3/min)	Flow (m^3/day)	TVHC	B	T	E	X	BTEX	System-On (Days in Period)	TVHC	B	T	E	X	BTEX
				(mg/m^3)							(kg)					
10/2/96	38	173	7061	9,450	107	67	34	45	253	15	1001	11	7	4	5	27
10/17/96	40	170	6919	7,030	56	81	53	89	279	33	1605	13	18	12	20	64
11/19/96	38	173	7061	12,100	74	154	123	184	535	28	2392	15	30	24	36	106
12/20/96	38	173	7061	10,600	53	123	95	136	407	28	2096	10	24	19	27	80
1/20/97	42	166	6777	9,740	34	116	108	136	394	27	1782	6	21	20	25	72
2/19/97	44	163	6635	8,990	41	120	113	155	429	28	1670	8	22	21	29	80
3/20/97	41	168	6848	7,940	29	76	83	125	313	28	1522	6	15	16	24	60
4/18/97	42	166	6777	6,760	26	48	69	78	221	17	779	3	6	8	9	25
5/16/97	24	197	8054	3,080	9	18	26	33	86	27	670	2	4	6	7	19
6/12/97	24	197	8054	3,950	16	22	28	46	112	40	1273	5	7	9	15	36
7/22/97	33	182	7415	7,100	20	43	59	91	213	28	1474	4	9	12	19	44
8/19/97	33	182	7415	2,960	9	12	11	16	48	20	439	1	2	2	2	7
9/8/97	33	182	7415	2,960	9	12	11	16	48	29	637	2	3	2	3	10
10/7/97	21	203	8267	2,960	9	12	11	16	48	0	0	0	0	0	0	0
10/28/97	30	187	7628	3,430	14	13	30	47	104	21	549	2	2	5	8	17
										Total Recovery	17888	88	170	159	229	647

Vacuum readings were obtained at regenerative blower unit (EG&G Model DR707).

Flow rates determined from blower manufacturer's performance curve (corrected for altitude of 3,800 feet above mean sea level).

System shut down between 9/8/97 and 10/7/97 due to plant turnaround and repairs.

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 8015 (TVHC) and 8020 (BTEX).

Samples were collected from the exhaust port in remediation trailer prior to conveyance into refinery boiler system.

FIGURE 6

SOIL VAPOR CONCENTRATIONS VERSUS TIME

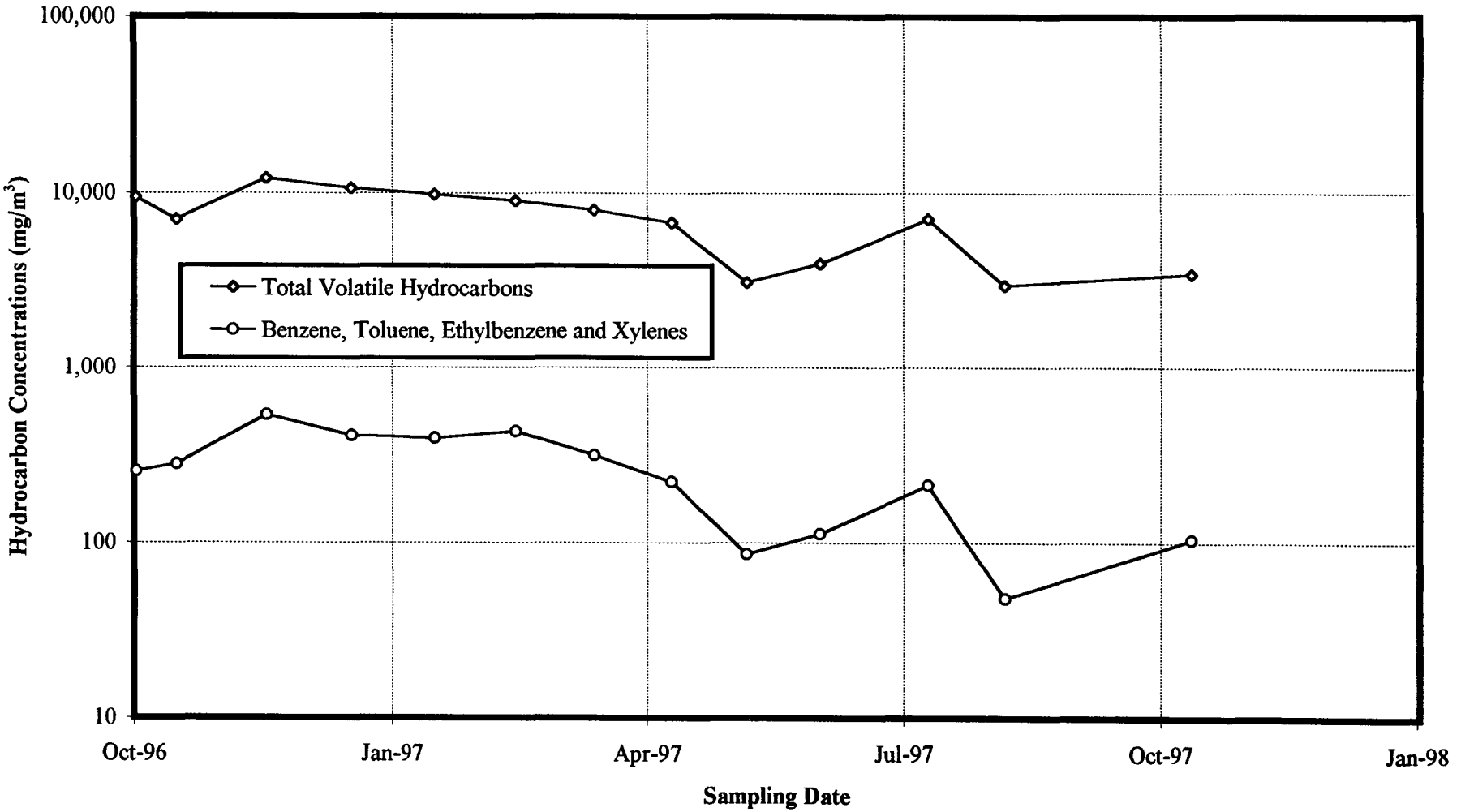


Table 7

Total Fluids Recovery System Performance

Navajo Refining Company - Lea Refinery

Date	Meter Reading (gallons)	Cumulative Volume Recovered (gallons)	Flow Rate (gpm)	System-On Time Percentage**
10/1/96	0	0	0.83	50%
10/2/96	1,200	1,200	0.83	100%
10/17/96	0 / 20,000*	20,000	0.83	95%
11/19/96	37,236	57,236	0.74	100%
12/20/96	72,158	92,158	0.78	100%
12/31/96	89,420	109,420	1.09	95%
1/20/97	119,886	139,886	1.06	100%
2/19/97	166,697	186,697	1.08	100%
3/19/97	219,986	239,986	1.32	100%
4/18/97	276,396	296,396	1.31	100%
5/16/97	321,070	341,070	1.11	64%
6/12/97	371,150	391,150	1.29	81%
7/22/97	456,092	476,092	1.47	100%
8/19/97	511,316	531,316	1.37	100%
9/13/97	558,828	578,828	1.32	100%
10/7/97	0	578,828	0.00	0%
10/28/97	38,988	617,816	1.29	100%
11/25/97	87,094	704,910	1.19	100%

* Old meter (Hayes dial-type) replaced with new meter (EDD electronic turbine-type). Total reading is estimated.

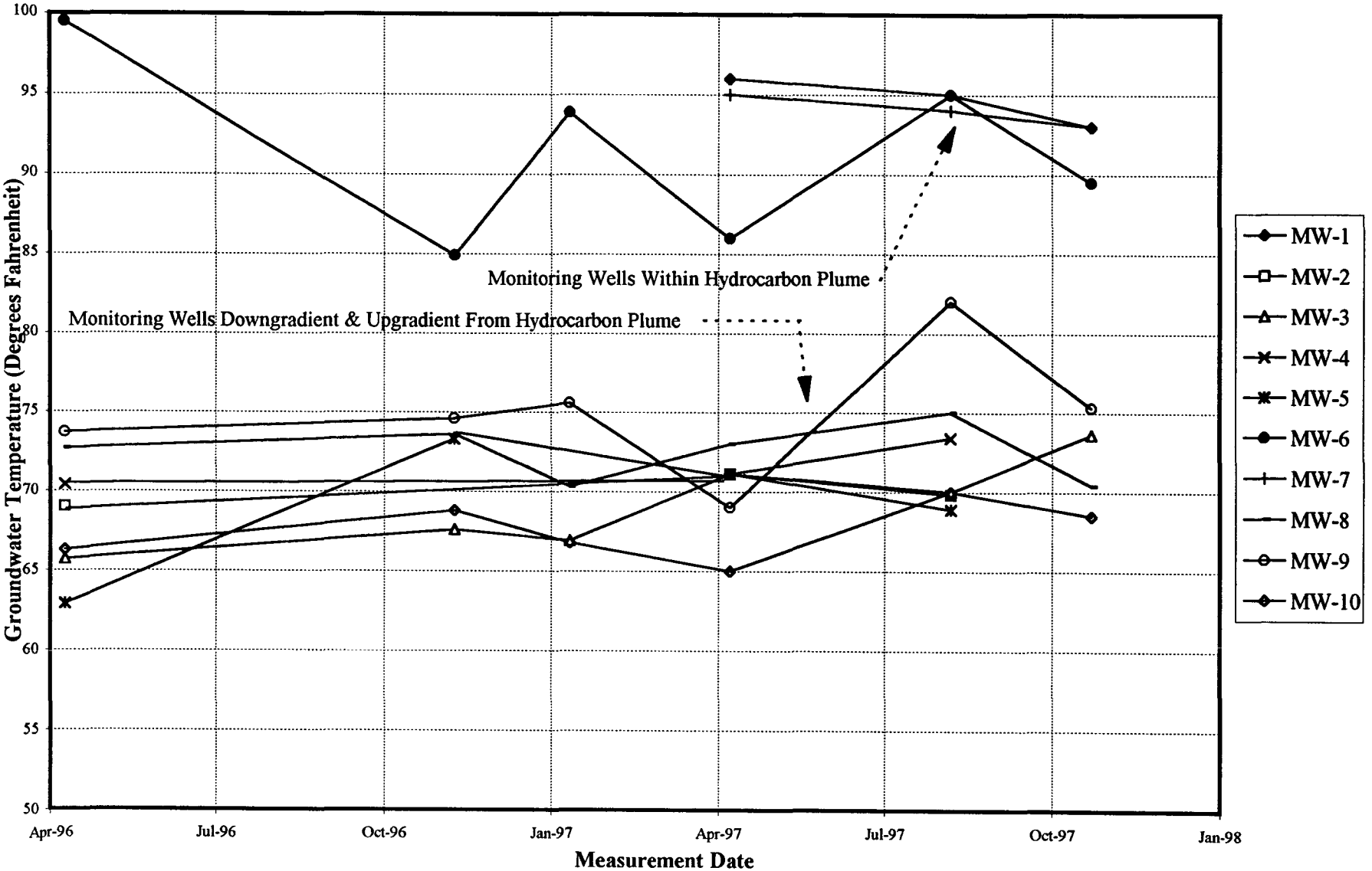
** Percentage of time system was on during period of record.

Pump system was down between May 6-21, 1997 due to lightening damage.

Pump system shut down during plant turnaround (September 13, 1997 - October 7, 1997)

FIGURE 7

GROUNDWATER TEMPERATURES



8.0 Conclusions

Conclusions relevant to groundwater conditions and the remediation performance at the Lea Refinery are presented below.

- BTEX concentrations in upgradient monitoring wells MW-2 and MW-4 and downgradient wells MW-3, MW-5, MW-8, and MW-10, have remained at levels below the laboratory detection limit of 0.001 mg/l and below WQCC standards.

- The benzene concentrations in monitoring well MW-9 continue to exceed the WQCC standard of 0.010 mg/l. Although benzene levels in MW-9 fluctuate over time, they have declined from a high of 1.69 mg/l in April 1996 to a concentration of 0.516 mg/l on October 28, 1997. This significant decrease has been attributed to the successful operation of the air sparge/vapor extraction system.

- Monitoring wells MW-6 and MW-9 had manganese concentrations of 0.32 mg/l and 0.51 mg/l, respectively which slightly exceeds the WQCC standard of 0.2 mg/l.

- Monitoring well MW-6 had a vanadium concentration of 0.23 mg/l which exceeds the WQCC standard of 0.05 mg/l.

- The WQCC standard for chloride (250 mg/l) was exceeded in MW-5 (250 mg/l), MW-6 (480 mg/l), MW-8 (960 mg/l) and MW-9 (6,500 mg/l). MW-9 was re-sampled on October 28, 1997, and recorded a chloride concentration of 1,200 mg/l which is more consistent with previous determinations.

- The WQCC standard for TDS (1,000 mg/l) was exceeded in MW-5 (1000 mg/l), MW-8 (1,800 mg/l) and MW-9 (2,300 mg/l).

- Monitoring well MW-6 had a fluoride concentration of 3.4 mg/l which exceeds the WQCC standard of 1.6 mg/l.

- Based on the analytical results of the VE exhaust and measured flow rates, the VE system has recovered an estimated 17,888 kilograms (8,100 lb.) of total volatile hydrocarbons since the startup of the system on October 2, 1996.

- About 704,910 gallons of total fluids (groundwater and free product) have been removed from recovery well RW-1 since October 1, 1996.

- Free product thickness have fluctuated since October 1996 but have generally declined to the present thicknesses of 3.86 feet and 2.53 feet in MW-1 and MW-7, respectively.

- Monitoring wells within the hydrocarbon plume (MW-1, MW-6 and MW-7) have elevated groundwater temperatures (approximately 20°F to 25°F above background groundwater temperatures of about 70°F).

9.0 Recommendations

The following recommendations are proposed for the remediation system and monitoring operations at the Lea Refinery.

- Continue groundwater recovery operations since the present system has been effective in recovering free product and dissolved hydrocarbons (about 704,910 gallons of total fluids) from RW-1.

- Continue air sparge and vapor extraction operations since the present system has been effective in recovering an estimated 17,888 kilograms (8,100 lb.) of total volatile hydrocarbons.

- Continue the sampling and monitoring program on a quarterly basis. The next sampling event is scheduled during the first quarter of 1998.

- Since the groundwater is not adversely impacted with inorganic constituents, as reported throughout the previous two years, analysis of dissolved metals and major ions is an unnecessary expense. Further analysis of the WQCC metals and major ions should be discontinued with the exception of manganese, chloride, sulfate, nitrate, fluoride and TDS.

APPENDIX A

Laboratory Analytical Reports

and

Chain of Custody Documentation

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM
Attention: Gil VanDeventer
415 West Wall, Suite 1818
Midland, TX 79701

November 03, 1997
Receiving Date: 10/30/97
Sample Type: Air/Gas
Charge Code: P/2292/6C
Project Location: NA
COC# 13159

Prep Date: 01/02/97
Analysis Date: 01/02/97
Sampling Date: 10/28/97
Sample Condition: Intact & Cool
Sample Received by: VW
Project Name: Navajo Lea Refining

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T84263	9710281505 VE Exhaust	3,430	14	13	30	47	104
QC	Quality Contrc	1,110	104	104	103	321	
Reporting Limit		100	1	1	1	1	
RPD		5	3	3	5	4	
% Instrument Accuracy		111	104	104	103	107	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: AG
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich

11-3-97
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM
Attention: Gil Van Deventer
415 West Wall, Suite 1818
Midland, TX 79701

November 21, 1997
Receiving Date: 10/30/97
Sample Type: Water
Charge Code No: P/2292/6C
Project Location: NA
COC# 13159

Prep Date: 11/04/97
Analysis Date: 11/04/97
Sampling Date: 10/28/97
Sample Condition: Intact & Cool
Sample Received by: VW
Project: Navajo Lea Refining

TA#	FIELD CODE	CHLORIDE (mg/L)	SULFATE (mg/L)	N03-N (mg/L)	ALKALINITY (mg/L as CaCo3) HC03	C03
T84261	9710281425 MW-9	1,200	27	<0.01	260	<1.0
QC	Quality Control	23	24	1.3	---	---
RPD		3	3	1	0	0
% Extraction Accuracy		100	102	101	---	---
% Instrument Accuracy		92	94	101	---	---
REPORTING LIMIT		10	10	0.01	1.0	1.0

METHODS: EPA 300.0, 353.3, 310.1.
CHEMIST: CHLORIDE/SULFATE/N03-N: RC ALKALINITY: JS
CHLORIDE SPIKE: 25 mg/L CHLORIDE. CHLORIDE QC: 23 mg/L CH
SULFATE SPIKE: 25 mg/L SULFATE. SULFATE QC: 23 mg/L SULFATE
N03-N SPIKE AND QC: 1.3 mg/L N03-N.

Director, Dr. Blair Leftwich

Date

6701 Aberdeen Avenue
Lubbock, Texas 79424
806•794•1296
FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM INTERNATIONAL
Attention: Gil Van Deventer
415 West Wall, Suite 1818
Midland, TX 79701

November 21, 1997
Receiving Date: 10/30/97
Sample Type: Water
Charge Code No: P/2292/6C
Project Location: NA
COC# 13159

Prep Date: 11/13/97
Analysis Date: 11/13/97
Sampling Date: 10/28/97
Sample Condition: Intact & Cool
Sample Received by: VW
Project Name: Navajo Lea Refining

TA#	FIELD CODE	N03-N (mg/L)
T84257	9710281026 MW-3	0.20
T84258	9710281135 MW-10	1.20
T84259	9710281141 MW-8	0.49
T84260	9710281358 MW-6	4.1
QC	Quality Control	1.3
REPORTING LIMIT		0.01
RPD		1
% Extraction Accuracy		101
% Instrument Accuracy		101

METHOD: EPA 353.3.
CHEMIST: RC
N03-N SPIKE AND QC: 1.3 mg/L N03-N.

Director, Dr. Blair Leftwich

(3)dec 97
DATE

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM
Attention: Gil Van Deventer
415 West Wall, Suite 1818
Midland, TX 79701

November 21, 1997
Receiving Date: 10/30/97
Sample Type: Water
Charge Code No: P/2292/6C
Project Location: NA
COC# 13159

Prep Date: 11/07/97
Analysis Date: 11/12/97
Sampling Date: 10/28/97
Sample Condition: Intact & Cool
Sample Received by: VW
Project Name: Navajo Lea Refining

TA#	Field Code	POTASSIUM (mg/L)	MAGNESIUM (mg/L)	CALCIUM (mg/L)	SODIUM (mg/L)
T84261	9710281425 MW-9	9.4	14	140	410
QC	Quality Control	47	49	49	50
Reporting Limit		0.30	0.01	0.01	0.40
RPD		1	1	0	1
% Extraction Accuracy		87	95	95	105
% Instrument Accuracy		93	97	97	100

METHODS: EPA 200.7.
CHEMIST: RR
SPIKE: 100 mg/L POTASSIUM, MAGNESIUM, CALCIUM, SODIUM.
QC: 50 mg/L POTASSIUM, MAGNESIUM, CALCIUM, SODIUM.

Director, Dr. Blair Leftwich

11/21/97
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM International
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Date: Nov 05, 1997
Date Rec: 10/30/97
Project: N/A
Proj Name: Navajo Lea Refining
Proj Loc: N/A

Lab Receiving # : 9710000500
Sampling Date: 10/28/97
Sample Condition: Intact and Cool
Sample Received By: VW

TA#	Field Code	MATRIX	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
T84257	9710281026 MW-3	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T84258	9710281135 MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T84259	9710281141 MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T84260	9710281358 MW-6	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T84261	9710281425 MW-9	Water	0.516	<0.010	<0.010	<0.010	0.516
T84262	9710281535 MW-11D	Water	0.474	<0.010	<0.010	<0.010	0.474
Method Blank			<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	
QC			0.113	0.114	0.114	0.335	

RPD	1	1	2	1
% Extraction Accuracy	114	114	112	113
% Instrument Accuracy	113	114	114	112

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	10/31/97	EPA 8020	11/2/97	AG	0.100 ea	0.1 ea

11-5-97

Director, Dr. Blair Leftwich

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

Chain of Custody

Date 10-28-97 Page 1 Of 1

Lab Name Trace Analysis Inc
Address 6701 Aberdeen
Lubbock, Tx 79424
Telephone 806-794-1296

Samplers (SIGNATURES) Gil VanDeventer John Fergerson

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 TVHC	TCLP: Vol., Semi-Vol. Herbicides, Pesticides	TCLP: Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide: Total Amenable	Chemical Oxygen Demand (COD)	NO_3	* Major Ions		Number of Containers
9710281026	Water	MW-3		✓			8425	7																	✓			3
9710281135	Water	MW-10		✓				58																	✓			3
9710281141	Water	MW-8		✓				59																	✓			3
9710281358	Water	MW-6		✓				60																	✓			3
9710281425	Water	MW-9		✓				61																	✓	✓		4
9710281535	Water	MW-11D		✓				62																				2
9710281505	Air/Gas	VE Exhaust		✓				63					✓															

* Major Ions

Project Information
Project: Navajo Lea Refinery
Project Director: Gil VanDeventer
Charge Code No.: P/2292/GC
Shipping ID. No.: 155-758-793-3
Via: Greyhound

Sample Receipt
Total No. of Containers
Chain of Custody Seals
Rec'd Good Condition/Cold
Conforms to Record
Lab No.

Special Instructions/Comments: PO # ABQ-97-0054
* Major Ions: Ca, Na, Mg, K, Cl, HCO_3, SO_4

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
John Fergerson (Signature) 1:30 PM (Time)	Helen Shelton (Signature) 6:15PM (Time)	(Signature) (Time)
John Fergerson (Printed Name) 10-29-97 (Date)	HELEN SHELTON (Printed Name) 10/29/97 (Date)	(Printed Name) (Date)
BDM International, Inc. (Company)	Trace Analysis (Company)	(Company)

Received By 1.	Received By 2.	Received By (Laboratory) 3.
Helen Shelton (Signature) (Time)	(Signature) (Time)	(Signature) (Time)
HELEN SHELTON 10-29-97 (Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
TRACE ANALYSIS (Company)	(Company)	(Laboratory)

Distribution: White, Canary-Laboratory • Pink, BDM

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

13159

Chain of Custody

Date 10-28-97 Page 1 Of 1

Lab Name Trace Analysis Inc
Address 6701 Aberdeen
Lubbock, Tx 79424
Telephone 806-794-1296

Samplers (SIGNATURES)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 TVHC	TCLP Vol., Semi-Vol. Herbicides, Pesticides	TCLP Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)	Nitrate	Major Ions		Number of Containers
9710281026	Water	MW-3		✓																				✓				3
1710281135	Water	MW-10		✓																				✓				3
1710281141	Water	MW-8		✓																				✓				3
1710281358	Water	MW-6		✓																				✓				3
1710281425	Water	MW-9		✓																				✓	✓			4
1710281535	Water	MW-11D		✓		[illegible]																						2
9710281505	Water	VE Effluent		✓									✓															

Project Information

Project Navajo Ref. Refinery
Project Director Gil Van Deventer
Charge Code No. P/22-12/66
Shipping ID. No.
Via:

Sample Receipt

Total No. of Containers
Chain of Custody Seals
Rec'd Good Condition/Cold
Conforms to Record
Lab No.

Special Instructions/Comments: PO# A80-97-00054
* Major Ions: Ca, Na, Mg, K, Cl, HCO3, SO4

Relinquished By	1.	Relinquished By	2.	Relinquished By	3.
(Signature)	(Time)	Signature	(Time)	(Signature)	(Time)
(Printed Name)	(Date)	(Printed Name)	(Date)	(Printed Name)	(Date)
(Company)		(Company)		(Company)	

Received By	1.	Received By	2.	Received By (Laboratory)	3.
(Signature)	(Time)	(Signature)	(Time)	(Signature)	(Time)
(Printed Name)	(Date)	(Printed Name)	(Date)	(Printed Name)	(Date)
(Company)		(Company)		(Laboratory)	

Distribution: White, Canary-Laboratory • Pink, BDM

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

Chain of Custody

Date 8-19-97 Page 1 Of 1

Lab Name Pantechs Laboratories, Inc
Address 4917 Homestead Ave.
Lubbock, Tx 79464
Telephone 806-797-4325

Samplers (SIGNATURES)

Gil Van Deventer

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP: Vol., Semi-Vol. Herbicides, Pesticides	TCLP: Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)	C1 - C15 Extended Analysis	O_2), N_2 & CO2	Number of Containers
970819100D	Gas/Air	VE Exhaust																							✓	✓	1

Project Information	Sample Receipt
Project Navajo Ign Refinery	Total No. of Containers
Project Director G. Van Deventer	Chain of Custody Seals
Charge Code No. 2292/2033-005	Rec'd Good Condition/Cold
Shipping ID. No. 355571348 6	Conforms to Record
Via: FedEx 2 day	Lab No.

Special Instructions/Comments: Gas temp = 112°F @ collection

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
(Signature) Gil Van Deventer (Time) 2:30p	(Signature) (Time)	(Signature) (Time)
(Printed Name) Gil Van Deventer (Date) 8-21-97	(Printed Name) (Date)	(Printed Name) (Date)
(Company) BDM Environmental Services	(Company)	(Company)
Received By 1.	**Received By 2.**	**Received By (Laboratory) 3.**
(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
(Printed Name) Russell Walker (Date) 10:44:02	(Printed Name) (Date)	(Printed Name) (Date)
(Company) Pantechs Labs 8/22/97	(Company)	(Laboratory)

Distribution: White, Canary Laboratory • Pink, BDM

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

315

13199

Chain of Custody

Date 8-14-97 Page 1 Of 1

Lab Name Trace Analysis Inc
Address 6701 Aberdeen Ave.
Lubbock, Tx 79424
Telephone 800-378-1296

Samplers (SIGNATURES) [signature] John Fergus

Analysis Request

	Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 (BTEX)	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP-Vol., Semi-Vol. Herbicides, Pesticides	TCLP-Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)	Metals*	Ca, Na, Mg, F, K, TDS	HCO_3, Cl, SO_4	Number of Containers
79791	970814 0815	Water	MW-10		✓																					✓	✓	✓	4
92	970814 0935	Water	MW-2		✓																					✓	✓	✓	4
93	970814 1115	Water	MW-4		✓																					✓	✓	✓	4
94	970814 1305	Water	MW-5		✓																					✓	✓	✓	4
95	970814 1350	Water	MW-3		✓																					✓	✓	✓	4
96	970814 1445	Water	MW-8		✓																					✓	✓	✓	4
97	970814 1555	Water	MW-9		✓																					✓	✓	✓	4
98	970814 1640	Water	MW-6		✓																					✓	✓	✓	4
99	970814 1730	Water	Rinsate		✓																								2

Project Information
Project Navajo - Lea Refinery
Project Director G. Van Deventer
Charge Code No. 8/2242/2033 ws
Shipping ID. No.
Via: Bus

Sample Receipt
Total No. of Containers 34
Chain of Custody Seals yes
Rec'd Good Condition/Cold yes
Conforms to Record yes
Lab No. 79791-99
2°C

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
(Signature) [signature] (Time) 1:40pm	(Signature) (Time)	(Signature) [signature] (Time)
(Printed Name) Gil Van Deventer (Date) 8-15-97	(Printed Name) (Date)	(Printed Name) (Date)
(Company) BDM Environmental Services	(Company)	(Company)

Received By 1.	Received By 2.	Received By (Laboratory) 3.
(Signature) (Time)	(Signature) (Time)	(Signature) [signature] (Time) 9:45
(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) Suzy Abbe (Date) 8/16/97
(Company)	(Company)	(Laboratory) Trace Analysis

Special Instructions/Comments: Total dissolved metals Al, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, U, V, Zn

Bill Navajo direct (Darrell Moore) → Filter + Pres in LAB

Distribution: White, Canary-Laboratory • Pink, BDM

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM International
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Date: Aug 25, 1997
Date Rec: 8/16/97
Project: N/A
Proj Name: Navajo Lea Refining
Proj Loc: N/A

Lab Receiving # : 9708000315
Sampling Date: 8/14/97
Sample Condition: Intact and Cool
Sample Received By: SA

TA#	Field Code	MATRIX	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
T 79791	MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 79792	MW-2	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 79793	MW-4	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 79794	MW-5	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 79795	MW-3	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 79796	MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 79797	MW-9	Water	1.68	<0.010	<0.010	<0.010	1.68
T 79798	MW-6	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 79799	Rinsate	Water	0.010	<0.001	0.002	0.007	0.019
Method Blank			<0.001	<0.001	<0.001	<0.001	
Reporting Limit			0.001	0.001	0.001	0.001	
QC			0.097	0.100	0.099	0.312	
RPD			1	2	1	2	
% Extraction Accuracy			103	103	103	109	
% Instrument Accuracy			97	100	99	104	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	8/20/97	EPA 8020	8/20/97	AG	0.100 ea	0.1 ea

Director, Dr. Blair Leftwich

8-25-97
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM
Attention: Gil Van Deventer
415 West Wall, Suite 1818
Midland, TX 79701

September 05, 1997
Receiving Date: 08/16/97
Sample Type: Water
Project No: P/2292/2033-005
Project Location: NA
COC# 13182

Prep Date: 08/25/97
Analysis Date: 09/03/97
Sampling Date: 08/14/97
Sample Condition: Intact & Cool
Sample Received by: SA
Project Name: Navajo - Lea Refinery

TA#	Field Code	POTASSIUM (mg/L)	MAGNESIUM (mg/L)	CALCIUM (mg/L)	SODIUM (mg/L)
T79791	9708140815 MW-10	1.6	7.9	77	32
T79792	9708140935 MW-2	1.9	14	130	52
T79793	9708141115 MW-4	2.0	7.4	72	27
T79794	9708141305 MW-5	2.8	18	200	80
T79795	9708141350 MW-3	2.5	11	97	37
T79796	9708141445 MW-8	7.5	28	320	230
T79797	9708141555 MW-9	67	110	1,100	3,300
T79798	9708141640 MW-6	3.4	5.3	37	310
QC	Quality Control	47	46	50	46
MET BLK	**METHOD BLANK**	**<0.30**	**<0.01**	**0.03**	**<0.40**
Reporting Limit		0.30	0.01	0.01	0.40
RPD		4	2	6	1
% Extraction Accuracy		95	87	84	106
% Instrument Accuracy		94	91	100	92

METHODS: EPA 200.7.
CHEMIST: RR
SPIKE: 100 mg/L POTASSIUM, MAGNESIUM, CALCIUM, SODIUM.
QC: 50 mg/L POTASSIUM, MAGNESIUM, CALCIUM, SODIUM.

Director, Dr. Blair Leftwich

9-5-97
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM
Attention: Gil Van Deventer
415 West Wall, Suite 1818
Midland, TX 79701

September 05, 1997
Receiving Date: 08/16/97
Sample Type: Water
Charge Code No.: P/2292/2033-005
Project Location: NA
COC# 13182

Prep Date: 08/18/97
Analysis Date: 08/18/97
Sampling Date: 08/14/97
Sample Condition: Intact & Cool
Sample Received by: SA
Project: Navajo - Lea Refinery

TA#	FIELD CODE	CHLORIDE (mg/L)	SULFATE (mg/L)	FLUORIDE (mg/L)	TDS (mg/L)	ALKALINITY (mg/L as CaCo3) HC03	C03
T79798	9708141640 MW-6	480	100	3.4	980	92	<1.0
QC	Quality Control	24	24	1.0	---	---	---
RPD		2	1	1	2	2	2
% Extraction Accuracy		98	97	93	---	---	---
% Instrument Accuracy		97	98	101	---	---	---
REPORTING LIMIT		2.0	2.0	0.1	---	1.0	1.0

METHODS: EPA 300.0, 340.2, 160.1, 310.1.
CHEMIST: CHLORIDE/NITRATE-N/SULFATE: RC FLUORIDE/TDS/ALKALINITY: JS
CHLORIDE SPIKE: 25 mg/L CHLORIDE. CHLORIDE QC: 25 mg/L CHLORIDE.
SULFATE SPIKE: 25 mg/L SULFATE. SULFATE QC: 25 mg/L SULFATE.
FLUORIDE SPIKE: 1.0 mg/L FLUORIDE. FLUORIDE QC: 1.0 mg/L FLUORIDE.

Director, Dr. Blair Leftwich

9-5-97
Date

TRACEANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM
Attention: Gil Van Deventer
415 West Wall, Suite 1818
Midland, TX 79701

September 11, 1997
Receiving Date: 08/16/97
Sample Type: Water
Charge Code No.: P/2292/2033-005
Project Location: NA
COC# 13182

Prep Date: 08/18/97
Analysis Date: 08/18/97
Sampling Date: 08/14/97
Sample Condition: Intact & Cool
Sample Received by: SA
Project: Navajo - Lea Refinery

TA#	FIELD CODE	CHLORIDE (mg/L)	SULFATE (mg/L)	FLUORIDE (mg/L)	TDS (mg/L)	ALKALINITY (mg/L as CaCo3) HC03	C03
T79791	9708140815 MW-10	42	110	1.1	480	170	<1.0
T79792	9708140935 MW-2	140	89	1.2	650	210	<1.0
T79793	9708141115 MW-4	49	95	1.1	400	170	<1.0
T79794	9708141305 MW-5	250	150	0.50	1,000	300	<1.0
T79795	9708141350 MW-3	73	90	0.87	470	220	<1.0
T79796	9708141445 MW-8	960	120	0.88	1,800	460	<1.0
T79797	9708141555 MW-9	6,500	38	0.80	2,300	230	<1.0
QC	Quality Control	25	25	1.0	---	---	---
RPD		2	1	1	2	2	2
% Extraction Accuracy		98	98	93	---	---	---
% Instrument Accuracy		98	98	101	---	---	---
REPORTING LIMIT		10	10	0.1	---	1.0	1.0

METHODS: EPA 300.0, 340.2, 160.1, 310.1.
CHEMIST: CHLORIDE/NITRATE-N/SULFATE: RC FLUORIDE/TDS/ALKALINITY: JS
CHLORIDE SPIKE: 25 mg/L CHLORIDE. CHLORIDE QC: 24 mg/L CHLORIDE.
SULFATE SPIKE: 25 mg/L SULFATE. SULFATE QC: 25 mg/L SULFATE.
FLUORIDE SPIKE: 1.0 mg/L FLUORIDE. FLUORIDE QC: 1.0 mg/L FLUORIDE.

BB
Director, Dr. Blair Leftwich

9-11-97
Date

TRACEANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

September 11, 1997
Receiving Date: 08/16/97
Sample Type: Water
Charge Code No.: P/2292/2033-005
Project Location: NA
COC# 13182

ANALYTICAL RESULTS FOR
BDM
Attention: Gil Van Deventer
415 West Wall, Suite 1818
Midland, TX 79701

Prep Date: 08/15/97
Analysis Date: 08/18/97
Sampling Date: 08/14/97
Sample Condition: Intact & Cool
Sample Received by: SA
Project: Navajo - Lea Refinery

TOTAL METALS

TA#	FIELD CODE	As (mg/L)	Se (mg/L)	Cd (mg/L)	Cr (mg/L)	Pb (mg/L)	Ag (mg/L)	Ba (mg/L)	Al (mg/L)	Be (mg/L)	U (mg/L)
T79793	9708141115 MW-4	<0.10	<0.05	<0.01	<0.05	<0.05	<0.01	<0.20	<0.20	<0.01	<1.0
T79794	9708141305 MW-5	<0.10	<0.05	<0.01	<0.05	<0.05	<0.01	<0.20	<0.20	<0.01	<1.0
T79795	9708141350 MW-3	<0.10	<0.05	<0.01	<0.05	<0.05	<0.01	<0.20	<0.20	<0.01	<1.0
T79796	9708141445 MW-8	<0.10	<0.05	<0.01	<0.05	<0.05	<0.01	<0.20	<0.20	<0.01	<1.0
T79798	9708141640 MW-6	<0.10	<0.05	<0.01	<0.05	<0.05	<0.01	0.3	<0.20	<0.01	<1.0
QC	Quality Control	5.1	5.0	5.1	5.0	5.0	0.099	4.8	4.9	4.7	4.9
HIGH		**10.9 109%	---	**9.4 94%	---	---	---	---	---	**9.26 93%	---
REPORTING LIMIT		0.10	0.05	0.01	0.05	0.05	0.01	0.20	0.20	0.01	1.0
RPD		0	2	0	1	0	28	0	1	3	7
% Extraction Accuracy		114	93	99	94	92	*67	87	86	119	105
% Instrument Accuracy		102	99	101	99	100	99	95	98	95	98

TA#	FIELD CODE	Hg (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	V (mg/L)	Zn (mg/L)	B (mg/L)
T79793	9708141115 MW-4	<0.001	<0.03	0.04	0.14	<0.01	<0.10	<0.20	<0.05	0.05	<0.2
T79794	9708141305 MW-5	<0.001	<0.03	0.03	0.75	<0.01	<0.10	<0.20	<0.05	0.05	<0.2
T79795	9708141350 MW-3	<0.001	<0.03	0.02	0.24	<0.01	<0.10	<0.20	<0.05	0.05	<0.2
T79796	9708141445 MW-8	<0.001	<0.03	0.03	0.21	0.04	<0.10	<0.20	<0.05	<0.02	<0.2
T79798	9708141640 MW-6	<0.001	<0.03	<0.02	0.76	0.32	<0.10	<0.20	0.23	0.04	<0.2
QC	Quality Control	0.0044	5.3	4.9	5.1	5.0	5.0	5.0	4.9	5.0	5.2
REPORTING LIMIT		0.001	0.03	0.02	0.03	0.01	0.10	0.20	0.05	0.02	0.2
RPD			1	3	2	0	0	0	0	0	5
% Extraction Accuracy		7	97	*74	91	92	98	92	92	91	104
% Instrument Accuracy		89	105	97	101	99	100	100	98	99	103

***NOTE: Extraction Accuracy is out of limits of 80-120%.**
****NOTE: High is out of limits of 95-105%.**
METHODS: EPA 200.7, 245.1.
CHEMIST: As, Se, Cd, Cr, Pb, Ag, Ba, Al, Be, Co, Cu, Fe, Mn, Mo, Ni, V, Zn, B: RR U, Hg: HC
TOTAL METALS SPIKE: 2.0 mg/L As, Se, Cd, Cr, Pb, Ba, Al, Be, U, Co, Cu, Fe, Mn, Mo, Ni, V, Zn, B; 1.0 mg/L Ag; 0.005 mg/L Hg.
TOTAL METALS QC: 5.0 mg/L As, Se, Cd, Cr, Pb, Ba, Al, Be, U, Co, cu, Fe, Mn, Mo, Ni, V, Zn, B; 1.0 mg/L Ag; 0.005 mg/L Hg

BS
Director, Dr. Blair Leftwich

9-11-97
DATE

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

September 11, 1997
Receiving Date: 08/16/97
Sample Type: Water
Charge Code No.: P/2292/2033-005
Project Location: NA
COC# 13182

ANALYTICAL RESULTS FOR
BDM
Attention: Gil Van Deventer
415 West Wall, Suite 1818
Midland, TX 79701

Prep Date: 08/15/97
Analysis Date: 08/18/97
Sampling Date: 08/14/97
Sample Condition: Intact & Cool
Sample Received by: SA
Project: Navajo - Lea Refinery

TOTAL METALS

TA#	FIELD CODE	As (mg/L)	Se (mg/L)	Cd (mg/L)	Cr (mg/L)	Pb (mg/L)	Ag (mg/L)	Ba (mg/L)	Al (mg/L)	Be (mg/L)	U (mg/L)
T79791	9708140815 MW-10	<0.10	<0.05	<0.01	<0.05	<0.05	<0.01	<0.20	<0.02	<0.01	<1.0
T79792	9708140935 MW-2	<0.10	<0.05	<0.01	<0.05	<0.05	<0.01	<0.20	<0.02	<0.01	<1.0
T79797	9708141555 MW-9	<0.10	<0.05	<0.01	<0.05	<0.05	<0.01	0.8	0.02	<0.01	<1.0
QC	Quality Control	5.1	5.0	5.1	5.0	5.0	0.099	4.8	4.9	4.7	4.9
HIGH		**10.9 109%	---	**9.4 94%	---	---	---	---	---	**9.26 93%	---
REPORTING LIMIT		0.10	0.05	0.01	0.05	0.05	0.01	0.20	0.02	0.01	1.0
RPD		0	2	0	1	0	28	0	1	3	7
% Extraction Accuracy		114	93	99	94	92	*67	87	86	119	105
% Instrument Accuracy		102	99	101	99	100	99	95	98	95	98

TA#	FIELD CODE	Hg (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	V (mg/L)	Zn (mg/L)	B (mg/L)
T79791	9708140815 MW-10	<0.001	<0.03	0.06	0.38	<0.01	<0.10	<0.20	<0.05	<0.02	<0.2
T79792	9708140935 MW-2	<0.001	<0.03	0.06	0.28	<0.01	<0.10	<0.20	<0.05	0.03	<0.2
T79797	9708141555 MW-9	<0.001	<0.03	0.02	0.47	0.51	<0.10	<0.20	<0.05	<0.02	<0.2
QC	Quality Control	0.0044	5.3	4.9	5.1	5.0	5.0	5.0	4.9	5.0	5.2
REPORTING LIMIT		0.001	0.03	0.02	0.03	0.01	0.10	0.20	0.05	0.02	0.2
RPD			1	3	2	0	0	0	0	0	5
% Extraction Accuracy		7	97	*74	91	92	98	92	92	91	104
% Instrument Accuracy		89	105	97	101	99	100	100	98	99	103

***NOTE: Extraction Accuracy is out of limits of 80-120%.**
****NOTE: High is out of limits of 95-105%.**

METHODS: EPA 200.7, 245.1.
CHEMIST: As, Se, Cd, Cr, Pb, Ag, Ba, Al, Be, Co, Cu, Fe, Mn, Mo, Ni, V, Zn, B: RR U, Hg: HC
TOTAL METALS SPIKE: 2.0 mg/L As, Se, Cd, Cr, Pb, Ba, Al, Be, U, Co, Cu, Fe, Mn, Mo, Ni, V, Zn, B; 1.0 mg/L Ag, 0.005 mg/L Hg.
TOTAL METALS QC: 5.0 mg/L As, Se, Cd, Cr, Pb, Ba, Al, Be, U, Co, cu, Fe, Mn, Mo, Ni, V, Zn, B; 1.0 mg/L Ag; 0.005 mg/L Hg

Director, Dr. Blair Leftwich

5-11-97
DATE

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

Chain of Custody

Date 8-19-97 Page 1 Of 1

Lab Name Trace Analysis Inc
Address 6701 Aberdeen Ave
Lubbock, Tx 79424
Telephone 806 794 1296

Samplers (SIGNATURES)
G. Van Deventer

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neut/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH-BTEX Modified 8015 TVHC	TCLP: Vol., Semi-Vol Herbicides, Pesticides	TCLP: Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide: Total Amenable	Chemical Oxygen Demand (COD)	Number of Containers
9708190948	Gas	VE Exhaust		✓									✓					80111							2

Project Information
Project Navajo-Lea Refinery
Project Director G. Van Deventer
Charge Code No. 2292/2033005
Shipping ID. No. 155-759-002-3
Via: Greyhound Bus

Sample Receipt
Total No. of Containers 2 ✓
Chain of Custody Seals ✓
Rec'd Good Condition/Cold ✓
Conforms to Record
Lab No.

Special Instructions/Comments: PO # ABQ-97-00054

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
G. Van Deventer 1045am	Helen Shelton 10:45 AM	Helen Shelton 7:15 PM
(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
G. I Van Deventer 8-20-97	HELEN SHELTON 8-20-97	HELEN SHELTON 8-20-97
(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
BDM Environmental Service	TRACE ANALYSIS	TRACE ANALYSIS
(Company)	(Company)	(Company)

Received By 1.	Received By 2.	Received By (Laboratory) 3.
(Signature) (Time)	(Signature) (Time)	JO Hardell
(Printed Name) (Date)	(Printed Name) (Date)	(Signature) (Time)
(Company)	(Company)	JO Hardell 9:45
		(Printed Name) (Date)
		Trace Analysis 8/21/97
		(Laboratory)

Distribution: White, Canary-Laboratory • Pink, BDM

Navajo Pipeline Greyhound 155-759-002-3

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM
Attention: Gil Van Deventer
415 West Wall, Suite 1818
Midland, TX 79701

August 27, 1997
Receiving Date: 08/21/97
Sample Type: Gas
Charge Code: 2292/2033-005
Project Location: NA
COC# 13184

Prep Date: 08/24/97
Analysis Date: 08/24/97
Sampling Date: 08/19/97
Sample Condition: Intact & Cool
Sample Received by: JH
Project Name: Navajo-Lea Refining

TA#	Field Code	Gasoline Range TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T80111	9708190948 VE Exhaust	2,960	9	12	11	16	48
QC	Quality Control	98	93	91	90	272	
Reporting Limit		100	1	1	1	1	
RPD		6	1	1	1	1	
% Extraction Accuracy		98	94	91	91	91	

METHODS: EPA SW 846-5030, 8020, 8015 Modified (Gasoline).
CHEMIST: AG
BTEX SPIKE AND QC: 0.100 mg/m3 BTEX.
TVHC (Gasoline Range) SPIKE AND QC: 1.00 mg/m3 TVHC (Gasoline Range).

Director, Dr. Blair Leftwich

8-27-97
Date

45T

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

Chain of Custody

Date 7-22-97 Page 1 Of 1

Lab Name Trace Analysis
Address 6701 Aberdeen, Ste 9
Lubbock, TX 79424-1515
Telephone 800-378-1296

Samplers (SIGNATURES)
Gil Van Deventer

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415.9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 TVHC	TCLP Vol Semi-Vol Herbicides, Pesticides	TCLP Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)	Number of Containers
9707221340	gas	VE Exhaust		✓									✓								78120				2

Project Information

Project Navajo Lea Refinery
Project Director Gil Van Deventer
Charge Code No. 22921L033-005
Shipping ID. No. 155-759-054-0
Via: Greyhound

Sample Receipt

Total No. of Containers	2
Chain of Custody Seals	✓
Rec'd Good Condition/Cold	✓
Conforms to Record	✓
Lab No.	

Special Instructions/Comments: PO# ABG-097-0054

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Gil Van Deventer 4:05p (Signature) (Time)	Helen Shelton (Signature) (Time)	(Signature) (Time)
Gil Van Deventer 7-23-97 (Printed Name) (Date)	HELEN SHELTON 8:45PM (Printed Name) (Date)	(Printed Name) (Date)
BDM Environmental Services (Company)	TRACE ANALYSIS 7/23/97 (Company)	(Company)

Received By 1.	Received By 2.	Received By (Laboratory) 3.
Helen Shelton 4:05pm (Signature) (Time)	(Signature) (Time)	Jennifer Hardell (Signature) (Time)
HELEN SHELTON 7/23/97 (Printed Name) (Date)	(Printed Name) (Date)	Jennifer Hardell 9:15 (Printed Name) (Date)
TRACE ANALYSIS (Company)	(Company)	Trace Analysis 7/24/97 (Laboratory)

Greyhound 155-759-054-0

Distribution: White, Canary Laboratory • Pink, BDM

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM
Attention: Dale Litlejohn
415 West Wall, Suite 1818
Midland, TX 79701

July 29, 1997
Receiving Date: 07/24/97
Sample Type: Gas
Charge Code: 2292/2033-005
Project Location: NA
COC# 13176

Prep Date: 07/24/97
Analysis Date: 07/24/97
Sampling Date: 07/22/97
Sample Condition: Intact & Cool
Sample Received by: JH
Project Name: Navajo Lea Refining

TA#	Field Code	Gasoline Range TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T78120	9707221340 VE Exhaust	7,100	20	43	59	91	213
QC	Quality Control	92	99	98	99	102	
Reporting Limit		100	1	1	1	1	
RPD		2	5	3	3	4	
% Extraction Accuracy		92	99	98	99	102	

METHODS: EPA SW 846-5030, 8020, 8015 Modified (Gasoline).
CHEMIST: AG
BTEX SPIKE AND QC: 0.100 mg/m3 BTEX.
TVHC (Gasoline Range) SPIKE AND QC: 1.00 mg/m3 TVHC (Gasoline Range).

Director, Dr. Blair Leftwich

7-29-97
Date

254 ~~224~~ 1:05 AM

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

Chain of Custody

Date 6/13/97 Page 1 Of 1

Lab Name: Trace Analysis, Inc
Address: 6701 Aberdeen, Lubbock, TX 79424
Telephone: 1-806-794-1296

Samplers (SIGNATURES): John Fergerson (signature)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 (BTEX)	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 (GRO)	TCLP- Vol., Semi-Vol Herbicides, Pesticides	TCLP Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)				Number of Containers
~~1942~~ 9706121005 75537	Air	Remediation VE Exhaust		✓									✓															2

Project Information	Sample Receipt		Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Project: Navajo - Lea Refinery	Total No. of Containers	2	(Signature) John Fergerson (signature) (Time) 1117	(Signature) Karen G. Winkler (signature) (Time)	(Signature) (Time)
Project Director: G. Van Deventer	Chain of Custody Seals		(Printed Name) John Fergerson (Date) 6/13/97	(Printed Name) Karen G. Winkler (Date)	(Printed Name) (Date)
Charge Code No. P/22612/2037-005	Rec'd Good Condition/Cold		(Company) BDM International	(Company) Trace	(Company)
Shipping ID. No.	Conforms to Record		**Received By 1.**	**Received By 2.**	**Received By (Laboratory) 3.**
	Lab No.		(Signature) Karen G. Winkler (signature) (Time) 11:17	(Signature) (Time)	(Signature) (signature) (Time)
Via:			(Printed Name) Karen G. Winkler (Date) 6/13/97	(Printed Name) (Date)	(Printed Name) (signature) (Date) 6-14-97
Special Instructions/Comments: INTACT			(Company) Trace	(Company)	(Laboratory) TRACE

Distribution: White, Canary Laboratory • Pink, BDM

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM INTERNATIONAL, INC.
Attention: Gil Van Deventer
415 W. Wall, Suite 1818
Midland, TX 79701

June 20, 1997
Receiving Date: 06/14/97
Sample Type: Air
Charge Code No: P/2292/2033-005
Project Location: NA
COC# 13161

Prep Date: 06/16/97
Analysis Date: 06/16/97
Sampling Date: 06/12/97
Sample Condition: Intact
Sample Received by: DH
Project NAme: Navajo - Lea Refinery

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T75537	9706121005 Remediation VE Exhaust	3,950	16	22	28	46	112
QC	Quality Control	1,035	104	100	97	310	
Reporting Limit		100	1	1	1	1	
RPD		10	1	1	1	1	
% Instrument Accuracy		104	105	100	98	104	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: AG
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr Blair Leftwich

6-20-97
Date

397

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

Chain of Custody

Date 5-19-97 Page 1 Of 1

Lab Name Trace Analysis
Address 6701 Aberdeen Ave
Lubbock, TX 79424
Telephone 806-794-1296

Samplers (SIGNATURES)
John Fergerson

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 GRO	TCLP Vol., Semi-Vol. Herbicides, Pesticides	TCLP Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)	Number of Containers
9716051210	Air	VE Exhaust		✓									✓											73949	2

Project Information
Project Navajo Lea Refinery
Project Director G.I Van Deventer
Charge Code No. P12292/2033-005
Shipping ID. No. 126-689-775-3
Via: GREYHOUND

Sample Receipt
Total No. of Containers 2
Chain of Custody Seals ✓
Rec'd Good Condition/Cold ✓
Conforms to Record ✓
Lab No. 73949

Special Instructions/Comments:

Relinquished By	Relinquished By	Relinquished By
1. John Fergerson 1411 (Time)	2. Helen Shelton 8:00 (Time)	3. (Time)
(Signature)	(Signature)	(Signature)
John Fergerson 5-19-97 (Date)	HELEN SHELTON 5-19-97 (Date)	(Date)
(Printed Name)	(Printed Name)	(Printed Name)
BDM International (Company)	TRACE ANALYSIS (Company)	(Company)

Received By	Received By	Received By (Laboratory)
1. Helen Shelton 2:19PM (Time)	2. (Time)	3. J.O. Hardell 9:20A (Time)
(Signature)	(Signature)	(Signature)
HELEN SHELTON 5-19-97 (Date)	(Printed Name) (Date)	Jennifer O. Hardell 5-20-97 (Date)
(Printed Name)	(Company)	(Printed Name)
TRACE ANALYSIS (Company)		TRACE Analysis (Laboratory)

Distribution: White, Canary-Laboratory • Pink, BDM

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM INTERNATIONAL
Attention: Gil VanDeventer
415 W. Wall, Suite 1818
Midland, TX 79701

May 27, 1997
Receiving Date: 05/20/97
Sample Type: Air
Project No: NA
Project Location: NA

Prep Date: 05/21/97
Analysis Date: 05/21/97
Sampling Date: 05/16/97
Sample Condition: I & C
Sample Received by: JH
Project Name: Navajo Lea Refining

TA#	Field Code	GRO* (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T73949	VE Exhaust	3,080	9	18	26	33	86
QC	Quality Control	997	102	102	101	280	
Reporting Limit		100	1.0	1.0	1.0	1.0	
RPD		0	3	3	3	3	
% Extraction Accuracy		---	102	101	101	93	
% Instrument Accuracy		100	102	102	102	94	

*GRO - Gasoline Range Organics
CHEMISTS: TRPHC: RC MTBE/BTEX: RW
METHODS: EPA SW 846-5030, 8020 Modified, 8015g Modified.
MTBE/BTEX QC: 0.1 mg/m3 MTBE/BTEX.
GRO QC: 1,000 mg/m3 GRO.

Director, Dr. Blair Leftwich

5-22-97
Date

3541/360

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

Chain of Custody

Date 4-18-97 Page 1 Of 1

Lab Name: Trace Analysis Inc
Address: 4701 Aberdeen, Lubbock, TX
Telephone: 806-794-1296

Samplers (SIGNATURES): John M Ferguson

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 GRO	TCLP - Vol, Semi-Vol, Herbicides, Pesticides	TCLP - Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)	Number of Containers
9704161010	Water	MW-10		✓																			7/924		2
9704161210	Water	MW-3		✓																			25		2
9704161600	Water	MW-8		✓																			26		2
9704161715	Water	MW-9		✓																			27		2
9704161745	Water	MW-11d		✓																			28		2
9704161840	Water	MW-6		✓																			29		2
9704180925	Air	SVE Exhaust		✓									✓										30		2

W 4-28

Project Information
Project: Navajo - Lea Refinery
Project Director: Gil Van Deventer
Charge Code No.: P/2292/2033-005
Shipping ID. No.: 126-689-864-4
Via: GREYHOUND

Sample Receipt
Total No. of Containers: 14
Chain of Custody Seals: yes
Rec'd Good Condition/Cold: yes
Conforms to Record: yes
Lab No.: 7/924-30

Special Instructions/Comments: BDM 30 Air. XL

	1.	2.	3.
Relinquished By (Signature)	John M. Ferguson	Helen Shelton	
Time	8:05	8:00 PM	
Printed Name	John M Ferguson	HELEN SHELTON	
Date	4-18-97	4/18/97	
Company	BDM	TRACE ANALYSIS	
Received By (Signature)	Helen Shelton		Blair Leftwich (Laboratory)
Time	5:05 pm		10 AM
Printed Name	HELEN SHELTON		BLAIR LEFTWICH
Date	4/18/97		4-19-97
Company	TRACE ANALYSIS		Trace Analysis

I/C
4,5,6 °C

Distribution: White, Canary Laboratory • Pink, BDM

BDM

BDM International, Inc.
415 West Wall
Suite 1818
Midland, TX 79701
(915) 682-0008
FAX: (915) 682-0028

13151

Chain of Custody

Date [illegible] Page 1 Of 1

Lab Name [illegible]
Address [illegible]
Telephone [illegible]
Samplers (SIGNATURES) [illegible]

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 (BTEX)	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 (GRO)	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)			Number of Containers
970416 [illegible]	Water	MW-[illegible]		✓																							[illegible]
970416	Water	MW-[illegible]		✓																							[illegible]
970416 [illegible]	Water	MW-[illegible]		✓																							[illegible]
970416 [illegible]	Water	MW-9		✓																							[illegible]
970416 [illegible]	Water	MW-11d		✓		Duplicate of MW-9																					[illegible]
970416 [illegible]	Water	MW-6		✓																							
[illegible]		[illegible]		✓									✓														

Project Information	Sample Receipt
Project Navajo - Lea Refinery	Total No. of Containers
Project Director G.I. Van Deventer	Chain of Custody Seals
Charge Code No. P/2242/2035-005	Rec'd Good Condition/Cold
Shipping ID. No.	Conforms to Record
Via: [illegible]	Lab No.

Relinquished By 1	Relinquished By 2	Relinquished By 3
(Signature) John M. Ferguson (Time) [illegible]	(Signature) (Time)	(Signature) (Time)
(Printed Name) John M. Ferguson (Date) 4-18-[illegible]	(Printed Name) (Date)	(Printed Name) (Date)
(Company) BDM	(Company)	(Company)

Received By 1	Received By 2	Received By (Laboratory) 3
(Signature) [illegible] (Time) [illegible]	(Signature) (Time)	(Signature) (Time)
(Printed Name) [illegible] (Date) [illegible]	(Printed Name) (Date)	(Printed Name) (Date)
(Company) [illegible]	(Company)	(Laboratory)

Special Instructions/Comments:

Distribution: White, Canary-Laboratory • Pink, BDM

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM International
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Date: Apr 28, 1997
Date Rec: 4/19/97
Project: N/A
Proj Name: Navajo Lea Refining
Proj Loc: N/A

Lab Receiving # : 9704000359
Sampling Date: 4/16/97
Sample Condition: Intact and Cool
Sample Received By: BL

TA#	Field Code	MATRIX	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
T 71924	MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 71925	MW-3	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 71926	MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 71927	MW-9	Water	0.347	<0.002	<0.002	0.007	0.354
T 71928	MW-11d	Water	0.288	<0.005	<0.005	<0.005	0.288
T 71929	MW-6	Water	<0.001	<0.001	<0.001	<0.001	<0.001
QC			0.093	0.096	0.098	0.304	
RPD			2	2	1	2	
% Extraction Accuracy			102	103	107	108	
% Instrument Accuracy			93	96	98	101	

Reporting Limit:			0.001	0.001	0.001	0.001	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	4/22/97	EPA 8020	4/22/97	RW	0.100 ea	0.1 ea

Director, Dr. Blair Leftwich

4-28-97
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM INTERNATIONAL
Attention: Gil Van Deventer
415 W. Wall, Suite 1818
Midland, TX 79701

April 24, 1997
Receiving Date: 04/19/97
Sample Type: Air
Charge Code No: P/2292/2033-005
Location: NA
COC# 13151

Prep Date: 04/20/97
Analysis Date: 04/20/97
Sampling Date: 04/18/97
Sample Condition: I & C
Sample Received by: BL
Project Name: Navajo - Lea Refinery

TA#	Field Code	GRO* (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T71930	9704180925 SVE Exhaust	6,760	26	48	69	78	221
QC	Quality Control	1,040	104	106	107	318	
Reporting Limit		100	1	1	1	1	
RPD		3	2	1	1	1	
% Instrument Accuracy		104	105	106	107	106	

*** = Gasoline Range Organics.**

CHEMIST: RW
METHODS: EPA SW 846-8020 Modified, 8015 Modified.
MTBE/BTEX QC: 100 mg/m3 MTBE/BTEX.
GRO QC: 1,000 mg/m3 GRO.

Director, Dr. Blair Leftwich

4-24-97
Date

GCL
Environmental Science and Engineering
A BDM International Company

❑ Albuquerque
505 Marquette NW, Ste. 1100
Albuquerque, NM 87102
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FAX: (505) 842-0595

❑ Mid Atlantic Region
4221 Forbes Blvd., Ste. 240
Lanham, MD 20706-4325
(301) 459-9677
FAX: (301) 459-3064

❑ NASA-WSTF
PO Drawer MM
Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

✗ Midland
415 W. Wall
Suite 1818
Midland, TX 79701

No 10275

Chain of Custody

Date March 17, 1997 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK TX 79424
Telephone (806) 794-1296

Samplers (SIGNATURES) Gil Van Deventer

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Tpn(GRO) Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)			Number of Containers
9703191240 69574	Air	SVE Exhaust		✓									✓														2

Project Information

Project Navajo - Lea Refinery
Project Director Gil Van Deventer
Charge Code No. P/2292/2033-05
Shipping ID. No. 126-689-847-9
Via:

Sample Receipt

Total No. of Containers
Chain of Custody Seals
Rec'd Good Condition/Cold
Conforms to Record
Lab No.

Special Instructions/Comments:

Relinquished By	1.	2.	3.
(Signature)	Gil Van Deventer 1:55pm	Helen Shelton 6:45PM	(Time)
(Printed Name)	Gil Van Deventer	HELEN SHELTON	(Printed Name)
(Company)	BDM	TRACE ANALYSIS	(Company)
(Date)	3/20/97	3/20/97	(Date)

Received By	1.	2.	3.
(Signature)	Helen Shelton 1:55PM		J. D. Hartwell 9:10A
(Printed Name)	HELEN SHELTON		J. D. HARTWELL
(Company)	TRACE ANALYSIS		Trace Analysis
(Date)	3/20/97		3/21/97

Distribution: White, Canary Laboratory • Pink, GCL

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM International
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Date: Mar 25, 1997
Date Rec: 3/21/97
Project: N/A
Proj Name: Navajo Lea Refining
Proj Loc: N/A

Lab Receiving # : 9703000360
Sampling Date: 3/20/97
Sample Condition: Intact and Cool
Sample Received By: JH

TA#	Field Code	MATRIX	GRO* (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX mg/m3
T69574	SVE Exhaust	Air	7,940	29	76	83	125	313
QC			1008	0.095	0.095	0.099	0.306	
RPD			2	0	0	0	0	
% Instrument Accuracy			101	95	95	99	102	

Reporting Limit:			100	1	1	1	1	
TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: mg/m3	
BTEX	EPA 5030	3/22/97	EPA 8020	3/22/97	RW	0.100 ea	0.1 ea	
GRO	EPA 5030	3/22/97	EPA 8015B	3/22/97	RW	1000	1000	

* Gasoline Range Organics

Director, Dr. Blair Leftwich

3-25-97
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
BDM International
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Date: Feb 27, 1997
Date Rec: 2/21/97
Project: N/A
Proj Name: Navajo Lea Refining
Proj Loc: N/A

Lab Receiving # : 9702000343
Sampling Date: 2/20/97
Sample Condition: Intact and Cool
Sample Received By: JH

TA#	Field Code	MATRIX	GRO* (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX mg/m3
T68094	SVE Exhaust	Air	8,990	41	120	113	155	429
QC			1059	0.108	0.107	0.105	0.317	
RPD			11	0	0	0	0	
% Instrument Accuracy			106	108	107	105	106	

Reporting Limit:			100	1	1	1	1
TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: mg/m3
BTEX	EPA 5030	2/21/97	EPA 8020	2/21/97	RW	0.100 ea	0.1 ea
GRO	EPA 5030	2/21/97	EPA 8015B	2/21/97	RW	1000	1000

* Gasoline Range Organics

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

2-27-97
Date

GCL
Environmental Science and Engineering
A BDM International Company

Albuquerque
505 Marquette NW, Ste. 1100
Albuquerque, NM 87102
(505) 842-0001
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Lanham, MD 20706-4325
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NASA WSTF
PO Drawer MM
Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

415 W. Wall, Ste 1813
Midland, TX 79701
(915) 682-0060
FAX (915) 682-0076

No 10326

Chain of Custody

Date 2-19-97 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK TX 79424
Telephone (806) 794-1296

Samplers (SIGNATURES)

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 TVHC	TCLP Vol., Semi-Vol. Herbicides, Pesticides	TCLP Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
9702191135	Air	SVE Exhaust		/									/																2
68094																													

Analysis Request

Project Information	Sample Receipt	Relinquished By 1.	Relinquished By 2.	Relinquished By 3
Project Navajo Lea Refinery	Total No. of Containers 2	(Signature) 2:10p (Time)	Signature 9:15PM (Time)	(Signature) (Time)
Project Director G.I Van Deventer	Chain of Custody Seals	Gil VanDeventer 2-20-97 (Printed Name) (Date)	HELEN SHELTON 2-20-97 (Printed Name) (Date)	(Printed Name) (Date)
Charge Code No. P/2242/2033 005	Rec'd Good Condition/Cold ✓	BDM International, Inc (Company)	TRACE ANALYSIS (Company)	(Company)
Shipping ID. No. 126-689-830 3	Conforms to Record ✓	Received By 1.	Received By 2.	Received By (Laboratory) 3.
Via: Greyhound bus	Lab No.	(Signature) 2:10AM (Time)	(Signature) (Time)	(Signature) (Time)
Special Instructions/Comments:		HELEN SHELTON 2-20-97 (Printed Name) (Date)	(Printed Name) (Date)	JO Hurdell 2:10p (Printed Name) (Date)
		TRACE ANALYSIS (Company)	(Company)	TRACE ANALYSIS 2-21-97 (Laboratory)

Distribution: White, Canary-Laboratory • Pink, GCL

GCL
Environmental Science and Engineering
A BDM International Company

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Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

№ 10288

Chain of Custody

Date 11/20/97 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK TX 79424
Telephone (806) 794-1296

Samplers (SIGNATURE)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 / BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)				Number of Containers
660446	9701201130	H2O	MW-10		2																							2
660447	9701201330	H2O	MW-3		2																							2
660448	9701201445	H2O	MW-8		2																							2
660449	9701201550	H2O	MW-9		2																							2
660450	9701201630	H2O	MW-9d		2																							2
660451	9701201645	H2O	Rinsate		2																							2
660452	9701201715	H2O	MW-6		2																							2
660453	9701201730	H2O	Trip Blank		2																							2

Project Information	Sample Receipt		Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Project Navajo RCRA	Total No. of Containers	16	(Signature) (Time)	Signature) (Time)	(Signature) (Time)
Project Director	Chain of Custody Seals	Y	(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
Charge Code No.	Rec'd Good Condition/Cold	Y	Company)	(Company)	(Company)
Shipping ID. No.	Conforms to Record	Y	Received By 1.	Received By 2.	Received By (Laboratory) 3.
Via:	Lab No.		(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
			(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
			(Company)	(Company)	(Laboratory)

Special Instructions/Comments:
Samples Dry

Distribution: White, Canary Laboratory • Pink, GCL

GCL
Environmental Science and Engineering
A BDM International Company

❑ Albuquerque
505 Marquette NW, Ste. 1100
Albuquerque, NM 87102
(505) 842-0001
FAX: (505) 842-0595

❑ Mid Atlantic Region
4221 Forbes Blvd., Ste. 240
Lanham, MD 20706-4325
(301) 459-9677
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❑ NASA-WSTF
PO Drawer MM
Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

Chain of Custody

Date _____ Page _____ Of _____

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK TX 79424
Telephone (806) 794-1296

Samplers (SIGNATURES)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)					Number of Containers
				X																									
				X																									
				X																									
		MW-9		X																									
		MW-9		X																									
		Rinsate		X																									
		MW-6		X																									
		Trip Blank		X																									

(Duplicate sample of MW-9)

Project Information	Sample Receipt	Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Project	Total No. of Containers	(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
Project Director	Chain of Custody Seals	(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
Charge Code No.	Rec'd Good Condition/Cold	(Company)	(Company)	(Company)
Shipping ID. No.	Conforms to Record	**Received By 1.**	**Received By 2.**	**Received By (Laboratory) 3.**
Via:	Lab No.	(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
Special Instructions/Comments:		(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
		(Company)	(Company)	(Laboratory)

Distribution: White, Canary Laboratory • Pink, GCL

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Date: Jan 24, 1997
Date Rec: 1/22/97
Project: Navajo
Proj Name: Navajo
Proj Loc:

Lab Receiving # : 9701000256
Sampling Date: 1/20/97
Sample Condition: Intact and Cool
Sample Received By: JH

TA#	Field Code	MATRIX	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
T 66046	MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 66047	MW-3	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 66048	MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 66049	MW-9	Water	0.335	<0.001	0.002	0.003	0.340
T 66050	MW-9d	Water	0.340	<0.001	0.002	0.003	0.345
T 66051	Rinsate	Water	<0.001	<0.001	<0.001	<0.001	<0.001
T 66052	MW-6	Water	0.004	<0.001	0.003	0.007	0.014
T 66053	Trip Blank	Water	<0.001	<0.001	<0.001	<0.001	<0.001
QC			0.097	0.098	0.098	0.298	
RPD			4	4	4	5	
% Extraction Accuracy			96	95	95	95	
% Instrument Accuracy			97	98	98	99	
Reporting Limit:			0.001	0.001	0.001	0.001	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
BTEX	EPA 5030	1/22/97	EPA 8020	1/22/97	RW	0.100 ea	0.100 ea

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

1-24-97
Date

DBPH-06 7/v

GCL
Environmental Science and Engineering
A BDM International Company

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Las Cruces, NM 88004
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FAX: (505) 524-5315

№ 10289

Chain of Custody

Date 1-20-97 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK TX 79424
Telephone (806) 794-1296
Samplers (SIGNATURES) [signature]

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 (BTEX)	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
9701201140	Air	SVE Exhaust		✓									✓																2

65995

Project Information	
Project	Navajo - Lea Refinery
Project Director	G.I. VanDeventer
Charge Code No.	P/2292/2033-005
Shipping ID. No.	126-687-813-8
Via:	GREYHOUND

Sample Receipt	
Total No. of Containers	2
Chain of Custody Seals	N
Rec'd Good Condition/Cold	Y
Conforms to Record	Y
Lab No.	

	1.	2.	3.
Relinquished By (Signature)	[signature]	Helen Shelton	[signature]
(Printed Name)	G.I. VanDeventer	HELEN SHELTON	
(Time)	1000	8:00	
(Date)	1-20-97		
(Company)	BDM	TRACE ANALYSIS	
Received By (Signature)	Helen Shelton		[signature]
(Printed Name)	HELEN SHELTON		Jennifer C. Hendell
(Time)	12:00PM		9:10
(Date)			1/21
(Company) / (Laboratory)	TRACE ANALYSIS		Trace Analysis

Special Instructions/Comments:

Distribution: White, Canary Laboratory • Pink, GCL

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Gil VanDeventer
415 W. Wall, Suite 1818
Midland, TX 79701

January 24, 1997
Receiving Date: 01/21/97
Sample Type: Air
Charge Code No: P/2292/2033-005
Project Location: NA
COC# 10289

Prep Date: 01/21/97
Analysis Date: 01/21/97
Sampling Date: 01/20/97
Sample Condition: Intact
Sample Received by: JH
Project Name: Navajo -Lea Refinery

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T65995	9701201140 SVE Exhaust	9,740	34	116	108	136	394
QC	Quality Control	1,120	96	97	96	290	
Reporting Limit		100	1	1	1	1	
RPD		0	2	1	1	1	
% Instrument Accuracy		112	96	97	96	97	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: RW
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

BB

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

1-24-97

Date

Fourth Quarter 1996 Sampling Event
Annual Report
Navajo Refining Company - Lea Refinery
Lea County, New Mexico

January 28, 1997

Prepared for:

Navajo Refining Company
P. O. Box 159
Artesia, New Mexico 88211

Prepared by:

BDM International, Inc.
Engineering Services Division
415 West Wall, Suite 1818
Midland, Texas 79701

Fourth Quarter 1996 Sampling Event
Annual Report
Navajo Refining Company - Lea Refinery
Lea County, New Mexico

January 28, 1997

Prepared for:

Navajo Refining Company
P. O. Box 159
Artesia, New Mexico 88211

Prepared by:

BDM International, Inc.
Engineering Services Division
415 West Wall, Suite 1818
Midland, Texas 79701

BDM
415 West Wall, Suite 1818
Midland, Texas 79701
915-682-0008
915-682-0028 (Fax)

January 28, 1997

Mr. William Olson - Hydrogeologist
New Mexico Energy, Minerals and Natural Resources Department
Oil Conservation Division
2040 South Pacheco
State Land Office Building
Santa Fe, New Mexico 87505

RE: FOURTH QUARTER 1996 SAMPLING EVENT - ANNUAL REPORT
NAVAJO REFINING COMPANY - LEA REFINERY
LEA COUNTY, NEW MEXICO

Dear Mr. Olson:

Navajo Refining Company (Navajo) has completed the fourth quarter 1996 groundwater sampling and monitoring operations at the above-referenced site in accordance with the requirements specified in your letter dated November 21, 1996. This annual report documents the latest sampling event conducted at the site and includes performance data for the remediation system. The sampling and monitoring events, and operation and maintenance activities for the remediation system were performed by BDM International - Engineering Services Division (BDM) (formerly Geoscience Consultants, Ltd.).

Procedures

Prior to sampling, the monitoring wells at the Lea Refinery (MW-1 through MW-10) were gauged for depth to groundwater and thickness of free product (phase-separated hydrocarbons) on November 19, 1996 using an oil/water interface probe (Kech Model KIR-96). Sampling activities were conducted under the oversight of Bill Olson of the New Mexico Energy, Minerals and Natural Resources Department - Oil Conservation Division (OCD) Santa Fe Office and Wayne Price (OCD) Hobbs District Office. Immediately prior to collecting groundwater samples, the monitoring wells were purged of a minimum of three well casing volumes of development water using using a decontaminated 2-inch diameter submersible pump (Grundfos Redi-Flo2). A total of approximately 63 gallons of water was purged from monitoring wells MW-3, MW-6, MW-8, MW-9, and MW-10. Groundwater samples were obtained using a new, decontaminated, disposable bailer for each well after purging. Groundwater parameters, including pH, conductivity, temperature, and dissolved oxygen were measured during purging operations, and prior to obtaining groundwater samples.

The first set of water samples were transferred into air-tight, septum-sealed, 40-ml glass VOA sample vials with zero head space for analysis of total benzene, toluene, ethylbenzene, and xylenes (BTEX) using EPA Method 8020. The water samples were placed in an ice-filled cooler immediately after collection and shipped to Trace Analysis, Inc. of Lubbock, Texas for laboratory analysis. At the request of Bill Olson, another set of water samples collected from MW-3, MW-8, and MW-10 were transferred into appropriately preserved containers for analysis of halogenated and purgeable volatiles (EPA Method 601/602), polynuclear aromatic hydrocarbons (PAH, EPA Method 8310), and major cations and anions for analysis at the state-contracted laboratory (American Environmental Network, Inc.). Chain-of-custody

(COC) forms documenting sample identification numbers, collection times, and delivery times to the laboratory were completed for each set of samples.

Groundwater Gradient

Groundwater elevations for the current and previous monitoring events are summarized in Table 1 (Attachment A). The elevation of the potentiometric surface (groundwater table) and direction of groundwater flow is depicted in Figure 1 (Attachment B).

The water table elevation has generally shown a continued decreasing trend (approximate average of 0.65 feet) since the previous measurements obtained on April 22, 1996 and September 10, 1995. Over the course of the last year, groundwater elevations have declined by approximately 0.50 to 1.27 feet. Depth to groundwater occurs at approximately 89 to 94 feet below ground surface across the site. The direction of flow is to the southeast with a hydraulic gradient of approximately 0.0045 feet/foot, which is consistent with determinations made from previous gauging events. Measurable increases in the groundwater elevation were noted in monitoring well MW-6, however this is due to its close proximity to an air sparge well (AS-6).

Analytical Results

Groundwater BTEX analytical results for the current and previous sampling events are summarized in Table 2 (Attachment A). Constituents with concentrations above the New Mexico Water Quality Control Commission (WQCC) standards are highlighted in boldface type. The laboratory reports and COC documentation for samples obtained by BDM are included in Attachment C. The most recent total dissolved BTEX concentrations are depicted graphically on Figure 2 (Attachment B).

BTEX concentrations in downgradient monitoring wells MW-3, MW-8, and MW-10 have remained at levels below the laboratory detection limit of 0.001 mg/l.

Only the benzene concentration in monitoring well MW-9 (0.679 mg/l) exceeded the WQCC standard of 0.010 mg/l. The BTEX constituents in each sampled monitoring well, with the exception of benzene in MW-9, were at levels below New Mexico Water Quality Control Commission (WQCC) standards.

Analytical results for samples obtained from monitoring wells MW-3, MW-8, and MW-10 and submitted by the OCD during the annual sampling event are included in Attachment D. The analytical results for major cation/anion, PAH (EPA Method 8310), and halogenated and aromatic volatiles (EPA Method 601/602) indicate none of the analyzed constituents exceeded the WQCC standards. All PAH, halogenated and aromatic volatile constituents recorded levels below the laboratory detection limits with the exception of monitoring well MW-8 which indicated an acenaphthene concentration equal to the laboratory detection limit of 0.001 mg/l.

Air Sparging/Soil Vapor Extraction System Performance Results

The installation of the air sparging/soil vapor extraction (AS/SVE) system was completed on September 25, 1996. The AS/SVE system was started on October 2, 1996 and has remained in continuous operation since that date with a few minor exceptions, such as during periodic maintenance activities. The AS/SVE system has maintained a 95 percent system-on time performance for the fourth quarter of 1996.

To monitor the performance of the AS/SVE system, bi-weekly and monthly samples of the SVE exhaust were obtained and analyzed for BTEX (EPA Method 8020) and total volatile hydrocarbons (TVHC, EPA Method 8015M - Gas Range). The samples were obtained at the exhaust port in the remediation trailer prior to conveyence into the refinery boiler system. BTEX concentrations ranged from 253 mg/m^3 on October 2, 1996 to 535 mg/m^3 on November 19, 1996. TVHC concentrations ranged from 7,030 mg/m^3 on October 17, 1996 to 12,100 mg/m^3 on November 19, 1996. Based on the analytical results of the SVE exhaust and measured flow rates, the system has recovered an estimated 5,854 kilograms (2,660 lbs.) of TVHC during the fourth quarter of 1996. These results indicate that the air sparge system is generating adequate levels of volatile hydrocarbons in the unsaturated zone and that the volatile hydrocarbons are being captured by the soil vapor extraction system. The AS/SVE system performance data is summarized in Table 3 (Attachment A

The groundwater analytical results from the November 19, 1996 sampling event indicate that the BTEX concentrations in downgradient monitoring wells MW-6 and MW-9 have declined significantly from previous sampling events (Figures 4 and 5). The decrease in BTEX concentrations for these two wells, which are located within the boundaries of the hydrocarbon plume, is attributed to the successful performance of the air sparge/soil vapor extraction system. The benzene concentration in MW-6 declined from 1.741 mg/l on April 23, 1996 to 0.002 mg/l on November 19, 1996. This well is located only 15 feet from air sparge/soil vapor extraction well AS-6, therefore the measured reduction in BTEX concentrations are somewhat skewed in this area. Monitoring well MW-9, on the other hand, is located approximately 160 feet downgradient from the nearest air sparge/soil vapor extraction well (AS-1) and still has shown a 60 percent decrease in benzene levels from a concentration of 1.690 mg/l on April 23, 1996 to 0.679 mg/l on November 19, 1996.

Total Fluids Recovery Results

During the fourth quarter of 1996, about 109,420 gallons of total fluids (groundwater and free product) have been removed from recovery well RW-1. A summary of the meter readings, cumulative volumes recovered and flow rates is listed in Table 4 Attachment A). The total fluids recovery system has maintained a 95 percent system-on time performance for the fourth quarter of 1996. A copy of the *Totalizing Meter Report* that was submitted to the New Mexico State Engineer Office is included in Attachment E.

Currently, the recovery system is pumping at an approximate rate of 1.09 gallons per minute (gpm). The submersible pump usually pumps at about 20 gpm for approximately 15 seconds and then shuts off as the fluid level reaches the pump intake. It takes approximately 4 minutes for the water table near the wellbore to recover before the pump reactivates for another pumping cycle. The total fluids are pumped to the refinery desalter unit where the free product is recovered by an electrostatic oil/water separation process along with other refinery discharge water. The recovered water then undergoes a steam stripping process prior to be being released into the Lovington publicly owned treatment works (POTW).

Since the total fluids recovery system is not configured to measure the volumes of free product recovered, system performance is evaluated based on the product thicknesses measured in monitoring wells MW-1 and MW-7. Approximately 2.37 feet and 1.79 feet of free product was observed in MW-1 and MW-7, respectively, during sampling activities on November 19, 1996. This indicates a decline from previous measurements of 6.48 feet and 5.37 feet in MW-1 and MW-7, respectively. This decrease in product thickness is attributed to the removal of free product from recovery well RW-1.

Conclusions

- A benzene concentration of 0.679 mg/l in MW-9 was the only BTEX constituent that exceeded the WQCC groundwater standard of 0.010 mg/l.
- The large decrease in BTEX concentrations in monitoring wells MW-6 and MW-9, which are located within the boundaries of the hydrocarbon plume, is attributed to the successful performance of the air sparge/soil vapor extraction system.
- Based on the analytical results of the SVE exhaust and measured flow rates, the SVE system has recovered an estimated 5,854 kilograms (2,660 lbs.) of total volatile hydrocarbons during the fourth quarter of 1996.
- The decrease in product thicknesses in MW-1 and MW-7 can be attributed to the successful removal of free product from recovery well RW-1.
- Based on the results of the PAH, halogenated and aromatic volatiles, and major cation and anion analyses from samples submitted by the OCD during the annual sampling event, the groundwater in the area of monitoring wells MW-3, MW-8, and MW-10 is not adversely affected or impacted with these constituents.

Navajo will notify the OCD at least one week in advance of the next sampling event. The next sampling event is tentatively scheduled for January 21, 1997. If you have any questions regarding this project please call me at 915-682-0008 or David Griffin at 505-748-3311.

Sincerely,
BDM International, Inc.
Engineering Services Division

Gilbert J. Van Deventer, REM
Project Manager /Hydrogeologist

Dale T. Littlejohn
Senior Director/Quality Assurance

Attachments

cc: David Griffin - Navajo Refining Company, Artesia, NM
Jerry Sexton, OCD-Hobbs, NM

ATTACHMENTS

ATTACHMENT A

TABLES

Table 1
Groundwater Elevations
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Gauged	Relative Ground Surface Elevation (feet)	Relative Top of Casing Elevation (feet)*	Depth to Groundwater Below Top of Casing (feet)	Relative Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-1	9/10/95	3835.90	3835.67	95.89	3745.38	6.44
	4/22/96	3835.90	3835.67	96.49	3744.82	6.48
	11/19/96	3835.90	3835.67	93.57	3744.16	2.37
MW-2	9/10/95	3835.14	3834.94	89.18	3745.76	0.00
	4/22/96	3835.14	3834.94	89.42	3745.52	0.00
	11/19/96	3835.14	3834.94	89.83	3745.11	0.00
MW-3	9/10/95	3829.83	3829.55	87.53	3742.02	0.00
	4/22/96	3829.83	3829.55	87.90	3741.65	0.00
	11/19/96	3829.83	3829.55	88.72	3740.83	0.00
MW-4	9/10/95	3837.85	3837.56	91.40	3746.16	0.00
	4/22/96	3837.85	3837.56	91.84	3745.72	0.00
	11/19/96	3837.85	3837.56	92.67	3744.89	0.00
MW-5	9/10/95	3813.87	3816.88	75.82	3741.06	0.00
	4/22/96	3813.87	3816.88	74.58	3742.30	0.00
	11/19/96	3813.87	3816.88	74.95	3741.93	0.00
MW-6	4/22/96	3835.70	3835.50	91.18	3744.32	0.00
	11/19/96	3835.70	3835.50	90.64	3744.86	0.00
MW-7	4/22/96	3836.07	3835.84	96.56	3743.95	5.37
	11/19/96	3836.07	3835.84	93.13	3744.27	1.79
MW-8	4/22/96	3834.42	3838.09	94.73	3743.36	0.00
	11/19/96	3834.42	3838.09	95.50	3742.59	0.00
MW-9	4/22/96	3833.06	3832.82	89.60	3743.22	0.00
	11/19/96	3833.06	3832.82	90.34	3742.48	0.00
MW-10	4/22/96	3831.34	3831.10	87.68	3743.42	0.00
	11/19/96	3831.34	3831.10	88.51	3742.59	0.00

Monitoring wells MW-1 through MW-7 were installed in September 1995.

Monitoring wells MW-8, MW-9 and MW-10 were installed in March and April 1996.

* Elevations surveyed by John W. West Engineering Company of Hobbs, New Mexico. The top of the monitoring well casings were marked on the north side to provide consistent reference points for future gauging operations.

** Groundwater elevations were corrected for product, if present (SG=0.87)

Groundwater flow is to the southeast with a hydraulic gradient of approximately 0.0045 feet/foot.

Table 2
BTEX Analytical Results In Groundwater
Navajo Refining Company - Lea Refinery

Monitoring Well	Date Sampled	Benzene (mg/l)	Toluene (mg/l)	Ethylbenzene (mg/l)	Xylenes (mg/l)
MW-1	9/10/95	PSH	PSH	PSH	PSH
	4/23/96	PSH	PSH	PSH	PSH
	11/19/96	PSH	PSH	PSH	PSH
MW-2	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
MW-3	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
MW-4	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
MW-5	9/10/95	< 0.001	< 0.001	< 0.001	< 0.001
	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
MW-6	9/10/95	**1.741**	0.021	**0.962**	**0.972**
	4/23/96	**1.150**	< 0.001	0.599	0.462
	11/19/96	0.002	< 0.001	0.011	0.002
MW-7	9/10/95	PSH	PSH	PSH	PSH
	4/23/96	PSH	PSH	PSH	PSH
	11/19/96	PSH	PSH	PSH	PSH
MW-8	4/23/96	0.002	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
MW-9	4/23/96	**1.690**	< 0.010	< 0.010	0.019
	11/19/96	**0.679**	< 0.005	< 0.005	< 0.005
MW-10	4/23/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96	< 0.001	< 0.001	< 0.001	< 0.001
	11/19/96[1]	< 0.001	< 0.001	< 0.001	< 0.001
WQCC Standards (mg/l)		0.010	0.75	0.75	0.62

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) unless specified otherwise.

1 Analyses performed by American Environmental Network, In. (Albuquerque, NM).

Samples analyzed for BTEX using EPA Method 8020 (9/10/95 and 11/19/96) and 8260 (4/23/96).

New Mexico Water Quality Control Commission (WQCC) standards are listed as specified in Section 3-103.

PSH indicates samples not obtained due to presence of phase-separated hydrocarbons.

Table 3
Air Sparging/Soil Vapor Extraction System Performance
Navajo Refining Company - Lea Refinery

Date	SVE System Flow Rates			SVE Exhaust Analytical Results						Hydrocarbon Recovery Performance						
	Vacuum	Flow	Flow	TVHC	B	T	E	X	BTEX	System-On	TVHC	B	T	E	X	BTEX
	Inches H2O	(ft^3/min)	(m^3/day)	(mg/m^3)						(Days in Perio	(kg)					
10/2/96	38	173	7061	9450	107	67	34	45	253	15	1001	11	7	4	5	27
10/17/96	40	170	6919	7030	56	81	53	89	279	33	1605	13	18	12	20	64
11/19/96	38	173	7061	12100	74	154	123	184	535	28	2392	15	30	24	36	106
12/20/96	34	180	7344	10600	53	123	95	136	407	11	856	4	10	8	11	33
										Per Month	2019	15	23	16	25	79
										Per Quarter	5854	45	68	49	75	237

Vacuum readings were obtained at regenerative blower unit (EG&G Model DR707).

Flow rates determined from blower manufacturer's performance curve (corrected for altitude of 3,800 feet above mean sea level).

Analyses performed by Trace Analysis, Inc. (Lubbock, Texas) using EPA Methods 8015 (TVHC) and 8020 (BTEX).

Samples were collected from the exhaust port in remediation trailer prior to conveyance into refinery boiler system.

Table 4

Groundwater Recovery System Performance

Total Fluids Extraction From RW-1

Navajo Refining Company - Lea Refinery

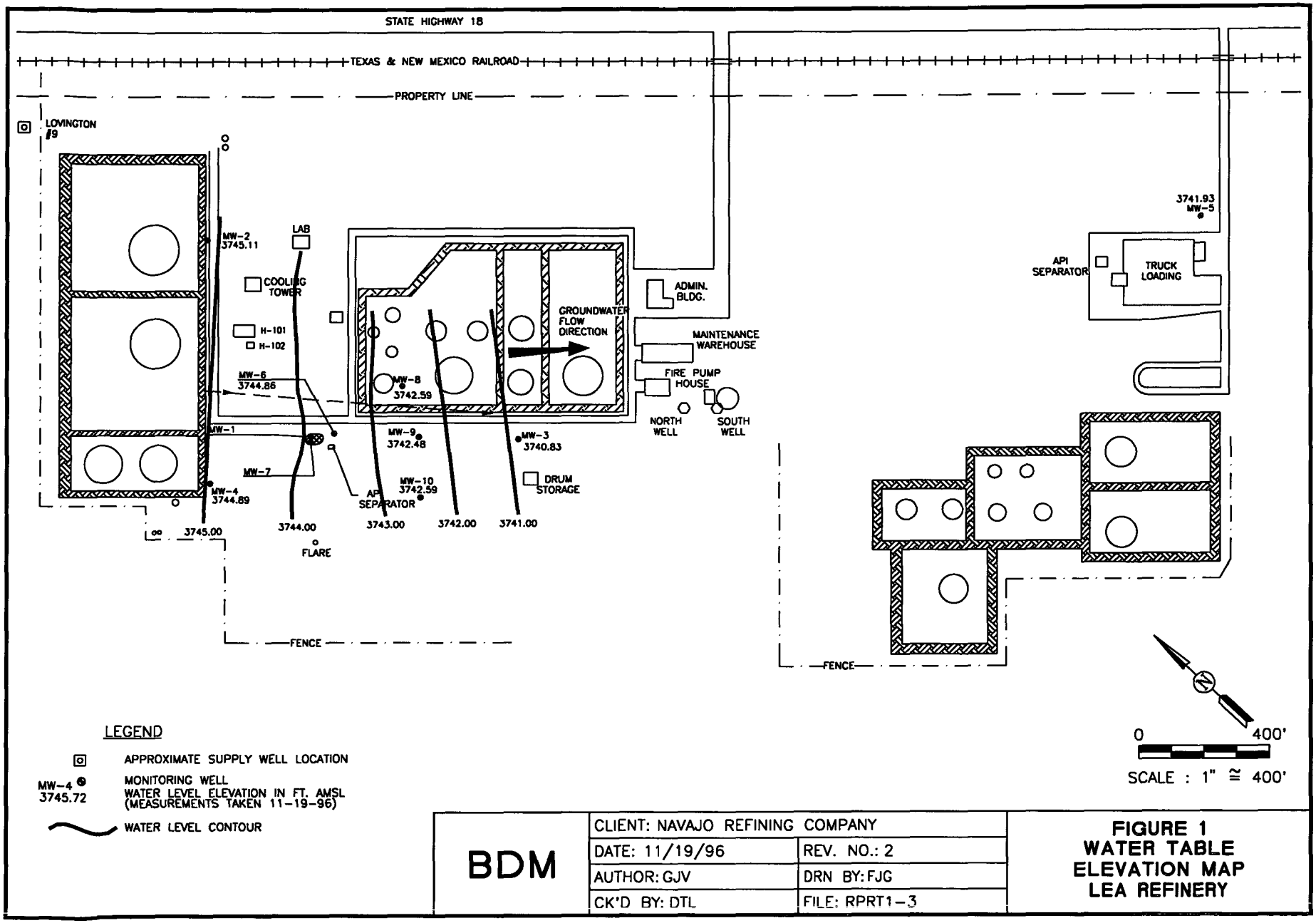
Date	Meter Reading (gallons)	Cumulative Volume Recovered (gallons)	Flow Rate (gpm)	System-On Time Percentage**
10/1/96	0	0	0.83	
10/2/96	1,200	1,200	0.83	
10/17/96	0 / 20,000*	20,000	0.83	
11/19/96	37,236	57,236	0.74	
12/20/96	72,158	92,158	0.78	
12/31/96	89,420	109,420	1.09	95%

* Old meter (Hayes dial-type) replaced with new meter (EDD electronic turbine-type). Total reading is estimated.

** Percentage of time system was on during the fourth quarter of 1996.

ATTACHMENT B

FIGURES



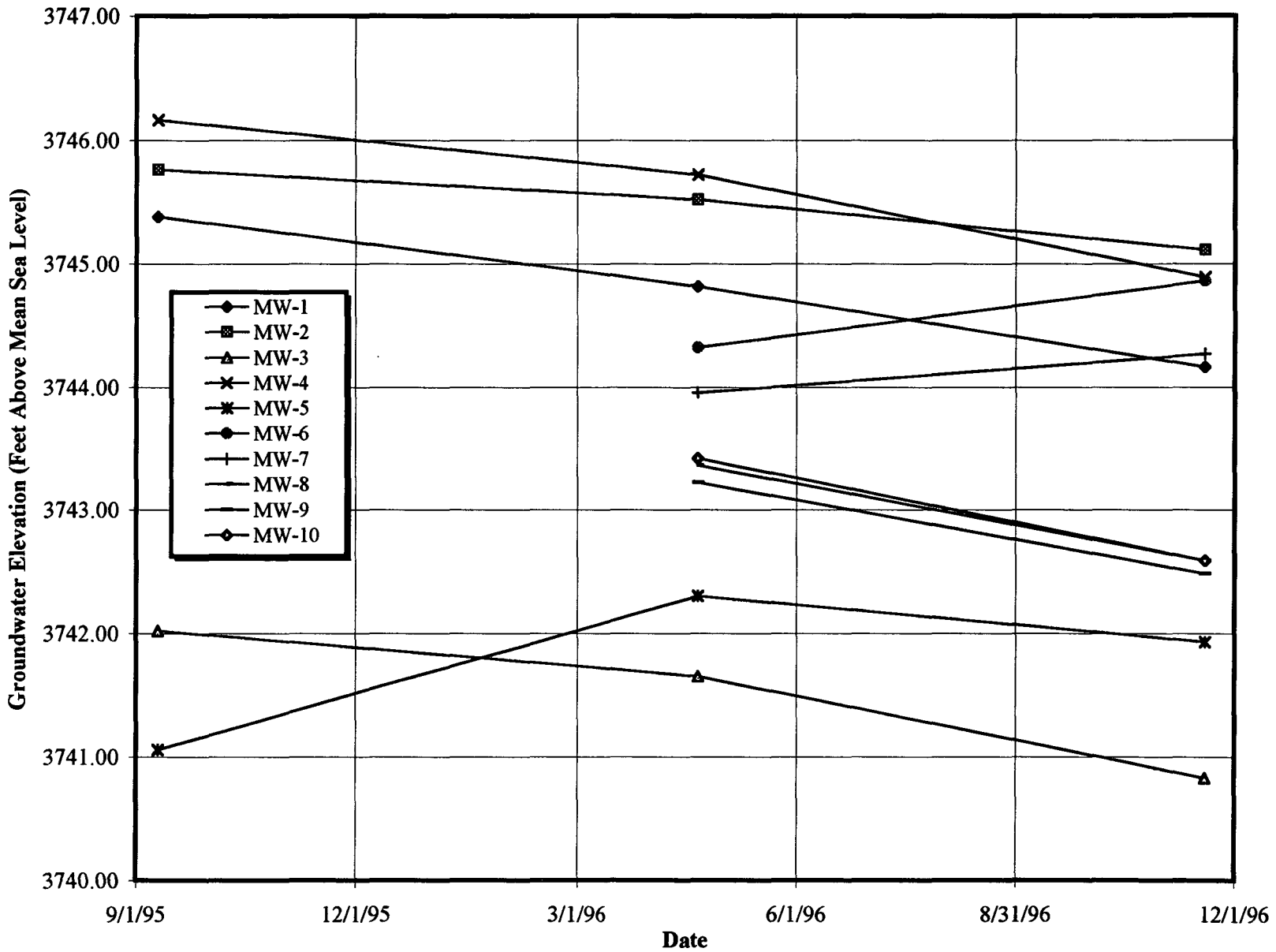
BDM	CLIENT: NAVAJO REFINING COMPANY	
	DATE: 11/19/96	REV. NO.: 2
	AUTHOR: GJV	DRN BY: FJG
	CK'D BY: DTL	FILE: RPRT1-3

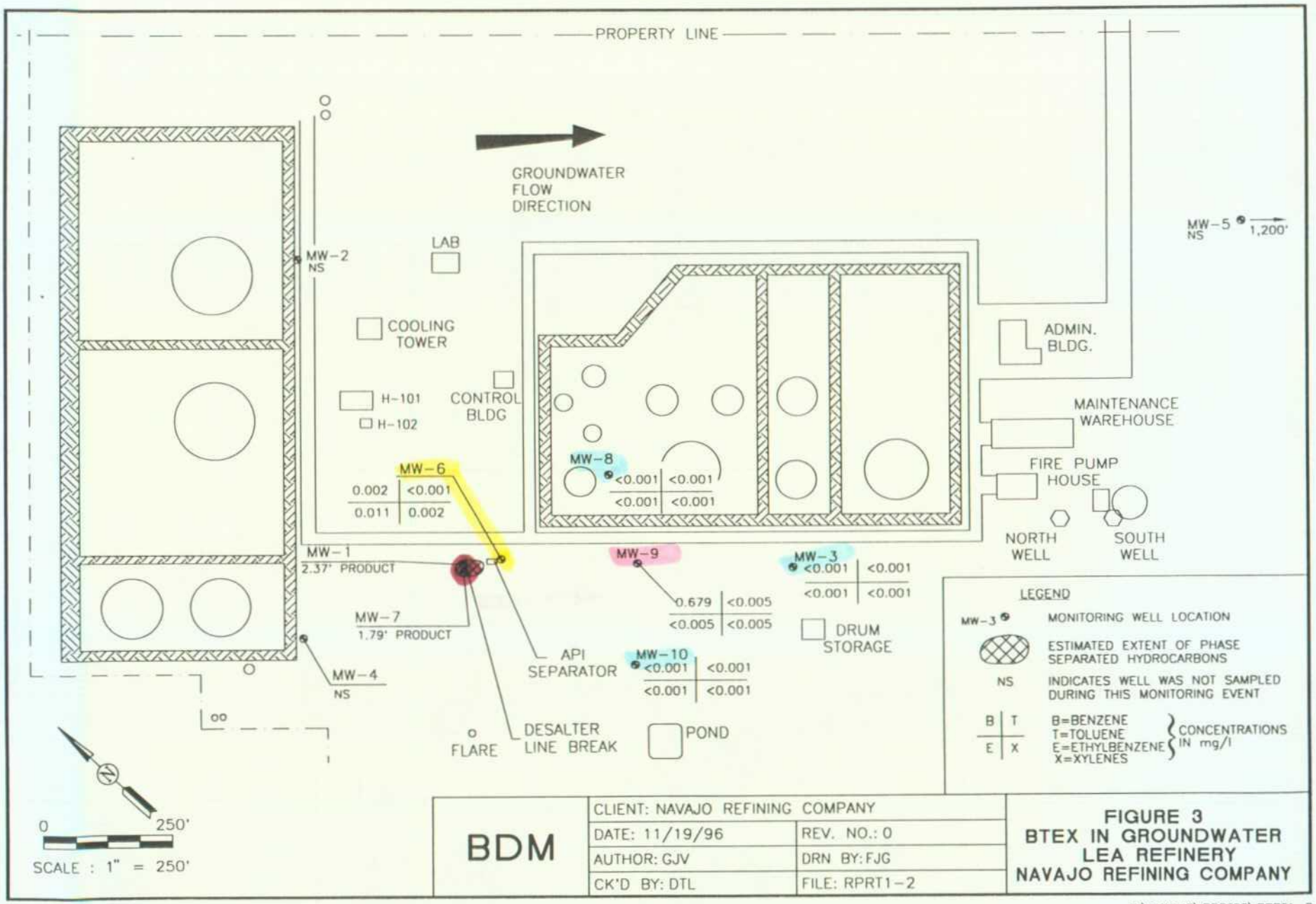
FIGURE 1
WATER TABLE ELEVATION MAP
LEA REFINERY

D:\NAVAJO\RPRT95\RPRT1-3

FIGURE 2

GROUNDWATER ELEVATIONS VERSUS TIME





BDM	CLIENT: NAVAJO REFINING COMPANY	
	DATE: 11/19/96	REV. NO.: 0
	AUTHOR: GJV	DRN BY: FJG
	CK'D BY: DTL	FILE: RPRT1-2

FIGURE 3
BTEX IN GROUNDWATER
LEA REFINERY
NAVAJO REFINING COMPANY

D:\NAVAJO\RPR195\RPRT1-2

FIGURE 4

BTEX CONCENTRATION VS. TIME (MW-6)

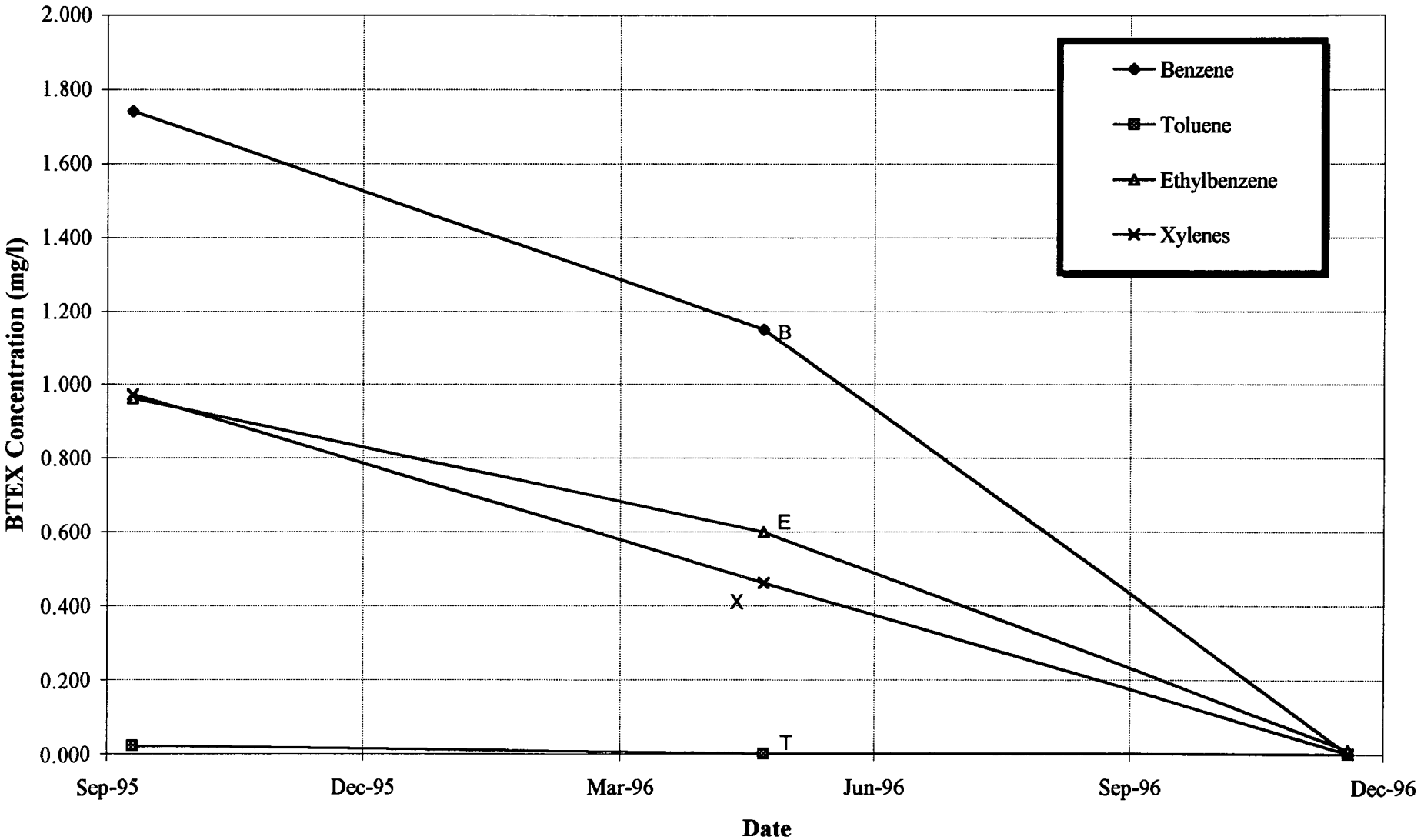
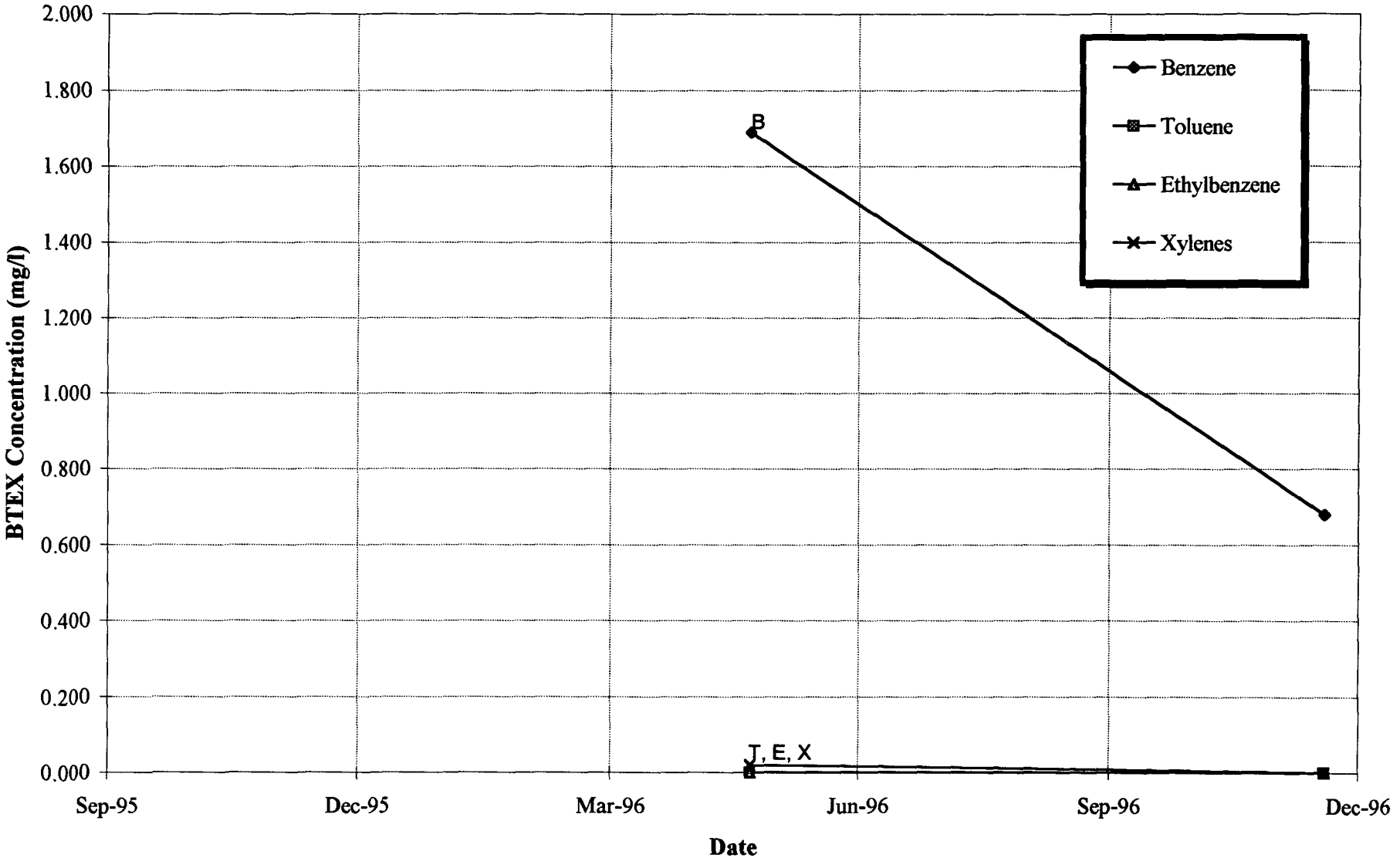


FIGURE 5

BTEX CONCENTRATION VS. TIME (MW-9)



ATTACHMENT C

LABORATORY ANALYTICAL REPORTS

AND CHAIN OF CUSTODY DOCUMENTATION

(Samples submitted by BDM)

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL
Attention Gil VanDeVenter
415 W. Wall, Suite 1818
Midland TX 79701

Date: Nov 26, 1996
Date Rec: 11/21/96
Project: 2033-005
Proj Name: Navajo-Lea Refining
Proj Loc: N/A

Lab Receiving # : 9611000381
Sampling Date: 11/19/96
Sample Condition: Intact and Cool
Sample Received By: ML

TA#	Field Code	MATRIX	MTBE (mg/L)	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL-BENZENE (mg/L)	M,P,O XYLENE (mg/L)	TOTAL BTEX (mg/L)
T 63120	MW-10	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
T 63121	MW-3	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
T 63122	MW-8	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
T 63123	MW-9 (1310)	Water	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
T 63124	MW-9 (1315)	Water	<0.005	0.679	<0.005	<0.005	<0.005	0.679
T 63125	MW-6	Water	<0.001	0.002	<0.001	0.012	<0.001	0.014
T 63126	MW-16	Water	<0.001	0.002	<0.001	0.011	0.002	0.015
QC			0.104	0.103	0.103	0.105	0.313	
RPD			1	1	0	0	1	
% Extraction Accuracy			108	106	107	109	106	
% Instrument Accuracy			104	103	103	105	104	
Reporting Limit:			0.001	0.001	0.001	0.001	0.001	

TEST	PREP METHOD	PREP DATE	ANALYSIS METHOD	ANALYSIS COMPLETED	CHEMIST	QC: (mg/L)	SPIKE: (mg/L)
MTBE/BTEX	EPA 5030	11/22/96	EPA 8020	11/22/96	BM	0.100 ea	.100 ea

BL

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

11-26-96
Date

381

№ 10177

GCL Environmental Science and Engineering
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FAX: (505) 842-0595

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Lanham, MD 20706-4325
(301) 459-9677
FAX: (301) 459-3064

☐ NASA-WSTF
PO Drawer MM
Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

Chain of Custody

Date 11-19-96 Page 1 of

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK, TEXAS 79424
Telephone (806) 794-1296

Samplers (SIGNATURES) Dwayne Salisbury

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
03120 9611191005	H20	MW-10		X																									2
21 9611191105	H20	MW-3		X																									2
22 9611191210	H20	MW-8		X																									2
23 9611191310	H20	MW-9		X																									2
24 9611191315	H20	MW-9		X																									2
25 9611191345	H20	MW-6		X																									2
2 ~~9611191350~~	~~H20~~	~~Trip Blank~~		X					D Salisbury																				1
20 9611191355	H20	MW-16		X																									2

Project Information		Sample Receipt	
Project	Navajo Refining	Total No. of Containers	14
Project Director	VanDeventer	Chain of Custody Seals	Y
Charge Code No.	2033.005	Rec'd Good Condition/Cold	Y
Shipping ID. No.	126-689-784-1	Conforms to Record	Y
Via:	Greyhound	Lab No.	

Special Instructions/Comments: ~~Bill directly to Navajo (Dave Griffin) SAV~~

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Dwayne Salisbury (Signature) 1500 (Time)	G.I. VanDeventer (Signature) 11-20-96 (Time)	Helen Shelton (Signature) (Time)
Dwayne Salisbury (Printed Name) 11/19/96 (Date)	G.I. VanDeventer (Printed Name) (Date)	HELEN SHELTON 8:00PM (Printed Name) (Date)
GCL (Company)	GCL (Company)	TRACE ANALYSIS 11-20-96 (Company)
Received By 1.	**Received By 2.**	**Received By (Laboratory) 3.**
G.I. VanDeventer (Signature) 1500 (Time)	Helen Shelton (Signature) 11:00AM (Time)	M Lopez (Signature) 11:27 (Time)
G.I. VanDeventer (Printed Name) 11/19/96 (Date)	HELEN SHELTON (Printed Name) 11/20/96 (Date)	M Lopez (Printed Name) 10:30 (Time)
GCL (Company)	TRACE (Company)	(Laboratory) 11-21-96 (Date)

Distribution: White, Canary-Laboratory • Pink, GCL

14 samples - HS

371 AD

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№ 10177

Chain of Custody

Date 11/19/96 Page 1 of

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK, TEXAS 79424
Telephone (806) 794-1296

Samplers (SIGNATURES) Duane Salisbury

Analysis Request

Columns: Halogenated Volatiles 601/8010; Aromatic Volatiles 602/8020 (circled); Phenols, Sub Phenols 604/8040; Pesticides/PCB 608/8080; Polynuclear Aromatic Hydrocarbons 610/8310; Volatile Compounds GC/MS 624/8240; Base/Neu/Acid Compounds GC/MS 625/8270; Total Organic Carbon (TOC) 415/9060; Total Organic Halides (TOX) 9020; Petroleum Hydrocarbons 418.1; TPH/BTEX Modified 8015; TCLP- Vol., Semi-Vol. Herbicides, Pesticides; TCLP- Metals; RCRA Metals(8); Priority Pollutant Metals (13); CAM Metals (18) TTLC/STLC; Flash Point; Corrosivity; Reactivity; Oil & Grease; Cyanide Total/Amenable; Chemical Oxygen Demand (COD); Number of Containers

Sample Number	Matrix	Location	Aromatic Volatiles 602/8020	Notes	Number of Containers
9611191005	H2O	MW-10	X	invest	2
9611191105	H2O	MW-3	X	invest	2
9611191210	H2O	MW-8	X	invest	2
9611191310	H2O	MW-9	X	rinsate	2
9611191315	H2O	MW-9	X	invest	2
9611191345	H2O	MW-6	X	invest	2
~~9611191350~~	~~H2O~~	~~Trip Blank~~	X	~~trip blank~~ Duane Salisbury	1
9611191355	H2O	MW-16	X	duplicate of MW-6	2

Project Information	
Project	Navajo Refining
Project Director	Van Deventer
Charge Code No.	2033.008
Shipping ID. No.	
Via:	Greyhound

Sample Receipt	
Total No. of Containers	
Chain of Custody Seals	
Rec'd Good Condition/Cold	
Conforms to Record	
Lab No.	

	1.	2.	3.
Relinquished By (Signature)	Duane Salisbury	G. Van Deventer	
(Time)	1500	11:20	
(Printed Name)	Duane Salisbury	G. I. Van Deventer	
(Date)	11/19/96	11/20/96	
(Company)	GCL	GCL	
Received By (Signature)	G. Van Deventer	Helen Shelton	(Laboratory)
(Time)	1500	11:00 AM	
(Printed Name)	G. I. Van Deventer	HELEN SHELTON	
(Date)	11/19/96	11/20/96	
(Company)	GCL	TRACE	(Laboratory)

Special Instructions/Comments: ~~Bill directly to Navajo (Darr Griffin)~~ GV

Distribution: White, Canary-Laboratory • Pink, GCL

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue · Lubbock, Texas 79424 · 806•794•1296 · FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Gil VanDeventer
415 W. Wall, Suite 1818
Midland, TX 79701

December 24, 1996
Receiving Date: 12/21/96
Sample Type: Air
Charge Code No: 2033-005
Project Location: NA
COC# 10285

Prep Date: 12/23/96
Analysis Date: 12/23/96
Sampling Date: 12/20/96
Sample Condition: Intact & Cool
Sample Received by: BL
Project Name: Navajo-Lea Refinery

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T64912	9612201217 SVE Exhaust	10,600	53	123	95	136	407
QC	Quality Control	901	102	98	94	286	
Reporting Limit		100	1	1	1	1	
RPD		7	2	2	3	3	
% Instrument Accuracy		91	102	98	94	95	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: McD
MTBE/BTEX QC: 100 mg/m3 MTBE/BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

12/27/96
Date

DISK #165

323

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Environmental Science and Engineering
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Las Cruces, NM 88004
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№ 10285

Chain of Custody

Date 12-20-96 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK TX 79424
Telephone (806) 794-1296

Samplers (SIGNATURES)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1 mod 8015	~~TPH/BTEX Modified 8015~~	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP - Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
96122012-17	Air	SVE Exhaust										✓	✓					-	64912										2

Project Information	Sample Receipt		Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Project Navajo-Lea Refinery	Total No. of Containers	2	(Signature) 1830 (Time)	(Signature) (Time)	(Signature) (Time)
Project Director G. VanDeventer	Chain of Custody Seals	yes	G.I Van Deventer 12-20-96 (Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
Charge Code No. 2033-005	Rec'd Good Condition/Cold	yes	Geoscience Consultants Ltd (Company)	(Company)	(Company)
Shipping ID. No.	Conforms to Record	yes	Received By 1.	Received By 2.	Received By (Laboratory) 3.
Via:	Lab No.		(Signature) (Time)	(Signature) (Time)	Trace Analysis (Signature) (Time) 10AM
Special Instructions/Comments:			(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date) BLAIR Leftwich 12-21-96
			(Company)	(Company)	(Laboratory)

Distribution: White, Canary-Laboratory • Pink, GCL

GCLMOD12.XLS (4141)

356 AE

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Gil VanDeventer
415 W. Wall, Suite 1818
Midland, TX 79701

November 26, 1996
Receiving Date: 11/21/96
Sample Type: Air
Charge Code No: 2033-005
Project Location: NA
COC# 10287

Prep Date: 11/22/96
Analysis Date: 11/22/96
Sampling Date: 11/19/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo - Lea Refining

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T63117	9611190825 SVE Exhaust	12,100	74	154	123	184	535
QC	Quality Control	969	103	103	105	313	
Reporting Limit		100	1	1	1	1	
RPD		4	1	0	0	1	
% Instrument Accuracy		97	103	103	105	104	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: McD
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

11-26-96
Date

DISK #62 378

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№ 10287

Chain of Custody

Date 11-20-96 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK TX 79424
Telephone (806) 794-1296

Samplers (SIGNATURES) [signature]

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/~~BTEX~~ Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
961119 0825	Air	SVE Exhaust 63117		✓									✓																2

Project Information	
Project	Navajo-Lea Refinery
Project Director	Gil Van Deventer
Charge Code No.	2033-005
Shipping ID. No.	126-689-784-1
Via:	Greyhound

Sample Receipt	
Total No. of Containers	2
Chain of Custody Seals	y
Rec'd Good Condition/Cold	y
Conforms to Record	y
Lab No.	

	1.	2.	3.
Relinquished By (Signature)	[signature]	Helen Shelton	[crossed out]
(Printed Name) / (Time)	Gil Van Deventer 1100	HELEN SHELTON 8:00PM	
(Company) / (Date)	GCL 11-20-96	TRACE ANALYSIS	
Received By (Signature)	Helen Shelton	[crossed out]	Received By (Laboratory) Melissa Lopez
(Printed Name) / (Time)	HELEN SHELTON 11:00		M. Lopez 10:00
(Company) / (Date)	TRACE 11-20-96		Trace 11-21-96

Special Instructions/Comments:

Distribution: White, Canary-Laboratory • Pink, GCL

GCLAIRGV.XLS (408) 1 hags - HS 276AA

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Gil VanDeventer
306 W. Wall, Suite 818
Midland, TX 79701

October 22, 1996
Receiving Date: 10/19/96
Sample Type: Air
Charge Code No: 3100-005
Project Location: NA
COC# 9771

Prep Date: 10/21/96
Analysis Date: 10/21/96
Sampling Date: 10/17/96
Sample Condition: I & C
Sample Received by: ML
Project Name: NRC - Lea Refinery

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T60731	9610171530 SVE Exhaust	7,030	56	81	53	89	279
QC	Quality Control	952	101	100	101	299	
Reporting Limit		100	1	1	1	1	
RPD		6	1	1	0	1	
% Instrument Accuracy		95	101	100	101	100	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: RW
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

10-22-96
Date

DISK 43 292

GCL
Environmental Science and Engineering
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❑ NASA-WSTF
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FAX: (505) 524-5315

№ 9771

Chain of Custody

Date 10-18-96 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK, TEXAS 79424
Telephone (806) 794-1296

Samplers (SIGNATURES)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 TVHC	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
9610171530	Air	SVE Exhaust 100731		✓									✓																2

10-22

Project Information	Sample Receipt	Relinquished By	Relinquished By	Relinquished By
Project NRC-Lea Refinery	Total No. of Containers	1. 0900	2. 5:00PM	3.
Project Director Gil VanDeventer	Chain of Custody Seals	(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
Charge Code No. 3100-005	Rec'd Good Condition/Cold	Gil VanDeventer 10-18-96	HELEN SHELTON 10-18-96	(Printed Name) (Date)
Shipping ID. No. 126-689-759-9	Conforms to Record	(Printed Name) (Date)	(Printed Name) (Date)	(Company)
Via: GREYHOUND	Lab No.	Geoscience Consultants, Ltd.	TRACE ANALYSIS	
Special Instructions/Comments:		(Company)	(Company)	
		Received By 1.	Received By 2.	Received By (Laboratory) 3.
		(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
		HELEN SHELTON 9:40AM		M LOPEZ 12:30
		(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
		HELEN SHELTON 10-18-96		Trace Analysis 10-19-96
		TRACE ANALYSIS		(Laboratory)
		(Company)	(Company)	

Distribution: White, Canary-Laboratory • Pink, GCL

GCLAir31.XLS run12 samples - HS

293 AP

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Gil VanDeventer
306 W. Wall, Suite 818
Midland, TX 79701

October 08, 1996
Receiving Date: 10/04/96
Sample Type: Air
Charge Code No: 2033-005
Project Location: NA
COC# 9711

Prep Date: 10/04/96
Analysis Date: 10/04/96
Sampling Date: 10/02/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo-Lea Refining

TA#	Field Code	TVHC (mg/m3)	BENZENE (mg/m3)	TOLUENE (mg/m3)	ETHYL-BENZENE (mg/m3)	M,P,O XYLENE (mg/m3)	TOTAL BTEX (mg/m3)
T59836	9610021310 SVE Exhaust	9,450	107	67	34	45	253
QC	Quality Control	1,068	110	109	109	326	
Reporting Limit		100	1	1	1	1	
RPD		5	1	1	1	2	
% Instrument Accuracy		107	110	109	109	109	

METHODS: EPA SW 846-8020 Modified; 8015 Modified.
CHEMIST: RW
BTEX QC: 100 mg/m3 BTEX.
TVHC QC: 1,000 mg/m3 TVHC.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

10-9-96
Date

DISK #43

GCL
Environmental Science and Engineering
A BDM International Company

❑ Albuquerque
505 Marquette NW, Ste. 1100
Albuquerque, NM 87102
(505) 842-0001
FAX: (505) 842-0595

❑ Mid Atlantic Region
4221 Forbes Blvd., Ste. 240
Lanham, MD 20706-4325
(301) 459-9677
FAX: (301) 459-3064

❑ NASA-WSTF
PO Drawer MM
Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

№ 9711

Chain of Custody

Date 10-3-96 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK, TEXAS 79424
Telephone (806) 794-1296

Samplers (SIGNATURES)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)				Number of Containers
9610021310	Air	SVE Exhaust		✓								✓											59836					2

Project Information		Sample Receipt	
Project	Navajo-Lea Refinery	Total No. of Containers	2
Project Director	Gil Van Deventer	Chain of Custody Seals	Y
Charge Code No.	2033-005	Rec'd Good Condition/Cold	Y
Shipping ID. No.		Conforms to Record	Y
Via:		Lab No.	

Special Instructions/Comments: Send original lab reports to GCL Midland office.

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
(Signature) 1210 (Time)	(Signature) 7:00pm (Time)	(Signature) (Time)
Gil Van Deventer 10-3-96 (Printed Name) (Date)	Bob Shelton 10/3/96 (Printed Name) (Date)	(Printed Name) (Date)
Geoscience Consultants, Ltd (Company)	Trace Analysis, Inc. (Company)	(Company)
Received By 1.	**Received By 2.**	**Received By (Laboratory) 3.**
(Signature) 12:15 (Time)	(Signature) (Time)	(Signature) M Lopez 10:30 (Time)
Bob Shelton 10/3/96 (Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) Trace Analysis 10-4-96 (Date)
Trace Analysis (Company)	(Company)	(Laboratory)

10-9

GCL Air36.XLS(3.5") 78AV

Distribution: White, Canary-Laboratory • Pink, GCL

ATTACHMENT D

LABORATORY ANALYTICAL REPORTS

AND CHAIN OF CUSTODY DOCUMENTATION

(Samples submitted by OCD)

NEW MEXICO ENERGY, MINERALS
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

January 8, 1997

Mr. Gilbert Van Deventer
BDM International, Inc.
415 West Wall, Suite 1818
Midland, Texas 79701

RE: SAMPLE ANALYSES
NAVAJO REFINERY
EDDY COUNTY, NEW MEXICO

Dear Mr. Van Deventer:

Enclosed you will find the laboratory analytical results of the New Mexico Oil Conservation Division's (OCD) November 19, 1996 monitor well sampling at the Navajo Lea Refinery in Lovington, New Mexico.

If you have any questions, please call me at (505) 827-7154.

Sincerely,

William C. Olson
Hydrogeologist
Environmental Bureau

Enclosure

xc: Jerry Sexton, OCD Hobbs District Supervisor
Wayne Price, OCD Hobbs District Office

American Environmental Network, Inc.

AEN I.D. 611334

December 16, 1996

N.M. OIL CONSERVATION DIVISION
2040 SOUTH PACHECO
SANTA FE, NM 87505

Project Name Navajo Lea Refinery
Project Number (none)

Attention: BILL OLSON

On 11/20/96 American Environmental Network (NM), Inc. (ADHS License No. AZ0015), received a request to analyze **aqueous** samples. The samples were analyzed with EPA methodology or equivalent methods. The results of these analyses and the quality control data, which follow each set of analyses, are enclosed.

EPA method 8010/8020 was performed by American Environmental Network (NM) Inc., Albuquerque, NM.

EPA method 8310 was performed by American Environmental Network (FL) Inc., Pensacola, FL.

All other analyses were performed by American Environmental Network (AZ) Inc., 9830 S. 51st Street, Suite B-113, Phoenix, AZ.

If you have any questions or comments, please do not hesitate to contact us at (505)344-3777.

Kimberly D. McNeill
Project Manager

H. Mitchell Rubenstein, Ph. D.
General Manager

MR: mt

Enclosure

2709-D Pan American Freeway, NE • Albuquerque, NM 87107 • (505) 344-3777 • Fax (505) 344-4413

American Environmental Network, Inc.

CLIENT : AMERICAN ENV. NETWORK OF NM, INC.
PROJECT # : 611334
PROJECT NAME : NMOCD

ATI I.D. : 611750

ATI #	CLIENT DESCRIPTION	MATRIX	DATE COLLECTED
01	611334-01	AQUEOUS	11/19/96
02	611334-02	AQUEOUS	11/19/96
03	611334-03	AQUEOUS	11/19/96

----- TOTALS -----

MATRIX	# SAMPLES
AQUEOUS	3

ATI STANDARD DISPOSAL PRACTICE

The samples from this project will be disposed of in thirty (30) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

American Environmental Network, Inc.

CLIENT	: N.M. OIL CONSERVATION DIVISION	AEN I.D.	: 611334
PROJECT #	: (none)	DATE RECEIVED	: 11/20/96
PROJECT NAME	: Navajo Lea Refinery	REPORT DATE	: 12/16/96

AEN ID. #	CLIENT DESCRIPTION	MATRIX	DATE COLLECTED
01	MW-10 (9611191005)	AQUEOUS	11/19/96
02	MW-3 (9611191105)	AQUEOUS	11/19/96
03	MW-8 (9611191210)	AQUEOUS	11/19/96
04	TRIP BLANK	AQUEOUS	11/15/96

American Environmental Network, Inc.

GENERAL CHEMISTRY RESULTS

ATI I.D. : 611750

CLIENT : AMERICAN ENV. NETWORK OF NM, INC.
PROJECT # : 611334
PROJECT NAME : NMOCD : 12/12/96

PARAMETER	UNITS	01	02	03
CARBONATE (CACO3)	MG/L	<1	<1	<1
BICARBONATE (CACO3)	MG/L	202	258	320
HYDROXIDE (CACO3)	MG/L	<1	<1	<1
TOTAL ALKALINITY (AS CACO3)	MG/L	202	258	320
BROMIDE (EPA 300.0)	MG/L	0.4	0.6	0.8
CHLORIDE (EPA 325.2)	MG/L	27	80	180
CONDUCTIVITY, (UMHOS/CM)		621	832	1260
FLUORIDE (EPA 340.2)	MG/L	1.03	0.85	1.48
PH (EPA 150.1)	UNITS	7.8	7.5	7.2
SULFATE (EPA 375.2)	MG/L	100	80	100
T. DISSOLVED SOLIDS (160.1)	MG/L	420	550	780

American Environmental Network, Inc.

GENERAL CHEMISTRY - QUALITY CONTROL

CLIENT : AMERICAN ENV. NETWORK OF NM, INC.
PROJECT # : 611334
PROJECT NAME : NMOCD ATI I.D. : 611750

PARAMETER	UNITS	ATI I.D.	SAMPLE RESULT	DUP. RESULT	RPD	SPIKED SAMPLE	SPIKE CONC	% REC
CARBONATE	MG/L	61175001	<1	<1	NA	NA	NA	NA
BICARBONATE	MG/L		202	200	1	NA	NA	NA
HYDROXIDE	MG/L		<1	<1	NA	NA	NA	NA
TOTAL ALKALINITY	MG/L		202	200	1	NA	NA	NA
BROMIDE	MG/L	61175001	0.4	0.4	0	2.4	2.0	100
CHLORIDE	MG/L	61175002	80	80	0	180	100	100
CONDUCTIVITY(UMHOS/CM)		61172401	833	831	0.2	NA	NA	NA
FLUORIDE	MG/L	61168702	1.98	1.97	0.5	3.97	2.00	100
PH	UNITS	61175001	7.8	7.7	1	NA	NA	NA
SULFATE	MG/L	61181701	16	16	0	32	20	80
TOTAL DISSOLVED SOLIDS	MG/L	61175001	420	430	2	NA	NA	NA

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative Percent Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

American Environmental Network, Inc.

METALS RESULTS

ATI I.D. : 611750

CLIENT : AMERICAN ENV. NETWORK OF NM, INC.
PROJECT # : 611334
PROJECT NAME : NMOCD

PARAMETER	UNITS	01	02	03
CALCIUM (EPA 200.7/6010)	MG/L	87.2	115	132
POTASSIUM (EPA 200.7/6010)	MG/L	3.5	2.1	5.2
MAGNESIUM (EPA 200.7/6010)	MG/L	9.7	14.1	14.7
SODIUM (EPA 200.7/6010)	MG/L	40.4	50.4	171

American Environmental Network, Inc.

METALS - QUALITY CONTROL

CLIENT : AMERICAN ENV. NETWORK OF NM, INC.
PROJECT # : 611334
PROJECT NAME : NMOCD ATI I.D. : 611750

PARAMETER	UNITS	ATI I.D.	SAMPLE RESULT	DUP. RESULT	RPD	SPIKED SAMPLE	SPIKE CONC	% REC
CALCIUM	MG/L	61175003	132	130	2	178	50.0	92
POTASSIUM	MG/L	61175003	5.2	5.0	4	119	100	114
MAGNESIUM	MG/L	61175003	14.7	14.6	0.7	39.6	25.0	100
SODIUM	MG/L	61175003	171	170	0.6	228	50.0	114

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative Percent Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

American Environmental Network, Inc.

DATE: 12-10-96

ION BALANCE

AEN ACCESSION NUMBER: 61175001
SAMPLE IDENTIFICATION: 611334-01
CLIENT: AMERICAN ENV. NETWORK OF NM, INC.

ANIONS	RESULT MG/L	FACTOR ME/L	TOTAL	
ALKALINITY (AS $CACO_3$)	202.000	0.02000	4.04000	
CHLORIDE	27.000	0.02821	0.76167	
FLUORIDE	1.030	0.05264	0.05422	
NITRATE AS N (NO_3(NO_3-N X 4.43)	NA	0.01613	0.00000	
SiO_3 (SILICON X 2.71)	NA	0.02629	0.00000	
SULFATE	100.000	0.02082	2.08200	
		TOTAL ANIONS		6.937889

CATIONS	RESULT	FACTOR	TOTAL	
CALCIUM	87.200	0.04990	4.35128	
POTASSIUM	3.500	0.02558	0.08953	
MAGNESIUM	9.700	0.08229	0.79821	
SODIUM	40.400	0.04350	1.75740	
		TOTAL CATIONS		6.996423
		%RPD (<10%)*		-0.84
TOTAL ANIONS/CATIONS	(CALCULATED)	390.030		
TOTAL DISSOLVED SOLIDS	(ANALYZED)	420	%RPD (<15%)*	-7.40
ELECTRICAL COND.		621	TDS/EC RATIO (0.65+/-0.10)	0.68

* If either Total Cations or Total Anions <10, then the %RPD Limit is not applicable.

American Environmental Network, Inc.

DATE: 12-10-96

ION BALANCE

AEN ACCESSION NUMBER: 61175002
SAMPLE IDENTIFICATION: 611334-02
CLIENT: AMERICAN ENV. NETWORK OF NM, INC.

ANIONS	RESULT MG/L	FACTOR ME/L	TOTAL	
ALKALINITY (AS $CaCO_3$)	258.000	0.02000	5.16000	
CHLORIDE	80.000	0.02821	2.25680	
FLUORIDE	0.850	0.05264	0.04474	
NITRATE AS N (NO_3(NO_3-N X 4.43)	NA	0.01613	0.00000	
SiO_3 (SILICON X 2.71)	NA	0.02629	0.00000	
SULFATE	80.000	0.02082	1.66560	
		TOTAL ANIONS		9.127144

CATIONS	RESULT	FACTOR	TOTAL	
CALCIUM	115.000	0.04990	5.7385	
POTASSIUM	2.100	0.02558	0.05372	
MAGNESIUM	14.100	0.08229	1.16029	
SODIUM	50.400	0.04350	2.19240	
		TOTAL CATIONS		9.144907
		%RPD (<10%)*		-0.19
TOTAL ANIONS/CATIONS	(CALCULATED)	497.250		
TOTAL DISSOLVED SOLIDS	(ANALYZED)	550	%RPD (<15%)*	-10.07
ELECTRICAL COND.		832	TDS/EC RATIO (0.65+/-0.10)	0.66

* If either Total Cations or Total Anions <10, then the %RPD Limit is not applicable.

American Environmental Network, Inc.

DATE: 12-10-96

ION BALANCE

AEN ACCESSION NUMBER: 61175003
SAMPLE IDENTIFICATION: 611334-03
CLIENT: AMERICAN ENV. NETWORK OF NM, INC.

ANIONS	RESULT MG/L	FACTOR ME/L	TOTAL	
ALKALINITY (AS $CACO_3$)	320.000	0.02000	6.40000	
CHLORIDE	180.000	0.02821	5.07780	
FLUORIDE	1.480	0.05264	0.07791	
NITRATE AS N (NO_3(NO_3-N X 4.43)	NA	0.01613	0.00000	
SiO_3 (SILICON X 2.71)	NA	0.02629	0.00000	
SULFATE	100.000	0.02082	2.08200	
		TOTAL ANIONS		13.63771

CATIONS	RESULT	FACTOR	TOTAL	
CALCIUM	132.000	0.04990	6.5868	
POTASSIUM	5.200	0.02558	0.13302	
MAGNESIUM	14.700	0.08229	1.20966	
SODIUM	171.000	0.04350	7.43850	
		TOTAL CATIONS		15.36798
		%RPD (<10%)*		-11.93
TOTAL ANIONS/CATIONS	(CALCULATED)	796.380		
TOTAL DISSOLVED SOLIDS	(ANALYZED)	780	%RPD (<15%)*	2.08
ELECTRICAL COND.		1260	TDS/EC RATIO (0.65+/-0.10)	0.62

* If either Total Cations or Total Anions <10, then the %RPD Limit is not applicable.

American Environmental Network, Inc.

GAS CHROMOTOGRAPHY RESULTS

TEST : PURGEABLE HALOCARBONS / AROMATICS (EPA 601/602)
CLIENT : N.M. OIL CONSERVATION DIVISION AEN I.D.: 611334
PROJECT # : (none)
PROJECT NAME : Navajo Lea Refinery

SAMPLE ID. #	CLIENT I.D.	MATRIX	DATE SAMPLED	DATE EXTRACTED	DATE ANALYZED	DIL. FACTOR
01	MW-10 (9611191005)	AQUEOUS	11/19/96	NA	11/21/96	1
02	MW-3 (9611191105)	AQUEOUS	11/19/96	NA	11/21/96	1
03	MW-8 (9611191210)	AQUEOUS	11/19/96	NA	11/21/96	1

PARAMETER	DET. LIMIT	UNITS	01	02	03
BENZENE	0.5	UG/L	< 0.5	< 0.5	< 0.5
BROMODICHLORMETHANE	0.2	UG/L	< 0.2	< 0.2	< 0.2
BROMOFORM	0.5	UG/L	< 0.5	< 0.5	< 0.5
BROMOMETHANE	1.0	UG/L	< 1.0	< 1.0	< 1.0
CARBON TETRACHLORIDE	0.2	UG/L	< 0.2	< 0.2	< 0.2
CHLOROBENZENE	0.5	UG/L	< 0.5	< 0.5	< 0.5
CHLOROETHANE	0.5	UG/L	< 0.5	< 0.5	< 0.5
CHLOROFORM	0.5	UG/L	< 0.5	< 0.5	< 0.5
CHLOROMETHANE	1.0	UG/L	< 1.0	< 1.0	< 1.0
DIBROMOCHLOROMETHANE	0.2	UG/L	< 0.2	< 0.2	< 0.2
1,2-DIBROMOETHANE (EDB)	0.2	UG/L	< 0.2	< 0.2	< 0.2
1,2-DICHLOROBENZENE	0.5	UG/L	< 0.5	< 0.5	< 0.5
1,3-DICHLOROBENZENE	0.5	UG/L	< 0.5	< 0.5	< 0.5
1,4-DICHLOROBENZENE	0.5	UG/L	< 0.5	< 0.5	< 0.5
1,1-DICHLOROETHANE	0.3	UG/L	< 0.3	< 0.3	< 0.3
1,2-DICHLOROETHANE (EDC)	0.5	UG/L	< 0.5	< 0.5	< 0.5
1,1-DICHLOROETHENE	0.2	UG/L	< 0.2	< 0.2	< 0.2
cis-1,2-DICHLOROETHENE	0.2	UG/L	< 0.2	< 0.2	< 0.2
trans-1,2-DICHLOROETHENE	1.0	UG/L	< 1.0	< 1.0	< 1.0
1,2-DICHLOROPROPANE	0.2	UG/L	< 0.2	< 0.2	< 0.2
cis-1,3-DICHLOROPROPENE	0.2	UG/L	< 0.2	< 0.2	< 0.2
trans-1,3-DICHLOROPROPENE	0.2	UG/L	< 0.2	< 0.2	< 0.2
ETHYLBENZENE	0.5	UG/L	< 0.5	< 0.5	< 0.5
METHYL-t-BUTYL ETHER	2.5	UG/L	< 2.5	< 2.5	< 2.5
METHYLENE CHLORIDE	2.0	UG/L	< 2.0	< 2.0	< 2.0
1,1,2,2-TETRACHLOROETHANE	0.5	UG/L	< 0.5	< 0.5	< 0.5
TETRACHLOROETHENE	0.5	UG/L	< 0.5	< 0.5	< 0.5
TOLUENE	0.5	UG/L	< 0.5	< 0.5	< 0.5
1,1,1-TRICHLOROETHANE	1.0	UG/L	< 1.0	< 1.0	< 1.0
1,1,2-TRICHLOROETHANE	0.2	UG/L	< 0.2	< 0.2	< 0.2
TRICHLOROETHENE	0.3	UG/L	< 0.3	< 0.3	< 0.3
TRICHLOROFLUOROMETHANE	0.2	UG/L	< 0.2	< 0.2	< 0.2
VINYL CHLORIDE	0.5	UG/L	< 0.5	< 0.5	< 0.5
TOTAL XYLENES	0.5	UG/L	< 0.5	< 0.5	< 0.5
SURROGATE:					
BROMOCHLOROMETHANE (%)			101	105	104
SURROGATE LIMITS	(73 - 117)				
TRIFLUOROTOLUENE (%)			94	93	99
SURROGATE LIMITS	(69 - 117)				

CHEMIST NOTES:
N/A

American Environmental Network, Inc.

GAS CHROMOTOGRAPHY RESULTS

TEST : PURGEABLE HALOCARBONS / AROMATICS (EPA 601/602)
CLIENT : N.M. OIL CONSERVATION DIVISION AEN I.D.: 611334
PROJECT # : (none)
PROJECT NAME : Navajo Lea Refinery

SAMPLE ID. #	CLIENT I.D.	MATRIX	DATE SAMPLED	DATE EXTRACTED	DATE ANALYZED	DIL. FACTOR
04	TRIP BLANK	AQUEOUS	11/15/96	NA	11/21/96	1

PARAMETER	DET. LIMIT	UNITS	04
BENZENE	0.5	UG/L	< 0.5
BROMODICHLORMETHANE	0.2	UG/L	< 0.2
BROMOFORM	0.5	UG/L	< 0.5
BROMOMETHANE	1.0	UG/L	< 1.0
CARBON TETRACHLORIDE	0.2	UG/L	< 0.2
CHLOROBENZENE	0.5	UG/L	< 0.5
CHLOROETHANE	0.5	UG/L	< 0.5
CHLOROFORM	0.5	UG/L	< 0.5
CHLOROMETHANE	1.0	UG/L	< 1.0
DIBROMOCHLOROMETHANE	0.2	UG/L	< 0.2
1,2-DIBROMOETHANE (EDB)	0.2	UG/L	< 0.2
1,2-DICHLOROBENZENE	0.5	UG/L	< 0.5
1,3-DICHLOROBENZENE	0.5	UG/L	< 0.5
1,4-DICHLOROBENZENE	0.5	UG/L	< 0.5
1,1-DICHLOROETHANE	0.3	UG/L	< 0.3
1,2-DICHLOROETHANE (EDC)	0.5	UG/L	< 0.5
1,1-DICHLOROETHENE	0.2	UG/L	< 0.2
cis-1,2-DICHLOROETHENE	0.2	UG/L	< 0.2
trans-1,2-DICHLOROETHENE	1.0	UG/L	< 1.0
1,2-DICHLOROPROPANE	0.2	UG/L	< 0.2
cis-1,3-DICHLOROPROPENE	0.2	UG/L	< 0.2
trans-1,3-DICHLOROPROPENE	0.2	UG/L	< 0.2
ETHYLBENZENE	0.5	UG/L	< 0.5
METHYL-t-BUTYL ETHER	2.5	UG/L	< 2.5
METHYLENE CHLORIDE	2.0	UG/L	< 2.0
1,1,2,2-TETRACHLOROETHANE	0.5	UG/L	< 0.5
TETRACHLOROETHENE	0.5	UG/L	< 0.5
TOLUENE	0.5	UG/L	< 0.5
1,1,1-TRICHLOROETHANE	1.0	UG/L	< 1.0
1,1,2-TRICHLOROETHANE	0.2	UG/L	< 0.2
TRICHLOROETHENE	0.3	UG/L	< 0.3
TRICHLOROFLUOROMETHANE	0.2	UG/L	< 0.2
VINYL CHLORIDE	0.5	UG/L	< 0.5
TOTAL XYLENES	0.5	UG/L	< 0.5
SURROGATE:			
BROMOCHLOROMETHANE (%)			103
SURROGATE LIMITS	(73 - 117)		
TRIFLUOROTOLUENE (%)			105
SURROGATE LIMITS	(69 - 117)		

CHEMIST NOTES:
N/A

American Environmental Network, Inc.

GAS CHROMOTOGRAPHY RESULTS
REAGENT BLANK

TEST	: PURGEABLE HALOCARBONS / AROMATICS (EPA 601/602)		
BLANK I.D.	: 112196	AEN I.D.	: 611334
CLIENT	: N.M. OIL CONSERVATION DIVISION	DATE EXTRACTED	: NA
PROJECT #	: (none)	DATE ANALYZED	: 11/21/96
PROJECT NAME	: Navajo Lea Refinery	SAMPLE MATRIX	: AQUEOUS

PARAMETER	UNITS	
BENZENE	UG/L	<0.5
BROMODICHLORMETHANE	UG/L	<0.2
BROMOFORM	UG/L	<0.5
BROMOMETHANE	UG/L	<1.0
CARBON TETRACHLORIDE	UG/L	<0.2
CHLOROBENZENE	UG/L	<0.5
CHLOROETHANE	UG/L	<0.5
CHLOROFORM	UG/L	<0.5
CHLOROMETHANE	UG/L	<1.0
DIBROMOCHLOROMETHANE	UG/L	<0.2
1,2-DIBROMOETHANE (EDB)	UG/L	<0.2
1,2-DICHLOROBENZENE	UG/L	<0.5
1,3-DICHLOROBENZENE	UG/L	<0.5
1,4-DICHLOROBENZENE	UG/L	<0.5
1,1-DICHLOROETHANE	UG/L	<0.3
1,2-DICHLOROETHANE (EDC)	UG/L	<0.5
1,1-DICHLOROETHENE	UG/L	<0.2
cis-1,2-DICHLOROETHENE	UG/L	<0.2
trans-1,2-DICHLOROETHENE	UG/L	<1.0
1,2-DICHLOROPROPANE	UG/L	<0.2
cis-1,3-DICHLOROPROPENE	UG/L	<0.2
trans-1,3-DICHLOROPROPENE	UG/L	<0.2
ETHYLBENZENE	UG/L	<0.5
METHYL -t-BUTYL ETHER	UG/L	<2.5
METHYLENE CHLORIDE	UG/L	<2.0
1,1,2,2-TETRACHLOROETHANE	UG/L	<0.5
TETRACHLOROETHENE	UG/L	<0.5
TOLUENE	UG/L	<0.5
1,1,1-TRICHLOROETHANE	UG/L	<1.0
1,1,2-TRICHLOROETHANE	UG/L	<0.2
TRICHLOROETHENE	UG/L	<0.3
TRICHLOROFLUOROMETHANE	UG/L	<0.2
VINYL CHLORIDE	UG/L	<0.5
TOTAL XYLENES	UG/L	<0.5
SURROGATE:		
BROMOCHLOROMETHANE (%)		105
SURROGATE LIMITS	(73 - 117)	
TRIFLUOROTOLUENE (%)		95
SURROGATE LIMITS	(69 - 117)	

CHEMIST NOTES:
N/A

American Environmental Network, Inc.

GAS CHROMOTOGRAPHY QUALITY CONTROL
MSMSD

TEST	: PURGEABLE HALOCARBONS / AROMATICS (EPA 601/602)		
MSMSD #	: 611334-03	AEN I.D.	: 611334
CLIENT	: N.M. OIL CONSERVATION DIVISION	DATE EXRACTED	: NA
PROJECT #	: (none)	DATE ANALYZED	: 11/21/96
PROJECT NAME	: Navajo Lea Refinery	SAMPLE MATRIX	: AQUEOUS
		UNITS	: UG/L

PARAMETER	SAMPLE RESULT	CONC SPIKE	SPIKED SAMPLE	% REC	DUP SPIKE	DUP % REC	RPD	REC LIMITS	RPD LIMITS
BENZENE	<0.5	10.0	9.9	99	10.3	103	4	(82 -128)	20
TOLUENE	<0.5	10.0	9.7	97	10.4	104	7	(87 -128)	20
1,1-DICHLOROETHENE	<0.2	10.0	9.0	90	9.9	99	10	(44 - 99)	20
TRICHLOROETHENE	<0.3	10.0	11.5	115	11.8	118	3	(89 - 127)	20
CHLOROBENZENE	<0.5	10.0	9.7	97	10.7	107	10	(87 - 124)	20

CHEMIST NOTES:
N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative Percent Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

American Environmental Network, Inc.

"FINAL REPORT FORMAT - SINGLE"

Accession:	611559
Client:	AMERICAN ENVIRONMENTAL NETWORK OF NEW MEXICO
Project Number:	611334
Project Name:	NMOCD
Project Location:	N/S
Test:	POLYNUCLEAR AROMATICS BY 8310
Analysis Method:	8310/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.
Extraction Method:	3510/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.
Matrix:	WATER
QC Level:	II

Lab Id:	001	Sample Date/Time:	19-NOV-96 1005
Client Sample Id:	611334-01	Received Date:	21-NOV-96
Batch: PAW220		Extraction Date:	22-NOV-96
Blank: B	Dry Weight %: N/A	Analysis Date:	26-NOV-96

Parameter:	Units:	Results:	Rpt Lmts:	Q:
ACENAPHTHENE	UG/L	ND	1	
ACENAPHTHYLENE	UG/L	ND	1	
ANTHRACENE	UG/L	ND	1	
BENZO(a)ANTHRACENE	UG/L	ND	1	
BENZO(a)PYRENE	UG/L	ND	0.1	
BENZO(b)FLUORANTHENE	UG/L	ND	1	
BENZO(g,h,i)PERYLENE	UG/L	ND	1	
BENZO(k)FLUORANTHENE	UG/L	ND	1	
CHRYSENE	UG/L	ND	1	
DIBENZO(a,h)ANTHRACENE	UG/L	ND	1	
FLUORANTHENE	UG/L	ND	1	
FLUORENE	UG/L	ND	1	
INDENO(1,2,3-cd)PYRENE	UG/L	ND	1	
NAPHTHALENE	UG/L	ND	1	
PHENANTHRENE	UG/L	ND	1	
PYRENE	UG/L	ND	1	
1-METHYLNAPHTHALENE	UG/L	ND	1	
2-METHYLNAPHTHALENE	UG/L	ND	1	
2-CHLOROANTHRACENE	%REC/SURR	78	28-138	
ANALYST	INITIALS	JBT		

Comments:

American Environmental Network, Inc.

"FINAL REPORT FORMAT - SINGLE"

Accession:	611559
Client:	AMERICAN ENVIRONMENTAL NETWORK OF NEW MEXICO
Project Number:	611334
Project Name:	NMOCD
Project Location:	N/S
Test:	POLYNUCLEAR AROMATICS BY 8310
Analysis Method:	8310/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.
Extraction Method:	3510/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.
Matrix:	WATER
QC Level:	II

Lab Id:	002	Sample Date/Time:	19-NOV-96 1105
Client Sample Id:	611334-02	Received Date:	21-NOV-96
Batch: PAW220		Extraction Date:	22-NOV-96
Blank: B	Dry Weight %: N/A	Analysis Date:	26-NOV-96

Parameter:	Units:	Results:	Rpt Lmts:	Q:
ACENAPHTHENE	UG/L	ND	1	
ACENAPHTHYLENE	UG/L	ND	1	
ANTHRACENE	UG/L	ND	1	
BENZO(a)ANTHRACENE	UG/L	ND	1	
BENZO(a)PYRENE	UG/L	ND	0.1	
BENZO(b)FLUORANTHENE	UG/L	ND	1	
BENZO(g,h,i)PERYLENE	UG/L	ND	1	
BENZO(k)FLUORANTHENE	UG/L	ND	1	
CHRYSENE	UG/L	ND	1	
DIBENZO(a,h)ANTHRACENE	UG/L	ND	1	
FLUORANTHENE	UG/L	ND	1	
FLUORENE	UG/L	ND	1	
INDENO(1,2,3-cd)PYRENE	UG/L	ND	1	
NAPHTHALENE	UG/L	ND	1	
PHENANTHRENE	UG/L	ND	1	
PYRENE	UG/L	ND	1	
1-METHYLNAPHTHALENE	UG/L	ND	1	
2-METHYLNAPHTHALENE	UG/L	ND	1	
2-CHLOROANTHRACENE	%REC/SURR	76	28-138	
ANALYST	INITIALS	JBT		

Comments:

American Environmental Network, Inc.

"FINAL REPORT FORMAT - SINGLE"

Accession:	611559
Client:	AMERICAN ENVIRONMENTAL NETWORK OF NEW MEXICO
Project Number:	611334
Project Name:	NMOCD
Project Location:	N/S
Test:	POLYNUCLEAR AROMATICS BY 8310
Analysis Method:	8310/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.
Extraction Method:	3510/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.
Matrix:	WATER
QC Level:	II

Lab Id:	003	Sample Date/Time:	19-NOV-96 1210
Client Sample Id:	611334-03	Received Date:	21-NOV-96
Batch: PAW220		Extraction Date:	22-NOV-96
Blank: B	Dry Weight %: N/A	Analysis Date:	27-NOV-96

Parameter:	Units:	Results:	Rpt Lmts:	Q:
ACENAPHTHENE	UG/L	1	1	
ACENAPHTHYLENE	UG/L	ND	1	
ANTHRACENE	UG/L	ND	1	
BENZO(a)ANTHRACENE	UG/L	ND	1	
BENZO(a)PYRENE	UG/L	ND	0.1	
BENZO(b)FLUORANTHENE	UG/L	ND	1	
BENZO(g,h,i)PERYLENE	UG/L	ND	1	
BENZO(k)FLUORANTHENE	UG/L	ND	1	
CHRYSENE	UG/L	ND	1	
DIBENZO(a,h)ANTHRACENE	UG/L	ND	1	
FLUORANTHENE	UG/L	ND	1	
FLUORENE	UG/L	ND	1	
INDENO(1,2,3-cd)PYRENE	UG/L	ND	1	
NAPHTHALENE	UG/L	ND	1	
PHENANTHRENE	UG/L	ND	1	
PYRENE	UG/L	ND	1	
1-METHYLNAPHTHALENE	UG/L	ND	1	
2-METHYLNAPHTHALENE	UG/L	ND	1	
2-CHLOROANTHRACENE	%REC/SURR	66	28-138	
ANALYST	INITIALS	JBT		

Comments:

American Environmental Network, Inc.

"Method Report Summary"

Accession Number: 611559
Client: AMERICAN ENVIRONMENTAL NETWORK OF NEW MEXICO
Project Number: 611334
Project Name: NMOCD
Project Location: N/S
Test: POLYNUCLEAR AROMATICS BY 8310

Client Sample Id:	Parameter:	Unit:	Result:
611334-03	ACENAPHTHENE	UG/L	1

"QC Report"

Title: Water Blank
Batch: PAW220
Analysis Method: 8310/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.
Extraction Method: 3510/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.

Blank Id: B Date Analyzed: 26-NOV-96 Date Extracted: 22-NOV-96

Parameters:	Units:	Results:	Reporting Limits:
ACENAPHTHENE	UG/L	ND	1
ACENAPHTHYLENE	UG/L	ND	1
ANTHRACENE	UG/L	ND	1
BENZO(a)ANTHRACENE	UG/L	ND	1
BENZO(a)PYRENE	UG/L	ND	1
BENZO(b)FLUORANTHENE	UG/L	ND	1
BENZO(g,h,i)PERYLENE	UG/L	ND	1
BENZO(k)FLUORANTHENE	UG/L	ND	1
CHRYSENE	UG/L	ND	1
DIBENZO(a,h)ANTHRACENE	UG/L	ND	1
FLUORANTHENE	UG/L	ND	1
FLUORENE	UG/L	ND	1
INDENO(1,2,3-cd)PYRENE	UG/L	ND	1
NAPHTHALENE	UG/L	ND	1
PHENANTHRENE	UG/L	ND	1
PYRENE	UG/L	ND	1
1-METHYLNAPHTHALENE	UG/L	ND	1
2-METHYLNAPHTHALENE	UG/L	ND	1
2-CHLOROANTHRACENE	%REC/SURR	88	28-138
ANALYST	INITIALS	JBT	

Comments:

American Environmental Network, Inc.

"QC Report"

Title: Water Reagent
Batch: PAW220
Analysis Method: 8310/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.
Extraction Method: 3510/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.

RS Date Analyzed: 24-NOV-96
RSD Date Analyzed: 24-NOV-96
RS Date Extracted: 21-NOV-96
RSD Date Extracted: 21-NOV-96

Parameters:	Spike Added	Sample Conc	RS Conc	RS %Rec	RSD Conc	RSD %Rec	RPD	RPD Lmts	Rec Lmts
ACENAPHTHYLENE	10.0	<1	5.0	50	5.0	50	0	46	46-110
BENZO(k)FLUORANTHENE	10.0	<1	8.0	80	7.9	79	1	30	58-128
CHRYSENE	10.0	<1	7.7	77	7.8	78	1	29	62-129
PHENANTHRENE	10.0	<1	7.7	77	7.7	77	0	28	61-116
PYRENE	10.0	<1	7.7	77	7.7	77	0	26	62-120
Surrogates:									
2-CHLOROANTHRACENE				81		81			28-138

Comments:

Notes:
N/S = NOT SUBMITTED N/A = NOT APPLICABLE D = DILUTED OUT
UG/L = PARTS PER BILLION. < = LESS THAN REPORTING LIMIT.
* = VALUES OUTSIDE OF QUALITY CONTROL LIMITS.
SOURCES FOR CONTROL LIMITS ARE INTERNAL LABORATORY QUALITY ASSURANCE PROGRAM AND REFERENCED METHOD.

American Environmental Network, Inc.

"QC Report"

Title: Water Matrix
Batch: PAW220
Analysis Method: 8310/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.
Extraction Method: 3510/Test Methods for Evaluating Solid and Haz Waste, SW-846, 3rd Ed.

Dry Weight %: N/A
Sample Spiked: 611559-2

MS Date Analyzed: 26-NOV-96
MSD Date Analyzed: 27-NOV-96

MS Date Extracted: 22-NOV-96
MSD Date Extracted: 22-NOV-96

Parameters:	Spike Added	Sample Conc	MS Conc	MS %Rec	MSD Conc	MSD %Rec	RPD	RPD Lmts	Rec Lmts
ACENAPHTHYLENE	10.0	<1	6.6	66	7.0	70	6	42	14-135
BENZO(k)FLUORANTHENE	10.0	<1	4.6	46	5.3	53	14	58	25-142
CHRYSENE	10.0	<1	6.3	63	7.0	70	11	51	3-176
PHENANTHRENE	10.0	<1	6.9	69	7.6	76	10	55	27-146
PYRENE	10.0	<1	6.9	69	7.7	77	11	47	15-157
Surrogates:									
2-CHLOROANTHRACENE				80		90			28-138

Comments:

Notes:
N/S = NOT SUBMITTED N/A = NOT APPLICABLE D = DILUTED OUT
UG/L = PARTS PER BILLION. < = LESS THAN REPORTING LIMIT.
* = VALUES OUTSIDE OF QUALITY CONTROL LIMITS.
SOURCES FOR CONTROL LIMITS ARE INTERNAL LABORATORY QUALITY ASSURANCE PROGRAM AND REFERENCED METHOD.

American Environmental Network, Inc.

Common notation for Organic reporting

N/S = NOT SUBMITTED
N/A = NOT APPLICABLE
D = DILUTED OUT
UG = MICROGRAMS
UG/L = PARTS PER BILLION.
UG/KG = PARTS PER BILLION.
MG/M3 = MILLIGRAM PER CUBIC METER.
PPMV = PART PER MILLION BY VOLUME.
MG/KG = PARTS PER MILLION.
MG/L = PARTS PER MILLION.
< = LESS THAN DETECTION LIMIT.
* = VALUES OUTSIDE OF QUALITY CONTROL LIMITS

SOURCES FOR CONTROL LIMITS ARE INTERNAL LABORATORY QUALITY ASSURANCE PROGRAM AND REFERENCED METHOD.

ORGANIC SOILS ARE REPORTED ON A DRYWEIGHT BASIS.

ND = NOT DETECTED ABOVE REPORTING LIMIT.

RPT LIMIT = REPORTING LIMITS BASED ON METHOD DETECTION LIMIT STUDIES.

RPD = RELATIVE PERCENT DIFFERENCE (OR DEVIATION)

AEN/GC/FID
AEN GAS CHROMATOGRAPHIC METHOD EMPLOYING DIRECT INJECTION ON COLUMN WITH FLAME IONIZATION DETECTOR (FID).

AEN/GC/FIX
AEN GAS CHROMATOGRAPHIC METHOD FOR ANALYSIS OF FIXED GASES EMPLOYING DIRECT INJECTION ON COLUMN WITH THERMAL CONDUCTIVITY DETECTOR (TCD) AND FLAME IONIZATION DETECTOR (FID).

AEN/GC/FPD
AEN GAS CHROMATOGRAPHIC METHOD EMPLOYING DIRECT INJECTION ON COLUMN WITH FLAME PHOTOMETRIC DETECTOR (FPD) IN SULFUR-SPECIFIC MODE.

AEN/GC/PID
AEN GAS CHROMATOGRAPHIC METHOD EMPLOYING DIRECT INJECTION ON COLUMN WITH PHOTOIONIZATION DETECTOR (PID).

AEN/GC/TCD
AEN GAS CHROMATOGRAPHIC METHOD EMPLOYING DIRECT INJECTION ON COLUMN WITH THERMAL CONDUCTIVITY DETECTOR (TCD).

SW = STEVE WILHITE
PL = PAUL LESCHENSKY
RW = ROBERT WOLFE
BV = BEN VAUGHN
BC = BETH COLEMAN
KS = KENDALL SMITH
KK = KERRY LEMONT
DWB = DAVID W. BOWERS
RP = ROB PEREZ
JBT = JENNIFER TORRANCE
LP = LAVERNE PETERSON

American Environmental Network (NM), Inc.
Albuquerque • Phoenix • Pensacola • Portland • Pleasant Hills • Columbia

CHAIN OF CUSTODY

DATE: 11/20/96 PAGE: 1 OF 1

AEN LAB I.D. 6411334

SHADED AREAS ARE FOR LAB USE ONLY.

PLEASE FILL THIS FORM IN COMPLETELY.

PROJECT MANAGER: Bill Olson

COMPANY: N.M. Oil Conservation Division
ADDRESS: 2040 S. Pacheco
Santa Fe, NM. 87505
PHONE: (505) 827-7154
FAX: (505) 827-8177

BILL TO: Same
COMPANY:
ADDRESS:

ANALYSIS REQUEST

SAMPLE ID	DATE	TIME	MATRIX	LAB I.D.	Petroleum Hydrocarbons (418.1) TRPH	(MOD.8015) Diesel/Direct/Inject	(M8015) Gas/Purge & Trap	Gasoline/BTEX & MTBE (M8015/8020)	BTXE/MTBE (8020)	BTEX & Chlorinated Aromatics (602/8020)	BTEX/MTBE/EDC & EDB (8020/8010/Short)	Chlorinated Hydrocarbons (601/8010)	504 EDB ☐ / DBCP ☐	Polynuclear Aromatics (610/8310)	Volatile Organics (624/8240) GC/MS	Volatile Organics (8260) GC/MS	Pesticides/PCB (608/8080)	Herbicides (615/8150)	Base/Neutral/Acid Compounds GC/MS (625/8270)	General Chemistry: Cations/Anions, 4 ion balance	Priority Pollutant Metals (13)	Target Analyte List Metals (23)	RCRA Metals (8)	RCRA Metals by TCLP (Method 1311)	Metals:	NUMBER OF CONTAINERS
MW-10 (961119 1005)	11/19/96	1005	water	-01					3			3		2						1						6
MW-3 (961119 1105)	11/19/96	1105	water	-02					3			3		2						1						6
MW-8 (961119 1210)	11/19/96	1210	water	-03					3			3		2						1						6
Trip Blank	11/15/96	1100	water	-04					1			1														1

PROJECT INFORMATION

PROJ. NO.:
PROJ. NAME: Navajo Ref Refinery
P.O. NO.:
SHIPPED VIA:

SAMPLE RECEIPT

NO. CONTAINERS	19
CUSTODY SEALS	Y/N/(NA)
RECEIVED INTACT	Y
BLUE ICE/ICE	Y

PRIOR AUTHORIZATION IS REQUIRED FOR RUSH PROJECTS

(RUSH) ☐ 24hr ☐ 48hr ☐ 72hr ☐ 1 WEEK (NORMAL) ☒

CERTIFICATION REQUIRED: ☐ NM ☐ SDWA ☐ OTHER

METHANOL PRESERVATION ☐

COMMENTS: FIXED FEE ☐

RELINQUISHED BY: 1.
Signature: Bill Olson Time: 1435
Printed Name: Bill Olson Date: 11/20/96
Company: NM OCD

RECEIVED BY: 1.
Signature: Time:
Printed Name: Date:
Company:

RELINQUISHED BY: 2.
Signature: Time:
Printed Name: Date:
Company:

RECEIVED BY: (LAB) 2.
Signature: Time: 1435
Printed Name: Date: 11/20/96
American Environmental Network (NM), Inc.

DISTRIBUTION: White, Canary - AEN Pink - ORIGINATOR

American Environmental Network
Albuquerque, New Mexico

Interlab Chain of Custody

DATE 11/20/96 PAGE 1 OF 1

NETWORK PROJECT MANAGER: KIMBERLY D. McNEILL

COMPANY: American Environmental Network
ADDRESS: 2709-D Pan American Freeway, NE
Albuquerque, NM 87107

611559

CLIENT PROJECT MANAGER:

Kim McNeill

SAMPLE ID	DATE	TIME	MATRIX	LAB ID
611334-01	11/19/96	1005	H_2O	
-02	↓	1105	↓	
-03	↓	1210	↓	

ANALYSIS REQUEST

SAMPLE ID	Metals - TAL	Metals - PP List	Metals - RCRA	RCRA Metals by TCLP (1311)	(illegible)	TOX	TOC	Gen Chemistry	8310	Oil and Grease	BOD	COD	Pesticides/PCB (608/8080)	Herbicides (615/8150)	Base/Neutral Acid Compounds GC/MS (625/8270)	Volatile Organics GC/MS (624/8240)	Polynuclear Aromatics (610/8310)	8240 (TCLP 1311) ZHE	8270 (TCLP 1311)			TCLP	Gross Alpha/Beta				NUMBER OF CONTAINERS
611334-01									X																		1
-02									X																		1
-03									X																		1

PROJECT INFORMATION

PROJECT NUMBER 611334
PROJECT NAME NMOCD
QC LEVEL (STD) IV
QC REQUIRED MS MSD BLANK
TAT (STANDARD) RUSH

DUE DATE 1215
RUSH SURCHARGE ϕ
CLIENT DISCOUNT Quote
SPECIAL CERTIFICATION REQUIRED: ☐ YES ☐ NO

SAMPLE RECEIPT

TOTAL NUMBER OF CONTAINERS	
CHAIN OF CUSTODY SEALS	
INTACT?	
RECEIVED GOOD COND./COLD	
LAB NUMBER	

SAMPLES SENT TO:

SAN DIEGO
Paragon
RENTON
PENSACOLA
PORTLAND
PHOENIX

RELINQUISHED BY: 1.

Signature: Time 1550
Printed Name: Miles Timansky Date 11/20/96
Albuquerque

RECEIVED BY: 1.

Signature: Linda L. Kitt Time 0845
Printed Name: Linda L. Kitt Date 11/21/96
Company: AEN/71

RELINQUISHED BY: 2

Signature Time
Printed Name Date
Company

RECEIVED BY: (LAB) 2.

Signature: Time
Printed Name: Date
Company

American Environmental Network (NM), Inc.
Albuquerque • Phoenix • Pensacola • Portland • Pleasant Hills • Columbia

CHAIN OF CUSTODY

DATE: 11/20/96 PAGE: 1 OF 1

AEN LAB I.D. 611334/611559

SHADED AREAS ARE FOR LAB USE ONLY.

PLEASE FILL THIS FORM IN COMPLETELY.

PROJECT MANAGER: Bill Olson

COMPANY: N.M. Oil Conservation Division
ADDRESS: 2040 S. Pacheco
Sant. Fe, NM. 87505
PHONE: (505) 827-7154
FAX: (505) 827-8177

BILL TO: Sime
COMPANY:
ADDRESS:

ANALYSIS REQUEST

SAMPLE ID	DATE	TIME	MATRIX	LAB I.D.	Petroleum Hydrocarbons (418.1) TRPH	(MOD.8015) Diesel/Direct/Inject	(M8015) Gas/Purge & Trap	Gasoline/BTEX & MTBE (M8015/8020)	BTXE/MTBE (8020)	BTEX & Chlorinated Aromatics (602/8020)	BTEX/MTBE/EDC & EDB (8020/8010/Short)	Chlorinated Hydrocarbons (601/8010)	504 EDB / DBCP	Polynuclear Aromatics (610/8310)	Volatile Organics (624/8240) GC/MS	Volatile Organics (8260) GC/MS	Pesticides/PCB (608/8080)	Herbicides (615/8150)	Base/Neutral/Acid Compounds GC/MS (625/8270)	General Chemistry:	Cations/Anion, 4 ion balance	Priority Pollutant Metals (13)	Target Analyte List Metals (23)	RCRA Metals (8)	RCRA Metals by TCLP (Method 1311)	Metals:	NUMBER OF CONTAINERS
MW-10 (9611191005)	11/19/96	1005	water	-01					3			3		2						1							6
MW-3 (9611191105)	11/19/96	1105	water	-02					3			3		2						1							6
MW-8 (9611191210)	11/19/96	1210	water	-03					3			3		2						1							6
Trip Blank	11/15/96	1100	water	-04					1			1															1

PROJECT INFORMATION

PROJ. NO.:
PROJ. NAME: Navajo Ref Refinery
P.O. NO.:
SHIPPED VIA:

SAMPLE RECEIPT

NO. CONTAINERS	19
CUSTODY SEALS	Y/N/(NA)
RECEIVED INTACT	Y
BLUE ICE/ICE	Y

PRIOR AUTHORIZATION IS REQUIRED FOR RUSH PROJECTS

(RUSH) ☐ 24hr ☐ 48hr ☐ 72hr ☐ 1 WEEK (NORMAL) X

CERTIFICATION REQUIRED: ☐ NM ☐ SDWA ☐ OTHER

METHANOL PRESERVATION ☐

COMMENTS: FIXED FEE ☐

RELINQUISHED BY: 1.	RELINQUISHED BY: 2
Signature: Time: 1435	Signature: Time:
Printed Name: Bill Olson Date: 11/20/96	Printed Name: Date:
Company: NM OCD	Company:
RECEIVED BY: 1.	**RECEIVED BY: (LAB) 2.**
Signature: Time:	Signature: Time: 1435
Printed Name: Date:	Printed Name: Date: 11/20/96
Company:	American Environmental Network (NM), Inc.

DISTRIBUTION: White, Canary - AEN Pink - ORIGINATOR

American Environmental Network
Albuquerque, New Mexico

Interlab Chain of Custody

DATE 11/20/96 PAGE 1 of 1

NETWORK PROJECT MANAGER: KIMBERLY D. McNEILL

COMPANY: American Environmental Network
ADDRESS: 2709-D Pan American Freeway, NE
Albuquerque, NM 87107

CLIENT PROJECT MANAGER:
Kim McNeill

ANALYSIS REQUEST

SAMPLE ID	DATE	TIME	MATRIX	LAB ID	Metals - TAL	Metals - PP List	Metals - RCRA	RCRA Metals by TCLP (1311)	F, Br, Ca, K, Mg, Na, Alk group	Cl, SO_4, TDS, pH, &c, cat/an. balance	TOX	TOC	Gen Chemistry		Oil and Grease	BOD	COD	Pesticides/PCB (608/8080)	Herbicides (615/8150)	Base/Neutral Acid Compounds GC/MS (625/8270)	Volatile Organics GC/MS (624/8240)	Polynuclear Aromatics (610/8310)	8240 (TCLP 1311) ZHE	8270 (TCLP 1311)			TCLP	Gross Alpha/Beta				NUMBER OF CONTAINERS
611334-01	11/19/96	1005	H_2O	1					X	X																						2
-02	↓	1105	↓	2					X	X																						2
-03	↓	1210	↓	3					X	X																						2

PROJECT INFORMATION

PROJECT NUMBER 611334
PROJECT NAME NMOCD
QC LEVEL (STD) IV
QC REQUIRED MS MSD BLANK
TAT STANDARD RUSH

DUE DATE 12/5
RUSH SURCHARGE ϕ
CLIENT DISCOUNT Quote
SPECIAL CERTIFICATION REQUIRED: ( ) YES ( ) NO

SAMPLE RECEIPT

TOTAL NUMBER OF CONTAINERS	3
CHAIN OF CUSTODY SEALS	NA
INTACT?	Y
RECEIVED GOOD COND./COLD	BLUE
LAB NUMBER	611750

SAMPLES SENT TO:
SAN DIEGO
Paragon
RENTON
PENSACOLA
PORTLAND
PHOENIX

RELINQUISHED BY: 1.
Signature: Kim McNeill Time 4pm
Printed Name: Kim McNeill Date 11/20/96
Albuquerque

RECEIVED BY: 1.
Signature: Time:
Printed Name: Date:
Company:

RELINQUISHED BY: 2
Signature Time
Printed Name Date
Company

RECEIVED BY: (LAB) 2
Signature Time
Printed Name Date
Company

American Environmental Network (NM), Inc.
Albuquerque • Phoenix • Pensacola • Portland • Pleasant Hills • Columbia

CHAIN OF CUSTODY

DATE: 11/20/96 PAGE: 1 OF 1

AEN LAB I.D. 611334

SHADED AREAS ARE FOR LAB USE ONLY.

PROJECT MANAGER: Bill Olson
COMPANY: N.M. Oil Conservation Division
ADDRESS: 2040 S. Pacheco
Santa Fe, NM. 87505
PHONE: (505) 827-7154
FAX: (505) 827-8177
BILL TO: Same
COMPANY:
ADDRESS:

ANALYSIS REQUEST

SAMPLE ID	DATE	TIME	MATRIX	LAB I.D.	Petroleum Hydrocarbons (418.1) TRPH	(MOD.8015) Diesel/Direct/Inject	(M8015) Gas/Purge & Trap	Gasoline/BTEX & MTBE (M8015/8020)	BTXE/MTBE (8020)	BTEX & Chlorinated Aromatics (602/8020)	BTEX/MTBE/EDC & EDB (8020/8010/Short)	Chlorinated Hydrocarbons (601/8010)	504 EDB ☐ / DBCP ☐	Polynuclear Aromatics (610/8310)	Volatile Organics (624/8240) GC/MS	Volatile Organics (8260) GC/MS	Pesticides/PCB (608/8080)	Herbicides (615/8150)	Base/Neutral/Acid Compounds GC/MS (625/8270)	General Chemistry:	[illegible]	Priority Pollutant Metals (13)	Target Analyte List Metals (23)	RCRA Metals (8)	RCRA Metals by TCLP (Method 1311)	Metals:	NUMBER OF CONTAINERS
MW-10 (961119 1005)	11/19/96	1005	water	-01					3	—	—	3		2						1							6
MW-3 (961119 1105)	11/19/96	1105	water	-02					3	—	—	3		2						1							6
MW-8 (961119 1210)	11/19/96	1210	water	-03					3	—	—	3		2						1							7
Trip Blank	11/15/96	1100	water	-04					1	—	—	1															1

PLEASE FILL THIS FORM IN COMPLETELY.

PROJECT INFORMATION
PROJ. NO.:
PROJ. NAME: Navajo Lea Refinery
P.O. NO.:
SHIPPED VIA:

SAMPLE RECEIPT
NO. CONTAINERS: 19
CUSTODY SEALS: Y/N/NA (NA circled)
RECEIVED INTACT: Y
BLUE ICE/ICE: Y (ICE circled)

PRIOR AUTHORIZATION IS REQUIRED FOR RUSH PROJECTS
(RUSH) ☐ 24hr ☐ 48hr ☐ 72hr ☐ 1 WEEK (NORMAL) ☒
CERTIFICATION REQUIRED: ☐ NM ☐ SDWA ☐ OTHER
METHANOL PRESERVATION ☐
COMMENTS: FIXED FEE ☐

RELINQUISHED BY: 1.
Signature: [signature] Time: 1435
Printed Name: Bill Olson Date: 11/20/96
Company: NM OCD

RECEIVED BY: 1.
Signature: Time:
Printed Name: Date:
Company:

RELINQUISHED BY: 2
Signature: Time:
Printed Name: Date:
Company:

RECEIVED BY: (LAB) 2.
Signature: [signature] Time: 1435
Printed Name: [signature] Date: 11/20/96
American Environmental Network (NM), Inc

ATTACHMENT E

TOTALIZING METER REPORT

(FOURTH QUARTER 1996)

NEW MEXICO STATE ENGINEER
TOTALIZING METER REPORT

Basin Supervisor
State Engineer Office
1900 West Second Street
Roswell, NM 88201

Dear Sir:

In accordance with the State Engineer regulation which requires that quarterly reports of meter readings be submitted on or before the 10th of January, April, July and October, the following information is submitted.

1. File No. L-4058-S-23(T)(Recovery Well) Date 01-03-97
   Name: Navajo Refining Company
   Address: P. O. Box 159, Artesia, NM 88211-0159

2. Well Description
   S. E. File No. L-4058-S-23(T)(Recovery Well) Company Well No. RW-1
   Location: Subdv. SE¼ NE¼ Sec. 36 Twp. 16S Rge. 36E

3. Totalizing Meter
   Serial No. EDD-600-13644 Units Gallons
   Make Electronic Data Devices Multiplier 1 (867.59 pulses/gal)

4. Reading
   Date: 01-01-97 Reading 91146 gallons
   Quantity of water used 111,146 gallons Quarter, 1996, Fourth

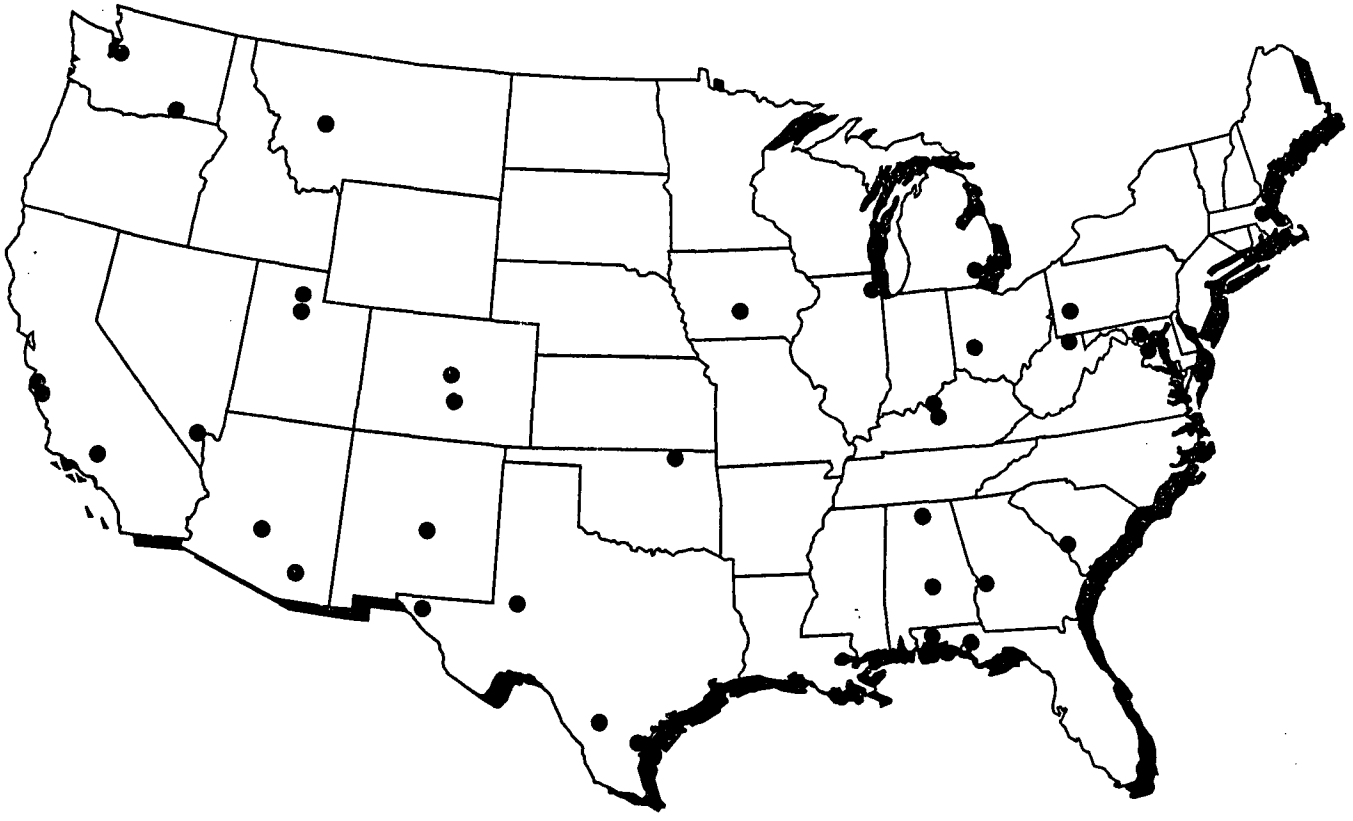
5. Remarks: This is the first totalizing meter report. Groundwater recovery was initiated on October 1, 1996. A dial-type flow meter (Hayes) was used initially, however after flowing an estimated 20,000 gallons, the meter was replaced with a better quality electronic turbine meter on Oct. 17, 1996.

By: Gilbert J. VanDeventer

INSTRUCTIONS:
(1) and (2) self-explanatory. (3) Description of meter, including multiplier or constant by which reading must be multiplied to obtain actual quantity of water. Units refer to acre-feet, gallons, barrels, etc. (4) Reading of figures on the meter and amount obtained by multiplying reading by multiplier. (5) Under remarks, give any pertinent information such as reading and date of installation of meter if a first report, information concerning repair of meter and dates out of service, etc.

FILE NO. _____ LOCATION NO. _____

Office Locations



UNITED STATES

Montgomery, Alabama
Huntsville, Alabama
Phoenix, Arizona
Tucson, Arizona
Redlands, California
Monterey, California
Denver, Colorado
Colorado Springs, Colorado
Washington, D.C.
Panama City, Florida
Pensacola, Florida
Fort Benning, Georgia
Chicago, Illinois
Des Moines, Iowa
Fort Knox, Kentucky
Louisville, Kentucky
Gaithersburg, Maryland
Germantown, Maryland
Lanham, Maryland
Boston, Massachusetts
Dearborn, Michigan
Helena, Montana
Las Vegas, Nevada
Albuquerque, New Mexico
Dayton, Ohio
Bartlesville, Oklahoma
Pittsburgh, Pennsylvania
N. Augusta, South Carolina
Corpus Christi, Texas
El Paso, Texas
Midland, Texas
San Antonio, Texas
Salt Lake City, Utah
Seattle, Washington
Richland, Washington
Morgantown, West Virginia

San Juan, Puerto Rico

INTERNATIONAL

Brazil
Egypt
Germany
Oman
Mexico
Saudi Arabia
Turkey

Soil and Groundwater Investigation and Remediation Work Plan
Lea Refinery, Lea County, New Mexico

October 11, 1996

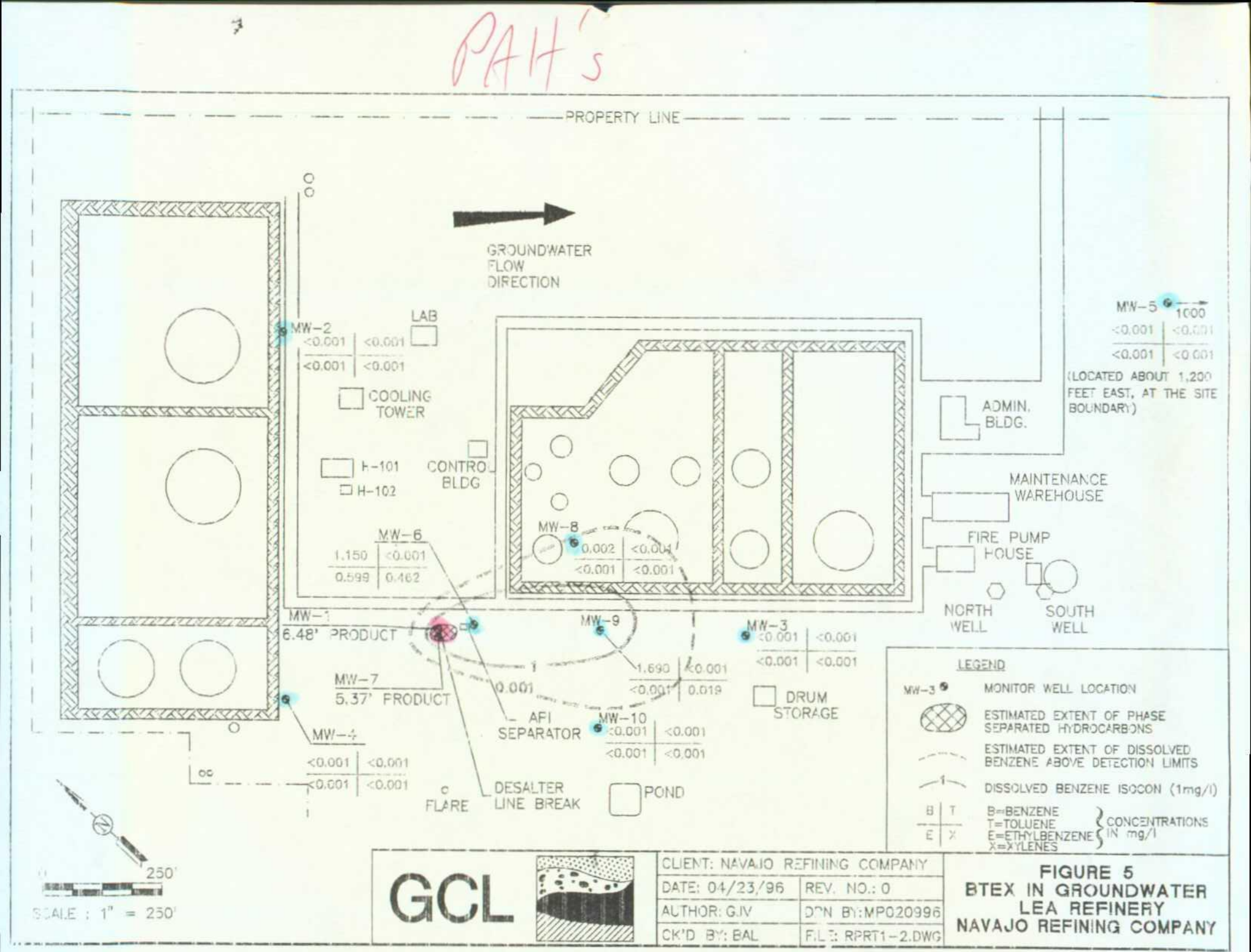
Prepared for:

Navajo Refining Company
P.O. Box 159
Artesia, New Mexico 88211

Geoscience Consultants, Ltd.
306 West Wall Street, Suite 818
Midland, Texas 79701
(915) 682-0008

GCL
Environmental Science and Engineering
A BDM International Company

PAH's

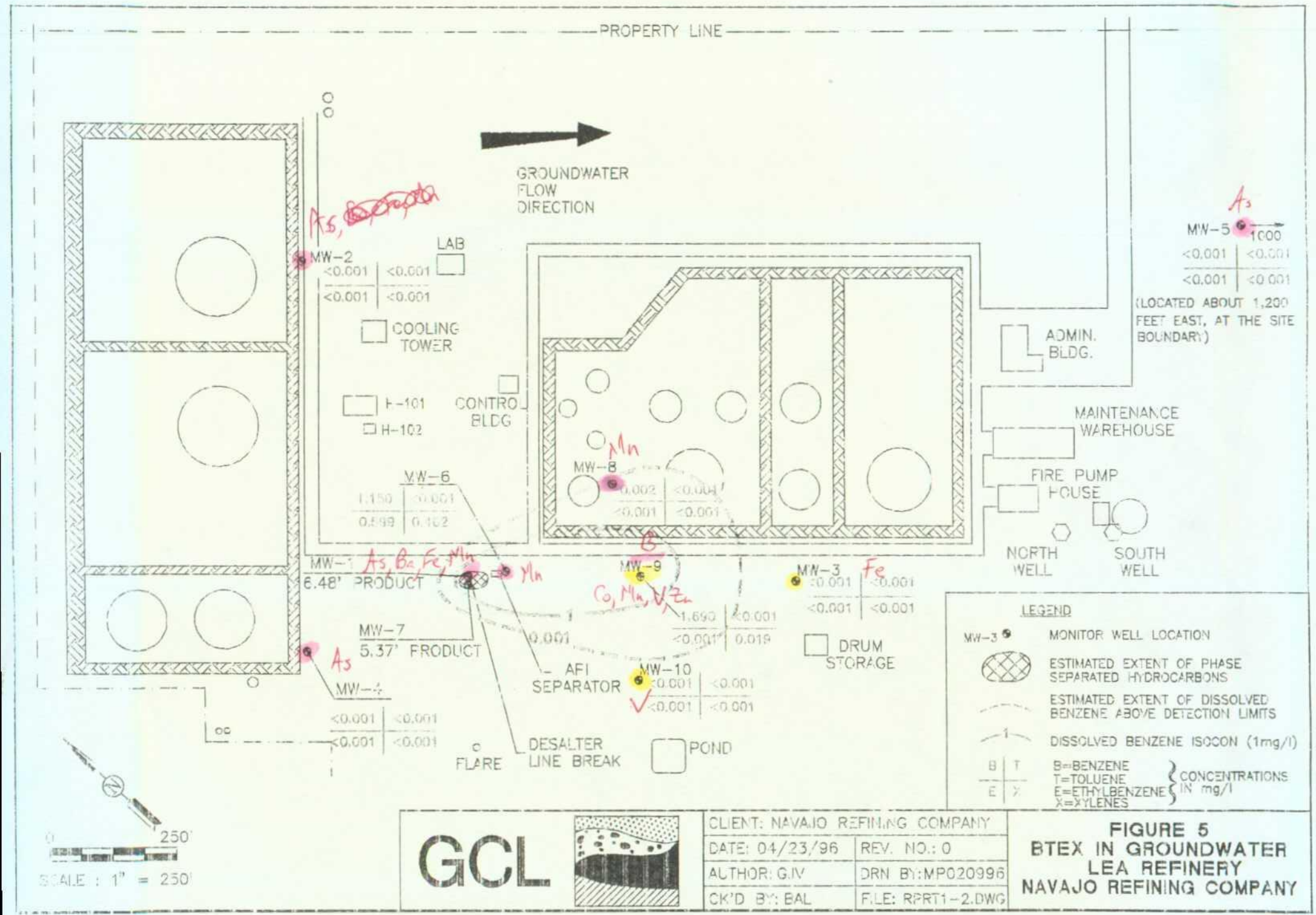


GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 04/23/96	REV. NO.: 0
AUTHOR: GJV	DWN BY: MP020996
CK'D BY: BAL	FILE: RPRT1-2.DWG

FIGURE 5
BTEX IN GROUNDWATER
LEA REFINERY
NAVAJO REFINING COMPANY

Metals

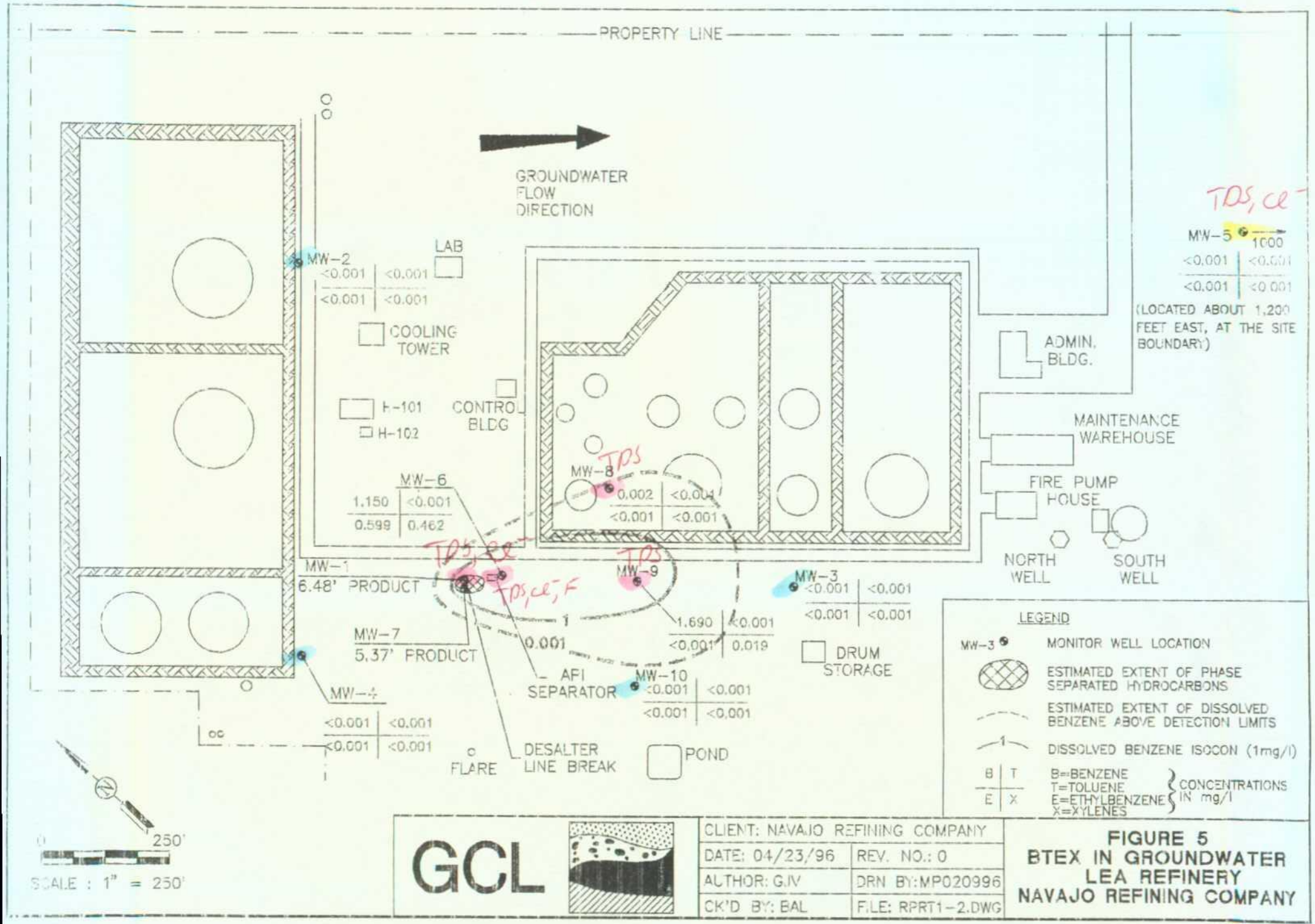


GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 04/23/96	REV. NO.: 0
AUTHOR: GJV	DRN BY: MP020996
CK'D BY: BAL	FILE: RPRT1-2.DWG

FIGURE 5
BTEX IN GROUNDWATER
LEA REFINERY
NAVAJO REFINING COMPANY

Cations / Anions



GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 04/23/96	REV. NO.: 0
AUTHOR: GJV	DRN BY: MP020996
CK'D BY: BAL	FILE: RPRT1-2.DWG

FIGURE 5
BTEX IN GROUNDWATER
LEA REFINERY
NAVAJO REFINING COMPANY

SOIL AND GROUNDWATER INVESTIGATION AND REMEDIATION WORKPLAN LEA REFINERY LEA COUNTY, NEW MEXICO

October 7, 1996

Prepared for:

Navajo Refining Company
David G. Griffin
Manager of Environmental Afairs for Water and Waste
P. O. Box 159
Artesia, New Mexico 88211-0159

Prepared by:

GEOSCIENCE CONSULTANTS, LTD.
306 West Wall Street
Suite 818
Midland, Texas 79701
(915) 682-0008
FAX (915) 682-0028

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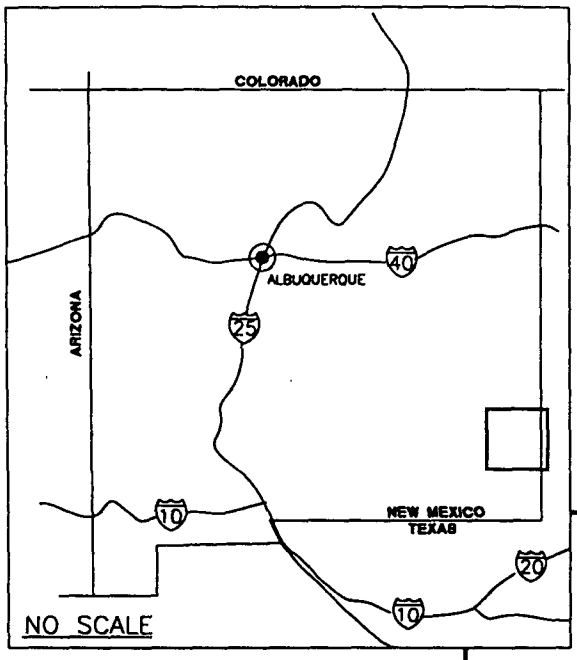
Appendix

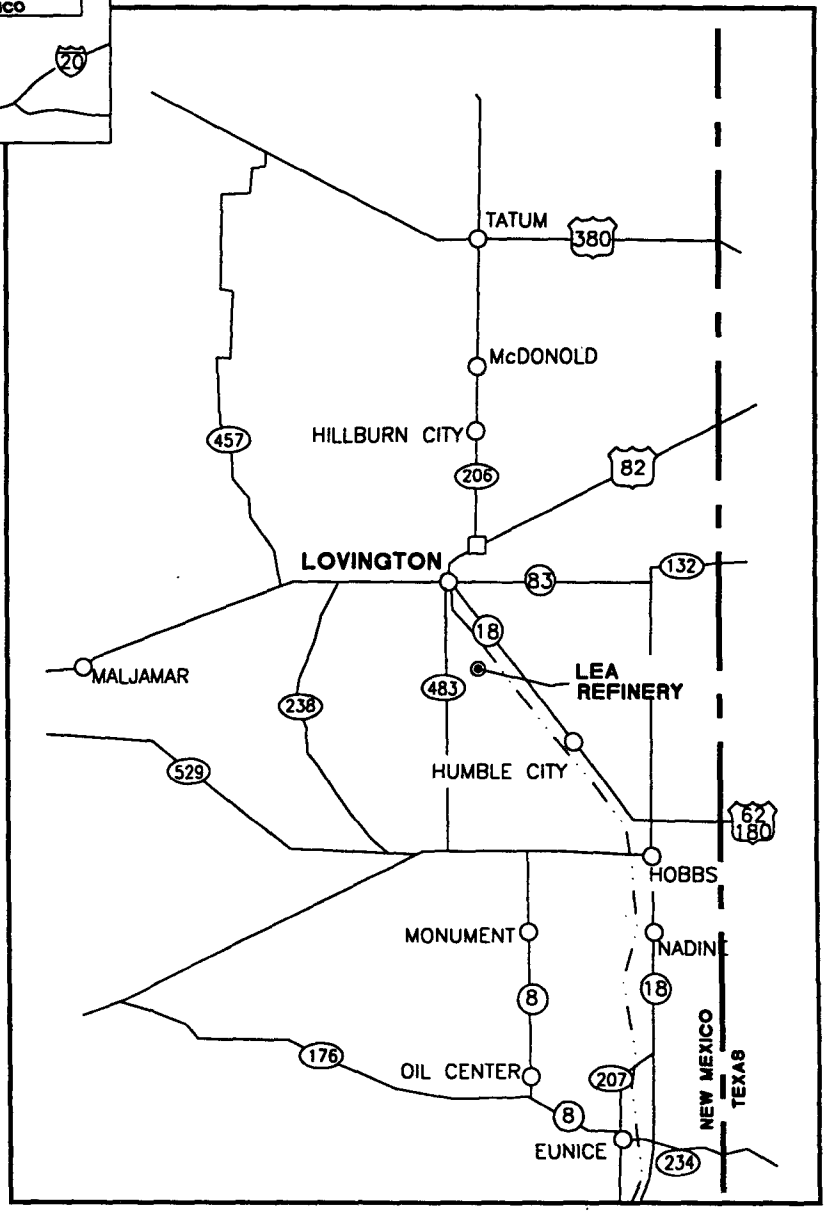
1.0 Introduction

In August 1995, the Navajo Refining Company (NRC) located a pipe leak at a sewer junction box at their Lea Refinery located on State Highway 18, about 5 miles south of Lovington, New Mexico. Regional and local site location maps are presented in Figures 1 and 2, respectively. Since the refinery was idle from 1984 to early 1991, the leak developed sometime after the early 1991 startup of refinery operations. Once the leak was identified, the Navajo Refining Company notified the New Mexico Oil Conservation Division (NMOCD) and initiated a subsurface investigation to determine the extent of the release. The NMOCD was informed throughout the progress of this initial subsurface investigation. The initial subsurface investigation revealed the presence of residual hydrocarbons within a limited area of the unsaturated zone, phase-separated hydrocarbons (free product) on the water table, and dissolved-phase hydrocarbons in the groundwater.

In their effort to address this problem, the Navajo Refining Company selected Geoscience Consultants, Ltd. (GCL) to design and install a soil and groundwater remediation system at the site. The initial subsurface investigation yielded sufficient information to design a remediation system. However, the additional subsurface information collected concurrent with the system installation helped to refine the initial remedial design. A remedial design workplan dated February 2, 1996 (GCL, 1996), was submitted to and approved by the NMOCD as stated in their letter dated March 18, 1996 to the Navajo Refining Company.

The purpose of this report is to present the results of the initial subsurface investigation conducted by NRC in 1995 and the recent subsurface investigation conducted by GCL in April 1996. This report also discusses the nearest potential receptors, regional and local hydrogeology, extent of soil and groundwater contamination, remedial system design, system operation and maintenance, and performance monitoring.





LEGEND

SITE LOCATION

TEXAS AND NEW MEXICO RAILROAD

(LOCATIONS APPROXIMATE)

N

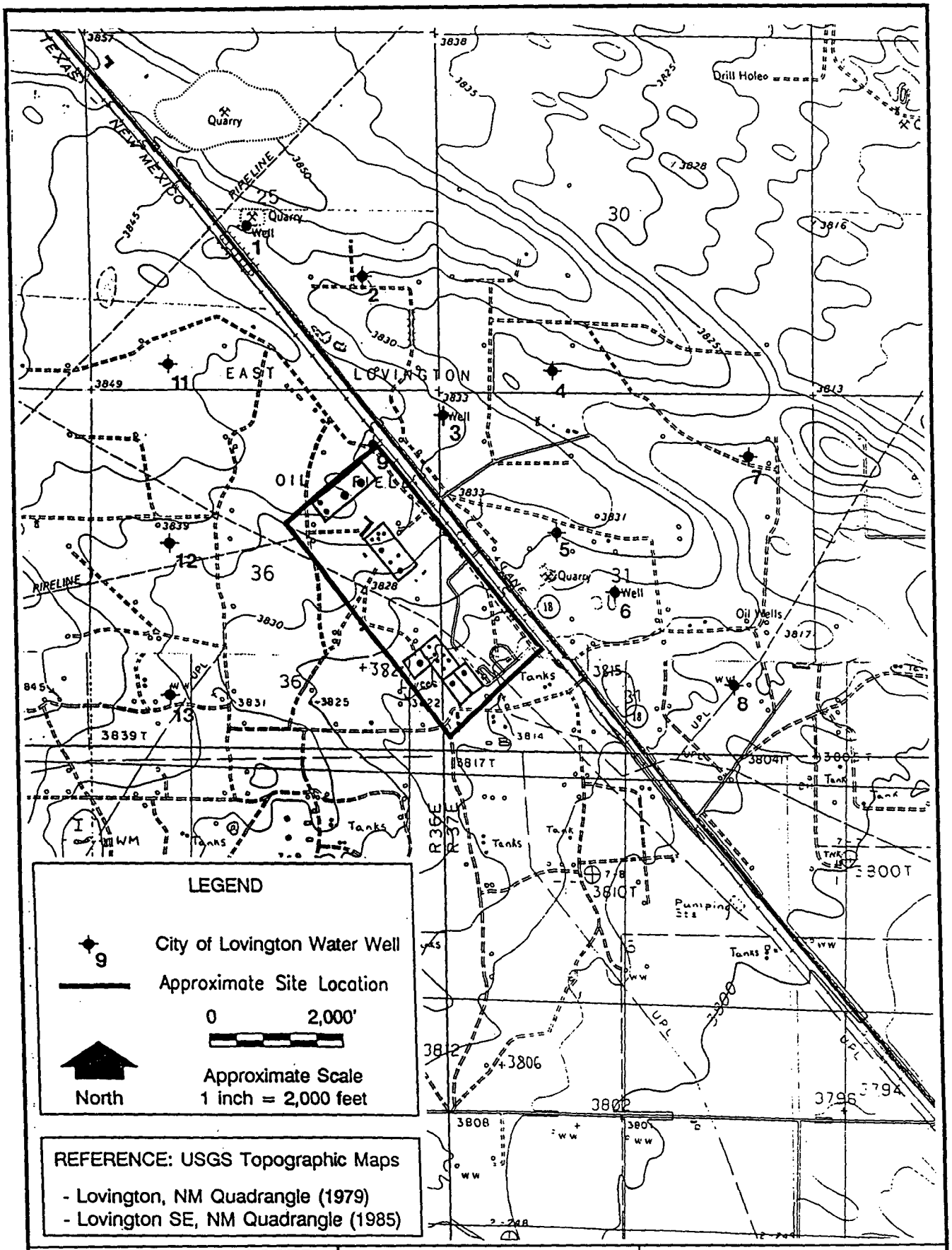
0 10

SCALE : 1" = 10 Miles

GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 11/16/95	REV. NO.: 0
AUTHOR: BAL	DRAWN BY: MP
CK'D BY: GJV	FILE: RPRT1-1.DWG

FIGURE 1
SITE LOCATION MAP
LEA REFINERY



GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 11/21/95	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: MP
CK'D BY: BAL	FILE: LEABRD.DWG

FIGURE 2
TOPOGRAPHIC MAP
LEA REFINERY

2.0 Potential Receptors

There is no immediate threat to human health as the nearest receptor is the refinery's own process water supply wells located about 1,000 feet downgradient of the release. The water supply is used for refinery processes and is not used for human consumption since the site drinking water is delivered as bottled water. A combined total daily flow rate from the two wells is estimated at about 431,000 gallons per day (300 gallons per minute) based on daily meter readings taken during the first quarter of 1996.

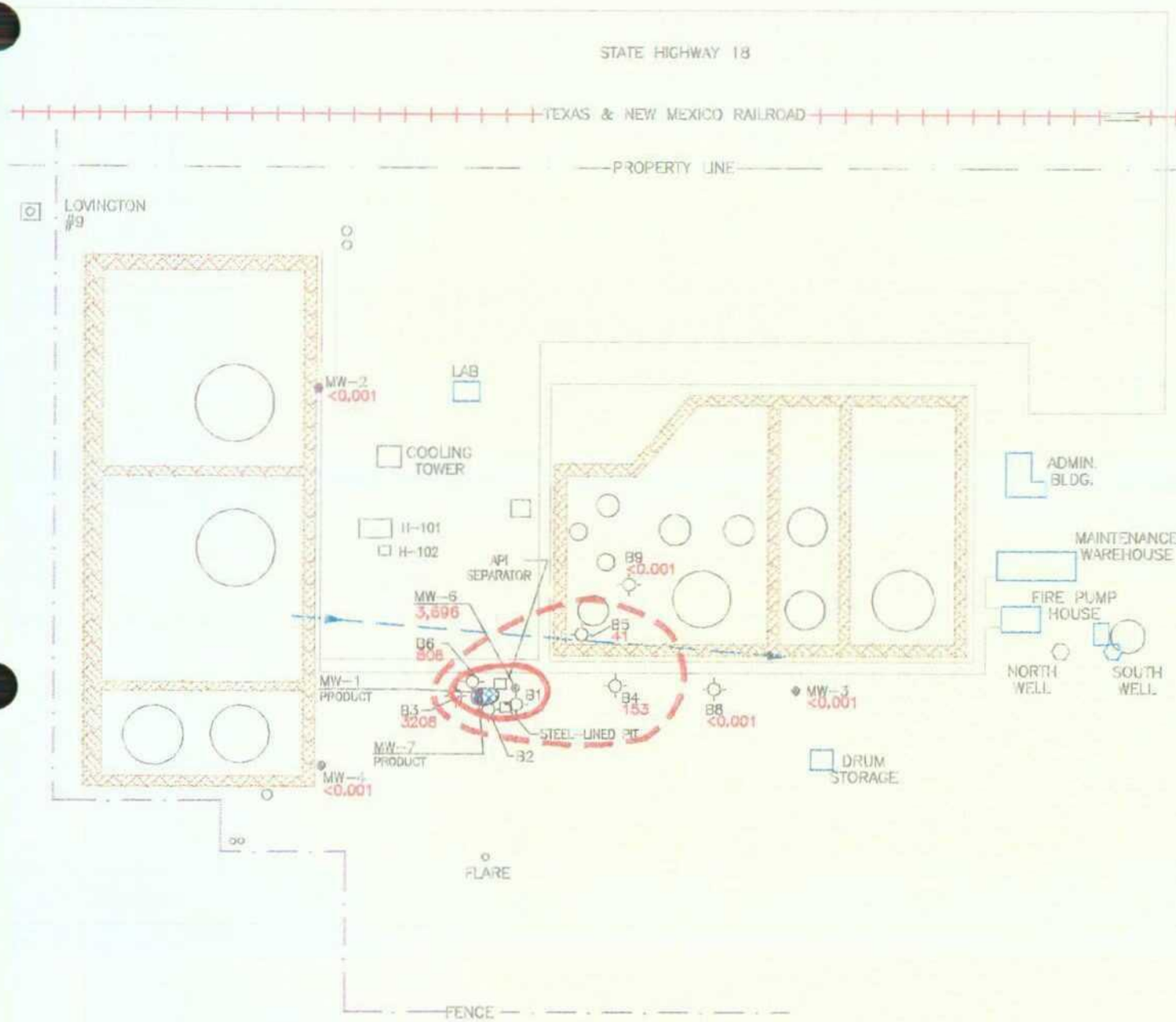
City of Lovingtion water supply wells are located along State Highway 18, southeast of the city as shown in Figure 2. The water supply well nearest to the site, Lovington No. 9, is located near the northeast property corner, about 1,500 feet north of the source. The identified water supply wells are not considered potential receptors based on their distance from the observed groundwater plume and the engineering controls that are designed to remediate the groundwater.

3.0 Initial Site Investigation

Navajo Refining Company, with the assistance of CMB Consulting, conducted the initial site investigation August and September 1995. The initial investigation included the installation of seven 2-inch diameter monitoring wells (MW-1 through MW-7) and eight soil borings (B1 through B8). Six of the soil borings (B-3, B-4, B-5, B-6, B-8 and B-9) were completed as temporary monitoring wells to obtain groundwater samples. Boring B-7 was converted into a permanent monitoring well (MW-6). As with the permanent monitoring wells, the temporary wells were constructed of 2-inch diameter SCH 40 PVC well casing and screen (0.010-inch machine-slot). All borings and temporary monitoring wells were plugged with a cement/bentonite grout. Well completion diagrams and lithologic logs for monitoring wells MW-1 through MW-7 are provided in Appendix B and C, respectively.

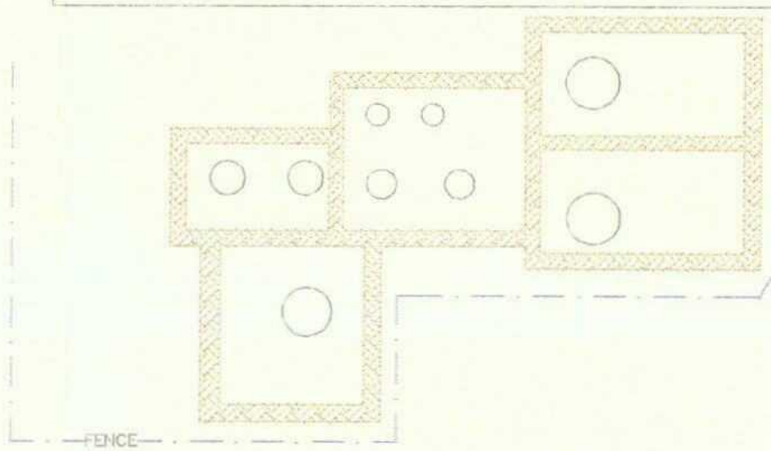
The initial site investigation revealed phase-separated hydrocarbons (free product) on the water table directly below the release (sewer junction box). Free product thickness in wells ranged from less than 0.5 feet in MW-7 to about 6 feet in MW-1. The investigation also delineated a dissolved-phase hydrocarbon plume extending about 360 feet downgradient (southeast) of the release. 3 shows the monitoring well and boring locations with analytical results for benzene, toluene, ethlybenzene, and total xylenes (BTEX).

The available field data and analytical results from this initial investigation is included in Appendix A. A summary of the analytical results is presented in section 6.0.



INITIAL INVESTIGATION – BTEX (mg/l) CONCENTRATIONS IN GROUNDWATER							
LOCATION	DATE	METHOD	BENZENE	TOLUENE	ETHYLBENZENE	TOTAL XYLENES	TOTAL BTEX
B3	SEP-95	EPA 602	1.100	0.341	0.757	1.000	3.208
B4	AUG-95	EPA 8020	0.074	0.021	0.039	0.019	0.153
B5	SEP-95	EPA 8020	0.041	<0.001	<0.001	<0.001	0.041
B6	SEP-95	EPA 8020	0.583	0.030	0.087	0.108	0.808
MW-6	SEP-95	EPA 8020	1.741	0.021	0.962	0.972	3.696
B8	SEP-95	EPA 8020	<0.001	<0.001	<0.001	<0.001	<0.001
B9	SEP-95	EPA 8020	<0.001	<0.001	<0.001	<0.001	<0.001
MW-2	SEP-95	EPA 8020	<0.001	<0.001	<0.001	<0.001	<0.001
MW-3	SEP-95	EPA 8020	<0.001	<0.001	<0.001	<0.001	<0.001
MW-4	SEP-95	EPA 8020	<0.001	<0.001	<0.001	<0.001	<0.001
MW-5	SEP-95	EPA 8020	<0.001	<0.001	<0.001	<0.001	<0.001
NMWQCC STANDARDS [1]			0.010	0.75	0.75	0.62	

[1] NEW MEXICO WATER QUALITY CONTROL COMMISSION HUMAN HEALTH STANDARDS
ALL ANALYSES CONDUCTED BY TRACE ANALYSIS, INC., LUBBOCK, TX



LEGEND

- LOVINGTON WATER SUPPLY WELL (APPROXIMATE)
- MW-4 MONITORING WELL
- B4 TEMPORARY BORING LOCATION
- TOTAL BTEX ISOCON (1.0 mg/l)
- TOTAL BTEX ISOCON (0.001 mg/l)
- ESTIMATED EXTENT OF PHASE SEPARATED HYDROCARBONS

0 300'

SCALE : 1" = 300'

GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 09/11/95	REV. NO.: 0
AUTHOR: BAL	DRN BY:RG082196
CK'D BY: GJV	FILE: RPRT1-5.DWG

FIGURE 3
INITIAL INVESTIGATION
BTEX CONCENTRATION MAP
LEA REFINERY

4.0 Regional Hydrogeology

The late Tertiary Age (Pliocene) Ogallala Formation underlies the site. It is composed of calcareous sands, silts, clays, and gravels (Nicholson and Clebsch, 1961 and Barnes, 1976). The near-surface Ogallala sediments are often calichified (indurated with cemented calcium carbonate). The presence of caliche generally decreases with depth becoming negligible at depths greater than 35 to 50 feet below the surface. The thickness of the Ogallala Formation varies locally as a result of significant paleo-topography at the top of the underlying Triassic Dockum Group. Pre-Tertiary erosion removed Cretaceous Age rocks in the region; consequently the Ogallala Formation rests unconformably on the Triassic Dockum Group. The uppermost unit of the Dockum Group is the Chinle Formation that primarily consists of micaceous red clay and shale, but also contains thin interbeds of fine-grained sandstone and siltstone. The red clays and shale of the Chinle Formation act as an aquitard beneath the waterbearing colluvial deposits, and therefore, limit the amount of recharge to the underlying Dockum Group.

The regional groundwater flow direction of the Ogallala aquifer is generally toward the southeast. Recharge occurs primarily by infiltration of precipitation with minor amounts from irrigation return flow. The recharge rate for downward percolation is one-quarter to one-half inch of water per year, which is characteristic of the arid climate of southern Lea County (Nicholson and Clebsch, 1961).

Groundwater discharge from the Ogallala aquifer occurs primarily from pumping for irrigation, stock, domestic, industrial, and public water supply uses. Minimal discharge occurs from evapotranspiration, seeps, or springs as there are very few areas where the water table is very shallow or in communication with surface water bodies (Ash, 1963).

Potable groundwater used in southern Lea County is derived primarily from the Ogallala Formation and the Quaternary alluvium. Waterbearing zones within the Triassic Dockum Group provide lower yields in a few scattered areas within southern Lea County. In the site area, potable water is not available below the Triassic Dockum Group.

5.0 Methods of Investigation and Well Installations

The data from the initial investigation was adequate to design a soil and groundwater remediation system. Consequently, further subsurface investigation was deemed unnecessary. However, to the extent possible, the information obtained during the installation of the remediation system allowed fine-tuning of the final remedial design (e.g., well locations, screen intervals). The remedial design included three additional monitoring wells (MW-8, MW-9, and MW-10), eight air sparging/vapor extraction (AS/VE) well clusters (AS-1 through AS-8), and a single groundwater recovery well (RW-1). The following sections summarize the drilling, soil and groundwater sampling, and well construction methods.

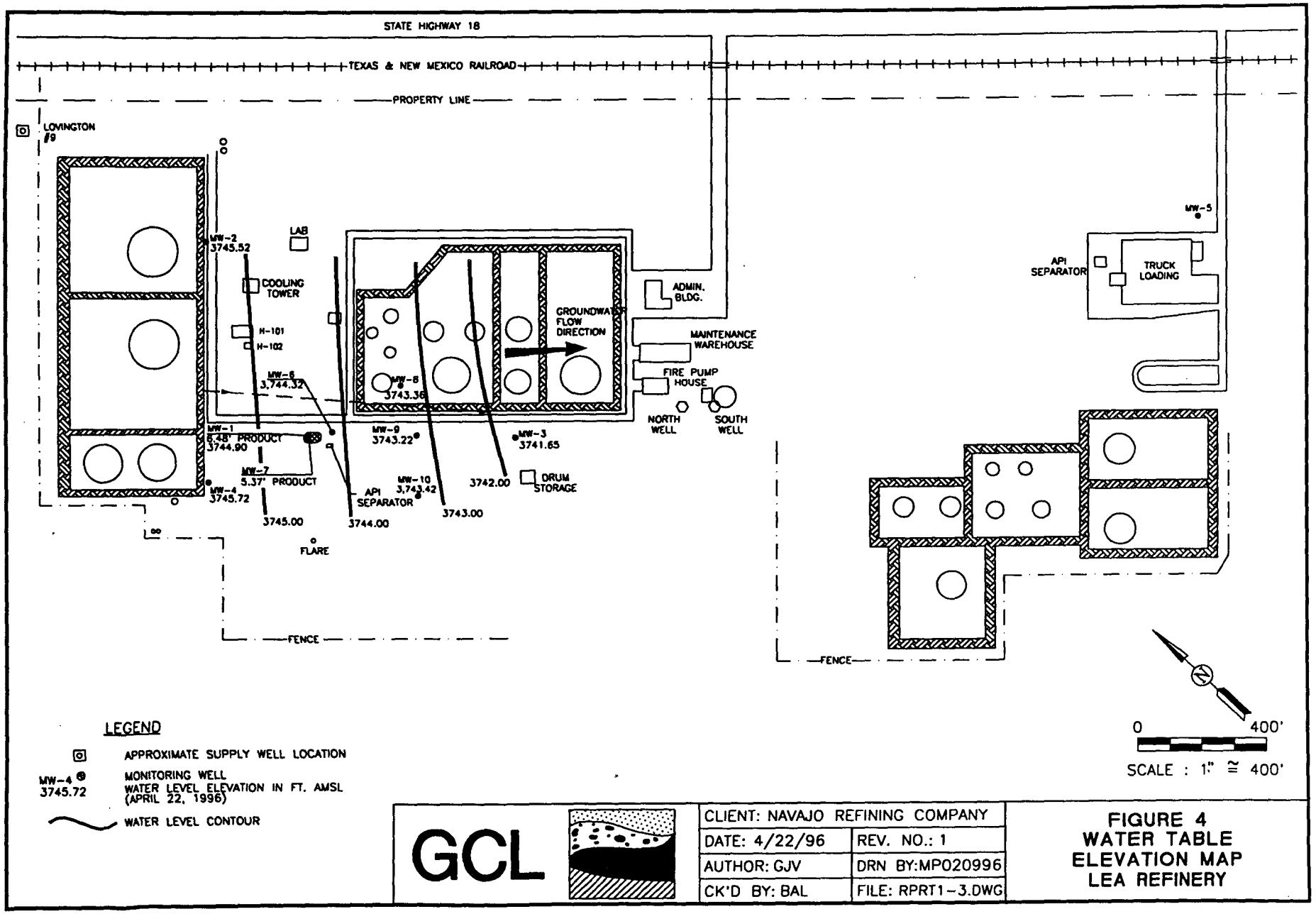
5.1 Well Locations and Uses

Three 2-inch diameter monitoring wells (MW-8, MW-9, MW-10) were installed between April 1 and April 15, 1996 at locations shown in Figure 4. At these locations, the dissolved-phase plume in the downgradient and crossgradient directions is further delineated and the performance of the remediation system can be monitored. Existing monitoring wells MW-2 and MW-4 delineate the upgradient (northwest) extent of the plume. Monitoring well MW-3, located directly southeast of the source and upgradient of the site supply wells, serves as the downgradient monitoring point that is outside the plume. Monitoring wells located within the plume include MW-1, MW-6, MW-7, and MW-9.

A 4-inch diameter recovery well (RW-1) was placed adjacent to the north side of the sewer junction box (source area) for total fluids (free product and groundwater) recovery. Eight AS/VE well clusters (AS-1 through AS-8) were located within the plume to remediate the dissolved-phase hydrocarbons.

5.2 Soil Sampling Procedures

Pool Environmental Drilling, Inc., of Roswell, New Mexico, conducted drilling and sampling operations using a hollow-stem auger drill rig. Even though the objective was to install the remediation system, a limited number of soil samples were obtained with a split-spoon for laboratory analysis. All samples were field-screened (headspace analysis) with a photoionization detector (PID) at ten-foot



GCL

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DATE: 4/22/96	REV. NO.: 1
AUTHOR: GJV	DRN BY:MP020996
CK'D BY: BAL	FILE: RPRT1-3.DWG

FIGURE 4
WATER TABLE ELEVATION MAP
LEA REFINERY

intervals. Prior to use, the MiniRae-75 PID was calibrated with 100 ppm isobutylene, which is directly proportional to benzene with respect to relative concentrations detected.

Field PID measurements were used to determine the presence of actionable soils. According to NMOCD guidelines (NMOCD, 1993), actionable soils are defined as having PID readings greater than 100 parts per million (ppm). Soil samples registering the highest PID readings in each of the wells RW-1, AS-5, and AS-7 were submitted to Trace Analysis, Inc. of Lubbock, Texas, to be analyzed for total petroleum hydrocarbons (TPH) using Environmental Protection Agency (EPA) Method 418.1 and benzene, toluene, ethylbenzene, and xylenes (BTEX) using EPA Method 8020.

Soil samples were placed in 125-milliliter (4-ounce) glass jars with Teflon-lined lids sealed with quality assurance/quality control (QA/QC) seals, and preserved at 4°C with zero headspace, according to EPA requirements (EPA 600/4-82-029). A completed chain-of-custody (COC) form documenting sample identification numbers, collection times, and delivery times to the laboratory accompanied each set of samples.

5.3 Well Construction Procedures

Monitoring wells MW-8, MW-9, and MW-10 are constructed of 2-inch diameter, Schedule 40 PVC well casing and screen (0.010-inch machine-slotted). The 20-foot long well screen in each monitoring well extends approximately 10 to 15 feet below the water table and about 5 to 10 feet above the water table. Recovery well RW-1 is constructed of 4-inch diameter Schedule 40 PVC well casing and screen (0.010-inch machine-slotted). The 30-foot long well screen in the recovery well extends about 25 feet below the water table.

A filterpack composed of 20/40 silica sand surrounds the screened portion of each well. The filterpack is sealed from above with 3 to 5 feet of bentonite. The remaining annular space for each well is sealed with a grout composed of Portland cement with a 5 percent bentonite mixture, emplaced from the top of the bentonite plug to ground surface. A 3-foot by 3-foot concrete pad and a locking steel well cover protects the casing at the surface.

The eight AS/VE well clusters (AS-1 through AS-8) consist of 1-inch diameter Schedule 40 PVC casing for the air sparge line and a 2-inch diameter Schedule 40 PVC pipe for the vapor extraction line and screen (0.010-inch machine slot). A fine-bubble, diffuser sparge point is attached to the bottom of the air sparge line. Additional shallow vapor extraction lines were placed in AS-5 and AS-7 for shallow soil remediation near the source area.

The construction details of the well casing/screen, filter pack, bentonite seal, and grout materials are detailed in the well construction diagrams in Appendix B.

5.4 Groundwater Sampling Procedures

Each newly-installed monitoring well was developed using a decontaminated submersible pump to reduce the amount of fine sediments and improve well yield. The decontaminated, 2-inch diameter, Grundfos Redi-Flo2 submersible pump allowed purging of 20 to 60 gallons of water immediately before collecting a groundwater sample. About 300 total gallons were purged during development of the eight monitoring wells (MW-2, MW-3, MW-4, MW-5, MW-6, MW-8, MW-9, and MW-10). Wells MW-1, MW-7, and RW-1 were not sampled due to the presence of free product. A Hydac Model 910 meter measured the field parameters pH, conductivity, and temperature. In addition, dissolved oxygen was measured with an ICM Model 31250 oxygen meter.

Groundwater samples were obtained with decontaminated, disposable bailers after field parameters stabilized during purging operations. Samples were analyzed for the following:

- BTEX, 40-milliliter (ml) glass VOA sample vials
- Polynuclear Aromatic Hydrocarbons (PAHs), 1-liter glass jars
- Total Metals, 250 ml plastic containers
- Major Cations/Anions, 250 ml plastic containers

Sample collection, preservation, shipping, and analysis was conducted in accordance with EPA protocol (EPA 600/2-82-029) using EPA-approved methods (SW-846). The water samples were placed in an ice-filled cooler immediately after collection and shipped to Trace Analysis, Inc. in Lubbock, Texas. For each set of samples, COC forms documenting sample identification numbers, collection times, and delivery times to the laboratory were completed.

6.0 Site Hydrogeology

6.1 Site Geology

A well-hardened and fractured sandy caliche, from the surface to about 4 to 9 feet below ground surface (bgs), underlies the site. Beneath the caliche is a silty calcareous sand that is composed of approximately 80% very fine-grained sand, 15% silt, and 5% disseminated calcium carbonate. At a depth of approximately 25 feet, the silty sand grades into moderately well sorted fine-grained sand that contains little or no fines (silts and clays). The lithology observed in all soil borings on site indicate that these conditions are continuous across the site.

Detailed descriptions of the soil lithologies and subsurface conditions observed during drilling and sampling operations are included on the lithologic logs in Appendix C.

6.2 Site Hydrology

John W. West Engineering of Hobbs, New Mexico surveyed the monitoring wells and soil boring locations. Ground surface elevations and top of casing elevations are within 0.01 feet relative to mean sea level. The survey data are provided in Appendix D. Monitoring wells MW-1 through MW-10 and recovery well RW-1 were gauged (depth to water/product thickness) on April 22, 1996.

The depth to groundwater is approximately 90 bgs across the site. The elevation of the water table and the direction of groundwater flow beneath the site is illustrated in Figure 4. Groundwater elevations and free product thicknesses are summarized in Table 1. Based on gauging data obtained on April 22, 1996, and previous dates, groundwater flows toward the southeast with a hydraulic gradient of about 0.004 feet/foot. These results agree with regional groundwater flow in the Ogalalla Aquifer in southern Lea County.

Based on observed lithology during drilling, the aquifer hydraulic conductivity for a fine-grained sand is estimated to range from about 25 to 75 feet/day. Effective porosity for a fine-grained sand is typically 25 percent. Using these parameters, groundwater flow velocity is estimated as 0.4 to 1.2 feet/day, or about 150 to 450 feet/year, based on Darcy equation as follows (Todd, 1980):

Table 1
Groundwater Elevations
Navajo Refining Company - Lea Refinery

Monitoring Well No.	Date	Relative Ground Surface Elevation (feet)	Relative Top of Casing Elevation (feet)*	Depth to Groundwater Below Top of Casing (feet)	Relative Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-1	04-22-96	3835.90	3835.67	96.49	3,744.49	6.48
MW-2	04-22-96	3835.14	3834.94	89.42	3,745.52	0.00
MW-3	04-22-96	3829.83	3829.55	87.90	3,741.65	0.00
MW-4	04-22-96	3837.85	3837.56	91.84	3,745.72	0.00
MW-5	04-22-96	3813.87	3816.88	74.58	3,742.30	0.00
MW-6	04-22-96	3835.70	3835.50	91.18	3,744.32	0.00
MW-7	04-22-96	3836.07	3835.84	96.56	3,743.68	5.37
MW-8	04-22-96	3834.42	3838.09	94.73	3,743.36	0.00
MW-9	04-22-96	3833.06	3832.82	89.60	3,743.22	0.00
MW-10	04-22-96	3831.34	3831.10	87.68	3,743.42	0.00
RW-1	04-22-96	3836.15	3835.91	96.70	3,742.83	4.41

*Elevations surveyed by John W. West Engineering Company of Hobbs, New Mexico. The monitor well casings were marked on the north side to provide consistent reference points for future gauging operations.

** Groundwater elevations corrected for product if present.

Groundwater flow is towards the southeast with a hydraulic gradient of approximately 0.004 feet/foot.

$$v = k * i \div n_e$$

where
- v = average linear groundwater flow velocity (feet/day)
- k = hydraulic conductivity (feet/day)
- i = hydraulic gradient (feet/foot)
- n_e = effective porosity (unitless)

$v_{k=25}$ = 25 feet/day * 0.004 feet/foot ÷ 0.25 = 0.4 foot/day ≈ 150 feet/year

$v_{k=75}$ = 75 feet/day * 0.004 feet/foot ÷ 0.25 = 1.2 feet/day ≈ 450 feet/year

The groundwater flow velocity may be locally influenced by the two on-site water supply wells located approximately 1,000 feet downgradient (southeast) of the source area. The effect of these process wells would be to slightly increase the local groundwater flow velocity.

7.0 Analytical Results

7.1 Soil Sampling Analytical Results

During the initial investigation conducted in 1995, a qualitative field assessment of cuttings from soil borings revealed the presence of residual hydrocarbons entrained within the vadose zone beneath the source. During drilling of monitoring wells MW-1 and MW-7 and soil boring B6, residual hydrocarbons were observed from the surface to the water table located about 90 feet bgs. These locations are within the immediate source area. Residual hydrocarbons were observed in downgradient soil boring B1 from 65 feet bgs to the water table and in B2 from the surface to about 65 bgs. The upgradient soil boring B3 was clean throughout the unsaturated zone. Impacted soil is limited to the subsurface immediately beneath the source area.

Hydrocarbon odors were noted in the borings for RW-1, AS-5, AS-7, and AS-8 from approximately 10 feet to 90 feet bgs where the last sample above the groundwater was obtained. PID readings in these borings varied from 4 ppm equivalent benzene (at 80 feet in AS-5) to 440 ppm (at 60 feet in AS-8). Hydrocarbon-impacted soils were not readily evident in the remaining borings (AS-1, AS-2, AS-3, AS-4, AS-6, and MW-8, MW-9, and MW-10) and PID measurements in these borings were below or near the instrument detection level of 1 ppm for each sampled interval.

The laboratory analytical results from the soil boring samples indicate that maximum total BTEX and TPH concentrations of 258 mg/kg and 22,500 mg/kg, respectively, were recorded in the 39 to 39.5-foot sample interval for RW-1. A summary of the laboratory analytical results for the soil sampling activities conducted during April 1996, is presented in Table 2. The laboratory analytical reports and COC documentation are provided in Appendix E.

In summary, the hydrocarbon-impacted unsaturated soils with petroleum hydrocarbons above the NMOCD recommended remediation action cleanup levels are limited to an area extending approximately 25 feet radially outward from the release point.

Table 2
Soil Hydrocarbon Concentrations
Navajo Refining Company - Lea Refinery

Boring Location	Date	Sample Interval (feet)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	Total BTEX (mg/kg)	TPH (mg/kg)
RW-1	03-27-96	29-30.5	1.37	9.86	38.2	82.3	**132**	**12,000**[1]
	03-27-96	39-39.5	1.64	9.85	78.7	168	**258**	**22,500**
	03-27-96	59-60.5	<1.00	7.73	25.9	62.7	**96.3**	**15,000**
AS-5	04-10-96	80-80.5	<0.05	<0.05	<0.05	<0.05	<0.05	<10
AS-7	04-10-96	29-30.5	1.30	6.42	33.3	65.7	**107**	**13,000**
	04-11-96	60-61	<1.00	3.71	14.8	33.2	**51.7**	**10,700**
	04-11-96	80-81	<0.50	<0.50	<0.50	<0.50	<0.50	85
NMOCD Recommended Remediation Action Level			10 ppm				50 ppm	100 ppm

Analyses performed by Trace Analysis, Inc. Lubbock, Texas.
Samples analyzed using EPA Method 8020 (BTEX) and EPA Method 418.1 (TPH) unless indicated otherwise.
[1] TPH concentration of 505 mg/kg was recorded for this sample using EPA Method 8015 (diesel range).
Values in **boldface** type indicate concentrations exceed recommended remediation action levels as specified by the NMOCD in Guidelines For Remediation of Leaks, Spills and Releases (August 13, 1993) for sites with a NMOCD ranking score greater than 19 points.

7.2 Groundwater Sampling Analytical Results

The analytical results for BTEX, PAHs, metals, and inorganics are listed in Tables 3 through 6 and summarized in the sections below. The New Mexico Water Quality Control Commision (WQCC) standards are also presented in each table for comparison.

7.2.1 Hydrocarbon Analytical Results

The only dissolved hydrocarbon constituents above WQCC standards occurred in monitoring wells MW-6, MW-9, and MW-1, as shown in Tables 3 and Table 4. The recent (April 1996) analytical results for MW-6 and MW-9 indicate benzene concentrations of 1.150 mg/l and 1.690 mg/l, respectively, which exceed the WQCC standard of 0.01 mg/l. Naphthalene at 0.094 mg/l in MW-1 (September 1995) was the only PAH constituent exceeding the WQCC standard of 0.03 mg/l. Hydrocarbon concentrations in monitoring wells MW-2, MW-3, MW-4, MW-5, MW-8, and MW-10 are near or below the laboratory detection limits for BTEX and PAH constituents and are below WQCC standards. Monitoring wells MW-1 and MW-7 were not sampled due to the presence of free product. The BTEX concentrations determined from the April 23, 1996 sampling event are illustrated in Figure 5.

Based on the results of the subsurface investigations, the areal extent of hydrocarbon-impacted groundwater is estimated as an oval-shaped area 300 feet wide by 600 feet long, as depicted in Figure 5.

7.2.2 Inorganic Analytical Results

The analytical results for metals are summarized in Table 5. The results indicate that monitoring well MW-1 exceeds the WQCC standards for arsenic (0.5 mg/l), barium (2.12 mg/l), iron (1.38 mg/l), and manganese (0.39 mg/l). Monitoring wells MW-2, MW-4, and MW-5 also indicate arsenic levels slightly above the WQCC standard of 0.1 mg/l with concentrations ranging from 0.3 mg/l to 0.5 mg/l. Arsenic and barium are common constituents of crude oil and/or produced water. Manganese concentrations of 0.39 mg/l and 1.70 mg/l in MW-1 and MW-6, respectively, exceed the WQCC

Table 3
Dissolved BTEX Analytical Results
Navajo Refining Company - Lea Refinery

Constituent	Date	MW-1 (mg/l)	MW-2 (mg/l)	MW-3 (mg/l)	MW-4 (mg/l)	MW-5 (mg/l)	MW-6 (mg/l)	MW-7 (mg/l)	MW-8 (mg/l)	MW-9 (mg/l)	MW-10 (mg/l)	WQCC Standards (mg/l)
Benzene	04-23-96	NS	<0.001	<0.001	<0.001	<0.001	**1.150**	NS	0.002	**1.690**	<0.001	0.010
Toluene	04-23-96	NS	<0.001	<0.001	0.001	<0.001	<0.001	NS	<0.001	<0.010	<0.001	0.75
Ethylbenzene	04-23-96	NS	<0.001	<0.001	<0.001	<0.001	0.599	NS	<0.001	<0.010	<0.001	0.75
Xylenes (Total)	04-23-96	NS	<0.001	<0.001	<0.001	<0.001	0.462	NS	<0.001	0.019	<0.001	0.62

Analyses performed by Trace Analysis, Inc. Lubbock, Texas.
All samples analyzed for BTEX using EPA Method 8260.
New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in Section 3-103.
Values in **boldface** type indicate concentrations exceed WQCC groundwater standards.
NS indicates not sampled due to presence of free product.
Blank indicates well not installed at sampling date.

Table 4
PAH Analytical Results
Navajo Refining Company - Lea Refinery

Constituent	MW-1 (mg/l) *09-08-95*	MW-2 (mg/l) *09-07-95*	MW-3 (mg/l) *09-08-95*	MW-4 (mg/l) *09-07-95*	MW-5 (mg/l) *09-07-95*	MW-6 (mg/l) *04-23-96*	MW-7 (mg/l) *04-23-96*	MW-8 (mg/l) *04-23-96*	MW-9 (mg/l) *04-23-96*	MW-10 (mg/l) *04-23-96*	WQCC Standards (mg/l)
Acenaphthene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Acenaphthalene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Anthracene	0.011	<0.001	<0.001	<0.001	<0.001	0.001	NS	<0.001	<0.001	<0.001	NA
Benzo(a)anthracene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Benzo(a)pyrene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	0.0007
Benzo(b)fluoranthene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Benzo(g,h,i)perylene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Benzo(k)fluoranthene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Chrysene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Dibenz(a,h)anthracene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Fluoranthene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Fluorene	0.010	<0.001	<0.001	<0.001	<0.001	0.002	NS	<0.001	<0.001	<0.001	NA
Indeno(1,2,3-cd)pyrene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Naphthalene*	**0.094**	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	0.03
Phenanthrene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA
Pyrene	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	NA

Analyses performed by Trace Analysis, Inc. using EPA Method 8270.
New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in Section 3-103.
Bold values indicate concentrations exceed WQCC groundwater standards.
* includes monomethylnaphthalenes.
NS indicates not sampled due to presence of free product.
NA indicates not applicable (no standard established).

Table 5
Metal Analytical Results
Navajo Refining Company - Lea Refinery

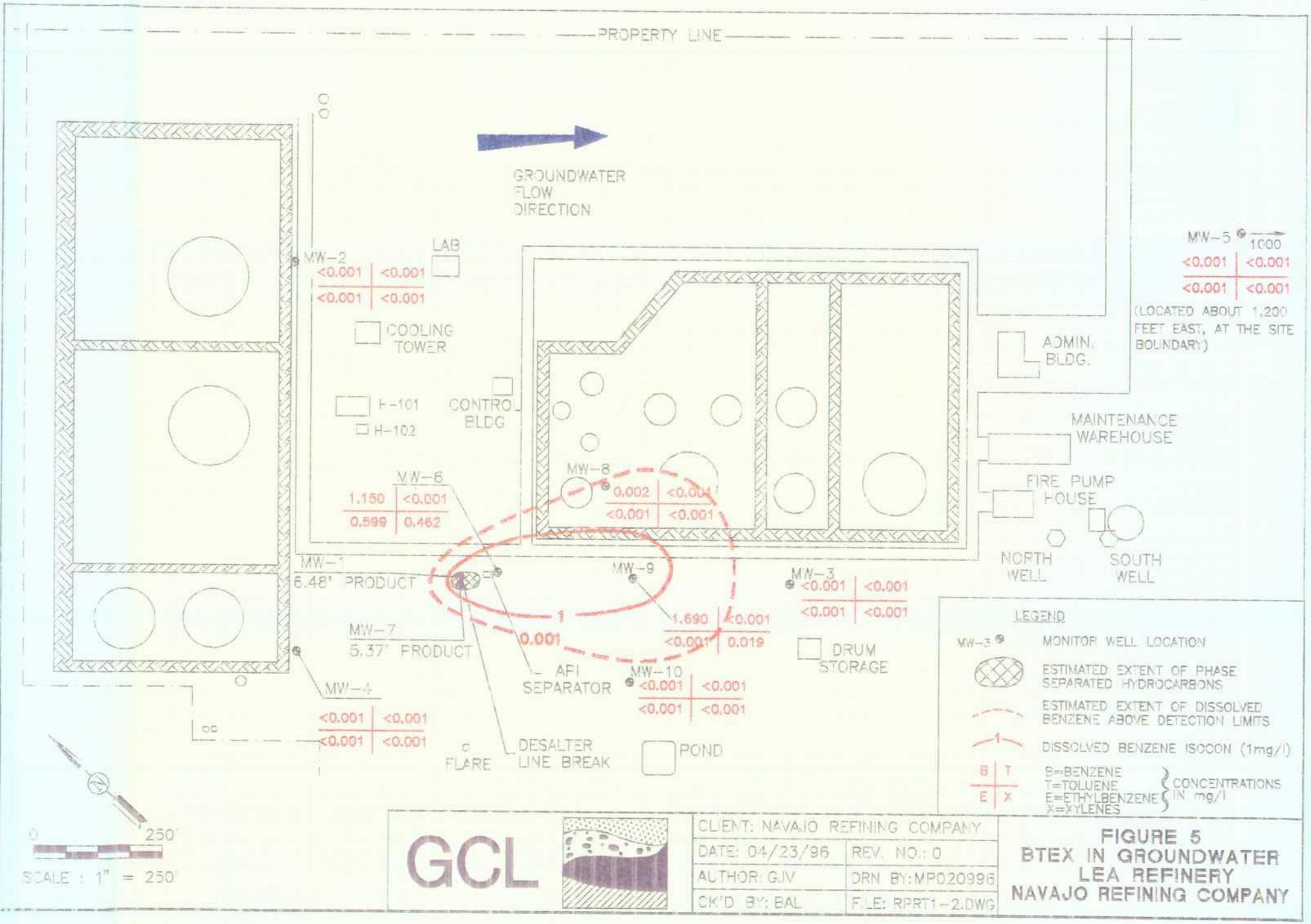
Constituent	MW-1 (mg/l) 09-08-95	MW-2 (mg/l) 09-07-95	MW-3 (mg/l) 09-08-95	MW-4 (mg/l) 09-07-95	MW-5 (mg/l) 09-07-95	MW-6 (mg/l) 04-23-96	MW-7 (mg/l) 04-23-96	MW-8 (mg/l) 04-23-96	MW-9 (mg/l) 04-23-96	MW-10 (mg/l) 04-23-96	WQCC Standards (mg/l)
Aluminum (Al)	1.2	0.5	1.0	0.5	1.8	<0.1	NS	0.27	0.13	0.10	5
Arsenic (As)	**0.5**	**0.3**	<0.2	**0.2**	**0.5**	<0.1	NS	<0.1	<0.1	<0.1	0.1
Barium (Ba)	**2.12**	0.12	0.10	0.11	<0.03	0.8	NS	0.2	0.7	<0.2	1
Berylium (Be)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NS	<0.01	<0.01	<0.01	<0.01
Boron (B)	0.66	0.25	0.15	0.16	0.26	0.21	NS	<0.03	0.83	0.11	0.75
Cadmium (Cd)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	NS	<0.01	<0.01	<0.01	0.01
Chromium (Cr)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NS	<0.05	<0.05	<0.05	0.05
Cobalt (Co)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.01	NS	<0.01	0.02	<0.01	0.05
Copper (Cu)	<0.02	0.05	<0.02	0.04	0.05	<0.01	NS	<0.01	<0.01	<0.01	1
Iron (Fe)	**1.38**	0.16	0.48	0.46	0.32	0.29	NS	<0.05	0.11	0.16	1
Lead (Pb)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	0.05
Manganese (Mn)	**0.39**	0.07	<0.01	0.04	0.05	**1.70**	NS	0.27	0.19	0.02	0.2
Mercury (Hg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001	0.002
Molybdenum (Mo)	0.1	0.2	0.2	0.1	0.3	<0.01	NS	0.03	<0.01	<0.01	1
Nickel (Ni)	<0.2	<0.2	<0.2	<0.2	<0.2	0.04	NS	0.06	0.05	<0.02	0.2
Selenium (Se)	<0.001	<0.001	0.003	<0.001	0.003	<0.001	NS	<0.1	<0.1	<0.1	0.05
Silver (Ag)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.01	NS	<0.01	<0.01	<0.01	0.05
Uranium (U)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	NS	<0.5	<0.5	<0.5	5
Vanadium (V)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	NS	0.02	0.02	0.03	0.05
Zinc (Zn)	0.05	<0.02	0.06	0.05	0.04	0.03	NS	0.02	6.10	0.24	10

Analyses performed by Trace Analysis, Inc. using EPA Methods 200.7, 239.2, 270.2, 272.2, 3015, 6010, and 7470.
New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in Section 3-103. **Bold** values indicate concentrations exceed WQCC standards.
NS indicates sample was not analyzed for this constituent.

Table 6
Major Cation and Anion Analytical Results
Navajo Refining Company - Lea Refinery

Constituent	MW-1 (mg/l) 9-8-95	MW-2 (mg/l) 9-7-95	MW-3 (mg/l) 9-8-95	MW-4 (mg/l) 9-7-95	MW-5 (mg/l) 9-7-95	MW-6 (mg/l) 4-23-96	MW-7 (mg/l) 4-23-96	MW-8 (mg/l) 4-23-96	MW-9 (mg/l) 4-23-96	MW-10 (mg/l) 4-23-96	WQCC Standards (mg/l)
Total Dissolved Solids (TDS)	**1,275**	523	454	438	853	**1,786**	NS	**1,004**	**2,658**	443	1,000
Calcium (Ca)	NS	133	NS	NS	196	83	NS	105	226	70	NA
Fluoride (F)	1.2	1.2	1.0	1.0	0.7	**1.65**	NS	1.2	0.5	1.0	1.6
Magnesium (Mg)	NS	16.9	NS	NS	23.6	14	NS	15	44	9	NA
Sodium (Na)	NS	65.7	NS	NS	82.4	501	NS	171	370	36	NA
Potassium (K)	NS	2.3	NS	NS	3.0	6.6	NS	5.8	9.1	2.5	NA
Bicarbonate (HCO_3)	349	283	223	254	230	319	NS	420	340	190	NA
Chloride (Cl)	**509**	61	35	23	198	**798**	NS	185	**1,190**	29	250
Nitrate (NO_3-N)	<0.15	1.65	2.54	1.19	1.49	<0.1	NS	0.2	<0.1	0.13	10
Sulfate (SO_4)	<5	105	93	88	119	13	NS	49	9	31	600

Analyses performed by Trace Analysis, Inc. using EPA Methods 160.1, 200.7, 340.2, 375.4, 353.3, 4500 C1-B, and 310.1
New Mexico Water Quality Control Commission (WQCC) Standards are listed as specified in Section 3-103.
NS indicates sample not analyzed for this constituent.
NA Not applicable (no regulatory standard established).
Values in **boldface** type indicate concentrations exceed WQCC groundwater standards.



GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 04/23/96	REV. NO.: 0
AUTHOR: GJV	DRN BY: MP020996
CK'D BY: BAL	FILE: RPRT1-2.DWG

FIGURE 5
BTEX IN GROUNDWATER
LEA REFINERY
NAVAJO REFINING COMPANY

standard of 0.2 mg/l. MW-1 also recorded an iron concentration of 1.38 mg/l which exceeds the WQCC standard of 1.0 mg/l. The elevated iron and manganese levels in monitoring wells MW-1 and MW-6 may be partially due to the chemically reduced conditions caused by the presence of hydrocarbons in the on-site soils and groundwater and partially from fluid released at the source (sewer junction box).

Major cation and anion analytical results are summarized in Table 6. A fluoride concentration of 1.65 mg/l recorded in MW-6 barely exceeds the WQCC standard of 1.6 mg/l. Fluoride is not a known constituent or byproduct generated from the refining processes occurring at the facility. The slightly elevated fluoride concentration is likely due to natural conditions or accuracy limitations of the laboratory analytical equipment.

Monitoring wells MW-1, MW-6, MW-8 and MW-9 recorded total dissolved solids (TDS) concentrations of 1,275 mg/l, 1,786 mg/l, 1,004 mg/l and 2,658 mg/l, respectively, which exceed the WQCC standard of 1,000 mg/l. Monitoring wells MW-1, MW-6, and MW-9 recorded chloride concentrations of 509 mg/l, 798 mg/l, and 1,190 mg/l, respectively, which exceed the WQCC standard of 250 mg/l. The elevated TDS and chloride levels are most likely attributed to the fluid released at the source.

8.0 Remediation System

Based on the initial investigation in 1995, a conceptual remedial design was developed. The objectives of the remedial design for the Lea Refinery include the following.

- Reduce residual hydrocarbons within the unsaturated zone beneath the source area.
- Remove free product from the water table beneath the source area.
- Remediate groundwater with total BTEX concentrations exceeding 1.0 mg/l.
- Enhance natural remediation to remediate the remaining downgradient portion of the dissolved-phase hydrocarbon plume.

Residual hydrocarbons in soil, free product, and high-BTEX groundwater are long-term sources of hydrocarbons for groundwater. Therefore, source removal is a key element in the remedial design. To achieve these objectives, the following combination of remediation technologies were selected.

- Pump-and-treat system for free product and high-BTEX groundwater removal beneath the source area.
- Air sparging/vapor extraction system to remediate the high-BTEX groundwater
- Vapor extraction to remediate unsaturated zone beneath the source

The portion of the plume not actively remediated (BTEX < 1.0 mg/l) will naturally attenuate due to the following processes: intrinsic bioremediation, dispersion, adsorption, and volatilization. Some degree of enhancement to intrinsic bioremediation will occur by the movement of upgradient, oxygenated groundwater from the air sparge system which will flow into the downgradient areas not actively remediated.

As a remedial option, natural attenuation is more effective in homogenous and permeable aquifers, single-source plumes, low groundwater gradients, absence of free product/soil contamination, and where hydrocarbon concentrations are 40.0 mg/l or less (NMED, 1995). These conditions are met for that portion of the plume not actively remediated at this site.

8.1 Total Fluids Pumping

To effectively remove the source (free product and high-BTEX groundwater), a ¾-horsepower (HP) Grundfos submersible pump was installed in the 4-inch recovery well (RW-1). The well construction diagram for RW-1 is in Appendix C. The discharge line is equipped with a shut-off valve, a check valve, sampling port, and a totalizing meter. Total fluids (free product and groundwater) will be pumped at up to 20 gpm into the refinery desalter unit. The recovery well as-built is shown in Figure 6. The approved well permit is provided in Appendix F.

Based on drawdown calculations, pumping the recovery well between 1 and 20 gallons per minute will produce a cone of depression sufficient to draw the free product/high-BTEX groundwater into the well. The total fluids will be pumped to the refinery desalter unit where free product is recovered by an electrostatic oil/water separation process. The recovered groundwater then undergoes a steam stripping process prior to being released to the Lovington publicly owned treatment works (POTW) along with site discharge water.

8.2 Air Sparging System

Air sparging/vapor extraction is most effective in uniform, sandy material, with little or no fines, similar to the actual site conditions. This approach injects hydrocarbon-free, compressed atmospheric air into the aquifer beneath contamination. Air injection creates an inverted cone of bubbles or discrete "air tubes" below the water table acting as an in-situ air stripper. Aqueous phase hydrocarbons are induced into the gaseous phase and travel to the top of the groundwater table where they build up within the unsaturated zone. The vapors are then collected by the vapor extraction wells located just above the water table.

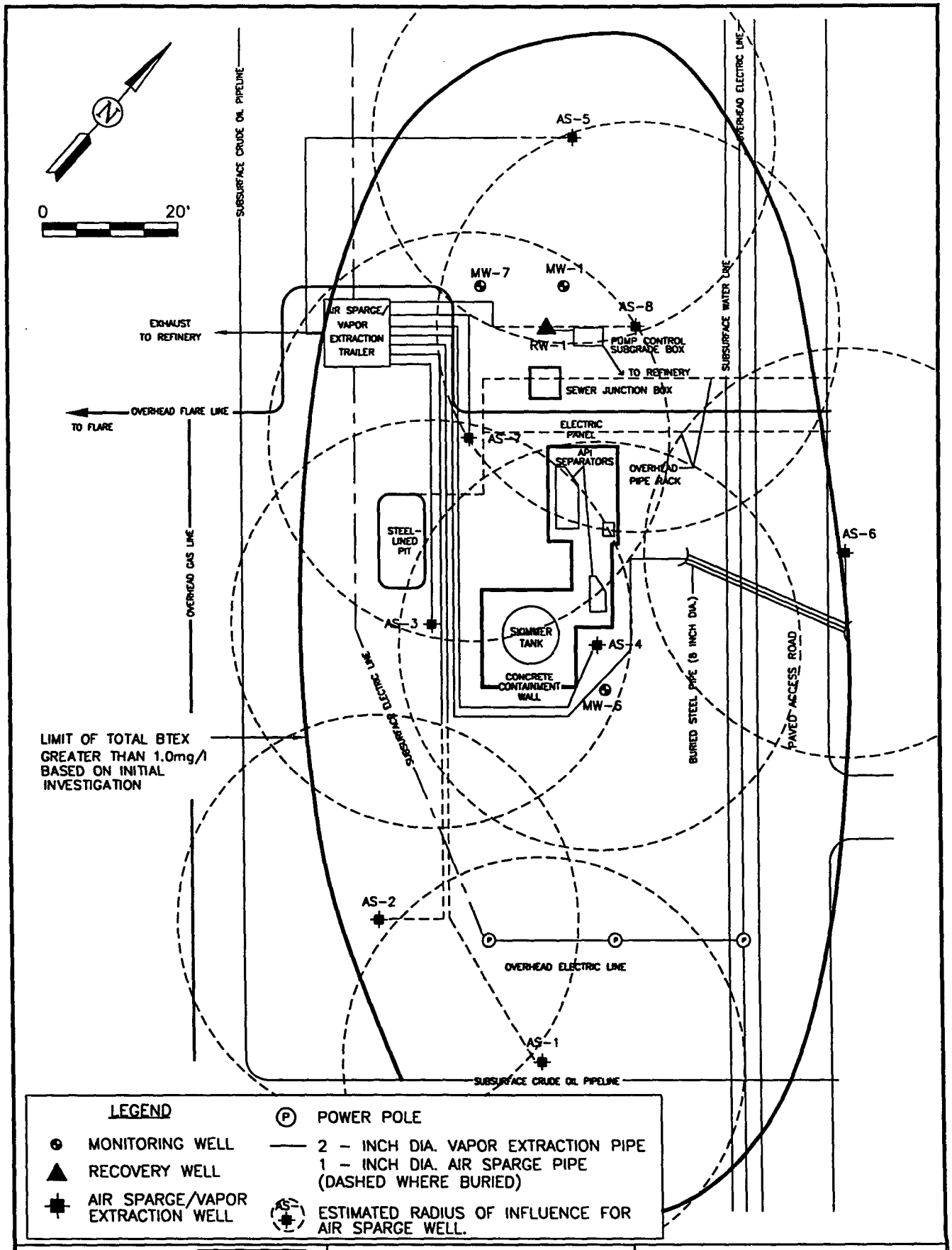
The area of the dissolved-phase plume with total BTEX of about 1.0 mg/l or greater is shown in Figure 3, based on results of the initial investigation. A single air sparging well is estimated to have a 30-foot radius of influence in the saturated materials present beneath the site. Consequently, eight sparging wells will provide the necessary coverage to remediate groundwater with 1.0 mg/l or greater of total BTEX as depicted in Figure 7. Vapor extraction tests will be conducted during the system startup operations to determine the actual radius of influence.

Each sparging well cluster is constructed with a sparge point installed at the bottom of the dissolved phase plume (estimated at about 10 to 15 feet below the water table) and a screened section within the unsaturated zone for soil-vapor extraction. A 1-inch diameter Schedule 40 PVC pipe delivers compressed and filtered atmospheric air into the aquifer through the submerged sparge point. A blower will deliver 5 to 10 cubic feet per minute (cfm), operating at 12 psi, to each sparge point. Dedicated pipes from the blowers to the sparge points allow for fine-tuning the sparging system. Each sparge line houses a control valve, flow meter, and pressure gauge port. Construction diagrams for the AS/VE wells are included in Appendix C. The engineering as-builts for the vapor extraction and air sparge system design are depicted in Figures 8 and 9, respectively.

In addition to the air-stripping action within the aquifer, air injection also increases the dissolved oxygen content which stimulates naturally occurring hydrocarbon-degrading aerobic bacteria present in the aquifer. This will enhance the intrinsic bioremediation of hydrocarbons within the air sparged and downgradient portions of the plume.

8.3 Vapor Extraction System

Hydrocarbon vapors will buildup within the unsaturated zone just above the water table. These vapors will be extracted through the eight 2-inch diameter Schedule 40 PVC extraction wells which were installed in the same boring as the air sparge wells. The 5 to 10-foot length of screen for each vapor extraction well was installed within the vadose zone about 5 feet above the water table. A vacuum pump operating at 60 psi will remove 15 to 30 cfm from each well. Typical designs remove about three to six times more air than is injected to ensure complete capture of unsaturated zone vapors. Two additional vapor extraction wells installed in AS-5 and AS-7 are available for added soil vapor

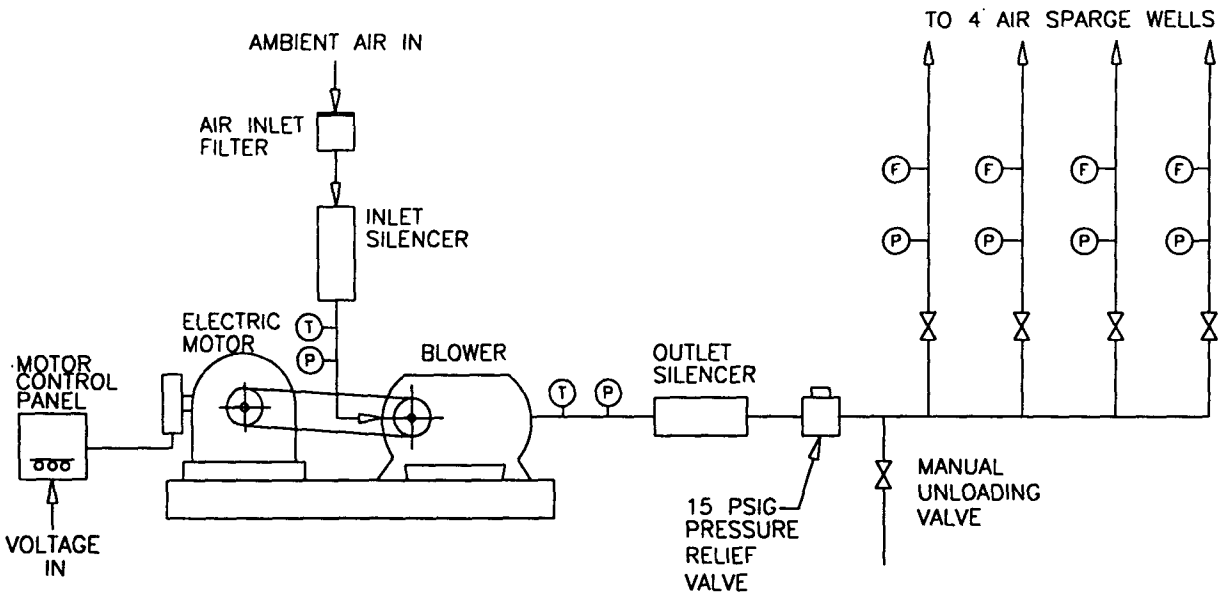


GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 5/30/96	REV. NO.: 1
AUTHOR: BAL	DRAWN BY: RG
CK'D BY: GJV	FILE: LEA6.DWG

FIGURE 7
REMEDIATION SYSTEM
LEA REFINERY

D:\NAVAJO\LEA4.DWG 4-30-96



ELECTRIC MOTOR
5hp
230/460 VOLT
12/6 amp
3450 rpm
6.25 inch dia. pulley
CLASS I, GROUP D
CLASS II, GROUPS F-G

MOTOR CONTROLLER
5hp
240 VOLT
12.5 amp
START/STOP/RESET
CLASS I, GROUPS C-D
CLASS II, GROUPS E-F-G

BLOWER
BOOTS FRAME 22
4.0 inch dia. pulley
5275 rpm

AIR SPARGE SYSTEM REQUIREMENTS

	EACH WELL	4 WELLS
FLOW RATE (CFM)	5-10	20-40
INJECTION PRESSURE (PSIG)	10-12	10-12

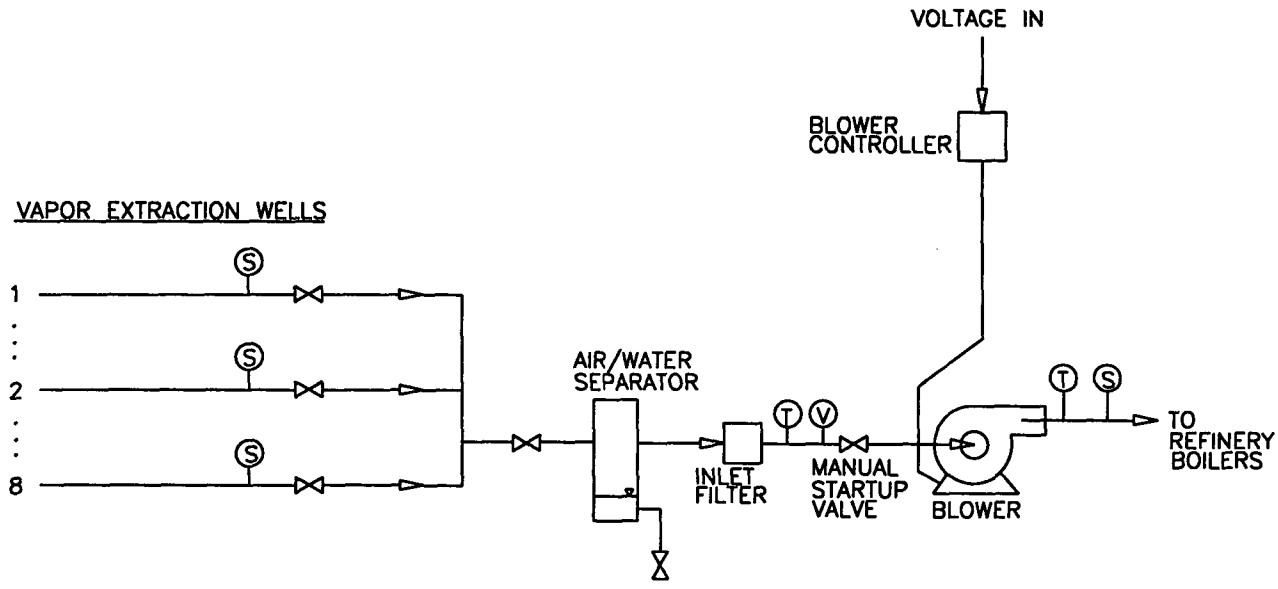
LEGEND
- (T) TEMPERATURE GAUGE
- (P) PRESSURE GAUGE
- (F) FLOW GAUGE
- VALVE

NOTE: TWO IDENTICAL AIR SPARGING SYSTEMS WILL BE USED AT 4 WELLS EACH, 8 TOTAL.

GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 5/16/96	REV. NO.: 0
AUTHOR: BAL	DRAWN BY: RG
CK'D BY: GJV	FILE: AIRSPAR.DWG

FIGURE 8
AIR SPARGING SYSTEM DESIGN
LEA REFINERY



BLOWER SPECS
5hp
220 VOLT
14 amp
CLASS I, GROUP D

VAPOR EXTRACTION SYSTEM DESIGN SPECS.

	EACH WELL	TOTAL (8 WELLS)
FLOW RATE (cfm)	15-30	120-240
VACUUM (psi)	60	60

LEGEND

- (T) TEMPERATURE GAUGE
- (V) VACUUM GAUGE
- (S) SAMPLE PORT (VELOCITY, TOTAL HYDROCARBONS, VACUUM)
- VALVE

GCL

CLIENT: NAVAJO REFINING COMPANY	
DATE: 5/16/96	REV. NO.: 0
AUTHOR: BAL	DRAWN BY: RG
CK'D BY: GJV	FILE: VAPOR.DWG

FIGURE 9
VAPOR EXTRACTION SYSTEM DESIGN
LEA REFINERY

extraction. These wells are screened in the vadose zone from 30- to 50-feet below ground surface where the highest hydrocarbon concentrations were observed.

Two banks of four vapor extraction wells each are connected to a common header prior to entry into the vacuum system. Each well is equipped with a flow meter, vacuum gage, and shutoff valve, all located in a central location for ease of operation and maintenance. The exhaust air stream from the vacuum extraction pump has been piped to both of the refinery boilers for thermal destruction.

9.0 System Startup

Each system component will be tested independently prior to system startup to ensure each component operates as expected. Once each component is shown to operate properly, the entire system will be activated and closely evaluated for one week. First, a step-drawdown test is conducted in recovery well RW-1 to determine the optimum pumping rate. The discharge line is connected to the desalter. Selected nearby monitoring wells will be checked for drawdown and product thickness during the test while the pumping rate is monitored.

Next, the vapor extraction system is activated with selected nearby monitoring wells and/or vapor extraction wells monitored for vacuum response. The vacuum discharge line is connected to both of the refinery's boilers for thermal destruction. The vacuum and flow rates will be monitored and used to determine the in-situ radius of influence. Finally, each bank of the air sparge system will be activated individually with dissolved oxygen and water levels measured in nearby monitoring wells. The injection pressure and air flow rates of the air sparge component will also be monitored.

10.0 Performance Monitoring and Sampling Frequency

Selected monitoring wells will be periodically sampled for groundwater BTEX concentrations (EPA Method 8020) in order to monitor the performance of the remediation system and natural attenuation of the hydrocarbon plume. Monitoring wells MW-1, MW-6, MW-7, and MW-9 are currently within the hydrocarbon plume, therefore these monitoring wells shall be sampled on a quarterly basis to closely monitor measurable BTEX concentrations during active remediation operations. Monitoring wells MW-2, MW-3, MW-4, MW-5, MW-8 and MW-10 delineate the upgradient, downgradient, and cross-gradient boundaries of the plume; therefore an annual sampling frequency for these wells will be sufficient to confirm the plume boundary conditions have not changed. Water levels, product thicknesses, and dissolved oxygen shall also be measured quarterly for all monitoring wells. Total fluid (groundwater and free product) recovery rates will monitored continuously with a totalizing meter.

Vapor samples obtained from the vacuum effluent discharge line of the vapor extraction system will be collected in Tevlar bags and analyzed for BTEX (EPA Method 8020) and TPH (EPA Method 8015-gas range) monthly for the first year of operation. Air injection and vapor extraction rates/volumes will be measured monthly.

The proposed parameters and frequency for performance monitoring of the remediation system and site conditions are summarized below.

Prior to Startup

- Depth to water and free product thicknesses
- Optimum pump rate in RW-1 for total fluid recovery
- Optimum blower rate for soil vapor extraction wells

Startup

- Depth to groundwater and free product thicknesses
- Dissolved oxygen
- Air injection rates
- Vapor extraction rates
- Vapor extraction sample for BTEX and TPH analysis
- Total fluid (groundwaterand free product) recovery rates

Monthly

- Vapor extraction sample for BTEX and TPH analysis
- Air injection rates/volumes
- Vapor extraction rates/volumes
- Groundwater/free product recovery rates
- Free product thicknesses

Quarterly

- Groundwater samples from MW-3, MW-6, MW-8, MW-9, and MW-10 for BTEX analysis
- Dissolved oxygen for selected monitoring wells
- Depth to groundwater in all monitoring wells
- Free product thickness
- Groundwater/free product recovery rates
- Vapor extraction sample for BTEX and TPH analysis
- Air injection rates/volumes
- Vapor extraction rates/volumes

Annually

- Groundwater samples from MW-2, MW-3, MW-4, MW-5, MW-6, MW-8, MW-9, and MW-10 for BTEX, metals (only in wells with WQCC-exceeded constituents if required by OCD), and major cations/anions analyses
- Dissolved oxygen for selected monitoring wells
- Depth to groundwater in all monitoring wells
- Free product thickness
- Groundwater/free product recovery rates
- Vapor extraction sample for BTEX and TPH analysis
- Air injection rates/volumes
- Vapor extraction rates/volumes

It is anticipated that the remediation system will operate for one to two years. After one year of operation, the system performance will be evaluated and recommendations provided to the NMOCD in an annual report, as requested by the NMOCD.

11.0 Operation and Maintenance

The remediation system and equipment will be periodically monitored for proper operation and the recommended maintenance (per equipment manufacturer) will be conducted. After system startup, operation and maintenance (O&M) visits are expected to occur monthly for the first year of operation. Daily and weekly inspections by NRC personnel will be conducted to confirm status of system (on, off, total fluid meter readings, check oil levels in blowers, etc.). An O&M schedule will be available at the site as well as a record of all maintenance conducted.

12.0 Conclusions

- Based on the analytical results from subsurface investigations conducted by NRC and GCL, the estimated areal extent of hydrocarbon-impacted soil above the OCD recommended action level of 50 ppm BTEX and 100 ppm TPH does not extend beyond an estimated 25 feet radius around the sewer junction box.

- The presence of phase-separated hydrocarbons (free product) in MW-1, MW-7, and RW-1 appears to be limited to within an estimated 20 feet radius around the sewer junction box.

- The areal extent of impacted groundwater has been estimated as covering an oval-shaped area approximately 300 feet wide by 600 feet long and is well within the property boundaries.

- The inorganic chemical analyses indicate that water samples from some monitoring wells exceed the WQCC standards for various constituents, including arsenic, barium, chloride, fluoride, iron, manganese, and/or total dissolved solids..These elevated constituents occur in a small localized area of the refinery and will attenuate by dilution, dispersion, and adsorption as the groundwater moves downgradient. The groundwater recovery system will also aid in the extraction of these constituents near the source area. The observed levels do not present a significant threat to any water supply wells.

- The apparent direction of groundwater flow is toward the southeast with a hydraulic gradient of approximately 0.004 feet/feet and an estimated average linear velocity of 150 to 450 feet/year.

- Based upon the calculation of the average linear velocity of groundwater flow, the age of the release, and the documented extent of hydrocarbon-impact, GCL concludes that the implemented remediation system and natural processes (intrinsic bioremediation, dispersion, adsorption, and volatilization) will effectively remove the hydrocarbons in the subsurface media.

13.0 Recommendations

- Continued operation of the installed air sparge soil vapor extraction and groundwater recovery system.

- Continued sampling and monitoring activities to monitor the performance of the remediation system and reduced migration of the hydrocarbon plume. Monitoring wells MW-3, MW-6, MW-8, MW-9, and MW-10 should be analyzed for BTEX on a quarterly basis. Annual sampling of the remaining monitoring wells (MW-2, MW-4, and MW-5) will be sufficient to verify that upgradient and downgradient groundwater is not impacted. The primary parameters to be monitored and sampled should include free product thicknesses, groundwater elevations, dissolved oxygen and BTEX concentrations.

- Based on the preponderance of concentrations that are below WQCC standards for metals, major ions, and PAHs , sampling for these constituents should be discontinued or reduced to an annual sampling frequency. Only those wells that have exceeded the WQCC standards should be sampled for the specific WQCC-exceeded constituents.

- Near the completion of the groundwater remediation system (estimated at two years) when BTEX levels are reduced to the lowest effective levels possible, it may be beneficial to analyze biological parameters (dissolved oxygen, nitrate, sulfate, iron, and aerobic bacteria populations) to monitor the efficacy of intrinsic bioremediation.

14.0 References

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U. S. Geological Survey, 1979. Lovington, NM USGS 7.5-minute quadrangle map

U. S. Geological Survey, 1985. Lovington SE, NM USGS 7.5-minute quadrangle map

APPENDICES

APPENDIX A

PRELIMINARY INVESTIGATION DATA
(Supplied by Navajo Refining Company)

MW-1 0-1' Topsoil **August 23, 1995**
1-4' rock
4-7' slightly softer rock turning to sand at bottom, vfg.
7-10' gray sand w/ HC odor
10-13' gray tuning dk. gray
13-20' Dk. gray w/ streaks of rock and odor. .
20-23' Dk. gray w/ odor turning black
23-48' Jet black .w/ strong odor
48-65' Dk. gray grading to lt. gray vfg.
65-97' Brown to lt. tan w/ odor. Water at 93'. .02' of product on water table. Water is very hot!!!!

MW-2 0-1' Topsoil **August 28, 1995**
1-4' caprock turning to sand at bottom.
4-102' vfg tan sand w/ no odor. Water at 89.18'

MW-3 0-1' Topsoil **August 29, 1995**
1-3' caprock turning to sand at bottom
3-103' vfg tan sand, no visible contamination, no odor. Water at 91.4'

MW-4 0-1' topsoil **August 30, 1995**
1-4' caprock turning to sand at bottom.
4-102' vfg tan sand, no odor, water at 92.72'

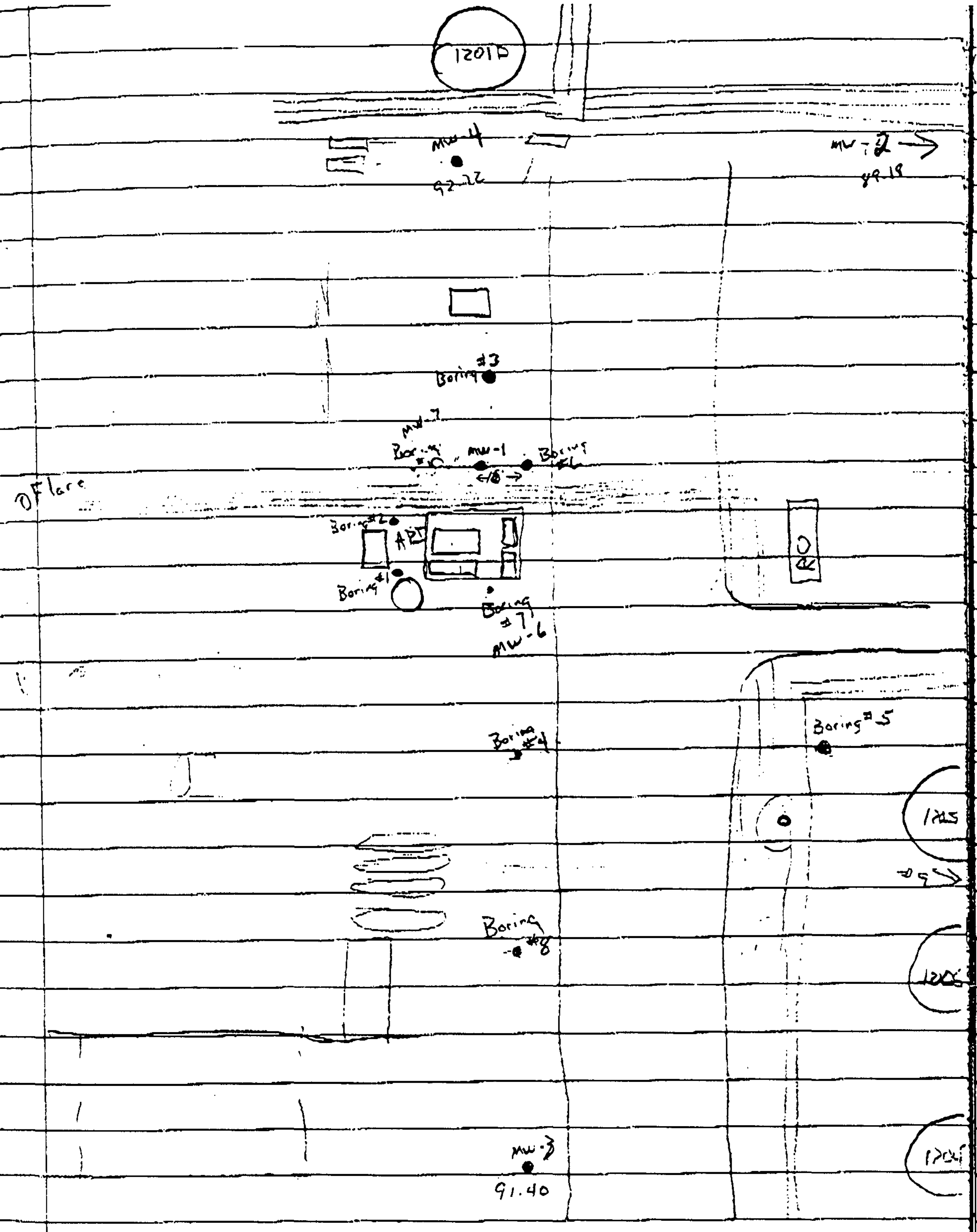
MW-5 0-1' Topsoil **September 6, 1995**
1-4' caprock turning to sand at bottom
4-96' vfg tan sand no odor, water at 76.08'

MW -6 (Boring 7 was turned into MW-6) **August 31, 1995**
1'-4' caprock
4'-99' vfg sand, odor at 91', water at 93'

MW-7 (Boring 10 was turned into MW-7) **September 6-7, 1995**
1'-4' caprock
4'-100' vfg sand, tan, fluid at 93' with 0.05'
of free product.

~~Finalized Well~~

	TD	Screen	Sand to	Bent Seal	
mw 1	98'	10'	86'	84'	8/22/95
2	102'	20'	81'	75.4	8/28
3	103'	20'	80.2	75.8	8/29
4	104'	20'	82	77.2	8/30
5	100' Set well 90'	20'	67.5	~~75~~ 65	9/6
6	99	20 10'	86	81	8/31
7					


1201P
MW-4
92.22
MW-2
Boring #3
MW-1
Boring #6
Flare
Boring #2
Boring #1
Boring #7
MW-6
Boring #4
Boring #5
1205
Boring #8
MW-3
91.40

none

CMB CONSULTING GEOLOGIST - WELL DATA FORM

Type Well ☒ MW ☐ Production ☐ Other	Type of Data ☒ Development ☒ Sampling ☐ Pump Test ☐ Other	Well No. MW-3 Sheet 1 of 1 Sheets
1 Project NAVAJO REFINING CO. - LEA REFINERY	2. Project Location LOVINGTON, NM	3. Date 9/8/95
4 Technician CM BARNHILL	GPS Coordinates: 32°52'42"N 103°18'08"W Elev. 4011	
7. Method (Pumping) (Surging) Air Lift (Bailing) Other	8. Manufacturer's Designation of Rig DSR 1000	9. Location of Well (Site, Description) MONITOR WELL #3

Water Levels

Initial	Final	Final + 24 Hours
Date: 9/8/95 Time: 7:15 AM	Date: 9/8/95 Time: 9:05 AM	Date: Time:
10. Total Depth of Well (from TOC) 102.0'	15. Total Depth of Well (from TOC) 102.0'	20 Total Depth of Well (from TOC)
11. Water Level (from TOC) 87.53'	16. Water Level (from TOC) 87.65'	21. Water Level (from TOC)

12. Water Column Height 14.47'	Nom Dia (Sch 40) Sch 80 (x = gal/ft)	17. 3 Well Volumes 7.56 GAL	22. Size and Type of (Pump) or Bailer
13. Well Diameter 2" SCH 40 PVC.	(2") 0.1743 0.1534	18. 5 Well Volumes 12.61 GAL.	Bailer: 1.5" PVC Pump: 1.5" Grundfos Redi-flo2
14. Well Volume (gal) (s) w.e. height) 2.52 GAL	4" 0.6613 0.5972 6" 1.5007 1.3540 8" 2.5856 2.3720	19. Purge Volume 60 GAL	

Final Field Analysis

23. Total Amount of Water Removed	24. Was Well Pumped Dry?	25. Was water added to well?	26. Was the Groundwater Sampled (Yes) No
60 GAL	Yes (No)	(No) Yes If yes, source:	If yes, what was the sample number & Date: Sampling Personnel? MW-3 9/8/95 CM BARNHILL 8:55 AM

27. Final Parameters

Time	Temp F	Conductivity x1000	pH	NTUs	WL	Removed	Flow Rate	Photo Roll #, Observations
8:55 AM	69.1	5.65	6.98	clear	89.6'	60 GAL	1.66 GPM	Clear H_2O

IF PETROLEUM IS IN THE WELL, DO NOT TAKE pH AND CONDUCTIVITY PARAMETERS

28. Physical Appearance and Remarks: SLIGHT Suspended fine Silt initially Clear Sample.

29. Purgewater disposal method: ON SURFACE.

Sampling / Development Parameters

Time	Temp F	Conductivity (umhos/cm) x1000	pH	NTUs	WL (from TOC)	Volume (gallons)	Flow Rate (gpm)	Photo #, Observations (1)
6:23 AM	65.5	6.73	6.89	Very Slight Brown	87.53'	1ST BAIL	—	Silty Brown Fine Silt
7:35 AM	66.2	6.27	7.36	Slight Silt	87.53'	56 GAL	0.41	Slight Silt Brown color.
SURGED well with SURGE BLOCK.						5		
7:52 AM	66.3	6.10	7.02	Slight Silt	87.53'	10	0.41	Slight Silt Brown color.
started redi-flo2 Pump. @ 8:23 AM				"	89.5'	10	1.6	Slight Silt
8:29 AM	68.2	6.50	7.09	Slight Silt	89.5	20	1.6	Slight Silt
8:42 AM	69.7	5.74	7.10	Clear	89.5	40.	1.6	Clear H_2O
8:55 AM	69.1	5.65	6.98	clear	89.5	60	1.6	Clear H_2O

(1) Note volume and physical character of sediments removed.
NTU = Nephelometric turbidity units
WL = Water Level from Top of PVC Casing

Checked By: Clayton Barnhill Date: 9/8/95

CMB CONSULTING GEOLOGIST - WELL DATA FORM

Type Well	Type of Data	Well No / Sheet
☒ MW ☐ Production ☐ Other	☒ Development ☒ Sampling ☐ Pump Test ☐ Other	Well No MW-4 Sheet 1 of 1 Sheets

1. Project	2. Project Location	3. Date
NAVAJO REFINING CO. LEA REFINERY	LOVINGTON, NM	9/7/95
4 Technician	GPS Coordinates: 32° 52' 43"N 103° 18' 14"W 3428' Elev.	
CM BARNHILL		
7. Method Pumping (Surging) Air Lift Bailing Other	8. Manufacturer's Designation of Rig	9. Location of Well (Site, Description)
	DSA-1000	MONITOR WELL # 4

Water Levels

Initial	Final	Final + 24 Hours
Date: 9/7/95 Time: 2:40 PM	Date: 9/7/95 Time: 4:05 PM	Date: Time:
10. Total Depth of Well (from TOC) 102.15	15. Total Depth of Well (from TOC) 102.15	20. Total Depth of Well (from TOC)
11. Water Level (from TOC) 91.40'	16. Water Level (from TOC) 91.40'	21. Water Level (from TOC)

12. Water Column Height	Nom Dia	x = gal/ft Sch 40	Sch 80	17. 3 Well Volumes	22. Size and Type of Pump or Bailer
10.75'	2"	0.1743	0.1534	5.62 Gal	
13. Well Diameter	4"	0.6613	0.5972	18. 5 Well Volumes	Bailer: 1.5" PVC
2" SCH 40 PVC.	6"	1.5007	1.3540	9.37 Gal.	Pump: 1.8" Grundfos
14. Well Volume (gal) (s) w.e. height) 1.876 Gal.	8"	2.5856	2.3720	19. Purge Volume 56 Gal.	Rel: Fig 2

Final Field Analysis

23. Total Amount of Water Removed	24. Was Well Pumped Dry?	25. Was water added to well?	26. Was the Groundwater Sampled?
50 Gal.	Yes (No)	(No) Yes If yes, source:	(Yes) No If yes, what was the sample number & Date: MW-4 9/7/95 Sampling Personnel? CM BARNHILL 4PM

27. Final Parameters

Time	Temp F	Conductivity X/000	pH	NTUs	WL	Removed	Flow Rate	Photo Roll #, Observations
4:00 PM	77.5	5.91	7.0	Clear	91.4	50 Gal	1.5 GPM	Clear H2O

IF PETROLEUM IS IN THE WELL, DO NOT TAKE pH AND CONDUCTIVITY PARAMETERS

28. Physical Appearance and Remarks: INITIALLY SLIGHT SILT - Clear H2O @ Sample.

29. Purgewater disposal method: ON SURFACE.

Sampling / Development Parameters

Time	Temp F	Conductivity (umhos/cm) X/000	pH	NTUs	WL (from TOC)	Volume (gallons)	Flow Rate (gpm)	Photo #, Observations (1)
2:57 PM	78	6.98	7.20	Slight Silt	91.40'	12 Bail	Initial	Slight Silt
3:08 PM	75.2	6.08	7.22	Slight Silt	91.40'	5	0.25	Slight Silt
Surged with Surge Block.	—	—	—	—	—	5	—	—
3:25 PM	Started Redi-flo Pump.			Slight Silt.	91.40	5	1 GPM	Slight Silt.
3:33 PM	77.8	6.12	7.02	Getting Clear.	91.4	15	1.5	Getting Clear.
3:41 PM	77.1	5.99	7.09	Clear.	91.4	25	1.5	Clear.
3:52 PM	77.0	5.97	7.02	Clear	91.4	40	1.5	Clear.
4:00 PM	77.5	5.91	7.0	Clear	91.4	50	1.5	Clear

(1) Note volume and physical character of sediments removed.
NTU = Nephelometric turbidity units
WL = Water Level from Top of PVC Casing

Checked By: Clayton M Barnhill. Date: 9/7/95

CMB CONSULTING GEOLOGIST · WELL DATA FORM

Type Well	Type of Data	Well No. / Sheet
☒ MW ☐ Production ☐ Other	☒ Development ☒ Sampling ☐ Pump Test ☐ Other	MW-2 Sheet 1 of 1 Sheets

1. Project	2. Project Location	3 Date
NAVAJO REFINING CO- LEA REFINERY	LOVINGTON, NM	9/7/95
4. Technician	**GPS COORDINATES:**	
C M BARNHILL	32° 57' 55"N 103° 18' 09"W 3644 ft elev.	
7. Method	**8. Manufacturer's Designation of Rig**	**9. Location of Well (Site, Description)**
Pumping (Surging) Air Lift (Bailing) Other	DSA-1000	MONITOR WELL #2

Water Levels

Initial	Final	Final + 24 Hours
Date: 9/7/95 Time: 12:35 PM	Date: 9/7/95 Time: 2:10 pm	Date: Time:
10. Total Depth of Well (from TOC) 98.40'	15. Total Depth of Well (from TOC) 98.40'	20. Total Depth of Well (from TOC)
11. Water Level (from TOC) 89.18'	16. Water Level (from TOC) 89.18'	21. Water Level (from TOC)

12. Water Column Height	Nom Dia	x = gal/ft Sch 40	Sch 80	17. 3 Well Volumes	22. Size and Type of Pump or Bailer
9.22'	(2")	0.1743	0.1534	4.82 GAL	Bailer: 1.8" PVC
13. Well Diameter	4"	0.6613	0.5972	18. 5 Well Volumes 8.03 GAL.	Pump: 1.8" Grundfos Red. Flo 2
2" SCH 40 PVC	6"	1.5007	1.3540		
14. Well Volume (gal) (5) w.e. height 1.60 gal	8"	2.5856	2.3720	19. Purge Volume 55 GAL	

Final Field Analysis

23. Total Amount of Water Removed	24. Was Well Pumped Dry?	25. Was water added to well?	26. Was the Groundwater Sampled?
55 GAL	Yes (No)	(No) Yes If yes, source:	(Yes) No If yes, what was the sample number & Date: MW-2 9/7/95 Sampling Personnel? CM Barnhill 2:16 pm

27 Final Parameters

Time	Temp F	Conductivity x1000	pH	NTUs	WL	Removed	Flow Rate	Photo Roll #, Observations
2:10 pm	76.4	7.62	6.71	Clear	89.18	55 GAL	1 GPM	Clear H2O

IF PETROLEUM IS IN THE WELL, DO NOT TAKE pH AND CONDUCTIVITY PARAMETERS

28 Physical Appearance and Remarks: Silty fine Brown initially – Clear @ Sample.

29. Purgewater disposal method: ON SURFACE.

Sampling / Development Parameters

Time	Temp F	Conductivity (umhos/cm) x1000	pH	NTUs	WL (from TOC)	Volume (gallons)	Flow Rate (gpm)	Photo #, Observations (1)
Yesterday	20 Gals was Removed from well. By Hand Bailing By.							D. Moore.
1:07 pm	74.9	7.68	6.78	Fine Silt	89.18'	INITIAL: —		Very Fine Silt Brown color.
1:20 pm	73.7	7.36	6.80	Very Fine Silt	8	25	0.38	Fine Suspended Brown Silt.
Surged well with Surge Block.								
1:39 pm	Started pumping with			Red. Flo 2	89.18'	25	~2 GPM	Fine Brown Suspended Silt
1:49 pm	76.6	7.60	6.56	Getting Clear	89.18'	35	1	getting clear.
1:59 pm	76.7	7.64	6.60	Clear	89.18	45	1	Clear.
2:10 pm	76.4	7.62	6.71	Clear.	89.18'	55	1	Clear

(1) Note volume and physical character of sediments removed.
NTU = Nephelometric turbidity units
WL = Water Level from Top of PVC Casing

Checked By: CM Barnhill Date: 9/7/95

NOV-21-1995 12:41 596 P.10

CMB CONSULTING GEOLOGIST - WELL DATA FORM

Type Well	Type of Data	Well No
[X] MW ☐ Production ☐ Other ______	[X] Development [X] Sampling ☐ Pump Test ☐ Other ______	MW-5 Sheet 1 of 1 Sheets 1

1. Project	2. Project Location	3. Date
NAVAJO REFINING CO. LEA REFINERY	LOVINGTON, N.M.	9/7/95
4. Technician	GPS Coordinates 32°52'34"N 103°17'42"W Elev. 4119	
CM BARNHILL		
7. Method: (Pumping) (Surging) Air Lift (Bailing) Other	8. Manufacturer's Designation of Rig: DSR 1000	9. Location of Well (Site, Description): MONITOR WELL #5

Water Levels

Initial	Final	Final + 24 Hours
Date: 9/7/95 Time: 10:10 AM	Date: 9/7/95 Time: 12:09 pm	Date: Time:
10. Total Depth of Well (from TOC) GL 90.15 95.10'	15. Total Depth of Well (from TOC) 95.10'	20. Total Depth of Well (from TOC)
11. Water Level (from TOC) GL 70.90 75.82'	16. Water Level (from TOC) 75.85'	21. Water Level (from TOC)

	Nom Dia	x = gal/ft (Sch 40)	Sch 80		
12. Water Column Height: 19.28'				17. 3 Well Volumes: 10.08 Gal.	22. Size and Type of Pump or (Bailer)
13. Well Diameter: 2" Sch 40 PVC	(2")	(0.1743)	0.1534	18. 5 Well Volumes: 16.80 Gal	1.8" PVC Bailer
	4"	0.6613	0.5972		1.8" Redi-flo 2 pump
	6"	1.5007	1.3540		
14. Well Volume (gal) (s) w.e. height): 3.36	8"	2.5856	2.3720	19. Purge Volume: 40 Gal.	

Final Field Analysis

23. Total Amount of Water Removed	24. Was Well Pumped Dry?	25. Was water added to well?	26. Was the Groundwater Sampled
40 Gal	Yes (No)	(No) Yes If yes, source:	(Yes) No If yes, what was the sample number & Date: MWS 9/7/95 Sampling Personnel? CM Barnhill 11:52 pm

27. Final Parameters

Time	Temp F	Conductivity X1000	pH	NTUs	WL	Removed	Flow Rate	Photo Roll #, Observations
11:48 AM	74.8	11.18	6.99	clear	75.94'	40	2.5 GPM	Clear

IF PETROLEUM IS IN THE WELL, DO NOT TAKE pH AND CONDUCTIVITY PARAMETERS

28. Physical Appearance and Remarks: Initially fine Silt - Clear @ 40 Gal Removed.

29. Purgewater disposal method: ON SURFACE.

Sampling / Development Parameters

Time	Temp F	Conductivity (umhos/cm) X1000	pH	NTUs	WL (from TOC)	Volume (gallons)	Flow Rate (gpm)	Photo #, Observations (1)
10:30 AM	73.3	11.26	7.15	Very Silty	95.10	INITIAL	1ST BAIL	Very Silt Brown
10:40 AM	72.7	11.08	7.02	Very fine Silt	—	5	0.20	Very fine Brown Silt.
SURGED WITH SURGE BLOCK.				—	—	5	—	—
11:00 AM	73.1	11.19	7.0	Very fine Silt	75.94	10	— 0.20	Very fine Silt. Surging
11:28 AM	started	pumping	with	Redi-flo 2 pump		15 @ 11:30 AM	2.5 GPM	Slight Silt
11:04 am	74.6	11.07	7.05	Slight Silt	75.94'	20	2.5 GPM	Very Slight Silt.
11:41 AM	74.3	11.05	7.05	clear.	75.94'	30	2.5	Clear H2O
11:48 AM	74.8	11.18	6.99	Clear	75.94'	40		

(1) Note volume and physical character of sediments removed.
NTU = Nephelometric turbidity units
WL = Water Level from Top of PVC Casing

Checked By [signature] Date 9/7/95

TOTAL P.005

CMB CONSULTING GEOLOGIST - WELL DATA FORM

Type Well ~~MW~~ ☐ Production ☐ Other _____	Type of Data ~~X~~ Development ~~X~~ Sampling ☐ Pump Test ☐ Other _____	Well No. MW-1 Sheet 1 of 1 Sheets 1
1. Project Navajo Refining Co. Lea Refinery	2. Project Location Lovington, N.M. GPS Coordinates	3. Date 9/8/95
4. Technician CM Barnhill		
7. Method (Pumping) (Surging) Air Lift (Bailing) Other	8. Manufacturer's Designation of Rig DSR-1000	9. Location of Well (Site, Description) Monitor well #1

Water Levels

Initial	Final	Final + 24 Hours
Date: 9/8/95 Time: 9:26 AM	Date: 9/8/95 Time: 11:10 AM	Date: Time:
10. Total Depth of Well (from TOC) 96.15'	15. Total Depth of Well (from TOC) 96.15'	20. Total Depth of Well (from TOC)
11. Water Level (from TOC) Free Product 89.45' H2O @ 95.89'	16. Water Level (from TOC) 90.57 Product. 90.65' H2O	21. Water Level (from TOC)

12. Water Column Height 6.71' product 0.26 H2O	Nom Dia	x = gal/ft (Sch 40)	Sch 80	17.3 Well Volumes 3.50 Gal
13. Well Diameter 2" Sch 40 PVC.	OD	0.1743	0.1534	18.5 Well Volumes 5.83 Gal.
14. Well Volume (gal) (s) w.c. height) 1.16	4"	0.6613	0.5972	19. Purge Volume 110. Gal.
	6"	1.5007	1.3540	
	8"	2.5856	2.3720	

22. Size and Type of ~~Pump~~ or ~~Bailer~~: Bailer: 1.8" PVC Pump: 1.8" Grundfos Redi-flo

Final Field Analysis

23. Total Amount of Water Removed	24 Was Well Pumped Dry? Yes (No)	25. ~~Was~~ water added to well? ~~No~~ Yes If yes, source:	26 Was the Groundwater Sampled ~~Yes~~ No If yes, what was the sample number & Date: Sampling Personnel? MW-1 9/8/95 CM Barnhill 11:05 AM.
110. Gal.			

27. Final Parameters

Time	Temp F	Conductivity	pH	NTUs	WL	Removed	Flow Rate	Photo Roll #, Observations
11:05 AM	Very Hot H2O		Product @ 90.57'		90.65'	110 Gal.	1.6 GPM	Very Contaminated

IF PETROLEUM IS IN THE WELL, DO NOT TAKE pH AND CONDUCTIVITY PARAMETERS

28. Physical Appearance and Remarks: Highly Contaminated with oil.

29. Purgewater disposal method: In DOT Approved 55 Gal. Drums.

Sampling / Development Parameters

Time	Temp F	Conductivity (umhos/cm)	pH	NTUs	WL (from TOC)	Volume (gallons)	Flow Rate (gpm)	Photo #, Observations (1)
Bailed 2.5 Gallons of Free Product. Decided to pump w/ Redi-flo Pump Pumped 110 Gals. of heavily contaminated water into 55 Gal. Drums. - Need free product recovery pump.								

(1) Note volume and physical character of sediments removed.
NTU = Nepholometric turbidity units
WL = Water Level from Top of PVC Casing

Checked By Clayton Bartlett Date 9/8/95

DISTILLATION RECORD

PLANT Lea Refining

Date 8-25-95

Tank No.

Tank Car No. MW-1

Gravity 32.1 Kind Recovered Oil

I.B.P. 270

5%		Flash (O.C.)	
10%	348	" (T.C.)	
20%	414	" (Foster)	
30%	462	" (P.M.)	
40%	498	Cetane	
50%	532	Vis. @	
60%	566	C.T.	
70%	614	Color	
75%		Doctor	
80%	668	Sulfur	0.989
85%		B.S. & W. %	
90%	720	C.R.	
95%		Stability	
D.P.	722	W. Cloud	
E.P.	760+	M. Cloud	
RON		Pour Point	
MON		Reid V.P.	
R+M / 2			

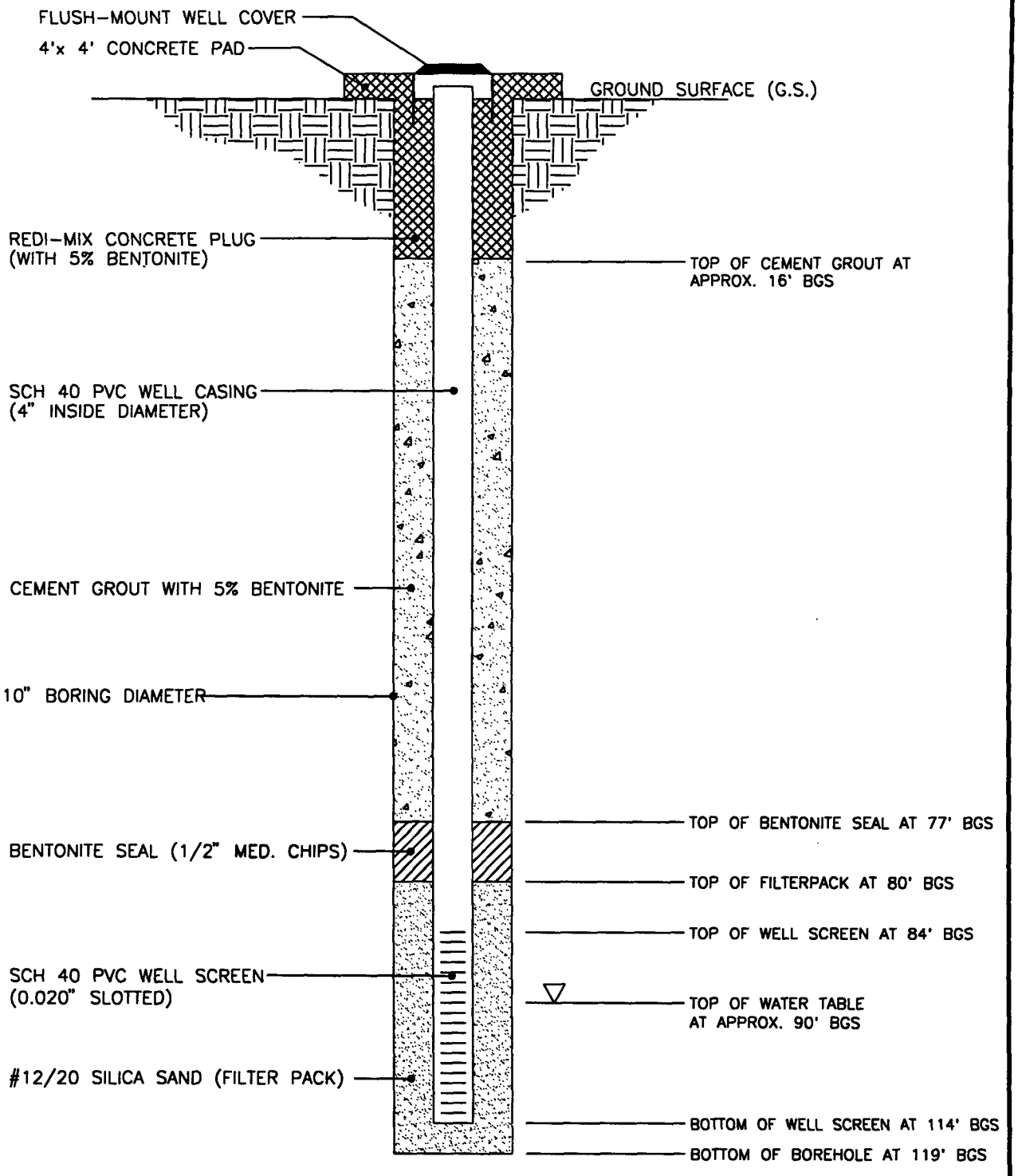
% Rec. 93 % Res. _____ % Loss _____

(Signed) _____

Bryan Printers & Stationers, Inc. Form No. 155

APPENDIX B

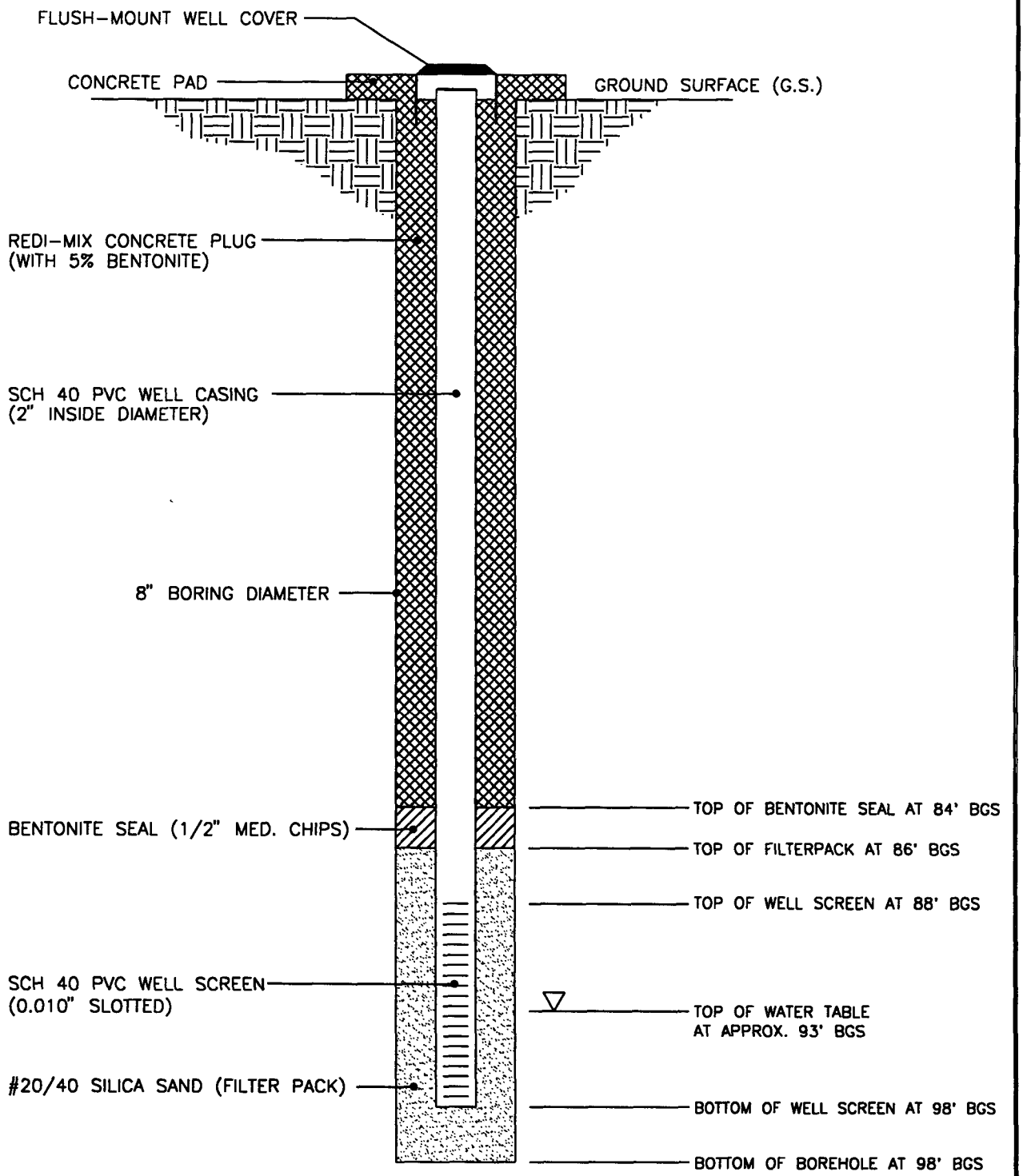
WELL CONSTRUCTION DIAGRAMS



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 8-06-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: SAS
CK'D BY: BAL	FILE: CS-RW1.DWG

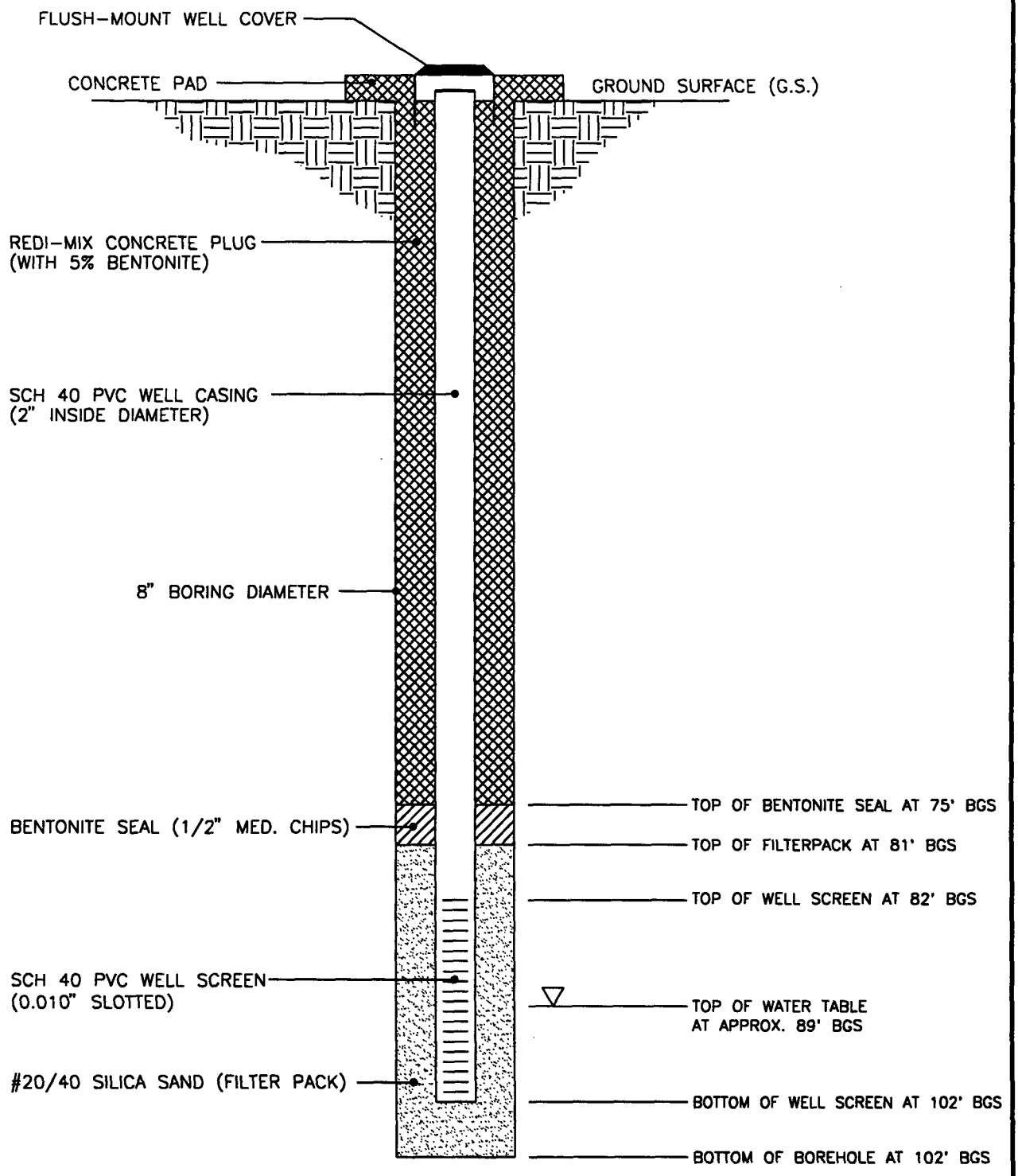
RECOVERY WELL CONSTRUCTION DIAGRAM RW-1 LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 8-22-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: RG
CK'D BY: BAL	FILE: CS-MW1.DWG

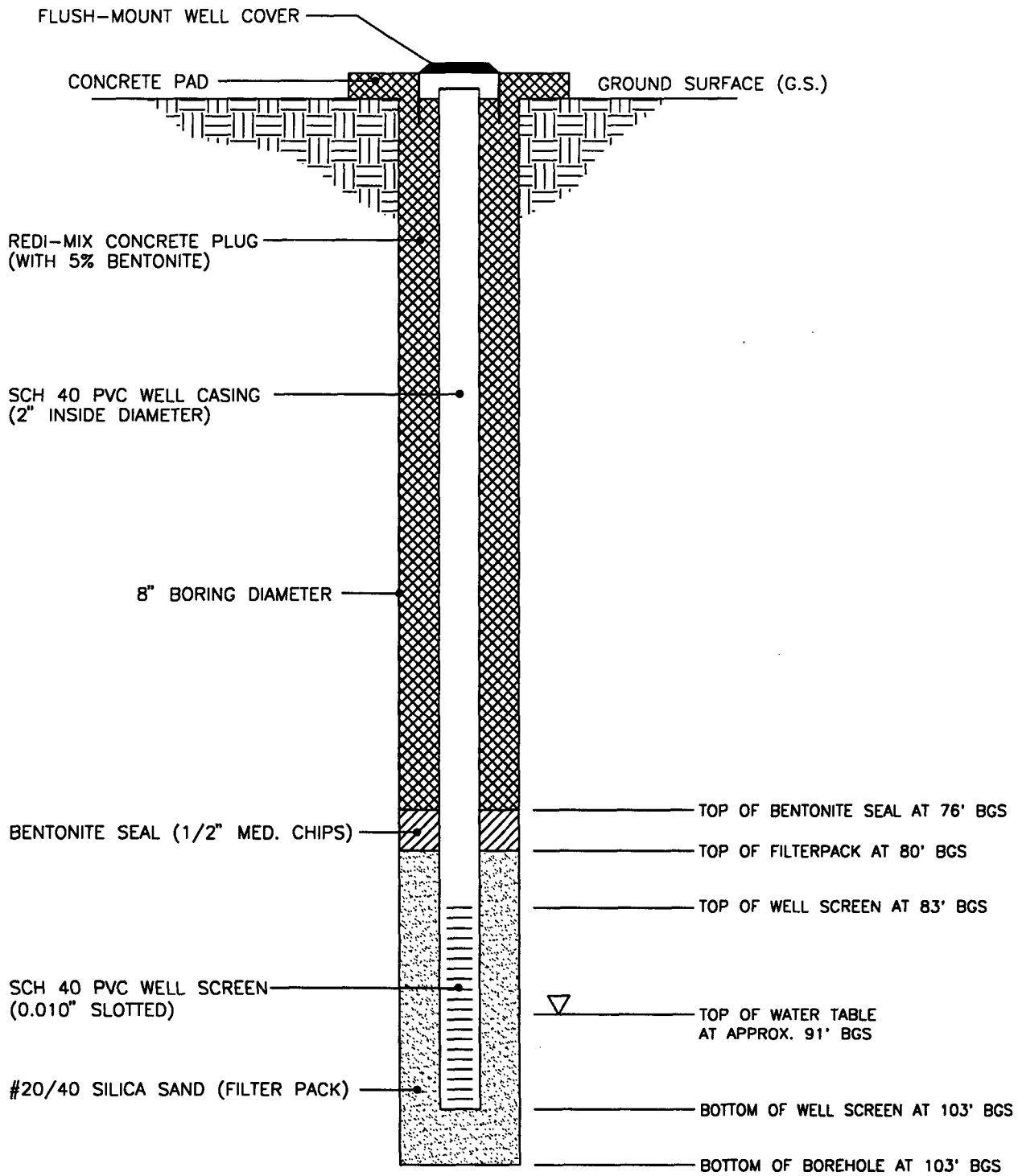
MONITORING WELL CONSTRUCTION DIAGRAM MW-1 LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 8-28-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: RG
CK'D BY: BAL	FILE: CS-MW2.DWG

MONITORING WELL CONSTRUCTION DIAGRAM MW-2 LOVINGTON REFINERY



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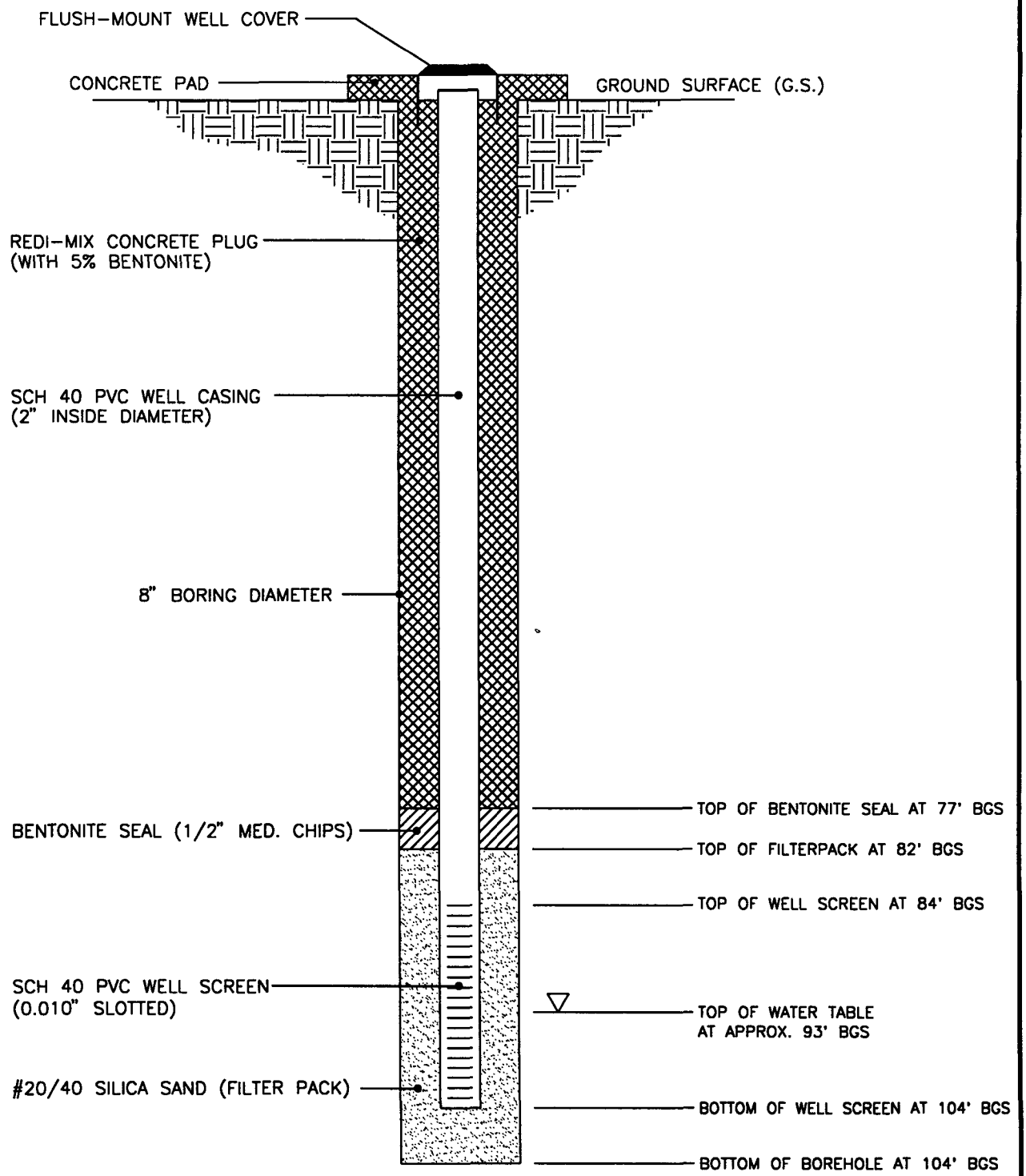
CLIENT: NAVAJO REFINING CO.	
DATE: 8-29-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: RG
CK'D BY: BAL	FILE: CS-MW3.DWG

MONITORING WELL CONSTRUCTION DIAGRAM MW-3 LOVINGTON REFINERY



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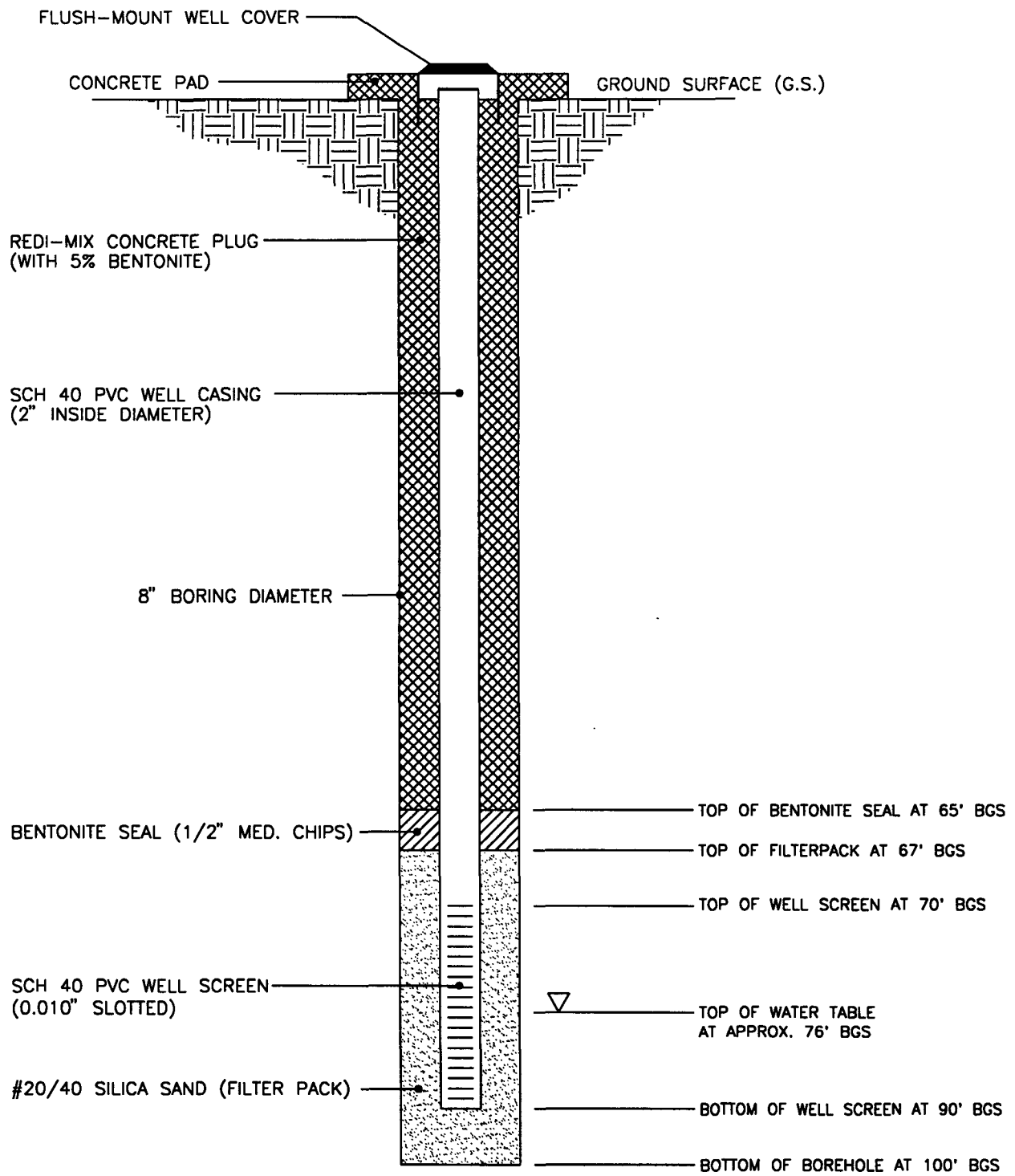
CLIENT: NAVAJO REFINING CO.	
DATE: 8-30-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: RG
CK'D BY: BAL	FILE: CS-MW4.DWG

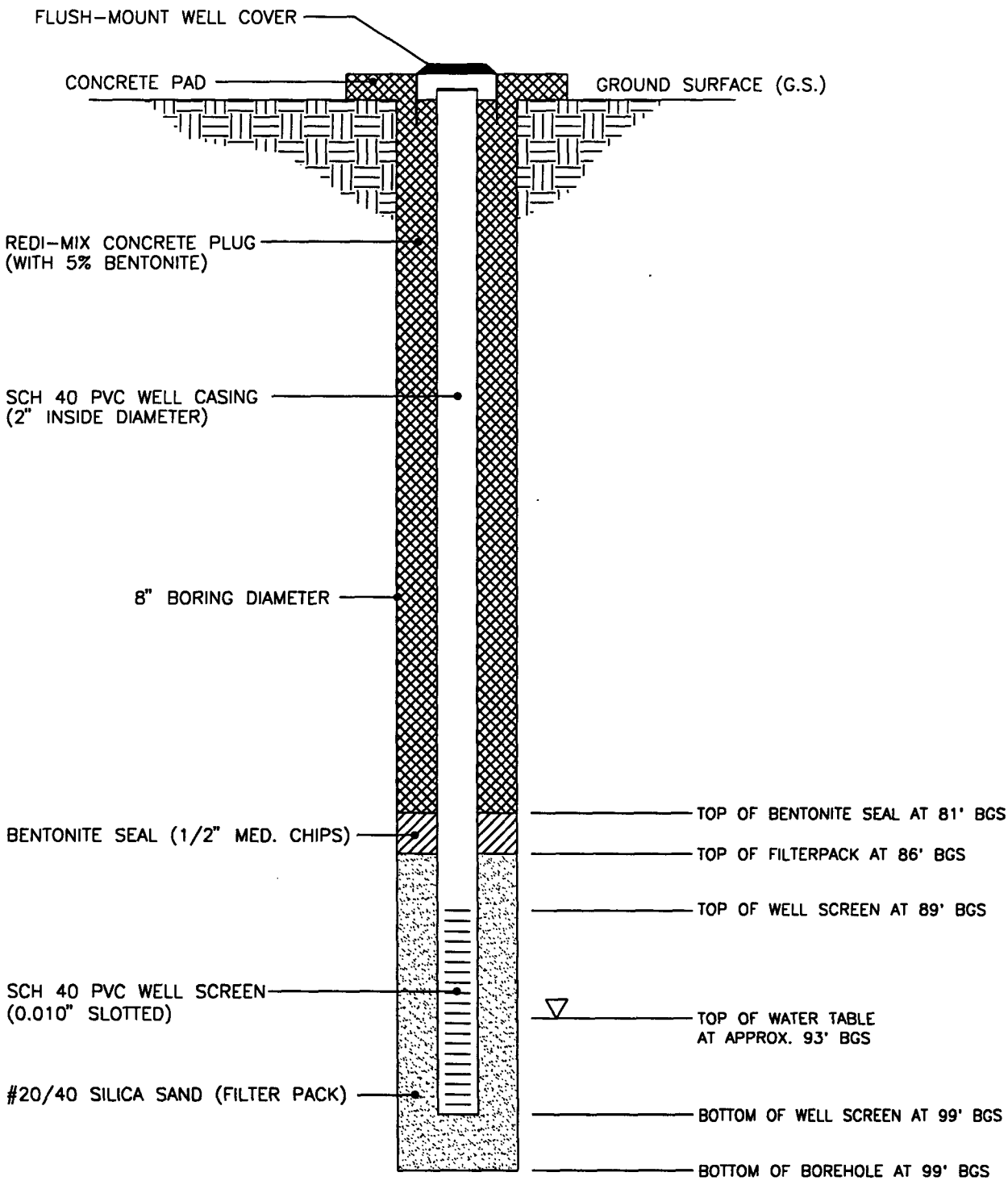
MONITORING WELL CONSTRUCTION DIAGRAM MW-4 LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 9-6-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: RG
CK'D BY: BAL	FILE: CS-MW5.DWG

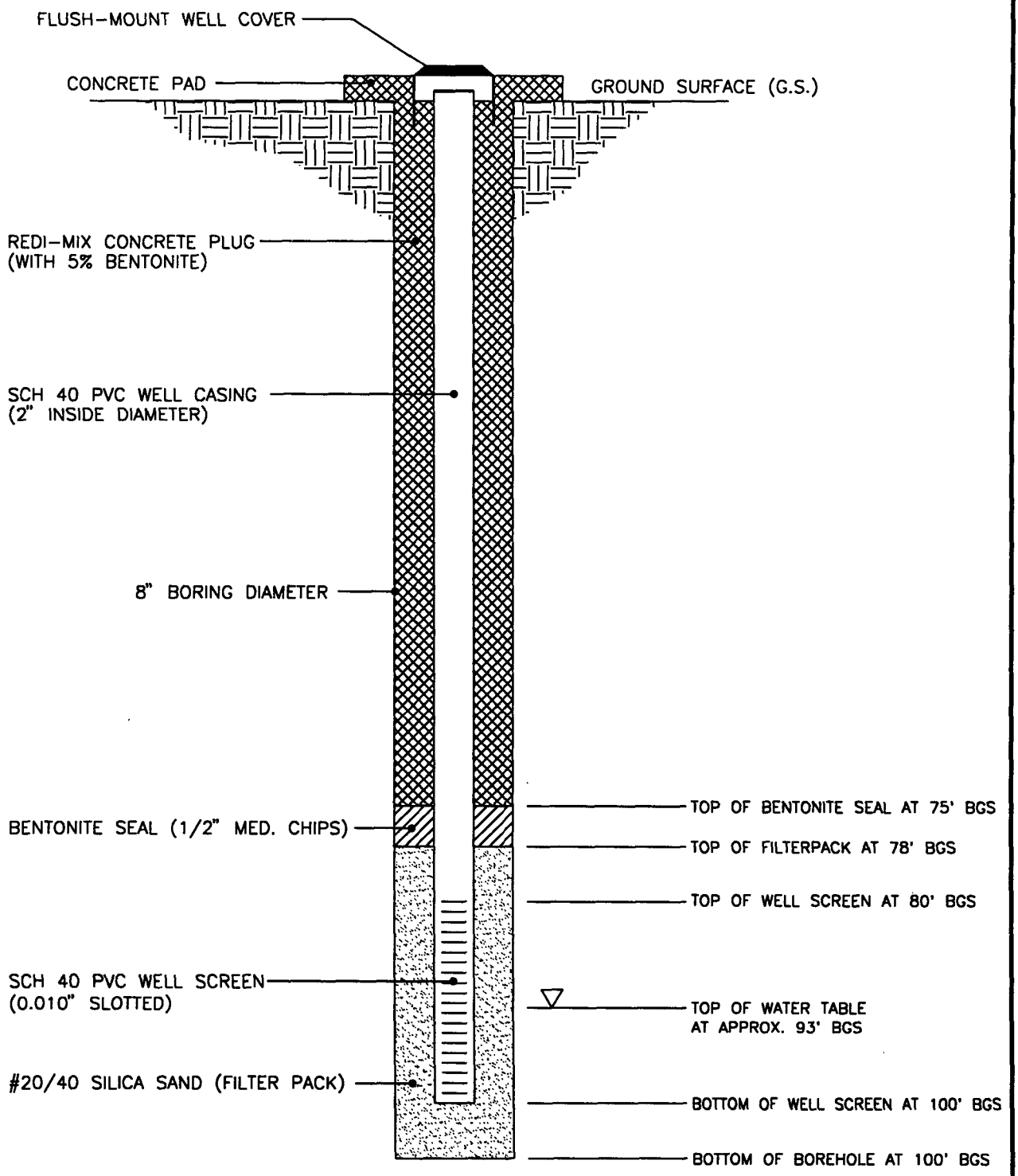
MONITORING WELL CONSTRUCTION DIAGRAM MW-5 LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 8-31-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: RG
CK'D BY: BAL	FILE: CS-MW6.DWG

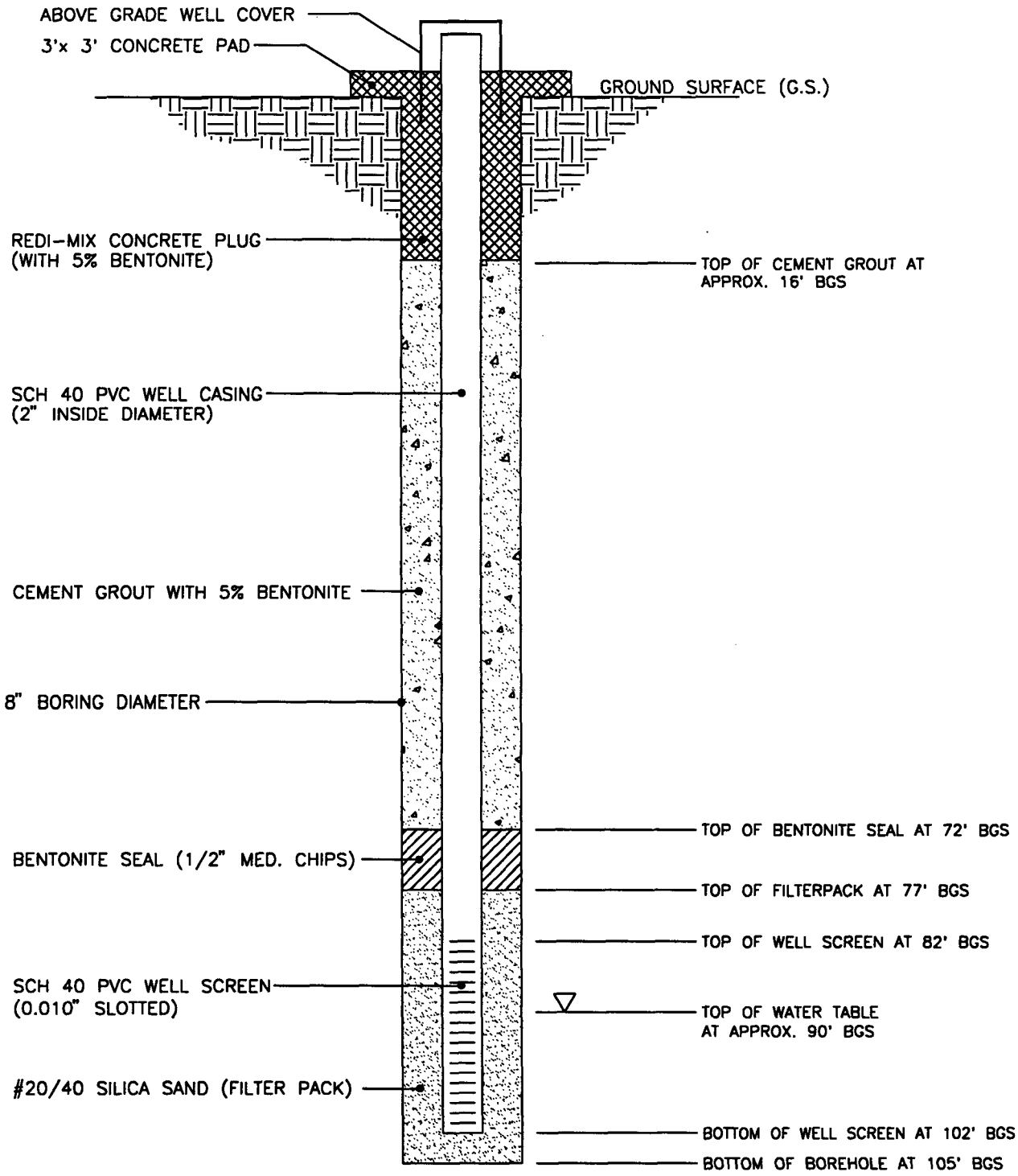
MONITORING WELL CONSTRUCTION DIAGRAM MW-6 LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 8-31-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: RG
CK'D BY: BAL	FILE: CS-MW6.DWG

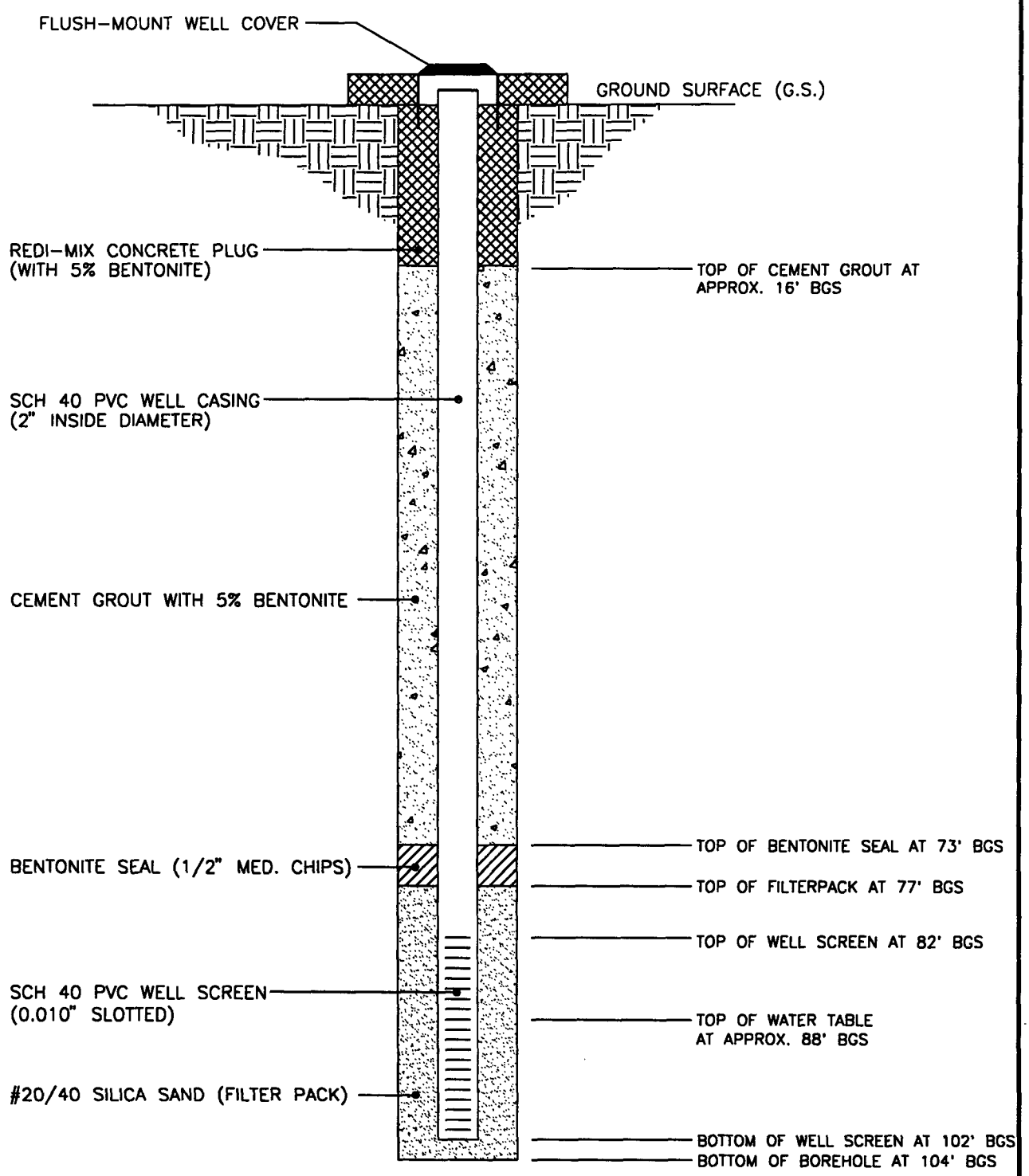
MONITORING WELL CONSTRUCTION DIAGRAM MW-7 LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-15-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: SAS
CK'D BY: BAL	FILE: CS-MW8.DWG

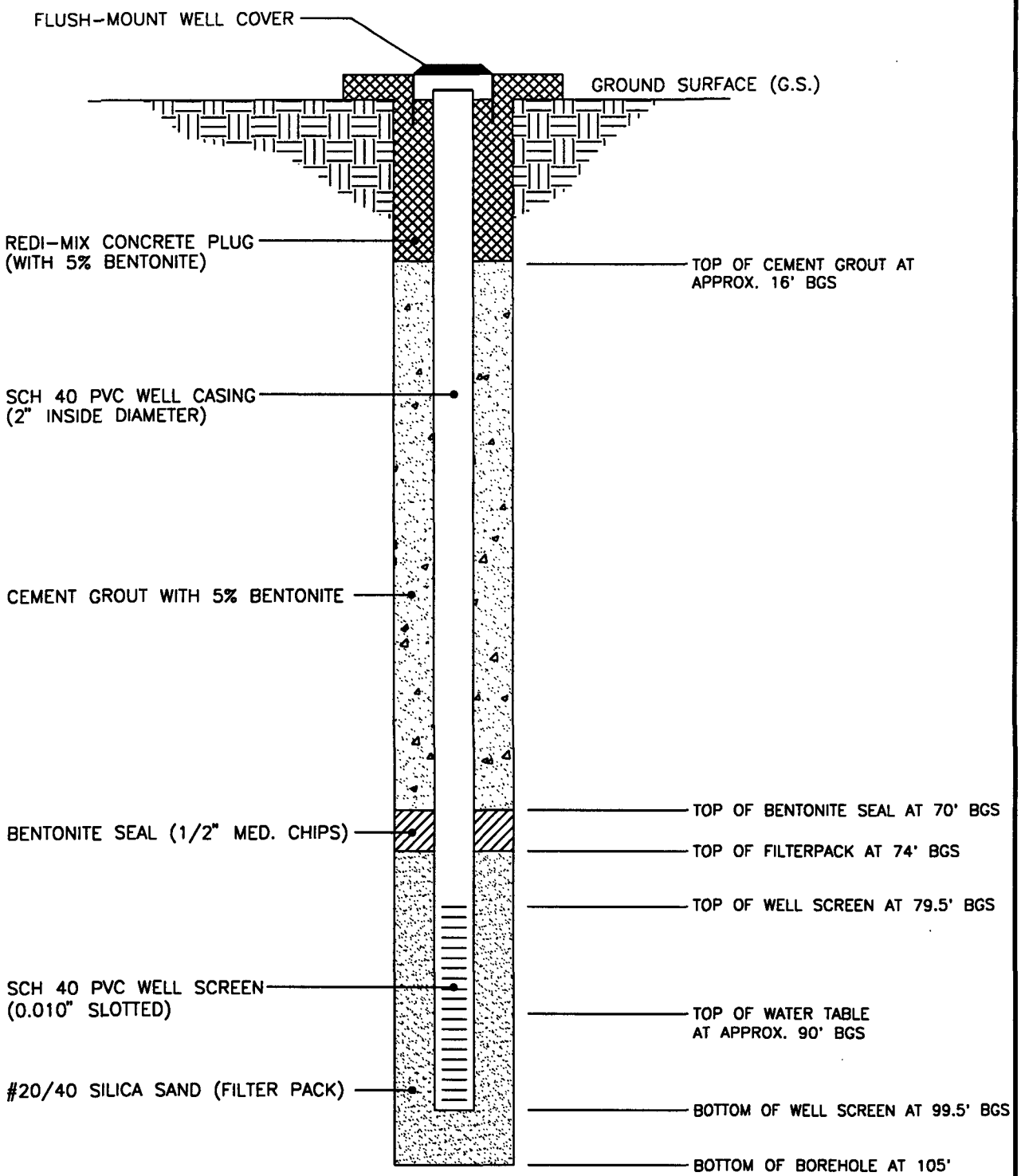
MONITORING WELL CONSTRUCTION DIAGRAM MW-8 LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-2-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: SAS
CK'D BY: BAL	FILE: CS-MW9.DWG

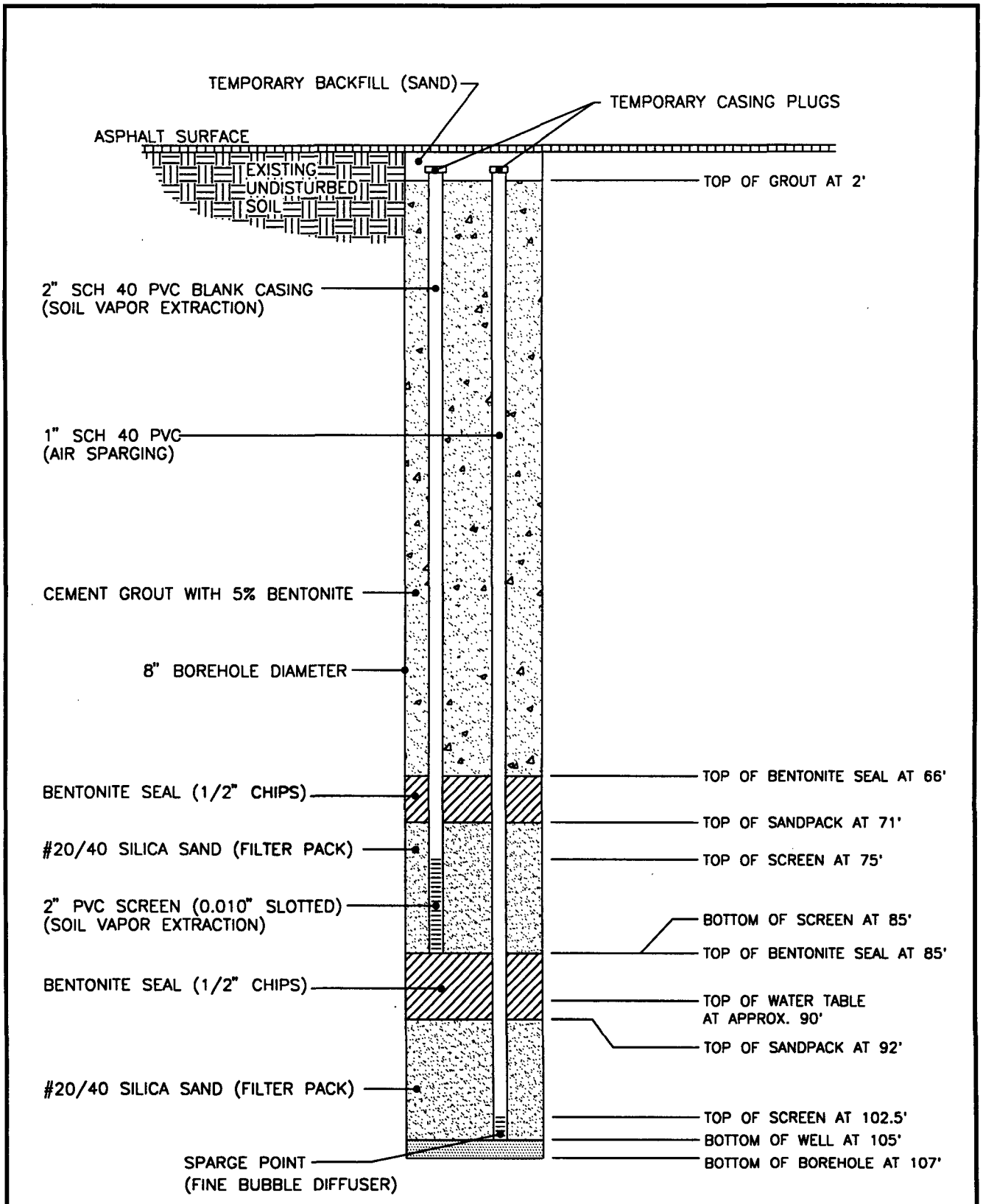
MONITORING WELL CONSTRUCTION DIAGRAM MW-9 LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-1-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: SAS
CK'D BY: BAL	FILE: CS-MW10.DWG

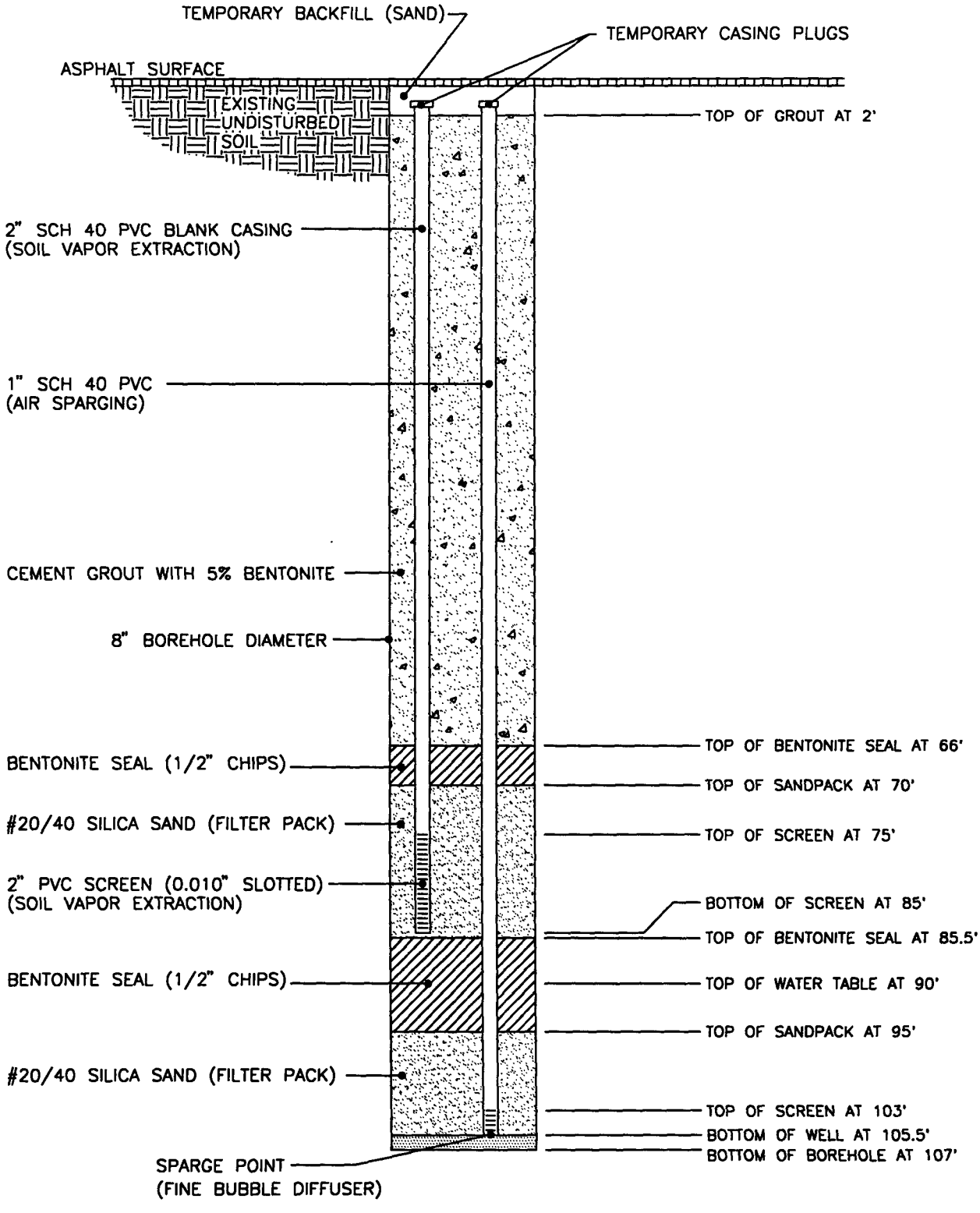
MONITORING WELL CONSTRUCTION DIAGRAM MW-10 LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-3-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: SAS
CK'D BY: BAL	FILE: CS-AS1.DWG

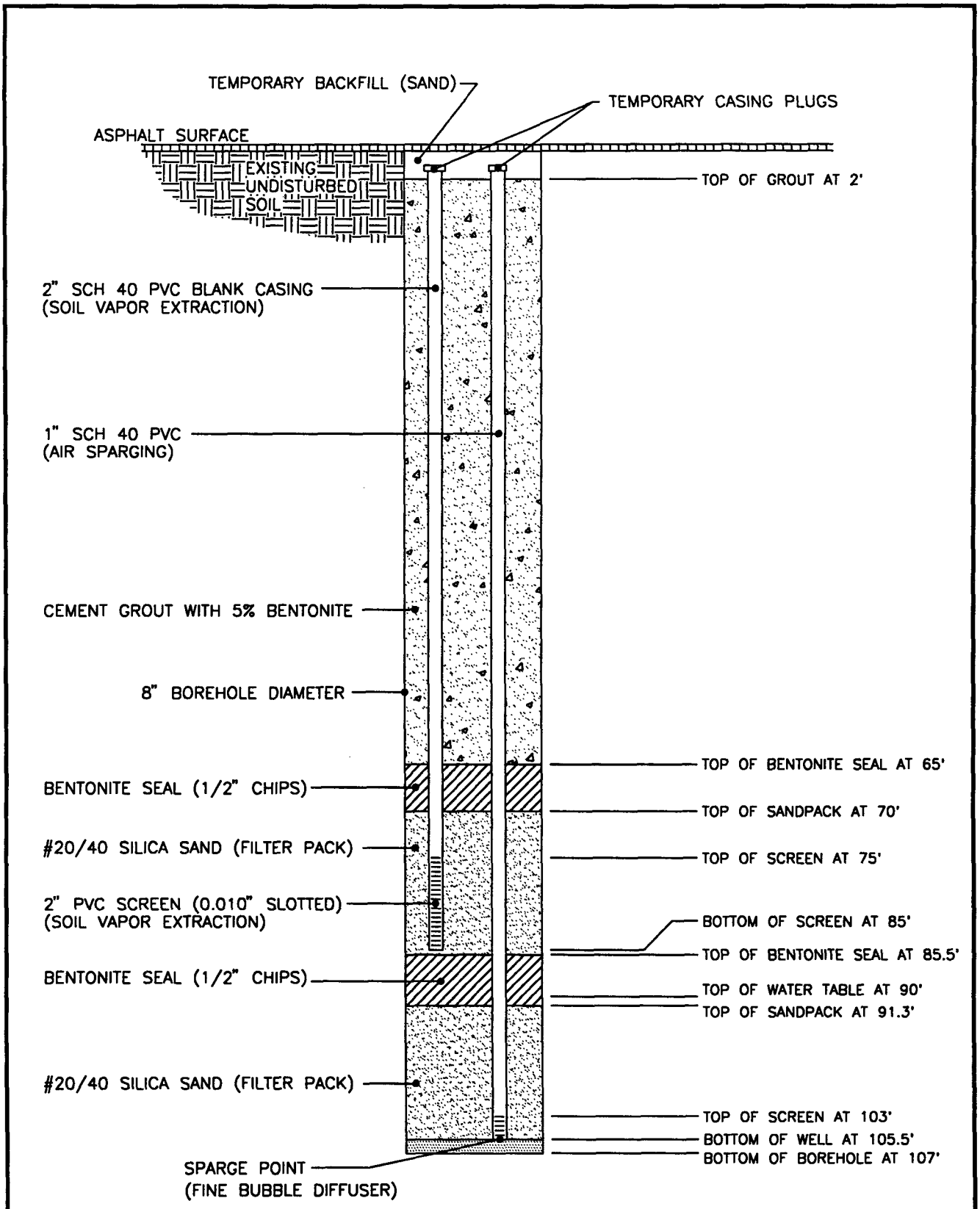
AS-1
WELL CONSTRUCTION DIAGRAM
LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-3-96	REV. NO.: 0
AUTHOR: JH	DRAWN BY: SAS
CK'D BY: GJV	FILE: CS-AS2.DWG

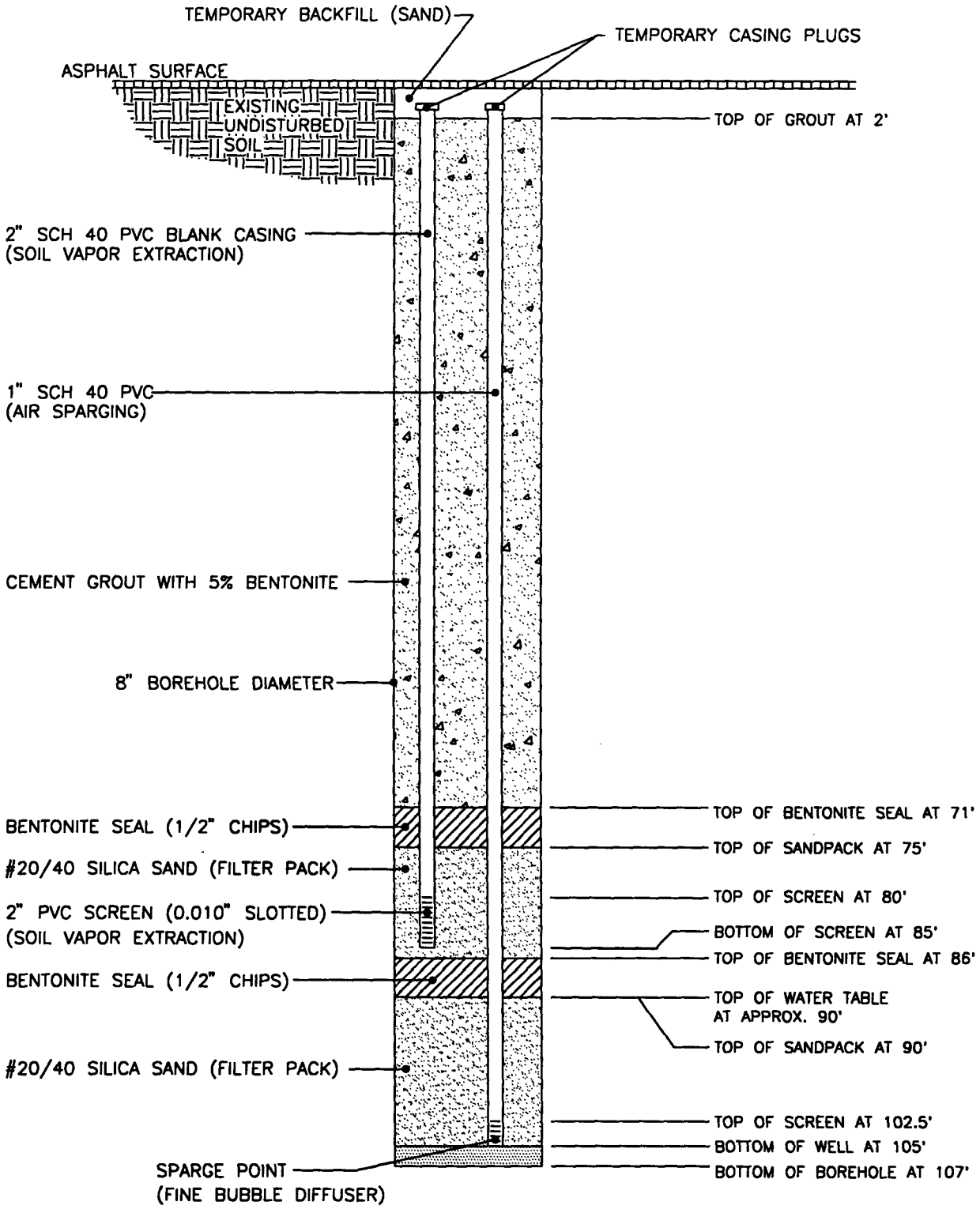
AS-2
WELL CONSTRUCTION DIAGRAM
LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-4-96	REV. NO.: 0
AUTHOR: JH	DRAWN BY: SAS
CK'D BY: GJV	FILE: CS-AS3.DWG

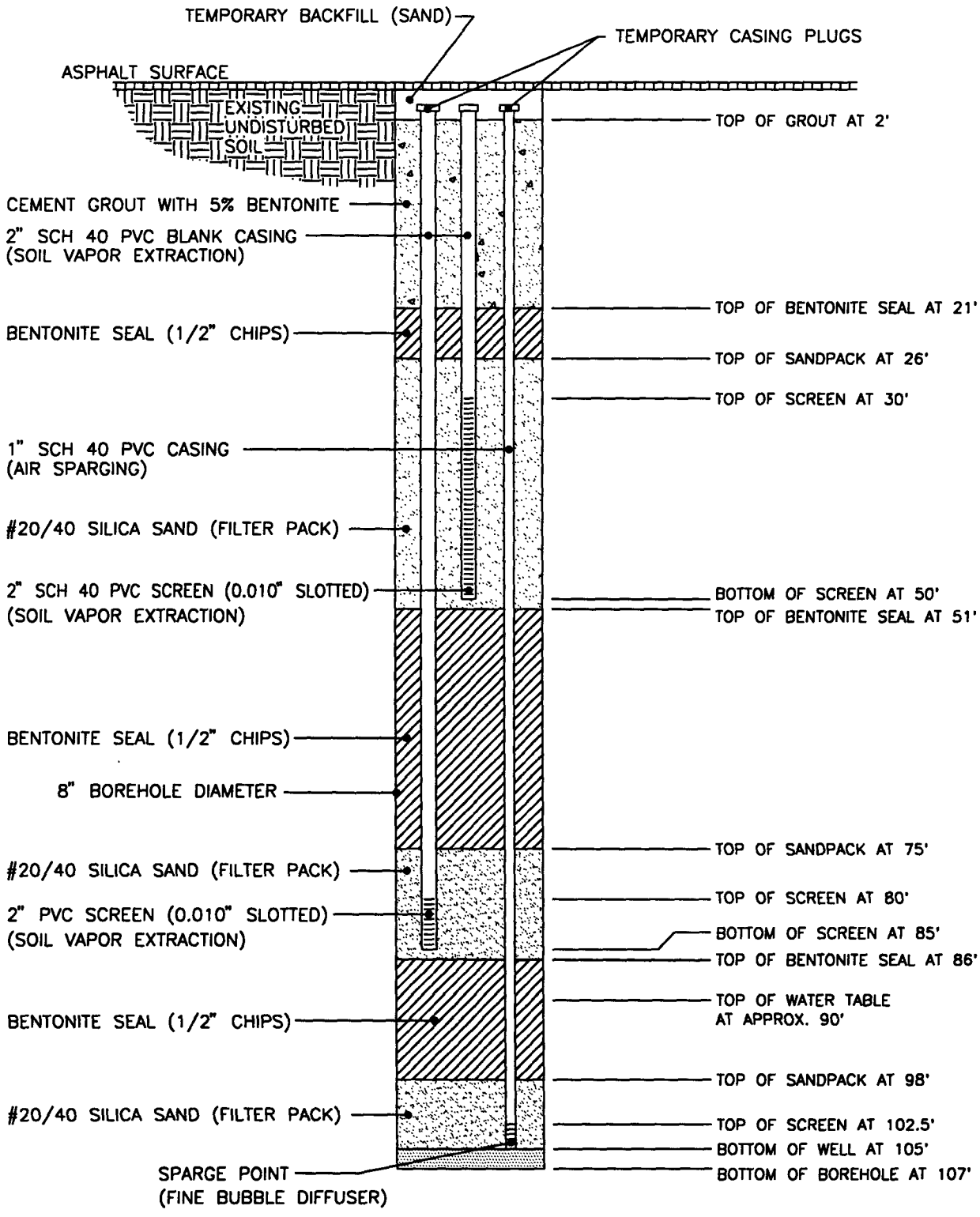
AS-3
WELL CONSTRUCTION DIAGRAM
LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-8-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: SAS
CK'D BY: BAL	FILE: CS-AS4.DWG

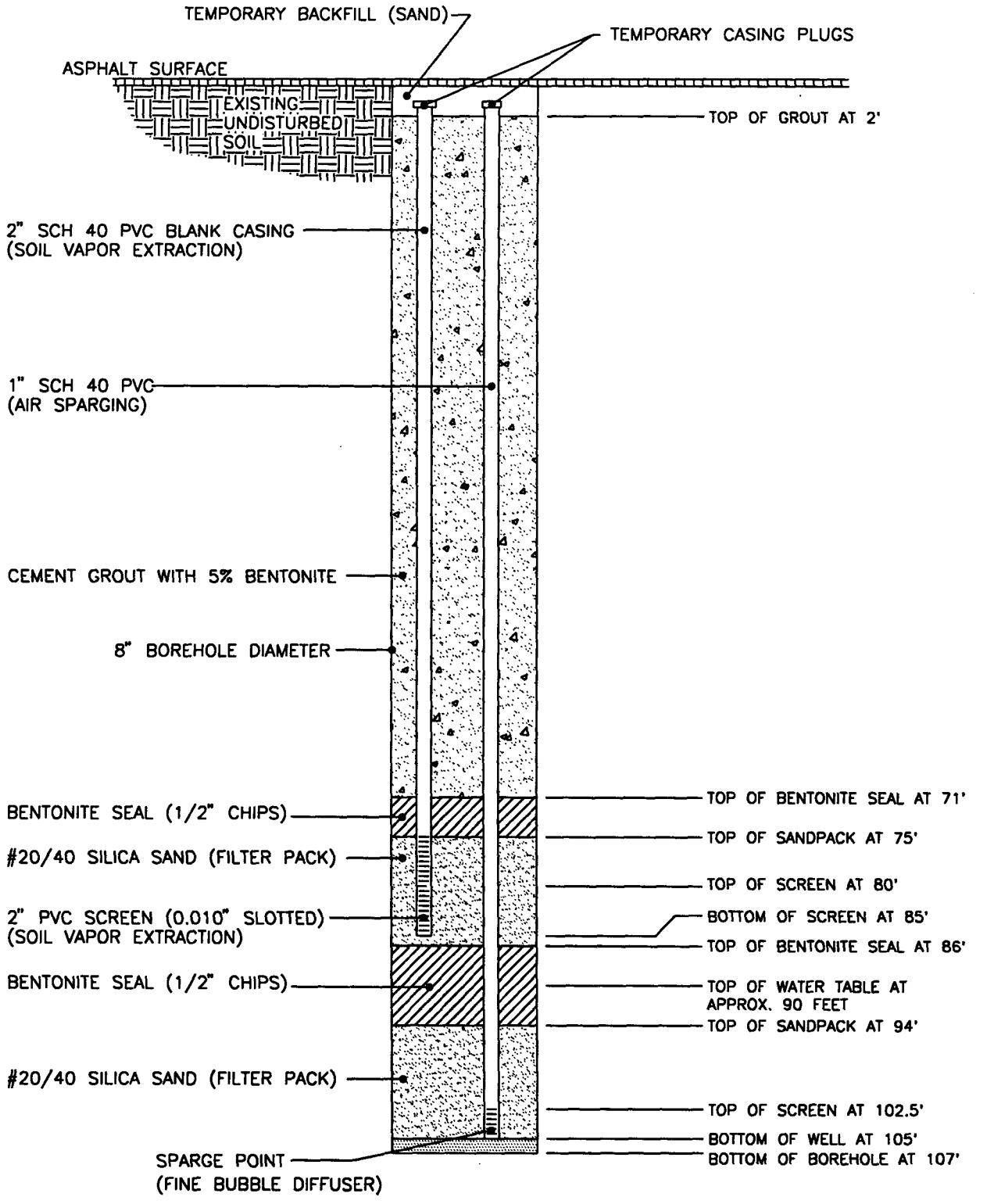
AS-4
WELL CONSTRUCTION DIAGRAM
LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-9-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: SAS
CK'D BY: BAL	FILE: CS-AS5.DWG

AS-5
WELL CONSTRUCTION DIAGRAM
LOVINGTON REFINERY



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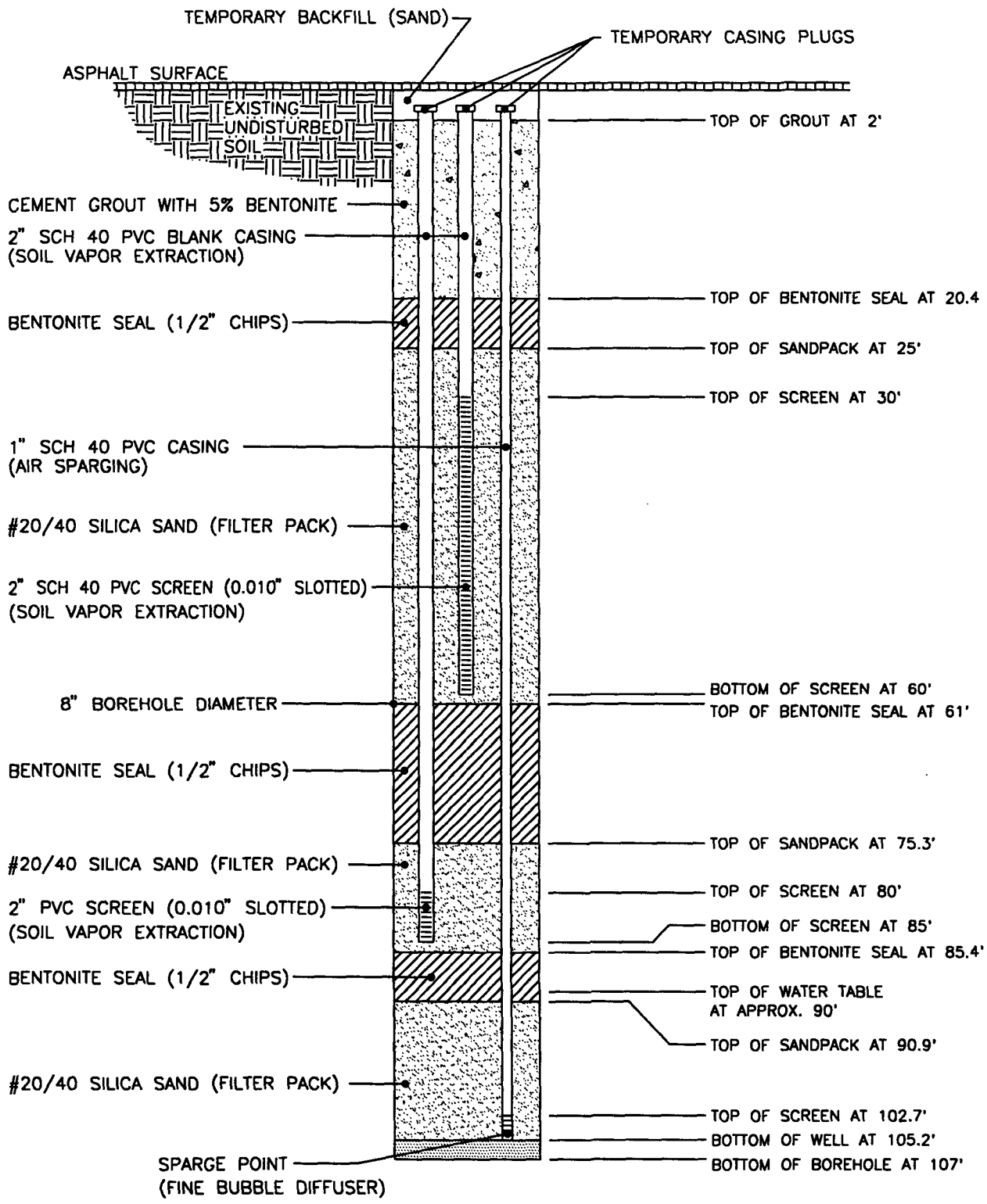
CLIENT: NAVAJO REFINING CO.	
DATE: 4-10-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: SAS
CK'D BY: BAL	FILE: CS-AS6.DWG

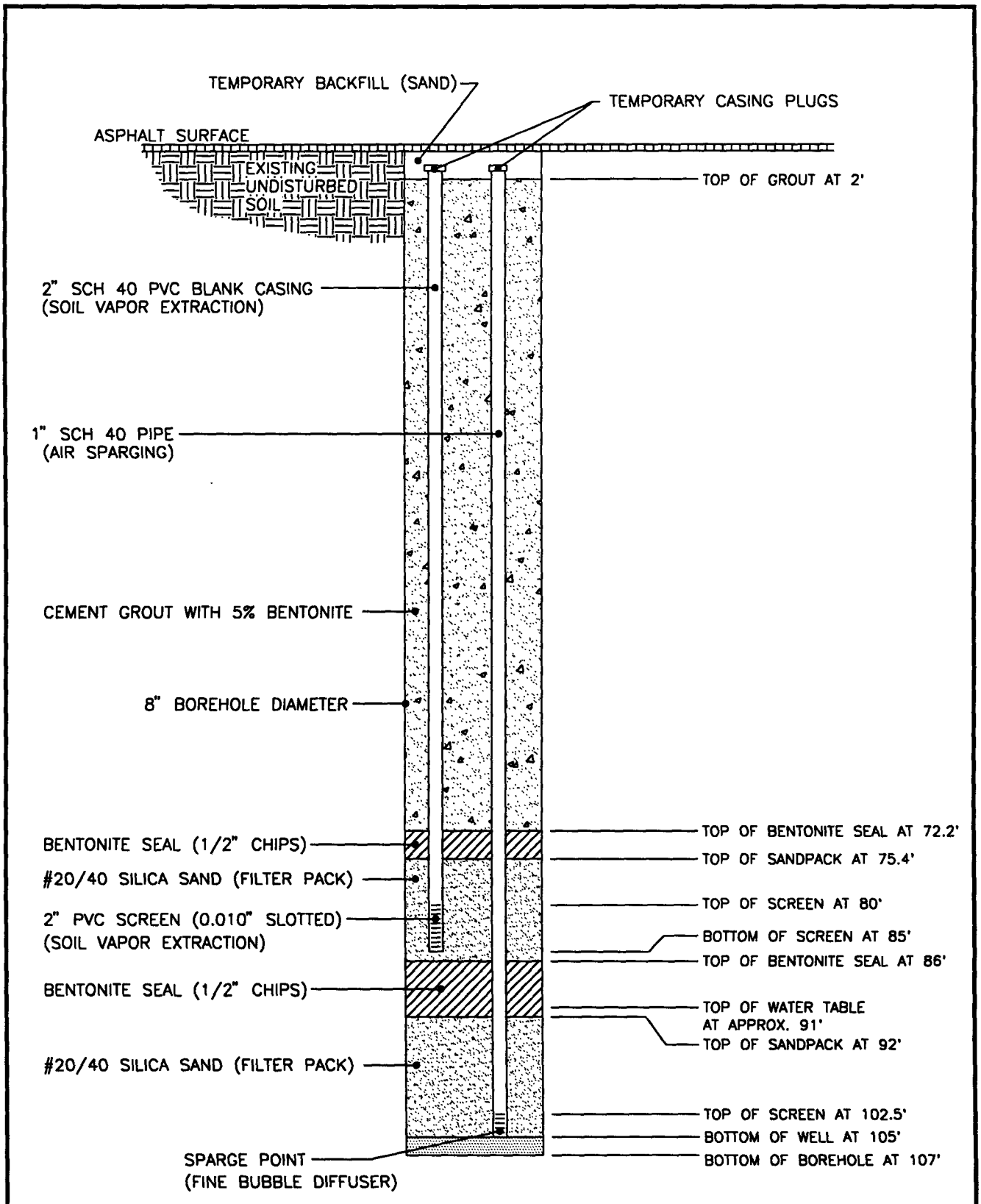
AS-6
WELL CONSTRUCTION DIAGRAM
LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-11-96	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: SAS
CK'D BY: BAL	FILE: CS-AS7.DWG

AS-7
WELL CONSTRUCTION DIAGRAM
LOVINGTON REFINERY



GCL

CLIENT: NAVAJO REFINING CO.	
DATE: 4-12-96	REV. NO.: 0
AUTHOR: DTL	DRAWN BY: SAS
CK'D BY: GJV	FILE: CS-AS8.DWG

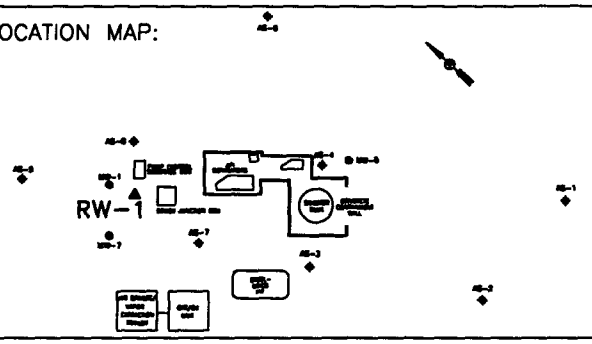
AS-8
WELL CONSTRUCTION DIAGRAM
LOVINGTON REFINERY

APPENDIX C

LITHOLOGIC LOGS

LITHOLOGIC LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: RW-1
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-19-S R-36-E
GROUND ELEVATION (ft. MSL): ~3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 3/27/96 DATE COMPLETED: 3/29/96
FIELD REP.: G. VAN DEVENTER (GCL)
COMMENTS: MODERATE TO STRONG HYDROCARBON ODORS AND STAINING OBSERVED IN BORING

LOCATION DESCRIPTION: LOCATED ADJACENT TO NORTH SIDE OF SEWER JUNCTION BOX

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	% REC	BLOW-COUNT	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
0			CAL						SANDY CALICHE, VERY PALE ORANGE (10YR 8/2), HARD (INDURATED), FRACTURED (WEATHERED), DRY
5									SILTY SAND, GRAYISH ORANGE (10YR 7/4), APPROX. 80% V. FINE-GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, MODERATE HYDROCARBON ODOR, LOOSE AND DRY.
10				9	10.5	100	8 8 8	280 ppm	
15			SM						AS ABOVE EXCEPT GRAYISH BLACK AND STRONG HYDROCARBON ODOR.
20									SILTY SAND AS ABOVE EXCEPT MEDIUM DENSE (HARD STREAK AT 18-18.5 FEET)
25				19	20.5	100	16 41 23	320 ppm	
30									SAND, BLACK, FINE-GRAINED, SUB-ROUNDED, WELL SORTED, STRONG HYDROCARBON ODOR, LOOSE, MOIST
35				29	30.5	100	5 14 10	360 ppm	
40			SW	39	40.5	50	52 22-1"	340 ppm	SAND AS ABOVE EXCEPT MEDIUM DARK GRAY AND DENSE
45									COLOR CHANGE TO MODERATE YELLOWISH BROWN (10 YR 5/4) ABOUT 45 FEET
50				49	50.5	100	1 54	320 ppm	SAND, MODERATE YELLOWISH BROWN (10YR 5/4), V. FINE TO FINE-GRAINED, SUB ROUNDED, MODERATELY SORTED, MODERATE HYDROCARBON ODOR, STIFF, DRY

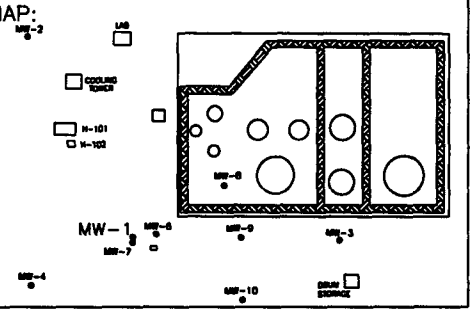
LITHOLOGIC LOG
(Continued)

LOCATION ID: RW-1

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	% REC	BLOW-COUNT	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60				59	60.5	50	0 10 50	340 ppm	SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), FINE-GRAINED, SUBROUNDED, WELL SORTED, MODERATE HYDROCARBON ODOR, MEDIUM DENSE, DRY
65									
70				69	70.5	50	0 1 50	240 ppm	SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), FINE-GRAINED, SUBROUNDED, WELL SORTED, MODERATE HYDROCARBON ODOR, MEDIUM DENSE, DRY
75									
80				79	80.5	50	0 3 50	160 ppm	SAND, LIGHT BROWN (5 YR 6/4), FINE-GRAINED, SUBROUNDED, WELL SORTED, MODERATE HYDROCARBON ODOR, MEDIUM DENSE, DRY
85			SW						
90				89	90.5	50	0 6 50	350 ppm	GROUNDWATER/FREE PRODUCT ENCOUNTERED AT APPROX. 90 FEET
95									
100									
105									
110									
115									
120									BOTTOM OF BORING AT 119 FEET

LITHOLOGICAL LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: MW-1
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): 3836
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 8-23-95 DATE COMPLETED: 8-23-95
FIELD REP.: DARRELL MOORE
COMMENTS: HYDROCARBON ODORS AND STAINING OBSERVED FROM 7ft. TO 97ft. BGS.

LOCATION DESCRIPTION: APPROX. 15 FEET NORTH OF SEWER JUNCTION BOX.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
			TOP	0	1		NO PID READINGS	TOP SOIL
		G C	CAL	1	4	CUTTINGS		ROCK (CALICHE)
5				4	7	CUTTINGS		SLIGHTLY SOFTER ROCK TURNING TO VERY FINE GRAINED SAND AT BOTTOM.
				7	10	CUTTINGS		GRAY SAND WITH HYDROCARBON ODOR.
10			SM	10	13	CUTTINGS		GRAY TURNING DARK GRAY.
				13	20	CUTTINGS		DARK GRAY WITH STREAKS OF ROCK AND ODOR.
15								
20				20	23	CUTTINGS		DARK GRAY WITH ODOR TURNING BLACK.
				23	48	CUTTINGS		JET BLACK WITH STRONG ODOR, FINE-GRAINED SAND, MODERATELY WELL SORTED.
25								
30								
35								
			SW					
40								
45								
				48	65	CUTTINGS		DARK GRAY GRADING TO LIGHT GRAY VERY FINE-GRAINED SAND.
50								

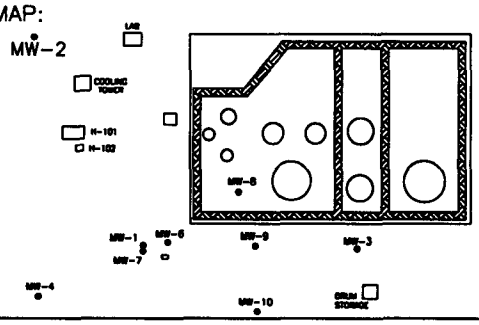
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-1

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60								
65			SW	65	97	CUTTINGS		BROWN TO LIGHT TAN WITH ODOR.
70								
75								
80								
85								
90								GROUNDWATER ENCOUNTERED AT APPROXIMATELY 93 FEET BGS.
95								0.02 FEET OF PRODUCT ON WATER TABLE.
100								BOTTOM OF BORING AT 98 FEET
105								
110								
115								
120								

LITHOLOGICAL LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: MW-2
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): ~3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 8-28-95 DATE COMPLETED: 8-28-95
FIELD REP.: DARRELL MOORE
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED.

LOCATION DESCRIPTION: LOCATED UPGRADIENT APPROX. 150 FEET NORTH OF COOLING TOWER.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
			TOP	0	1	CUTTINGS	NO PID READINGS	TOP SOIL
			CAL					CAPROCK (CALICHE) TURNING TO SAND AT BOTTOM.
5			SM	4	102	CUTTINGS		TAN SAND, VERY FINE-GRAINED
10								
15								
20								
25			SW	25	102	CUTTINGS		SAND, FINE-GRAINED, MODERATELY WELL SORTED.
30								
35								
40								
45								
50								

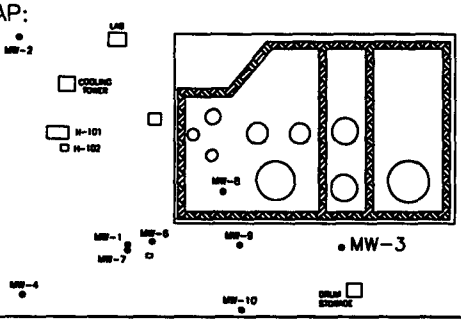
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-2

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60			SW	25	102	CUTTINGS		TAN SAND, FINE GRAINED, MODERATELY WELL SORTED.
65								
70								
75								
80								
85								
90								GROUNDWATER ENCOUNTERED AT 89.18 FEET.
95								
100								
105								BOTTOM OF BORING AT 102 FEET
110								
115								
120								

LITHOLOGICAL LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: MW-3
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): ~3830
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 8-29-95 DATE COMPLETED: 8-29-95
FIELD REP.: DARRELL MOORE
COMMENTS: NO ODORS, NO VISIBLE CONTAMINATION

LOCATION DESCRIPTION: LOCATED DOWNGRADIENT APPROX. 600 FEET SOUTH OF SEWER JUNCTION BOX.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
			TOP	0	1	CUTTINGS	NO PID READINGS	TOP SOIL
			CAL	1	3	CUTTINGS		CAPROCK (CALICHE) TURNING TO SAND AT BOTTOM.
			SM	3	103	CUTTINGS		TAN SAND, VERY FINE-GRAINED
25			SW	25	103	CUTTINGS		SAND, FINE-GRAINED, MODERATELY WELL SORTED.

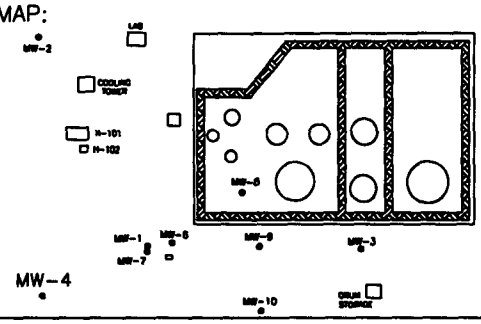
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-3

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60			SW	25	102	CUTTINGS		TAN SAND, FINE GRAINED, MODERATELY WELL SORTED.
65								
70								
75								
80								
85								
90								GROUNDWATER ENCOUNTERED AT 91.4 FEET.
95								
100								
105								BOTTOM OF BORING AT 103 FEET
110								
115								
120								

LITHOLOGICAL LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: MW-4
SITE LOCATION (SECTION, TOWNSHIP, RANGE): NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): ~3838
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 8-30-95 DATE COMPLETED: 8-30-95
FIELD REP.: DARRELL MOORE
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED.

LOCATION DESCRIPTION: LOCATED UPGRADIENT APPROX. 300 FEET WEST-NORTHWEST OF SEWER JUNCTION BOX.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
			TOP	0	1	CUTTINGS	NO PID READINGS	TOP SOIL
			CAL	1	4	CUTTINGS		CAPROCK (CALICHE) TURNING TO SAND AT BOTTOM.
5			SM	4	102	CUTTINGS		TAN SAND, VERY FINE-GRAINED
10								
15								
20								
25			SW	25	102	CUTTINGS		SAND, FINE-GRAINED, MODERATELY WELL SORTED.
30								
35								
40								
45								
50								

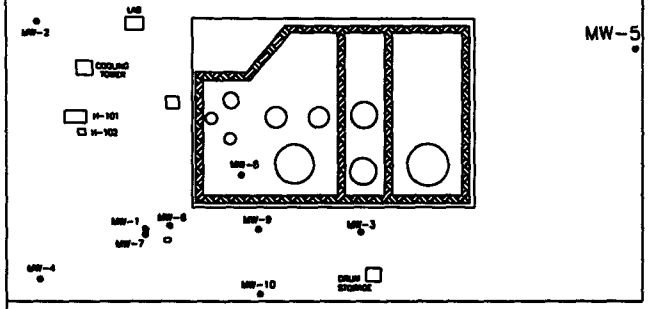
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-4

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60			SW	25	102	CUTTINGS		TAN SAND, FINE GRAINED, MODERATELY WELL SORTED.
65								
70								
75								
80								
85								
90								
95								GROUNDWATER ENCOUNTERED AT 92.72 FEET.
100								
105								BOTTOM OF BORING AT 104 FEET
110								
115								
120								

LITHOLOGICAL LOG

LOCATION MAP:



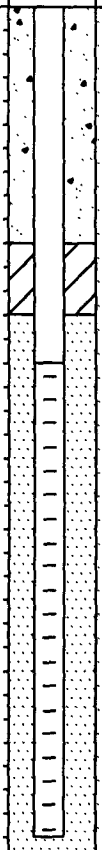
SITE ID: LOVINGTON REFINERY LOCATION ID: MW-5
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): ~3814
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 9-06-95 DATE COMPLETED: 9-06-95
FIELD REP.: DARRELL MOORE
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED.

LOCATION DESCRIPTION: LOCATED DOWNGRADIENT NEAR SOUTHEAST BOUNDARY OF PROPERTY.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
			TOP	0	1	CUTTINGS	NO PID READINGS	TOP SOIL
			CAL	1	4	CUTTINGS		CAPROCK (CALICHE) TURNING TO SAND AT BOTTOM.
5			SM	4	96	CUTTINGS		TAN SAND, VERY FINE-GRAINED
10								
15								
20								
25			SW	25	96	CUTTINGS		SAND, FINE-GRAINED, MODERATELY WELL SORTED.
30								
35								
40								
45								
50								

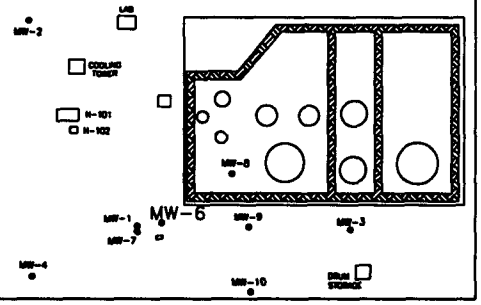
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-5

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60			SW	25	96	CUTTINGS		TAN SAND, FINE GRAINED, MODERATELY WELL SORTED.
65								
70								
75								GROUNDWATER ENCOUNTERED AT 76.08 FEET.
80								
85								
90								
95								
100								BOTTOM OF BORING AT 96 FEET
105								
110								
115								
120								

LITHOLOGICAL LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: MW-6
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): ~3836
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 8-31-95 DATE COMPLETED: 8-31-95
FIELD REP.: DARRELL MOORE
COMMENTS: HYDROCARBON ODORS NOTED AT 91 FEET BGS (FORMERLY BORING 7).

LOCATION DESCRIPTION: LOCATED DOWNGRADIENT APPROXIMATELY 50 FEET SOUTHEAST OF SEWER JUNCTION BOX.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
			TOP	0	1	CUTTINGS	NO PID READINGS	TOP SOIL
		G C	CAL	1	4	CUTTINGS		CAPROCK (CALICHE) TURNING TO SAND AT BOTTOM.
5			SM	4	99	CUTTINGS		TAN SAND, VERY FINE-GRAINED
10								
15								
20								
25			SW	25	99	CUTTINGS		SAND, FINE-GRAINED, MODERATELY WELL SORTED.
30								
35								
40								
45								
50								

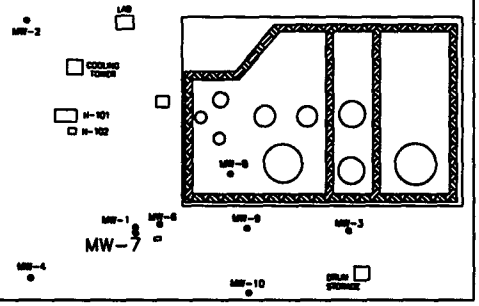
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-6

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60			SW	25	99	CUTTINGS		TAN SAND, FINE GRAINED, MODERATELY WELL SORTED.
65								
70								
75								
80								
85								
90								HYDROCARBON ODOR NOTED AT APPROX. 91 FEET. GROUNDWATER ENCOUNTERED AT 93 FEET.
95								
100								BOTTOM OF BORING AT 99 FEET
105								
110								
115								
120								

LITHOLOGICAL LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: MW-7
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): ~3836
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 9-06-95 DATE COMPLETED: 9-07-95
FIELD REP.: DARRELL MOORE
COMMENTS: 0.05 FEET OF FREE PRODUCT AT 93 FEET BGS (FORMERLY BORING 10).

LOCATION DESCRIPTION: LOCATED APPROXIMATELY 15 FEET NORTH OF SEWER JUNCTION BOX.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
0			TOP	0	1	CUTTINGS	NO PID READINGS	TOP SOIL
			CAL	1	4	CUTTINGS		CAPROCK (CALICHE) TURNING TO SAND AT BOTTOM.
5			SM	4	100	CUTTINGS		TAN SAND, VERY FINE-GRAINED
10								
15								
20								
25			SW	25	100	CUTTINGS		SAND, FINE-GRAINED, MODERATELY WELL SORTED.
30								
35								
40								
45								
50								

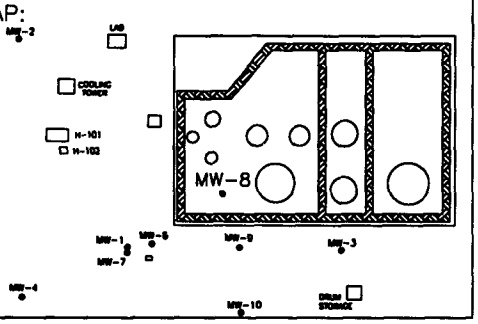
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-7

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
			SW	25	100	CUTTINGS		TAN SAND, FINE GRAINED, MODERATELY WELL SORTED.
60								
65								
70								
75								
80								
85								
90								
95								GROUNDWATER ENCOUNTERED AT 93 FEET. WITH 0.05 FEET OF FREE PRODUCT.
100								BOTTOM OF BORING AT 100 FEET
105								
110								
115								
120								

LITHOLOGIC LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: MW-8
SITE LOCATION (SECTION, TOWNSHIP, RANGE): NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): ~ 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-15-96 DATE COMPLETED: 4-15-96
FIELD REP.: G. VAN DEVENTER (GCL)
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED IN DRILL CUTTINGS

LOCATION DESCRIPTION: LOCATED APPROX. 20 FEET SOUTHEAST OF TANK NO. 1205

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
0		C C C	CAL					SANDY CALICHE, GRAYISH ORANGE (10 YR 7/4), HARD, FRACTURED AND DRY.
5								
10				10	10	CUTTINGS	<1 ppm	SILTY SAND, GRAYISH ORANGE (10 YR 7/4), APPROX. 80% VERY FINE-GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, SUBROUNDED, MODERATELY SORTED, LOOSE, DRY
15			SM					
20				20	20	CUTTINGS	<1 ppm	SILTY SAND, GRAYISH ORANGE (10 YR 7/4), APPROX. 80% VERY FINE-GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, SUBROUNDED, MODERATELY SORTED, LOOSE, DRY
25								
30				30	30	CUTTINGS	<1 ppm	SAND, LIGHT BROWN (5 YR 5/6), VERY FINE AND FINE GRAINED SAND, MODERATELY SORTED, SUBROUNDED, LOOSE, DRY
35								
40			SW	40	40	CUTTINGS	<1 ppm	SAND, LIGHT BROWN (5 YR 5/6), VERY FINE AND FINE GRAINED SAND, MODERATELY SORTED, SUBROUNDED, LOOSE, DRY
45								
50				50	50	CUTTINGS	<1 ppm	SAND, LIGHT BROWN (5 YR 6/4), VERY FINE AND FINE-GRAINED SAND, MODERATELY SORTED, SUBROUNDED, LOOSE, DRY

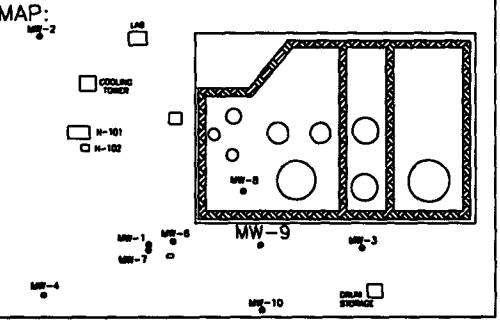
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-8

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60				60	60	CUTTINGS	<1 ppm	SAND, LIGHT BROWN (5 YR 6/4), VERY FINE AND FINE-GRAINED SAND, MODERATELY SORTED, SUBROUNDED, LOOSE, DRY
65								
70				70	70	CUTTINGS	<1 ppm	SAND, LIGHT BROWN (5 YR 6/4), VERY FINE AND FINE-GRAINED SAND, MODERATELY SORTED, SUBROUNDED, LOOSE, DRY
75								
80			SW	80	80	CUTTINGS	<1 ppm	SAND, LIGHT BROWN (5 YR 6/4), FINE-GRAINED, WELL SORTED, SUBROUNDED, LOOSE, DRY
85								
90				90	90	CUTTINGS	<1 ppm	GROUNDWATER ENCOUNTERED AT APPROX. 90 FEET
95								
100								
105								BOTTOM OF BOREHOLE AT 105 FEET
110								
115								
120								

LITHOLOGICAL LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: MW-9
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-1-96 DATE COMPLETED: 4-2-96
FIELD REP.: G. VAN DEVENTER
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED IN DRILL CUTTINGS.

LOCATION DESCRIPTION: LOCATED APPROX. 55 FEET EAST OF SIX LPG TANKS (20)FEET WEST OF ROAD)

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
5		C G C C C	CAL			NO SAMPLES COLLECTED		SANDY CALICHE, PALE YELLOWISH BROWN (10 YR 6/2), HARD, FRACTURED AND DRY.
10			SM	10	10	CUTTINGS	<1PPM	SILTY SAND, GRAYISH ORANGE (10 YR 7/4), 80% VERY FINE-GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY
20				20	20	CUTTINGS	<1PPM	SILTY SAND, LIGHT BROWN (5 YR 6/4), 80% VERY FINE-GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY
30			SW	30	30	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
40				40	40	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
50				50	50	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY

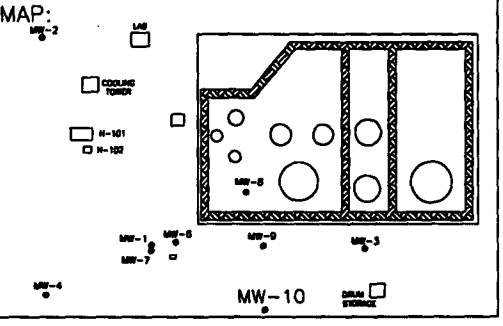
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-9

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
								SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
60				60	60	CUTTINGS	<1 ppm	DARK YELLOWISH ORANGE (10 YR 6/6)
65								
70				70	70	CUTTINGS	<1 ppm	MODERATE YELLOWISH BROWN (10 YR 5/4)
75								
80			SW	80	80	CUTTINGS	<1 ppm	LIGHT BROWN (5 YR 6/4)
85								
90				90	90	CUTTINGS	<1 ppm	GROUNDWATER ENCOUNTERED AT APPROXIMATELY 88 FEET BGS
95								
100								
105								BOTTOM OF BORING AT 104 FEET
110								
115								
120								

LITHOLOGICAL LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: MW-10
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 3-29-96 DATE COMPLETED: 4-1-96
FIELD REP.: G. VAN DEVENTER
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED IN DRILL CUTTINGS.

LOCATION DESCRIPTION: LOCATED APPROX. 60 FEET WEST OF SIX LPG TANKS

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
5		C C C C C	CAL			NO SAMPLES COLLECTED		SANDY CALICHE, PALE YELLOWISH BROWN (10 YR 6/2), HARD, FRACTURED, DRY
10			SM	10	10	CUTTINGS	<1PPM	SILTY CALCAREOUS SAND, GRAYISH ORANGE (10 YR 7/4), 80% VERY FINE GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY
15								
20				20	20	CUTTINGS	<1PPM	SILTY CALCAREOUS SAND, LIGHT BROWN (5 YR 6/4), 80% VERY FINE GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY
25			SW	25	25	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
30				30	30	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
35								
40				40	40	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
45								
50				50	50	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY

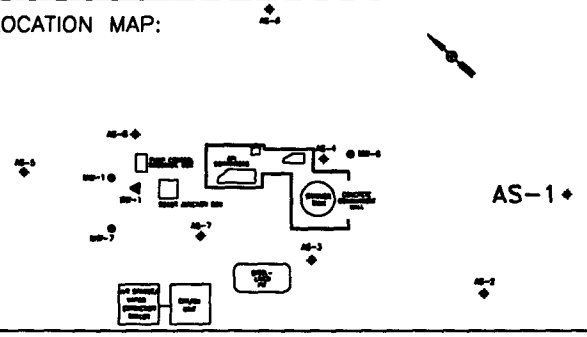
LITHOLOGIC LOG
(Continued)

LOCATION ID: MW-10

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
								SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
60				60	60	CUTTINGS	<1PPM	DARK YELLOWISH ORANGE (10 YR 6/6)
65								
70				70	70	CUTTINGS	<1PPM	MODERATE YELLOWISH BROWN (10 YR 5/4)
75								
80			SW	80	80	CUTTINGS	<1PPM	LIGHT BROWN (5 YR 6/4)
85								
90				90	90	CUTTINGS	<1PPM	GROUNDWATER ENCOUNTERED AT APPROXIMATELY 90 FEET BGS
95								
100								
105								BOTTOM OF BORING AT 105 FEET
110								
115								
120								

LITHOLOGIC LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: AS-1
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-2-96 DATE COMPLETED: 4-3-96
FIELD REP.: G. VAN DEVENTER
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED.

LOCATION DESCRIPTION: LOCATED APPROX. 57 FEET SOUTH OF SKIMMER TANK

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
5			CAL			NO SAMPLES COLLECTED		SANDY CALICHE, VERY PALE ORANGE (10 YR 8/2), HARD (INDURATED), FRACTURED (WEATHERED), DRY
10			SM	10	10	CUTTINGS	<1PPM	SILTY SAND, GRAYISH ORANGE (10 YR 7/4), APPROX. 80% VERY FINE-GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY
20				20	20	CUTTINGS	<1PPM	SILTY SAND, LIGHT BROWN (5 YR 6/4), APPROX. 80% VERY FINE-GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY
30			SW	30	30	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
40				40	40	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
50				50	50	CUTTINGS	<1PPM	SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY

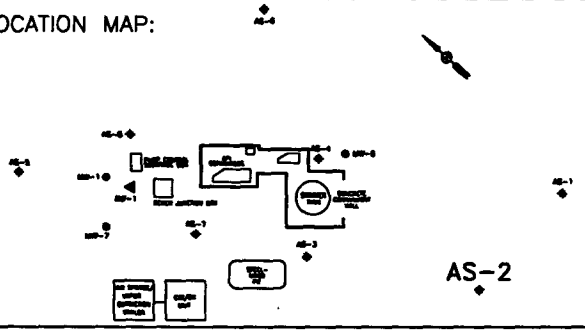
LITHOLOGIC LOG
(Continued)

LOCATION ID: AS-1

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
						NO SAMPLES COLLECTED		SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
60				60	60	CUTTINGS	<1ppm	DARK YELLOWISH ORANGE (10 YR 6/6)
65								
70				70	70	CUTTINGS	<1ppm	MODERATE YELLOWISH BROWN (10 YR 5/4)
75								
80			SW	80	80	CUTTINGS	<1ppm	LIGHT BROWN (5 YR 6/4)
85								
90								GROUNDWATER ENCOUNTERED AT APPROX. 90 FEET
95								
100								
105								
110								BOTTOM OF BORING AT 107 FEET
115								
120								

LITHOLOGIC LOG

LOCATION MAP:



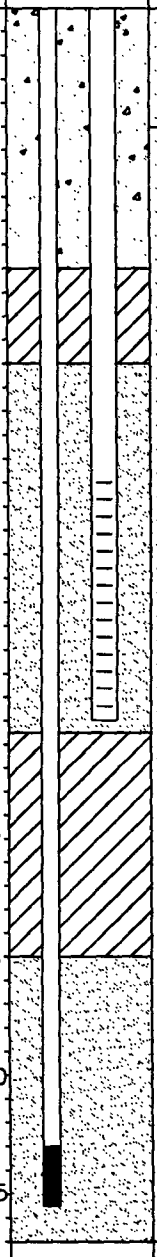
SITE ID: LOVINGTON REFINERY LOCATION ID: AS-2
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-3-96 DATE COMPLETED: 4-3-96
FIELD REP.: JINGFANG HE
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED.

LOCATION DESCRIPTION: LOCATED APPROX. 100 FEET NORTH OF SIX LARGE LPG TANKS AND 40 FEET WEST OF ROAD.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
0			CAL			NO SAMPLES COLLECTED	NO PID READINGS	SANDY CALICHE, PALE YELLOWISH BROWN, VERY HARD TO DRILL THROUGH
5			SW					FINE SAND, LIGHT BROWN WELL SORTED, SUBROUNDED, DRY
10								
15								
20								
25								
30								
35								FINE SAND, GRAYISH ORANGE, WELL SORTED, SUBROUNDED, DRY
40								
45								FINE SAND, LIGHT BROWN, WELL SORTED, SUBROUNDED, DRY
50								

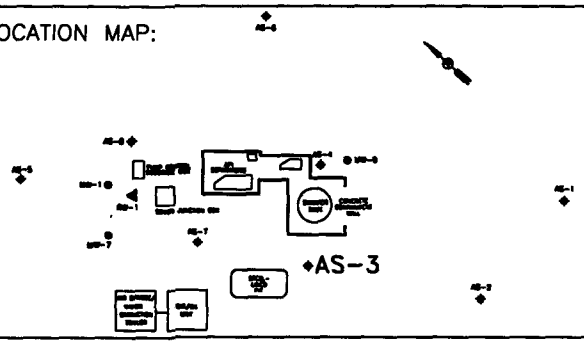
LITHOLOGIC LOG
(Continued)

LOCATION ID: AS-2

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60			SM			NO SAMPLES COLLECTED	NO PID READINGS	FINE SAND WITH SOME SILT (~10%), MODERATE YELLOWISH BROWN, WELL SORTED, SUBROUNDED, DRY
65				60	70	CUTTINGS		FINE SAND WITH ~5% SILT, LIGHT BROWN, WELL SORTED, SUBROUNDED, DRY
70								
75				70	85	CUTTINGS		FINE SAND, LIGHT BROWN, WELL SORTED, SUBROUNDED, DRY
80			SW					
85								
90								
95				85	105	CUTTINGS		FINE SAND, MODERATE YELLOWISH BROWN, WELL SORTED, SUBROUNDED, SLIGHTLY WET TO WET AT THE BOTTOM (SATURATED)
100								
105								
110								BOTTOM OF BORING AT 107 FEET
115								
120								

LITHOLOGIC LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: AS-3
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-19-S R-36-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-4-96 DATE COMPLETED: 4-4-96
FIELD REP.: JINGFANG HE
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED.

LOCATION DESCRIPTION: LOCATED APPROX. 10 FEET WEST OF SKIMMER TANK.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
0		C C C	CAL			NO SAMPLES COLLECTED	NO PID READINGS	SANDY CALICHE, PALE YELLOWISH BROWN (10 YR 6/2), HARD (INDURATED), FRACTURED (WEATHERED), DRY
5			SM					
10								
15								SILTY SAND, GRAYISH ORANGE (10 YR 7/4), 80% VERY FINE GRAINED SAND, 15% SILT, 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY
20								
25			ML					
30								CLAYEY SILT, OLIVE GRAY (5 YR 3/2), SLIGHT PLASTICITY, MEDIUM STIFF, SLIGHTLY MOIST
35								
40								
45			SW					SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, WELL SORTED, SUBROUNDED, SLIGHTLY MOIST TO DRY
50								

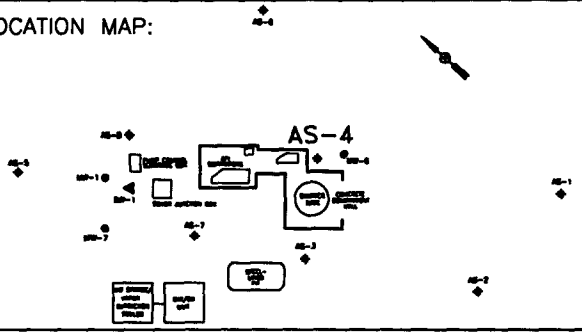
LITHOLOGIC LOG
(Continued)

LOCATION ID: AS-3

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60			SW	55	80	CUTTINGS		SAND, LIGHT BROWN (5 YR 5/6), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
65								
70								
75								
80			SM	80	85	CUTTINGS		SILTY SAND, GRAYISH BROWN (5 YR 2/2), APPROX. 90% VERY FINE TO FINE GRAINED SAND AND 10% SILT, MOIST TO WET
85								
90			SW	85	107	CUTTINGS		SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), SUBROUNDED, WELL SORTED, WET
95								
100								
105								
110								BOTTOM OF BORING AT 107 FEET
115								
120								

LITHOLOGIC LOG

LOCATION MAP:



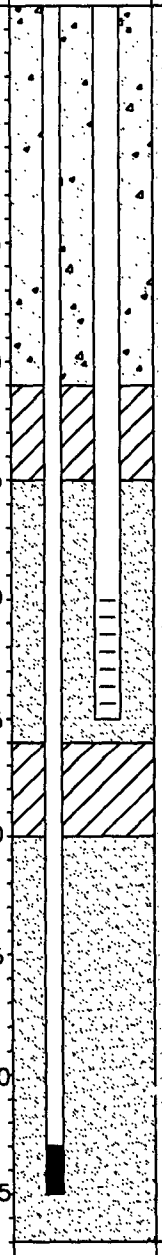
SITE ID: LOVINGTON REFINERY LOCATION ID: AS-4
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-X-S R-X-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-4-96 DATE COMPLETED: 4-5-96
FIELD REP.: JINGFANG HE
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED.

LOCATION DESCRIPTION: LOCATED APPROX. 8 FEET EAST OF SKIMMER TANK AND 15 FEET WEST OF ROAD.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
0		C C C	CAL	0	4	CUTTINGS	NO PID READINGS	SANDY CALICHE, DARK YELLOWISH BROWN (TOP) PALE YELLOWISH BROWN (0.5 FEET – 4 FEET), VERY HARD TO DRILL, DRY
5								
10			SW	4	17	CUTTINGS		FINE SAND, GRAYEY ORANGE, WELL SORTED, SUBROUNDED, DRY
15								
20								
25			SW	17	35	CUTTINGS		FINE SAND, LIGHT BROWN, WELL SORTED, SUBROUNDED, DRY TO SLIGHTLY MOIST
30								
35			ML	35	40	CUTTINGS		FINE SAND WITH 10% SILT, LIGHT BROWN, WELL SORTED, SUBROUNDED, SLIGHTLY WET
40								
45			SW	40	55	CUTTINGS		FINE SAND, GRAYEY ORANGE, WELL SORTED, SUBROUNDED, DRY TO SLIGHTLY MOIST
50								

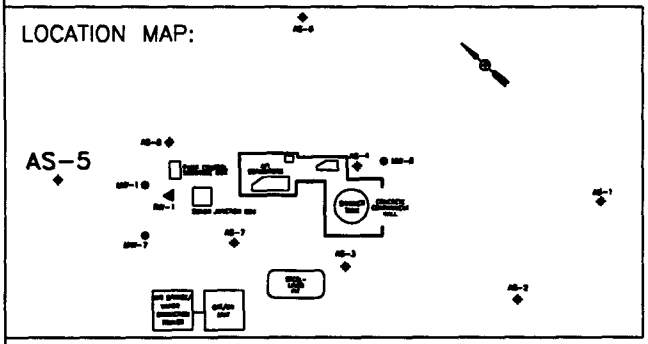
LITHOLOGIC LOG
(Continued)

LOCATION ID: AS-4

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60								
65								
70								
75								
80			SW	55	107	CUTTINGS		FINE SAND, GRAYISH ORANGE, WELL SORTED, SUBROUNDED, DRY TO SLIGHTLY MOIST
85								
90								GROUNDWATER ENCOUNTERED AT APPROX. 90 FEET
95								
100								
105								
110								BOTTOM OF BORING AT 107 FEET
115								
120								

LITHOLOGIC LOG

LOCATION MAP:



SITE ID: LOVINGTON REFINERY LOCATION ID: AS-5
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-9-96 DATE COMPLETED: 4-9-96
FIELD REP.: G. VAN DEVENTER
COMMENTS:

LOCATION DESCRIPTION: APPROX. 35 FEET NORTHWEST OF SEWER JUNCTION BOX.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
0-10			CAL	0	10	CUTTINGS	200 ppm	SANDY CALICHE, PALE YELLOWISH BROWN (10 YR 6/2), HARD, FRACTURED WITH INTERMITTENT LAYERS OF SILTY VERY FINE-GRAINED SAND, LOOSE, DRY
10-25			SM	10	25	CUTTINGS	200 ppm	SILTY SAND, PALE YELLOWISH BROWN (10 YR 6/2), APPROX 80% VERY FINE-GRAINED SAND, 15% SILT, AND 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY MODERATE HYDROCARBON ODORS
25-50			SW	25	30	CUTTINGS	240 ppm	
				30	40	CUTTINGS	180 ppm	SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY, MODERATE HYDROCARBON ODORS
				40	50	CUTTINGS	110 ppm	

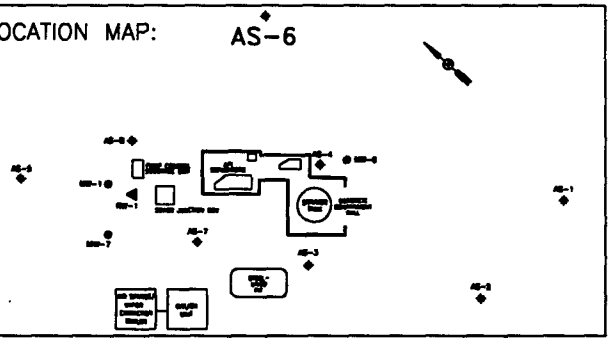
LITHOLOGIC LOG
(Continued)

LOCATION ID: AS-5

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60				60	70	CUTTINGS	40 ppm	SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
65								
70				70	80	CUTTINGS	30 ppm	SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
75			SW					
80				80	80.5	SPLIT SPOON	4 ppm	SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
85								
90				80	90	CUTTINGS	6 ppm	GROUNDWATER ENCOUNTERED AT APPROX. 90 FEET
95								
100								
105								
110								BOTTOM OF BORING AT 107 FEET
115								
120								

LITHOLOGIC LOG

LOCATION MAP: AS-6



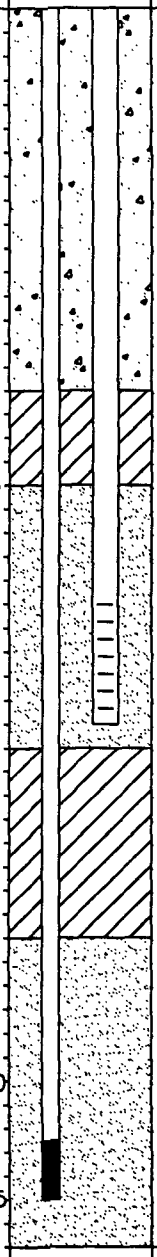
SITE ID: LOVINGTON REFINERY LOCATION ID: AS-6
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-10-96 DATE COMPLETED: 4-10-96
FIELD REP.: G. VAN DEVENTER
COMMENTS: NO HYDROCARBON ODORS OR STAINING OBSERVED.

LOCATION DESCRIPTION: LOCATED APPROX. 35 FEET NORTHEAST OF API SEPARATOR.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
5		C C C C	CAL	5	7	CUTTINGS	<1ppm	SANDY CALICHE, PALE YELLOWISH BROWN (10 YR 6/2), HARD, FRACTURED, DRY
10			SM	7	10	CUTTINGS	<1ppm	SILTY SAND, PALE YELLOWISH BROWN (10 YR 6/2), APPROX. 80% VERY FINE-GRAINED SAND, 15% SILT, AND 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY
15								
20				10	20	CUTTINGS	<1ppm	
25								
30				20	30	CUTTINGS	<1ppm	SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOS, DRY
35								
40			SW	30	40	CUTTINGS	<1ppm	
45								
50				40	50	CUTTINGS	<1ppm	

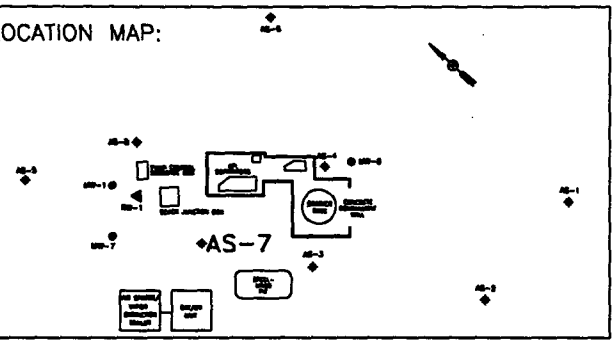
LITHOLOGIC LOG
(Continued)

LOCATION ID: AS-6

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60			SW	50	60	CUTTINGS	<1ppm	SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), FINE-GRAINED, SUBROUNDED, WELL SORTED, LOOSE, DRY
65								
70				60	70	CUTTINGS	<1ppm	
75								
80				70	80	CUTTINGS	<1ppm	
85								
90				80	90	CUTTINGS	<1ppm	GROUNDWATER ENCOUNTERED AT APPROX. 90 FEET
95								
100								
105								
110								BOTTOM OF BORING AT 107 FEET
115								
120								

LITHOLOGIC LOG

LOCATION MAP:



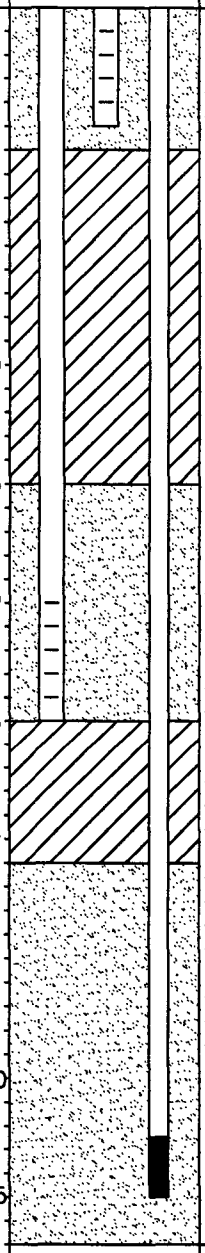
SITE ID: LOVINGTON REFINERY LOCATION ID: AS-7
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-36-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-10-96 DATE COMPLETED: 4-11-96
FIELD REP.: G. VAN DEVENTER/DALE LITTLEJOHN
COMMENTS: MODERATE TO STRONG HYDROCARBON ODORS.

LOCATION DESCRIPTION: APPROX. 16 FEET SOUTH OF SEWER JUNCTION BOX.

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
		C C C						SANDY CALICHE, PALE YELLOWISH BROWN (10 YR 6/2), HARD (INDURATED), FRACTURED (WEATHERED) DRY
5			CAL					SILTY SAND, GRAYISH ORANGE (10 YR 5/4), APPROX. 80% VERY FINE-GRAINED SAND, 15% SILT, AND 5% DISSEMINATED CALCIUM CARBONATE, LOOSE, DRY, CHANGING TO GRAYISH BLACK AT 9 FEET WITH MODERATE HYDROCARBON ODOR
10				10	10	CUTTINGS	260 ppm	
15			SM					
20				20	20	CUTTINGS	280 ppm	
25								SAND, GRAYISH BLACK (CHANGING TO BLACK AT 29 FEET), FINE-GRAINED, SUBROUNDED, WELL SORTED, STRONG HYDROCARBON ODOR, LOOSE, DRY
30				29	30.5	SPLIT SPOON	340 ppm	
35								
40			SW	40	40	CUTTINGS	340 ppm	
45								
50				50	50	CUTTINGS	260 ppm	

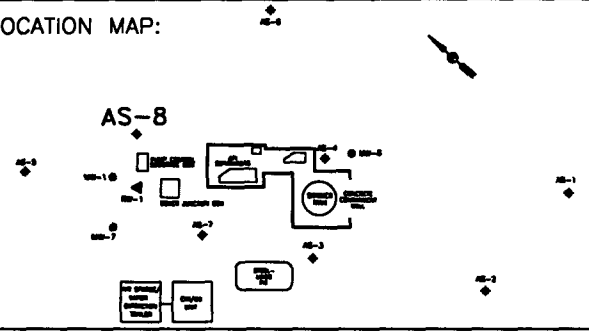
LITHOLOGIC LOG
(Continued)

LOCATION ID: AS-7

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60				60	61	SPLIT SPOON	260 ppm	SAND, LIGHT BROWN, FINE GRAIN (5–10% SILT), SUBROUNDED, WELL SORTED UNCONSOLIDATED, STRONG HYDROCARBON ODOR, NO STAINING OR DISCOLORATION
65								
70				70	70	CUTTINGS	280 ppm	
75								
80			SW	80	81	SPLIT SPOON	280 ppm	
85								
90				90	90	CUTTINGS	180 ppm	GROUNDWATER ENCOUNTERED AT APPROX. 90 FEET
95								
100								
105								
110								BOTTOM OF BORING AT 107 FEET
115								
120								

LITHOLOGIC LOG

LOCATION MAP:



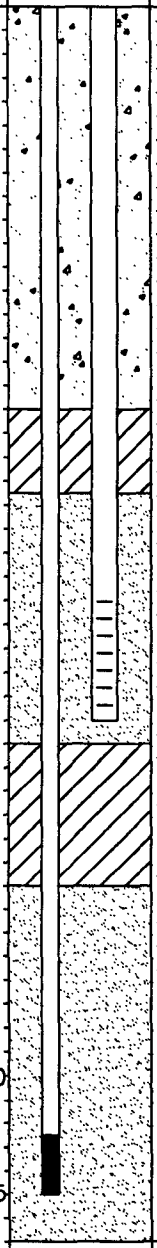
SITE ID: LOVINGTON REFINERY LOCATION ID: AS-8
SITE LOCATION (SECTION, TOWNSHIP, RANGE):
NE 1/4 SECTION 36 T-16-S R-37-E
GROUND ELEVATION (ft. MSL): 3835
STATE: NEW MEXICO COUNTY: LEA
DRILLING METHOD: HOLLOW-STEM AUGER
DRILLING CONTR.: POOL ENVIRONMENTAL DRILLING
DATE STARTED: 4-11-96 DATE COMPLETED: 4-12-96
FIELD REP.: DALE LITTLEJOHN
COMMENTS:

LOCATION DESCRIPTION: LOCATED APPROX. 20 FEET NORTHEAST OF ELECTRIC CONTROL BOX

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	FROM	TO	TYPE	PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
5		C C C C	CAL					SANDY CALICHE, PALE YELLOWISH BROWN (10 YR 6/2) WITH HARD LAYERS, VERY FINE GRAIN, POORLY SORTED SAND, DRY (NO ODORS)
10			SM	10	10	CUTTINGS	10 ppm	SILTY SAND, LIGHT YELLOWISH BROWN, VERY FINE GRAIN (25% SILT), POORLY SORTED SAND, DRY, SILT DECREASING WITH DEPTH
15								
20				20	20	CUTTINGS	300 ppm	SAND, GRAY (DISCOLORED), VERY FINE GRAIN, WELL SORTED, SUBANGULAR, STRONG HYDROCARBON ODOR
25								
30				30	30	CUTTINGS	360 ppm	SAND, GRAYISH DARK BROWN, FINE GRAINED, WELL SORTED, SUBANGULAR, STRONG HYDROCARBON ODOR
35			SW					
40				40	40	CUTTINGS	300 ppm	
45								
50				50	50	CUTTINGS	340 ppm	

LITHOLOGIC LOG
(Continued)

LOCATION ID: AS-8

DEPTH	WELL CONST.	LITH.	SAMPLE USCS	SAMPLE FROM	SAMPLE TO	SAMPLE TYPE	SAMPLE PID READING	LITHOLOGIC DESCRIPTION (LITH., USCS, GRAIN SIZE PROPORTIONS, WET COLOR, RNDG., SORT., CONSOL., DIST. FEATURES)
60				60	60	CUTTINGS	440 ppm	SAND, BROWN TO DARK BROWN, FINE-GRAINED, WELL SORTED, SUBANGULAR, HYDROCARBON ODOR, DRY
65								
70				70	70	CUTTINGS	420 ppm	
75								
80			SW	80	80	CUTTINGS	320 ppm	
85								
90								
95								ENCOUNTERED GROUNDWATER AT APPROXIMATELY 93 FEET
100								
105								
110								BOTTOM OF BORING AT 107 FEET
115								
120								

APPENDIX D

MONITORING WELL SURVEY DATA
(Supplied by John West Engineering Company)

AREA 505
393-3942

AREA 505
393-3117

JOHN WEST
ENGINEERING
COMPANY
EMPLOYEE OWNED

412 North Dal Paso
Hobbs, New Mexico 88240

APRIL 29, 1996

GIL VAN DEVENTER
GEOSCIENCE CONSULTANTS, INC.
306 W. WALL ST., SUITE 818
MIDLAND, TEXAS 79701

RE: NAVAJO'S LOVINGTON (LEA) REFINERY MONITOR WELLS

DEAR GIL,

HERE ARE THE RESULTS OF THE SURVEY PERFORMED ON THE FOUR MONITOR WELLS IN SECTION 31, T16S, R37E, N.M.P.M., LEA COUNTY, NEW MEXICO ON 4-23-1996.

ELEVATIONS

	TOP OF CONC. (NORTH SIDE)	TOP OF PVC PIPE (NORTH SIDE)
WELL RW-1	3836.15'	3835.91'
WELL MW-8	3834.42'	3838.09'
WELL MW-9	3833.06'	3832.82'
WELL MW-10	3831.34'	3831.10'

VERTICAL MEASUREMENTS WERE BASED UPON ELEVATION'S PREVIOUSLY ESTABLISHED IN THE PLANT AND WERE COMPARED WITH ELEVATIONS ON WELLS FROM A PRIOR SURVEY.

THANK YOU FOR THIS OPPORTUNITY AND SHOULD YOU HAVE ANY QUESTIONS, PLEASE CALL.

SINCERELY

Gary

GARY EIDSON
PS NO. 12641
W.O. 96110500

REVISED WELL NUMBERS

ELEVATIONS

	NORTH SIDE OF METAL RIM		*TOP OF 2" PVC (NORTH SIDE)*
WELL NO. 1	*3835.90'*		*3835.67'*
WELL NO. 2	*3835.14'*		*3834.94'*
WELL NO. 3	*3829.83'*		*3829.55'*
WELL NO. 4	*3837.85'*		*3837.56'*
WELL NO. 5	*3813.87'*	*(EDGE OF CONC. BOX)*	*3816.88'*
WELL NO. 6	*3835.70'*		*3835.50'*
WELL NO. 7	*3836.07'*		*3835.84'*

APPENDIX E

LABORATORY ANALYTICAL REPORTS AND CHAIN-OF-CUSTODY DOCUMENTATION

LABORATORY ANALYTICAL REPORTS
FROM INVESTIGATION CONDUCTED BY
GEOSCIENCE CONSULTANTS, LTD.
(March-April, 1996)

DISK 16

Fwd 4-16

№ 9849

GCL
Environmental Science and Engineering
A BDM International Company

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505 Marquette NW, Ste. 1100
Albuquerque, NM 87102
(505) 842-0001
FAX: (505) 842-0595

❑ Mid Atlantic Region
4221 Forbes Blvd., Ste. 240
Lanham, MD 20706-4325
(301) 459-9677
FAX: (301) 459-3064

❑ NASA-WSTF
PO Drawer MM
Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

Chain of Custody

Date 4-4-96 Page 1 of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK, TEXAS 79424
Telephone (806) 794-1296

Samplers (SIGNATURES) Gil Van Deventer

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015 (Diesel)	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)				Number of Containers
9603271500	Soil	RW-1 (29'-30.5')		✓								✓	✓													50601		
9603271535	Soil	RW-1 (39'-39.5')		✓								✗	[redacted]														02	
9603271725	Soil	RW-1 (59'-60.5')		✓								✗	[redacted]														03	

96AJ

96AJ

Project Information		Sample Receipt	
Project	Lovington Refinery	Total No. of Containers	3
Project Director	Bernie Lauctes	Chain of Custody Seals	✓
Charge Code No.	2033-001	Rec'd Good Condition/Cold	✓
Shipping ID. No.	126-689-646-6	Conforms to Record	✓
Via:	Greyhound	Lab No.	

Special Instructions/Comments: Please FAX results to GCL-Midland office (915-682-0028)

Relinquished By	1.	2.	3.
(Signature)	Gil Van Deventer 1440	Helen Shelton 7:30PM	
(Printed Name)	Gil Van Deventer	HELEN SHELTON	
(Date)	4/4/96	4/4/96	
(Company)	Geoscience Consultants, Ltd.	TRACE ANALYSIS	

Received By	1.	2.	3.
(Signature)	Helen Shelton 2:20PM		
(Printed Name)	HELEN SHELTON		Steven Havranek
(Date)	4/4/96		10:25
(Company)	Trace Analysis		Trace Analysis (Laboratory) 4-5-96

fax to both alb/mid.

3 samples - HS

X - changed verbally Gil - Helen

Distribution: White, Canary-Laboratory • Pink, GCL

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

April 16, 1996
Receiving Date: 04/13/96
Sample Type: Soil
Charge Code No: 2033-001
Project Location: Lovington, NM
COC #9772

Prep Date: 04/14/96
Analysis Date: 04/15/96
Sampling Date: 04/9-11/96
Sample Condition: Intact & Cool
Sample Received by: DH
Project Name:Lovington Refinery

TA#	Field Code	TRPHC (mg/kg)	BENZENE (mg/kg)	TOLUENE (mg/kg)	ETHYL-BENZENE (mg/kg)	M,P,O XYLENE (mg/kg)	TOTAL BTEX (mg/kg)
T50986	9604090945 AS-5 (80-80.5')	<10	<0.050	<0.050	<0.050	<0.050	<0.050
T50987	9604101730 AS-7 (29-30.5')	13,000	1.300	6.420	33.300	65.700	106.720
T50988	9604110856 AS-7 (60-61')	10,700	<1.000	3.710	14.800	33.200	51.710
T50989	9604111020 AS-7 (80-81')	85	<0.500	<0.500	<0.500	<0.500	<0.500
QC	Quality Control	104	0.096	0.097	0.095	0.191	
Reporting Limit		10	0.050	0.050	0.050	0.050	
RPD		4	1	2	1	1	
% Extraction Accuracy		92	106	109	108	110	
% Instrument Accuracy		104	96	97	95	96	

METHODS: EPA SW 846-8020, 5030, 3550 HIGH LEVEL; EPA 418.1.
BTEX SPIKE: 2.500 mg/kg BTEX.
TRPHC SPIKE: 8.500 mg/kg TRPHC.
BTEX QC: 0.100 mg/L BTEX.
TRPHC QC: 100 mg/L TRPHC.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

4-16-96
Date

104AA DISC 1/-

Faxed 4-12

№ 9772

GCL
Environmental Science and Engineering
A BDM International Company

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505 Marquette NW, Ste. 1100
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☐ Mid Atlantic Region
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Lanham, MD 20706-4325
(301) 459-9677
FAX: (301) 459-3064

☐ NASA-WSTF
PO Drawer MM
Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

Chain of Custody

Date 4/12/96 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK, TEXAS 79424
Telephone (806) 794-1296

Samplers (SIGNATURES)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020 BTEX	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP - Vol., Semi-Vol. Herbicides, Pesticides	TCLP - Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
186 960409 0945	Soil	AS-5(80'-80.5')		✓								✓																	1
87 960410 1730	Soil	AS-7(29'-30.5')		✓								✓																	1
88 960411 0856	Soil	AS-7(60'-61')		✓								✓																	1
89 960411 1020	Soil	AS-7(80'-81')		✓								✓																	1

104AA

104AA

Project Information	Sample Receipt
Project Lovington Refinery	Total No. of Containers
Project Director Bernie Lauctes	Chain of Custody Seals
Charge Code No. 2033-001	Rec'd Good Condition/Cold
Shipping ID. No. 126-689-651-0	Conforms to Record
Via: GREYHOUND	Lab No.

Special Instructions/Comments: Please FAX results to Midland (915-682-0028) & send rpts to ABQ.

Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
(Signature) 1630 (Time)	Helen Shelton 7:15 PM (Time)	(Signature) (Time)
Gil Van Deventer 4-12-96 (Printed Name) (Date)	HELEN SHELTON 4-12-96 (Printed Name) (Date)	(Printed Name) (Date)
Geoscience Consultants, Ltd (Company)	TRACE ANALYSIS (Company)	(Company)
Received By 1.	**Received By 2.**	**Received By (Laboratory) 3.**
(Signature) 4:30 (Time)	(Signature) (Time)	(Signature) 9:20 (Time)
HELEN SHELTON 4-12-96 (Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) 4/13/96 (Date)
TRACE ANALYSIS (Company)	(Company)	(Laboratory)

Distribution: White, Canary-Laboratory • Pink, GCL

Shipped Greyhound 126-689-651-0

TRACEANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

April 18, 1996
Receiving Date: 04/05/96
Sample Type: Soil
Charge Code No: 2033-001
Project Location: Lovington, NM
COC #9849

Prep Date: 04/05/96
Analysis Date: 04/05/96
Sampling Date: 03/27/96
Sample Condition: Intact & Cool
Sample Received by: SH
Project Name:Lovington Refinery

TA#	Field Code	TRPHC Diesel (mg/kg)	TRPHC (mg/kg)	BENZENE (mg/kg)	TOLUENE (mg/kg)	ETHYL-BENZENE (mg/kg)	M,P,O XYLENE (mg/kg)	TOTAL BTEX (mg/kg)
T50601	9603271500-RW-1 (29-30.5')	505	12,000	1.370	9.860	38.200	82.300	131.730
T50602	9603271535-RW-1 (39-39.5')	NR	22,500	1.640	9.850	78.700	168.000	258.190
T50603	9603271725-RW-1 (59-60.5')	NR	15,000	<1.000	7.730	25.900	62.700	96.330
QC	Quality Control	243	99	0.099	0.100	0.099	0.199	
REPORTING LIMIT		10	10	0.050	0.050	0.050	0.050	
RPD		20	0	24	23	24	23	
% Extraction Accuracy		111	101	116	119	120	120	
% Instrument Accuracy		97	99	99	100	99	100	

NR = NOT RUN

METHODS: EPA SW 846-8020, 5030, 3550 HIGH LEVEL, 8015 Modified; EPA 418.1.
BTEX SPIKE: 2.500 mg/kg BTEX.
TRPHC SPIKE: 8.500 mg/kg TRPHC.
TRPHC (Diesel) SPIKE: 100 mg/kg TRPHC (Diesel).
BTEX QC: 0.100 mg/L BTEX.
TRPHC QC: 100 mg/L TRPHC.
TRPHC (Diesel) QC: 250 mg/L TRPHC (Diesel).

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

4-18-96
Date

01001 11

GCL
Environmental Science and Engineering
A BDM International Company

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Albuquerque, NM 87102
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FAX: (505) 842-0595

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FAX: (301) 459-3064

☐ NASA-WSTF
PO Drawer MM
Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

PAH by 8270 per BL. 4-24-96 ML

SO4 ... DISK #23

№ 10047

Chain of Custody

Date 4/22/96 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK, TEXAS 79424
Telephone (806) 794-1296

Samplers (SIGNATURES) D Nee

Analysis Request

	Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020	Phenols, Sub Phenols 604/8040	Pesticides PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240 BTEX ✓	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	~~TCLP~~ Metals 7 18	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	~~Flash Point~~ PAH ~~8240~~ 8270	~~Corrosivity~~ No3	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)	Nitrate	Sulfate	HCO/HPC	Major Cation/Anions + TDS	Number of Containers
1501	9604221630	H2O	MW-4						2																					2
2	9604221745	H2O	MW-2						2																					2
3	9604230830	H2O	MW-5						2																					2
4	9604230940	H2O	MW-3						2																	1	1	1	X	2 5
5	9604231045	H2O	MW-10						2							1				1	1								1	6
6	9604231215	H2O	MW-9						2							1				1	1								1	6
7	9604231315	H2O	MW-8						2							1				1	1								1	6
8	9604231335	H2O	Rinsate						2																					2
9	9604231345	H2O	Trip Blank						1																					1
10	9604231430	H2O	MW-6						2							1				1	1								1	6

Project Information

Project Navajo
Project Director Lacutes
Charge Code No. 2033-003
Shipping ID. No.

Via: Greyhound

Special Instructions/Comments:

Sample Receipt

Total No. of Containers	40
Chain of Custody Seals	Y
Rec'd Good Condition/Cold	✓
Conforms to Record	Y
Lab No.	

Relinquished By 1.
(Signature) D Nee (Time) 1600
(Printed Name) DAVID NEE (Date) 4/23/96
(Company) GCL

Relinquished By 2.
(Signature) (Time)
(Printed Name) (Date)
(Company)

Relinquished By 3.
(Signature) (Time)
(Printed Name) (Date)
(Company)

Received By 1.
(Signature) (Time)
(Printed Name) (Date)
(Company)

Received By 2.
(Signature) (Time)
(Printed Name) (Date)
(Company)

Received By (Laboratory) 3.
(Signature) M Lopez (Time) 9135
(Printed Name) M Lopez (Date) 4-24-96
(Laboratory) Trace Analysis

115AE

Distribution: ~~White~~, Canary-Laboratory, Pink, GCL

6701 Aberdeen Avenue
Lubbock, Texas 79424
806•794•1296
FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/22/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604221745 MW - 2
TA#: T51502

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	ND	1
Toluene	ND	1
Ethylbenzene	ND	1
m & p-Xylene	ND	1
o-Xylene	ND	1

SURROGATES	RECOVERY
Dibromofluoromethane	106
Toluene-d8	110
4-Bromofluorobenzene	97

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

5-6-96

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

Date

6701 Aberdeen Avenue
Lubbock, Texas 79424
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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604230940 MW - 3
TA#: T51504

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	ND	1
Toluene	ND	1
Ethylbenzene	ND	1
m & p-Xylene	ND	1
o-Xylene	ND	1

SURROGATES	RECOVERY
Dibromofluoromethane	108
Toluene-d8	109
4-Bromofluorobenzene	100

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
Date

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/22/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604221630 MW - 4
TA#: T51501

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	ND	1
Toluene	1	1
Ethylbenzene	ND	1
m & p-Xylene	ND	1
o-Xylene	ND	1

SURROGATES	RECOVERY
Dibromofluoromethane	109
Toluene-d8	108
4-Bromofluorobenzene	98

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
Date

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604230830 MW - 5
TA#: T51503

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	ND	1
Toluene	ND	1
Ethylbenzene	ND	1
m & p-Xylene	ND	1
o-Xylene	ND	1

SURROGATES	RECOVERY
Dibromofluoromethane	107
Toluene-d8	109
4-Bromofluorobenzene	97

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
Date

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604231430 MW-6
TA#: T51510

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	1,150	10
Toluene	ND	10
Ethylbenzene	599	10
m & p-Xylene	462	10
o-Xylene	ND	10

SURROGATES	RECOVERY
Dibromofluoromethane	111
Toluene-d8	108
4-Bromofluorobenzene	100

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
Date

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604231315 MW - 8
TA#: T51507

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	2	1
Toluene	ND	1
Ethylbenzene	ND	1
m & p-Xylene	ND	1
o-Xylene	ND	1

SURROGATES	RECOVERY
Dibromofluoromethane	111
Toluene-d8	105
4-Bromofluorobenzene	99

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
Date

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604231215 MW - 9
TA#: T51506

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	1,690	10
Toluene	ND	10
Ethylbenzene	ND	10
m & p-Xylene	19	10
o-Xylene	ND	10

SURROGATES	RECOVERY
Dibromofluoromethane	112
Toluene-d8	108
4-Bromofluorobenzene	98

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
Date

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604231045 MW - 10
TA#: T51505

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	ND	1
Toluene	ND	1
Ethylbenzene	ND	1
m & p-Xylene	ND	1
o-Xylene	ND	1

SURROGATES	RECOVERY
Dibromofluoromethane	109
Toluene-d8	108
4-Bromofluorobenzene	101

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

5-6-96

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

Date

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604231335 Rinsate
TA#: T51508

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	ND	1
Toluene	ND	1
Ethylbenzene	ND	1
m & p-Xylene	ND	1
o-Xylene	ND	1

SURROGATES	RECOVERY
Dibromofluoromethane	108
Toluene-d8	110
4-Bromofluorobenzene	98

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
Date

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604231345 Trip Blank
TA#: T51509

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	ND	1
Toluene	ND	1
Ethylbenzene	ND	1
m & p-Xylene	ND	1
o-Xylene	ND	1

SURROGATES	RECOVERY
Dibromofluoromethane	115
Toluene-d8	109
4-Bromofluorobenzene	99

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
Date

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Sampling Date: 04/23/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo
Extraction Date: 04/25/96
Analysis Date: 04/29/96
COC# 10047

PAH

T51510
Reporting 9604231430

8270 Compounds (mg/L)	Limit	MW-6	QC	RPD	%EA	%IA
Naphthalene	0.001	ND	99	0	89	99
Acenaphthylene	0.001	ND	98	1	97	98
Acenaphthene	0.001	ND	98	1	90	98
Fluorene	0.001	0.002	98	3	92	98
Phenanthrene	0.001	ND	103	1	84	103
Anthracene	0.001	0.001	100	1	86	100
Fluoranthene	0.001	ND	105	4	87	105
Pyrene	0.001	ND	99	1	84	99
Benzo[a]anthracene	0.001	ND	102	4	88	102
Chrysene	0.001	ND	101	3	135	101
Benzo[b]fluoranthene	0.001	ND	107	9	60	107
Benzo[k]fluoranthene	0.001	ND	96	11	59	96
Benzo[a]pyrene	0.001	ND	103	3	58	103
Indeno[1,2,3-cd]pyrene	0.001	ND	106	5	63	106
Dibenz[a,h]anthracene	0.001	ND	106	7	80	106
Benzo[g,h,i]perylene	0.001	ND	105	3	60	105

ND = Not Detected

	% RECOVERY
Nitrobenzene-d5 SURR	90
2-Fluorobiphenyl SURR	84
Terphenyl-d14 SURR	98

METHODS: EPA SW 846-8270, 3510.
CHEMIST: RD/CC

5-6-96

Director, Dr. Blair Leftwich — DATE
Director, Dr. Bruce McDonell

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Sampling Date: 04/23/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo
Extraction Date: 04/25/96
Analysis Date: 04/29/96
COC# 10047

PAH

T51507
Reporting 9604231315

8270 Compounds (mg/L)	Limit	MW-8	QC	RPD	%EA	%IA
Naphthalene	0.001	ND	99	0	89	99
Acenaphthylene	0.001	ND	98	1	97	98
Acenaphthene	0.001	ND	98	1	90	98
Fluorene	0.001	ND	98	3	92	98
Phenanthrene	0.001	ND	103	1	84	103
Anthracene	0.001	ND	100	1	86	100
Fluoranthene	0.001	ND	105	4	87	105
Pyrene	0.001	ND	99	1	84	99
Benzo[a]anthracene	0.001	ND	102	4	88	102
Chrysene	0.001	ND	101	3	135	101
Benzo[b]fluoranthene	0.001	ND	107	9	60	107
Benzo[k]fluoranthene	0.001	ND	96	11	59	96
Benzo[a]pyrene	0.001	ND	103	3	58	103
Indeno[1,2,3-cd]pyrene	0.001	ND	106	5	63	106
Dibenz[a,h]anthracene	0.001	ND	106	7	80	106
Benzo[g,h,i]perylene	0.001	ND	105	3	60	105

ND = Not Detected

	% RECOVERY
Nitrobenzene-d5 SURR	90
2-Fluorobiphenyl SURR	84
Terphenyl-d14 SURR	87

METHODS: EPA SW 846-8270, 3510.
CHEMIST: RD/CC

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
DATE

TRACE ANALYSIS, INC.
A Laboratory for Advanced Environmental Research and Analysis

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Sampling Date: 04/23/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo
Extraction Date: 04/25/96
Analysis Date: 04/29/96
COC# 10047

PAH

T51506

Reporting 9604231215

8270 Compounds (mg/L)	Limit	MW-9	QC	RPD	%EA	%IA
Naphthalene	0.001	ND	99	0	89	99
Acenaphthylene	0.001	ND	98	1	97	98
Acenaphthene	0.001	ND	98	1	90	98
Fluorene	0.001	ND	98	3	92	98
Phenanthrene	0.001	ND	103	1	84	103
Anthracene	0.001	ND	100	1	86	100
Fluoranthene	0.001	ND	105	4	87	105
Pyrene	0.001	ND	99	1	84	99
Benzo[a]anthracene	0.001	ND	102	4	88	102
Chrysene	0.001	ND	101	3	135	101
Benzo[b]fluoranthene	0.001	ND	107	9	60	107
Benzo[k]fluoranthene	0.001	ND	96	11	59	96
Benzo[a]pyrene	0.001	ND	103	3	58	103
Indeno[1,2,3-cd]pyrene	0.001	ND	106	5	63	106
Dibenz[a,h]anthracene	0.001	ND	106	7	80	106
Benzo[g,h,i]perylene	0.001	ND	105	3	60	105

ND = Not Detected

	% RECOVERY
Nitrobenzene-d5 SURR	80
2-Fluorobiphenyl SURR	78
Terphenyl-d14 SURR	90

METHODS: EPA SW 846-8270, 3510.
CHEMIST: RD/CC

5-6-96

Director, Dr. Blair Leftwich — DATE
Director, Dr. Bruce McDonell

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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Sampling Date: 04/23/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo
Extraction Date: 04/25/96
Analysis Date: 04/29/96
COC# 10047

PAH

T51505
Reporting 9604231045

8270 Compounds (mg/L)	Limit	MW-10	QC	RPD	%EA	%IA
Naphthalene	0.001	ND	99	0	89	99
Acenaphthylene	0.001	ND	98	1	97	98
Acenaphthene	0.001	ND	98	1	90	98
Fluorene	0.001	ND	98	3	92	98
Phenanthrene	0.001	ND	103	1	84	103
Anthracene	0.001	ND	100	1	86	100
Fluoranthene	0.001	ND	105	4	87	105
Pyrene	0.001	ND	99	1	84	99
Benzo[a]anthracene	0.001	ND	102	4	88	102
Chrysene	0.001	ND	101	3	135	101
Benzo[b]fluoranthene	0.001	ND	107	9	60	107
Benzo[k]fluoranthene	0.001	ND	96	11	59	96
Benzo[a]pyrene	0.001	ND	103	3	58	103
Indeno[1,2,3-cd]pyrene	0.001	ND	106	5	63	106
Dibenz[a,h]anthracene	0.001	ND	106	7	80	106
Benzo[g,h,i]perylene	0.001	ND	105	3	60	105

ND = Not Detected

	% RECOVERY
Nitrobenzene-d5 SURR	89
2-Fluorobiphenyl SURR	83
Terphenyl-d14 SURR	107

METHODS: EPA SW 846-8270, 3510.
CHEMIST: RD/CC

5-6-96

Director, Dr. Blair Leftwich — DATE
Director, Dr. Bruce McDonell

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

July 16, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 04/24/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

TOTAL METALS (mg/L)

TA#	Field Code		As	Se	Cr	Cd	Pb	Ba	Ag	Hg	Ni	Mo
T51505	9604231045	MW-10	<0.1	<0.05	<0.05	<0.01	<0.001	<0.2	0.01	<0.001	<0.02	<0.01
T51506	9604231215	MW-9	<0.1	<0.05	<0.05	<0.01	<0.001	0.7	0.01	<0.001	0.05	<0.01
T51507	9604231315	MW-8	<0.1	<0.05	<0.05	<0.01	<0.001	0.2	<0.01	<0.001	0.06	0.03
T51510	9604231430	MW-6	<0.1	<0.05	<0.05	<0.01	<0.001	0.8	<0.01	<0.001	0.04	<0.01
QC	Quality Control		5.86	5.05	5.49	0.12	0.025	5.01	1.12	0.0051	1.23	2.04
Reporting Limit			0.1	0.05	0.05	0.01	0.001	0.2	0.01	0.001	0.02	0.01
RPD			4	2	6	2	0	6	8	0	4	10
% Extraction Accuracy			101	99	96	98	100	81	103	98	98	105
% Instrument Accuracy			117	101	110	98	100	0	112	102	98	102
			Zn	**Al**	**Fe**	**Co**	**Be**	**V**	**Mn**	**Cu**	**B**	**U**
T51505	9604231045	MW-10	0.24	0.10	0.16	<0.01	<0.01	0.03	0.02	<0.01	0.11	<0.5
T51506	9604231215	MW-9	6.10	0.13	0.11	0.02	<0.01	0.02	0.19	<0.01	0.83	<0.5
T51507	9604231315	MW-8	0.02	0.27	<0.05	<0.01	<0.01	0.02	0.27	<0.01	<0.03	<0.5
T51510	9604231430	MW-6	0.03	0.03	0.29	<0.01	<0.01	<0.01	1.70	<0.01	0.21	<0.5
QC	Quality Control		1.24	4.95	2.45	1.23	0.122	1.22	1.28	0.62	1.03	2.4
Reporting Limit			0.01	0.02	0.05	0.01	0.01	0.01	0.01	0.01	0.03	0.5
RPD			4	2	2	6	10	0	2	0	6	0
% Extraction Accuracy			98	101	99	97	95	100	99	100	103	93
% Instrument Accuracy			99	99	98	98	98	98	99	99	82	96

METHODS: EPA SW 846-3015, 6010, 7470, 7421.
CHEMIST: As,Se,Cr,Cd,Pb,Ba,Ag,Ni,Mo,Zn,Al,Fe,Co,Be,V,Mn,Cu,B,U: RR Hg: RC
TOTAL METALS SPIKE: 8.0 mg/L As, Se, Ba; 0.8 mg/L Cr; 0.2 mg/L Cd, Ag, 0.020 mg/L Pb; 0.0050 mg/L Hg; 2.00 mg/L Ni, Mo, Zn, Co, V, Mn; 8.00 mg/L Al; 4.00 mg/L Fe; 0.20 mg/L Be; 1.00 mg/L Cu; 2.0 mg/L B, U.
TOTAL METALS QC: 5.0 mg/L As, Se, Cr, Ba; 1.0 mg/L Ag; 0.0050 mg/L Hg; 0.13 mg/L Cd; 0.025 mg/L Pb; 1.25 mg/L Ni, Zn, Co, V, Mn, B; 2.00 mg/L Mo; 5.00 mg/L Al; 2.50 mg/L Fe; 0.125 mg/L Be; 0.625 mg/L Cu; 2.5 mg/L U.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

7-16-96
Date

TRACE ANALYSIS, INC.
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ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Anette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 23, 1996
Receiving Date: 04/24/96
Sample Type: Water
Project No: 2033-003
Project Location: NA
COC# 10047

Extraction Date: 04/25/96
Analysis Date: 05/03/96
Sampling Date: 04/23/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo

TA#	Field Code	DISSOLVED POTASSIUM (mg/L)	DISSOLVED MAGNESIUM (mg/L)	DISSOLVED CALCIUM (mg/L)	DISSOLVED SODIUM (mg/L)
T51505	9604231045 MW-10	2.5	9	70	36
T51506	9604231215 MW-9	9.1	44	226	370
T51507	9604231315 MW-8	5.8	15	105	171
T51510	9604231430 MW-6	6.6	14	83	501
QC	Quality Control	44	4.0	20.4	19.6
Reporting Limit		0.3	0.2	0.2	0.4
RPD		1	0	3	10
% Extraction Accuracy		106	77	120	90
% Instrument Accuracy		120	100	102	98

METHODS: EPA SW 846-3005, 6010.
CHEMIST: RR
SPIKE: 4.0 mg/L POTASSIUM; 100.0 mg/L MAGNESIUM, CALCIUM, SODIUM.
QC: 40 mg/L POTASSIUM, MAGNESIUM; 20.0 mg/L SODIUM, CALCIUM.

BS

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-23-96

Date

6701 Aberdeen Avenue
Lubbock, Texas 79424
806•794•1296
FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Anette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Project No: 2033-003
Project Location: NA
COC# 10047

Extraction Date: 04/24/96
Analysis Date: 04/24/96
Sampling Date: 04/23/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo

TA#	FIELD CODE	CHLORIDE (mg/L)	SULFATE (mg/L)	TDS (mg/L)	FLUORIDE (mg/L)	(NO3-NO2)-N (mg/L)	ALKALINITY (mg/L as CaCo3) HCO3	CO3
T51510	9604231430 MW-6	798	13	1,786	1.65	<0.1	319	0
QC	Quality Control	471	10.0	---	1.01	0.99	---	---
REPORTING LIMIT		0.5	1.0	---	0.1	0.1	---	---
RPD		1	2	0	1	2	0	0
% Extraction Accuracy		97	83	---	100	94	---	---
% Instrument Accuracy		94	103	---	101	100	---	---

METHODS: EPA 375.4, 160.1, 340.2, 353.3, 310.1; SM 4500 Cl-B.
CHEMIST: Chloride: JT Sulfate, Fluoride: MS TDS: RP (NO3-NO2)-N: JW/MS Alkali
SULFATE SPIKE AND QC: 10.0 mg/L SULFATE.
FLUORIDE SPIKE AND QC: 1.0 mg/L FLUORIDE.
(NO3-NO2)-N SPIKE: 1.33 mg/L (NO3-NO2)-N.
(NO3-NO2)-N QC: 1.0 mg/L (NO3-NO2)-N.
CHLORIDE SPIKE AND QC: 500 mg/L CHLORIDE.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-13-96
DATE

6701 Aberdeen Avenue
Lubbock, Texas 79424
806•794•1296
FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Anette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Project No: 2033-003
Project Location: NA
COC# 10047

Extraction Date: 04/24/96
Analysis Date: 04/24/96
Sampling Date: 04/23/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo

TA#	FIELD CODE	CHLORIDE (mg/L)	SULFATE (mg/L)	TDS (mg/L)	FLUORIDE (mg/L)	(NO3-NO2)-N (mg/L)	ALKALINITY (mg/L as CaCo3) HCO3	CO3
T51505	9604231045 MW-10	29	31	443	1.0	0.13	190	0
T51506	9604231215 MW-9	1,190	9	2,658	0.5	<0.1	340	0
T51507	9604231315 MW-8	185	49	1,004	1.2	0.2	420	0
QC	Quality Control	494	10.0	---	0.91	0.99	---	---
REPORTING LIMIT		0.5	1.0	---	0.1	0.1	---	---
RPD		1	2	4	13	2	5	5
% Extraction Accuracy		100	83	---	85	94	---	---
% Instrument Accuracy		99	103	---	95	100	---	---

METHODS: EPA SM 4500 Cl-B, 375.4, 160.1, 340.2, 353.3, 310.1.
CHEMIST: Chloride,Sulfate,TDS: MS Fluoride: MS/BD (NO3-NO2)-N: JW/MS Alkalinity: RCD
CHLORIDE SPIKE AND QC: 500 mg/L CHLORIDE.
SULFATE SPIKE AND QC: 10.0 mg/L SULFATE.
FLUORIDE SPIKE AND QC: 1.0 mg/L FLUORIDE.
(NO3-NO2)-N SPIKE: 1.33 mg/L (NO3-NO2)-N.
(NO3-NO2)-N QC: 1.0 mg/L (NO3-NO2)-N.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-23-96
DATE

6701 Aberdeen Avenue
Lubbock, Texas 79424
806•794•1296
FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Anette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Project No: 2033-003
Project Location: NA
COC# 10047

Extraction Date: 04/24/96
Analysis Date: 04/24/96
Sampling Date: 04/23/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo

TA#	FIELD CODE	SULFATE (mg/L)	(NO3-NO2)-N (mg/L)
T51504	9604230940 MW-3	22	0.2
QC	Quality Control	10.0	0.99
REPORTING LIMIT		1.0	0.1
RPD		2	2
% Extraction Accuracy		83	94
% Instrument Accuracy		103	100

METHODS: EPA 375.4, 353.3.
CHEMIST: Sulfate: MS (NO3-NO2)-N: JW/MS
SULFATE SPIKE AND QC: 10.0 mg/L SULFATE.
(NO3-NO2)-N SPIKE: 1.33 mg/L (NO3-NO2)-N.
(NO3-NO2)-N QC: 1.0 mg/L (NO3-NO2)-N.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-6-96
DATE

6701 Aberdeen Avenue
Lubbock, Texas 79424
806•794•1296
FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 28, 1996
Receiving Date: 04/24/96
Sample Type: Water
Project No: 2033-003
Project Location: NA
COC# 10047

Prep Date: 05/21/96
Analysis Date: 05/21/96
Sampling Date: 04/23/96
Sample Condition: I & C
Sample Received by: ML
Project Name: Navajo

TA#	FIELD CODE		HPC (CFU/ml)	HUB (CFU/ml)
T51504	9604230940	MW-3	8.85 x 10E3	5.87 x 10E2

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

5-28-96
DATE

DISK #2

GCL
Environmental Science and Engineering
A BDM International Company

Albuquerque
505 Marquette NW, Ste. 1100
Albuquerque, NM 87102
(505) 842-0001
FAX: (505) 842-0595

Mid Atlantic Region
4221 Forbes Blvd., Ste. 240
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NASA WSTF
PO Drawer MM
Las Cruces, NM 88004
(505) 524-5353
FAX: (505) 524-5315

№ 10050

Chain of Custody

Date 4/23/96 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK, TEXAS 79424
Telephone (806) 794-1296

Samplers (SIGNATURES)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020	Phenols, Sub Phenols 604/8040	Pesticides PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neut/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415.9050	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total Amenable	Chemical Oxygen Demand (COD)				Number of Containers
9604231515	H2O	MW-6d						2																				2

Project Information	Sample Receipt		Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Project NAVAJO	Total No. of Containers	2	(Signature) D Nee (Time) 1600	(Signature) (Time)	(Signature) Faxed 5-6 (Time)
Project Director Lawctes	Chain of Custody Seals	Y/N	(Printed Name) DAVID NEE (Date) 4/23/96	(Printed Name) (Date)	(Printed Name) (Date)
Charge Code No. 2033-003	Rec'd Good Condition/Cold	Y	Company GCL	(Company)	(Company)
Shipping ID. No.	Conforms to Record	Y	**Received By 1.**	**Received By 2.**	**Received By (Laboratory) 3.**
Via Greyhound	Lab No.		(Signature) (Time)	(Signature) (Time)	(Signature) M Lopez (Time) 9:35
Special Instructions/Comments:			(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) M Lopez (Date) 4-24-96
			(Company)	(Company)	(Laboratory) Trace Analysis

Distribution: White, Canary-Laboratory • Pink, GCL

GCL
Environmental Science and Engineering
A BDM International Company

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PO Drawer MM
Las Cruces, NM 88004
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№ 10050

Chain of Custody

Date 4/23/96 Page 1 Of 1

Lab Name TRACE ANALYSIS
Address 6701 ABERDEENE AVENUE
LUBBOCK, TEXAS 79424
Telephone (806) 794-1296

Samplers (SIGNATURES)

Analysis Request

Sample Number	Matrix	Location	Halogenated Volatiles 601/8010	Aromatic Volatiles 602/8020	Phenols, Sub Phenols 604/8040	Pesticides/PCB 608/8080	Polynuclear Aromatic Hydrocarbons 610/8310	Volatile Compounds GC/MS 624/8240	Base/Neu/Acid Compounds GC/MS 625/8270	Total Organic Carbon (TOC) 415/9060	Total Organic Halides (TOX) 9020	Petroleum Hydrocarbons 418.1	TPH/BTEX Modified 8015	TCLP- Vol., Semi-Vol. Herbicides, Pesticides	TCLP- Metals	RCRA Metals(8)	Priority Pollutant Metals (13)	CAM Metals (18) TTLC/STLC	Flash Point	Corrosivity	Reactivity	Oil & Grease	Cyanide Total/Amenable	Chemical Oxygen Demand (COD)					Number of Containers
960423151S	H_2O	MW-6d						2			duplicate of						MW-6												2

Project Information	Sample Receipt	Relinquished By 1.	Relinquished By 2.	Relinquished By 3.
Project NAVAJO	Total No. of Containers	(Signature) (Time) 1600	(Signature) (Time)	(Signature) (Time)
Project Director Lawles	Chain of Custody Seals	(Printed Name) DAVID NEE (Date) 4/23/96	(Printed Name) (Date)	(Printed Name) (Date)
Charge Code No. 2033-003	Rec'd Good Condition/Cold	(Company) GCL	(Company)	(Company)
Shipping ID. No.	Conforms to Record	Received By 1.	Received By 2.	Received By (Laboratory) 3.
Via Greyhound	Lab No.	(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
Special Instructions/Comments:		(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
		(Company)	(Company)	(Laboratory)

Distribution: White, Canary-Laboratory • Pink, GCL

6701 Aberdeen Avenue
Lubbock, Texas 79424
806•794•1296
FAX 806•794•1298

ANALYTICAL RESULTS FOR
GCL ENVIRONMENTAL
Attention: Annette Montoya
505 Marquette NW, Suite 1100
Albuquerque, NM 87102

May 02, 1996
Receiving Date: 04/24/96
Sample Type: Water
Charge Code No: 2033-003
Project Location: NA
COC# 10050

Prep Date: 04/25/96
Analysis Date: 04/25/96
Sampling Date: 04/23/96
Sample Condition: Intact & Cool
Sample Received by: ML
Project Name: Navajo

FIELD CODE: 9604231515 MW-6d
TA#: T51511

8240 Compounds	Concentration (ug/L)	Reporting Limit
Benzene	1,140	10
Toluene	ND	10
Ethylbenzene	609	10
m & p-Xylene	470	10
o-Xylene	ND	10

SURROGATES	RECOVERY
Dibromofluoromethane	107
Toluene-d8	110
4-Bromofluorobenzene	100

ND = Not Detected

METHODS: EPA SW 846-5030; EPA 8260.
CHEMIST: RP

5-6-96

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

Date

LABORATORY ANALYTICAL REPORTS
FROM INITIAL INVESTIGATION
CONDUCTED BY NAVAJO REFINING COMPANY
(August-September, 1995)

TRACEANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING COMPANY
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 06, 1995
Receiving Date: 09/01/95
Sample Type: Water
Project No: NA
Project Location: Lovington & Artesia, NM

Prep Date: 09/05/95
Analysis Date: 09/05/95
Sampling Date: 08/31/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TA#	Field Code	MTBE (ug/L)	BENZENE (ug/L)	TOLUENE (ug/L)	ETHYL-BENZENE (ug/L)	M,P,O XYLENE (ug/L)	TOTAL BTEX (ug/L)
T40649	Lea Refining Boring 4	<1	74	21	39	19	153
QC	Quality Control	99	105	103	99	296	
Reporting Limit		1	1	1	1	1	
RPD		5	3	2	2	3	
% Extraction Accuracy		123	110	101	99	93	
% Instrument Accuracy		99	105	103	99	99	

METHODS: EPA SW 846-5030, 8020.
BTEX SPIKE AND QC: 100 ug/L BTEX.

BS

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-6-95
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING COMPANY
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 12, 1995
Receiving Date: 09/08/95
Sample Type: Water
Project No: NA
Project Location: Lovington, NM

Prep Date: 09/09/95
Analysis Date: 09/09/95
Sampling Date: 09/05, 07/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TA#	Field Code	BENZENE (ug/L)	TOLUENE (ug/L)	ETHYL-BENZENE (ug/L)	M,P,O XYLENE (ug/L)	TOTAL BTEX (ug/L)
T40892	Lea Refining Boring #7 (MW-6)	1,741	21	962	972	3,696
T40893	Lea Refining Boring #5	41	<1	<1	<1	41
T40894	Lea Refining Boring #6	583	30	87	108	808
QC	Quality Control	93	94	96	289	
Reporting Limit		1	1	1	1	
RPD		3	4	7	4	
% Extraction Accuracy		92	93	94	95	
% Instrument Accuracy		93	94	96	96	

METHODS: EPA SW 846-5030, 8020.
BTEX SPIKE AND QC: 100 ug/L BTEX.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-12-95
Date

Sep-12-95 09:34P P.01

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING COMPANY
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 13, 1995
Receiving Date: 09/12/95
Sample Type: Water
Project No: NA
Project Location: Lovington, NM

Prep Date: 09/12/95
Analysis Date: 09/12/95
Sampling Date: 09/11/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TA#	Field Code	BENZENE (ug/L)	TOLUENE (ug/L)	ETHYL-BENZENE (ug/L)	M,P,O XYLENE (ug/L)	TOTAL BTEX (ug/L)
T41118	Lea Refining Boring #8	<1	<1	<1	<1	<1
T41119	Lea Refining Boring #9	<1	<1	<1	<1	<1
QC	Quality Control	103	101	108	310	
Reporting Limit		1	1	1	1	
RPD		9	3	0	1	
% Extraction Accuracy		107	106	109	107	
% Instrument Accuracy		103	101	108	103	

METHODS: EPA SW 846-5030, 8020.
BTEX SPIKE AND QC: 100 ug/L BTEX.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-13-95
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1293

ANALYTICAL RESULTS FOR
NAVAJO REFINING COMPANY
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 26, 1995
Receiving Date: 09/23/95
Sample Type: Water
Project No: NA
Project Location: Lovington, NM

Prep Date: 09/25/95
Analysis Date: 09/25/95
Sampling Date: 09/20/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TA#	Field Code	MTBE (ug/L)	BENZENE (ug/L)	TOLUENE (ug/L)	ETHYL-BENZENE (ug/L)	M,P,O XYLENE (ug/L)	TOTAL BTEX (ug/L)
T41699	Lea Refining Boring #3	<2	1,110	341	757	1,000	3,208
QC	Quality Control	99	94	108	105	310	
Reporting Limit		1	1	1	1	1	
RPD		1	1	1	1	2	
% Extraction Accuracy		87	83	99	101	300	
% Instrument Accuracy		99	94	108	105	310	

METHODS: EPA 602.
BTEX SPIKE AND QC: 100 ug/L BTEX.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-26-95
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING

September 28, 1995
Receiving Date: 09/09/95
Sample Type: Water
Project No: NA
Project Location: Artesia & Lovington, NM

Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

Prep Date: 09/11/95
Analysis Date: 09/11/95
Sampling Date: 09/7-8/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TA#	FIELD CODE	TDS (mg/L)	NO3-N (mg/L)	pH (s.u.)	CHLORIDE (mg/L)	FLUORIDE (mg/L)	SULFATE (mg/L)	ALKALINITY (mg/L as CaCO3) HCO3	CO3	CONDUCTIVITY (uMHOS/cm)
T41049	Lea Refining MW-4	438	1.19	7.9	23	1.0	88	254	0	590
T41050	Lea Refining MW-3	454	2.54	7.8	35	1.0	93	223	0	616
T41051	Lea Refining MW-1	1,275	<0.15	7.5	509	1.2	<5	349	0	2,007
QC	Quality Control	---	1.04	7.0	489	1.0	10.0	---	---	1,427
RPD		2	2	0	2	2	8	2	2	0
% Extraction Accuracy		---	103	---	100	97	119	---	---	---
% Instrument Accuracy		---	102	100	98	100	98	---	---	100
REPORTING LIMIT		---	0.01	---	1	0.1	1	10	10	---

METHODS: EPA 375.4, 310.1, 340.2; 4500 Cl-B, 160.1, 150.1, 120.1, 353.3.
QC: 500 mg/L CHLORIDE; 1.0 mg/L FLUORIDE; 10.0 mg/L SULFATE.
NO3-N SPIKE: 4.33 mg/L as N. NO3-N QC: 1.0 mg/L as N.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-28-95
Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moo
501 E. Main
Artesia, NM 88210

September 28, 1995
Receiving Date: 09/08/95
Sample Type: Water
Project No: NA
Project Location: Lovington, NM

Prep Date: 09/ /95
Analysis Date: 09/ /95
Sampling Date: 09/07/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TA#	FIELD CODE	TDS (mg/L)	NO3-N (mg/L)	pH (s.u.)	CHLORIDE (mg/L)	FLUORIDE (mg/L)	SULFATE (mg/L)	ALKALINITY (mg/L as CaCO3) HCO3	CO3	CONDUCTIVITY (uMHOS/cm)
T40391	Lea Refining MW-5	853	1.49	7.2	198	0.7	119	230	0	1,089
T40395	Lea Refining MW-2	523	1.65	7.4	61	1.2	105	283	0	733
QC	Quality Control	---	1.00	7.0	489	1.0	10.0	---	---	1,427
RPD		2	0	0	2	2	8	2	2	0
% Extraction Accuracy		---	103	---	100	97	119	---	---	---
% Instrument Accuracy		---	101	100	98	100	98	---	---	100
REPORTING LIMIT		---	0.01	---	0.5	0.1	1	---	---	---

METHODS: EPA 375.4, 310.1, 340.2; 4500 Cl-B, 160.1, 150.1, 120.1, 353.3.
NO3-N SPIKE: 1.33 mg/L NO3-N. NO3-N QC: 1.0 mg/L NO3-N.
CHLORIDE SPIKE AND QC: 500 mg/L CHLORIDE.
FLUORIDE SPIKE AND QC: 1.0 mg/L FLUORIDE.
SULFATE SPIKE AND QC: 10 mg/L SULFATE.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-28-95
Date

Sep-29-95 05:13P P.04

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 29, 1995
Receiving Date: 09/08/95
Sample Type: Water
Project No: NA
Project Location: Lovington, NM

Prep Date: 09/14/95
Analysis Date: 09/14/95
Sampling Date: 09/07/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TA#	Field Code	POTASSIUM (mg/L)	MAGNESIUM (mg/L)	CALCIUM (mg/L)	SODIUM (mg/L)
T40895	Lea Refining MW-2	2.3	16.9	133	65.7
QC	Quality Control	18.24	3.7	18.9	20.26
Reporting Limit		0.3	0.01	0.01	0.4
RPD		4	4	4	4
% Extraction Accuracy		96	120	121	134
% Instrument Accuracy		91	93	94	101

METHODS: EPA 200.7.
QC: 20.0 mg/L POTASSIUM, CALCIUM, SODIUM; 4.0 mg/L MAGNESIUM.
SPIKE: 20.0 mg/L POTASSIUM; 200.0 mg/L MAGNESIUM, CALCIUM, SODIUM.

BB

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-29-95

Date

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 29, 1995
Receiving Date: 09/08/95
Sample Type: Water
Project No: NA
Project Location: Lovington, NM

Prep Date: 09/14/95
Analysis Date: 09/14/95
Sampling Date: 09/07/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TA#	Field Code	POTASSIUM (mg/L)	MAGNESIUM (mg/L)	CALCIUM (mg/L)	SODIUM (mg/L)
T40891	Lea Refining MW-5	3.0	23.6	196	82.4
QC	Quality Control	18.24	3.7	18.9	20.26
Reporting Limit		0.3	0.01	0.01	0.4
RPD		4	4	4	4
% Extraction Accuracy		96	120	121	134
% Instrument Accuracy		91	93	94	101

METHODS: EPA 200.7.
QC: 20.0 mg/L POTASSIUM, CALCIUM, SODIUM; 4.0 mg/L MAGNESIUM.
SPIKE: 20.0 mg/L POTASSIUM; 200.0 mg/L MAGNESIUM, CALCIUM, SODIUM.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-29-95
Date

6701 Aberdeen Avenue
Lubbock, Texas 79424
806•794•1296
FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 28, 1995
Receiving Date: 09/09/95
Sample Type: Water
Sample Condition: I & C
Sample Received by: MS
Project Name: NA
Location: Artesia &
Lovington, NM
Sampling Date: 09/7-8/95
Extraction Date: 09/13/95
Analysis Date: 09/13/95

PAH Compounds (mg/L)	Reporting Limit	T41051 Lea MW-1	QC	RPD	%EA	%IA
Naphthalene	0.01	0.094				
Acenaphthylene	0.01	ND				
Acenaphthene	0.01	ND				
Fluorene	0.01	0.010				
Phenanthrene	0.01	ND				
Anthracene	0.01	0.011				
Fluoranthene	0.01	ND				
Pyrene	0.01	ND				
Benzo[a]anthracene	0.01	ND				
Chrysene	0.01	ND				
Benzo[b]fluoranthene	0.01	ND				
Benzo[k]fluoranthene	0.01	ND				
Benzo[a]pyrene	0.01	ND				
Indeno[1,2,3-cd]pyrene	0.01	ND				
Dibenz[a,h]anthracene	0.01	ND				
Benzo[g,h,i]perylene	0.01	ND				

*ND = Not Detected

	% RECOVERY
Nitrobenzene-d5 SURR	88
2-fluorobiphenyl SURR	95
Terphenyl-d14 SURR	95

METHODS: EPA 625.

Director, Dr. Blair Leftwich

9-28-95
DATE

Director, Dr. Bruce McDonell

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ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 29, 1995
Receiving Date: 09/08/95
Sample Type: Water
Sample Condition: I & C
Sample Received by: MS
Project Name: NA
Location: Lovington, NM
Project No: NA
Sampling Date: 09/07/95
Extraction Date: 09/13/95
Analysis Date: 09/13/95

PAH

T40895

PAH Compounds (mg/L)	Reporting Limit	Lea MW-2	QC	RPD	%EA	%IA
Naphthalene	0.001	ND	93			93
Acenaphthylene	0.001	ND	97			97
Acenaphthene	0.001	ND	100	1	77	100
Fluorene	0.001	ND	97			97
Phenanthrene	0.001	ND	100			100
Anthracene	0.001	ND	100			100
Fluoranthene	0.001	ND	102			102
Pyrene	0.001	ND	111	4	82	111
Benzo[a]anthracene	0.001	ND	105			105
Chrysene	0.001	ND	87			87
Benzo[b]fluoranthene	0.001	ND	92			92
Benzo[k]fluoranthene	0.001	ND	93			93
Benzo[a]pyrene	0.001	ND	96			96
Indeno[1,2,3-cd]pyrene	0.001	ND	114			114
Dibenz[a,h]anthracene	0.001	ND	119			119
Benzo[g,h,i]perylene	0.001	ND	122			122

*ND = Not Detected

% RECOVERY

Nitrobenzene-d5 SURR	91
2-Fluorobiphenyl SURR	92
Terphenyl-d14 SURR	94

METHODS: EPA 625.

9-29-95

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Director, Dr. Bruce McDonell

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Lubbock, Texas 79424
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ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 28, 1995
Receiving Date: 09/09/95
Sample Type: Water
Sample Condition: I & C
Sample Received by: MS
Project Name: NA
Location: Artesia & Lovington, NM
Sampling Date: 09/7-8/95
Extraction Date: 09/13/95
Analysis Date: 09/13/95

PAH Compounds (mg/L)	Reporting Limit	T41050 Lea MW-3	QC	RPD	%EA	%IA
Naphthalene	0.001	ND				
Acenaphthylene	0.001	ND				
Acenaphthene	0.001	ND				
Fluorene	0.001	ND				
Phenanthrene	0.001	ND				
Anthracene	0.001	ND				
Fluoranthene	0.001	ND				
Pyrene	0.001	ND				
Benzo[a]anthracene	0.001	ND				
Chrysene	0.001	ND				
Benzo[b]fluoranthene	0.001	ND				
Benzo[k]fluoranthene	0.001	ND				
Benzo[a]pyrene	0.001	ND				
Indeno[1,2,3-cd]pyrene	0.001	ND				
Dibenz[a,h]anthracene	0.001	ND				
Benzo[g,h,i]perylene	0.001	ND				

*ND = Not Detected

	% RECOVERY
Nitrobenzene-d5 SURR	89
2-Fluorobiphenyl SURR	93
Terphenyl-d14 SURR	91

METHODS: EPA 625.

Director, Dr. Blair Leftwich

9-28-95
DATE

Director, Dr. Bruce McDonell

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Lubbock, Texas 79424
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ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 28, 1995
Receiving Date: 09/09/95
Sample Type: Water
Sample Condition: I & C
Sample Received by: MS
Project Name: NA
Location: Artesia & Lovington, NM
Sampling Date: 09/7-8/95
Extraction Date: 09/13/95
Analysis Date: 09/13/95

	Reporting	T41049 Lea				
PAH Compounds (mg/L)	Limit	MW-4	QC	RPD	%EA	%IA
Naphthalene	0.001	ND				
Acenaphthylene	0.001	ND				
Acenaphthene	0.001	ND				
Fluorene	0.001	ND				
Phenanthrene	0.001	ND				
Anthracene	0.001	ND				
Fluoranthene	0.001	ND				
Pyrene	0.001	ND				
Benzo[a]anthracene	0.001	ND				
Chrysene	0.001	ND				
Benzo[b]fluoranthene	0.001	ND				
Benzo[k]fluoranthene	0.001	ND				
Benzo[a]pyrene	0.001	ND				
Indeno[1,2,3-cd]pyrene	0.001	ND				
Dibenz[a,h]anthracene	0.001	ND				
Benzo[g,h,i]perylene	0.001	ND				

*ND = Not Detected

	% RECOVERY
Nitrobenzene-d5 SURR	90
2-Fluorobiphenyl SURR	91
Terphenyl-d14 SURR	94

METHODS: EPA 625.

Director, Dr. Blair Leftwich
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9-28-95
DATE

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ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 29, 1995
Receiving Date: 09/08/95
Sample Type: Water
Sample Condition: I & C
Sample Received by: MS
Project Name: NA
Location: Lovington, NM
Project No: NA
Sampling Date: 09/07/95
Extraction Date: 09/13/95
Analysis Date: 09/13/95

PAH

PAH Compounds (mg/L)	Reporting Limit	T40891 Lea MW-5	QC	RPD	%EA	%IA
Naphthalene	0.001	ND	93			93
Acenaphthylene	0.001	ND	97			97
Acenaphthene	0.001	ND	100	1	77	100
Fluorene	0.001	ND	97			97
Phenanthrene	0.001	ND	100			100
Anthracene	0.001	ND	100			100
Fluoranthene	0.001	ND	102			102
Pyrene	0.001	ND	111	4	82	111
Benzo[a]anthracene	0.001	ND	105			105
Chrysene	0.001	ND	87			87
Benzo[b]fluoranthene	0.001	ND	92			92
Benzo[k]fluoranthene	0.001	ND	93			93
Benzo[a]pyrene	0.001	ND	96			96
Indeno[1,2,3-cd]pyrene	0.001	ND	114			114
Dibenz[a,h]anthracene	0.001	ND	119			119
Benzo[g,h,i]perylene	0.001	ND	122			122

*ND = Not Detected

	% RECOVERY
Nitrobenzene-d5 SURR	88
2-Fluorobiphenyl SURR	93
Terphenyl-d14 SURR	94

METHOD: EPA 625.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-29-95
DATE

TRACE ANALYSIS, INC.

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ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 28, 1995
Receiving Date: 09/09/95
Sample Type: Water
Project No: NA
Project Location: Artesia & Lovington, NM

Prep Date: 09/14/95
Analysis Date: 09/14/95
Sampling Date: 09/7-8/95
Sample Condition: Intact & Cool
Sample Received by: McD
Project Name: NA

TOTAL METALS

TA#	FIELD CODE	As (mg/L)	Cr (mg/L)	Cd (mg/L)	Ba (mg/L)	U (mg/L)	Mo (mg/L)	Zn (mg/L)	Ni (mg/L)	Be (mg/L)	[redacted] (mg/L)	[redacted] (mg/L)
T41051	Lea Refining [redacted]	0.5	<0.05	<0.02	2.12	<0.5	0.1	0.05	<0.2	<0.01	[redacted]	[redacted]
QC	Quality Control	5.3	1.98	5.2	2.0	4.9	1.98	1.9	1.8	1.97	1.86	1.95
REPORTING LIMIT		0.2	0.05	0.02	0.03	0.5	0.1	0.02	0.20	0.01	0.03	0.01
RPD		6	10	4	2	4	2	6	8	4	2	2
% Extraction Accuracy		68	82	98	92	110	86	93	76	68	86	87
% Instrument Accuracy		107	99	104	100	99	99	97	92	98	93	98

TA#	FIELD CODE	Co (mg/L)	V (mg/L)	Cu (mg/L)	Al (mg/L)	B (mg/L)	Hg (mg/L)	Se (mg/L)	Pb (mg/L)	Ag (mg/L)
T41051	Lea Refining MW-1	<0.03	<0.05	<0.02	1.2	0.66	<0.001	<0.001	<0.001	<0.0001
QC	Quality Control	1.96	1.9	1.97	1.9	2.0	0.0049	0.045	0.02	0.030
REPORTING LIMIT		0.03	0.05	0.05	0.20	0.03	0.001	0.001	0.001	0.0001
RPD		4	2	2	8	0	6	0	6	0
% Extraction Accuracy		82	85	85	115	97	99	120	100	107
% Instrument Accuracy		98	93	99	97	99	99	98	80	120

METHODS: EPA 200.7, 239.2, 270.2, 272.2, 245.1.
QC: 2.0 mg/L As, Cr, Cd, Ba, Mo, Zn, Ni, Be, Fe, Mn, Cu; 8.0 mg/L Al, B, Co, V; 9.0 mg/L U; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.050 mg/L Se.
SPIKE: 2.0 mg/L As, Cr, Cd, Ba, U, Ni, Mn, V, Al, Mo, Zn, Be, Fe, Co, Cu; 1.0 mg/L B; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.020 mg/L Se.

BE
Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-28-95
DATE

TRACE ANALYSIS, INC.
6701 Aberdeer Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 29, 1995
Receiving Date: 09/08/95
Sample Type: Water
Project No: NA
Project Location: Lovington, NM

Prep Date: 09/13/95
Analysis Date: 09/14/95
Sampling Date: 09/07/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TOTAL METALS

TA#	FIELD CODE	As (mg/L)	Cr (mg/L)	Cd (mg/L)	Ba (mg/L)	U (mg/L)	Mo (mg/L)	Zn (mg/L)	Ni (mg/L)	Be (mg/L)	Fe (mg/L)	Mn (mg/L)
T40895	Lea Refining MW-2	0.3	<0.05	<0.02	0.12	<0.5	0.2	<0.02	<0.2	<0.01	0.16	0.07
QC	Quality Control	5.3	5.36	5.2	2.0	4.9	2.0	1.9	1.8	2.0	1.9	1.95
REPORTING LIMIT		0.20	0.05	0.02	0.03	0.5	0.10	0.02	0.2	0.01	0.03	0.01
RPD		6	4	4	2	4	2	5	8	4	2	2
% Extraction Accuracy		68	99	98	92	110	86	93	76	88	86	87
% Instrument Accuracy		107	108	104	100	99	99	97	92	98	93	98

TA#	FIELD CODE	Co (mg/L)	V (mg/L)	Cu (mg/L)	Al (mg/L)	B (mg/L)	Hg (mg/L)	Se (mg/L)	Pb (mg/L)	Ag (mg/L)
T40895	Lea Refining MW-2	<0.03	<0.05	0.05	0.5	0.25	<0.001	<0.001	<0.001	<0.0001
QC	Quality Control	1.96	1.9	1.97	1.94	2.0	0.005	0.045	0.02	0.03
REPORTING LIMIT		0.03	0.05	0.02	0.20	0.03	0.001	0.001	0.001	0.0001
RPD		4	2	2	8	0	6	0	6	0
% Extraction Accuracy		82	85	85	115	97	99	120	100	107
% Instrument Accuracy		98	93	99	97	99	99	98	80	120

METHODS: EPA 200.7, 239.2, 270.2, 272.2, 245.1.
QC: 5.0 mg/L As, Cr, Cd, Ba, Mo, Zn, Ni, Be, Fe, Mn, Cu, Al, B, Co, V; 9.0 mg/L U; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.050 mg/L Se.
SPIKE: 2.0 mg/L As, Cr, Cd, Ba, U, Ni, Mn, V, Al, Mo, Zn, Be, Fe, Co, Cu; 1.0 mg/L B; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.020 mg/L Se.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-29-95
DATE

Sep-29-95 05:13P P.01

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 28, 1995
Receiving Date: 09/09/95
Sample Type: Water
Project No: NA
Project Location: Artesia & Lovington, NM

Prep Date: 09/14/95
Analysis Date: 09/14/95
Sampling Date: 09/7-8/95
Sample Condition: Intact & Cool
Sample Received by: McD
Project Name: NA

TOTAL METALS

TA#	FIELD CODE	As (mg/L)	Cr (mg/L)	Cd (mg/L)	Ba (mg/L)	U (mg/L)	Mo (mg/L)	Zn (mg/L)	Ni (mg/L)	Be (mg/L)	Fe (mg/L)	Mn (mg/L)
T41050	Lea Refining MW-3	<0.2	<0.05	<0.02	0.10	<0.5	0.2	0.06	<0.2	<0.01	0.48	<0.01
QC	Quality Control	5.3	1.98	5.2	2.0	4.9	1.93	1.9	1.8	1.97	1.36	1.95
REPORTING LIMIT		0.2	0.05	0.02	0.03	0.5	0.1	0.02	0.20	0.01	0.03	0.01
RPD		6	10	4	2	4	2	6	8	4	2	2
% Extraction Accuracy		68	32	98	92	110	86	93	76	88	86	87
% Instrument Accuracy		107	99	104	100	99	99	97	92	98	93	93

TA#	FIELD CODE	Co (mg/L)	V (mg/L)	Cu (mg/L)	Al (mg/L)	B (mg/L)	Hg (mg/L)	Se (mg/L)	Pb (mg/L)	Ag (mg/L)
T41050	Lea Refining MW-3	<0.03	<0.05	<0.02	1.0	0.15	<0.001	0.003	<0.001	<0.0001
QC	Quality Control	1.96	1.9	1.97	1.9	2.0	0.0049	0.045	0.02	0.030
REPORTING LIMIT		0.03	0.05	0.05	0.20	0.03	0.001	0.001	0.001	0.0001
RPD		4	2	2	8	0	6	0	6	0
% Extraction Accuracy		82	85	85	115	97	99	120	100	107
% Instrument Accuracy		98	93	99	97	99	99	98	80	120

METHODS: EPA 200.7, 239.2, 270.2, 272.2, 245.1.
QC: 2.0 mg/L As, Cr, Cd, Ba, Mo, Zn, Ni, Be, Fe, Mn, Cu; 8.0 mg/L Al, B, Co, V; 9.0 mg/L U; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.050 mg/L Se.
SPIKE: 2.0 mg/L As, Cr, Cd, Ba, U, Ni, Mn, V, Al, Mo, Zn, Be, Fe, Co, Cu; 1.0 mg/L B; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.020 mg/L Se.

Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-28-95
DATE

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 28, 1995
Receiving Date: 09/09/95
Sample Type: Water
Project No: NA
Project Location: Artesia & Lovington, NM

Prep Date: 09/14/95
Analysis Date: 09/14/95
Sampling Date: 09/7-8/95
Sample Condition: Intact & Cool
Sample Received by: McD
Project Name: NA

TOTAL METALS

TA#	FIELD CODE	As (mg/L)	Cr (mg/L)	Cd (mg/L)	Ba (mg/L)	U (mg/L)	Mo (mg/L)	Zn (mg/L)	Ni (mg/L)	Be (mg/L)	Fe (mg/L)	Mn (mg/L)
T41049	Lea Refining MW-4	0.2	<0.05	<0.02	0.11	<0.5	0.1	0.05	<0.2	<0.01	0.46	0.04
QC	Quality Control	5.3	1.98	5.2	2.0	4.9	1.98	1.9	1.8	1.97	1.86	1.95
REPORTING LIMIT		0.2	0.05	0.02	0.03	0.5	0.1	0.02	0.20	0.01	0.03	0.01
RPD		6	10	4	2	4	2	6	8	4	2	2
% Extraction Accuracy		68	82	98	92	110	86	93	76	88	85	87
% Instrument Accuracy		107	99	104	100	99	99	97	92	98	93	98

TA#	FIELD CODE	Co (mg/L)	V (mg/L)	Cu (mg/L)	Al (mg/L)	B (mg/L)	Hg (mg/L)	Se (mg/L)	Pb (mg/L)	Ag (mg/L)
T41049	Lea Refining MW-4	<0.03	<0.05	0.04	0.5	0.16	<0.001	<0.001	<0.001	<0.0001
QC	Quality Control	1.96	1.9	1.97	1.9	2.0	0.0049	0.045	0.02	0.030
REPORTING LIMIT		0.03	0.05	0.05	0.20	0.05	0.001	0.001	0.001	0.0001
RPD		4	2	2	8	0	6	0	6	0
% Extraction Accuracy		82	85	85	115	97	99	120	100	107
% Instrument Accuracy		98	93	99	97	99	99	98	80	120

METHODS: EPA 200.7, 239.2, 270.2, 272.2, 245.1.
QC: 2.0 mg/L As, Cr, Cd, Ba, Mo, Zn, Ni, Be, Fe, Mn, Cu; 8.0 mg/L Al, B, Co, V; 9.0 mg/L U; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.050 mg/L Se.
SPIKE: 2.0 mg/L As, Cr, Cd, Ba, U, Ni, Mn, V, Al, Mo, Zn, Be, Fe, Co, Cu; 1.0 mg/L B; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.020 mg/L Se.

BB
Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-29-95
DATE

TRACE ANALYSIS, INC.
6701 Aberdeen Avenue Lubbock, Texas 79424 806•794•1296 FAX 806•794•1298

ANALYTICAL RESULTS FOR
NAVAJO REFINING
Attention: Darrell Moore
501 E. Main
Artesia, NM 88210

September 29, 1995
Receiving Date: 09/08/95
Sample Type: Water
Project No: NA
Project Location: Lovington, NM

Prep Date: 09/13/95
Analysis Date: 09/14/95
Sampling Date: 09/07/95
Sample Condition: Intact & Cool
Sample Received by: MS
Project Name: NA

TOTAL METALS

TA#	FIELD CODE	As (mg/L)	Cr (mg/L)	Cd (mg/L)	Ba (mg/L)	U (mg/L)	Mo (mg/L)	Zn (mg/L)	Ni (mg/L)	Be (mg/L)	Fe (mg/L)	Mn (mg/L)
T40891	Lea Refining MW-5	0.5	<0.05	<0.02	<0.03	<0.5	0.3	0.04	<0.2	<0.01	0.32	0.05
QC	Quality Control	5.3	5.2	5.2	5.2	4.9	2.0	1.9	1.8	2.0	1.9	1.95
REPORTING LIMIT		0.20	0.05	0.02	0.03	0.5	0.10	0.02	0.2	0.01	0.03	0.01
RPD		20	0	0	0	1	2	6	8	4	2	2
% Extraction Accuracy		77	86	87	96	110	86	93	76	88	86	87
% Instrument Accuracy		106	103	104	105	99	99	97	92	98	93	98

TA#	FIELD CODE	Co (mg/L)	V (mg/L)	Cu (mg/L)	Al (mg/L)	B (mg/L)	Hg (mg/L)	Se (mg/L)	Pb (mg/L)	Ag (mg/L)
T40891	Lea Refining MW-5	<0.03	<0.05	0.05	1.8	0.26	<0.001	0.003	<0.001	<0.0001
QC	Quality Control	1.96	1.9	1.97	1.94	2.0	0.005	0.045	0.02	0.03
REPORTING LIMIT		0.03	0.05	0.02	0.20	0.03	0.001	0.001	0.001	0.0001
RPD		4	2	2	8	0	6	0	6	0
% Extraction Accuracy		82	85	85	115	97	99	120	100	107
% Instrument Accuracy		98	93	99	97	99	99	98	80	120

METHODS: EPA 200.7, 239.2, 270.2, 272.2, 245.1.
QC: 5.0 mg/L As, Cr, Cd, Ba, Mo, Zn, Ni, Be, Fe, Mn, Cu, Al, B, Co, V; 9.0 mg/L U; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.050 mg/L Se.
SPIKE: 2.0 mg/L As, Cr, Cd, Ba, U, Ni, Mn, V, Al, Mo, Zn, Be, Fe, Co, Cu; 1.0 mg/L B; 0.005 mg/L Hg; 0.025 mg/L Pb; 0.003 mg/L Ag; 0.020 mg/L Se.

BF
Director, Dr. Blair Leftwich
Director, Dr. Bruce McDonell

9-29-95
DATE

Sep-29-95 05:13P

APPENDIX F

RECOVERY WELL PERMIT

STATE OF NEW MEXICO

STATE ENGINEER OFFICE

ROSWELL

THOMAS C. TURNEY
State Engineer

DISTRICT II
1900 West Second St.
Roswell, New Mexico 88201
(505) 622-6521

May 14, 1996

FILE: L-4058-S-23 (T) (Recovery Well)

Navajo Refining Company
501 East Main Street
Artesia, NM 88211

Gentlemen:

Enclosed is your copy of Application for Permit to Supplement the Underground Waters of the State of New Mexico, as numbered above, which has been approved subject to the following conditions:

1. The diversion of water from all combined sources shall be limited to a maximum of 35.0 acre-feet per annum measured at well L-4058-S-23 (T) (Recovery Well) for groundwater remediation (Industrial).

2. This well shall not penetrate any formation below the Ogallala formation.

3. This well shall be located at least 660 feet from all wells of other ownership.

4. Well L-4058-S-23 (T) shall be equipped with a totalizing meter of a type approved by and installed in a manner acceptable to the State Engineer.

5. Records of the amount of water pumped during the preceding calendar months shall be submitted to the State Engineer Office in Roswell on or before the 10th day of January, April, July and October of each year.

Please see that the well driller files log of well in this office within 10 days after completion of drilling.

Proof of Completion of Well should be filed in this office as soon as well is completed.

Yours truly,

Johnny R. Hernandez
Lea County Basin Supervisor

JRH/rpa
encl.
cc: Santa Fe
Gilbert J. Van Deventer

Revised August 1967

IMPORTANT—READ INSTRUCTIONS ON BACK BEFORE FILLING OUT THIS FORM

APPLICATION FOR PERMIT

Supplement
To ~~Appropriate~~ the Underground Waters of the State of New Mexico

Date Received 04-01-96 File No. L-4058-S-23 (T) (Recovery Well)

1. Name of applicant Navajo Refining Company
   Mailing address 501 East Main Street
   City and State Artesia, New Mexico 88211
2. Source of water supply Shallow Water Aquifer located in Lea County Basin
   (artesian or shallow water aquifer) (name of underground basin)
3. The well is to be located in the ___ ¼ SE ¼ ___ ¼, Section 36 Township 16S
   Range 36E N.M.P.M., or Tract No. ___ of Map ___ of the ___ District,
   on land owned by Navajo Refining Company (Leasee) City of Lovington (Owner).
4. Description of well: name of driller Pool Environmental Drilling, Inc.;
   Outside Diameter of casing 4-1/2" inches; Approximate depth to be drilled 115 feet;
5. Quantity of water to be appropriated and beneficially used 35 acre feet,
   (consumptive use, diversion)
   for ground water remediation (industrial) purposes.
6. Acreage to be irrigated or place of use Not applicable acres:

Subdivision	Section	Township	Range	Acres	Owner

96 APR 1 AM 11 48

7. Additional statements or explanations The proposed recovery well will be used for the purpose of groundwater recovery to aid in pollution control. The recovery well pump rate will be adjusted as necessary to assure hydrocarbon plume capture, but will not likely exceed 20 gallons per minute. The recovered water will replace water currently supplied by a water well owned by the City of Lovington and, as such, will be utilized in the desalting system as make-up water for crude oil washing purposes; therefore, there will be no net increase in total groundwater withdrawal as a result of the proposed recovery operations. After leaving the desalter system, the water stream undergoes additional treatment (product separation, volatile stripping, steam heating, etc.) prior to being released into the City of Lovington publicly owned treatment works along with site discharge water.

I, David G. Griffin, affirm that the foregoing statements are true to the best of my knowledge and belief and that development shall not commence until approval of the permit has been obtained.

Navajo Refining Co., Permittee,

By: David G. Griffin.

Subscribed and sworn to before me this 27 day of March, A.D., 19 96.

My commission expires: September 16, 1998

Notary Public

Number of this permit L-4058-S-23 (T) Recovery Well

ACTION OF STATE ENGINEER

After notice pursuant to statute and by authority vested in me, this application is approved provided it is not exercised to the detriment of any others having existing rights; further provided that all rules and regulations of the State Engineer pertaining to the drilling of shallow wells be complied with; and further subject to the following conditions:

1. The diversion of water from all combined sources shall be limited to a maximum of 35.0 acre-feet per annum measured at well L-4058-S-23 (T) Recovery Well for groundwater remediation (Industrial).
2. This well shall not penetrate any formation below the Ogallala formation.
3. This well shall be located at least 660 feet from all wells of other ownership.
4. Well L-4058-S-23 (T) shall be equipped with a totalizing meter of a type approved by and installed in a manner acceptable to the State Engineer.
5. Records of the amount of water pumped during the preceding calendar months shall be submitted to the State Engineer Office in Roswell on or before the 10th day of January, April, July and October of each year.

Proof of completion of well shall be filed on or before May 31, 19 98

Proof of application of water to beneficial use shall be filed on or before N/A , 19

Witness my hand and seal this 16 TH day of May , A.D., 19 96

Thomas C. Turney
~~State Engineer~~ State Engineer

By: Glenn W. Brim

Glenn W. Brim, District II Supervisor

INSTRUCTIONS

This form shall be executed, preferably typewritten, in triplicate and shall be accompanied by a filing fee of $5.00. Each of triplicate copies must be properly signed and attested.

A separate application for permit must be filed for each well used.

Secs. 1–4—Fill out all blanks fully and accurately.

Sec. 5—Irrigation use shall be stated in acre feet of water per acre per annum to be applied on the land. If for municipal or other purposes, state total quantity in acre feet to be used annually.

Sec. 6—Describe only the lands to be irrigated or where water will be used. If on unsurveyed lands describe by legal subdivision "as projected" from the nearest government survey corners, or describe by metes and bounds and tie survey to some permanent, easily located natural object.

Sec. 7—If lands are irrigated from any other source, explain in this section. Give any other data necessary to fully describe water right sought.

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Navajo Refining Company Owner's Well No. RW-1

Street or Post Office Address 501 E. Main

City and State Artesia, NM 88211

*Issued at later date

Well was drilled under Permit No. L-4058-S-23* and is located in the:

a. ____ ¼ ____ ¼ SE ¼ NE ¼ of Section 36 Township 19S Range 36E N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____ Subdivision, recorded in Lea County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Pool Environmental Drilling, Inc. License No. WD-1266

Address P.O. Box 604, Roswell, NM 88201

Drilling Began 3-27-96 Completed 3-29-96 Type tools Hollow stem auger Size of hole 10 in.

Elevation of land surface or ____ at well is 3835 ft. Total depth of well 119 ft.

Completed well is ☐ shallow ☐ artesian. Depth to water upon completion of well 90 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
90	119	29	Light brown fine grained sand	15-20

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
4	PVC	Sch 40	Surf	119	119	Closed	84	114

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
77	80	10"	Bentonite Pellets		Tremie
Surf	77	10"	Cement Grout		Tremie

Section 5. PLUGGING RECORD

Plugging Contractor ____

Address ____

Plugging Method ____

Date Well Plugged ____

Plugging approved by:

State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ FWL ____ FSL ____

File No. ____ Use ____ Location No.

From	To	In Feet	
0	5	5	Caliche, Tan
5	27	22	Silty Sand, Grayish Orange
27	119	92	Sand, fine grained, brown to dark gray

Section 7. REMARKS AND ADDITIONAL INFORMATION

This well was drilled and completed in March, 1996 as a groundwater monitor well. On September 10, 1996, the owner/agent contacted us and informed us that the well is now to be used as a pollution recovery well and asked that we file the well record. We hereby submit this well record on the owner's behalf.

undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

NEW MEXICO STATE ENGINEER
TOTALIZING METER REPORT

Basin Supervisor
State Engineer Office
1900 West Second Street
Roswell, NM 88201

Dear Sir:

In accordance with the State Engineer regulation which requires that quarterly reports of meter readings be submitted on or before the 10th of January, April, July and October, the following information is submitted.

1. File No. _____ Date _____
   Name: _____
   Address: _____

2. Well Description
   S.E. File No. _____ Company Well No. _____
   Location: Subdv. _____ Sec. _____ Twp. _____ Rge. _____

3. Totalizing Meter
   Serial No. _____ Units _____
   Make _____ Multiplier _____

4. Reading
   Date: _____ Reading _____
   Quantity of water used _____ Quarter, 19___, _____

5. Remarks: _____
   _____
   _____
   _____

   _____
   By: _____

INSTRUCTIONS:
(1) and (2) self-explanatory. (3) Description of meter, including multiplier or constant by which reading must be multiplied to obtain actual quantity of water. Units refer to acre-feet, gallons, barrels, etc. (4) Reading of figures on the meter and amount obtained by multiplying reading by multiplier. (5) Under Remarks, give any pertinent information such as reading and date of installation of meter if a first report, information concerning repair of meter and dates out of service, etc.

FILE NO. _____ LOCATION NO. _____

GEOSCIENCE CONSULTANTS, LTD.
306 WEST WALL, SUITE 818
MIDLAND, TEXAS 79701
(915) 682-0008

March 28, 1996

Mr. John Hernandez - Area Supervisor
State Engineer Office
1900 W. Second St.
Roswell, NM 88201-1712

RE: Application for Recovery Well Permit
Navajo Refining Company
Lovington Refinery
Lea County, New Mexico

Mr. Hernandez:

Geoscience Consultants, Ltd. (GCL) has been retained by Navajo Refining Company (NRC) to implement groundwater remediation activities at the above-referenced site. On behalf of NRC, GCL respectfully requests your approval to operate one groundwater recovery well to aid in pollution control. Enclosed are copies of the February 8, 1996, "Work Plan for Soil and Groundwater Remediation at the Navajo Refining Company Lovington Refinery". Also enclosed is the March 18, 1996 letter from Bill Olson of the New Mexico Oil Conservation Commission (OCD) which documents OCD approval of the work plan. The third enclosure is the completed "Application For Permit". NRC will submit a notice of the filing of the application to be published in the local Lovington newspaper (The Lovington Daily Leader).

As stated in the workplan, the recovery well will be installed to about 25 feet below the present water table, about 115 feet below ground surface. A well construction diagram is included in the workplan and also attached to this application. To remove the free product and groundwater containing dissolved hydrocarbons, a submersible total fluids pump will be installed in the 4-inch diameter recovery well. The conveyance line for the total fluids will contain a shut-off valve, totalizing meter, flow rate meter, and sampling port. Groundwater withdrawal volumes will be submitted to the State Engineer Office on a quarterly basis as per current requirements.

The recovery well pump rate will be adjusted as necessary to assure hydrocarbon plume capture, but will not likely exceed 20 gallons per minute. The recovered water will replace water currently supplied by two registered on-

site process water supply wells. The recovered water will be utilized in the desalting system as make-up water for crude oil washing purposes. Therefore, there will be no net increase in total groundwater withdrawal as a result of the proposed recovery operations. After leaving the desalter system, the water undergoes additional treatment (product separation and volatile stripping) prior to being released into the City of Lovington publicly owned treatment works along with site discharge water.

Upon completion of the groundwater remediation project, which is expected to take approximately two years, the recovery well will be properly plugged. If you have any questions, please call me at 915-682-0008.

Sincerely,
Geoscience Consultants, Ltd.

Gilbert J. Van Deventer, REM
Project Hydrogeologist

GJV/cat

cc: David Griffin - NRC (Artesia)
Bill Olson - OCD (Sante Fe)
Jerry Sexton - OCD (Hobbs)
Bob Carter - City Manager of Lovington, NM

GCL
Environmental Science and Engineering
A BDM International Company

ENGINEERING CALCULATION

Sheet 1 of 1
Date 3-29-96
By GJV
File

NAVAJO REFINING COMPANY - LOVINGTON REFINERY

1 cm² = 0 1550 in²
1 m² = 6 452 cm²
1m² = 10 764 ft²
1 ft² = 929 0 cm²

1 acre = 43 560 ft²
= 4049 m²

1 hectare = 10 000 m²
= 2 471 acres

1 mi² = 2 590 km²
= 640 acres

Volume

1 m³ = 1000 liters
= 35 314 ft³
= 264 gal (U S)

1 ft³ = 28 320 liters
= 7 481 gal (U S)

1 gal = 3 785 liters

1 acre foot = 43 560 ft³
= 3 259 x 10⁵ gal
= 1234 m³

Discharge

1ft³/min = 0 472 liters/sec
1 acre foot/day
= 3 259 x 10⁵ gal/day
sec = 448 8 gal/min
724 acre feet/year

Density

Water 1 000 g/cm³ at 4°C
0 998 g/cm³ at 20°C
Sea water 1 025 g/cm³ at 15°C
Mercury 13 55 g/cm³ at 20°C
Air 1 29 x 10⁻³ g/cm³ at 20°C and atmospheric pressure

Specific weight water in air

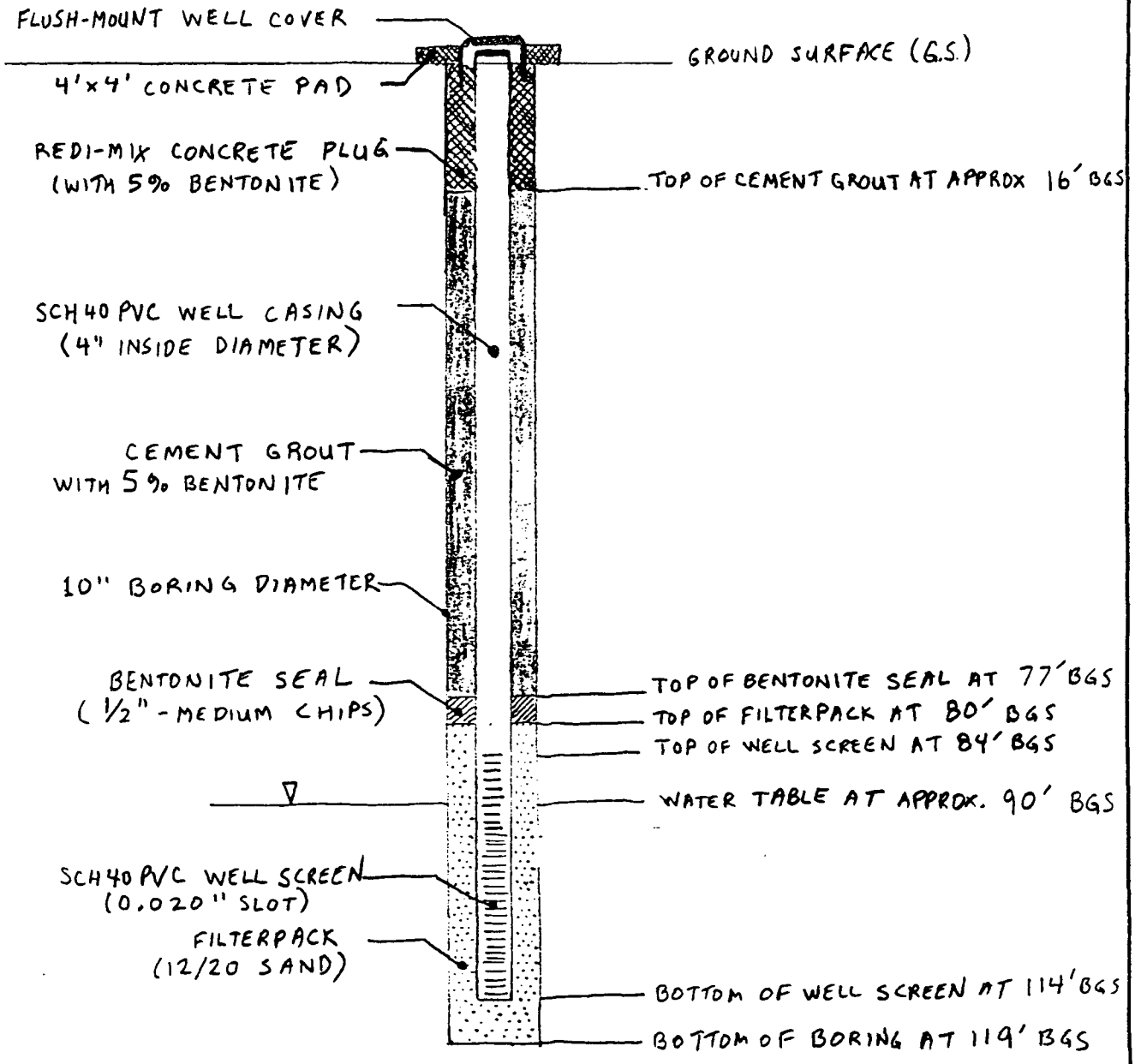
8 335 lb/gal at 0°C
8 328 lb/gal at 60° F
8 322 lb/gal at 20° C
62 18 lb/ft³ at 60° F

Pressure

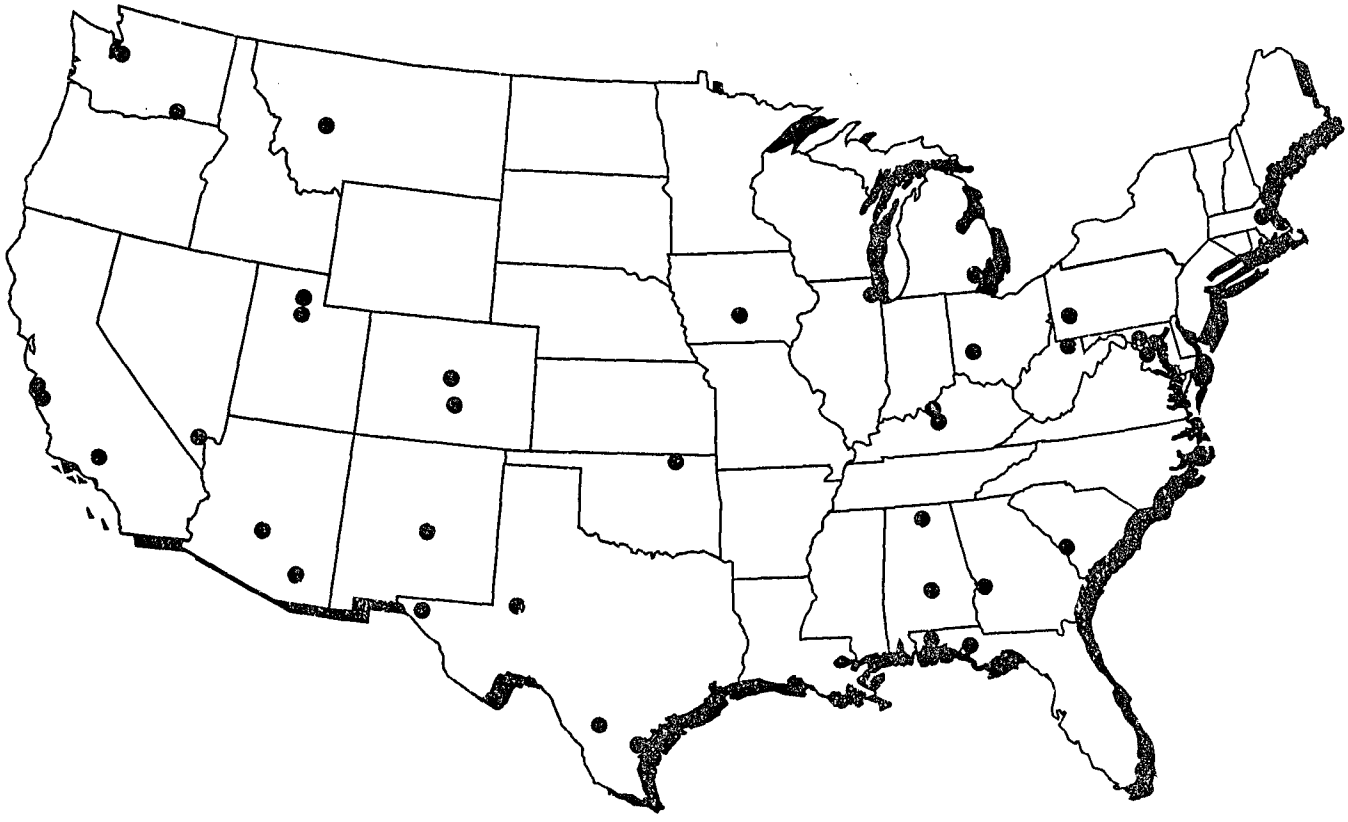
1 bar = 0 9869 atmosphere
= 10⁶ dynes/cm²
= 14 50 lb/in²

pressure developed from static liquid
1 cm mercury
= 0 01316 atmosphere
1 ft water
= 0 02950 atmosphere
33 90 ft water
= 1 00 atmosphere

WELL CONSTRUCTION DIAGRAM FOR RECOVERY WELL (RW-1)



Office Locations



UNITED STATES

Montgomery, Alabama
Huntsville, Alabama
Phoenix, Arizona
Tucson, Arizona
Redlands, California
Monterey, California
Denver, Colorado
Colorado Springs, Colorado
Washington, D.C.
Panama City, Florida
Pensacola, Florida
Fort Benning, Georgia
Chicago, Illinois
Des Moines, Iowa
Fort Knox, Kentucky
Louisville, Kentucky
Gaithersburg, Maryland
Germantown, Maryland
Lanham, Maryland
Boston, Massachusetts
Dearborn, Michigan
Helena, Montana
Las Vegas, Nevada
Albuquerque, New Mexico
Dayton, Ohio
Bartlesville, Oklahoma
Pittsburgh, Pennsylvania
N. Augusta, South Carolina
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INTERNATIONAL

Brazil
Egypt
Germany
Oman
Mexico
Saudi Arabia
Turkey

FOR MORE INFORMATION, CALL 1-800-563-0014

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WORK PLAN FOR SOIL AND GROUNDWATER REMEDIATION AT THE NAVAJO REFINING COMPANY LOVINGTON REFINERY

February 8, 1996

Prepared for:

Navajo Refining Company
David G. Griffin
Manager of Environmental Affairs
for Water and Waste
P.O. Box 159
Artesia, NM 88211-0159

Geoscience Consultants, Ltd.
505 Marquette NW, Ste. 1100
Albuquerque, New Mexico 87102
(505) 842-0001
FAX: (505) 842-0595

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List of Figures and Tables

Figures

Tables

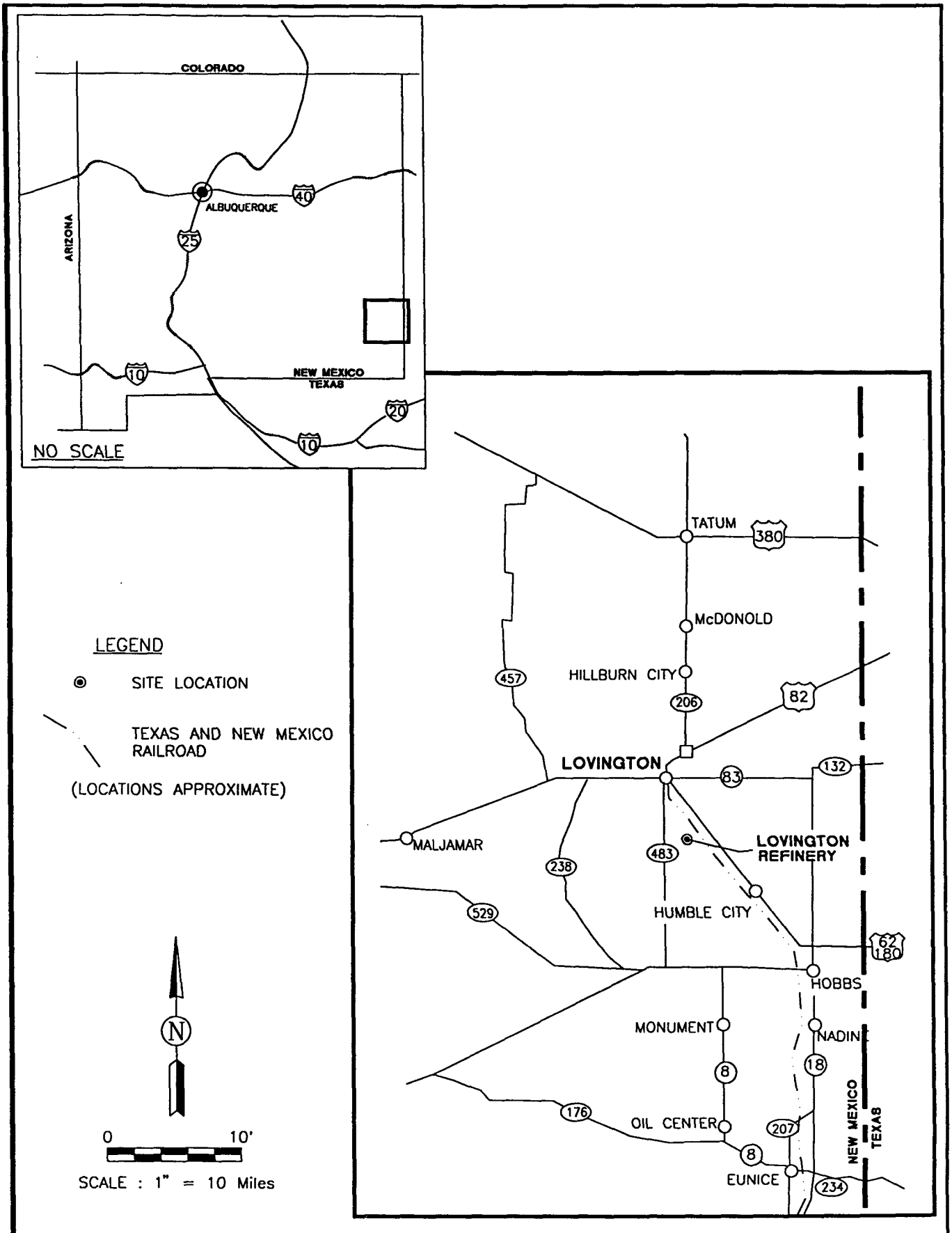
1.0 INTRODUCTION

Navajo Refining Company (NRC) proposes this work plan to remediate soil and groundwater at their Lovington Refinery (site) located about five miles southeast of Lovington, New Mexico (Figure 1). After a break in the process sewer junction box (Figure 1) was discovered, the NRC initiated a soil and groundwater investigation in August 1995.

The investigation revealed the presence of residual petroleum hydrocarbons within the vadose zone, phase-separated hydrocarbons (free product) on the water table, and a dissolved-phase hydrocarbon groundwater plume. The refinery was idle from 1984 to early 1991, and the release is expected to have occurred sometime after the startup in early 1991.

In their effort to address this problem, the NRC retained Geoscience Consultants, Ltd. (GCL) to design and install a soil and groundwater remediation system at the site.

The NRC presents this work plan to identify potential receptors, determine the extent of soil and groundwater contamination, review regional and site hydrogeology, develop remedial system design objectives, and present the design, construction, and operation plans for the remediation system.



GCL

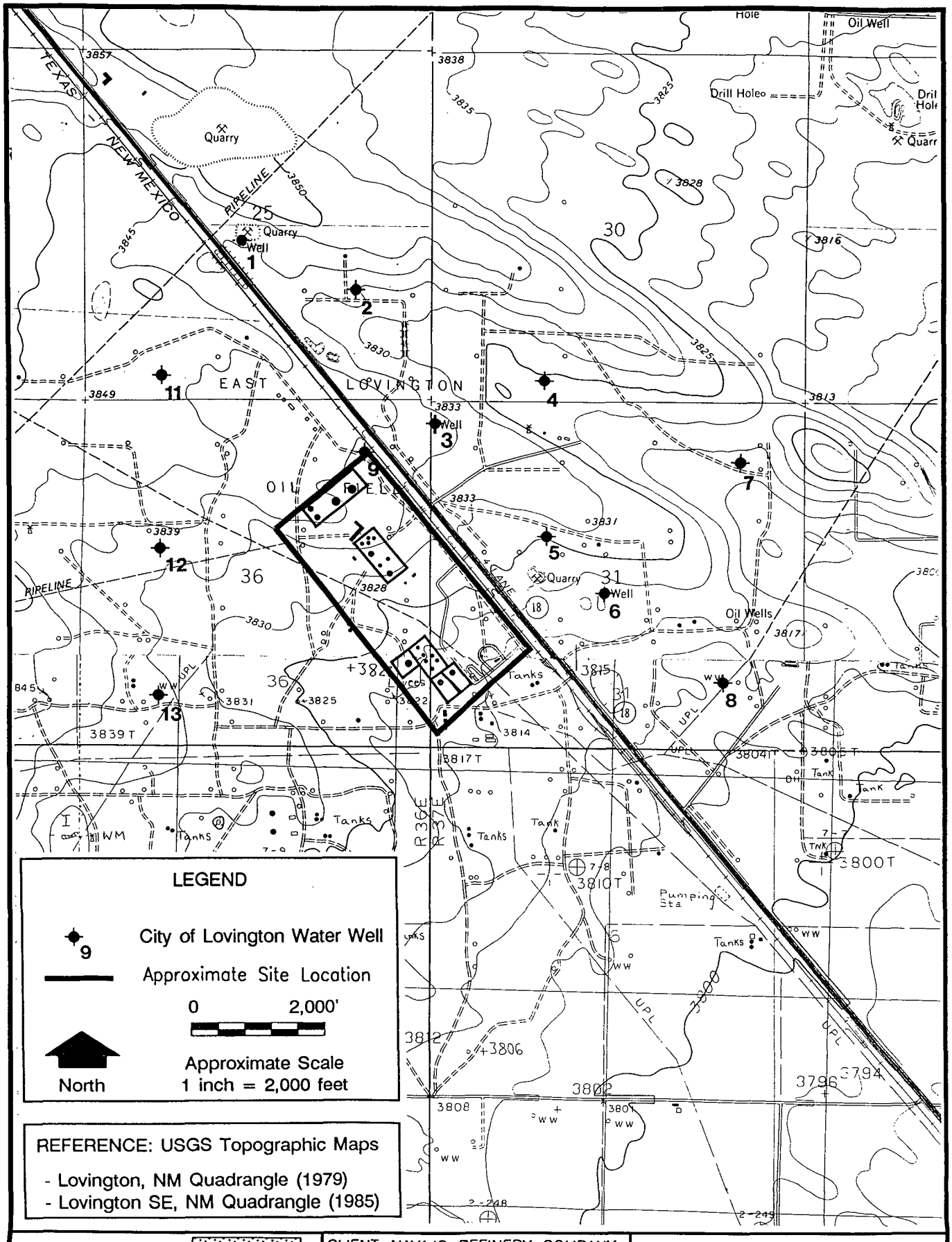
CLIENT: NAVAJO REFINERY COMPANY	
DATE: 11/16/95	REV. NO.: 0
AUTHOR: BAL	DRAWN BY: MP
CK'D BY: BAL	FILE: RPRT1-1.DWG

FIGURE 1
SITE LOCATION MAP
LOVINGTON REFINERY
NAVAJO REFINERY COMPANY

2.0 POTENTIAL RECEPTORS

There is no immediate threat to human health as the nearest receptor is the site's own process water supply wells located about 1,000 feet downgradient from the source. A combined total daily flow rate from the two wells is estimated at 350 gallons per minute. This supply is not used for human consumption, as the site drinking water is delivered as bottled water.

City of Lovington water supply wells are located along State Highway 18, southeast of the city. The nearest water supply well, Lovington No. 9, is located near the northeast corner of the site, about 1,500 feet north of the source (Figure 2). These crossgradient wells are not considered potential receptors.



GCL

CLIENT: NAVAJO REFINERY COMPANY	
DATE: 11/21/95	REV. NO.: 0
AUTHOR: GJV	DRAWN BY: MP
CK'D BY: BAL	FILE: LEABRD.DWG

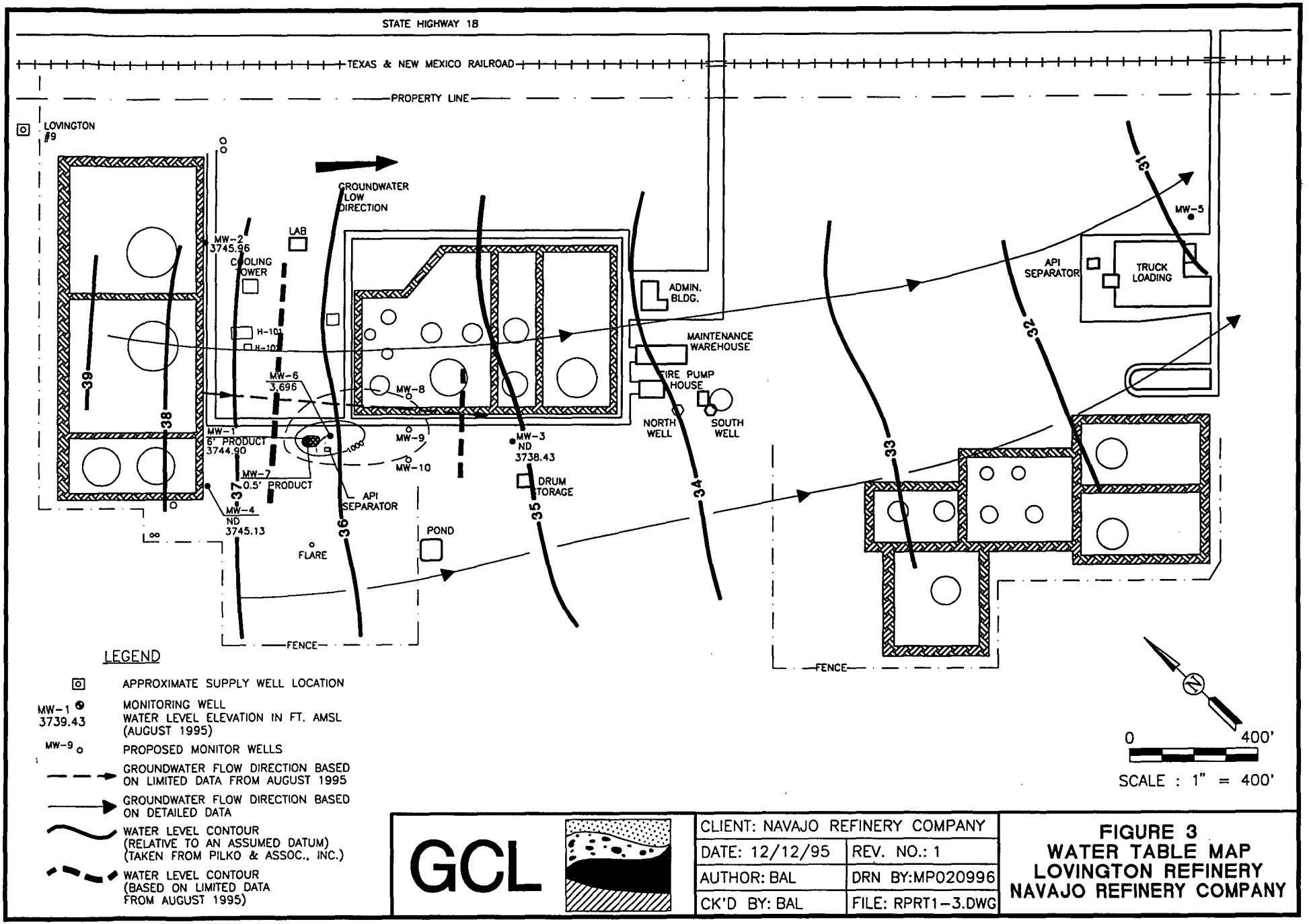
FIGURE 2
WATER WELL LOCATION MAP
LOVINGTON REFINERY
NAVAJO REFINERY COMPANY

3.0 SITE HYDROGEOLOGIC CONDITIONS

A thorough understanding of the site hydrogeology is the single most important criterion for designing remediation systems. The site is underlain by a well-hardened caliche, from the surface to approximately 14 feet below the surface. The caliche grades into the underlying Pliocene Ogallala Formation (Ogallala Aquifer) of homogeneous fine- to medium-grained sand that contains little or no fines (silts and clays). Based on the soil boring data, these conditions appear to be continuous in the area of contamination.

Groundwater beneath the site occurs within the Ogallala Aquifer at about 90 feet below the ground surface (bgs). Groundwater flows toward the southeast with a slope (hydraulic gradient) of 0.007 feet/foot which is consistent with the regional flow direction in this area of the Ogallala Aquifer (Figure 3). Based on observed lithology during drilling, aquifer hydraulic conductivity is estimated to be about 25 to 75 feet/day. Effective porosity for these types of materials is typically 25 percent. Using this data, groundwater flow velocity is estimated to range from 0.7 to 2.1 feet/day, or about 1 to 2 feet/day. This velocity may be locally influenced by the two site process water supply wells located about 1,000 feet downgradient of the source area.

Water levels at the site have been falling about 1 foot each year, which is consistent with the regional lowering of the Ogallala Aquifer water table. This will influence the remedial design and was taken into consideration in our design.



GCL

CLIENT: NAVAJO REFINERY COMPANY	
DATE: 12/12/95	REV. NO.: 1
AUTHOR: BAL	DRN BY:MP020996
CK'D BY: BAL	FILE: RPRT1-3.DWG

FIGURE 3
WATER TABLE MAP
LOVINGTON REFINERY
NAVAJO REFINERY COMPANY

4.0 Distribution of Petroleum Hydrocarbons in Soil and Groundwater

The area of soil and groundwater impacted by petroleum hydrocarbons is centered at the source, the desalter line break. The primary constituents of concern are benzene, toluene, ethylbenzene, and xylenes (BTEX). The following sections describe the distribution of hydrocarbons in the subsurface soils and groundwater. In addition to BTEX, major cations/anions, metals, and water quality parameters (pH, total dissolved solids, alkalinity) are discussed.

4.1 Residual Hydrocarbons in Soil

A qualitative field assessment of cuttings from soil borings revealed the presence of residual hydrocarbons entrained within the vadose zone beneath the source. In monitoring wells MW-7 and MW-1 and soil boring B6, residual hydrocarbons were observed from the surface to the water table located about 90 bgs. These locations are within the immediate source area. Residual hydrocarbons were observed in downgradient soil boring B1 from 65 feet bgs to the water table and in B2 from the surface to about 65 bgs. No hydrocarbons were observed in the upgradient soil boring B3 throughout the vadose zone. The areas of impacted soil is limited to immediately beneath the source area.

4.2 Benzene, Toluene, Ethylbenzene, Xylenes and Polynuclear Aromatic Hydrocarbons in Groundwater

The site investigation revealed a limited area of free product on the water table directly below the desalter line break with measured product thicknesses ranging from less than 0.5 feet in MW-7 to about 6 feet in MW-1. The investigation also delineated a dissolved-phase *hydrocarbon plume* extending about 360 feet downgradient of the source.

Total BTEX concentrations in groundwater range from about 3,700 parts per billion (ppb) in monitoring well MW-6 located near the source area to about 41 ppb in soil boring B5 located near the leading edge of the plume. In a further downgradient monitoring well (MW-3), BTEX is below laboratory detection limits. Table 1 and Figure 4 summarize total BTEX concentrations in groundwater.

PAHs were not detected above Water Quality Control Commission (WQCC) standards in upgradient or downgradient monitoring wells (MW-2 through MW-5). However, naphthalene and mononaphthalenes were detected above the standard of 30 ppb in MW-1 at 94 ppb. Table 2 summarizes the PAH concentrations in groundwater.

4.3 Metals in Groundwater

Groundwater samples analyzed for metals indicated concentrations below New Mexico Water Quality Control Commission (NMWQCC) standards with a few exceptions. MW-1 exceeded standards for barium, iron, and manganese. Most samples were only slightly above standards for arsenic in upgradient and downgradient wells. This suggests a regionally elevated arsenic concentrations in the Ogallala Aquifer, due to natural conditions. A summary of metal concentrations is listed in Table 3.

4.4 Water Quality Parameters

Groundwater samples were also analyzed for major cations/anions, total dissolved solids (TDS), pH, alkalinity, and electrical conductivity. Only MW-1 exceeded WQCC standards for TDS and chloride. Results are summarized in Table 4.

Table 1
BTEX in Groundwater at the Lovington Refinery

TABLE 1. BTEX (µg/L) in Groundwater at the Lovington Refinery

Location	Date	Method	Benzene	Toluene	Ethylbenzene	Total Xylenes	Total BTEX
B3	Sep-95	EPA 602	1,100	341	757	1,000	3,208
B4	Aug-95	EPA 8020	74	21	39	19	153
B5	Sep-95	EPA 8020	41	ND1	ND1	ND1	41
B6	Sep-95	EPA 8020	583	30	87	108	808
B7(MW-6)	Sep-95	EPA 8020	1,741	21	962	972	3,696
B8	Sep-95	EPA 8020	ND1	ND1	ND1	ND1	ND1
B9	Sep-95	EPA 8020	ND1	ND1	ND1	ND1	ND1
MW-3	Jun-95	EPA 8020	ND1	ND1	ND1	ND1	ND1
MW-9	Jun-95	EPA 8020	ND1	ND1	ND1	ND1	ND1
NMWQCC Standards[1]			10	750	750	620	2,130

na = not applicable
ND1 = compound not detected above the detection limit (1 or 2 µg/L)
[1]New Mexico Water Quality Control Commission Human Health Standards
All analyses conducted by Trace Analysis, Inc., Lubbock, TX

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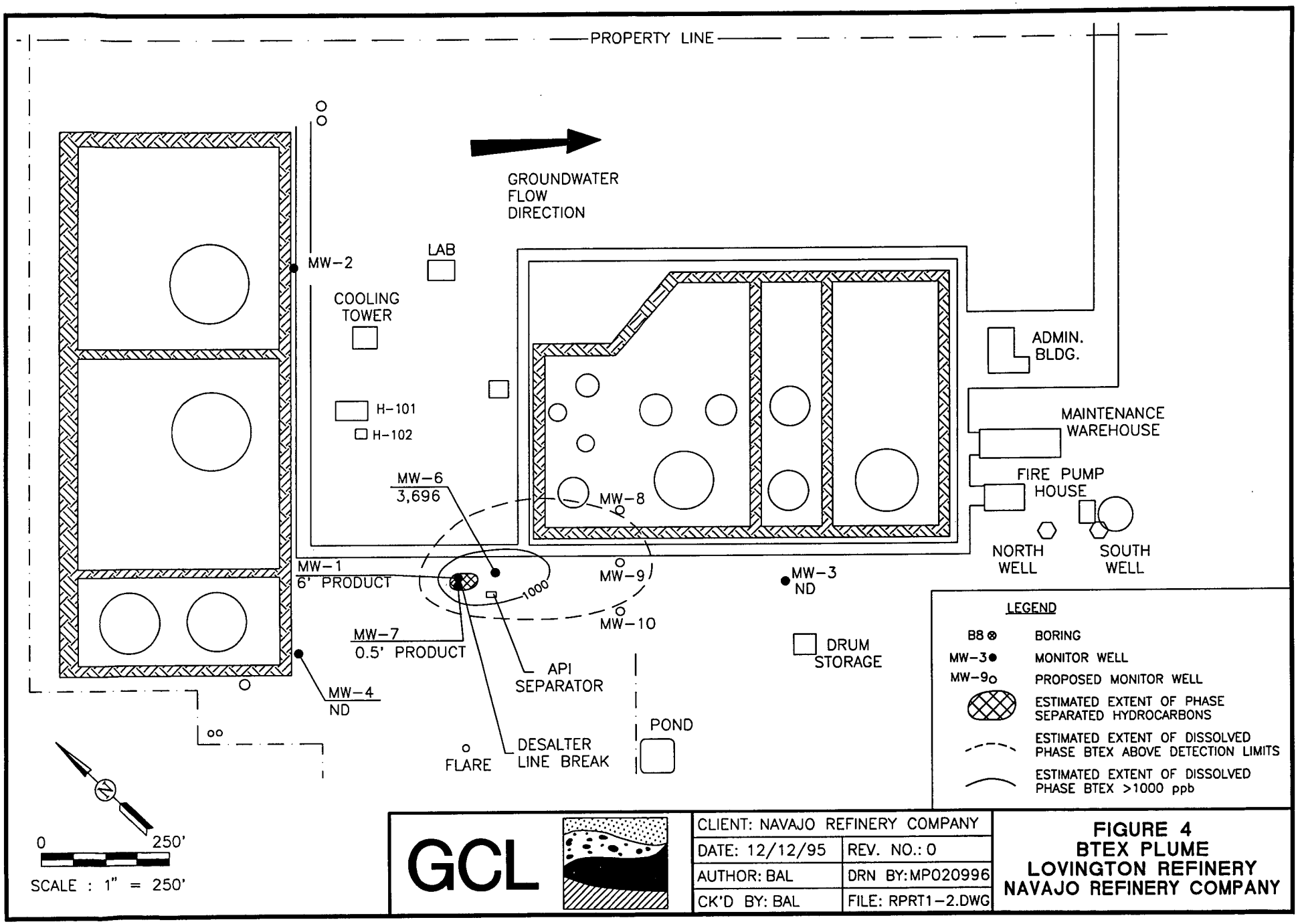
PROPERTY LINE
GROUNDWATER FLOW DIRECTION
MW-2
LAB
COOLING TOWER
H-101
H-102
ADMIN. BLDG.
MAINTENANCE WAREHOUSE
FIRE PUMP HOUSE
NORTH WELL
SOUTH WELL
MW-6
3,696
MW-8
MW-1
6' PRODUCT
MW-9
MW-3
ND
1000
MW-10
MW-7
0.5' PRODUCT
API SEPARATOR
DRUM STORAGE
MW-4
ND
POND
FLARE
DESALTER LINE BREAK
0
250'
SCALE : 1" = 250'
LEGEND
B8 ⊗ BORING
MW-3 ● MONITOR WELL
MW-9 o PROPOSED MONITOR WELL
ESTIMATED EXTENT OF PHASE SEPARATED HYDROCARBONS
ESTIMATED EXTENT OF DISSOLVED PHASE BTEX ABOVE DETECTION LIMITS
ESTIMATED EXTENT OF DISSOLVED PHASE BTEX >1000 ppb
GCL
CLIENT: NAVAJO REFINERY COMPANY
DATE: 12/12/95
REV. NO.: 0
AUTHOR: BAL
DRN BY: MP020996
CK'D BY: BAL
FILE: RPRT1-2.DWG
FIGURE 4
BTEX PLUME
LOVINGTON REFINERY
NAVAJO REFINERY COMPANY

Table 2
PAHs in Groundwater at the Lovington Refinery

TABLE 2. PAHs (ug/L) in Groundwater at the Lovington Refinery

PAH Compound	MW-1	MW-2	MW-3	MW-4	MW-5	NMWQCC Standards
Acenaphtene	ND10	ND1	ND1	ND1	ND1	na
Acenaphthylene	ND10	ND1	ND1	ND1	ND1	na
Anthracene	11	ND1	ND1	ND1	ND1	na
Benzo(a)anthracene	ND10	ND1	ND1	ND1	ND1	na
Benzo(a)pyrene	ND10	ND1	ND1	ND1	ND1	0.7
Benzo(b)fluoranthene	ND10	ND1	ND1	ND1	ND1	na
Benzo(g,h,i)perylene	ND10	ND1	ND1	ND1	ND1	na
Benzo(k)fluoranthene	ND10	ND1	ND1	ND1	ND1	na
Chrysene	ND10	ND1	ND1	ND1	ND1	na
Dibenz(a,h)anthracene	ND10	ND1	ND1	ND1	ND1	na
Fluoranthene	ND10	ND1	ND1	ND1	ND1	na
Fluorene	10	ND1	ND1	ND1	ND1	na
Indeno(1,2,3-cd)pyrene	ND10	ND1	ND1	ND1	ND1	na
Naphthalene*	94	ND1	ND1	ND1	ND1	30
Phenanthrene	ND10	ND1	ND1	ND1	ND1	na
Pyrene	ND10	ND1	ND1	ND1	ND1	na

na = Not Applicable
ND1 = Compound not detected above the detection limit (1 or 10 µg/L)
EPA Method 625
* includes monomethylnaphthalenes
All analyses conducted by Trace Analysis, Inc., Lubbock, TX

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Table 3
Metals in Groundwater at the Lovington Refinery

TABLE 4. Metals in Groundwater (mg/L) at the Lovington Refinery

Metal Compound	MW-1	MW-2	MW-3	MW-4	MW-5	NMWQCC Standard
Aluminum	1.20	0.50	1.00	0.50	1.80	5
Arsenic	0.50	0.30	ND.2	0.20	0.50	0.1
Barium	2.12	0.12	0.10	0.11	ND.03	1
Beryllium	ND.01	ND.01	ND.01	ND.01	ND.01	1
Boron	0.66	0.25	0.15	0.16	0.26	0.75
Cadmium	ND.02	ND.02	ND.02	ND.02	ND.02	0.01
Chromium	ND.05	ND.05	ND.05	ND.05	ND.05	0.05
Cobalt	ND.03	ND.03	ND.03	ND.03	ND.03	0.05
Copper	ND.02	0.05	ND.02	0.04	0.05	1
Iron	1.38	0.16	0.48	0.46	0.32	1
Lead	ND.001	ND.001	ND.001	ND.001	ND.001	0.05
Manganese	0.39	0.07	ND.01	0.04	0.05	0.2
Mercury	ND.001	ND.001	ND.001	ND.001	ND.001	0.002
Molybdenum	0.10	0.20	0.20	0.10	0.30	1
Nickel	ND.2	ND.2	ND.2	ND.2	ND.2	0.2
Selenium	ND.001	ND.001	ND.003	ND.001	ND.003	0.05
Silver	ND.0001	ND.0001	ND.0001	ND.0001	ND.0001	na
Uranium	ND.5	ND.5	ND.5	ND.5	ND.5	5
Vanadium	ND.05	ND.05	ND.05	ND.05	ND.05	na
Zinc	0.05	ND.02	0.06	0.05	0.04	10

na = Not Applicable
ND0.05 = Compound not detected above the detection limit (0.0001 to 0.5 mg/L)
EPA Methods: 200.7, 239.2, 270.2, 272.2, 245.1
All analysis conducted by Trace Analysis, Inc., Lubbock, TX

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Table 4
Inorganic Groundwater Chemistry at the Lovington Refinery

TABLE 3. Inorganic Groundwater Chemistry (mg/L) at the Lovington Refinery														
Location	Date	TDS	pH	Alkalinity (as CaCO3)		Conductivity[3]	Potassium	Magnesium	Calcium	Sodium	Chloride	Fluoride	Sulfate	Nitrate
				HCO_3	CO_3									
MW-1	Sep-95	1,275	7.50	349	0	2,007					509	1.20	ND5	ND.15
MW-2	Sep-95	523	7.40	283	0	733	2.30	16.90	133	65.70	61	1.20	105	1.65
MW-3	Sep-95	454	7.80	223	0	618					35	1	93	2.54
MW-4	Sep-95	438	7.90	254	0	590					23	1	88	1.19
MW-5	Sep-95	853	7.20	230	0	1,089	3	23.60	196	82.40	198	0.70	119	1.49
NMWQCC Standards[1]:		1000	6 to 9	na	na	na	na	na	na	na	250	1.6	600	10[2]

na = not applicable
ND5 = Compound not detected above the detection limit (5 mg/L)
[1] New Mexico Water Quality Control Commmission Water Supply Standards
[2] Nitrate as N
[3] Conductivity reported in units of FOHMs/cm
All analyses conducted by Trace Analysis, Inc., Lubbock, TX

5.0 REMEDIATION DESIGN OBJECTIVES

The objectives of the proposed remediation system for the Lovington Refinery include:

- Remove residual hydrocarbons within the vadose zone beneath the source area.
- Remove free product from the water table beneath the source area.
- Remediate groundwater that contains dissolved-phase hydrocarbons with a total BTEX concentration of 1,000 ppb or greater.
- Enhance natural intrinsic bioremediation to remediate the remaining downgradient portion of the dissolved-phase hydrocarbon plume.

To achieve these objectives, GCL selected the following combination of remediation technologies:

- Pump-and-treat system for free product and high-BTEX groundwater removal beneath the source area.
- Air sparging/vapor extraction system to remediate the high-BTEX groundwater and the vadose zone near the source.

Residual hydrocarbons in soil, free product, and high-BTEX groundwater are long-term sources of hydrocarbons for groundwater. Source removal is a key element in this remediation system design. Free product and high-BTEX groundwater will be removed using a submersible total fluids pump installed within a recovery well installed at the source.

Air sparging/vapor extraction is most effective in uniform, coarse-grained material, with little or no fines, similar to site conditions. This approach injects hydrocarbon-free compressed atmospheric air into the aquifer beneath contamination. Air injection creates an inverted cone of bubbles or discrete "air tubes" below the water table that advance toward the surface. Hydrocarbons dissolved in the groundwater and sorbed onto soil particles are essentially stripped into the gaseous phase by the rising air, break through at the water table, and are removed from the vadose zone by the vapor extraction system.

The portion of the plume not actively remediated (BTEX <1,000 ppb) will attenuate naturally but with some enhancement to encourage biodegradation of the hydrocarbons. Attenuation will occur by both enhanced intrinsic bioremediation and dilution (dispersion/mixing).

Intrinsic bioremediation of hydrocarbons without the addition of any nutrients into the subsurface. Enhanced intrinsic bioremediation is when oxygen and/or other nutrients are added to the aquifer within or upgradient of the plume. This effectively increases growth of naturally occurring bacteria which accelerates the rate at which hydrocarbons are biodegraded. Enhancement will occur by the movement of oxygenated groundwater from the upgradient sparged groundwater flowing into low-oxygen downgradient areas.

Based on the experience of the New Mexico Environment Department (NMED), intrinsic bioremediation works best in homogenous and permeable aquifers, single-source plumes, low groundwater gradients, absence of free product/soil contamination, and where hydrocarbon concentrations are 40,000 ppb or less (NMED, 1995). Most of these conditions are met for that portion of the plume not actively remediated.

6.0 System Design and Installation

The remediation system for the Lovington Refinery consists of a total fluids pumping for source removal and air sparge/vapor extraction to promote cleanup of the groundwater. The system focuses on aggressive physical removal while simultaneously stimulating naturally occurring hydrocarbon degrading bacteria.

6.1 Total Fluids Pumping

To aggressively remove the source, free product and high-BTEX groundwater, a submersible total fluids pump will be installed in a 4-inch recovery well (RW-1), located just downgradient of MW-1 (Figure 5). Figure 6 shows typical recovery well construction. The well will be installed to about 15 feet below the present water table, about 115 feet bgs.

The total fluids will be pumped to an existing facility tank. The conveyance line will contain a shut-off valve, totalizing meter, flow meter, and sampling port. Drawdown calculations indicate a pumping rate of about 20 gallons per minute (gpm) will produce a cone of depression sufficient to draw free product/high-BTEX groundwater into the well.

The total fluids pumped will undergo treatment including product recycling. The treated water is released to the Lovington publicly operated treatment works along with site discharge water. It is expected that existing refinery treatment processes are adequate to treat the total fluids waste stream.

6.2 Air Sparging System

The area of the dissolved-phase plume with total BTEX of about 1,000 ppb or greater is shown on Figures 3 and 4. Based on GCL's experience, a single air sparging well is expected to have a 30-foot radius of influence in the materials observed beneath the site. Consequently, eight sparging wells will provide the necessary coverage to remediate groundwater with 1,000 ppb of BTEX or greater as depicted in Figure 5.

Each sparging well cluster will be constructed with a sparge point installed below the groundwater plume (estimated at about 10 to 15 feet below the water table) and a screened section within the vadose zone for soil-vapor extraction. A 1-inch diameter HDPE or galvanized pipe delivers compressed filtered atmospheric air into the aquifer through the submerged sparge point. Figure 6 shows a typical air sparge/VES well design. It is estimated that each sparge point will deliver 5 to 10 cubic feet per minute (cfm), operating at 12 psi.

Dedicated piping will be used for each sparge point to allow for fine-tuning the sparging system. Each sparge line will house a valve, flow meter, and pressure gage.

In addition to the air-stripping action within the aquifer, air injection also increases the dissolved oxygen content which stimulates naturally occurring microbes present in the aquifer. This will cause greater biodegradation of hydrocarbons than would occur naturally.

6.3 Vapor Extraction System

Vadose zone vapors will be extracted through 2-inch diameter Schedule 80 PVC pipe and 10- to 20-foot long screens installed within the vadose zone about 5 feet about the water table. Longer, or multiple, screens will be used in the source area to remove residual hydrocarbons observed from the surface to the water table. A blower operating at 60 psi will remove 15 to 30 cfm from each well. Typical designs

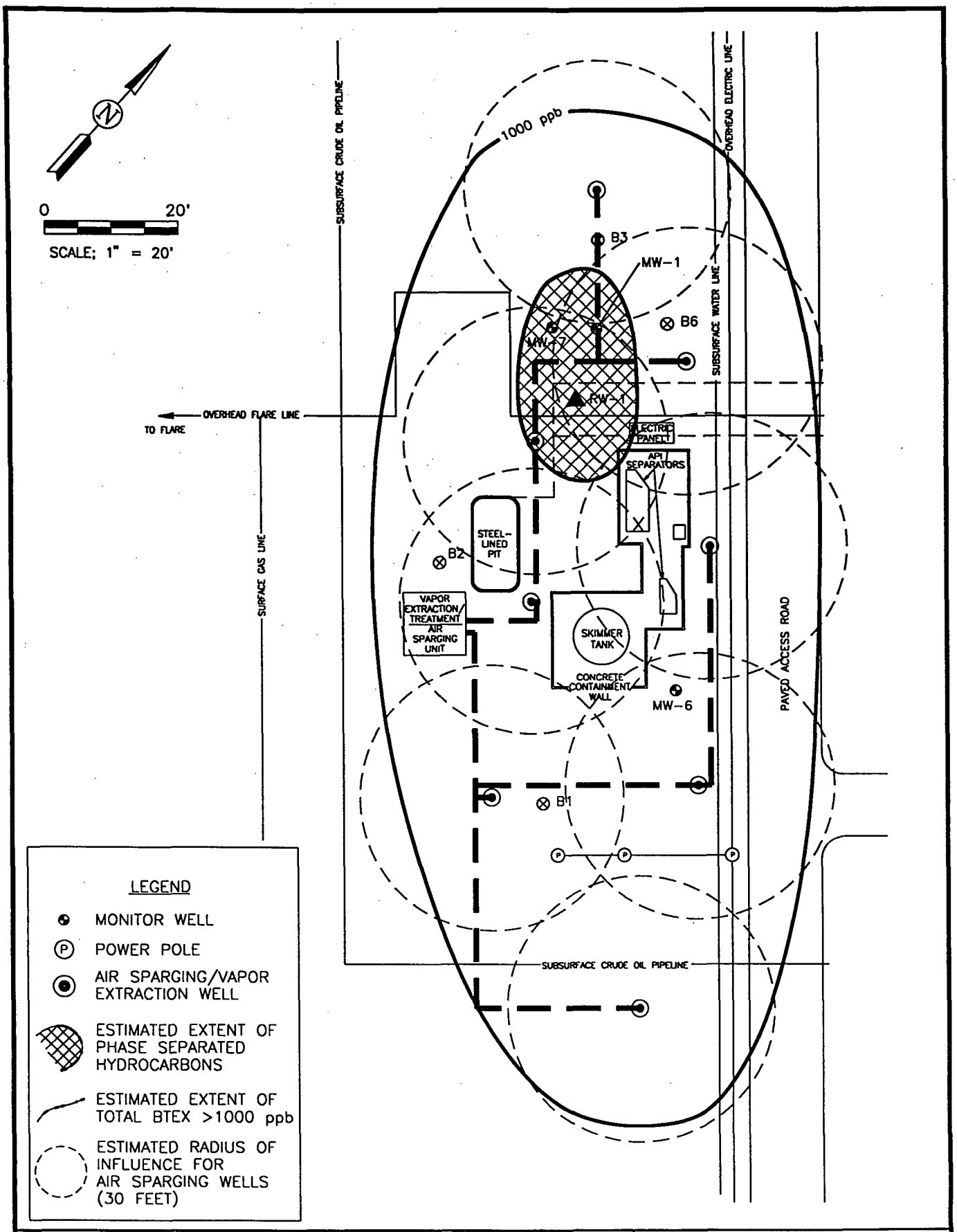

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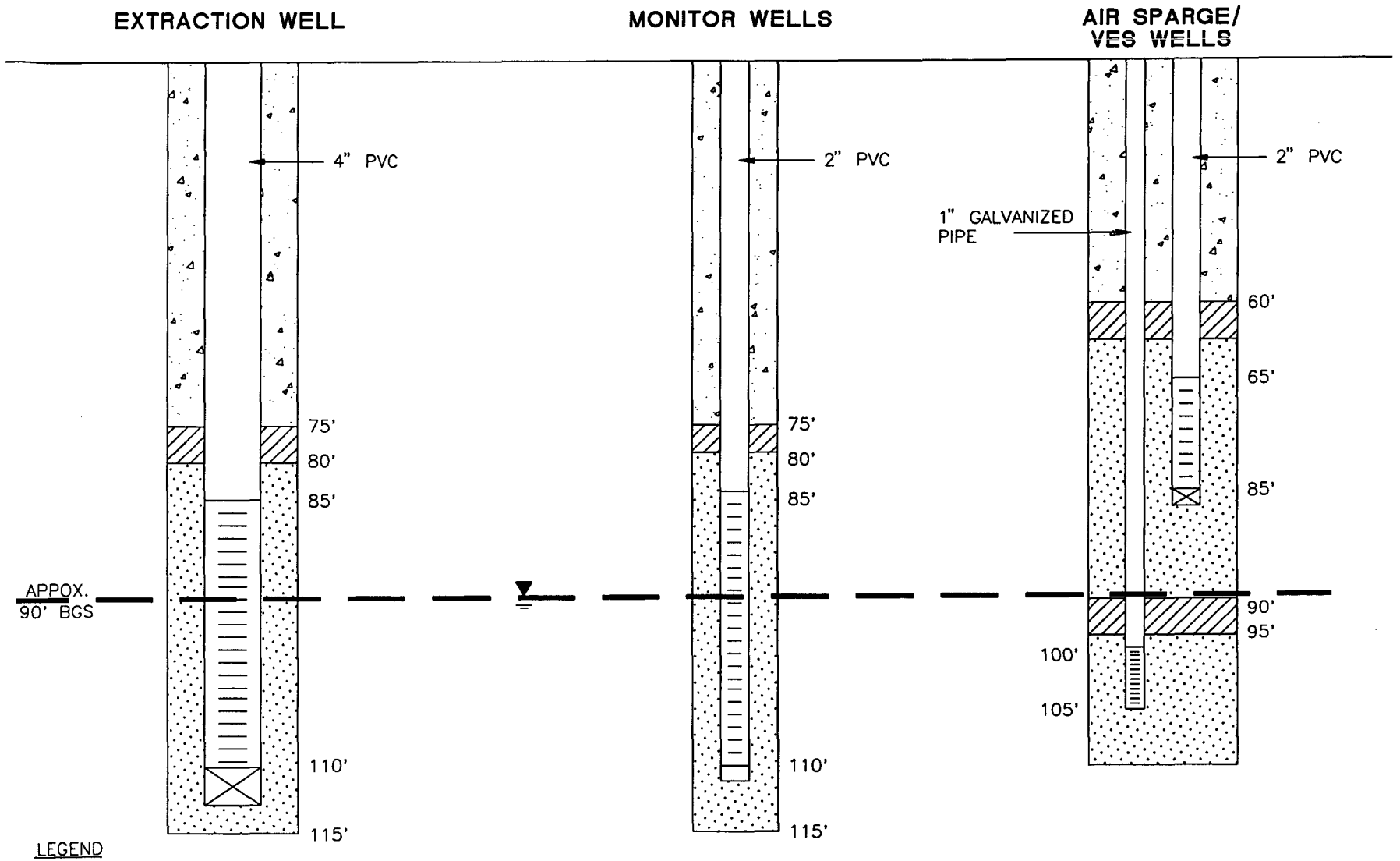
FIGURE 5
PROPOSED REMEDIATION SYSTEM
LOVINGTON REFINERY COMPANY
NAVAJO REFINERY COMPANY



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CK'D BY: BAL	FILE: TYPWCD01

FIGURE 6
TYPICAL
WELL CONSTRUCTION
DIAGRAMS

remove about three to six times more air than is injected to ensure complete capture of vadose zone vapors.

Two banks of four wells each will be connected to a common header prior to entry into the vacuum system. Each well will be equipped with a flow meter, vacuum gage, and valve, all located in a central location for ease of operation and maintenance.

Initial hydrocarbon vapor concentrations will likely exceed the New Mexico Air Quality Board limit of 10 pounds per hour (pph). Consequently, the air stream will be treated using an internal combustion engine/catalytic oxidation treatment unit. It is expected that emissions will drop below 10 pph within three to six months, at which time the treatment unit will be removed and vapors will be vented directly to the atmosphere.

6.4 Monitoring Well Installation

Three 2-inch diameter monitoring wells (MW-8, MW-9, MW-10) will be installed as shown in Figure 3 to better delineate the dissolved-phase plume in downgradient and crossgradient directions. These locations are also ideal for monitoring the performance of the remediation system. Figure 6 shows the typical monitoring well construction.

6.5 Pilot Testing

Each system component will be tested independently prior to system startup to ensure each component of the remediation system performs as expected. Once each component is demonstrated to be operating properly, the entire system will be activated and evaluated closely for one week.

A step-drawdown test will be conducted in recovery well RW-1 to determine the radius of influence, the optimum pumping rate, and well efficiency. The connection to the desalter line will be completed prior to testing. Nearby monitoring wells MW-1, MW-6, and MW-7 will be monitored for drawdown/product thickness during the test.

To determine the site-specific radius of influence for the vapor extraction system, a monitoring well with at least 3 to 5 feet of exposed screen within the vadose zone will be vacuum tested. Vacuum in the nearest three suitable wells will be monitored and analyzed to estimate the radius of influence for a single well. The results will guide the final spacing of sparge wells.

6.6 Installation Schedule

The expected schedule for installing the remediation system is as follows:

Task	Duration
Develop Work Plan/ Client Review	2 weeks
NMOCD Work Plan Approval	3 weeks
Well Installation	2 weeks
Equipment Procurement	2 weeks
Remediation Equipment Installation	1 week
Pilot Testing	1 week
Startup	2 weeks

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7.0 System Operation and Maintenance

GCL will manage the remediation system operation and maintenance, conduct performance monitoring, and report quarterly to the New Mexico Oil Conservation Division (NMOCD).

During the first week of operation, system performance parameters such as water levels, carbon dioxide, dissolved oxygen, air injection pressures/flow rates, vapor extraction vacuum/flow/concentration, and groundwater pumping rate will be monitored.

NRC personnel will be trained in adherence to applicable health and safety plans, on emergency shutdown procedures, and record keeping.

8.0 PERFORMANCE MONITORING

System performance is based on soil vapor and groundwater BTEX concentrations. Soil-vapor samples will be collected from the input and output of the proposed off-gas treatment system.

To provide baseline groundwater chemistry, groundwater samples from monitoring wells MW-1, MW-3, MW-4, MW-6, MW-7, and newly-installed monitoring wells (MW-7, MW-8, MW-9) will be analyzed for BTEX using Environmental Protection Agency (EPA) Method 8020. Water level and product thickness will be collected prior to activating the remediation system.

Based on the preponderance of non-detectable levels for metals, major cations/anions, and PAHs, groundwater samples will be tested for BTEX contaminants only. However, groundwater samples will be analyzed for the biodegradation indicator parameters such as dissolved oxygen, nutrients, sulfate, nitrate, and indigenous bacteria populations.

Three 4-inch diameter PVC monitoring well (MW-7, MW-8, MW-9) will be installed downgradient and crossgradient of the plume to monitor plume concentrations during remediation. Groundwater samples from monitoring wells will be analyzed for BTEX.

The proposed schedule for performance monitoring is as follows:

- Prior to system startup, collect a baseline round of water/product levels and groundwater samples.
- At system startup, record water/product levels and collect vapor samples.
- Collect weekly water/product levels and vapor and groundwater samples during the first month of operation.
- Collect groundwater samples from selected monitoring wells after three months of operation.
- Conduct long-term monitoring by collecting quarterly groundwater and soil samples and water/product levels.

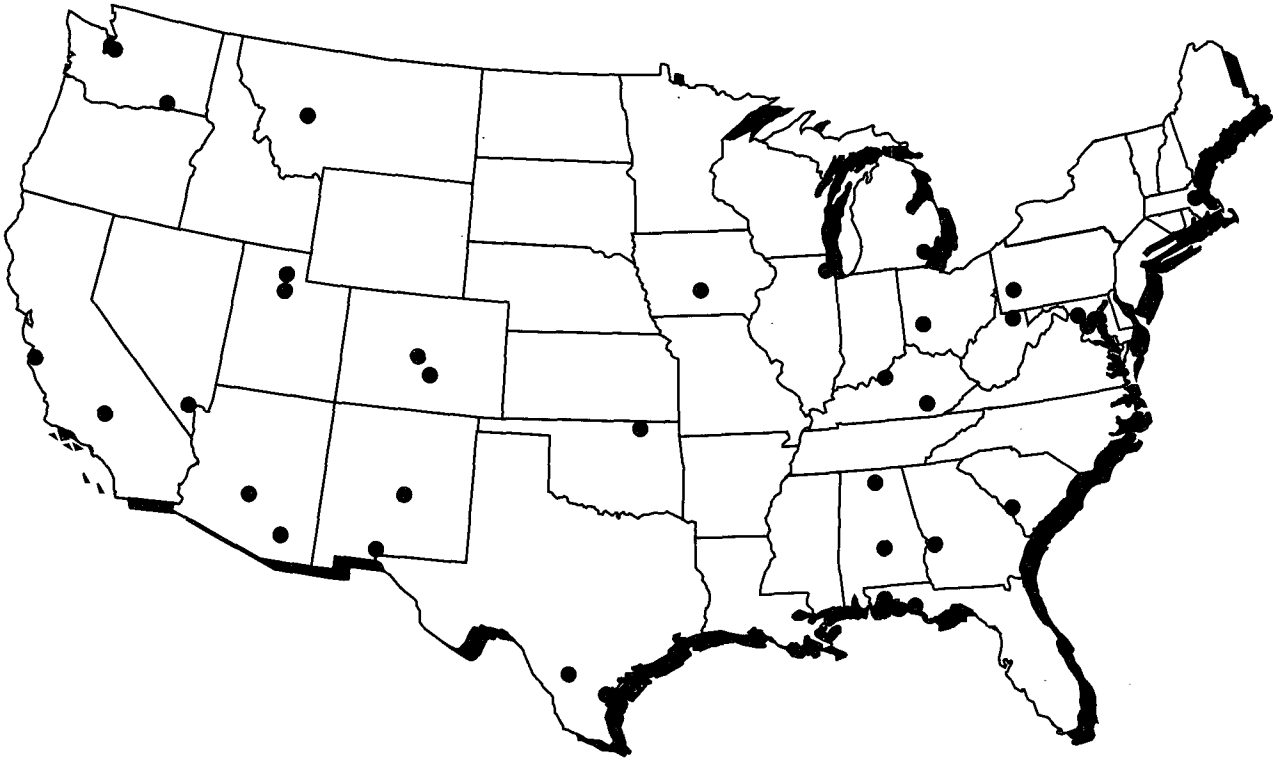
The data collected during remediation will be compared to the baseline data collected prior to activating the system. The comparison allows one to quantify the system performance with regard to petroleum hydrocarbons in groundwater/soil remediation.

It is anticipated that the remediation system will operate for one to two years. After one year of operation, the system performance will be evaluated and recommendations provide to the NMOCD.

9.0 REFERENCES

NMED, 1995. Tank Notes, Vol. 7, No. 4.

Office Locations



UNITED STATES

Montgomery, Alabama
Huntsville, Alabama
Phoenix, Arizona
Tucson, Arizona
Redlands, California
Monterey, California
Denver, Colorado
Colorado Springs, Colorado
Washington, D.C.
Panama City, Florida
Pensacola, Florida
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FOR MORE INFORMATION, CALL 1-800-563-0014

WORK PLAN FOR SOIL AND GROUNDWATER REMEDIATION AT THE NAVAJO REFINING COMPANY LOVINGTON REFINERY

December 12, 1995

Prepared for:

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Tables

1.0 INTRODUCTION

Navajo Refining Company (NRC) proposes this work plan to remediate soil and groundwater at their Lovington Refinery (site) located about five miles southeast of Lovington, New Mexico (Figure 1). After a break in the process sewer junction box (Figure 1) was discovered, the NRC initiated a soil and groundwater investigation in August 1995.

The investigation revealed the presence of residual petroleum hydrocarbons within the vadose zone, phase-separated hydrocarbons (free product) on the water table, and a dissolved-phase hydrocarbon groundwater plume. The refinery was idle from 1984 to early 1991, and the release is expected to have occurred sometime after the startup in early 1991.

In their effort to address this problem, the NRC retained Geoscience Consultants, Ltd. (GCL) to design and install a soil and groundwater remediation system at the site.

The NRC presents this work plan to identify potential receptors, determine the extent of soil and groundwater contamination, review regional and site hydrogeology, develop remedial system design objectives, and present the design, construction, and operation plans for the remediation system.

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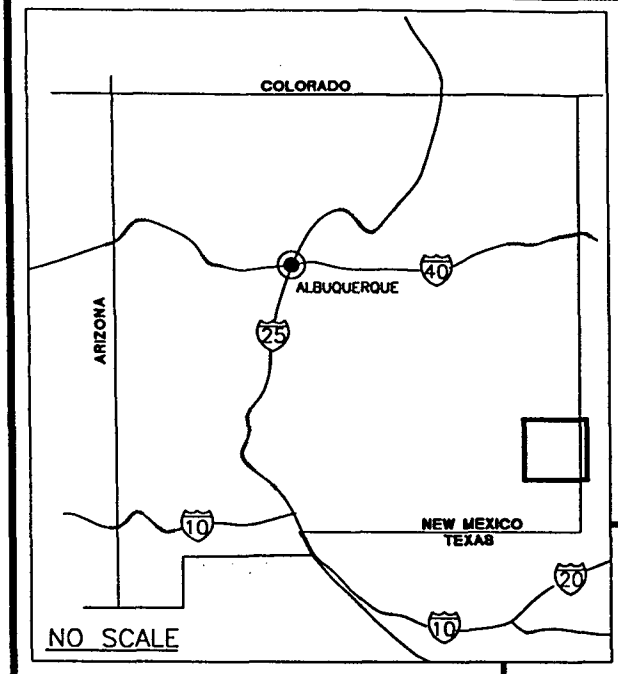
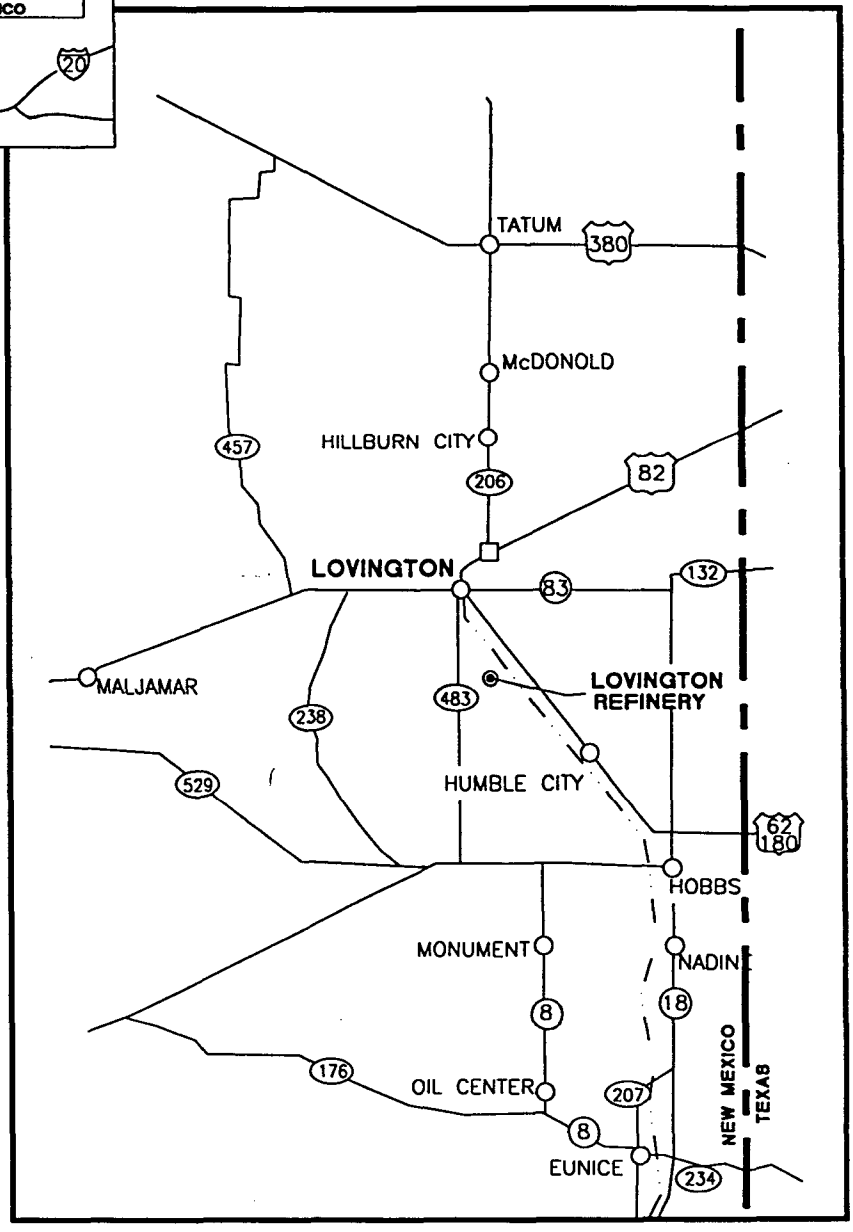


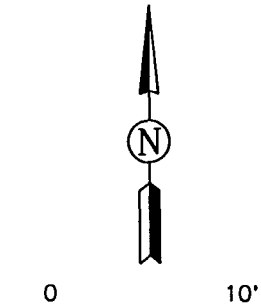
LEGEND

SITE LOCATION

TEXAS AND NEW MEXICO RAILROAD

(LOCATIONS APPROXIMATE)





SCALE : 1" = 10 Miles

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FIGURE 1
SITE LOCATION MAP
LOVINGTON REFINERY
NAVAJO REFINERY COMPANY

2.0 POTENTIAL RECEPTORS

There is no immediate threat to human health as the nearest receptor is the site's own process water supply wells located about 1,000 feet downgradient from the source. A combined total daily flow rate from the two wells is estimated at 350 gallons per minute. This supply is not used for human consumption, as the site drinking water is delivered as bottled water.

City of Lovington water supply wells are located along State Highway 18, southeast of the city. The nearest water supply well, Lovington No. 9, is located near the northeast corner of the site, about 1,500 feet north of the source (Figure 2). These crossgradient wells are not considered potential receptors.

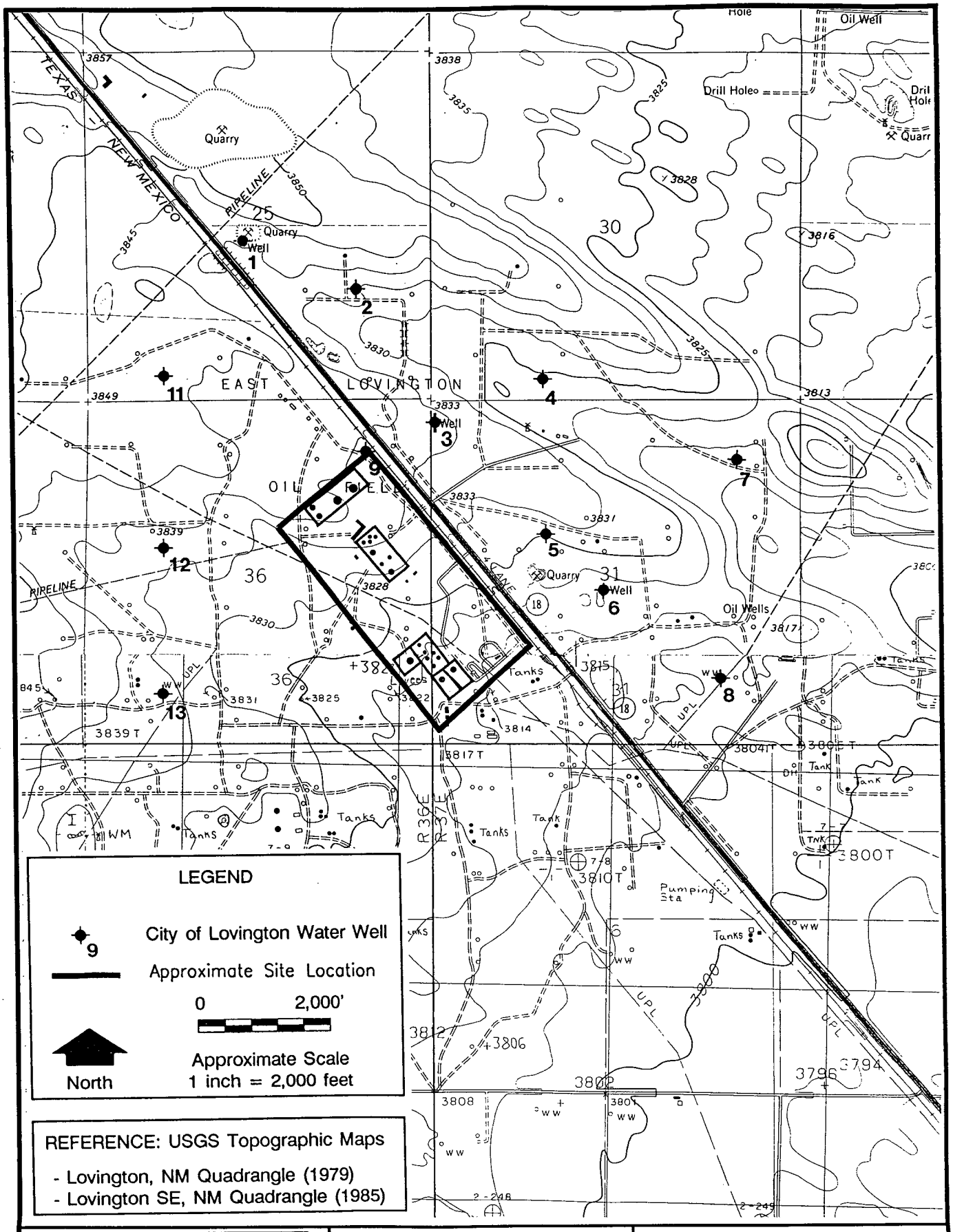

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FIGURE 2
WATER WELL LOCATION MAP
LOVINGTON REFINERY
NAVAJO REFINERY COMPANY

3.0 SITE HYDROGEOLOGIC CONDITIONS

A thorough understanding of the site hydrogeology is the single most important criterion for designing remediation systems. The site is underlain by a well-hardened caliche, from the surface to approximately 14 feet below the surface. The caliche grades into the underlying Pliocene Ogallala Formation (Ogallala Aquifer) of homogeneous fine- to medium-grained sand that contains little or no fines (silts and clays). Based on the soil boring data, these conditions appear to be continuous in the area of contamination.

Groundwater beneath the site occurs within the Ogallala Aquifer at about 90 feet below the ground surface (bgs). Groundwater flows toward the southeast with a slope (hydraulic gradient) of 0.007 feet/foot which is consistent with the regional flow direction in this area of the Ogallala Aquifer (Figure 3). Based on observed lithology during drilling, aquifer hydraulic conductivity is estimated to be about 25 to 75 feet/day. Effective porosity for these types of materials is typically 25 percent. Using this data, groundwater flow velocity is estimated to range from 0.7 to 2.1 feet/day, or about 1 to 2 feet/day. This velocity may be locally influenced by the two site process water supply wells located about 1,000 feet downgradient of the source area.

Water levels at the site have been falling about 1 foot each year, which is consistent with the regional lowering of the Ogallala Aquifer water table. This will influence the remedial design and was taken into consideration in our design.

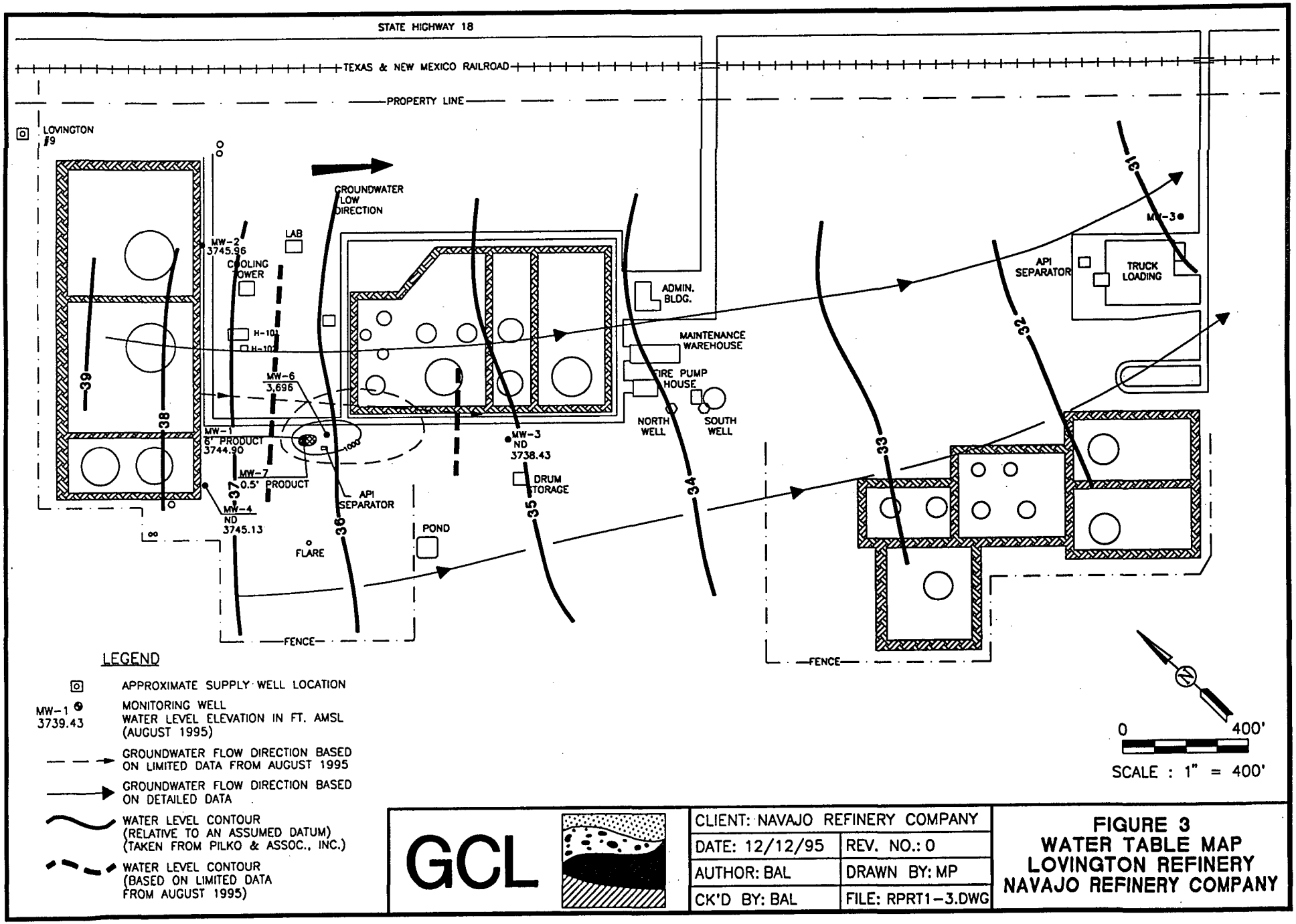

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FIGURE 3
WATER TABLE MAP
LOVINGTON REFINERY
NAVAJO REFINERY COMPANY

4.0 Distribution of Petroleum Hydrocarbons in Soil and Groundwater

The area of soil and groundwater impacted by petroleum hydrocarbons is centered at the source, the desalter line break. The primary constituents of concern are benzene, toluene, ethylbenzene, and xylenes (BTEX). The following sections describe the distribution of hydrocarbons in the subsurface soils and groundwater. In addition to BTEX, major cations/anions, metals, and water quality parameters (pH, total dissolved solids, alkalinity) are discussed.

4.1 Residual Hydrocarbons in Soil

A qualitative field assessment of cuttings from soil borings revealed the presence of residual hydrocarbons entrained within the vadose zone beneath the source. In monitoring wells MW-7 and MW-1 and soil boring B6, residual hydrocarbons were observed from the surface to the water table located about 90 bgs. These locations are within the immediate source area. Residual hydrocarbons were observed in downgradient soil boring B1 from 65 feet bgs to the water table and in B2 from the surface to about 65 bgs. No hydrocarbons were observed in the upgradient soil boring B3 throughout the vadose zone. The areas of impacted soil is limited to immediately beneath the source area.

4.2 Benzene, Toluene, Ethylbenzene, Xylenes and Polynuclear Aromatic Hydrocarbons in Groundwater

The site investigation revealed a limited area of free product on the water table directly below the desalter line break with measured product thicknesses ranging from less than 0.5 feet in MW-7 to about 6 feet in MW-1. The investigation also delineated a dissolved-phase hydrocarbon plume extending about 360 feet downgradient of the source.

Total BTEX concentrations in groundwater range from about 3,700 parts per billion (ppb) in monitoring well MW-6 located near the source area to about 41 ppb in soil boring B5 located near the leading edge of the plume. In a further downgradient monitoring well (MW-3), BTEX is below laboratory detection limits. Table 1 and Figure 4 summarize total BTEX concentrations in groundwater.

PAHs were not detected above Water Quality Control Commission (WQCC) standards in upgradient or downgradient monitoring wells (MW-2 through MW-5). However, naphthalene and mononaphthalenes were detected above the standard of 30 ppb in MW-1 at 94 ppb. Table 2 summarizes the PAH concentrations in groundwater.

4.3 Metals in Groundwater

Groundwater samples analyzed for metals indicated concentrations below New Mexico Water Quality Control Commission (NMWQCC) standards with a few exceptions. MW-1 exceeded standards for barium, iron, and manganese. Most samples were only slightly above standards for arsenic in upgradient and downgradient wells. This suggests a regionally elevated arsenic concentrations in the Ogallala Aquifer, due to natural conditions. A summary of metal concentrations is listed in Table 3.

4.4 Water Quality Parameters

Groundwater samples were also analyzed for major cations/anions, total dissolved solids (TDS), pH, alkalinity, and electrical conductivity. Only MW-1 exceeded WQCC standards for TDS and chloride. Results are summarized in Table 4.

Table 1
BTEX in Groundwater at the Lovington Refinery

TABLE 1. BTEX (µg/L) in Groundwater at the Lovington Refinery

Location	Date	Method	Benzene	Toluene	Ethylbenzene	Total Xylenes	Total BTEX
B3	Sep-95	EPA 602	1,100	341	757	1,000	3,208
B4	Aug-95	EPA 8020	74	21	39	19	153
B5	Sep-95	EPA 8020	41	ND1	ND1	ND1	41
B6	Sep-95	EPA 8020	583	30	87	108	808
B7(MW-6)	Sep-95	EPA 8020	1,741	21	962	972	3,696
B8	Sep-95	EPA 8020	ND1	ND1	ND1	ND1	ND1
B9	Sep-95	EPA 8020	ND1	ND1	ND1	ND1	ND1
MW-3	Jun-95	EPA 8020	ND1	ND1	ND1	ND1	ND1
MW-9	Jun-95	EPA 8020	ND1	ND1	ND1	ND1	ND1
NMWQCC Standards[1]			10	750	750	620	2,130

na = not applicable
ND1 = compound not detected above the detection limit (1 or 2 µg/L)
[1]New Mexico Water Quality Control Commission Human Health Standards
All analyses conducted by Trace Analysis, Inc., Lubbock, TX

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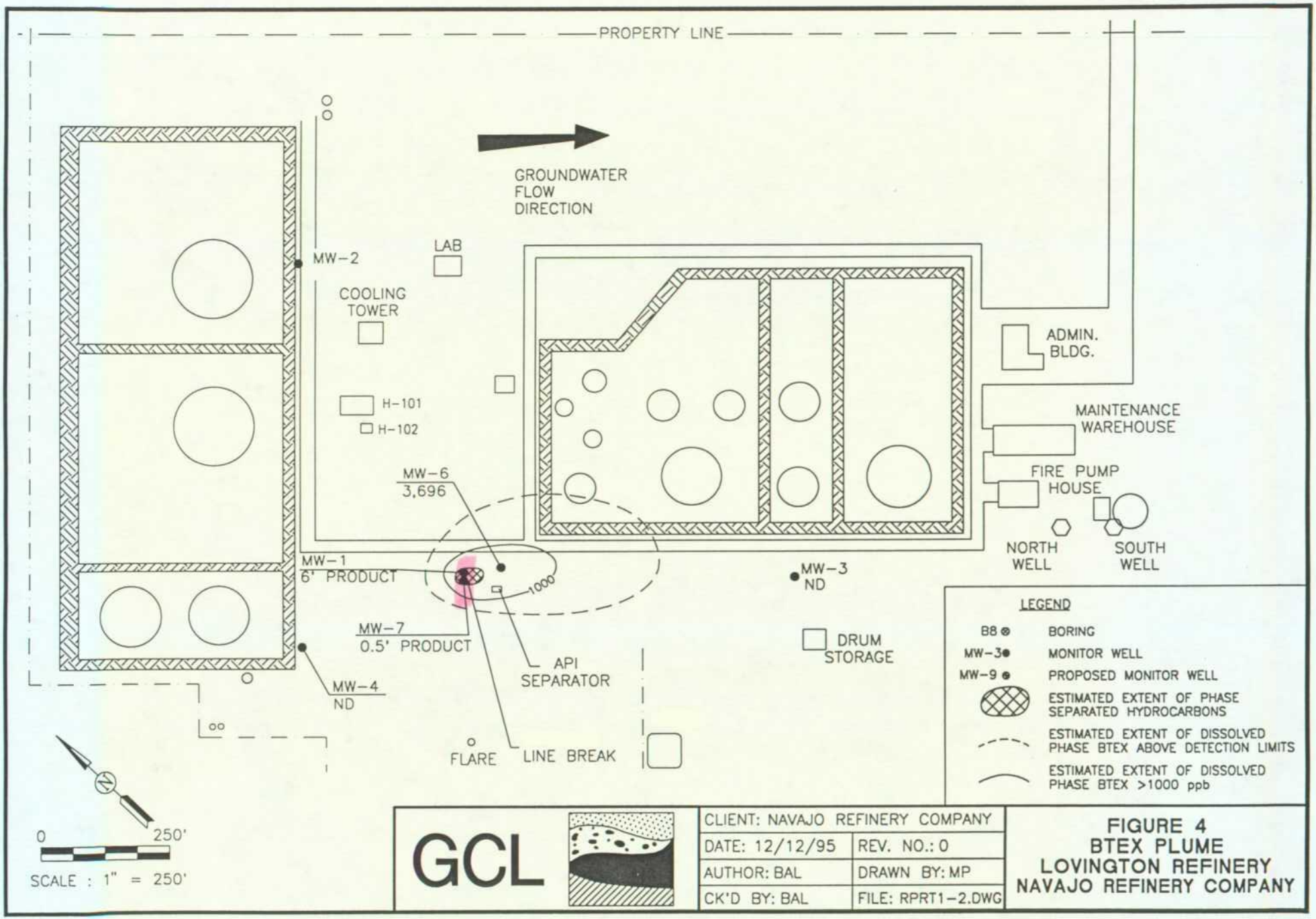

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CLIENT: NAVAJO REFINERY COMPANY	
DATE: 12/12/95	REV. NO.: 0
AUTHOR: BAL	DRAWN BY: MP
CK'D BY: BAL	FILE: RPRT1-2.DWG

FIGURE 4
BTEX PLUME
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NAVAJO REFINERY COMPANY

Table 2
PAHs in Groundwater at the Lovington Refinery

TABLE 2. PAHs (ug/L) in Groundwater at the Lovington Refinery

PAH Compound	MW-1	MW-2	MW-3	MW-4	MW-5	NMWQCC Standards
Acenaphtene	ND10	ND1	ND1	ND1	ND1	na
Acenaphthylene	ND10	ND1	ND1	ND1	ND1	na
Anthracene	11	ND1	ND1	ND1	ND1	na
Benzo(a)anthracene	ND10	ND1	ND1	ND1	ND1	na
Benzo(a)pyrene	ND10	ND1	ND1	ND1	ND1	0.7
Benzo(b)fluoranthene	ND10	ND1	ND1	ND1	ND1	na
Benzo(g,h,i)perylene	ND10	ND1	ND1	ND1	ND1	na
Benzo(k)fluoranthene	ND10	ND1	ND1	ND1	ND1	na
Chrysene	ND10	ND1	ND1	ND1	ND1	na
Dibenz(a,h)anthracene	ND10	ND1	ND1	ND1	ND1	na
Fluoranthene	ND10	ND1	ND1	ND1	ND1	na
Fluorene	10	ND1	ND1	ND1	ND1	na
Indeno(1,2,3-cd)pyrene	ND10	ND1	ND1	ND1	ND1	na
Naphthalene*	94	ND1	ND1	ND1	ND1	30
Phenanthrene	ND10	ND1	ND1	ND1	ND1	na
Pyrene	ND10	ND1	ND1	ND1	ND1	na

na = Not Applicable
ND1 = Compound not detected above the detection limit (1 or 10 µg/L)
EPA Method 625
* includes monomethylnaphthalenes
All analyses conducted by Trace Analysis, Inc., Lubbock, TX

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Table 3
Metals in Groundwater at the Lovington Refinery

TABLE 4. Metals in Groundwater (mg/L) at the Lovington Refinery

Metal Compound	MW-1	MW-2	MW-3	MW-4	MW-5	NMWQCC Standard
Aluminum	1.20	0.50	1.00	0.50	1.80	5
Arsenic	0.50	0.30	ND.2	0.20	0.50	0.1
Barium	2.12	0.12	0.10	0.11	ND.03	1
Beryllium	ND.01	ND.01	ND.01	ND.01	ND.01	1
Boron	0.66	0.25	0.15	0.16	0.26	0.75
Cadmium	ND.02	ND.02	ND.02	ND.02	ND.02	0.01
Chromium	ND.05	ND.05	ND.05	ND.05	ND.05	0.05
Cobalt	ND.03	ND.03	ND.03	ND.03	ND.03	0.05
Copper	ND.02	0.05	ND.02	0.04	0.05	1
Iron	1.38	0.16	0.48	0.46	0.32	1
Lead	ND.001	ND.001	ND.001	ND.001	ND.001	0.05
Manganese	0.39	0.07	ND.01	0.04	0.05	0.2
Mercury	ND.001	ND.001	ND.001	ND.001	ND.001	0.002
Molybdenum	0.10	0.20	0.20	0.10	0.30	1
Nickel	ND.2	ND.2	ND.2	ND.2	ND.2	0.2
Selenium	ND.001	ND.001	ND.003	ND.001	ND.003	0.05
Silver	ND.0001	ND.0001	ND.0001	ND.0001	ND.0001	na
Uranium	ND.5	ND.5	ND.5	ND.5	ND.5	5
Vanadium	ND.05	ND.05	ND.05	ND.05	ND.05	na
Zinc	0.05	ND.02	0.06	0.05	0.04	10

na = Not Applicable
ND0.05 = Compound not detected above the detection limit (0.0001 to 0.5 mg/L)
EPA Methods: 200.7, 239.2, 270.2, 272.2, 245.1
All analysis conducted by Trace Analysis, Inc., Lubbock, TX

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Table 4
Inorganic Groundwater Chemistry at the Lovington Refinery

TABLE 3. Inorganic Groundwater Chemistry (mg/L) at the Lovington Refinery

Location	Date	TDS	pH	Alkalinity (as CaCO3) HCO_3	Alkalinity (as CaCO3) CO_3	Conductivity[3]	Potassium	Magnesium	Calcium	Sodium	Chloride	Fluoride	Sulfate	Nitrate
MW-1	Sep-95	1,275	7.50	349	0	2,007					509	1.20	ND5	ND.15
MW-2	Sep-95	523	7.40	283	0	733	2.30	16.90	133	65.70	61	1.20	105	1.65
MW-3	Sep-95	454	7.80	223	0	618					35	1	93	2.54
MW-4	Sep-95	438	7.90	254	0	590					23	1	88	1.19
MW-5	Sep-95	853	7.20	230	0	1,089	3	23.60	196	82.40	198	0.70	119	1.49
NMWQCC Standards[1]:		1000	6 to 9	na	na	na	na	na	na	na	250	1.6	600	10^2

na = not applicable
ND5 = Compound not detected above the detection limit (5 mg/L)
[1] New Mexico Water Quality Control Commmission Water Supply Standards
[2] Nitrate as N
[3] Conductivity reported in units of FOHMs/cm
All analyses conducted by Trace Analysis, Inc., Lubbock, TX

5.0 REMEDIATION DESIGN OBJECTIVES

The objectives of the proposed remediation system for the Lovington Refinery include:

- Remove residual hydrocarbons within the vadose zone beneath the source area.
- Remove free product from the water table beneath the source area.
- Remediate groundwater that contains dissolved-phase hydrocarbons with a total BTEX concentration of 1,000 ppb or greater.
- Enhance natural intrinsic bioremediation to remediate the remaining downgradient portion of the dissolved-phase hydrocarbon plume.

To achieve these objectives, GCL selected the following combination of remediation technologies:

- Pump-and-treat system for free product and high-BTEX groundwater removal beneath the source area.
- Air sparging/vapor extraction system to remediate the high-BTEX groundwater and the vadose zone near the source.

Residual hydrocarbons in soil, free product, and high-BTEX groundwater are long-term sources of hydrocarbons for groundwater. Source removal is a key element in this remediation system design. Free product and high-BTEX groundwater will be removed using a submersible total fluids pump installed within a recovery well installed at the source.

Air sparging/vapor extraction is most effective in uniform, coarse-grained material, with little or no fines, similar to site conditions. This approach injects hydrocarbon-free compressed atmospheric air into the aquifer beneath contamination. Air injection creates an inverted cone of bubbles or discrete "air tubes" below the water table that advance toward the surface. Hydrocarbons dissolved in the groundwater and sorbed onto soil particles are essentially stripped into the gaseous phase by the rising air, break through at the water table, and are removed from the vadose zone by the vapor extraction system.

The portion of the plume not actively remediated (BTEX <1,000 ppb) will attenuate naturally but with some enhancement to encourage biodegradation of the hydrocarbons. Attenuation will occur by both enhanced intrinsic bioremediation and dilution (dispersion/mixing).

Intrinsic bioremediation of hydrocarbons without the addition of any nutrients into the subsurface. Enhanced intrinsic bioremediation is when oxygen and/or other nutrients are added to the aquifer within or upgradient of the plume. This effectively increases growth of naturally occurring bacteria which accelerates the rate at which hydrocarbons are biodegraded. Enhancement will occur by the movement of oxygenated groundwater from the upgradient sparged groundwater flowing into low-oxygen downgradient areas.

Based on the experience of the New Mexico Environment Department (NMED), intrinsic bioremediation works best in homogenous and permeable aquifers, single-source plumes, low groundwater gradients, absence of free product/soil contamination, and where hydrocarbon concentrations are 40,000 ppb or less (NMED, 1995). Most of these conditions are met for that portion of the plume not actively remediated.

6.0 System Design and Installation

The remediation system for the Lovington Refinery consists of a total fluids pumping for source removal and air sparge/ vapor extraction to promote cleanup of the groundwater. The system focuses on aggressive physical removal while simultaneously stimulating naturally occurring hydrocarbon degrading bacteria.

6.1 Total Fluids Pumping

To aggressively remove the source, free product and high-BTEX groundwater, a submersible total fluids pump will be installed in a 4-inch recovery well (RW-1), located just downgradient of MW-1 (Figure 5). The well will be installed to about 15 feet below the present water table, about 115 feet bgs.

The total fluids will be pumped to an existing facility tank. The conveyance line will contain a shut-off valve, totalizing meter, flow meter, and sampling port. Drawdown calculations indicate a pumping rate of about 20 gallons per minute (gpm) will produce a cone of depression sufficient to draw free product/ high-BTEX groundwater into the well.

The total fluids pumped will undergo treatment including product recycling. The treated water is released to the Lovington publicly operated treatment works along with site discharge water. It is expected that existing refinery treatment processes are adequate to treat the total fluids waste stream.

6.2 Air Sparging System

The area of the dissolved-phase plume with total BTEX of about 1,000 ppb or greater is shown on Figures 3 and 4. Based on GCL's experience, a single air sparging well is expected to have a 30-foot radius of influence in the materials observed beneath the site. Consequently, eight sparging wells will provide the necessary coverage to remediate groundwater with 1,000 ppb of BTEX or greater as depicted in Figure 5.

Each sparging well cluster will be constructed with a sparge point installed below the groundwater plume (estimated at about 10 to 15 feet below the water table) and a screened section within the vadose zone for soil-vapor extraction. A 1-inch diameter HDPE pipe delivers compressed filtered atmospheric air into the aquifer through the submerged sparge point. It is estimated that each sparge point will deliver 5 to 10 cubic feet per minute (cfm), operating at 12 psi.

Dedicated piping will be used for each sparge point to allow for fine-tuning the sparging system. Each sparge line will house a valve, flow meter, and pressure gage.

In addition to the air-stripping action within the aquifer, air injection also increases the dissolved oxygen content which stimulates naturally occurring microbes present in the aquifer. This will cause greater biodegradation of hydrocarbons than would occur naturally.

6.3 Vapor Extraction System

Vadose zone vapors will be extracted through 2-inch diameter Schedule 80 PVC pipe and 10- to 20-foot long screens installed within the vadose zone about 2 to 3 feet about the water table. Longer, or multiple, screens will be used in the source area to remove residual hydrocarbons observed from the surface to the water table. A blower operating at 60 psi will remove 15 to 30 cfm from each well. Typical

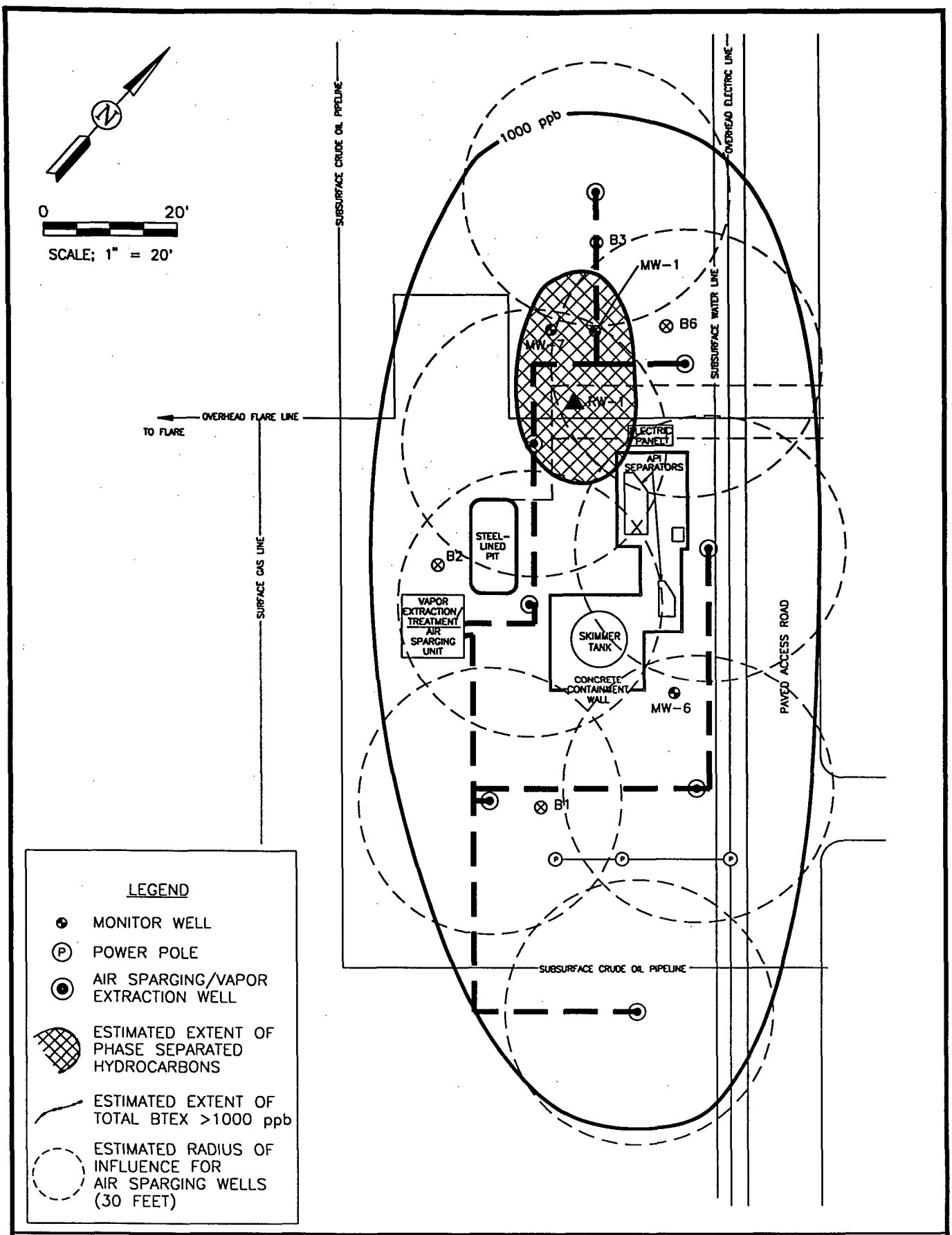

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FIGURE 5
PROPOSED REMEDIATION SYSTEM
LOVINGTON REFINERY COMPANY
NAVAJO REFINERY COMPANY

designs remove about three to six times more air than is injected to ensure complete capture of vadose zone vapors.

Two banks of four wells each will be connected to a common header prior to entry into the vacuum system. Each well will be equipped with a flow meter, vacuum gage, and valve, all located in a central location for ease of operation and maintenance.

Initial hydrocarbon vapor concentrations will likely exceed the New Mexico Air Quality Board limit of 10 pounds per hour (pph). Consequently, the air stream will be treated using an internal combustion engine/catalytic oxidation treatment unit. It is expected that emissions will drop below 10 pph within three to six months, at which time the treatment unit will be removed and vapors will be vented directly to the atmosphere.

6.4 Monitoring Well Installation

Three 4-inch diameter monitoring wells (MW-7, MW-8, MW-9) will be installed as shown in Figure 3 to better delineate the dissolved-phase plume in downgradient and crossgradient directions. These locations are also ideal for monitoring the performance of the remediation system.

6.5 Pilot Testing

Each system component will be tested independently prior to system startup to ensure each component of the remediation system performs as expected. Once each component is demonstrated to be operating properly, the entire system will be activated and evaluated closely for one week.

A step-drawdown test will be conducted in recovery well RW-1 to determine the radius of influence, the optimum pumping rate, and well efficiency. The connection to the desalter line will be completed prior to testing. Nearby monitoring wells MW-1, MW-6, and MW-7 will be monitored for drawdown/product thickness during the test.

To determine the site-specific radius of influence for the vapor extraction system, a monitoring well with at least 3 to 5 feet of exposed screen within the vadose zone will be vacuum tested. Vacuum in the nearest three suitable wells will be monitored and analyzed to estimate the radius of influence for a single well. The results will guide the final spacing of sparge wells.

6.6 Installation Schedule

The expected schedule for installing the remediation system is as follows:

Task	Duration
Develop Work Plan/ Client Review	2 weeks
NMOCD Work Plan Approval	3 weeks
Well Installation	2 weeks
Equipment Procurement	2 weeks
Remediation Equipment Installation	1 week
Pilot Testing	1 week
Startup	2 weeks

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7.0 System Operation and Maintenance

GCL will manage the remediation system operation and maintenance, conduct performance monitoring, and report quarterly to the New Mexico Oil Conservation Division (NMOCD).

During the first week of operation, system performance parameters such as water levels, carbon dioxide, dissolved oxygen, air injection pressures/flow rates, vapor extraction vacuum/flow/concentration, and groundwater pumping rate will be monitored.

NRC personnel will be trained in adherence to applicable health and safety plans, on emergency shutdown procedures, and record keeping.

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8.0 PERFORMANCE MONITORING

System performance is based on soil vapor and groundwater BTEX concentrations. Soil-vapor samples will be collected from the input and output of the proposed off-gas treatment system.

To provide baseline groundwater chemistry, groundwater samples from monitoring wells MW-1, MW-3, MW-4, MW-6, MW-7, and newly-installed monitoring wells (MW-7, MW-8, MW-9) will be analyzed for BTEX using Environmental Protection Agency (EPA) Method 8020. Water level and product thickness will be collected prior to activating the remediation system.

Based on the preponderance of non-detectable levels for metals, major cations/anions, and PAHs, groundwater samples will be tested for BTEX contaminants only. However, groundwater samples will be analyzed for the biodegradation indicator parameters such as dissolved oxygen, nutrients, sulfate, nitrate, and indigenous bacteria populations.

Three 4-inch diameter PVC monitoring well (MW-7, MW-8, MW-9) will be installed downgradient and crossgradient of the plume to monitor plume concentrations during remediation. Groundwater samples from monitoring wells will be analyzed for BTEX.

The proposed schedule for performance monitoring is as follows:

- Prior to system startup, collect a baseline round of water/product levels and groundwater samples.
- At system startup, record water/product levels and collect vapor samples.
- Collect weekly water/product levels and vapor and groundwater samples during the first month of operation.
- Collect groundwater samples from selected monitoring wells after three months of operation.
- Conduct long-term monitoring by collecting quarterly groundwater and soil samples and water/product levels.

The data collected during remediation will be compared to the baseline data collected prior to activating the system. The comparison allows one to quantify the system performance with regard to petroleum hydrocarbons in groundwater/soil remediation.

It is anticipated that the remediation system will operate for one to two years. After one year of operation, the system performance will be evaluated and recommendations provide to the NMOCD.

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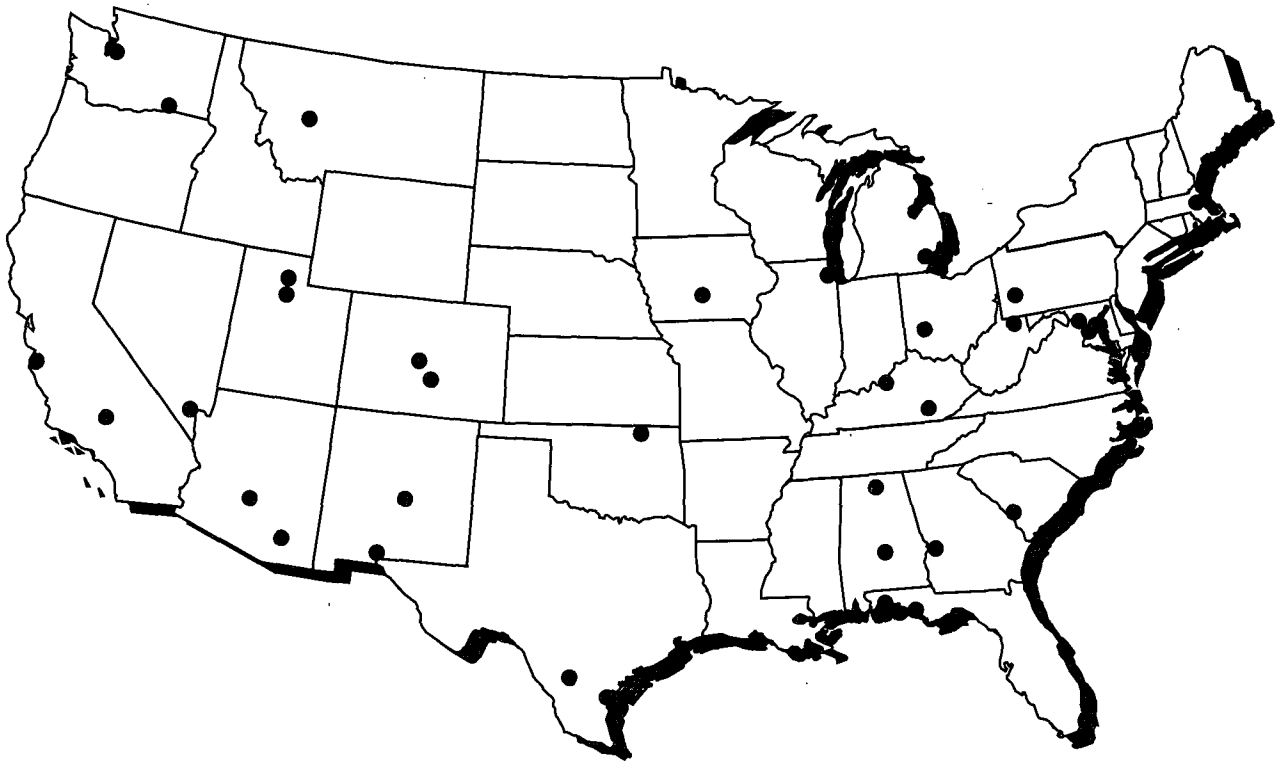
9.0 REFERENCES

NMED, 1995. Tank Notes, Vol. 7, No. 4.

Office Locations



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